

## Broadband $\Psi$ Shaped Antenna for Multiple Frequency Coverage

<sup>1</sup>P.Kartik, <sup>2</sup>A.Sravya Pratyusha, <sup>3</sup>P.Harish Babu, <sup>4</sup>P.Nukaraju Reddy,  
<sup>5</sup>R.Vijaya Durga

<sup>1,2,3,4</sup>Student, Department of ECE, Lendi Institute Of Engineering And Technology, Vizianagaram, India.

<sup>5</sup>Assistant professor, Department of ECE, Lendi Institute Of Engineering And Technology, Vizianagaram, India.

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**Abstract:** The design of a Broadband  $\Psi$  shaped antenna for multiple band coverage i.e for Bluetooth, Wifi, WiMax and satellite communication applications is presented in this paper. The Antenna designed in this paper is used for Bluetooth operating at 2.4Ghz band and Wifi operates at frequency of 5Ghz and WiMax operates at frequency of 2.5/3.5-Ghz. The antenna design proposed in this paper is of FR4 epoxy substrate whose dimensions are 48.5mm and 26mm with thickness of 6mm. The rectangular substrate is now cut into a  $\Psi$  shape of required dimensions. The rectangular substrate is now cut into split rings at four positions on the substrate, and another split ring is employed in first split ring for the better gain and low reflection coefficient by edge feeding. The dimensions of the patch, the ground, and the three slots are optimized to obtain these desired functional frequency ranges.

**Keywords:** Broadband rectangular microstrip antenna, Edge feeding  $\Psi$ -shaped microstrip antenna.

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### I. Introduction

Microstrip antennas have a conducting patch printed on a microwave substrate, and have the features of low profile, light weight, easy fabrication. However, microstrip antennas naturally have a narrow bandwidth, and bandwidth enhancement necessary for practical applications. These antennas have wide range of applications in wireless communications. To distribute the power from the transmitter a power network must be used.

The commonly used technique for realizing a broadband microstrip antenna (MSA) is to cut slots of different shapes – such as a U-shaped slot, a V-shaped slot, an L-shaped slot, or a pair of rectangular or toothbrush shaped slots – at an appropriate position inside the patch.

Because of the rapid and wide development of wireless communications, there is a need to have a compact, lightweight, multi-band and low cost antenna. Ultra Wide Band antennas have the advantage of covering a very wide frequency range. Low cost antenna advantage. Ultra Wide Band antennas have the advantage of covering a very wide frequency range.

The aim of the multi-band antennas is to be able to integrate several frequency bands on one single antenna, making it flexible to operate at several frequency ranges. The two antennas working on multi-frequency bands is presented.

In various designs, Wifi, WiMax and Bluetooth coverage has been presented which covers the multiple frequency bands.

In this paper, dual split ring slots are used where the one split-ring slot enclosed inside a rectangular patch and another split-ring slot which is enclosed inside the first split ring slot.

Due to the multiple frequency coverage, there is reduction in return loss, smaller size and simpler structure which covers the three desired bands for Bluetooth, Wifi WiMAX and satellite applications. The geometry and the design guidelines of the proposed antenna structures are presented in Section 2. Simulated results are presented in Section 3. In Section 4 a brief conclusion is given.

## II. Antenna Configuration

The structure of the psi shaped antenna Design is as shown in design 1. In this design there are no split rings in it it is a basic design with 6 mm-thick FR4 epoxy substrate with dimensions 48.5 mm×26 mm has the reflection coefficient of 15.0/18.5 at frequency 7/4.7 respectively as shown in fig.

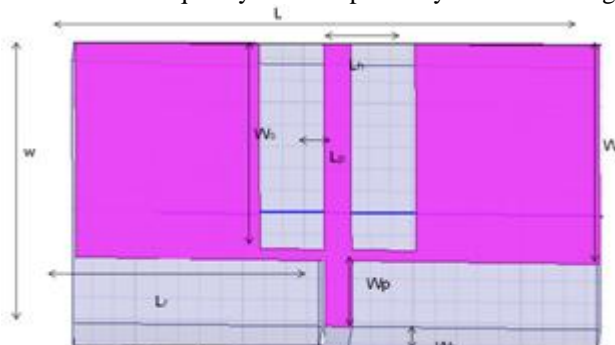


Fig: Basic psi shaped antenna design

parameters	Size(mm)	parameters	Size(mm)
L	48.5	Wp	6
W	26	Wh	6
Lr	23	Wr	19
Ws	19	Lh	6
Lp	2.5		

Table1: Dimensions for design 1

The output response of psi shaped antenna can be observed using by the following parameters.

1) **Input Impedance:** Generally, the input impedance is important to determine maximum power transfer between transmission line and the antenna. This transfer only happens when the input impedance of the antenna and the input impedance of the transmission line are matched. If not match, the reflected wave will be generated at the antenna terminal and travel back towards the energy source.

This reflection of energy results causes a reduction in the overall system efficiency.

$$Z_{in} = R_{in} + jX_{in} \quad (1)$$

2) **VSWR :** Voltage Standing Wave Ratio (VSWR) is the ratio between the maximum voltage and the minimum voltage along the transmission line. Increasing in VSWR indicates an increase in the mismatch between the antenna and the transmission line. A decrease VSWR means good matching with minimum VSWR is one. Most wireless system operates at 50 Ohm impedance. Hence the antenna must be designed with an impedance as close to 50 ohms as possible.

A VSWR of 1 indicates an antenna impedance of exactly 50 ohms. Mostly, the ratio of  $VSWR \geq 1$ .

3) **Gain :** The gain of an antenna is essentially a measure of 100% efficient, it would have a gain equal to its directivity. There are many factors that affect and reduce at the overall efficiency of an antenna losses and By considering of all factors, it would appear that the antenna must overcome a lot of adversity in order to achieve acceptable gain performance.

$$G(\theta, \varphi) = \frac{4\pi U(\theta, \varphi)}{P_{in}}$$

The **return loss** is the other factor by which we can estimate the frequency at which the antenna can be

operated. The antenna with higher return loss has good efficiency.

The following are the return loss, radiation patterns and the 3D polar plot of the  $\psi$  shaped basic antenna.

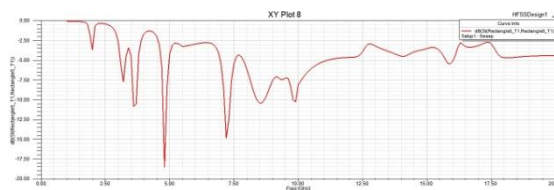


Fig 1: Return loss for psi shaped antenna

The radiation patterns of a patch may be calculated using either an electric-current model or a magnetic-current model. These models are usually divided assuming that either the electric current on the patch or the electric field at the boundary of the patch corresponds to that of the dominant patch mode for a patch with ideal (magnetic wall) boundaries.

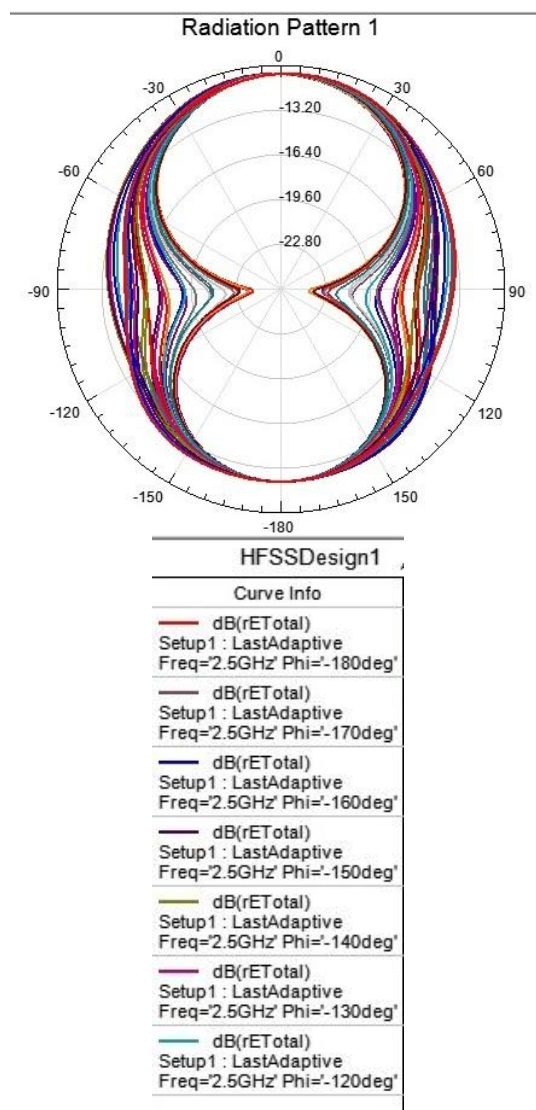


Fig 2: Radiation pattern for psi shaped antenna

The model of the HFSS will be in this form with the x,y and z co-ordinates, the rectangular shape is the substrate in which the antenna designed, and the rectangular antenna is fed with edge fed on that power

divider branch like psi shaped slots is placed and the optimization is done. This is the closer view of the design process given in following figure.

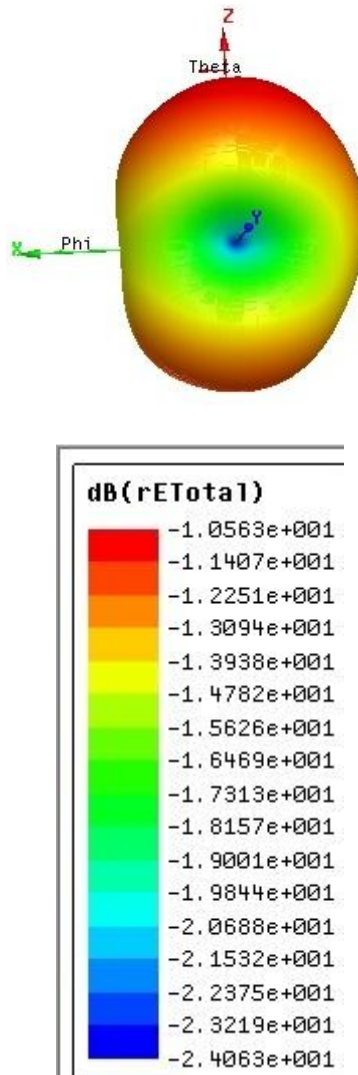


Fig 3: 3D polar plot of PSI shaped antenna

Basic design observed output specifications:

Frequency (GHZ)	Reflection Coefficient(db)	VSWR	Application
4.52	-18.5	1.11	Bluetooth, wimax
7.20	-14.5	1.14	Microwave, Radar , satellite

To enhance some better results than the basic proposed design we had inserted rectangular slots in the psi shaped slots on both the sides. Hence we can yield better results.

By placing the split rings in design the reflection coefficient decreased. coefficient was reduced to the value of 21 at the frequency of 3.5Ghz .This is used for WiMax application.

**Bandwidth :** Another important parameter of any antenna is the bandwidth it covers. Only impedance bandwidth is specified most of the time. However , it is important to realize that several definitions of bandwidth exist impedance bandwidth, directivity bandwidth, polarization bandwidth , and efficiency bandwidth. Directivity and efficiency are often combined as gain bandwidth.

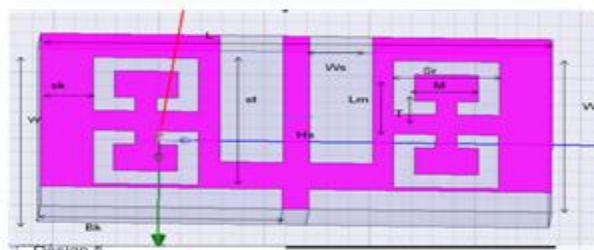


Fig: design 3

This is further modified with small dimensional change. Due to this change the reflection coefficient was reduced to 20 at frequency of 6.9GHz which is used for the application of satellite communication. Little more change in the design with same with 6 mm-thick FR4 epoxy substrate with dimensions 48.5 mm×26 mm. Has the greater change of coefficient of 22.50 at frequency of 7GHz which is used for satellite communication.

Here there are the designs with return loss, radiation pattern and polar plot.

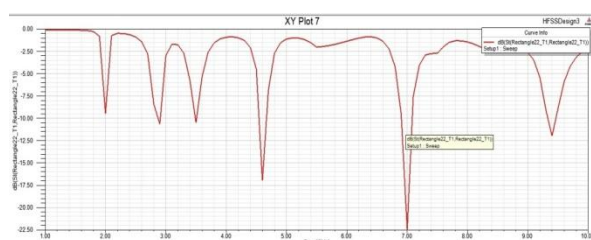


Fig4: Return loss for design2

Fig: Radiation pattern

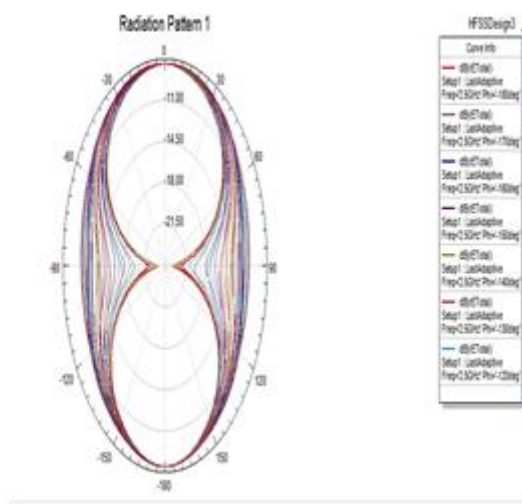


Fig: Dimension table design 3

Observed output specifications:

Frequency (GHZ)	Reflection Coefficient	VSWR	Applications
7	-24.2	1.08	Satellite comm..
4.6	-19	1.11	Bluetooth

Now in design 3 the split rings are placed as shown in the design 2. Two split rings are placed one inside the other with the dimensions as shown.

With with 6 mm-thick FR4 epoxy substrate with dimensions 48.5 mm×26 mm.

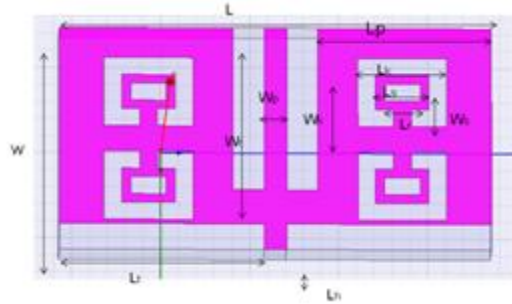


Fig: Double slots Inserted in psi shaped antenna

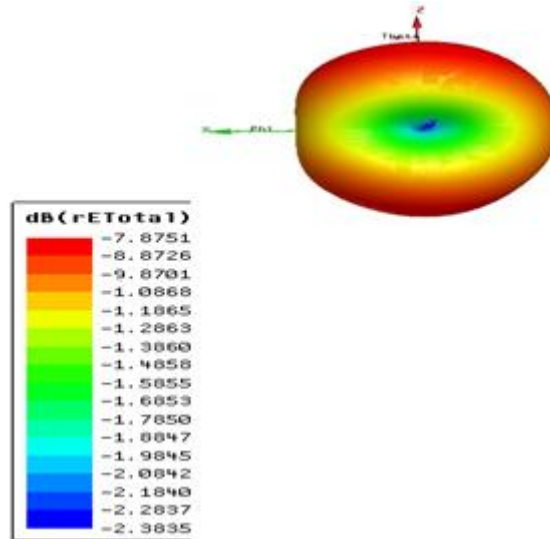


Fig:3D polarplot

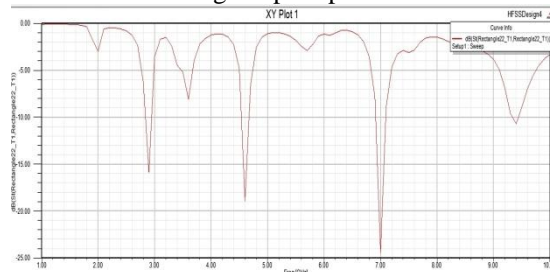


Fig: Return loss for design 3

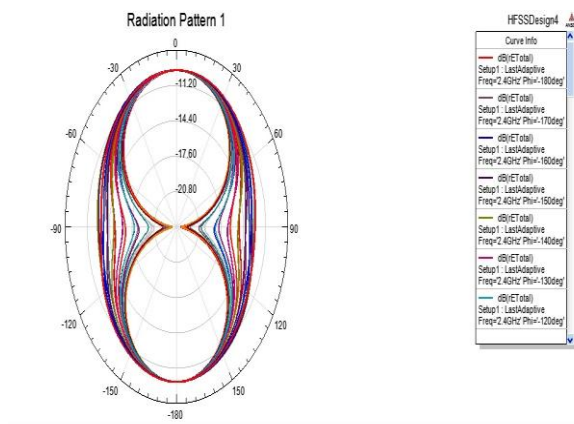


Fig: Radiation Pattern for design3



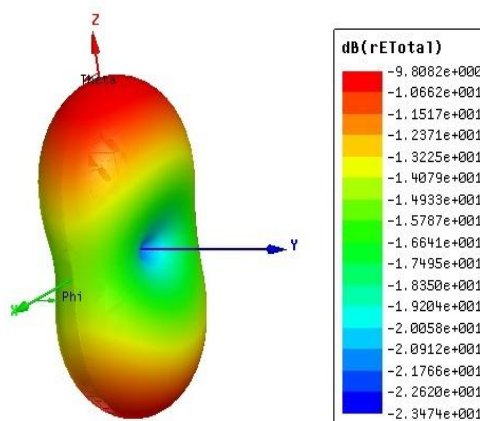


Fig: 3D polar plot for design 3

Observed specifications for design 3:

Frequency (GHZ)	Reflection Coefficient	VSWR	Application
2.8	-20.5	1.10	Wimax, Bluetooth
6.9	-17	1.12	Microwave comm..

### III. Conclusion

A novel multiple slot triple-band antenna suitable for Wifi/WiMAX/Bluetooth/satellite communication applications is proposed in this paper. Using a dual split-ring slot implanted in the rectangular patch three resonant modes with excellent impedance performance and great reduction in return loss has been achieved.

The compact size, multiple band frequency, excellent radiation patterns, great reduction in return loss, good gain and a simple structure makes this antenna suitable for practical wireless communication systems, working on Wifi, Bluetooth, WiMAX and satellite communication networks, in three different frequency bands, 2.4-2.5, 3-4, 6.9, 7 GHz

### References

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