On the Design of Triangular Microstrip Antenna for Wireless Communication

Jagtar Singh
Yadavindra College of Engineering Talwandi Sabo

A.P Singh
Sant Longowal Institute of Engineering Longowal:

T.S.Kamal
Director Radiant College of Engineering Abohar

ABSTRACT
Microstrip patch antenna has attracted wide interest due to its important properties such as light weight ,low profile ,simple to fabricate and easy to integrate with RF devices. In this paper very small size triangular microstrip antenna is designed by using method of moments (MoM) based IE3D software for wireless communication. The proposed antenna is compact, small, simple to design and fabricate. This antenna can be used for transmission and reception of radio signal at frequency of 13.34GHz. Antenna has a good gain of 4.7858db at resonant frequency of 13.34GHz GHz has large bandwidth of 1.39GHz. Also effect of different commercially available materials Roger RT 5880 Duriod, Roger 5870, Benzocyctobuten and Epoxy on the performance parameters of this antenna has been studied and Roger 5870 found good material for the design of this antenna.

Keywords
Triangular, Microstrip, Antenna, Design, Gain

1. INTRODUCTION
Microstrip patch antennas have been attractive due to their conformal properties [1]. These antennas are preferred for satellite and mobile communication due to their advantages of small size and low manufacturing cost [2]. A microstrip antenna consists of a very thin metallic patch placed a small fraction of a wavelength above a conducting ground plane. The strip and ground are separated by a dielectric sheet referred as substrate. The radiating element and feed lines is normally photo etched on dielectric substrate. The radiating patch conductor is generally of copper and can assume any shape square, rectangular, circular, elliptical, triangular or any other desired configuration [3]. Square, rectangular, dipole and circular are the most common because of ease of analysis and fabrication and their attractive radiation [4]. As the thickness of microstrip is normally very small, the waves generated within the dielectric substrate undergo reflections to some extent when they arrive at the edge of strip, resulting radiations. Methods to feed microstrip antenna are microstrip line, coaxial probe, aperture coupling and proximity coupling [5], [6]. The extreme low profile antenna makes its light weight and occupies very little volume of structure or vehicle on which it is mounted. It can be mounted on to a curved surface so that it is aesthetically appealing and aerodynamically sound. These antennas are used in various applications such as mobile radio and wireless communications. Because of small size, light weight, less cost and good performance these types of antennas are also used in spacecraft, satellite and missile applications [7],[8]. Microstrip antennas can be easily integrated into arrays [9-11] and can be arranged in a rectangular or in triangular lattice. The operational disadvantages of micro-strip antennas are their low efficiency, low power, high Q, poor polarization purity, poor. scan performance, spurious feed radiation and very narrow frequency bandwidth, which is typically only a fraction of a percent or at most a few percent [12]. The traingular microstrip antennas ais suitable choice for radiating elements because of the relatively wider bandwidth compared to other resonant conventional microstrip [13].

Subtrate play a vital role in antenna design,primarily for giving mechancal strength to antenna. Energy storage effect of subtrate also responsible for degraded electrical properties of antenna . So extra care shohld be taken while slecting substare to satisfy both electrical and mechanical reqiurements for the antenna.[14] In this paper traingular microstrip antenna is designed using Method of moments (MoM) based IE3D software and then effect of different commercially available materials Roger RT 5880 Duriod, Roger 5870, Benzocyctobuten and Epoxy on the performance parameters of this antenna has been studiedPAGE SIZE

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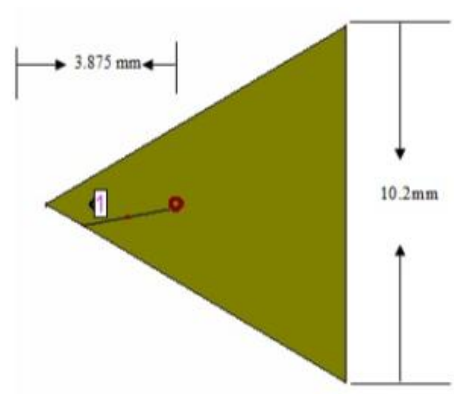

Fig 1: Triangular Microstrip Antenna

2. DESIGN OF TRAINGULAR MICROSTRIP PATCH ANTENNA
For design of equilateral triangular microstrip antenna side length =10.2mm, dielectric constant = 2.2, height of substrate

h=1.59mm was taken. This patch antenna uses a coaxial line feed at distance of 3.875mm from the vertex of triangle and structure is shown in figure.1. This particular feed is one of a number of feed arrangements that can be used with microstrip patch antennas. Each feed configuration has its own advantage and disadvantages. For impedance matching purposes, offset microstrip line feed is easiest to use since the offset depth controls the input impedance of the antenna [13] that's why this type feed is used for the design of this triangular microstrip patch antenna. An effective loss tangent needs top be added to account for the power that is lost to radiation. .

3. EFFECT OF DIFFERENT COMMERCIALLY AVAILABLE MATERIALS ON THE PERFORMANCE PARAMETERS OF ANTENNA

To study the effect of different material on the performance parameters, side length of antenna =10.2mm, height of substrate h=1.588mm and four different substrate Roger RT 5880 Duriod, Roger 5870, Benzocyctobuten and Epoxy with electrical permittivity of 2.2, 2.33, 2.6 and 3.6 taken respectively. This patch antenna uses a coaxial line feed at distance of 3.875mm from the vertex of triangle. Method of moments (MoM) based IE3D software has been used for the simulation of this antenna. Results in terms of performance parameters such as gain, return loss, antenna efficiency and bandwidth are shown in Table.1 from the table we found that antenna with Roger 5870 as substrate material has highest gain of 4.78 db, minimum return loss -26.1729 and overall efficiency of 56.92 which is highest in comparison to antennas with other substrate material. Thus we found that overall antenna with Roger 5870 as substrate material is best. With the increase in electrical permittivity of substrate material resonant frequency shifts to lower value as shown in Fig.2.

4. SIMULATED RESULTS

Place Results for design of triangular microstrip antenna with Roger 5870 as substrate material in terms of performance parameters like reflection coefficient, radiation pattern, antenna efficiency and voltage standing wave ratio are given below

4.1 Reflection Coefficient

Reflection coefficient (S11) or return loss is defined as the ratio of reflected power to the incident power. For practical antenna its value should be less than -9.54 db. Simulated return loss in case of designed triangular microstrip antenna is – 26.1729 db at resonant frequency 13.343 GHz as shown in fig.3.

4.2 Voltage Standing Wave Ratio (VSWR)

Voltage standing wave ratio should have the value less than 2 for the antenna to radiate. In case of designed rectangular microstrip antenna it comes out to be 1.231 as shown in Fig.4.

4.3 Directive Gain

All practical antennas concentrate its energy to more or less content in certain preferred directions. The extent to which a practical antenna concentrates its radiated energy relative to that of some standard antenna is termed as directive gain. For practical antenna its value should be more than zero. Directive

Table I. Effect of different commercially available materials on performance parameters of rectangular microstrip antenna

Substrat e Material	ε	f_r	S_{11}	η	Gai n	Ban dwi dth
Roger RT 5880 Duriod	2.2	13.311	-24.2625	54.43	4.68	1.77
Roger 5870	2.3 3	13.343	-26.1729	56.92	4.78	1.39
Benzocy ctobuten	2.6	13.313	-17.3644	38.59	2.79	2.36
Epoxy	3.6	12.535	-17.8003	23.33	0.69	2.68

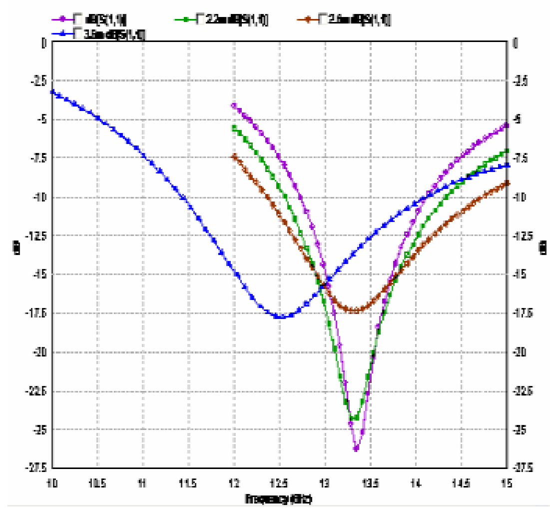

Fig 2: Effect of different commercially available materials Roger RT 5880 Duriod, Roger 5870, Benzocyctobuten and Epoxy.

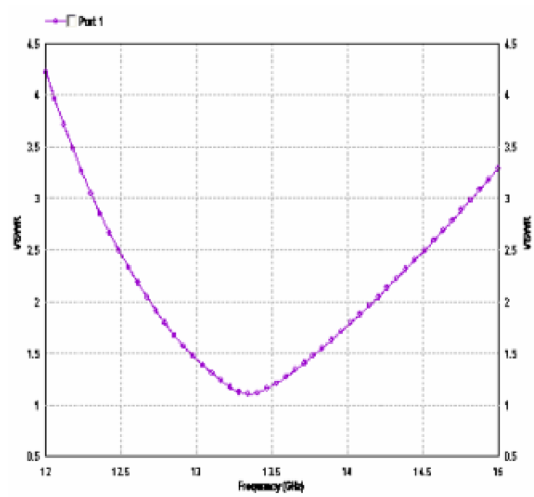

Fig.4: VSWR versus Frequency plot of proposed triangular microstrip antenna

gain of this antenna is 4.78 Db as shown in fig.5&7 which is again quite large.

4.4 Radiation Pattern

It is found, in practice that radiated energy from antenna is not of same strength in all directions. Instead it is more in one direction less or zero in other direction. The radiated energy in a particular direction is measured in terms of field strength at a point which at particular distance from the antenna. Radiation pattern is a graph which shows the variation of actual field strength of electromagnetic field at all points which are at equal distance from antenna. So the graph of radiation pattern will be three dimensional. Practical antennas are designed to have directional radiation pattern, i.e. they will radiate or receive radiation more effectively in one specified direction [12]. 3-D radiation pattern of the triangular microstrip antenna is shown in Fig.5&7.

4.5 Antenna Efficiency

Efficiency of an antenna may be defined as the ratio of power radiated to total input power supplied to the antenna and is denoted by η.

$$\eta = \frac{P_r}{P_I} = \frac{I^2 R_r}{I^2 R_r + I^2 R_L} = \frac{R_r}{R_r + R_L}$$

In our results antenna efficiency comes out to be 56.92%.

4.6 Directivity

Maximum directive gain is called directivity. Plot in form of three dimensional radiation pattern of proposed spiral antenna with solid angle versus directivity is shown in fig.6. So directivity of triangular microstrip antenna is 8.2484 dB, which is quite large.

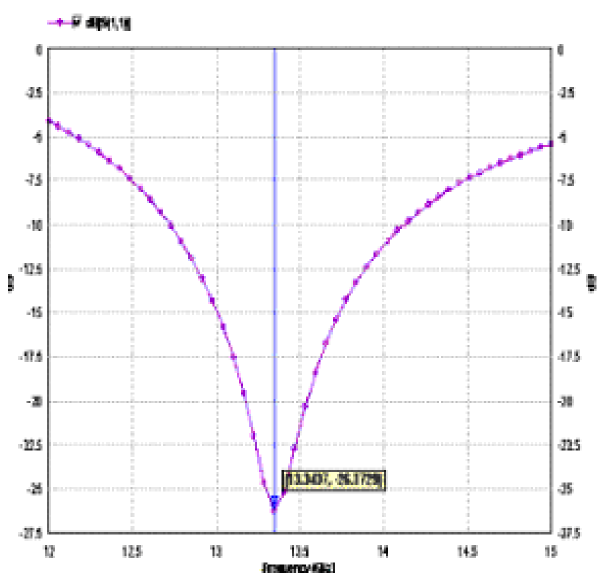

Fig.3: Return losses Versus Frequency triangular microstrip patch antenna

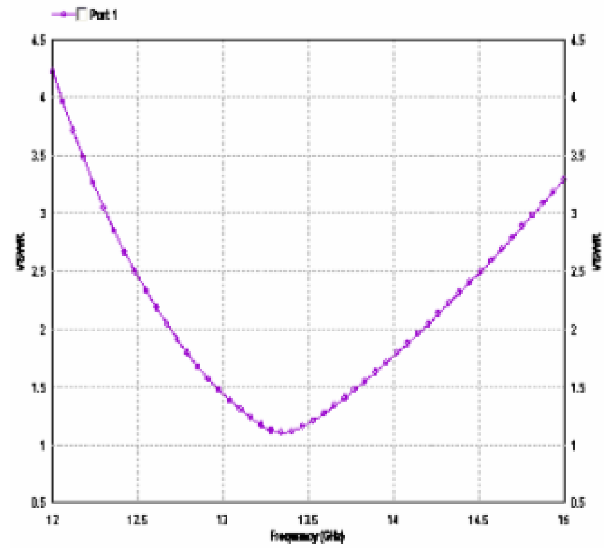

Fig.4: VSWR versus Frequency plot of proposed triangular microstrip antenna

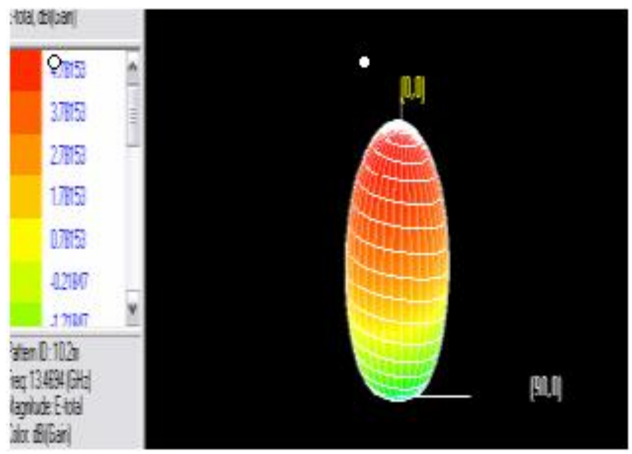

Fig. 5: True three dimensional Radiation pattern of triangular microstrip patch antenna with dBi (gain)

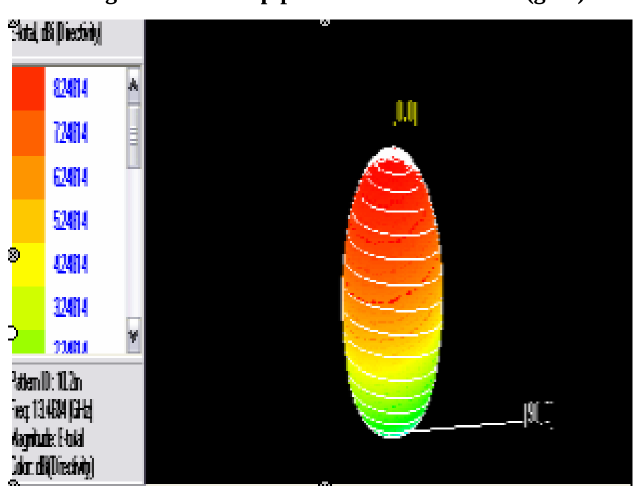

Fig. 6: True three dimensional Radiation pattern of triangular microstrip patch antenna with dBi (directivity)

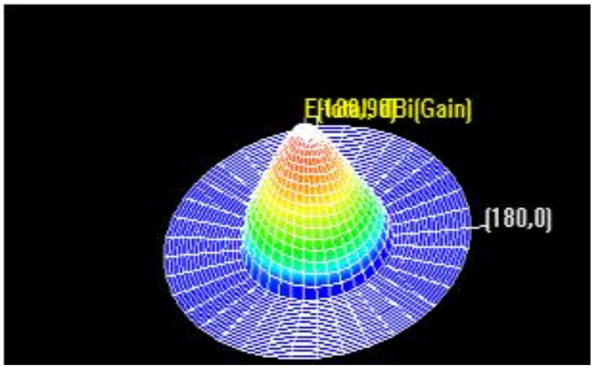

Fig.7: Mapped three dimensional Radiation pattern of triangular microstrip patch antenna

5. CONCLUSION

Design of compact triangular micostrip antenna is presented and discussed in this paper. Effect of different commercially available materials Roger RT 5880 Duriod, Roger 5870, Benzocyctobuten and Epoxy on the performance parameters of this antenna has been studied and Roger 5870 found good material for the design of this antenna. This antenna can be allocated frequency of 13.343 GHz in small size of wireless devices.

6. REFERENCES

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