Design and Development of Star Shaped Microstrip Patch Antenna for ISM Band Applications

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Abstract

The design of a star shaped microstrip patch antenna with microstrip feed line for ISM band (2.38GHz – 2.45GHz) is proposed. The designed antenna consists of star shaped radiating patch formed by isosceles and equilateral triangles. This model is made up of conducting material (copper). A microstrip feed line is used to energize the radiating patch which results in enhanced bandwidth. Antenna parameters such as return loss, VSWR, radiation pattern, gain and directivity are investigated. The proposed antenna has a high gain at 2.4GHz frequency. CST software is used to model and stimulate the patch antenna.

Keywords: Antenna, ISM, Microstrip star patch, Microstrip feed, CST software, Return loss, Radiation pattern, VSWR

1. Introduction

The rapid improvement of wireless communication systems [1] and the ensuing burst of remote gadgets put a few requests on the antenna structures. Contrasted with customary microwave antennas, Microstrip antennas have a few points of interest, and in this way different applications cover the wide bandwidth from 100MHz to 100GHz .Microstrip antennas are portrayed by several parameters and they can be intended to have various geometric shapes and measurements. A Microstrip Patch Antenna (MPA) comprises of a transmitting patch of any planar or non-planar geometry on one side of the dielectric substrate with ground plane on opposite side. Different fix arrangements, for example, square, annular-ring, circle, rectangular, symmetrical triangular and dipole have been explored for recent years.

These fix reception apparatuses [2] have numerous attractive highlights like low profile, light weight, moderately economical to make, thin profile setup , direct and round polarization are conceivable with basic feed and can be effortlessly incorporated with microwave coordinated circuits. These antennas have excellent low power handling capacity and hence they can be used in low power transmitting and receiving applications. These features make microstrip patch [3], [4] antennas useful for many applications in radar and wireless communication systems.

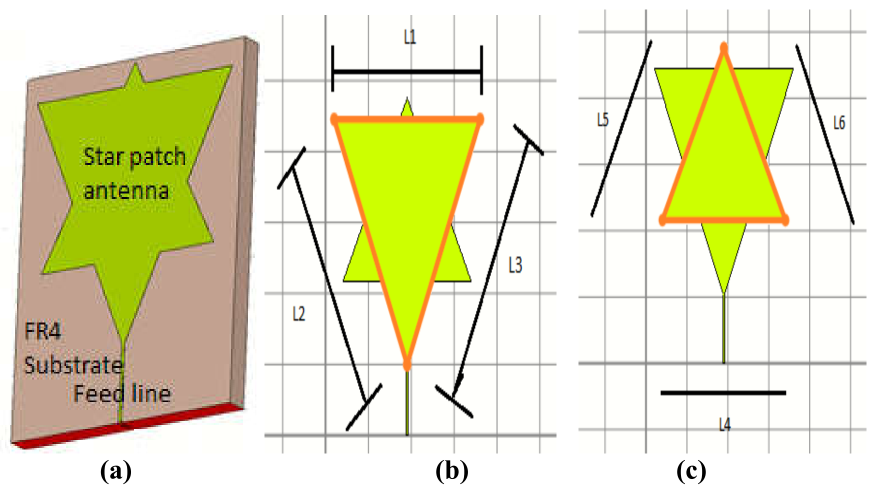
Other than having more focal points, one of the main constraints of such microstrip fix radio wires is their extremely limited transfer speed, which is on the request of a couple of percent and low mandate gain. Many techniques [5] – [7] have been suggested to enhance the impedance bandwidth of microstrip antennas. They involve less metalized territory on the dielectric substrate than other existing setups and a low radiation loss. In high-performance aircraft, spacecraft, satellite, and missile applications, where size, weight, cost, performance, ease of installation, and aerodynamic profile are constraints, and low-profile antennas may be required. Presently there are many other government and commercial applications, such as mobile radio and wireless communications [8] that have similar specifications. To meet these requirements, patch antennas can be used. These antennas are low profile, conformable to planar and nonplanar surfaces, simple and inexpensive to manufacture using modern printed-circuit technology, mechanically robust when mounted on rigid surfaces, perfect with MMIC plans, and when the specific fix shape and mode are chosen, they are extremely adaptable as far as full recurrence, polarization, example, and impedance. The Square, rectangular, dipole (strip), and round are the most widely recognized due to simplicity of investigation and creation, and their appealing radiation qualities, particularly low cross-polarization radiation.

The industrial, scientific and medical (ISM) radio bands [9], [10] are radio bands (portions of the radio spectrum) reserved internationally for the use of radio frequency (RF) energy for industrial, scientific and medical purposes other than telecommunications. Precedents of uses in these groups incorporate radio-recurrence process warming, microwaves, and medicinal diathermy machines. The great discharges of these gadgets can make electromagnetic impedance and upset radio correspondence utilizing a similar recurrence, so these gadgets were constrained to specific groups of frequencies. As a rule, correspondences gear working in these groups must endure any obstruction created by ISM applications, and clients have no administrative assurance from ISM gadget task.

In this project one equilateral triangle and one isosceles triangle are considered and are placed one above the other to get a star shape patch. The star shape radiating patch [11] is energized by microstrip probe-feed line. Microstrip line feed is one of the easier methods to fabricate as it is a just conducting strip connecting to the patch and therefore can be consider as extension of patch. It is simple to model and easy to match by controlling the inset position. The modified equilateral triangle patch and isosceles triangle patch in the form of star is simulated using CST studio software. The results obtained in accordance with the proposed antenna are given below. The designed antenna has high gain at the frequency 2.4GHz.

2. Antenna Configuration

A patch antenna is a type of radio antenna with a low profile which can be mounted on a flat surface. It consists of a flat rectangular sheet or patch of metal, mounted over a larger sheet of metal called ground plane. In this paper the star shaped patch [11] configuration is designed for ISM band [12]-[13] applications. Shape of radiation part is star where two triangles (isosceles and equilateral triangle) are inverted and added.



(a) (b) (c)

Figure 1. (a) Side View; (b) Isosceles Triangle; (c) Equilateral Triangle

The designed model [14] is placed on FR 4 substrate with dielectric constant of 4.4 and thickness of 1.6 mm. The star patch is made up of conducting material (copper). A microstrip feed line [15] of 0.5mmx15mm is used to energize the radiating patch. The star patch is exited using microstrip line feed from the edge of the patch which results in enhanced bandwidth. The star shaped patch is formed by inverting and adding equilateral and isosceles triangle. Figure 1 represents the side view, isosceles triangle and equilateral triangle of star shaped patch antenna. The dimensions of proposed model is represented in table 1. The designed antenna is suitable for 2.4 GHz.

Table1. Dimensions of Proposed Model

L1	34
L2	37.9
L3	37.9
L4	30
L5	30
L6	30

3. Results and Discussions

Figure 2 represents the simulated return loss of proposed model. The ISM band is obtains due to the star shaped patch antenna. Return loss is the loss of power in the signal returned/reflected by a discontinuity in a transmission line or optical fiber. This discontinuity can be a mismatch with the terminating load or with a device inserted in the line. It is usually expressed as a ratio in decibels (dB). It shows the -47.6 dB return loss at 2.4 GHz.

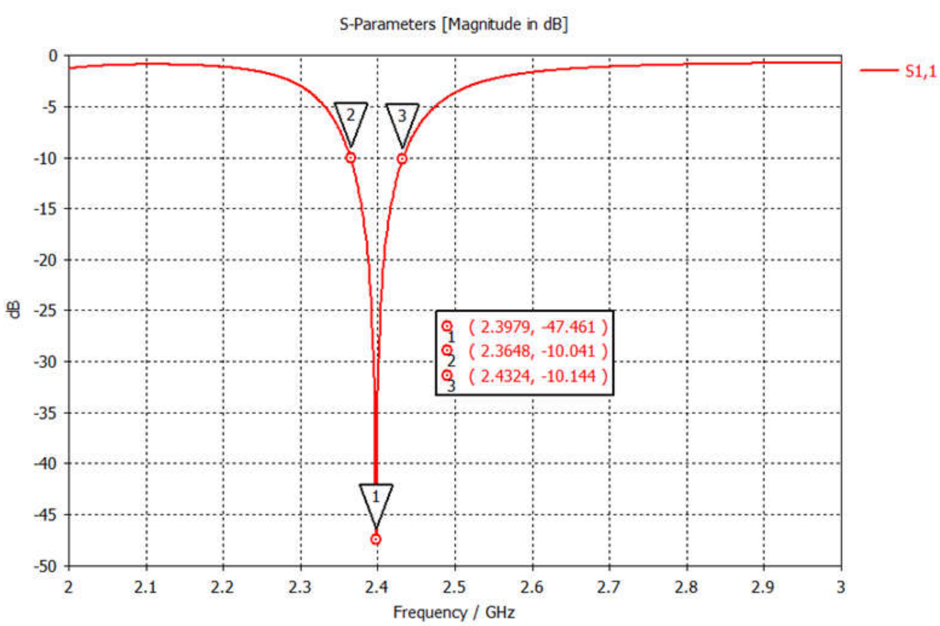


Figure 2. Simulated Return Loss at 2.4 GHz

The VSWR is a function of the reflection coefficient, which describes the power reflected from the antenna. Figure 3 represents the simulated VSWR at 2.4 GHz. The proposed antenna has VSWR of 1.02 at 2.4 GHz.

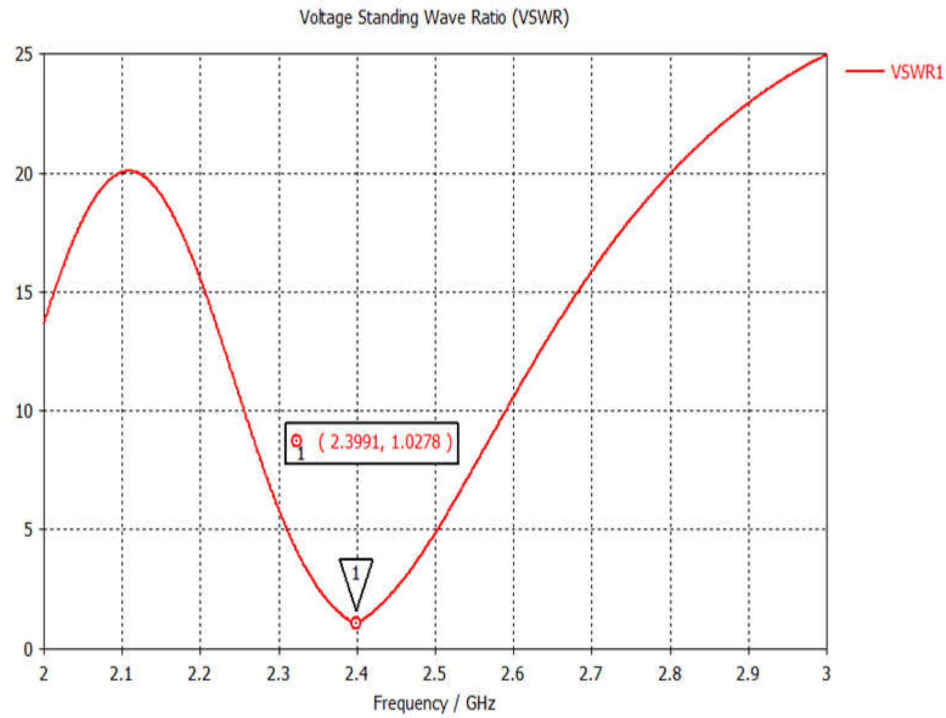


Figure 3. Simulated VSWR at 2.4 GHz

Figure 4 represents the simulated gain at 2.4 GHz. In electromagnetics, an antenna's power gain or simply gain is a key performance number which combines the antenna's directivity and electrical efficiency. In a transmitting antenna, the gain describes how well the antenna converts input power into radio waves headed in a specified direction. The energy radiated by an antenna is represented by the Radiation pattern of the antenna. Radiation Patterns are diagrammatical representations of the distribution of radiated energy into space, as a function of direction. Figure 4 represents the gain of 6.6 dBi at 2.4 GHz.

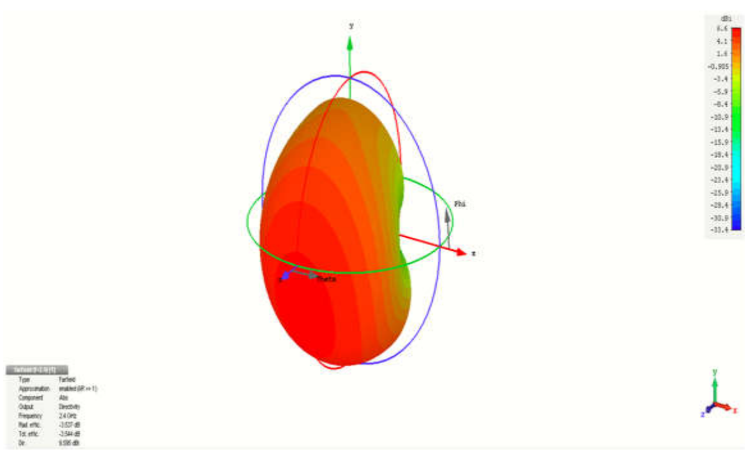


Figure 4. Simulated Gain at 2.4 GHz

4. Conclusion

The compact microstrip star patch antenna with a microstrip feed line is proposed. The design and simulated results were performed using Computer Simulation Technology (CST) software. The antenna achieves gain of 6.6dBi and VSWR is 1.0278 at desired band. The return loss of proposed model is -47.46dB at 2.4GHz and the proposed antenna is suitable for ISM band applications.

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