World Academy of Science, Engineering and Technology
International Journal of Electronics and Communication Engineering
Vol:9, No:4, 2015

Design of S-Shape GPS Application Electrically Small Antenna

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***Abstract*—** The microstrip antennas area has seen some inventive work in recent years and is now one of the most dynamic fields of antenna theory. A novel and simple wideband monopole antenna is presented printed on a single dielectric substrate which is fed by a 50 ohm microstrip line having a low-profile antenna structure with two parallel s-shaped meandered line of same size. This antenna is fed by a coaxial feeding tube.

In this research, S–form microstrip patch antenna is designed from measuring the prototypes of the proposed antenna one available bands with 10db return loss bandwidths of about GPS application (GPS L2 1490 MHz) and covering the 1400 to 1580 MHz frequency band at 1.5 GHz, the simulated results for main parameters such as return loss, impedance bandwidth, radiation patterns, and gains are also discussed herein. The modeling study shows that such antennas, in simplicity design and supply, can satisfy GPS application. Two parallel slots are incorporated to disturb the surface flow path, introducing local inductive effect. This antenna is fed by a coaxial feeding tube.

***Keywords*—**Bandwidth, electrically small antenna, microstrip patch antenna, GPS.

I. Introduction

A MICROSTRIP patch antenna comprises a dielectric substrate, with a ground plane on the other side. Because of its advantages such as light weight, low profile flat configuration, lower manufacturing cost and the ability to integrate with microwave integrated circuit technology, the microstrip patch antenna is well suited for applications as the wireless communication system, GPS, cell phones, pagers, radar and satellite communications systems. [21]-[23].

The development of small antennas integrated plays an important role in the progress of the rapid expansion applications of military and commercial communications. High-speed wireless promises to make interactive, data, and video services available voice anytime anywhere. The technology to support these applications has made possible by recent advances in high-density RF and the microwave circuit packaging. [24]-[27] System requirements for faster data transmission in compact designs lighter drive technology area, increasing design solutions often Great designs require integration density microwave devices, circuits and radiating elements that offer light weight, small size, and optimum performance. [1]-[3] During the last two decades, microstrip patch antenna has received considerable attention for use in staff communication systems and synthetic aperture radar applications because of their compactness among other advantages. Intensive research has been carried out with develop new techniques to overcome the patch microstrip [4]-[7] antennas drawbacks, the most restrictive to be narrowband. Increasing bandwidth and return loss improved without increasing the size of the antenna and production process is important to apply this antenna to Modern mobile communications systems and need to be carried out. Many applications in communications and radars require double circular or linear polarization, and flexibility provided by microstrip antenna technology has led to a wide variety of designs and techniques to fill this need [8], [9]. In recent years, demand for compact mobile phone terminals has grown. Phones with the size of a pocket have begun to appear on the market, as demand for increase in the electron mobility increases, the need for small phones will most likely increase. A small antenna size is required as one of the important factors in portable mobile communication systems. The Micro-strip Patch Antennas (MPA) is widely used due to its low volume and Features thin profile. MPA size is basically determined by its length and width resonance. Reduction patch size can be achieved by using patches substrate material with high permittivity and small substrate height [10], [11]. However, in this case, the low radiation efficiency reduces the gain of the antenna.

In this study, a patch antenna S as a novel optimized for simplicity in design and proposed power. We have a feature that also meets the application of GPS system. Antenna parameters, such as return loss, impedance bandwidth, radiation patterns and gains are treated in this paper [12], [13].

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II. S-Shaped Patch Small Antenna Analysis

The results of the development of a wideband radiator for use in applications of wireless communications are presented in this section [14], [15]. Bandwidth is specified as frequency band in which the return loss is less than -10 dB.

The proposed geometry of the microstrip patch antenna as shown in S-shape Fig. 1. The proposed antenna is loaded with two notches. The design specification of the antenna is given in Table I.

First the conventional patch length and width is designed. After designing the patch, we have taken out two slits from the patch to make it S-shape patch. Basic length and width are designed with the use of following equations [16]-[18].

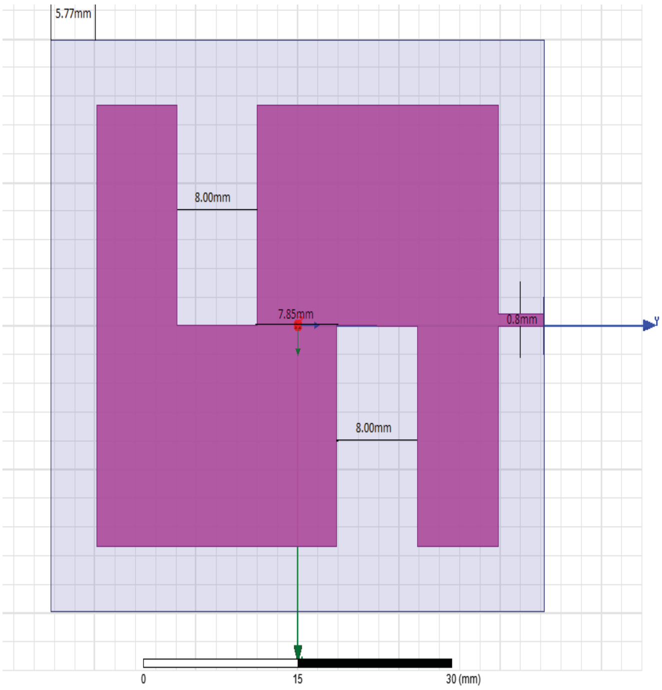

Fig. 1 S-shape top view design

Width of the patch can be designed using the equation:

$$w = \frac{c}{2 f_0 \sqrt{\frac{\varepsilon_r + 1}{2}}} \tag{1}$$

where ε_r = relative permittivity, f_0 = center frequency, C= speed of light.

$$L_{eff} = \frac{c}{2 f_0 \sqrt{\varepsilon_{reff}}} \tag{2}$$

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r + 1}{2}\left(\frac{1}{\frac{\sqrt{1+12t}}{w}}\right) \tag{3}$$

$$\Delta L = 0.412t \frac{(\varepsilon_{reff} + 0.3)(\frac{w}{t} + 0.264)}{(\varepsilon_{reff} - 0.258)(\frac{w}{t} + 0.8)} \tag{4}$$

$$L = L_{eff} - 2\Delta L \tag{5}$$

where t = thickness of the substrate. Here, (2)-(5) using at design the length of the patch. We used the total of the equation having designed the electrically small antenna in S-shape design of GPS application. Here, we have designed the rectangular patch, so length and width are different. We have taken out two slit from the patch to make it S–shape and to improve the results as shown in Fig. 1. Top view of the design is shown in Fig. 1.

Table I shows details about the material. Patch is of the copper material. The substrate is of Rogers RT/duroid 5870 (tm) material with ε_r =2.3. The base material is also of copper [19], [20].

TABLE I
DIMENSION LIST

Length of the rectangular patch (*L*)	39.69 mm
Width of the rectangular patch (*W*)	30.78 mm
Substrate Thickness	3.5 mm
Dielectric constant of the material	2.3

TABLE II
MATERIAL LIST

	Material
Patch	Copper
Substrate	Rogers RT/duroid 5870 (tm)

III. Simulation Results and Discussions

For simulation, we used HFSS 15 of Ansoft, which is an excellent simulator for RF antennas. After simulating the design, the result we got is as follows.

Fig. 2 shows the Return Loss (S_{11}) plot of the design and Table II shows values of Return Loss (S_{11}) in dB for single bands with their frequency. The minimum return loss that we are getting for this design is -30 dB for the one band centered around 1.500 GHz.

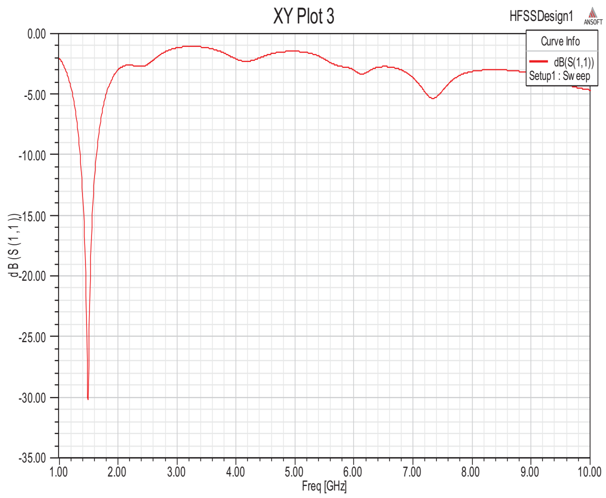

Fig. 2 Return Loss (S_{11}) parameter of the antenna

VSWR plot of the design in Fig. 3 shows the values of VSWR for different frequencies. For the whole range VSWR less than 2 and at frequency 1490 MHz and its value at that point is 1.47. Fig. 4 shows the radiation pattern for frequency 1490 MHz for all the phi values for gain 10.48 db values. Fig. 5 shows the polar plot for frequency 1480 MHz for all the phi values for gain values.

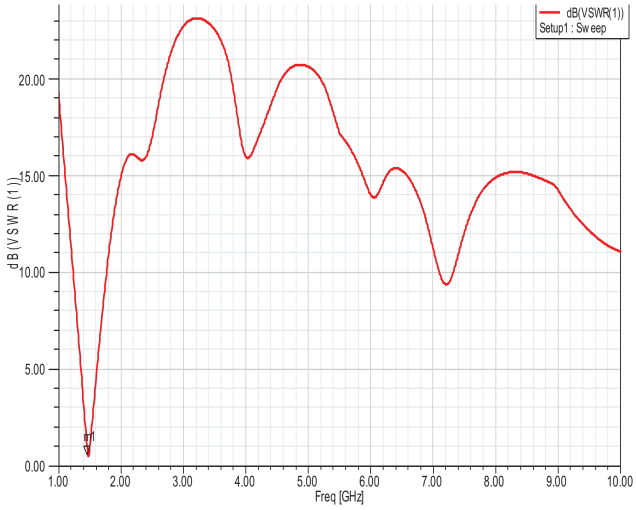

Fig. 3 Return Loss (S_{11}) parameter of the antenna VSWR

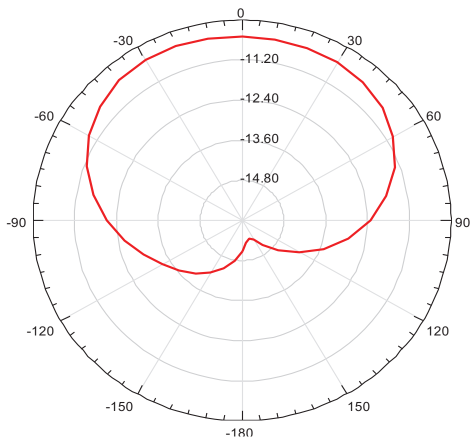

Fig. 4 Radiation pattern of S- shape ESA GPS antenna

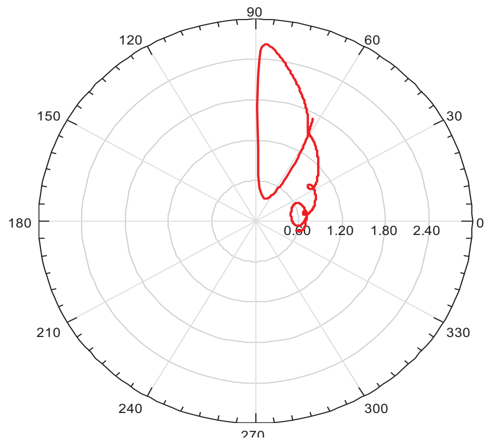

Fig. 5 Polar plot of S- shape ESA GPS antenna

IV. Conclusion

Microstrip antennas have become a rapidly growing area of research. Their potential applications are limitless, because of their light weight, compact size, and ease of manufacturing. The low profile S-shape patch is presented in this paper. Simulations and results of the S-shape microstrip patch antenna have provided a useful design for an antenna operating at the frequency of 1480.5 MHz for the GPS applications. The reflection coefficient is below −10 dB from 1400 MHz to 1580 MHz. At the same time, the antenna is thin and compact with the use of low dielectric constant substrate material, and this antenna is electrically small antenna and compact antenna, and small weight antenna.

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