Comparative analysis for Bandwidth Enhancement of RMPA using EBG and varying feed line lengths

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Abstract— An antenna is a device with its specific features of propagating electromagnetic waves through free space. One of its types is Microstrip Antenna which possess lower cost and smaller dimensions and effectively used in mobile applications. In this paper a Rectagular Microstrip Patch Antenna is desined using Electromagnetic Band gap Structures. The microstrip feed line is used in such a manner that capacitive coupling between patch and feed line is increased gradually. The material used as a substrate was FR 4 epoxy and after simulation using High Frequency Structure Simulator software we obtained maximum bandwidth of 8.3% when length of feed line is kept as 6mm. In the same case Return Loss of -17dB was obtained and VSWR of 1.3 obtained.

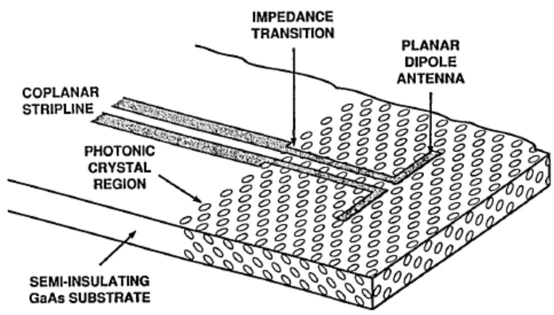
Index Terms- Rectangular patch, EBG, Superstrate, GHz, Port, Ansoft HFSS, electromagnetic spectrum, Microstrip feed line.

1. INTRODUCTION

Microstrip patch antennas have been an attractive choice in mobile and radio wireless communication. This is because they have advantages such as low profile, conformal, low cost and robust. However, at the same time they have disadvantages oflow efficiency, narrow bandwidth and surface wave losses.Recently, there has been considerable research effort in the electromagnetic bandgap (EBG) structure for antenna application to suppress the surface wave and improve the radiation performance of the antenna.

In order to overcome the limitations of microstrip antennas such as narrow bandwidth (< 5%), lower gain (-6 dB), excitation of surface waves etc, a new solution method; using electromagnetic bandgap (EBG) materials, as substrates has attracted increasing attention. Unlike other methods, this new method utilizes the inherent properties of dielectric materials to enhance microstrip antenna performance. These periodic structures have the unique property of preventing the propagation of electromagnetic waves for specific frequencies and directions which are defined by the shape, size, symmetry, and the material used in their construction. Some EBG structures include drilled holes in dielectrics, patterns etched in the ground plane, metallic patches placed around microstrip structures.

The performances of design MSP antenna such as radiation pattern, return loss, directivity, VSWR and gain are simulated by using HFSS software.



The structure is simply describing the representation for a Band Gap Structures which confirms regarding the distribution of energy along all the facets of Patch. The scientific and technological interest towards electromagnetic band gaps _EBGs_ has been growing rapidly since their discovery.The essence of any EBG structure, a periodical structure with certain geometry and dimension, lies in its resonant origin. Due to this fundamental property different interesting effects can be observed, such as band gaps, controllable dispersion, and defect-based waveguiding, field localization, or resonant transmission.

2. simulation models of Desired antenna configurations

The proposed research work is an outcome of the rigorous work made with antenna designing software. In this work we considered 5 different cases of capacitive coupling. The dimension of both the patch and feed line was altered to get the outcomes as per its standard outcomes. The used FR 4 Epoxy substrate was of dimension 74mm×63.6mm×3mm with dielectric loss tangent of 0.02 and relative permittivitty of 4.4. The dimension of Patch was calculated as 38mm×27.6mm with center position of 10,15,3 along X, Y, Z axis. A microstrip feed line technique is utilized to excite patch with Lumped Port. The dimensions of feed line was considered as 2.156mm×14.3mm. The EBG structures which are considered in this regards are cyclindrical structures having radius of 2mm and height of 2.5 mm from the ground plane.

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

2.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 :

$$L_g = 6h + L$$

Where h is height of substrate

L is length of patch

Width of the ground plane :

$$W_g = 6h + W$$

We calculated our results using following basic formula.

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

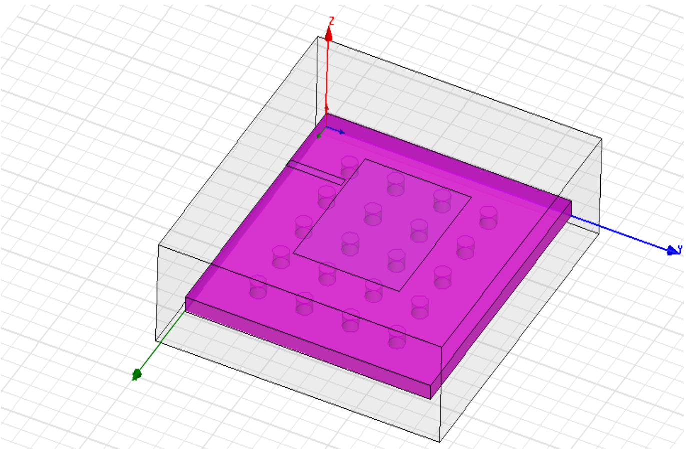
$$Impedencee\ Bandwidth = f_H - f_L \text{...................... (ii)}$$

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

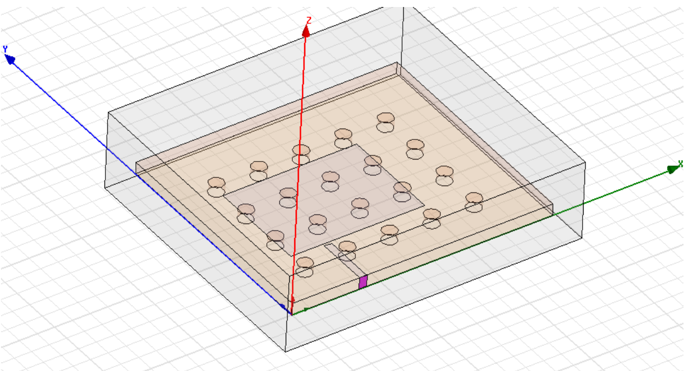
2.b Case I Rectangular Microstrip Patch Antenna DESIGN (Contacting Feed Line)

In order to go ahead with the functional details odNow 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..

(i) Pictorial View of Rectangular Microstrip Antenna



(ii) EBG with emphasised Lumped Port:
The Proposed Rectangular Microstrip Patch:



The afore designed microstrip patch antenna is proposed to radiate effectively at K microwave frequency band. The resonant frequency is getting varied from 15GHz to 18 Ghz as dimensions of feed line patch are getting changed.

Tabular Representation for all the feed lines :

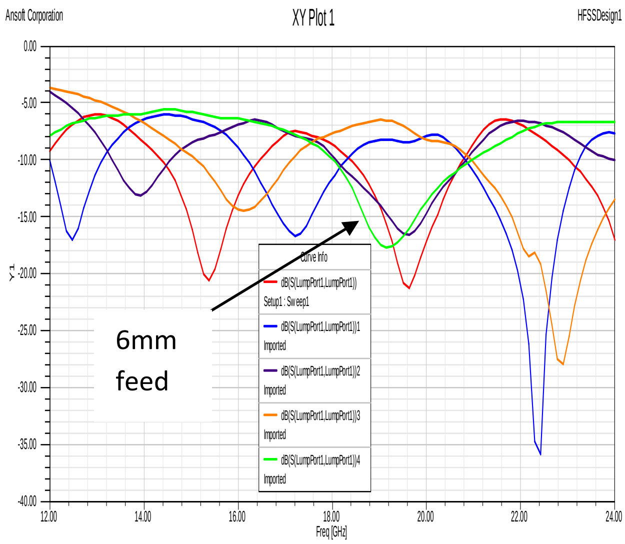
Solution Frequency- 16GHz

Resonance Frequency-13 to 17 Ghz (obtained)

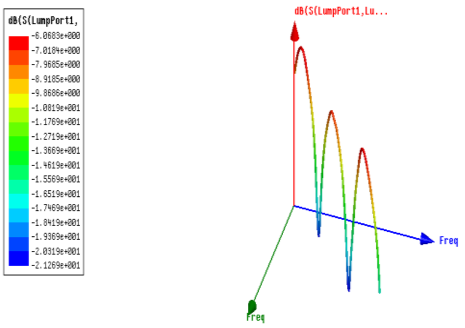
3. RESULTS AND DISCUSSION

The desired rectangular microstrip patch antenna is now evaluated under the tags of Return Loss, VSWR Plot, Smith Plot. As a matter of point, 5 different cases are considered for analysis of RMPA. Thus we are displaying combined plots of all the cases.

3.1. Combined Return Loss Plot: The plot is describing the representation of 5 different cases observed for different feed line lengths and patch. The marked arrow is showing that the maximum bandwidth obtained feed line length.

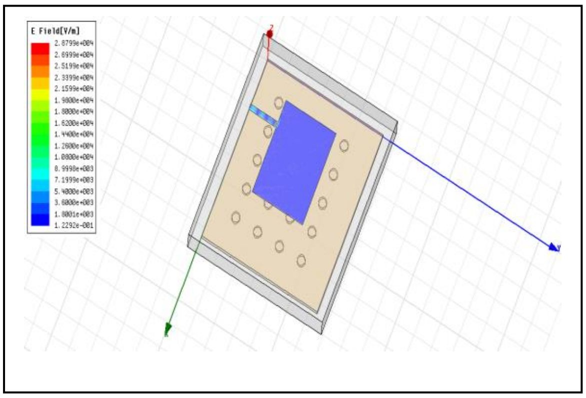


3.2. 3D Cartesian Plot: This plot is specifically designed for describing the variation of return loss with respect to specified frequency. The coloured distribution is describing fact of field distribution along the field applied



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.

3.3 Field Distribution Plot: The energy from capacitive coupled feed is being distributed along the dimesnsion of the patch.



S.No.	Feed Line Length	Return Loss	VSWR	Bandwidth
1.	14.3mm	-20dB	1.3	6.5%
2.	12mm	-16.6dB	1.3	6.2%
3.	10mm	-16.3dB	1.2	6.1%
4.	8mm	-15B	1.4	6.12%
5.	6mm	-17dB	1.3	8.3

3.4 Tabular Representation of Obtained outcomes:

4. CONCLUSION

At this stage we are now in position of finding out the conclusion that amongst the above all observed cases we obtain maximum bandwidth of 8.3% at feed line of length of 6mm and VSWR of 1.2at feed line of length of.10mm. The return loss in this obtained as -17dB which is the maximum obtained with respect to other cases. The electromagnetic band gap structures played a very tremendous role in order to get distribution of field symmetrically along patch. This work can be further extended by using Photonic Band gap Structures and DGS structures to be utilized for bandwidth enhancement.

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