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Analysis of Non Capacitive coupled Traingular Microstrip Patch Antennas for different dielectric substrates

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Abstract— The recent growth in miniaturization in microstrip antenna has paved tremendous way to enhance bandwidth, directivity and radiation of the antenna, The conventional microstrip antenna consists of a pair of parallel conducting layers separating a dielectric medium, referred to as the substrate. As a matter of course, The simulation of the designed triangular microstrip patch antenna using an array of symmetrical triangles on patch has played a important role in amending the bandwidth. The structure shows the effectiveness of the antenna in terms of bandwidth, gain, directivity. The different antenna configurations are made of using different dielectric substrates with regularly increasing relative permittivity. The comparative result analysis of all the designed cases shows that we obtained maximum bandwidth of 25% and Return Loss -40dB with VSWR of 1.2 when Substarate material was used as RT Duroid 3010. The remaining cases are also displayed hereunder.

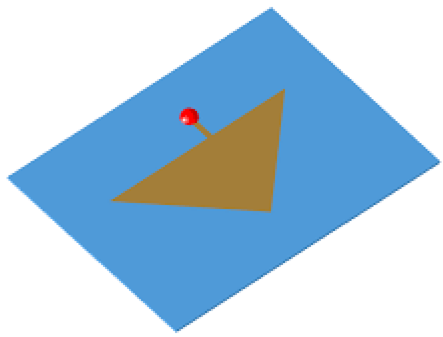
Index Terms- Traingular patch, Superstrate, GHz, Port, Ansoft HFSS, electromagnetic spectrum, Microstrip feed line.

1. INTRODUCTION

Conventional microstrip antennas in general have a conducting patch printed on a grounded microwave substrate, and have the attractive features of low profile, light weight, easy fabrication, and conformability to mounting hosts.

However, microstrip antennas inherently have a narrow bandwidth, and bandwidth enhancement is usually demanded for practical applications. In addition, applications in present-day mobile communication systems usually require smaller antenna size in order to meet the miniaturization requirements of mobile units. Thus, size reduction and bandwidth enhancement are becoming major design considerations for practical applications of microstrip antennas. For this reason, studies to achieve compact and broadband operations of microstrip antennas have greatly increased. Much significant progress in the design of compact microstrip antennas with broadband, dual-frequency, dualpolarized, circularly polarized, and gain-enhanced operations have been reported over the past several years. In addition, various novel broadband microstrip antenna designs with dual-frequency, dual-polarized, and circularly polarized operations have been published in the open literature.

The bandwidth of the MSA increases with an increase in the substrate thickness h or with a decrease in the dielectric constant εr. However, there is a practical limit on increasing the h, and if increased beyond 0.1λ0 , surface-wave propagation takes place, resulting in degradation in antenna performance. Also, with an increase in h, the probe inductance increases and probe compensation techniques have to be employed to obtain impedance matching. There are several ways to overcome this problem such as use modified patch shape and use array technique. Although rectangular and circular geometries are most commonly used, other geometries having greater size reduction find wide applications in wireless communication systems, where the prime concern is compactness. The triangular patch antenna configuration is chosen because it has the advantage of occupying less metalized area on substrate than other existing configurations .



2. SIMULATION MODELS OF DESIRED ANTENNA CONFIGURATIONS

In this designing configuration of antenna we are making a Triangular Microstrip Patch Antenna with different dielectric substrates. In the first case RT duroid 5880 dielectric material was used, the dimensions of Substrate was 73×63×3 MM. The triangular microstrip patch was then configured on the basis of Rectangular Patch. The length of feed line in this case was kept as 14.3mm. In the second case the used substrate is FR epoxy with dielectric constant of 4.4. Rogers 3003 with dielectric constant of 3 is used in 3rd case. The triangular microstrip patch with dielectric constant of 6.15 named as RT Duroid 3010 is used in 4th case. The last substrate material was used as RT Duroid 3010 with dielectric constant of 10. All the cases are designed using High Frequency Structure Simulator software version 11 and thus designed on the basis of Return Loss, VSWR Plot and Smith Plot. To get ourselves more concerned with the design we are showing the following formulae that we used for the determination of dimensions of Substrate, Patch and ground plane.

2.a Traingular Microstrip Patch Antenna Design Formulae in terms of Rectangular patch

The basic equation for resonant frequency is given by:

$$F_{(m,n,l)} = \frac{2c}{3a\sqrt{\varepsilon r}}\sqrt{m^2+n^2}+\sqrt{mn}$$

where *m*, *n* and *l* are the mode integers due to the electric and magnetic boundary conditions, *c* is the speed of light in free space, □□is the dielectric constant and *a* is the sidelength of the equilateral triangle.

However, several methods for correcting the sidelength due to the effect of the fringing fields have been discussed by various authors. The simplest correction was given by Dahele and Lee:

$$a_{eff} = a+\frac{h}{\sqrt{\varepsilon r}}$$

Gang proposed another version of *aeff* which keeps the same expression as that given in Equation (2) but uses the effective dielectric constant given by the following formula:

$$\varepsilon r = \frac{1}{2}\,(\varepsilon r+1)+\frac{1}{2}\,(\varepsilon r-1)\,(\alpha t)$$

We calculated our results using following basic formula.

$$Percentage\ Bandwidth = f_H - f_L/2f_c*100 \text{............... (i)}$$

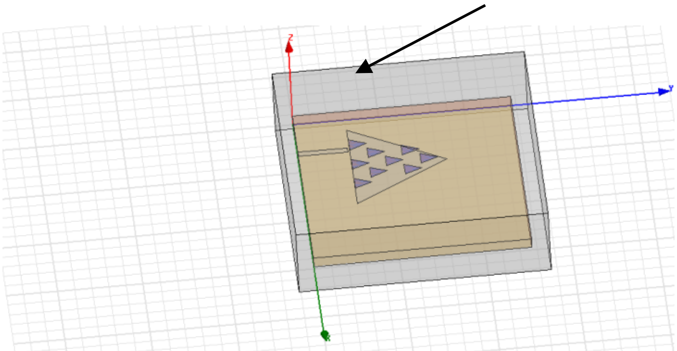
$$Impedencee\ Bandwidth = f_H - f_L \text{..................... (ii)}$$

We calculated all the parameters by using the above mentioned formulae. The

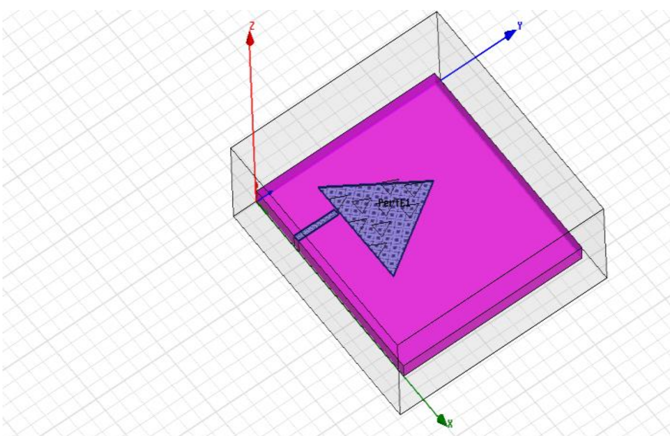
2.b Case I Traingular Microstrip Patch Antenna DESIGN(Contacting Feed Line)

Traingular Microstrip Patch Antenna is utilized with an array of smaller triangular patches. This design is specifically representing the view of our antenna from which we will be obtaining the Return Loss plot and VSWR plot. The actual creation of a Traingular Antenna takes place from creation of a Rectangular Patch and then this designed rectangular patch is cut by the use of a line in such a manner so that a regular triangular microstrip shape can be designed efficiently. We are now in position to define Traingular Microstrip Antenna by its regular structures as follows:

Pictorial View of TMPA:



CaseII Excitation Representation for Traingular Patch:



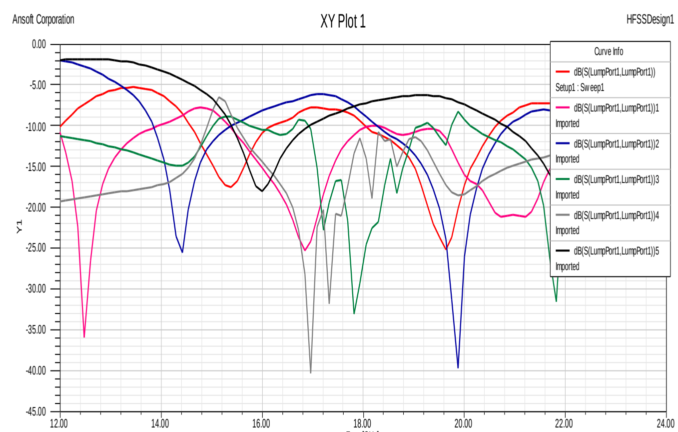
To analyze triangular microstrip antenna we are with 2 very important terms as Wave Port and Lumped Port. The wave port is something which is used to calculate characterstic Impedance, Complex Propagation Constant, and generalized S Parameters. In the other end Lumped Ports are those lumped ports which can be located internallyand have a complex user defined impedance. A patch antenna with parasitic elements is one of the best candidates among those antennas because of its simple design and implementation for array element antennas. The three element gap-coupled microstrip antennas are designed, simulated and fabricated. By using the concept of gap-coupling the bandwidth of microstrip antenna has been increased. In this paper, single patch is fed and the two parasitic patches are excited by the gap-coupling. Figure 3 shows the ETMA geometry of the three elements gap-coupled microstrip proposed antennas with the patches are of the same size.

The solution frequency in this regards is considered as around 12GHz. The resonance frequency in these cases is getting shifted from 13 to 18Ghz.

3. RESULTS AND DISCUSSION

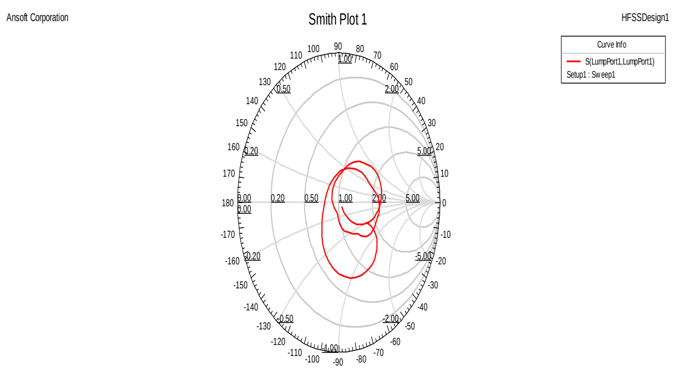
Microstrip Antenna with transmission line feed technique is now shown with different outcomes. The generalized results on the basis of aforesaid mechanism is now shown with following results: The basic outcomes will be discussed in terms of evaluation of Return Loss (dB), which will be emphasizing the actual impedance matching of feed line with respect to patch., Also representation of VSWR Plot and Smith Chart plot will be given.

3.1 Return Loss Plot:



As per the above structures it is being shown that maximum return loss of -40dB is obtained when Rogers 3010 dielectric material was used. The maximum bandwidth in this regards is calculated as 25% for the same material used as substrate.

3.2 Smith Plot:



The Smith Plot in all the five mentioned cases is evaluated as distributed along the resistive line. The smith loss plot is effectively showing that VSWR is under the range of 1 to 1.5 for all the considered cases.

Tabular Representation for all the obtained outcomes :

S.No.	**Substrate Used**	**Return Loss**	**VSWR**	**Bandwidth**
1.	RT Duroid 5880	-18dB	1.3	5.12%
2.	FR 4 Epoxy	-25dB	1.2	22.6%
3.	Rogers 3003	-40dB	1.4	6.4%
4.	RT Duroid 3006	-32dB	1.1	7.9%
5.	RT Duroid 3010	-40dB	1.2	25%

As a matter of fact, after observing the tabular representation it may be said that we are getting maximum bandwidth of 25% and VSWR of 1.1RT duroid 3006 substrate with contacting for substrate material used as RT Duroid 3010 with permittivity of 10.2. In fact, the return loss which is obtained in this case is of quite higher value compared to that which is obtained in other substrate changing materials.

CONCLUSION

The designed Traingular Microstrip Patch Antenna is representing the effectiveness and compactness of design. The proposed antenna with introduction of superstrate is providing the return loss of -40dB and the field distribution of generated energy is bounded under the boundary of patch. This is why radiation other than the desired region is not taking place. The designed can antenna can be efficiently utilized for different kind of mobile communication at dual band operation. This representation of return loss provides the surety of efficiently distribution of energy along the surface of Patch.

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