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Design of a Dual Band Rectangular Microstrip Antenna

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Abstract
The objective of the paper is to design and investigate a rectangular microstrip antenna that covers the band from 2.4 to 3.6 GHz. The proposition consolidates investigation of fundamentals of microstrip patch antenna. A progression of simulation in Ansoft HFSS (High Frequency System Simulation) has been carried out to discover the dual operating frequency. The qualities of the patch antenna rely on its different geometrical parameters. The investigation is carried in terms of two prime factors: Return loss and radiation pattern.

Keywords- Microstrip antenna, Dual band, Return loss, Bandwidth

1. Introduction

A microstrip antenna is of low profile and low weight (Garg et al., 2001). It is basically a narrowband antenna that can be made effectively on the printed circuit board. Here a metallic layer in a specific shape is reinforced on a dielectric substrate, which frames a transmitting component and another persistent metallic layer on the opposite side of as ground plane (Mishra, 2016). Any persistent shape can be utilized as the transmitting patch. Microstrip antennas are mechanically rough and can be effortlessly mounted on any surfaces. The span of the microstrip antenna is identified with the operating frequency. The utilizations of microstrip antennas are more over the microwave frequency (Coulibaly et al., 2008) because of their geometry and sharp resonance. At frequencies lower than a microwave, microstrip antenna fails to synchronize well on account of the sizes required. Microwave frequency accounts for the frequency greater than 1 GHz.

A symmetric presentation of the microstrip antenna is shown in Fig. 1. Here two metallic layers and a dielectric layer form the important part of the basic antenna. These three layers are transmitting plane, confined plane and ground plane. Copper makes it very easy and comfortable to design the conducting layers (Mishra et al., 2016). The shape of the microstrip antenna can be square, rectangular, dipole, triangular, curved or some fundamental shapes (Su et al., 2005). For the ease of design and simplicity, rectangular shape is chosen in this paper. The dielectric constant of the confining layers is in between 2.4 and 12.1. In our paper, we choose this value as 4.4 (Mishra et al., 2016). This is the dielectric constant of FR4. This is most easy in availability and also the cheapest one.

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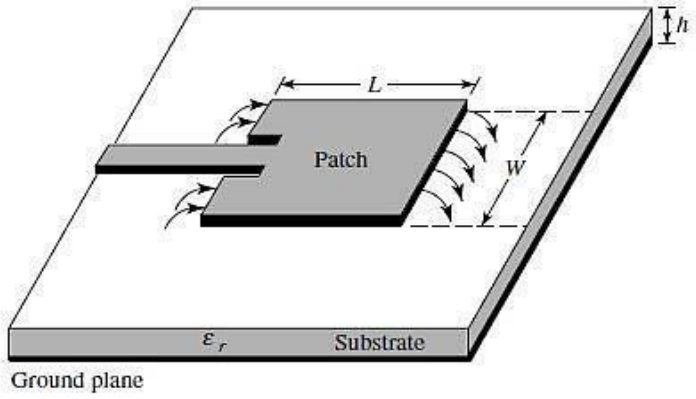

Fig. 1. Microstrip patch antenna

2. Antenna Dimension and Result

In a rectangular microstrip antenna its dimension is primary factors for effective radiation. The dimensions are its length and width.

The effective Length (L) and Width (W) of the antenna are given as (Balanis, 2012):

$$L = c/f_r = \frac{c}{2f_r\sqrt{\varepsilon_r}}$$

$$W = \left(\frac{c_0}{2f_r}\right)\left(\frac{\varepsilon_r+1}{2}\right)^{-1/2}.$$

Here, f_r is the operating resonant frequency and $\mathcal{E}_r$ is the dielectric constant.

At 2.4 GHz (the main resonant frequency), the two dimensional planer representation of the antenna is shown in Fig. 2, whereas the different dimensions are shown in Table 1.

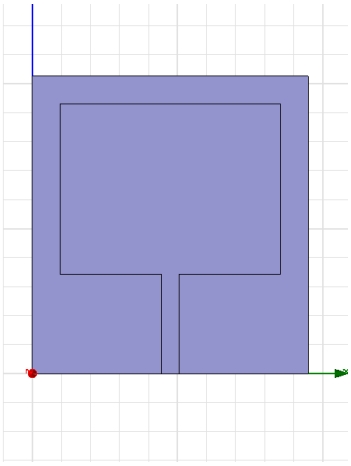

Fig. 2. Simulated structure of antenna

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Table 1. Dimension of rectangular microstrip antenna

S. No.	Parameters	Value (in mm)
1	Height of substrate	1.58
2	Length of substrate	51.29
3	Width of substrate	47.49
4	Length of ground plane	51.29
5	Width of ground plane	47.0
6	Thickness of ground plane	0
7	Origin of radiation box	-5, -5, -5
8	Length of radiation box	61.29
9	Width of radiation box	57.49
10	Thickness of radiation box	11.58
11	Origin of port	22.23, 0, 0
12	Thickness of port	1.58
13	Width of port	3.02
14	Origin of patch	4.74, 17.12, 1.58
15	Length of patch	29.43
16	Width of patch	38.01
17	Position of feed line	22.23, 0, 1.58
18	Length of feed line	17.12
19	Width of feed line	3.02

The resonant frequency plot (return loss) is shown in Fig. 3. It is clear from the figure that it is single band antenna. A rectangular structure contained from the set of dimension equation results in a single band.

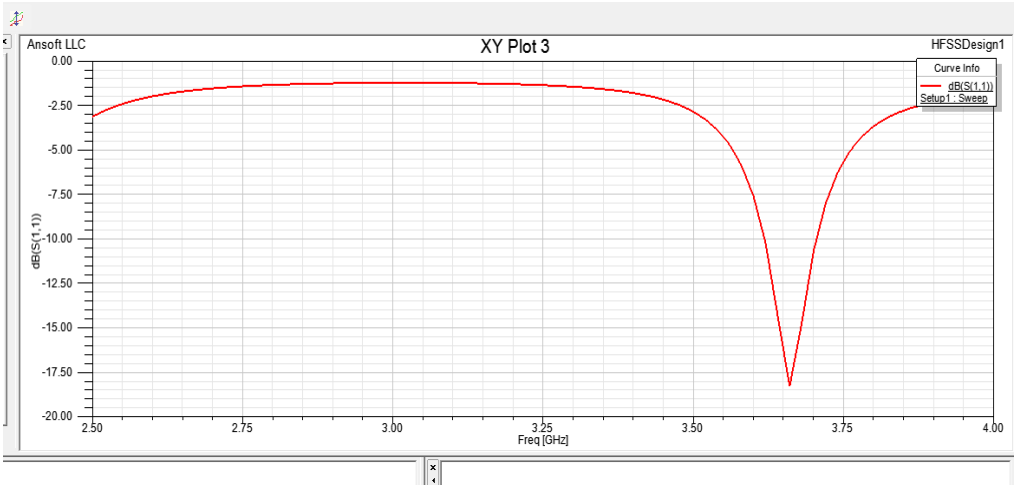

Fig. 3. Return loss of antenna

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In the final step one rectangular cut (slot) is carve don the patch (rectangular front structure). The systematic diagram and dimensions are shown in Fig. 4 and Table 2 respectively.

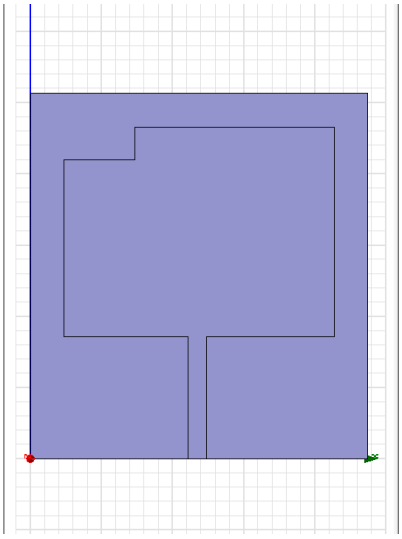

Fig. 4. Antenna (final) with a rectangular slot

Table 2. Dimension of final antenna

S. No.	Parameters	Value (in mm)
1	Height of substrate	1.58
2	Length of substrate	51.29
3	Width of substrate	47.49
4	Length of ground plane	51.29
5	Width of ground plane	47.0
6	Thickness of ground plane	0
7	Origin of radiation box	-5, -5, -5
8	Length of radiation box	61.29
9	Width of radiation box	57.49
10	Thickness of radiation box	11.58
11	Origin of port	22.23, 0, 0
12	Thickness of port	1.58
13	Width of port	3.02
14	Origin of patch	4.74, 17.12, 1.58
15	Length of patch	29.43
16	Width of patch	38.01
17	Position of feed line	22.23, 0, 1.58
18	Length of feed line	17.12
19	Width of feed line	3.02
20	Position of slot	4.74, 46.55, 1.58
21	Length of slot	-4.55
22	Width of slot	10

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The rectangular slot creates a capacitive effect and produced one more resonance. Thus the final antenna ha s2 resonance of frequencies. These two produces the desired dual band.

The return loss plot of the final antenna showing the two bands is shown in Fig. 5.

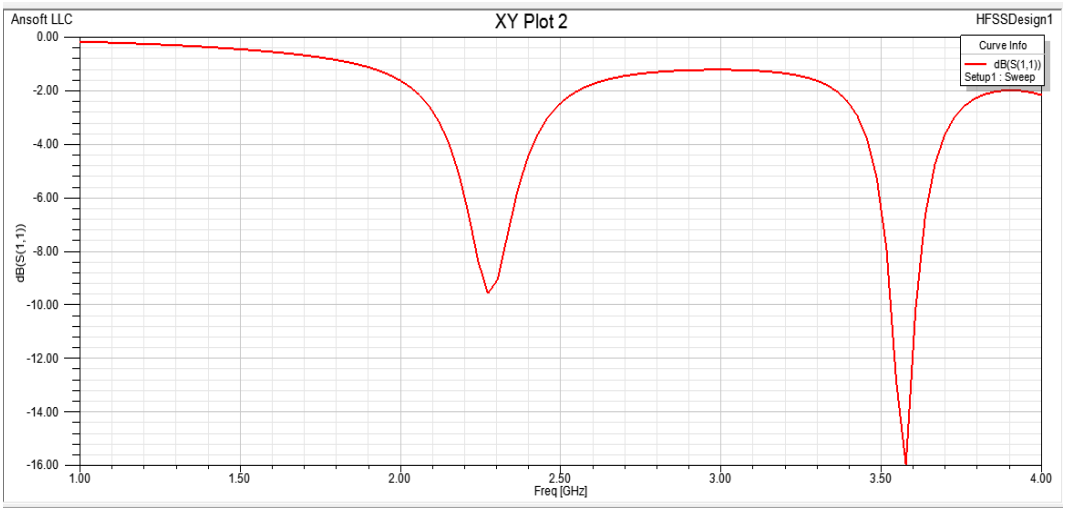

Fig. 5. Return loss of Final Antenna.

The radiation pattern is shown in Fig. 6. It has two lobes resulting from the two bands.

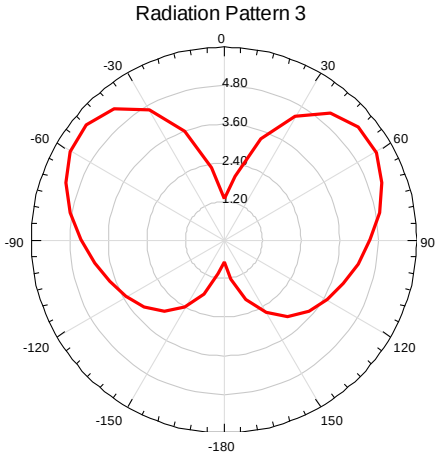

Fig. 6. Radiation pattern of final antenna

3. Conclusion

A rectangular microstrip antenna showing resonance operation at dual band antenna has been designed and presented. The antenna supports a good dual frequency operation in the range 2.4 GHz and 3.6 GHz. the radiation pattern is distinct and directional. The simple rectangular antenna is good operating in Microwave frequency.

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