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A Novel Geometry of Multiband Planar Antenna for Wireless Applications

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ABSTRACT

The compact multiband antenna is of practical interest for the fast growing modern communication industry. In this regard radiation performance of modified rectangular multiband antenna, designed on FR-4 substrate is proposed in this paper. The geometry is operating at three different frequencies in the considered range of 4-6 GHz and offers excellent matching with the feedline for each resonant frequency.

KEYWORDS: *multiband, return loss, bandwidth and VSWR*

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1. INRODUCTION

Microstrip antennas have become very popular for wireless applications, because they present numerous advantages over conventional antenna. These include easily conformable to non-planar surfaces, inexpensive to manufacture in large quantities using modern printed circuit techniques and mechanically robust [1-4]. Disadvantages of the microstrip antenna include smaller bandwidth, presence of surface wave, poor polarization purity, limited power capacity and tolerance problem. Despite the disadvantages the advantages of microstrip antennas have led to their use in many applications in civilian, military and telecommunication systems. The microstrip antenna may act as a filter for narrow band applications to stop unwanted frequency components. [5].

The fast growth of electronics and wireless communications led to great demand for compact sized devices that can operate at different frequencies. Microstrip antenna has come up as potential candidate meeting these two requirements and recently lot of research is going on to design microstrip antenna for multiband operation. Various techniques to design multiband microstrip antennas have been reported, which include stacked parasitic elements, antenna arrays, use of different ground structure and genetic algorithm to optimize patch geometry [6-11]. The use of slot is also one of the methods to obtain multiband performance. The slot can have virtually any shape. Generally, the slot antennas are bidirectional, that is, they radiate on both sides of the slot. When slots are embedded, the resonant features of the microstrip patch antenna changes. When slits is introduced to the patch, the path of the current becomes more and hence it changes the radiation parameters of the microstrip patch antenna [5]. PIFA designs with multi bands have been reported in [12-13]. In [14] quadruple bands have been achieved using monopole radiator and authors in [15] have proposed a loop structure mixed with monopole to accomplish multi bands for communications.

In this paper a multiband geometry is presented operating at three different frequencies in the considered range of 4-6 GHz. The design is fabricated using FR-4 substare and simulated and measured results are found to be in good agreement with each other.

2. Antenna Geometry

Initially, the rectangular patch is considered with dimensions 20×30 mm. The considered simple rectangular geometry is simulated by using IE3D simulation software [16]. The patch is etched on a dielectric substrate of relative dielectric constant ε_r = 4.4 and thickness h=1.59 mm. The patch is excited by a coaxial probe having 50 ohm impedance and radius of 0.62 mm. The simulated variation of reflection coefficient for rectangular patch antenna with frequency of antenna reveals that in the frequency range 3 to 4 GHz, antenna resonates at a single frequency 3.356 GHz at reflection coefficient of -32.18 dB as shown in figure 2. The simulated impedance bandwidth (corresponding to -10dB return loss) with respect to central frequency 3.356 GHz is 112 MHz or 3.33%. The VSWR corresponding to resonating frequency is 1.07 which shows good matching between antenna and feedline as shown in figure 3.

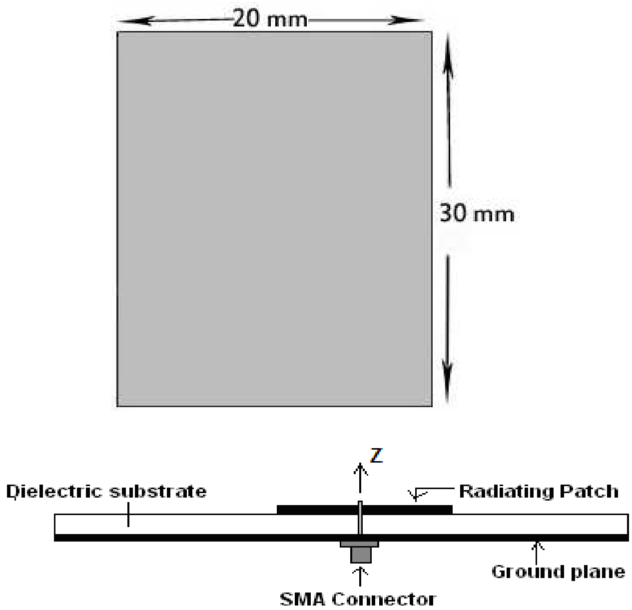

Figure1. Top and side view of simple rectangular geometry.

However, the antenna in present form is resonating at single frequency only and is not suitable for multiband operation. Therefore, the rectangular antenna is modified by cutting slits in the geometry. The design and performance of modified geometry is discussed in the next section.

3. Modified Rectangular Geometry with slits and slot

The layout of the proposed structure is shown in figure 4. The rectangular patch is modified by introducing 4 slits of dimensions 0.7×10mm along the y axis and 6×0.7mm along the x axis of the patch as shown in figure 4. The simulated variation of reflection coefficient with respect to frequency is shown in figure 5 which signify that antenna now has resonant frequency of 5.35 GHz and 5.78 GHz. The resonance frequencies of this modified antenna are higher as compared to rectangular geometry discussed in the preceding section (3.35 GHz) perhaps due to excitation of different mode due to introduction of slits. As shown in figure 6, the simulated VSWR value at the resonant frequencies is 1.08 and 1.23 which shows still fine matching between antenna and probe feed. The bandwidth of antenna is now increased to 13.56% which is more than thrice of earlier reported simple rectangular patch geometry.

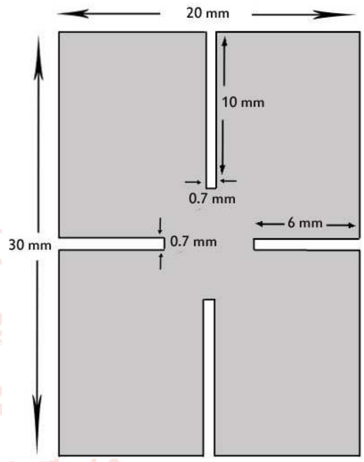

Figure4. Top view of modified geometry with four slits

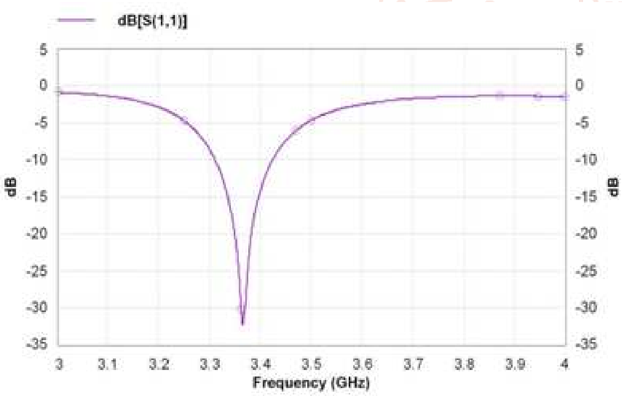

Figure2. Variation of simulated return loss as a function of frequency for simple rectangular patch

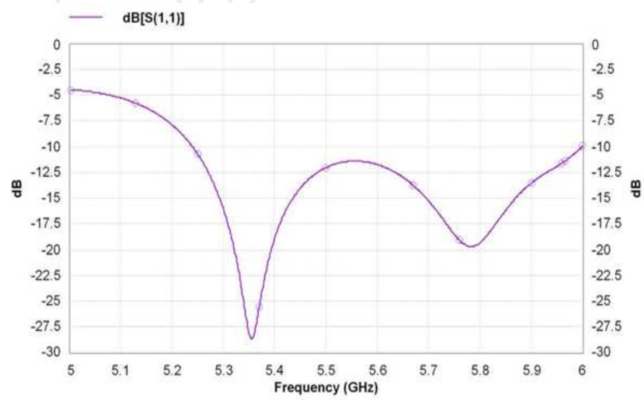

Figure5.Variation of simulated return loss as a function of frequency for modified geometry

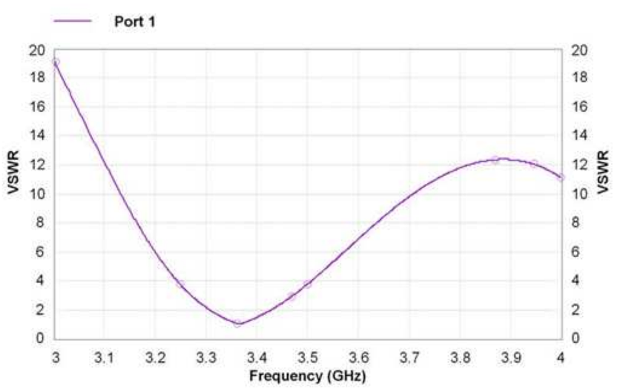

Figure3. Variation of simulated VSWR as a function of frequency for simple rectangular patch

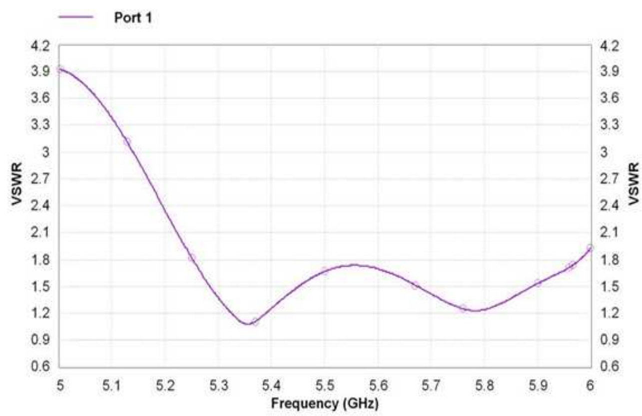

Figure6. Variation of simulated VSWR as a function of frequency for modified geometry

On introducing a circular slot in the modified geometry with four slits as shown in figure 7(a), the multiband behaviour of antenna is observed and the simulated resonant frequencies of geometry as shown in figure 8 are 4.81 GHz, 5.20 GHz and 5.62 GHz. The VSWR values at three resonating frequencies are approaching to unity (1.02, 1.04 and 1.02 respectively) which signify that antenna geometry has excellent match with the coaxial feed line. The input impedance related to three resonant frequencies are (49.411+j0.819) ohm, (47.84+j0.856) ohm and (49.598+j0.908) ohm respectively which are nearly reaching to 50 ohm impedance of the coaxial feed line.

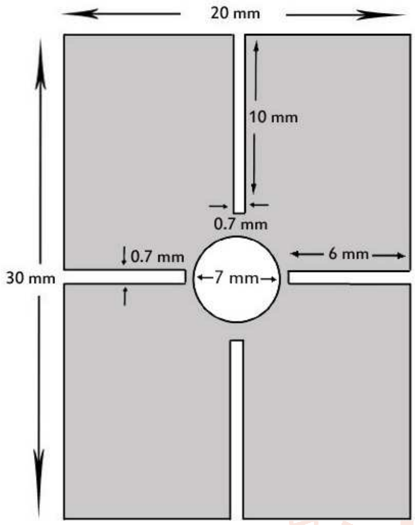

Figure7. Top view of proposed geometry

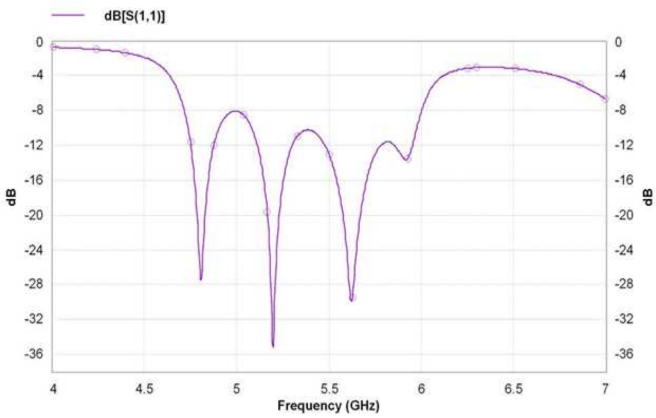

Figure8. Variation of simulated return loss as a function of frequency for proposed geometry

4. Conclusion

In this paper, the modified geometry of rectangular microstrip antenna with slits and slot for multiband operation is presented. It is difficult to obtain multiband performance using conventional rectangular shaped microstrip antenna since bands are dictated by the mode distribution. To overcome this problem, slots and slits have been introduced. The position and size of slits and slot along with location of feed position are optimized to obtain best results. Due to its multiband behaviour and compact size, it can be useful for various communication applications.

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