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Slit loaded H- Shaped Microstrip Patch Antenna for 2.4 GHz

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Abstract

The low cost, low profile, ease of fabrication are some of the advantages of microstrip patch antenna that makes it viable in various next generation wireless networks. The microstrip patch antenna can resonate at various frequencies. This paper, presents an H shaped patch antenna fabricated on FR4 substrate, having a dielectric constant 4.4. The antenna is designed and simulated using CST STUDIO SUITE. The antenna resonates at 2.4 GHz frequency with return loss of -31 dB. The designed antenna is loaded with two slits for performance improvement.

Keywords: Microstrip Ptch Antenna, H shape, FR4 substrate

INTODUCTION

The low profile, light weight, ease of fabrication and integration of active and passive components are some of the advantages that makes microstrip patch antennas popular in next generation wireless networks and applications [1]. The patch antennas are also very versatile in terms of its input and output parameters and these can be used at frequency ranges from 1-100 GHz [2]. Therefore, patch antenna are widely used in radar, satellite networks and biomedical applications etc [3]. Due to their small size, these can also be used for body wearable applications [4]. But despite of its advantages, the microstrip patch antennas suffers from narrow bandwidth and low efficiency [5]. However in literature, various techniques have been proposed to enhance the patch antenna performance. The limitations of patch antenna overcame by using different shapes of patches slotting in patch, using metamaterials or by using array of patch antennas [6].

The main components of patch antennas are dielectric substrate, the ground plane and metallic patch which radiates. In literature, various types of substrate are used in designing of patch antennas [7]. The choice of substrate is very crucial in antenna design. The dielectric permittivity of the substrate should be in the range of $2.2<\varepsilon_r<12$. Mostly used substrate is FR4 epoxy resin [8].Various other substrates viz. RT Duroid, LCP etc. can also be used [9], but they are costlier than FR4. Nowadays, patch antennas are used for bodywearable applications, so various textiles materials are used as a substrate material. In the research field use of polyamide, polyester, washed cotton, jeans and various other suitable substrates are used due to their efficient results and compatibility. The electro textiles materials like flectron, shieldit and zelt are used as substrate [10]. The author in [11] gives a complete survey of various substrate material used in patch antenna design.

The performance parameters of patch antenna are also improved by designing different patch shapes. The most common shapes for patch are rectangular and circular [12]. These shapes can be designed from different antenna design models like transmission line model, cavity model etc [13].

These basic shapes can be modified by slotting and notching in patch. The researchers used rectangular, circular, swastika shape, E shape [14] etc. For further improvement in antenna output performance and reduction of body SAR values, researchers used metamaterials antennas and planer inverted F antenna (PIFA) [15]. Thus it is concluded that for particular applications, the antenna can be designed by using combinations of above mentioned techniques. Due to wide range of applications and in order to operate in other bands of communication, there is a need to develop some more microstrip patch antennas [16].

The remaining paper is organized as, section 2 presents antenna design, section 3 gives the simulation results and discussion and finally we conclude the results in section 4.

ANTENNA DESIGN

This paper presents the designing and simulation of H shaped microstrip patch antenna. We designed these antennas using CST STUDIO SUITE tool. It is already mentioned that three basic parameters must be known to design a microstrip patch antenna. The very first step is to select the values of these basic parameters. After the selection of these three basic parameters next step is to select the shape of the patch and dimensions as well. The dimensions that have been taken for this rectangular patch are derived from transmission line model [5]. In this section, a design of small sized, low profile patch antenna is proposed for 2.4 GHz frequency. An H shaped antenna loaded with slits is shown in fig. 1.

For an antenna to radiate it should attain a return loss more that -10 dB. Even though the designed antenna was working normally at desired frequency, there was a possibility of some improvements. Thus we cut slits on the patch. Slitting gives further improvement in return loss. The antenna is simulated on an FR4 substrate with a dielectric constant of 4.4 and a loss tangent of 0.01. The thickness of the substrate is 1.6mm. The length and the width of the antenna is 38.02 mm X 28.78 mm respectively. It is clear from the literature review that, by loading slots to the patch we can enhance the output parameters of an antenna. We cut two slots in our design. The simulation parameters and antenna geometry information is given in table 1.

Table 1. Design Parameters for H shape antenna

Design Parameter	Value
Operating Frequency	2.4 GHz
Dielectric constant	4.4
Height of the Substrate	1.6mm
Feeding Technique	Waveguide port
Patch Length (L)	38.02 mm
Patch Width (W)	28.78 mm
Depth of Feed	8.10 mm
Width of Feed	3 mm
Slot Length	6 mm
Slot Width	0.5 mm

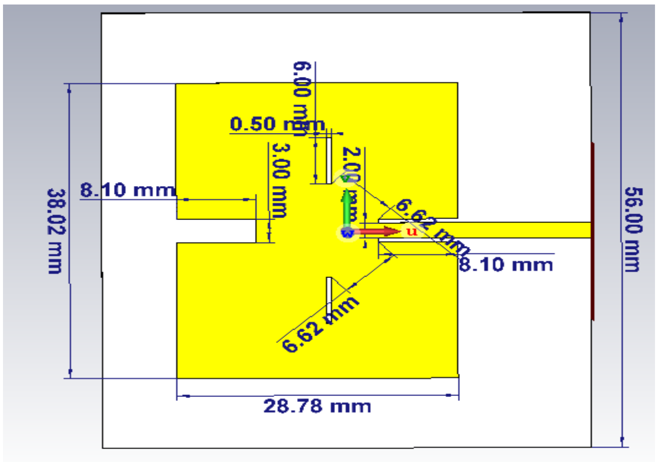

Figure 1. H shaped antenna

RESULTS AND DISCUSSIONS

The designed antenna is simulated and the performance analysis is done on the basis of reflection coefficient and directivity. The return loss or reflection coefficient is the ratio of reflected wave to the incident wave. For antenna to efficiently radiate its return loss has to be below -10 dB. The figure 2 shows the return loss for designed H shaped antenna.

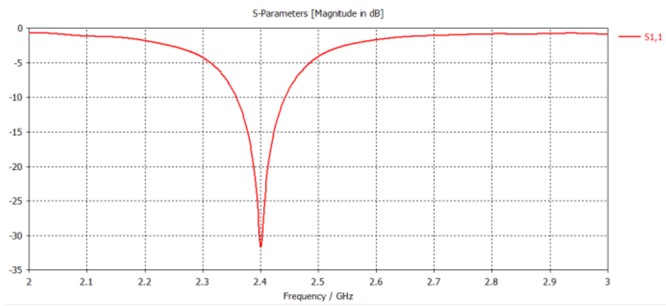

Figure 2. Return loss of H shape antenna

It is clear from the figure that, our designed antenna resonates at designed frequency of 2.4 GHz with return loss well below -30 dB. The simulated directivity of designed antenna is shown in fig. (3a,3b) for phi 90 degree and theta 0 degree.

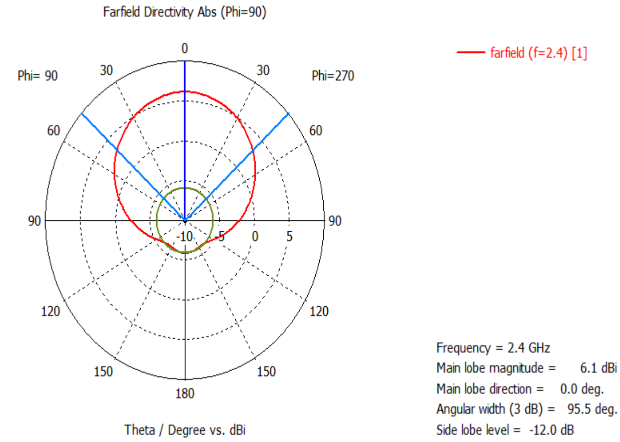

Figure 3a. Farfield directivity at 2.4 GHz for phi=90 deg

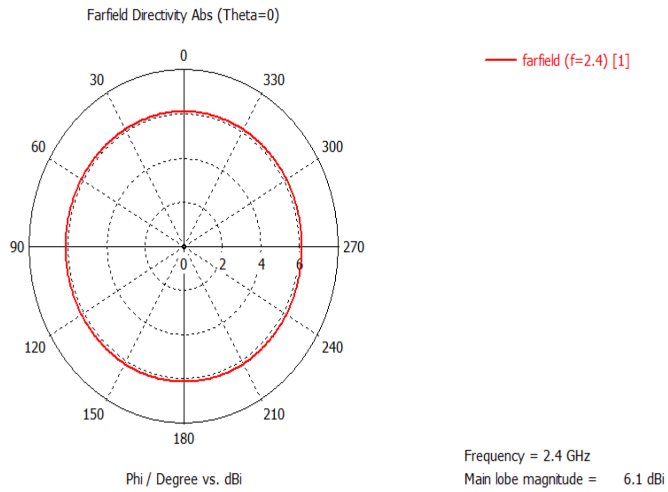

Figure 3b. Farfield directivity at 2.4 GHz for theta =00 deg

CONCLUSION

H shape antenna is designed and simulated in CST STUDIO SUITE successfully. The simulation results show that, the designed antenna radiates at 2.4 GHz frequency with return loss of -31dB. The antenna output parameters are satisfactory

The various patch shapes and different substrate can also be used to enhance antenna performance. Various textile materials can also be used for antenna design so that they can be used in bodywearable applications. In recent scenario, metamaterials have made a rapid growth as a substitute for research in microstrip patch antenna. The use of metamaterials significantly improves the performance of antenna in terms of gain, return loss, bandwidth and efficiency. The wearable antenna design may consist of combination of mentioned techniques. The right technique should be chosen such that the antenna gives the optimum performance for desired applications. Various feasible shapes and attributes can be tested and combined for better results.

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