A Rectangular Microstrip Antenna Designed for Ultra band Application using Superstrate

Tripti Basedia[1] Devyanshu Rao[2]
[1,2]Shri Ram Engineering College, Jabalpur, India

Abstract— In this paper, the bandwidth enhancement of Microstrip patch antenna is done by making a direct contact between patch and feed line. The design antenna obtained good results such as Return Loss of -18dB and -21.5dB, at two frequencies with the solution frequency of 10 GHz. The VSWR of 1 and 1.1 is obtained at the two resonant frequencies. This paper is effectively designed to work in X Band. The broadband characteristics of antenna are shown in simulated application results of design microstrip patch antenna. The designed structure and performance of antenna is simulated using High Frequency Structure Simulator (HFSS) simulation software. The antenna is fed by 50Ωmicrostrip line feed. The concept of Superstrate is introduced to make the work more efficacious and highly useful in latest industry trends.

Key words: Rectangular Patch, Superstrate, GHz, Port, Ansoft HFSS, Electromagnetic Spectrum, Microstrip Feed Line

I. INTRODUCTION

At that time the demand of microstrip patch [MSP] antenna increases day by day because antennas play an important role for broadband devices such like mobile phone, radio, laptop with wireless connection . The purpose of new design antenna presents to enhance the bandwidth of double slotted H shape MSP antenna for many broadband applications such as military, wireless communication, satellite communication, global positioning system (GPS), RF devices, WLAN/WI -MAX application . The major drawbacks of MSP antennas in basic form are narrow bandwidth and low gain and many techniques are used to enhance bandwidth and gain of MSP patch antennas. By using thick substrate with low dialectic constant and compact slotted patch can enhance the bandwidth and gain of antennas . The MSP antenna have good features such as low cost, low profile, light weight, high efficiency, simply manufacture and easy to implement with circuits.The design structure components of antenna become small in size and have low processing cost . In this paper transmission line method are used to analysis the rectangular MSP antenna. The design resonant frequency of rectangular MSP antenna is 10GHz with 50Ωmicrostrip line feed. MSP antenna is characterized by using thickness (h), dialectic constant (εr), and length (Lg, L), width (Wg, W) of ground plane and patch. The performances of design MSP antenna such as radiation pattern, return loss, directivity, VSWR and gain are simulated by using HFSS software.

There are numerous techniques employed for feeding the microstrip patches such as mcirostrip transmission line feed, coaxial feed, aperture coupled feed and proximity coupled feed. When operations are to be performed on simplified basis microstrip transmission line (MTL) feed techniques are employed. In this work MTL technique is utilized and one of the important amendments made is introduction of Superstrate which is not only used to protect external radiation but also effectively utilized to protect the designed antenna from external calamities.

II. SIMULATION MODELS OF DESIRED ANTENNA CONFIGURATIONS

In order to start with the design of the Microstrip patch antenna a rectangular patch of calculated Length (l) and width (w) was considered first. The overall analysis was made by using Microstrip Transmission Line. The dimensions of patch and feed line are selected in such a manner so that the required antenna will be following the standard norms of Radio Wave Propagation. The complete design of the Patch antenna is containing the following geometry of substrate, superstrate, ground plane, patch and boundary. The dimension of ground plane and substrate is 25×30 mm with substrate having thickness of 0.05mm. The substrate is having material of Rogers RT/Duroid 6002 with Relative Permittivity of 2.94 and Dielectric Loss Tangent of 0.0012 and the Superstrate is also having the same material of Rogers RT/Duroid 6002 with dielectric constant ε_r of equal value. The reason of putting both as same is just to observe the behavior of dielectric material changing with respect to creation of Lumped Port. of The rectangular patch of dimension 10mm×13mm×0.05mm was designed. A lumped Port extending from ground plane towards the patch was configured quite safely so that excessive loss of energy can be saved with prior focus. A superstrate above the patch was also designed.

The following expressions are safest mode of creating various dimensions of antenna.

A. Rectangular Microstrip Patch Antenna Design Formulae in terms of Rectangular patch

- Dimensions for Patch:
- Width of the patch (W):

$$W = \frac{c}{2 f_o \sqrt{(\epsilon r+1)/2}}$$

Where c is speed of light
f_o is solution frequency
ε_r- Relative Permitivity of dielectric
Length of the Patch (L):

$$L = L_{eff} - 2\,\Delta L$$

where L_{eff} is the effective length of patch
Δ L is the length extension for patch
Ground plane dimensions:
Length of ground plane:

$$Lg = 6h + L$$

Where h is height of substrate
L is length of patch
Width of the ground plane:

$$Wg = 6h + W$$

We calculated our results using following basic formula.

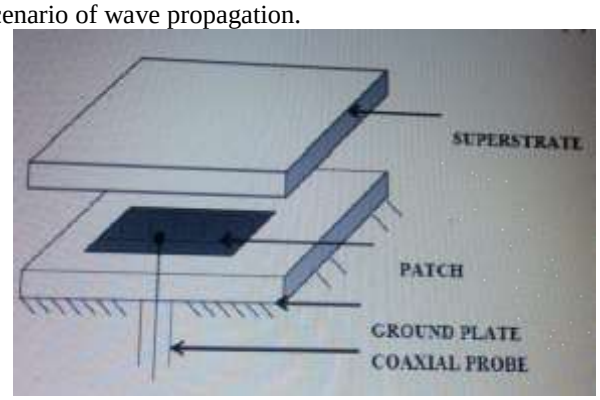
$$\text{Percentage Bandwidth} = f_H - f_L / 2f_c * 100 \quad \text{..... (i)}$$

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

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

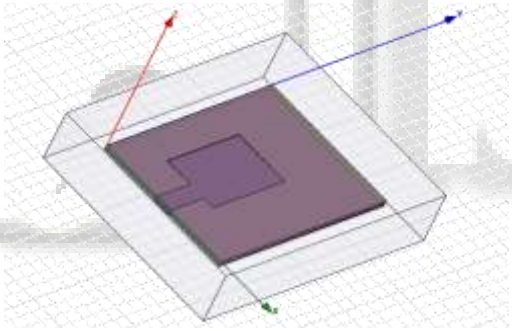
B. Case I Rectangular Microstrip Patch Antenna DESIGN (Contacting Feed Line)

Now a depictive representation of the rectangular microstrip antenna is shown here just to analyze the varying aspects of it. The representation is widely showing Patch, Feed Line, Port, Ground Plane, Boundary etc. with their specified dimensions. The superposition of superstrate has made certain complexity in the design but its comprehensive use makes the designer comfortable in manner that one can have the entire chance to make the antenna useful in largest scenario of wave propagation.



The superstrate concept is representing the sandwitched structure of Patch between two dielectric substrates of varying Permittivity. This structure allows analysis of field distribution under the walls of Patch.

C. The Proposed Rectangular Microstrip Patch:



D. Case II Rectangular Microstrip Patch Antenna DESIGN (Contacting Feed Line)

1) Tabular Representation for all the feed lines:
Solution Frequency- 10GHz
Resonance Frequency-10.6GHz (obtained)

III. Results and Discussion

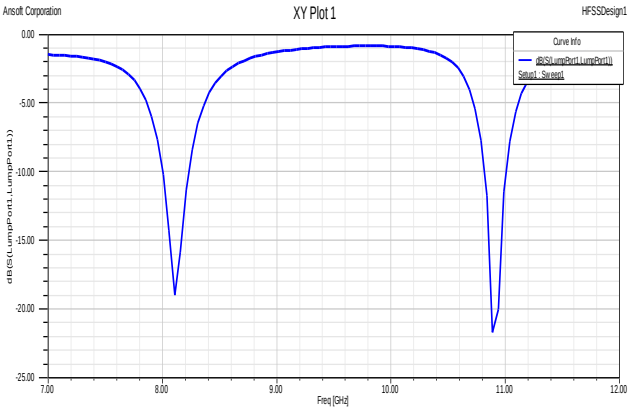
The made design is configured on the basis of RT Duroid 6006 dielectric material. This part of the paper is showing the tabular form representation of designed antenna. In this, the Voltage Standing Wave Ratio, Impedance Matching, Smith Chart plot are designed. The calculated parameters the real outcomes of the designed antenna.

S.No	Feed Line Length	Return Loss	VS WR	Bandwidth
1.	6 MM feed line	-21.5dB	1.1	5%

In fact, after having a glimpse of the tabular representation it may be said that we are getting maximum bandwidth of 5% and VSWR of 1with contacting feed line. In fact, the return loss which is obtained in this case is of quite higher value of -21.5dB.

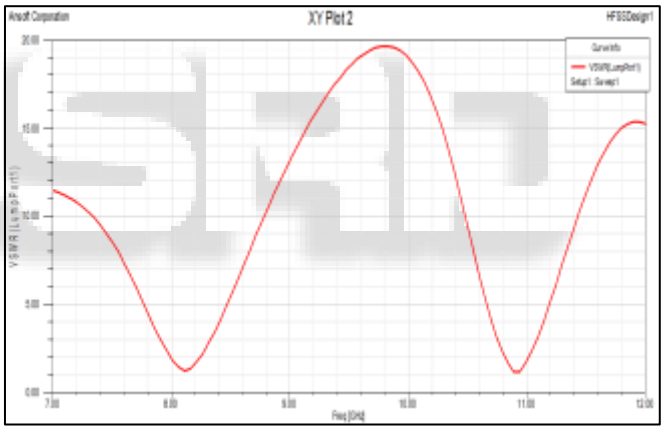
In order to obtain the well-defined results we are herewith representing the Return Loss, VSWR and Smith Chart Plot. The Smith Chart is surely representing the view of its traversion through the resistive part only.

A. Rectangular Plot (Contacting Coupled Feed):

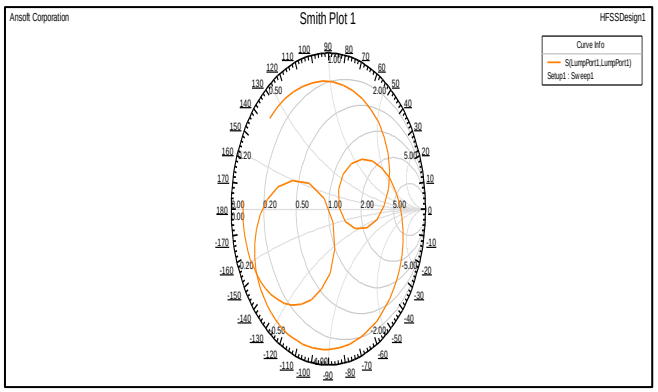


The two dip below -10dB is specifically representing the dual frequency operation with respect to the designed antenna. A return loss of -21.5 Db is also obtained in this case.

B. VSWR Plot (Contacting Feed):



C. Shith Chart Plot:



Impedance matching is widely representing the actual resonant condition. The proper impedance matching is accomplished in order get the ranges under specified set.

IV. Conclusion

The designed Rectangular Microstrip Patch Antenna is focusing on the simplicity and compactness of design. The

configured antenna with inclusion of sandwitched structure of patch between 2 substrates is providing the return loss of -21.5dB at the solution frequency of 10GHz. In this millimetric range of structure distribution of generated energy is bounded under the boundary of rectangular patch. This is why radiation other than the desired region is not taking place. The effective use of this kind of antenna can be made in satellite communication as a transponders appliance.

REFERENCES

[1] Constantine A. Balanis, "ANTENNA THEORY ANALYSIS AND DESIGN", Wiley, 2nd edition.
[2] R. Garg microstrip design handbook. Boston, mass.[u.a.]: artech house, 2001.
[3] Sarkar, P.P. Sarkar, S.K. Chowdhury "A New Compac Printed Antenna for Mobile Communication", 2009 Loughborough Antennas & Propagation Conference,16-17 November 2009, pp 109-11.
[4] Adil Hameed Ahmad and Basim Khalaf Jar'alla, "Design & simulation of RMSA", Eng.Tech.V0l.26, No1, 2008
[5] I. J. Bahl & P. Bhartia, "Microstrip Antennas" Artech House.
[6] Kin-Lu Wong, "Compact and Broadband Microstrip Antennas", John Wiley and Sons, Inc., pp. 112 – 113, 2002

