

MICROSTRIP PACTH ANTENNAS FOR IRNSS APPLICATION

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ABSTRACT

This paper presents a study about Microstrip Circular patch antenna for S band satellite application. We proposed it for Indian Regional Satellite System which having the operational frequency band of 2-4 GHz. The DGS (Defective Ground Structure) implies a defective ground structure in place of a simple conventional ground structure. The developed design is succeed to achieve a low profile return loss. We simulate the prototype on HFSS with Rogers RT duroid and FR4 Epoxy materials. The proposed antenna achieved the bandwidth of 166.2 MHz The proposed prototype is consisting of two frequency bands for operation with low profile S parameters.

Index Terms – Microstrip Patch antenna, Circular patch, DGS, IRNSS, Return loss.

I. INTRODUCTION

The requirement of newly designing techniques in place of conventional designing methodology is increasing as the need of simple, compact and durable devices reaches on peak. The conventional satellite antennas consist bulky size and complex designing so that it looks difficult to apply them for mobile and small utilities. For example as mobile GPS systems, small navigation systems which have to matched with satellite and installed in various applications like aircrafts, public transports or various security and public utilities. So as the applications of these fields are robust and almost typical, there is a need to improve the designing of antenna technology so as small in size, less complex, easy to designing and fabrication, better improved parameters. For achieving maximum improved parameter from same size antenna there are lots of designing techniques available.

If we talk about the satellite systems, it has worldwide uses for many utilities. The surveillance and navigation is one of its crucial applications. We are very much familiar with GPS for universal tracking and surveillance, but GPS is an American standard service. The biggest limitation of GPS system is that it is not reliable in hostile situation which India already faced during Kargil war when USA refused to provide information data. So the need of an own navigational and surveillance system is much required.

IRNSS is such an independent, regional satellite system approached by India for India and regional territories. It is named as Indian Regional Navigational Satellite System. It is a 24 hours operational Indian Regional System which works over Indian Air, Land and Sea. The satellites of IRNSS are stationed in geo

stationary orbit. The crucial advantage of geo stationary orbital satellite is that it provides large signal coverage with minimum number of satellite. IRNSS is supposed to operate on two modes of services – (a) Standard Positioning System (b) Restricted Services. SPS will be open to all civilian uses whereas RS is only for military users or authorized users. RS will consist of an encrypted type of service so that only authorized authority can utilize this service. Figure-1 shows the satellite positions of IRNSS.

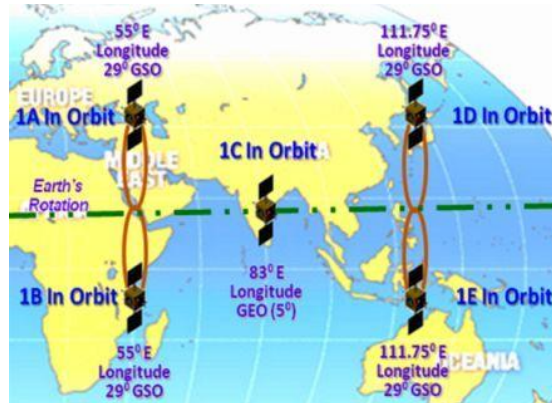


Figure 1 IRNSS Satellite Positions

The operating frequencies of IRNSS are supposed to be operated on L5 band (1176.45 MHz) and S band (2492.08 MHz). The distribution of 7 satellites of IRNSS is as 3 satellites are installed in Geo Stationary orbit and 4 in Geo Synchronous orbit.

II.ANTENNA REQUIREMENTS

Antenna is an essential component any type of a wireless communication system. It works like transducers as it converts EM radiation into electrical signal. For mobile use and device flexibility it should be required that the antenna should be light weighted, small sized easily producible. For satellite use it requires that it should perform circular polarization radiation. While considering the necessity of Antenna and its model for GNSS system, a short observation of features of small strip antenna development in 1970's is made and its important options are : consists of four elements specifically, patch, ground plane, substrate, and the feeding half. ii) it's tiny in size and thus lightweight weight. Due to size reduction it's usually utilized in handsets, GPS receivers and different factory-made wireless merchandise. By using modern fabrication methods, we can produce antennas as small and can be mounted on both planar and flat surface. The traveling Radiation energy, formed on spiral arms, permits for broadband performance (due to mutual coupling development occurring between arms of spiral and through propagation enable the Radiation energy to travel through the spiral arm.

III. ANTENNA FOR IRNSS

As discussed earlier, we concluded on the points that antenna system for such a type system should be light weighted, easy to manufacture, circularly polarized and with a low profile return loss. Microstrip patch antennas, spiral antenna and/array of spiral antenna with options like: i) Rectangular Slot / triangular Slot /

Spiral Slot/different slots on a similar substrate ii) /circularly polarized radiation / RHCP radiation (Right Hand Circularly Polarized radiation iii)Tri-band or Multiband resonant frequencies iv)Horizontal and Vertical Stacking, multi-stacking and/or staking with QIFA. v) shape attributes of associate antenna [antenna using a shape or self-similar style to extend the perimeter among a given total expanse or volume] vi) operation with Single layer or 2 layer or multilayer substrate, vii) Reduction in size viii) dielectric loss tangent, thermal growth and conductivity properties of Microstrip patch antennas has been planned by numerous man of science for application of GNSS and IRNSS Satellite navigation system. If we discussed about the various antenna geometries which are familiar for various patch designs, so basically there are basically five types of patch geometries – i) rectangular patch ii) circular patch, iii)annular patch iv) elliptical patch v) Triangular patch. In this paper we discussed the comparative study of circular patch and annular ring patch geometries [1]. The both comparisons are based on the simulation testing on HFSS. We consider two geometries in all of above because these designs are easy to fabricate, easy to designs, less complex and with variety of designs. Till now we discussed the satellite part and now we are going to showing antenna technology proposed for such a system.

IV ANTENNA DESIGNING

There has been an ever-growing demand of multi band radio system, which is revolutionizing the major advances in wireless communication, networking and radar [2]. The antenna should possess the small size, conformal, low cost, ultra wide band and ease of fabrication. Microstrip – like antenna is one of them. The limitations of the conventional microstrip antenna are its narrow bandwidth, efficiency, and size [3-4]. The Microstrip antenna is an efficient radiator around half wavelength long. As the size of the antenna becomes less than $\lambda/2$, the radiation resistance, gain and bandwidth of the antennas deteriorate. Circular geometry is a very good solution for this problem [4]. These structures recognized by their self-similarity, space filling properties. In the recent years, geometrical properties of self-similarity and space filling nature have motivated antenna research to meet the target of multi-band wideband and miniaturization [5-6].

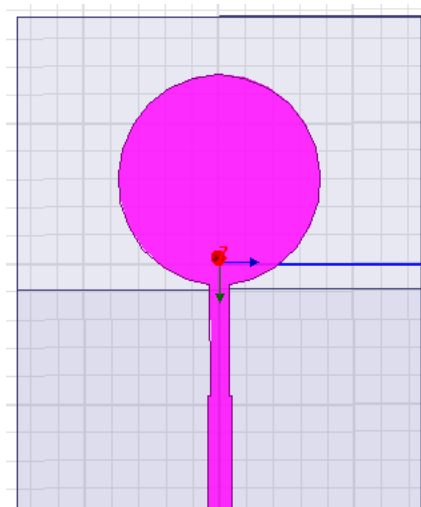


Fig.1 Circular Patch Microstrip Patch antenna with partial ground structure

Above figure shows an simple circular microstrip patch antenna with partial ground structure. The proposed antenna has the following geometry parameters –

Length – 30 mm thickness of substrate is 0.83 mm

Width – 35 mm

The simulation is performed on the FR-4 Epoxy substrate with dielectric constant of 4.4.

V. RESULTS & SIMMULATION

The simulated results are given as follow-

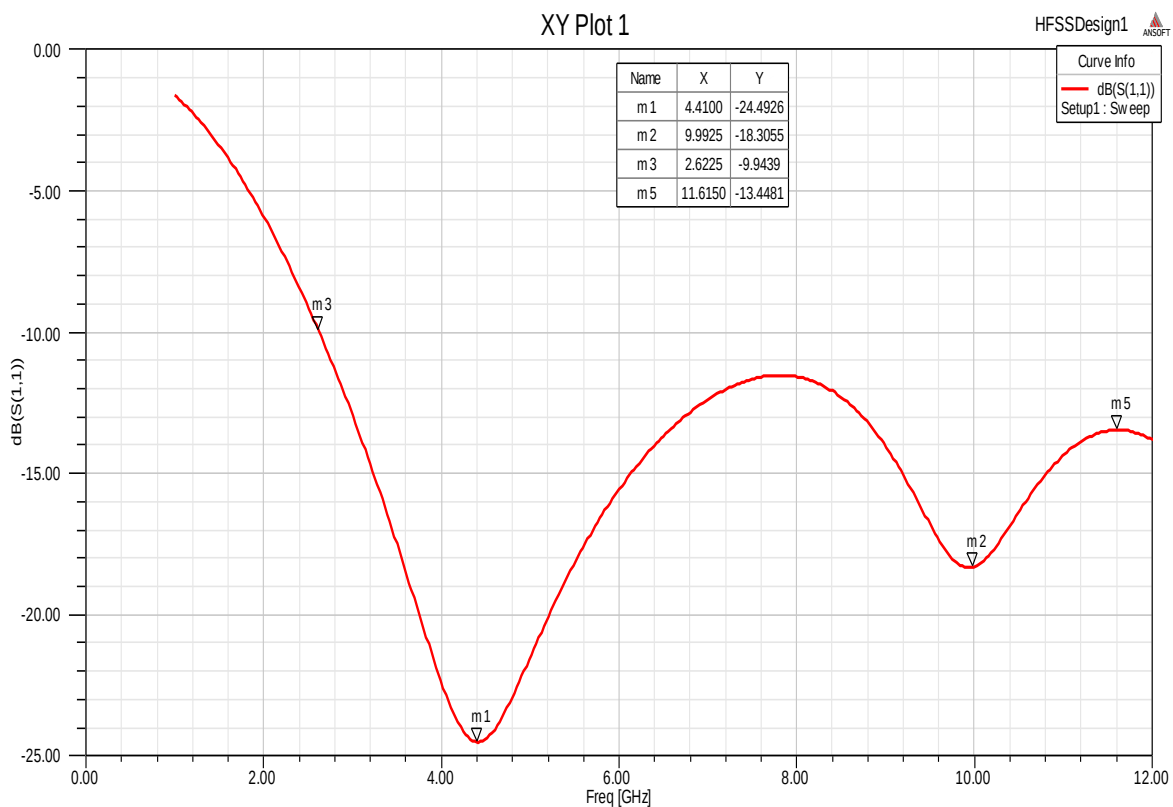


Fig. 2 – S parameters of the given Circular Patch microstrip patch antenna

The figure shows the S parameter of circular patch antenna. S parameters are also termed as reflection coefficient or return also some time. Practically S parameters can be measured by network analyzer of appropriate frequency range. In above figure, it shows very clearly that the return loss of the circular patch antenna is about -24 dB at 4.4 GHz freq. From above result also cleared that the bandwidth achieved by this type of antenna is also very high about 500 MHz.

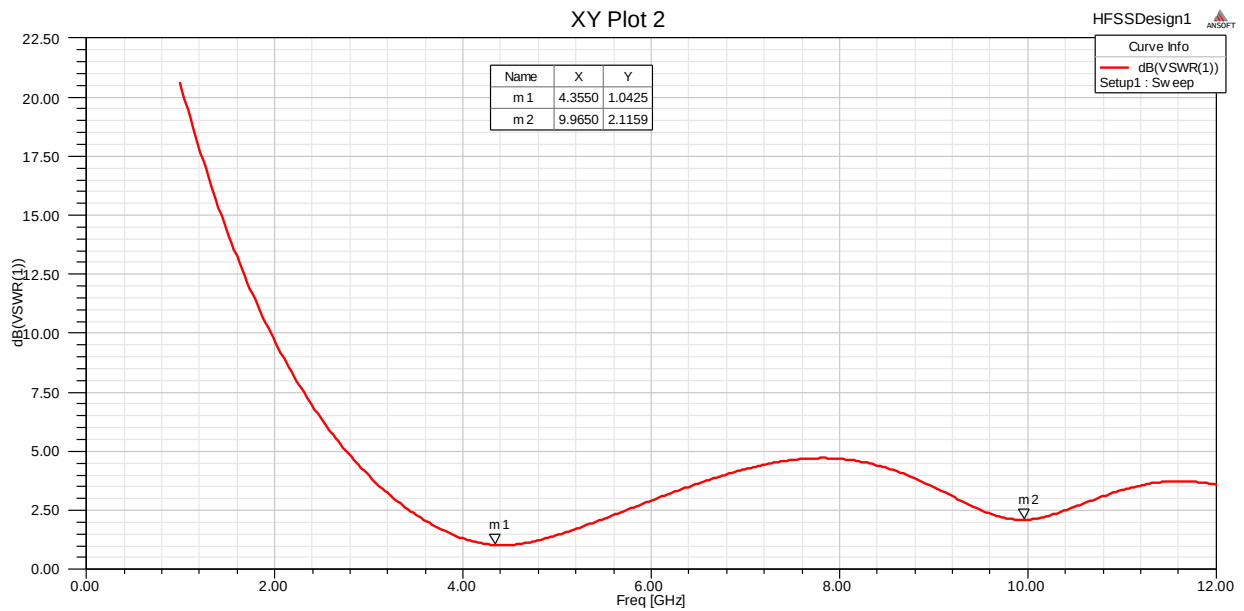


Fig.3 - VSWR of the Circular patch antenna.

VSWR stands for Voltage Standing Wave Ratio, and is additionally stated as Standing Wave Ratio (SWR). VSWR could be a perform of the reflection constant, that describes the facility mirrored from the antenna. It is usually supposed to lie between 0-2 dB, from above figure 3 it is cleared that the VSWR of given antenna is about 1 & 2, which is acceptable.

VI. ANNULAR RING PATCH ANTENNA

Ayappam M proposed an annular ring antenna with a low profile return loss. We also observed that the annular ring patch antenna gives much better results than a simple conventional circular patch antenna.

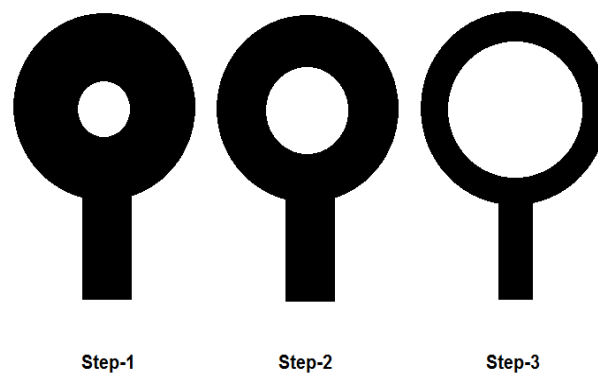


Fig.4 – Variation in annular ring shape

The above figure shows the step to step variation from a circular patch antenna to a annular ring patch antenna.

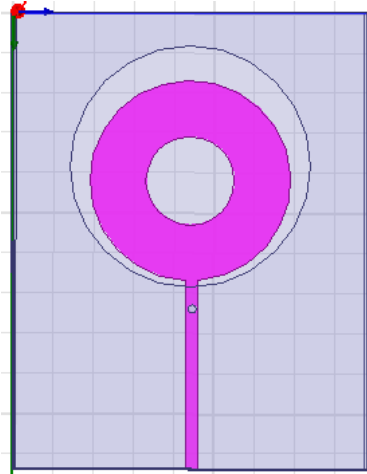


Fig. 5- Annular ring patch antenna

The circular patch geometry has been modified by inserting a circular slot. By inserting the slot, the current path on the patch increases resulting in better antenna efficiency. By varying the size of the slot the effective radius of the patch decreases thereby increasing the resonant frequency of antenna. In the proposed antenna design after inserting the circular slot higher bandwidth of about 440 MHz and low return loss of -31 dB was obtained thereby reducing the narrow bandwidth problem. Higher bandwidth makes them suitable for embedded application.

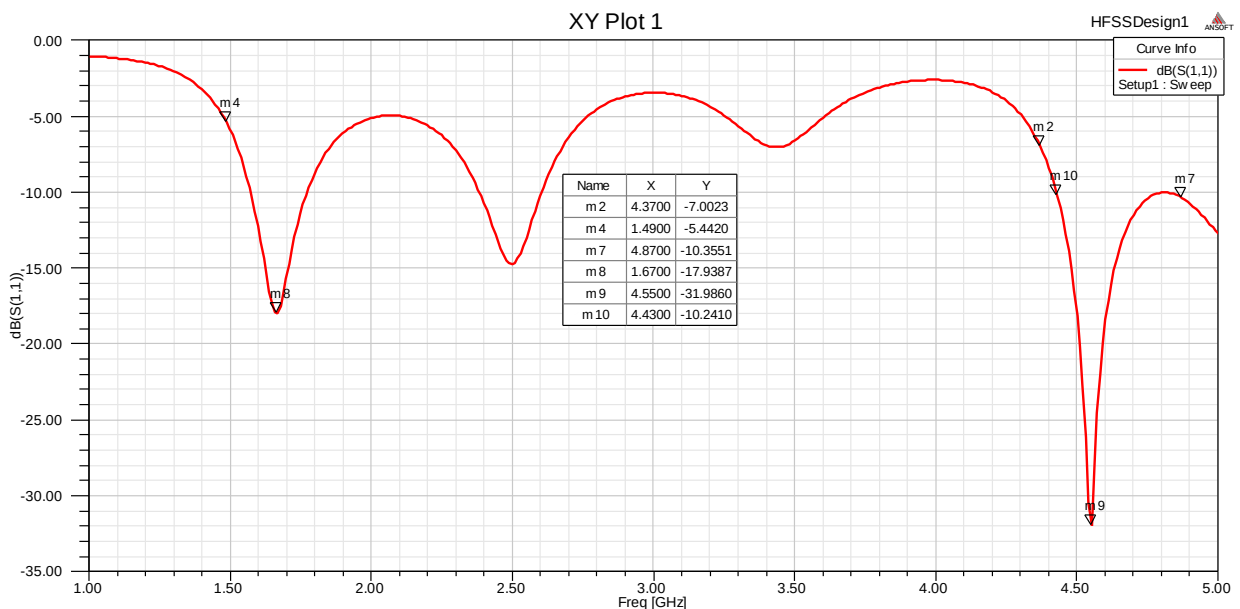


Fig. 6 – S parameters of annular ring patch antenna.

The Annular ring patch design gives much improved low profile return loss as compared to conventional circular patch. We can see it clearly that at 4.5 GHz it gives -31.9 dB return loss which is much improved from conventional circular patch antenna.

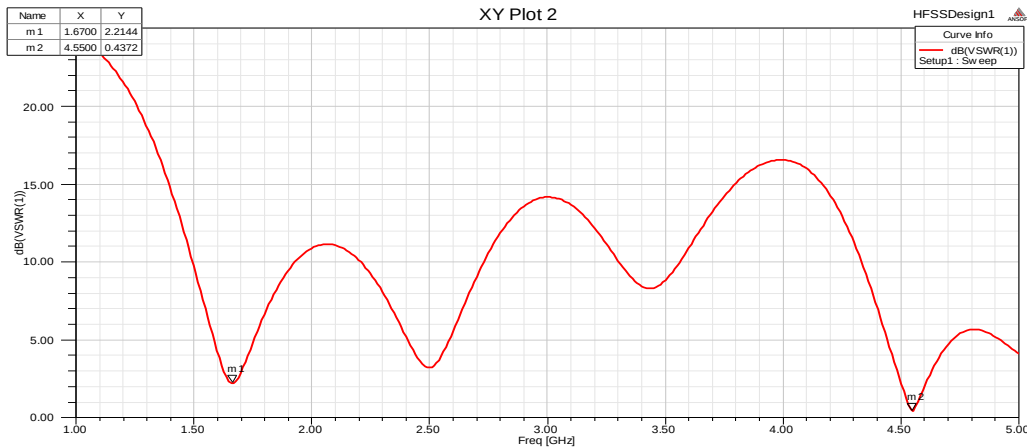


Fig. 7 – VSWR of Annular patch antenna

Figure 7 shows VSWR of the annular patch antenna. It is about range 0-2 dB which is quite acceptable.

VII. CONCLUSION

A comparative study between circular patch antenna and annular ring patch antenna is discussed in this paper. We also discussed the antenna requirements for IRNSS and also discussed a brief introduction of IRNSS. The constant study showed that broadband characteristics are achieved for a smaller antenna solely with the appropriate selection of parameters. The above antennas were designed for 4.4 GHz frequency and their simulated results are comparing with each other.

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