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C0-axial Feed Rectangular Patch Antenna over High Impedance Surface

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I.

Abstract--- **In the field of wireless communication as the demand for small size systems are increasing, the compact size, low profile, light weight micro strip antennas are attracting the antenna designers attention. But these antennas have some drawbacks like narrow band width, low gain and surface waves. So many researches have proposed different techniques to enhance the band width. Now in present paper I am adopting the HIS(High Impedance Surface) as reflecting ground plane insisted of optically planar ground surface. This HIS performs mainly two functions first one is suppress the surface waves, next it will reflects the waves in phase. Hence this will enhance the band width and gain of proposed patch antenna. In current paper comparative analysis of results obtained in conventional design and 2D HIS design were presented.**

***Key words*: 2D HIS, Co-axial feed, surface waves,**

I. INTRODUCTION

In conventional micro strip antenna design uses flat metal sheet as a ground plane that will redirects one half of radiation energy into opposite direction this will no doubted improves the gain of antenna by the amount of 3db but practically shields the objects behind. If radiating antenna is very close to conducting surface then image currents produced are out of phase with currents in antenna so the resultant radiation pattern is the combination of ground reflected and radiated waves. But these will be added destructively resulting in poor radiation efficiency. On more problems with flat metal surface is that it supports surface wave. (Surface waves occur on the interface between two dissimilar metals they exponentially decays to edges or corners and spreads into surrounding metals. When antenna operates at radio frequency the fields developed due to these waves can extend thousands of wave length into surrounding space results multipath interference)

II. DESIGN

A .Conventional Antenna Shape

The basic structure of micro strip antenna consists of patch antenna functions as a radiating element on one side of a dielectric substrate on the other side is supported with ground plane as shown in Figure 1. The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate. Micro strip patch antennas radiate primarily because of the fringing fields between the patch edge and the ground plane. For good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable since this provides better efficiency, larger bandwidth and better radiation but dielectric conductor losses will be more.

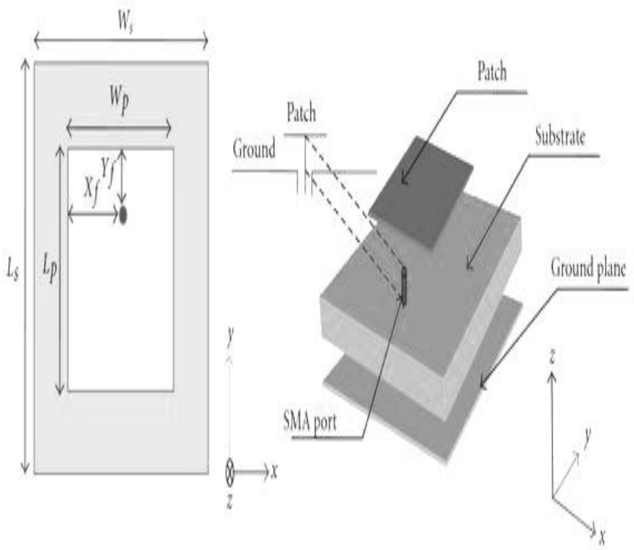

Fig: Block diagram view of a conventional patch antenna

III. HIGH IMPEDANCE STRUCTURE

The structure of High Impedance Surface consists of an array of flat metal protrusions on flat metal conducting

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sheet both are connected by metal pin via. HIS also produce image currents which are in phase with currents in antenna hence it will improves the performance of antenna on compare with conventional design, even when radiating element very close to metal surface. The HIS is discontinued structure hence it does not support propagation of surface waves thus radiation pattern is smooth and avoid multipath interference along the ground plane

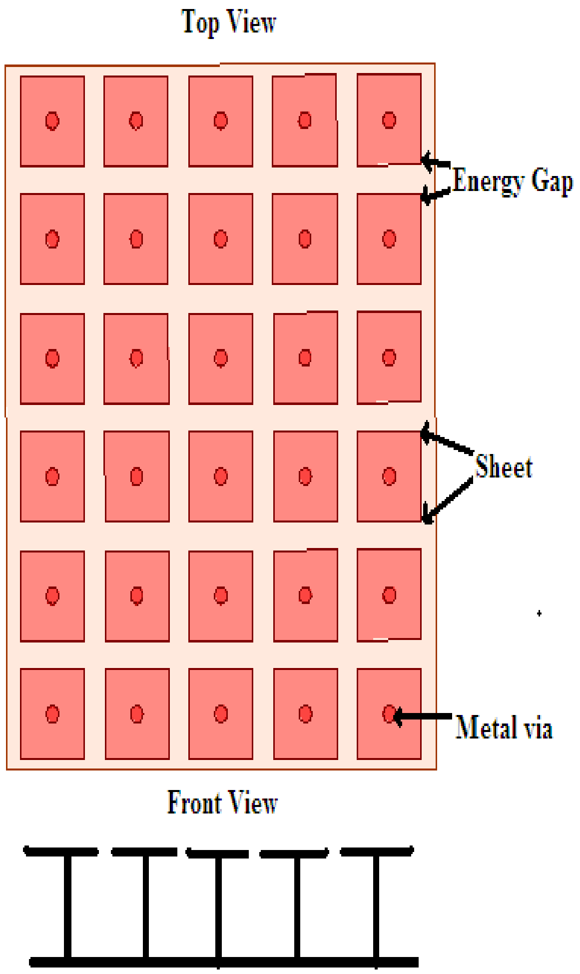


Fig: HIS Top and Front Views

In the design of HIS mainly four parameters need to considered carefully. which are effecting the design performance, like rectangular width(W), gap width(g), substrate thickness(h), substrate permittivity(ε_r) and vertical via radius(r), to have larger band width values the width of rectangular patch antenna(radiating element) is considered larger than the length of patch. The proposed antenna is designed to operate at frequency 2GHz. The antenna is excited by co-axial feed in both structures, the point of excitation is so chosen to give perfect impedance matching between antenna and feed. The Di-electric substrate used here is Neletec NY9220(IM)(tm) whose Di-electric constant is 2.2 and loss tangent is 0.0009.

IV. FEED POINT

The Coaxial feed or probe feed is a very common technique used for feeding Micro-strip patch antennas. As seen from Figure 6, the feed method consists of the inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane. The main advantage of this type of feeding scheme is that the feed can be placed at any desired location inside the patch in order to match with its input impedance. This feed method is easy to fabricate and has low spurious radiation. However, its major disadvantage is to drill a hole in the substrate and the connector protrudes outside the ground plane, thus not making it completely planar for thick substrates ($h > 0.02\ \lambda\ 0$). Also, for thicker substrates, the increased probe length makes the input impedance more inductive, leading to matching problems. It is seen above that for a thick dielectric substrate, which provides broad bandwidth, the Micro-strip line feed and the coaxial feed suffer from numerous disadvantages. Such as non-contacting feed.

V. DIELECTRIC SUBSTRATE:

Considering the trade-off between the antenna dimensions and its performance, it was found suitable to select a thin dielectric substrate with low dielectric constant. Thin substrate permits to reduce the size and also spurious radiation as surface wave, and low dielectric constant − for higher bandwidth, better efficiency and low power loss.

HIS Numerical Design:

Antenna Part	Parameter	Value
Patch	Length	5.93cm
	Width	4.98cm
Substrate	Relative Permittivity	2.2
	Thickness	62mil
	Dielectric loss tangent	0.0009
HIS Structure	Square Width	2.2cm
	Gap width	0.15cm
	Height	0.5cm

Table1 Geometrical configuration of the patch antenna & HIS Structure

VI. SOFTWARE FOR SIMULATION:

Present project is executed in Ansoft HFSS v 13. By the availability of latest simulation software, now a days it become very easy to design our ideas or proposals and check for results before going to real time implementation. Results of return loss, Gain, Directivity, Impedance, VSWR were presented in comparison with conventional antenna.

VII. SIMULATION RESULTS

A. Return Loss

Bellow figure the return loss graphs of conventional and proposed antenna were shown. Their respective return loss as -18dB for conventional antenna and -19dB for proposed antenna According to simulation data it is clear that the proposed antenna have less loss than the conventional type which means the power supplied to the port is completely transferred to radiating element in proposed design.

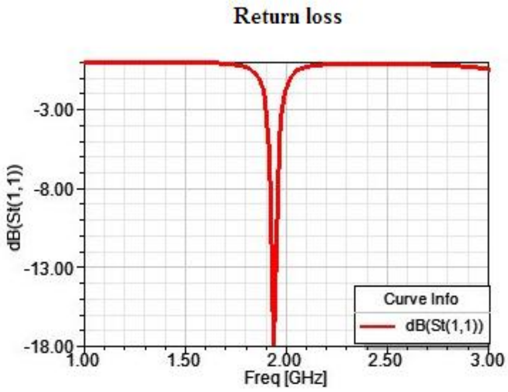


Fig : (a)

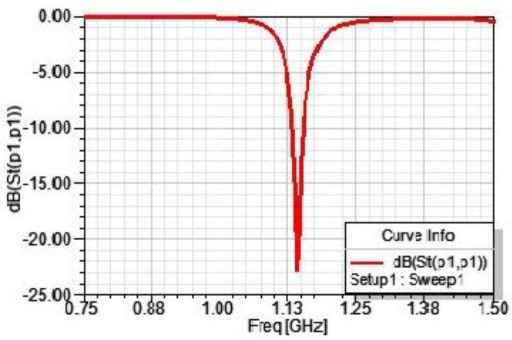
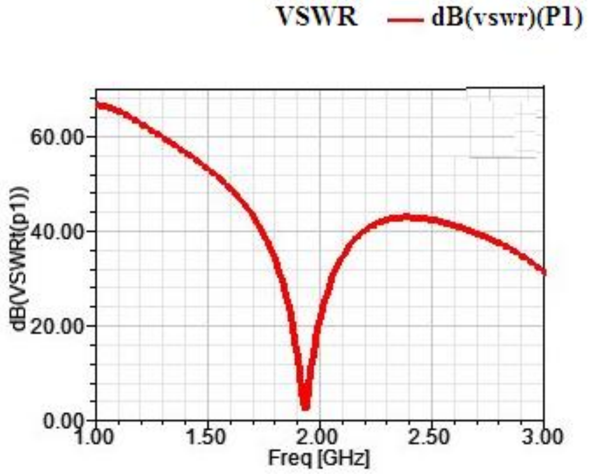


Fig : (b)

Fig: (a) Return loss curve for conventional antenna
(b) Return loss curve for proposed antenna

B. VSWR

the VSWR curves of both conventional and proposed antenna are presented in the following figure. For better results the value of VSWR should lie between 1and 2.



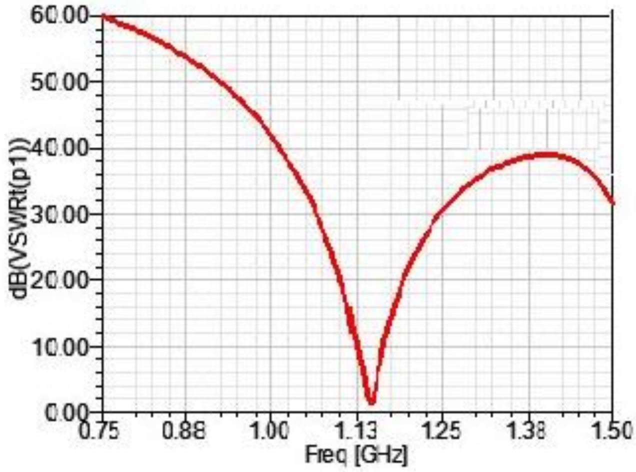


Fig: (a),(b) VSWR vs Frequency curves for conventional & proposed antennas respectively.

C. Input Impedance

The following figure represents the input impedance for both antennas respectively.

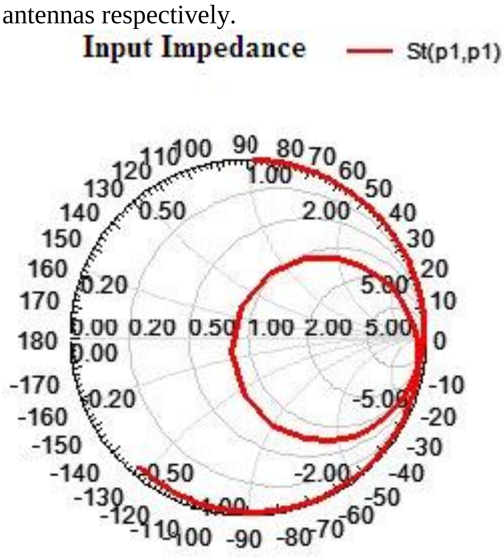


Fig : (a)

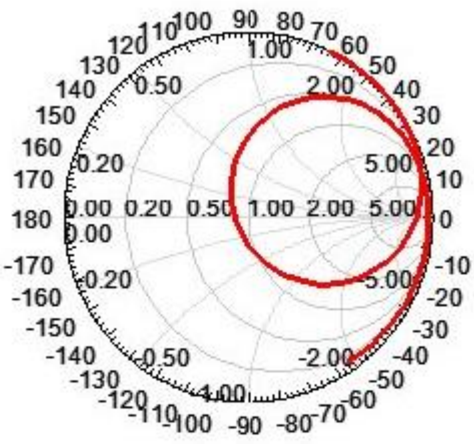


Fig : (b)

Fig : (a),(b) input impedance smith chart curves for conventional and proposed antennas

D. Gain in 2D & Gain in 3D:

Gain explains figure of merit of antenna which combines antennas directivity and electrical efficiency. In present paper the gain is shown in both 2D and 3D views. In the 3D view the conventional antenna have the radiation all over where as the designed antenna have better gain in above direction since it is enhanced in the upward direction because Ground is replaced by HIS.

By the simulated results the gain is 5.2dB and 5.6dB for both conventional and designed antennas.

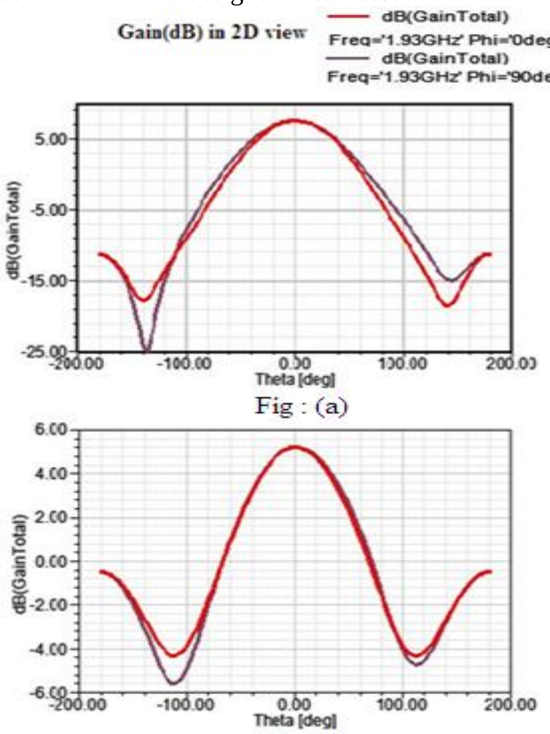


Fig : (a),(b) Gain(db) in 2D view for conventional and propsed antenna respectivly.

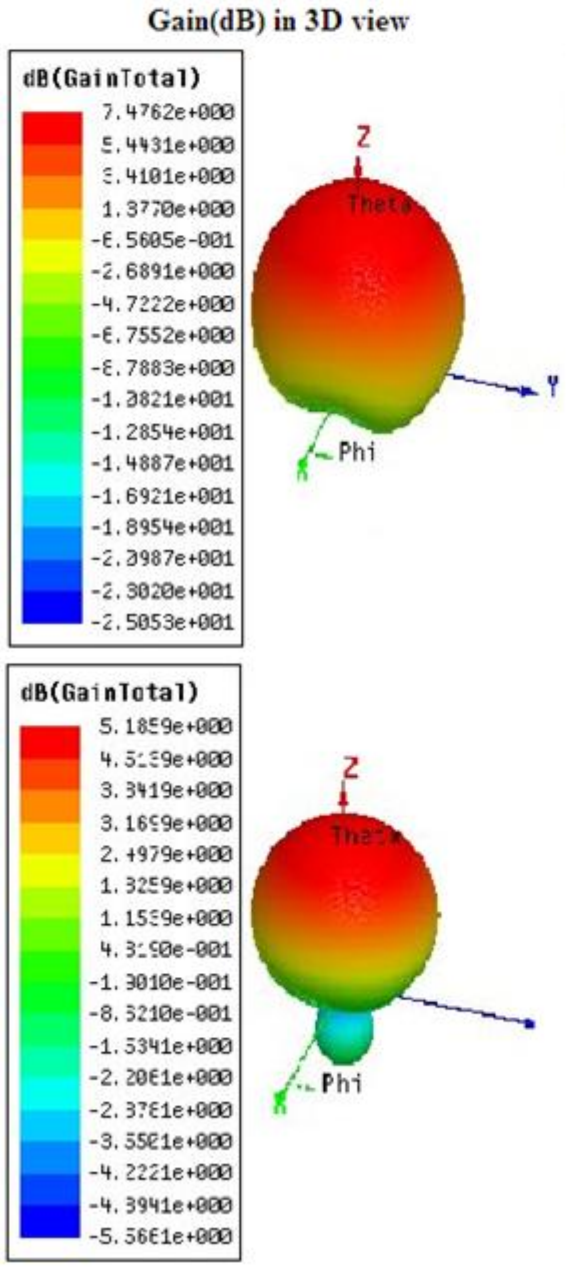
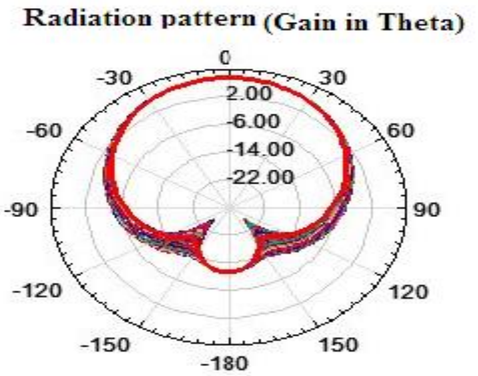


Fig : (a),(b) Gain in 3D view for conventional and proposed antenna.

E. Radiation pattern

The radiation pattern is a three dimensional graph. from figure its is clear that the conventional antenna exhibits the omni pattern but where as our proposed antenna have maximum radiation distributed in theta= -90°to +90° directions and radiation pattern of proposed antenna have better enhancement in that direction.



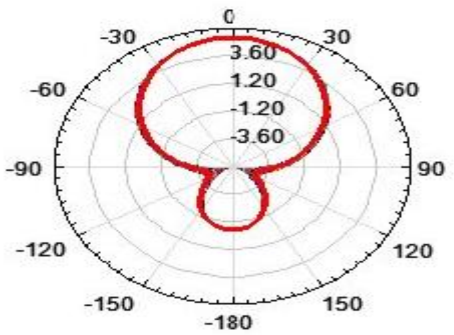
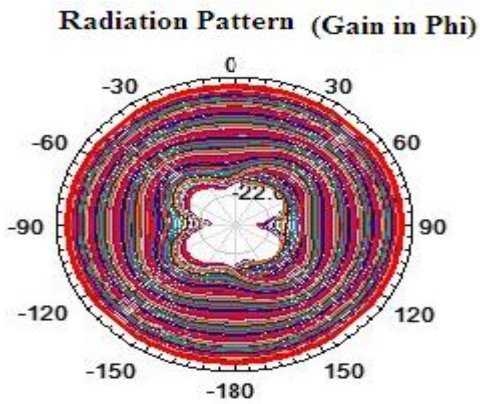


Fig : (a),(b) Radiation pattern of conventional and propsed antenna respectivly in theta direction along all degrees.



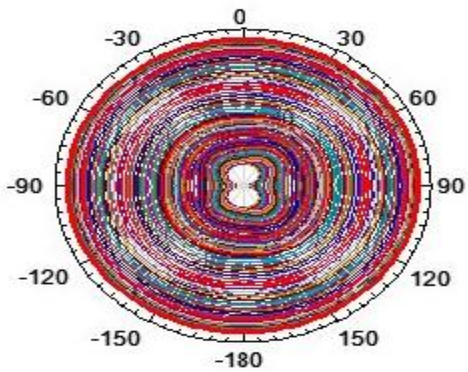


Fig : (a),(b) Radiation pattern of conventional and propsed antenna respectivly in phi direction along all degrees.

Antenna parameters

Quantity	Proposed antenna (value)	Conventional antenna (value)
Max U	0.00398624(W/sr)	0.00235836(W/sr)
Peak Directivity	5.83795	3.41048
Peak Gain	5.59267	3.30058
Peak Realized Gain	5.05186	3.00913
Radiated Power	0.0085807(W)	0.00868988(W)
Accepted Power	0.00895704(W)	0.00897925(W)
Incident Power	0.00991591(W)	0.00984894(W)
Radiation Efficiency	0.957984	0.967774
Front to Back Ratio	74.2241	3.69322

In the above table when comparing the antenna parameters peak directivity, peak gain and front to back ratio of proposed antenna are 5.83795dB, 5.59267dB and 74.2241respectively where as for conventional antenna they are 3.41048dB, 3.30058dB and 3.69322 respectively The radiation efficiency of the proposed antenna have better radiation efficiency than the conventional antenna. the proposed antenna have better antenna parameters than the conventional antenna

VIII. Conclusion

In present project co-axial feed rectangular patch antenna was designed once in conventional method and next case ground plane is replaced with High Impedance Surface. the various parameters of conventional design and HIS design analyzed and presented in comparatively. The enhancement in band width was obtained in HIS structure.

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