Development of Microstrip Antenna for Personal Communication

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Abstract – In this paper new design of Microstrip Antenna design has been proposed. Swastika shaped Microstrip Antenna has been Designed structure is simulated using IE3D software. Low Light weight, low volume, low profile planar configurations which can be made conformal are advantages of this antenna. We have designed antenna at frequency 1.575 GHz because for Personal communication we use (1 GHz to 2 GHz) and thickness 1.49mm flame retardant 4 (FR4) substrate is used. After the simulation, the antenna performances characteristics such as Bandwidth, Gain and Return loss obtained.

Keywords- Microstrip Antenna, Flame Retardant 4(FR4), IE3D software

I. Introduction

In high performance aircrafts, spacecrafts, satellites, missiles and other aerospace applications where size, weight, performance, ease of installation and aerodynamics profile are the constraints, a low or flat/conformal profile antenna may be required (1). In recent years various types of flat profile printed antennas have been developed such as Microstrip antenna (MSA), strip line, slot antenna, cavity backed printed antenna and printed dipole antenna. When the characteristics of these antenna types are compared, the microstrip antenna is found to be more advantageous.

Advantages are-

- Light weight, low volume, low profile planar configurations which can be made conformal.
- Low fabrication cost, readily amenable to mass production, Can be made thin hence they do not perturb the aerodynamics of host aerospace vehicles.
- The antennas can be easily mounted on missiles, rockets and satellites without major alterations.

Disadvantages are:

- Narrow bandwidth.
- Reduced gain and efficiency as well as unacceptably high levels of cross-polarization and mutual coupling within an array element at high frequencies

Personal communication devices have become an important part of everyday life (2). To design small, lightweight and user-Friendly mobile-communication devices has increased accordingly, creating the need for the optimal antennas for mobile application. This project will be designed and simulated using Zeland IE3D software.

II. Proposed Algorithm

A. Antenna structure and Design method:

This antenna consists of a ground plane, dielectric layer and Swastika-shaped patch. The three essential parameters for the design of a rectangular Microstrip Patch Antenna, using Transmission Line Model, are:

- Operating Frequency (f_0)
- Dielectric Constant of Substrate (εr)
- Height Of Dielectric Substrate (h)

The length and width of rectangular patch antenna are calculated from below equations. Where c is the velocity Light, Ɛr is the dielectric constant of substrate (3).

1: Calculation of the Width (Wp):

The width of the Microstrip patch antenna is given by equation as:

$$W = \frac{c}{2f\sqrt{(\varepsilon_r + 1)/2}}$$

2: Calculation of Effective dielectric constant (Ɛreff):

The following equation gives the effective dielectric constant as:

$$\varepsilon_{reff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2}\left[1 + 10\frac{h}{W}\right]^{-\frac{1}{2}}$$

3: Calculation of the Effective length (Leff): The following equation gives the effective length as:

$$L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{reff}}}$$

4: Calculation of the length extension (ΔL):

The following equation gives the length extension as:

$$\frac{\Delta l}{h} = 0.412\frac{(\varepsilon_{reff} + 0.300)\left(\frac{W}{h} + 0.262\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.813\right)}$$

5: Calculation of actual length of patch (Lp):

The actual length is obtained by the following equation:

$$L = L_{eff} - 2\Delta L$$

6: Calculation of the ground plane dimensions (Lg and Wg):

Ideally the ground plane is assumed of infinite size in length and width but it is practically impossible to make an infinite size ground plane, so to calculate the length and width of a ground plane following equations are given as:

$$L_g = L + 6h$$
$$W_g = W + 6h$$

Wg

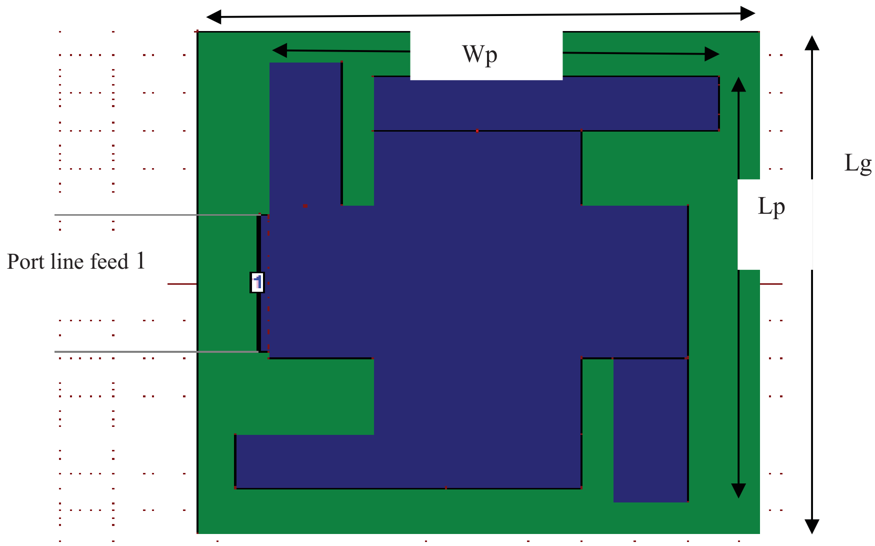

Fig1. Microstrip Antenna Structure view in IE3D

Sl. No.	Parameter	Design of Patch
1	Operating Frequency (f_0)	1.5 GHz
2	Dielectric Constant of Substrate (ε_r)	4.4
3	Loss Tangent	0.0012
4	Thickness of Substrate (h)	1.49 mm
5	Width of Ground Plane (W_g)	66.7 mm
6	Length of Ground Plane (L_g)	49.3 mm
7	Width of Patch (W_p)	57.95 mm
8	Length of Patch (L_p)	45.16 mm

III. EXPERIMENT AND RESULT

Simulation of the designed antenna is done using IE3D software. In this simulation analysis we try to optimize different performance parameters of the antenna such as return loss, gain, radiation pattern etc.

1. Return Loss:

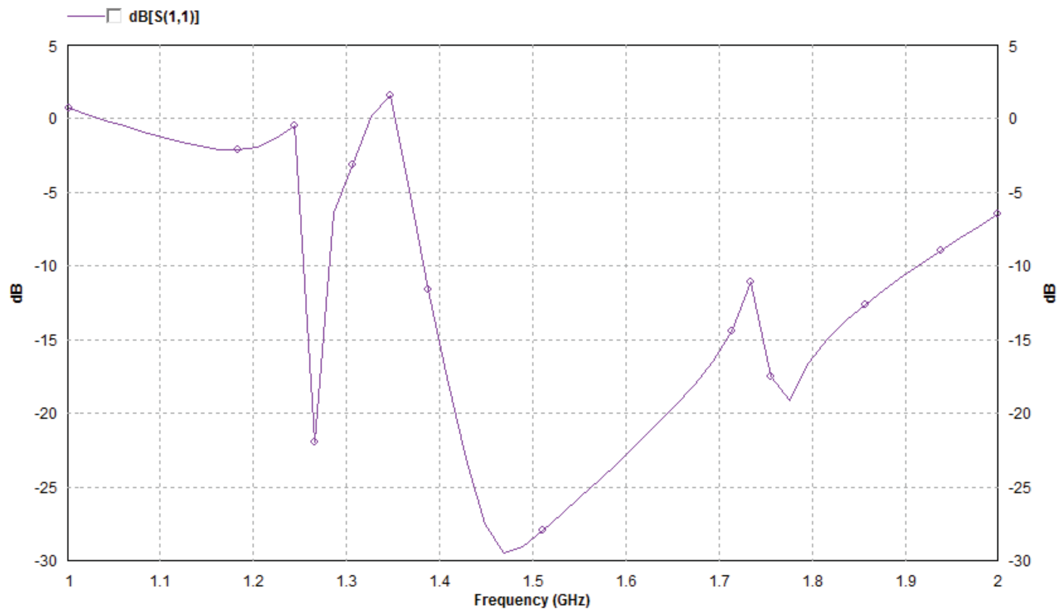

Fig 2. Return loss

The S11 parameter for the proposed antenna was calculated and the simulated return loss results are shown in Figure 2. Return loss is a convenient way to characterize the input and output of the signal sources or when the load is mismatched, not all the available power from generator is delivered to the load. This "loss" is termed as the return loss (RL). The value of return loss is -30dB in this proposed antenna.

2. Gain

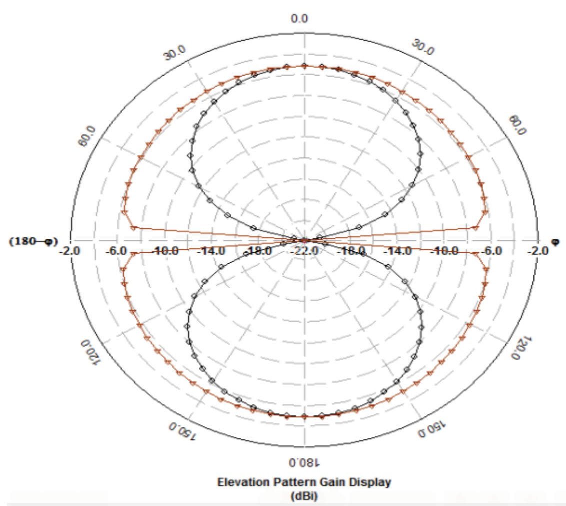

Fig 3. Gain

Gain is a very important parameter of every antenna. Basically, the gain is the ratio of the radiated field intensity by test antenna to the radiated field intensity by the reference antenna [9]. Antenna gain, usually expressed in dB, simply refers to the direction of maximum radiation.

3. Directivity

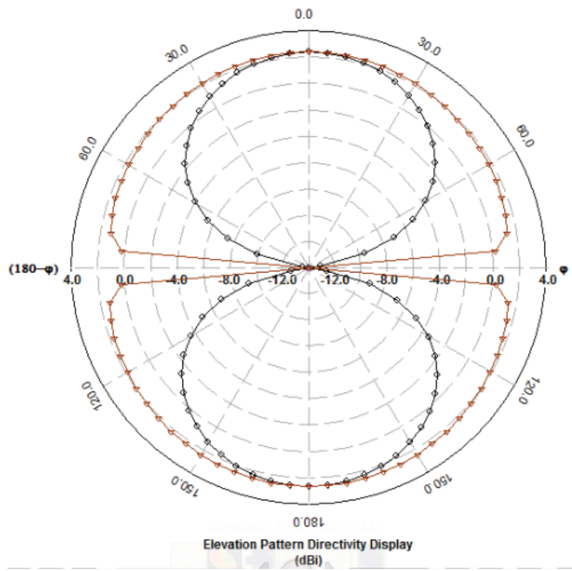

Fig4. Directivity

It is desirable to maximize the radiation pattern of the antenna response in a fixed direction in order to transmit or receive power. Likewise, the directivity is dependent only on the shape of the radiation pattern. The achieved directivity of proposed antenna is 3 dBi at resonating frequency of 1.575 GHz as shown in figure 4. It shows that proposed antenna radiates in Omni-directional nature.

IV.CONCLUSION

The designed microstrip patch antenna is operating in the frequency band of 1.575 GHz covering personal communication standard (4). The resultant bandwidth at 1.575 GHz frequency is around 130 MHz with the corresponding value of return loss -30 dB which shows that the impedance matching is good at this frequency. The resultant gain of desired antenna is -3 dB which is not so good but it can be increased by using gain enhancement techniques, Array configuration and the directivity of the proposed antenna is 3 dBi which shows that the antenna radiates in Omni-directional nature. The resultant bandwidth is good due to defected ground structure but the size of the antenna is not very small. Work is going on to achieve even best results.

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