Swastika Shaped Microstrip Patch Antenna for ISM Band Applications

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Abstract - *As the wireless communication grows very fast, the antenna devices' **designs must have enhanced output parameters according to the new generation's** need. This paper represents the design of Swastika shaped microstrip patch antenna for Industrial Scientific and Medical (ISM) band applications. The design has four slots as same as Swastika shape into it and it resonates at 2.416 GHz frequency. Feeding method used for this design is Inset feed. Gain, Bandwidth, Return loss, Voltage Standing Wave Ratio (VSWR) and Directivity are investigated. CST Studio Suite 2011 simulation tool is used for design and simulation.*

Key Words: Microstrip Patch Antenna, Swastika Shape, Bandwidth, Return loss, VSWR

1. INTRODUCTION

Swastika shaped patch antenna is four slotted microstrip patch antenna design, which shape is exactly as one of the Hindu religion's signs, "Swastika". It is widely useful for ISM band applications. Four components are needed to fabricate this microstrip patch antenna and they are Swastika shaped microstrip patch, ground plane, feed line and dielectric substrate [4]. The basic structure of microstrip patch antenna is shown in Figure 1.

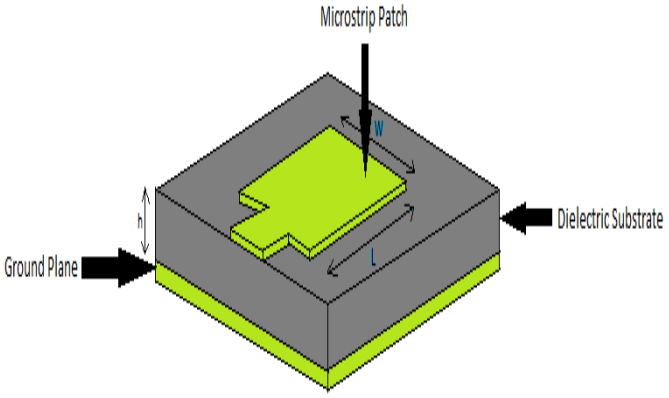

Fig -1: Basic Structure of Microstrip Patch Antenna

There are some advantages of microstrip patch antenna like small dimensions, lower fabrication cost, lower weight etc. [5]. There are many disadvantages of the microstrip patch antenna like lower efficiency, lower gain, excitation of surface waves etc. [5]. The dielectric, patch and ground plane materials should be used as per the need. Microstrip patch shape can be any of rectangle, square, triangle etc. and it directly affects the output parameters of the antenna [6]. Figure 2 shows the inset feeding technique of this design.

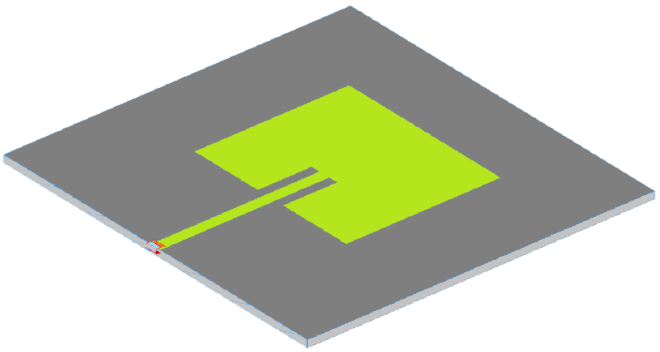

Fig -2: Inset Feed

The other feeding techniques are also there, which can be used to feed the antenna, like Microstrip Line, Coaxial Probe, Proximity Coupled and Aperture Coupled [5].
The Industrial Scientific and Medical (ISM) band can be used band for many wireless applications like WLAN, Bluetooth etc. at around 2.4 GHz frequency So, the microstrip patch antennas should be designed in a better and efficient way for the next generation of wireless equipments.

2. DESIGN OF THE PROPOSED ANTENNA

The slots are cut off from the rectangular microstrip patch to design the Swastika shape of the patch. Four slots are there in this design. The FR4 is used as dielectric substrate material and copper is used as Swastika shaped patch and ground plane material. Inset feed is used as a feeding technique in this design. The design of the presented antenna is as shown below in Figure 3.

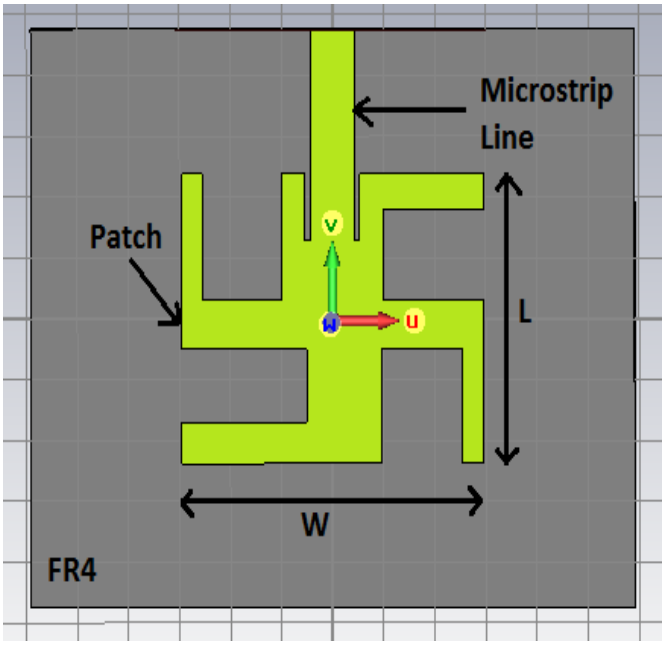

Fig -3: Swastika Shaped Microstrip Patch Antenna

The width of the patch can be given by,

$$W = \frac{1}{2f_r\sqrt{\mu_o\epsilon_o}}\sqrt{\frac{2}{1+\epsilon_r}}$$

From the calculations, the width of the patch W is equal to 38.13 mm. And the equations of the length of the microstrip patch are,

$$L = \frac{\lambda_o}{2\sqrt{\epsilon_{eff}}} - 2\Delta L$$

Where,

$$\epsilon_{eff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2\sqrt{1+12h/W}}$$

And

$$\Delta L = 0.4h\frac{(\epsilon_{eff}+0.3)(W/h+0.27)}{(\epsilon_{eff}-0.26)(W/h+0.8)}$$

As per the calculations, the length of the patch L is equal to 29.94 mm. The height of the copper patch Mt is equal to 0.15 mm and dielectric substrate height h is equal to 4.5 mm. The CST Studio Suite 2011 is used for simulation of the design as the tool is widely used and reliable.

3. SIMULATION RESULTS

3.1 Resonant Frequency

The antenna resonates exactly at 2.416 GHz frequency. This frequency comes under the Industrial Scientific and Medical (ISM) band and can be used for wireless applications.

3.2 Return loss

The return loss output of Swastika shaped microstrip patch antenna is as shown below in Figure 4.

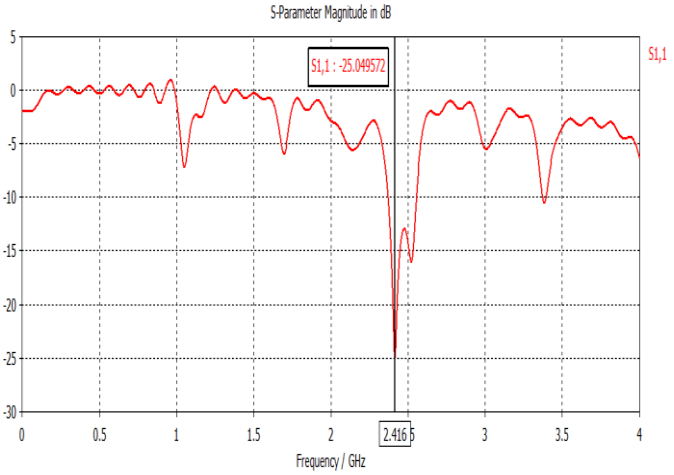

Fig -4: Return loss output

From above Figure 4, return loss of the antenna at resonant frequency 2.416 GHz, is below -10 dB and is equal to - 25.049 dB

3.3 Voltage Standing Wave Ratio (VSWR)

The VSWR output of Swastika shaped microstrip patch antenna is as shown below in the Figure 5.

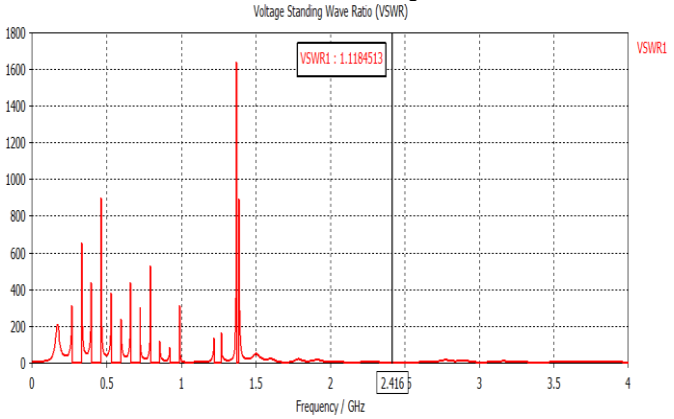

Fig -5: VSWR output

From the Figure 5, the VSWR of the Swastika shaped patch antenna is 1.11 at the resonant frequency 2.416 GHz.

3.4 Bandwidth

The bandwidth can be defined practically as the difference between the higher and lower frequencies at -10 dB return loss divided by cut off frequency. It is 7.89% for this antenna. Theoretically it can be given by,

$$BW = 100 \times (F_H - F_L) / F_C$$

3.5 Farfield Patterns

Figure 6 shows the farfield output of the Swastika shaped microstrip patch antenna. The 3D pattern is of omnidirectional antenna.

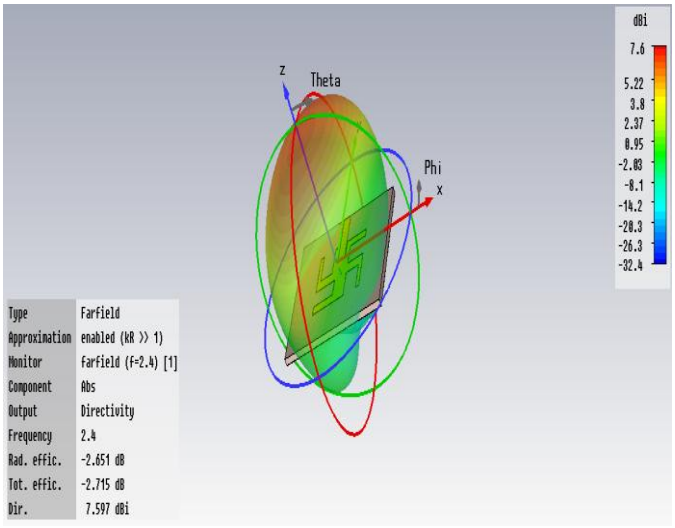

Fig -6: Farfield Pattern

The directivity of the proposed design is 7.597 dBi

3.6 Gain

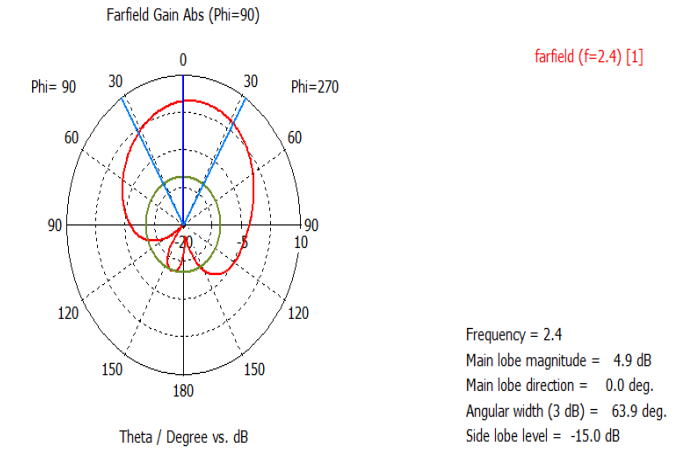

Fig -7: Farfield Gain

The gain of the antenna is 4.947 dB

Here is the Table 1 gives detail of all output parameters.

Table -1: Result Table

Resonant Frequency	2.416 GHz
Return loss	-25.049dB
VSWR	1.11 dBi
Bandwidth	7.89%
Directivity	7.597 dBi
Gain	4.947 dB

4. CONCLUSION

The design of Swastika shaped microstrip patch antenna for ISM band applications is described briefly in this paper. The small of the antenna has enhanced output parameters and the antenna resonates at 2.416 GHz, i.e. ISM band frequency, which can be useful for the applications like Bluetooth, WLAN etc. This design has efficient output parameters than conventional and regular slotted microstrip patch antenna.

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BIOGRAPHIES

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