DESIGN OF MULTIBAND S-SHAPE MICROSTRIP PATCH ANTENNA FOR 4G DEVICES

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Abstract: In this design study, the main purpose was to design an S- shape micro strip antenna. Previous works are also dealing with the bandwidth increasing techniques by changes on the geometry. Some articles and applications are examined about micro strip antennas. There is an S- shape antenna which operates for 4G devices, but they do have a wider bandwidth. The development of antenna for wireless communication also requires an antenna with more than one operating frequencies. This is due to many reasons, mainly because there are various wireless communication systems and many telecommunication operators using various frequencies. However, the general micro strip patch antennas have some disadvantages such as narrow bandwidth etc. Enhancement of the performance to cover the demanding bandwidth is necessary. Design results of VSWR and return loss S_{11} is shown in this paper. The design and results are obtained by using CST Software.

Index Terms - Fractal antenna, Directivity, Beam width, Gain, Return Loss, CST Software etc.

1. INTRODUCTION

An antenna (or aerial) is an electrical device which converts electric power into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver. In transmission, a radio transmitter supplies an electric current oscillating at radio frequency such as a high frequency alternating current (AC) to the antennas terminal and the antenna radiates the energy from the current as electromagnetic waves (radio waves) [2]. In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals that is applied to a receiver to be amplified.

The first antenna were build in 1888 by German physicist Heinrich Hertz in his pioneering experiments to prove the existence of electromagnetic wave predicted by the theory of James Clark Maxwell. They usually are constructed by taking a few iterations of a fractal design, printing the design in copper and then laminating the design onto a non-conductive substrate [5]. Antenna is essential components of all equipment that uses radio. They are used in system such as radio broadcasting, broadcast television, two-way radio, communications receivers, radar, cell phones, and satellite communications, as well as other devices such as garage door openers, wireless microphones, bluetooth-enabled devices, wireless computer networks, baby monitors, and RFID tags on merchandise.

2. ANTENNA PARAMETERS

2.1.1 Return Loss: In telecommunication, 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 [3]. RL is usually expressed as the ratio in decibels (dB).

$$RL\ (dB) = 10 \log_{10} P_i/Pr \qquad (1)$$

Where RL (dB) is the return loss in dB, Pi is the incident power and Pr is the reflected power.

2.1.2 VSWR: *Voltage Standing Wave Ratio* is the ratio of maximum radio frequency voltage to minimum radio-frequency voltage on a transmission line. It is given by:

$$VSWR = Vmax/Vmin \qquad (2)$$

2.1.3 Radiation Pattern: The radiation pattern is a graphical representation of the characteristics of an antenna radiation in a certain direction [5].

2.1.4 Gain: There are two types of gain.

(i) Absolute Gain and

(ii) Relative Gain.

Absolute Gain : Absolute Gain of an antenna is defined as the ratio between the antennas radiation intensity in a certain direction and the intensity that would be generated by an isotropic antenna fed by the same input power, therefore it can given by.

$$G(\theta, \Phi) = U(\theta, \Phi)/U0 \quad (3)$$

Relative Gain: Relative Gain of an antenna is defined as the ration between the antenna radiation intensity in a certain direction and the intensity that would be generated by a reference antenna [6].

2.1.4 Directivity: This is an important parameter that allows us to measure the concentration of radiated power in a certain direction.

2.1.5 Beam width: The beam width of an antenna is a very important figure of merit and often is used as a tread –off between it and the side lobe level; that is, as the beam width decreases, the side lobe increase and vise versa.

3. MATHEMATICAL FORMULAE'S AND DESIGN

i: **Calculation of the Width (*W*):**

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

$$w = \frac{c}{2f\sqrt{(\varepsilon_r+1)/2}} \quad (4)$$

ii: **Calculation of Effective dielectric constant (ε_{reff}) :**

The following equation gives the effective dielectric constant as

$$\varepsilon_{reff} = \frac{\varepsilon_{r+1}}{2} + \frac{\varepsilon_r}{2}\left[1 + 12\frac{h}{w}\right]^{-1/2} \quad (5)$$

iii : Calculation of the Effective length (L_{eff}):

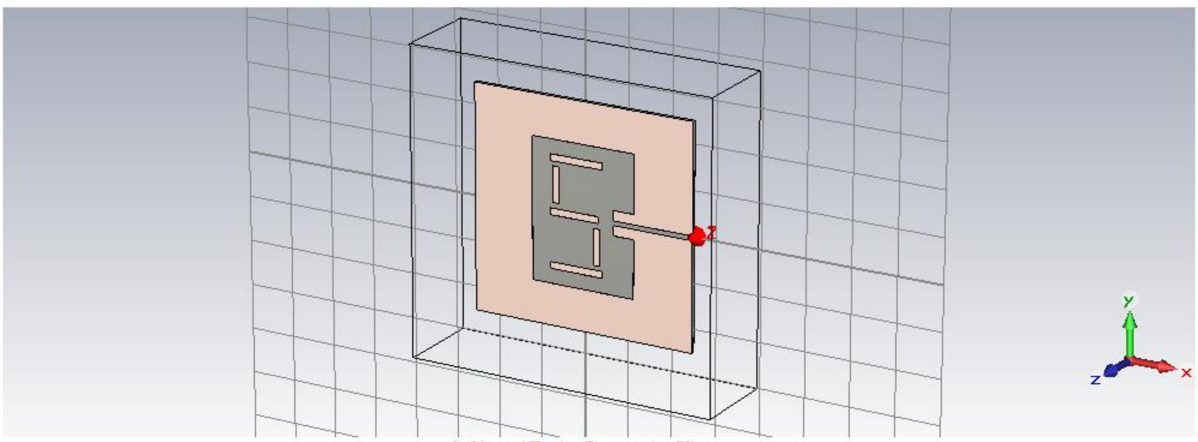
The following equation gives the effective length as:

$$L_{eff} = \frac{c}{2f\sqrt{\varepsilon_{reff}}} \quad (6)$$

iv: Calculation of the length extension (Δ*L*):

The following equation gives the length extension us:

$$\Delta L = 0.412h\,\frac{(\varepsilon_{reff+0.3})}{(\varepsilon_{reff-0.258})}\,\frac{(\frac{W}{h}+0.264)}{(\frac{W}{h}+0.8)} \quad (7)$$



S-Shaped Design Perspective View

Fig. (a) S-Shaped Design view

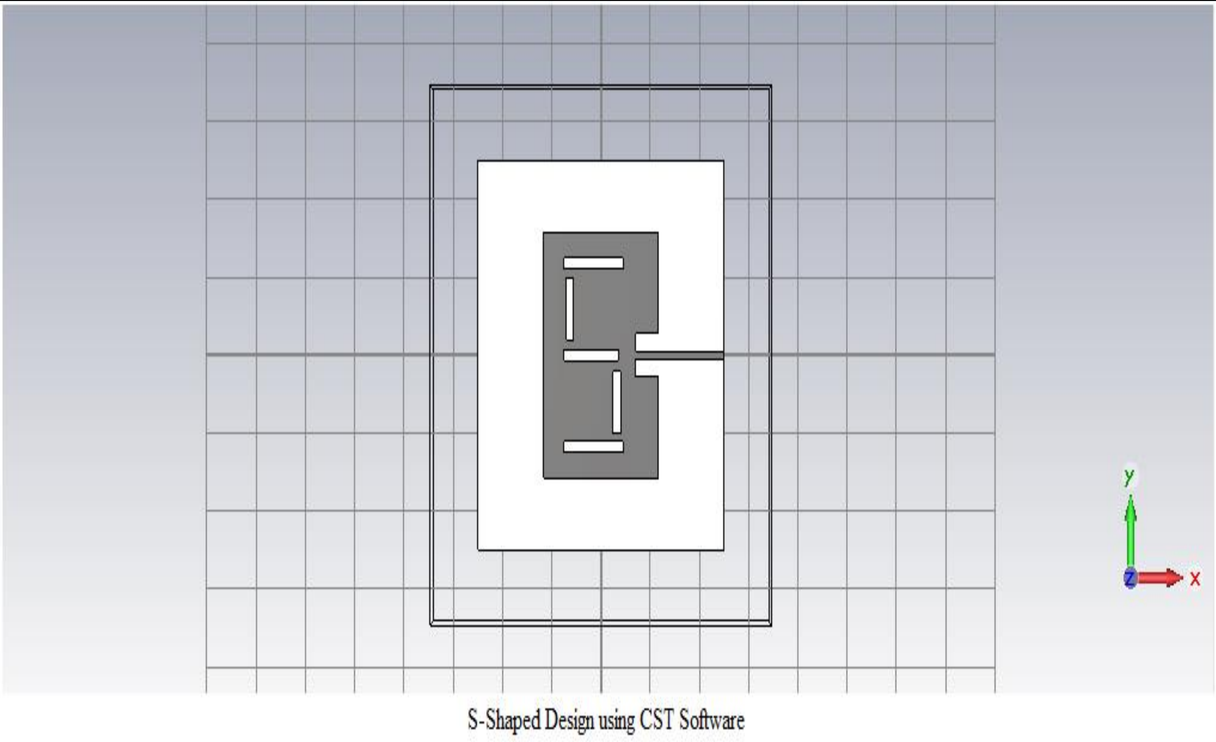


Fig.(b) S-shaped Design front view

4. RESULT AND DISCUSSION

In this research paper result is simulated using CST software at cut off frequency of 1.5GHz and width, Length are calculated using given above formulas which are as follows: L = 47.39mm and W = 60.85mm, h = 1.6mm, tan δ = 0.02 and ε_r = 4.2.

VSWR pattern, Return Loss, radiation pattern and smith chart is calculated using CST software in figure c, d, e and f respectively.

Fig (c) shows return loss in dB with respect to frequency in GHz, which should be below than -10 dB which menans radiated power is approx 90 % is transmitted and only 10% is reflected back.

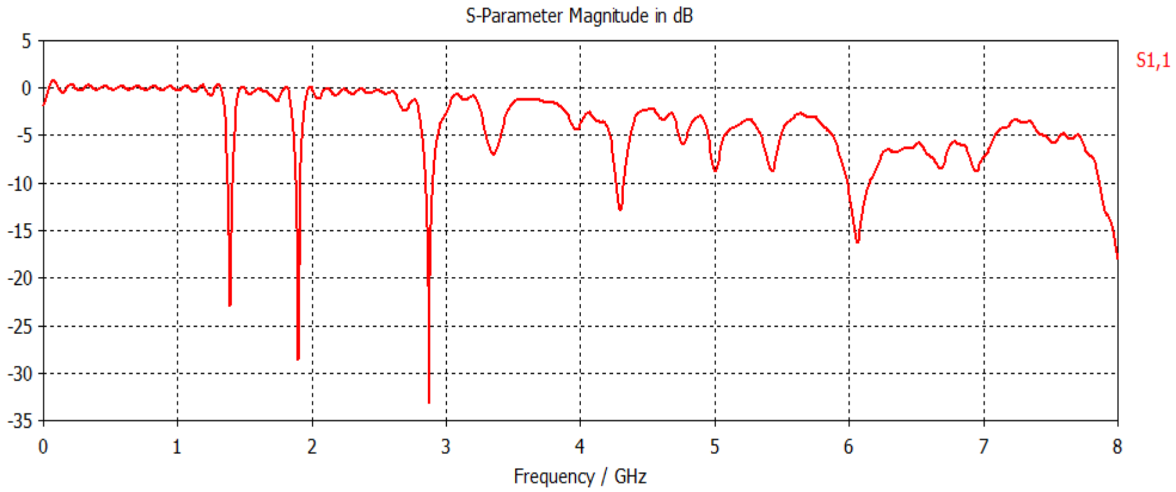


Fig. (c) : Return Loss in dB

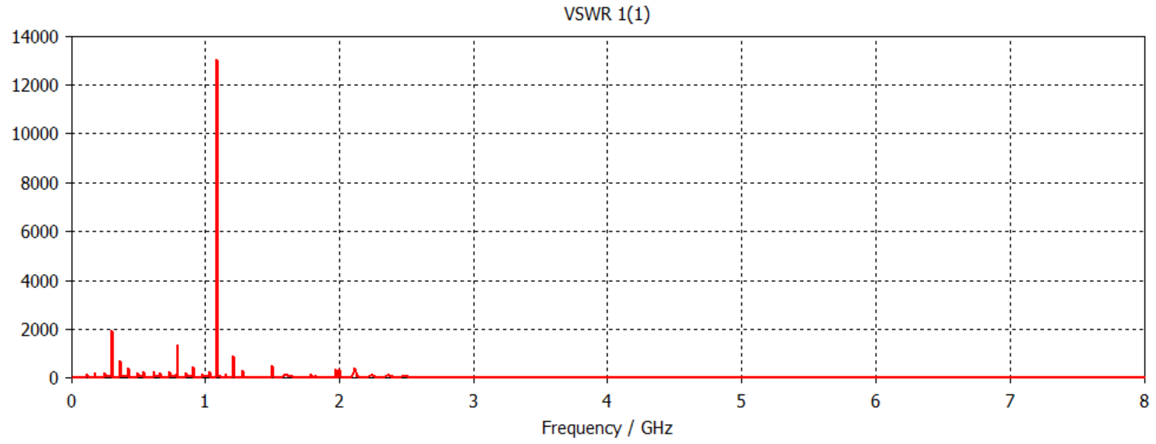


Fig. (d) : VSWR Pattern

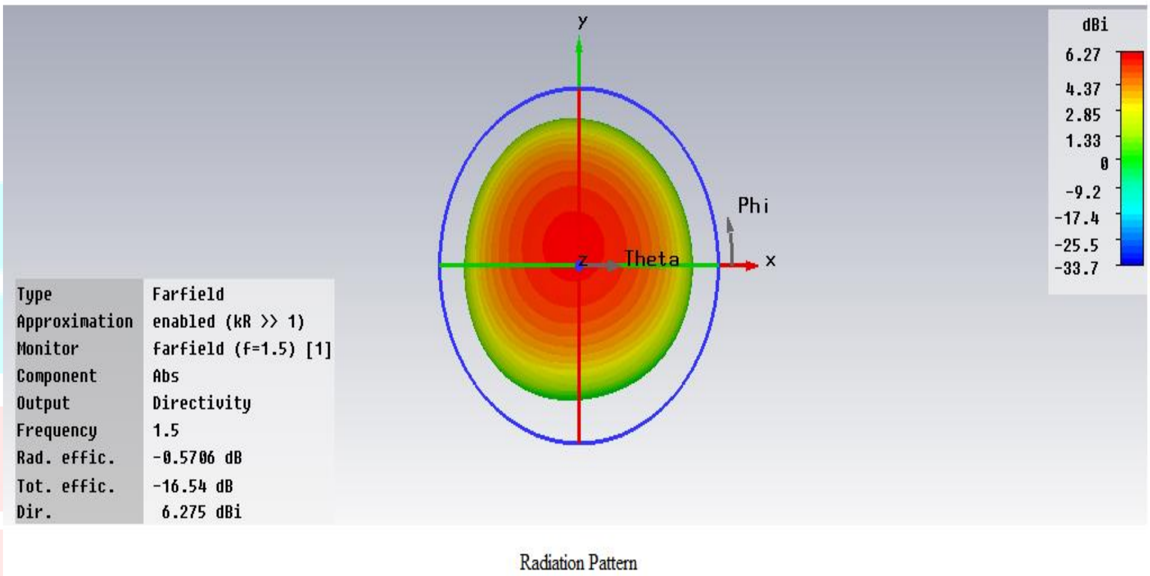


Fig. (e) : Radiation Pattern

Fig (e) shows radiation pattern of final design. In this pattern red color shows the radiation in desired direction.

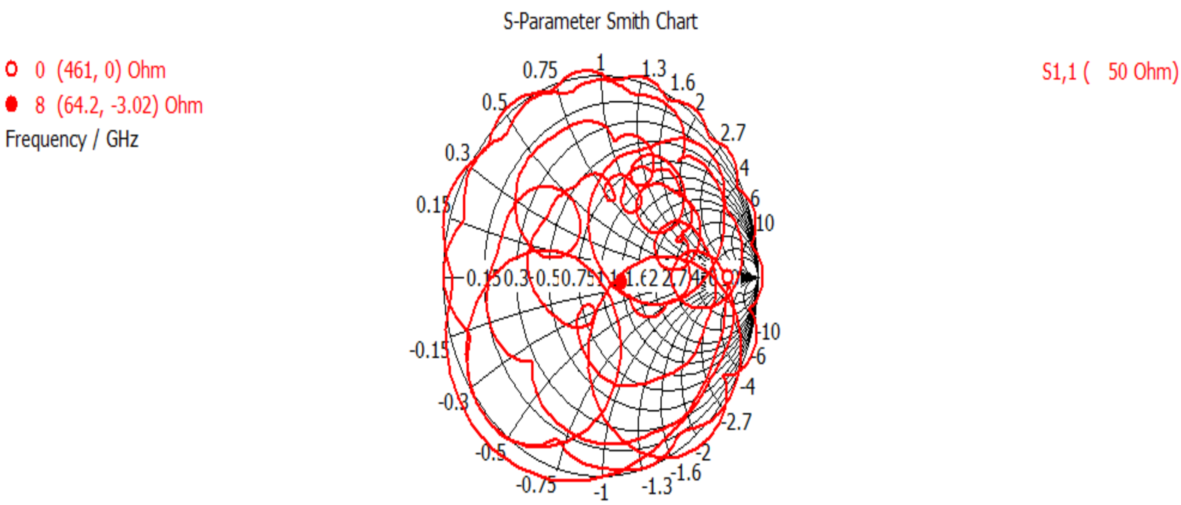


Fig. (f) : Smith chart result

According to the simulation on CST software the design is getting different bandwidth, return loss and VSWR. Following table I is showing the characteristics of designed antenna.

TABLE I. SIMULATED RESULTS OF FRACTAL ANTENNA

Frequency	Band width	Return Loss	VSWR
1.4 GHz	2-8 GHz	-23.3 dB	1.42
1.8 GHz	2-8 GHz	-28.2 dB	1.30
2.8 GHz	2-8 GHz	-33.5 dB	1.06
4.2 GHz	2-8 GHz	-13.3 dB	2.28
6.1 GHz	2-8 GHz	-16.6 dB	3.45

I. CONCLUSION

In this research paper, focused is given on compact area and better result for future work. The companies that supply transmission systems for use on the ground and aboard spacecraft must continuously innovate as satellite operators strive to meet their users growing demand for telecommunications services [8]. Yet even as they overcome daunting technological challenges, antenna companies must also deliver equipment that is more reliable, easier to use, smaller and less expensive than before just to stay competitive. Today's wireless communication, satellite communication and advanced military systems, require antennas of higher performance, higher gain, wider bandwidth, multiband support, low cost and conventionally smaller design dimensions. Fractal antennas are designed using fractal geometries which show properties like self-similarity, space filling, and complexity in their structure. One of the researchers described a family of complex shapes that possess an inherent self-similarity or self-affinity in their geometrical structure [9]. The design issues include microstrip antenna dimensions, feeding techniques and various polarization mechanisms whereas the performance issues include gain enhancement, bandwidth issues and reconfigurable microstrip antennas. This paper is also aimed to introduce few applications of micro strip antennas like Wi-Fi, Wi-MAX, RF energy harvesting, Cognitive radio, GSM, Radar and ultra-wide band. Micro strip antennas are also having disadvantages like low gain and low efficiency.

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