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Stubbed Line Slotted Inset Fed Microstrip Patch Antenna

Gopika Anirudhan, Tinchu Sara Kuriakose

M.Tech Scholar, Asst.Professor

Department of Electronics and Communication,
Gurudeva Institute of Science And Technology, Vennimala Hills, Payyappady, Puthuppally, Kottayam, Kerala,India

gopikaraponzel@gmail.com,tinchus07@gmail.com

***Abstract*— A stubbed line slotted inset fed microstrip patch antenna designed, simulated and optimized using HFSS has been presented in the thesis. The antenna operates at 2.4 GHz and 3.52 GHz. After analyzing the simulation results of the antenna it shows, it operates in the bands for WLAN and WIMAX applications. Now in the field of wireless communication miniaturization of the antennas has been of great demand. This work has done for designing a compact sized microstrip antenna.**

The substrate material used for the stubbed line slotted inset fed microstrip antenna has been FR4 epoxy material, which has been low cost and readily available. Hence it has been selected. In the stubbed line slotted inset fed microstrip antenna, it consists of two line slots and a stub. For the applications involving WLAN and WIMAX it requires dual band operating antennas. The two line slots have been included to provide the dual band operation and the stub has added to improve the gain of the antenna. In this design an emphasis has given to the size miniaturization too.

Key words: stubbed line slotted inset fed microstrip patch antenna,FR4 epoxy material, line slots, stub

I. Introduction

An antenna is a transducer that transmits or receives electromagnetic waves. By transmitting a signal as radio waves the antenna transforms electric current into electromagnetic waves and vice versa by receiving. Antenna is also said to radiate when transmitting. The IEEE definition of an antenna is given by the following phrase “That part of a transmitting or receiving system that is designed to radiate or receive electromagnetic waves”.

The concept of microstrip radiators was first proposed by Deschamps in 1953.A patient was issued in France in 1955 in the names of Gutton and Baissinor. However 20 years passed before practical antennas were fabricated. Development during the 1970’s was accelerated by the availability of good substrates with low loss tangent and attractive thermal and mechanical properties, improved photolithographic techniques, and the better theoretical models. The first practical antenna was developed by Howell and Munson.

In this era of rapid changing wireless communication systems, miniaturized multiband antennas are playing an inevitable role. Due to this microstrip antennas are being widely used in communication systems. Microstrip antennas are having important features like low profile, light weight, low cost, ease of fabrication and can be easily integrated with other communication systems.

Now in the world of modern wireless communication applications Wireless Local Area Network (WLAN) and Worldwide Interpretability for Microwave Access (Wi-MAX) technology have been widely applied in mobile devices such as handheld computers and intelligent phones. This technique has been widely considered as a cost-effective, viable, and high-speed data connectivity solution, enabling user mobility. These features provide them a wider acceptability among the users.

For the applications involving WLAN and WIMAX it requires dual band operating antennas. In this work it is proposed to introduce stubbed line slot rectangular patch geometry for dual band operation. In this design great emphasis is given to the size miniaturization too.

II. Methodology

A. Design Procedure

The arrangement of an arbitrary shaped patch microstrip antenna is given in figure 1.It consists of patch, substrate, ground plane and feeding point, A patch is a two-dimensional element, which is often rectangular n shape. It is of a very thin thickness of metallic strip on top of a material known as the substrate with thickness h.

In the typical design procedure of microstrip patch antenna, the essential parameters are :

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Frequency of operation (fr): The resonant frequency

Parameter	Description	Dimension(mm)
LSUB	Length of substrate	47.1
WSUB	Width of substrate	50
WP	Width of patch	38
LP	Length of patch	28.01
LS	Length of slot	15.2
LST	Length of stub	10
WST	Width of stub	2
LF	Length of feed line	20.3
WF	Width of feed line	3

of the antenna must be selected appropriately. The resonant frequencies selected for this antenna design is 2.4 GHz and 3.5 GHz.

Dielectric constant of the substrate (ϵ_r):The dielectric constant of substrate material plays an important role in the patch design. A substrate with

	Antenna Design Parameters		
	Ground	Patch	Substrate
Length(mm)	47.1	29.4	47.1
Width (mm)	50	38	50
Height(mm)	.05	.05	1.6

a high dielectric constant reduces the dimensions of the antenna but it also affects the antenna performance. So there is a trade-off between size and performance of patch antenna.

Height of dielectric substrate (h): For the microstrip patch antenna to be used in wireless communication systems, it is essential that the antenna is not bulky. Hence, the height of the dielectric substrate should be less.

TABLE I
ANTENNA DESIGN PARAMETERS

B. Antenna Geometry

The geometry of the new microstrip antenna is shown in figure 2.The antenna has been designed using HFSS-Ansoft software. The figure 2 shows the basic configuration of the proposed antenna for WLAN and WIMAX application, which consists of rectangular radiating patch with line slot geometry. The antenna has a compact dimension of 47.1*50 mm^2, is constructed on a FR4 substrate with thickness (h) of 1.6mm and relative dielectric constant(ϵ r): 4.4.To achieve good impedance matching a stub has been appended to the radiating patch. Table 2 shows the antenna design parameters obtained after optimization for the proposed antenna.

TABLE 2
ANTENNA DESIGN PARAMETERS OBTAINED AFTER OPTIMIZATION FOR THE PROPOSED ANTENNA

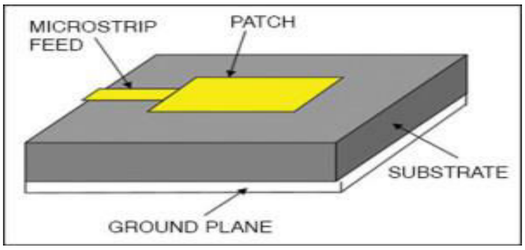

Figure 1: Microstrip Patch Antenna

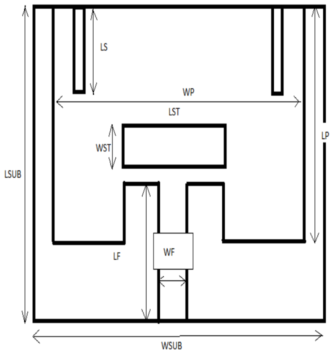

Figure 2: Geometry of the Proposed Antenna

C. Methodology

The proposed design consists of step by step changes on the geometry which improves the values required in specifications. Optimizations have been performed on the geometry and substrate by changing several parameters. Bandwidth and efficiency of a microstrip antenna depends on many factors like patch size, shape, substrate thickness, dielectric constant of the substrate, feed point type and its location etc. Rectangular micro strip patch has been modified for some application to other shapes.

D. Steps for modeling microstrip antenna

The various steps for modeling a microstrip patch antenna is as follows:

The first step is to draw the geometric model of the structure that is to be analyzed. The next step is to select the materials that the various drawn objects are made of. An accurate definition of boundaries for the structure, such as, perfect magnetic or electric conductor follows next. In HFSS, a port or a voltage source needs to be defined to excite the structure. This is done as part of boundary definitions. Once the structure is completely modeled, the solution is set up. This includes definition of various parameters such as the frequency at which the adaptive mesh refinement

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takes place and the convergence criterion. Finally, after the completion of the simulation, the solution data is post processed which may include display of far-field plots, Smith Chart graphs and tables of S-parameter data.

III. RESULT AND DISCUSSION

The objectives indicated earlier are achieved which includes designing and simulation of antenna for WLAN and WIMAX applications. Analyzed the antenna parameters in terms of return loss and gain of the antenna. Compared the measurement and simulation results.

A. *Effect of patch on antenna performance*

To analyze the effect of the length of patch on antenna performance or the resonant frequency, parametric analysis is done. The length variation has done for 27mm to 31mm.From the results the maximum performance has obtained for 28mm patch length. The length of the antenna has varied from 28.01 mm to 28.05 mm with step size 0.01 mm.

The study has done by various length of patch from 28.01 mm to 28.05 mm. A minimum return loss has obtained when the length of the patch is 28.01mm.The length increase the resonating frequency decreases.

B. *Return loss*

It is the difference between forward and reflected power, in dB, generally measured at the input to the coaxial cable connected to the antenna. For maximum power transfer the return loss should be as small as possible. Since the reflected power from an antenna input terminal reduces radiated power, so it is good practice to reduce the return loss.

-25 dB has obtained at 2.4 GHz which is the WLAN frequency, which shows the return loss is minimum.-34 dB has obtained at 3.5 GHz which is the WIMAX frequency and return loss obtained is minimum.

C. *Gain(3D polar plot)*

The radiation pattern of an antenna is a graphical representation of radiation properties as a function of space coordinates. The gain of an antenna is the ratio of maximum radiation intensity in a given direction to the maximum radiation intensity from a reference antenna produced in the same direction with same power input.

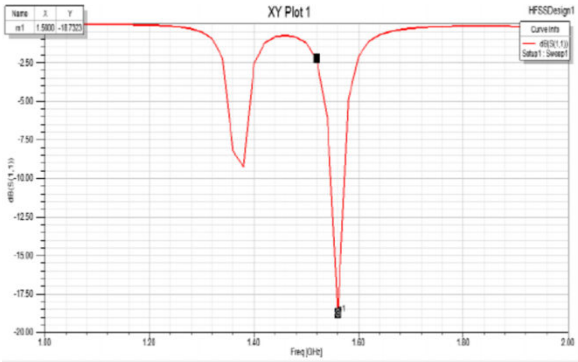

Figure 3: Radiation pattern Vs Frequency

IV. CONCLUSION

A stubbed line slotted inset fed microstrip patch antenna for WLAN and WIMAX applications has been simulated and fabricated in this thesis. An overview of microstrip antenna has been discussed with advantage and disadvantage of microstrip patch antenna. It can be concluded that microstrip patch antenna is advantageous over wire antennas for WLAN and WIMAX devices as the requirement of antenna to be conformal.

A stubbed line slotted inset fed microstrip patch antenna was designed, simulated and optimized using HFSS. The antenna operates at 2.4 GHz and 3.55 GHz and -25 dB has obtained at 2.4 GHz which is the WLAN frequency.-34 dB has obtained at 3.5 GHz which is the WIMAX frequency. After analyzing the simulation results of the antenna we can conclude that it is suitable for WLAN and WIMAX applications. As compared with conventional patch antennas, this antenna has more return loss

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