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Original Article

A compact multi band microstrip antenna

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ABSTRACT

This paper presents the design of microstrip antennas for L, S and C band applications. The rectangular microstrip patch antennas are designed at a frequency of 2GHz and have been simulated using Mentor Graphics IE3D simulation software. The substrate used in the design is FR-4 glass epoxy, which has a dielectric constant of 4.2. The operating frequency range is 1-7 GHz. The modified microstrip antenna with plus shaped slot at the center of the patch yields an overall bandwidth of 10.47 % and lowest resonant frequency of 1.71 GHz. This antenna provides a size reduction of 13.63 %.

1. Introduction

A microstrip patch antenna consists of a ground plane on one side of the dielectric substrate and a radiating patch on the other side. The radiating patch is generally made of conducting material such as copper or gold. The substrates whose dielectric constant lies between 2.2 and 12 are used for microstrip antennas. [1-2].

Microstrip antennas possess low weight and can are easily compatible with other electrical devices. However, they suffer from narrow bandwidth and surface wave excitation in the dielectric substrate. These antennas are used in the frequency range of UHF to millimeter waves. [3].

In [4], Zaka Ullah et.al have designed shirt shape microstrip antenna to produce gains of 5.3, 5.03 and 5.27 dB at the three resonant frequencies of 4.4, 6.2 and 8.5 GHz, respectively. In [5], Sondarya S et.al have designed microstrip antenna operating at dual frequencies 2.4 and 3.6 GHz, respectively. Two rectangular slots are etched on the patch to produce VSWR of 1.16 and 1.48 at 2.4 and 3.6 GHz, respectively. In [6], B. Neeththi Aadithiya et al. have designed square shaped patch antenna with slots on the patch. The antenna is producing omni directional radiation pattern with return loss equal to -13 dB at 2.5 GHz. In [7], Poonam A. Kadam et al. have proposed the design of multi band microstrip antenna with pi shape slot etched in the ground plane. A broad band response of 164 MHz (6.5 %) is produced. A highest gain of 4 dBi is also obtained. The surface current is altered to yield broadside radiation pattern. In [8], Akansha Tandon et al. have presented frequency reconfigurable patch antenna for X band using PIN diode as a switch. When the PIN diode is incorporated in the slot and is turned OFF, bandwidth of 320 MHz (2.79 %) is obtained. When the PIN diode is switched ON, the bandwidth is decreased to 250 MHz (2.01 %). In [9], Zubair Ahmed et al. have proposed differential fed slot loaded patch antenna. The antenna is showing reduced side lobe level of -12 dB and bandwidth of 21 MHz.

2. Design of microstrip patch antenna

The conventional microstrip antenna depicted in Fig. 1 is designed at 2 GHz. The radiating patch dimensions, quarter wave transformer and feed are 46.5 mm × 36.2 mm, 18.8 mm × 3.32 mm and 18.8 mm × 1.27 mm. The microstrip antenna is fed by stripline feeding method.

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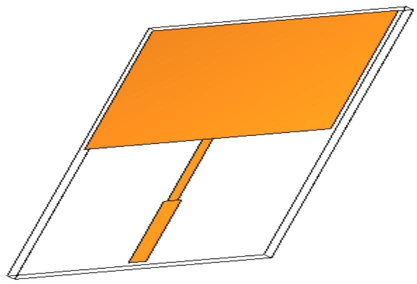

Fig 1. Conventional microstrip antenna.

In Fig. 2, the upper part shown in brown color is the radiating patch, the middle part in brown color is the quarter wave transformer and the lower part in brown color is the feed. The radiating patch is fed at its midpoint, as shown in Fig. 2. The quarter wave transformer is employed to match the impedance of radiating patch and the feed.
The conventional microstrip antenna is replaced with a plus shaped slot at the center of the radiating patch to design the modified microstrip antenna as shown in Fig.3. The plus shaped slot is formed by placing two rectangular slots perpendicular to each other in horizontal and vertical positions. The dimensions of each of the rectangular slots are 20 mm×3 mm. A slot means where a part of the copper is removed.

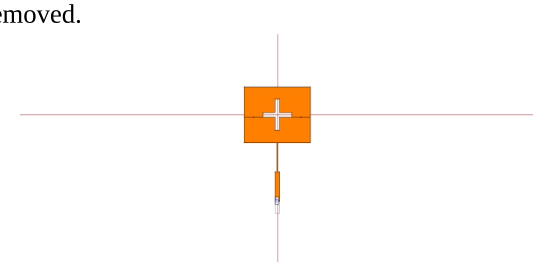

Fig 2. Modified microstrip antenna.

3. Results

The return loss characteristics of the former and latter antennas are shown in Fig 3 and Fig 4.

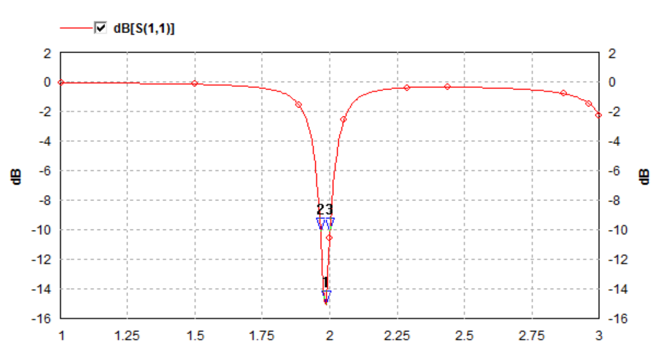

Fig 3. Return loss versus frequency of conventional microstrip antenna.
From Fig. 3, the conventional microstrip antenna is resonating at a frequency of 1.98 GHz, as indicated by point 1 in Fig. 3. The bandwidth of conventional microstrip antenna is equal to 51.18 MHz. Bandwidth (%) is determined by using equation (1).

$$\frac{\text{Bandwidth}}{\text{Resonant frequency}} \times 100\% \quad (1).$$

Hence the calculated bandwidth (%) of conventional microstrip antenna is equal to 2.58 %.

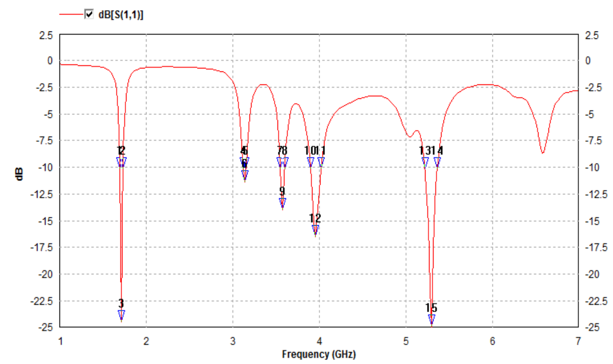

Fig 4. Return loss versus frequency of modified microstrip antenna.
From Fig.5 the modified antenna is resonating at five frequencies i.e. 1.71, 3.14, 3.58, 3.96 and 5.3 GHz, respectively. These values are indicated by points 3, 6, 9, 12 and 15 in Fig. 5. The bandwidths at the corresponding resonant frequencies are equal to 37.27, 29.83, 55.98, 122.22 and 143.19 MHz. Hence the overall bandwidth of modified microstrip antenna is equal to 10.47 %. Thus, the bandwidth (%) of modified microstrip antenna equal to 10.47 % is greater than that of conventional microstrip antenna equal to 2.58 %.
From Figs. 4 and 5, we observe that the fundamental resonant frequency of the modified microstrip antenna is equal to 1.71 GHz as against 1.98 GHz of the conventional microstrip antenna. The modified microstrip antenna is resonating at a lower fundamental frequency compared to conventional microstrip antenna. This contributes to virtual size reduction. The virtual size reduction (%) produced is calculated by using equation (2).

$$\left(\frac{f1-f2}{f1}\right) \times 100 \qquad (2)$$

In equation (2), f1 and f2 designate the fundamental resonant frequencies of conventional and modified microstrip antennas. Hence the virtual size reduction produced by modified microstrip antenna is equal to 13.63%.

4. Conclusion

A compact multi band rectangular microstrip patch antenna is designed and simulated. successfully. By etching a plus shaped slot in the patch of conventional microstrip antenna, multi resonant frequencies are excited with acceptable return losses. A maximum of five resonant frequencies is obtained. Enhanced bandwidth of 10.47 % is obtained. Virtual size reduction of 13.63 % demonstrates the improved performance of the modified antenna over the conventional antenna. Resonant frequencies are observed in the L, S and C bands, respectively.

Conflict of Interest

The authors declare that they have no conflict of interest

References

1. Balanis CA. Antenna theory: analysis and design (Ed. 2). New Jersey: John Wiley & Sons; 1997
2. Bahl I J, Bhartia P. Microstrip antennas. Artech House; 1980
3. Ludwig R, Bretchko P. RF circuit design: theory and applications (Ed. 2). New Jersey: Pearson; 2009
4. Ullah Z, Khattak MI, Haq E, Ahmed S, Khattak A. Design and Analysis of Compact Triple Band Microstrip Patch Antenna for Multiband Applications. EAI Endorsed Trans. Mobile Communications Applications. 2018; 3(13):e2.
5. Soundarya S, Meghana S, & Shanthi P. Design of dual band micro strip antenna for 2.4 GHz and 3.6 GHz. International Journal of Recent Technology and Engineering. 2019, 8(1), 2404-2406.
6. Aadithiya BN, Andrews NV, & Manikandan M. design of patch antenna with inverted U-slot for Wimax applications. Indian Journal of Science and Technology. 2018; 11(17), 1-4.
7. Kadam PA, Deshmukh AA. Multiband Microstrip Antenna Using Modified Pi-Shape Slot on Ground Plane. IJ Wireless and Microwave Technologies. 2019;1, 23-35.
8. Tandon A, Dutta BR, Bhomia YK. Design and simulation of a tunable frequency microstrip patch antenna. International Journal of Research in Engineering and Technology. 2013;2(12):805-808
9. Ahmed Z, Ahmed MM, Ihsan MB. A novel differential fed high gain patch antenna using resonant slot loading. Radioengineering. 2018;27(3):662-670.

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