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Spiral Antenna Array using RT-Duroid Substrate for Indian Regional Navigational Satellite System

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Abstract:- India is planned to develop a satellite based navigation systems known as Indian Regional Navigational Satellite System (IRNSS) for positioning applications. Design of IRNSS antenna at user segment is necessary. In order to design antenna, a new planar, wideband feed for a slot spiral antenna is designed using HFSS software simulations. This paper describes a spiral antenna on RT DUROID Substrate for the operating frequency range of 1.2 -1.6 GHz These specifications should be satisfied at the frequency L5 (1175 MHz).Array of spiral antennas can be used to increase the gain. Spiral antennas are reduced size antennas with its windings making it an extremely small structure. The antenna uses four spiral elements to provide broadband satellite coverage and can also be used in conjunction with a space-time adaptive processor (STAP) for interference suppression. This paper presents the input impedance, radiation pattern and gain.

Keywords: Spiral antenna, RT Duroid Substrate.

I. INTRODUCTION

The proposed IRNSS would provide two services, with the Standard Positioning Service open for civilian use and the restricted service, encrypted one, for authorised users'military.The satellites will be placed at a higher geostationary orbit to have a larger signal footprint and lower number of satellites to map the region. IRNSS signals will consist of a Special Positioning Service and a Precision Service. Both will be carried

on L5 (1176.45 MHz) and S band (2492.08 MHz). The SPS signal will be modulated by a 1 MHz BPSK signal[1]. The ground segment of IRNSS constellation would consist of a Master Control Center , ground stations to track and estimate the satellites' orbits and ensure the integrity of the network (IRIM), and additional ground stations to monitor the health of the satellites with the capability of issuing radio commands to the satellites .The MCC would estimate and predict the position of all IRNSS satellites, calculate integrity, makes necessary ionospheric and clock corrections and run the navigation software. Spiral antennas are particularly known for their ability to produce very wideband, almost perfectly circularly-polarized radiation over their full coverage region slot spiral is not burdened with many of these difficulties and as is demonstrated in this paper, the balun and feed structure can be integrated into the planar radiating structure[2].The traveling wave, formed on spiral arms, allows for broadband performance, fast wave due to mutual coupling phenomenon occurring between arms of spiral and leaky wave leaks the energy during propagation through the spiral arms to produce radiation. The traveling wave, formed on spiral arms, allows for broadband performance, fast wave due to mutual coupling phenomenon occurring between arms of spiral and leaky wave leaks the energy during propagation through the spiral arms to produce radiation.The satellites of the GPS broadcast radio signals to enable GPS receivers on near the earth's surface to determine location and synchronized time. The satellite network uses a CDMA spread-spectrum technique where the low-bitrate message data is encoded with a high-rate_Pseudo Random sequence that is different for each satellite. The receiver must be aware of the PRN codes for each satellite to reconstruct the actual message data.[3].

II. SUBSTRATE MATERIAL

The choice of dielectric substrate will play an important role in the design and simulation of the antennas. The substrate choice depends upon permittivity, dielectric loss tangent, thermal expansion and conductivity, cost and manufacturability. In this present work, we used a RT-DUROID substrate material .The RT-DUROID materials are preferable due to low cost, low dielectric constant and having low loss tangent.

III. DESIGN SPEICIFICATIONS

The antenna uses spiral elements to achieve the required number of elements in the array, the dual-band radiation coverage, and to have a small aperture, small volume, and be lightweight. The antenna and integrated feed parameters are optimized for the L1 and L2 band radiation coverage, and the size of the antenna and feed with four elements is 4"x4"x0.02 With such a small size, the antenna can easily be used for a handheld device. Also, in addition to being able to receive satellite signals in the L5 band the antenna has good interference suppression performance.

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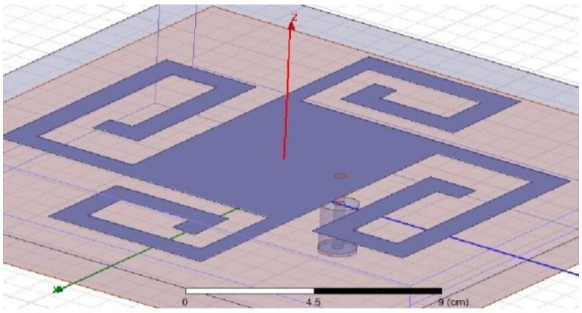

Figure.1: Spiral Antenna

The spiral element is composed of four square Archimedean spirals arranged 2x2 with the center arms shorted together. spiral antennas are reduced size antennas with its windings making it an extremely small structure. Lossy cavities are usually placed at the back to eliminate back lobes because a unidirectional pattern is usually preferred in such antennas.

IV. RESULTS AND DISCUSSIONS

A. Input impedance

The input impedance of an electrical network is the equivalent impedance "seen" by a power source connected to that network. In this we calculate the bandwidth of 1MHz accurately at the respected frequency.

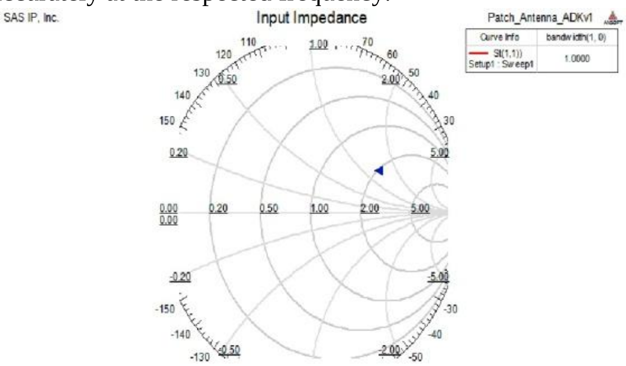

Fig.2: Input Impedance

B. Gain

In this we calculate for both 2D and 3D. The gain raised up to 9dB nearly for a single spiral element.

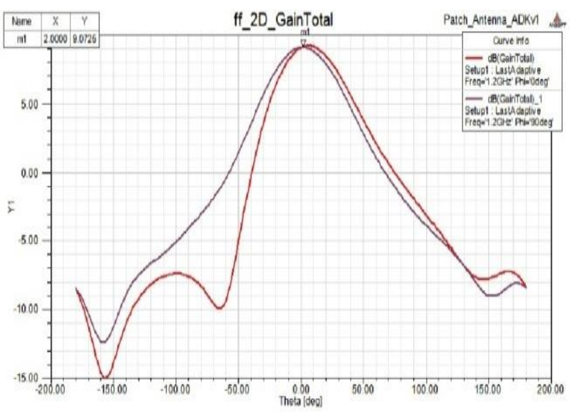

Fig.3:Gain

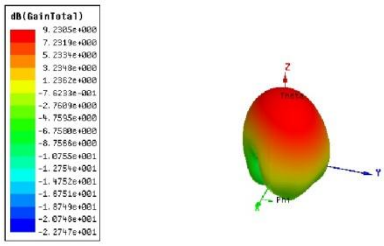

Fig.4: 3D Gain

C.Radiation pattern

In this radiation pattern the main lobe can be accurate and sidelobes are nullified at 0 angle with frequency 1175 MHz.

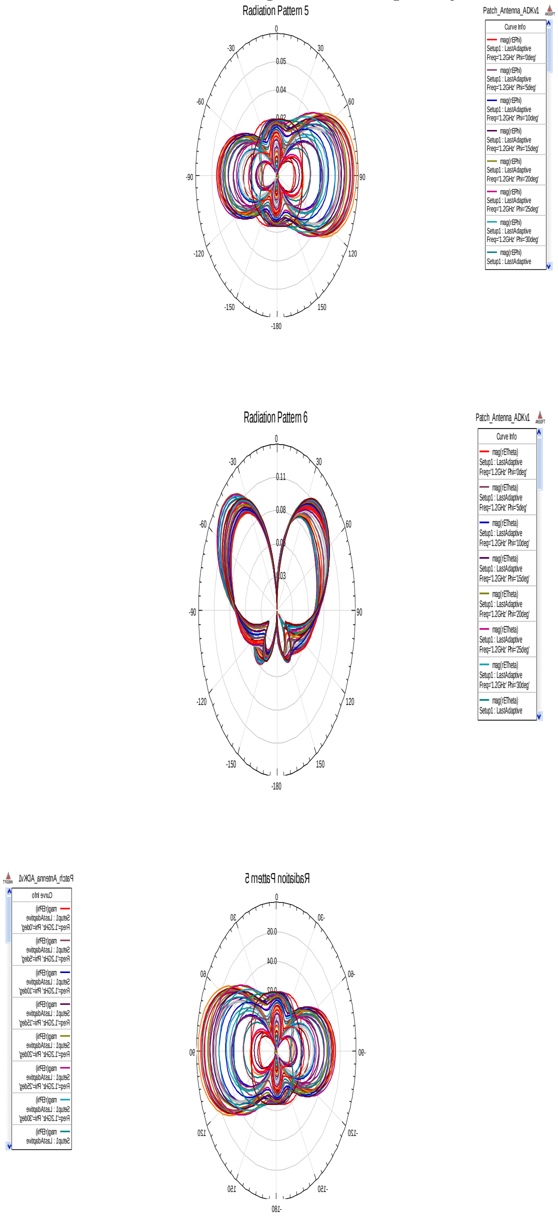

Fig.5: Radiation pattern

D. Field Distributions

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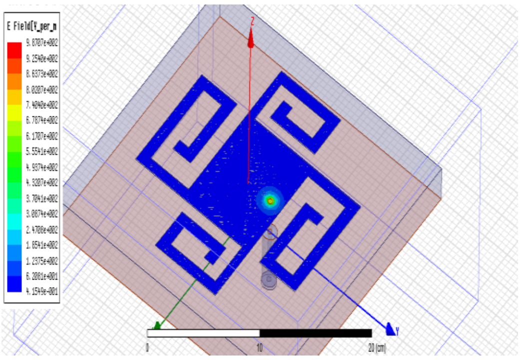

Fig.6: E-Field distribution

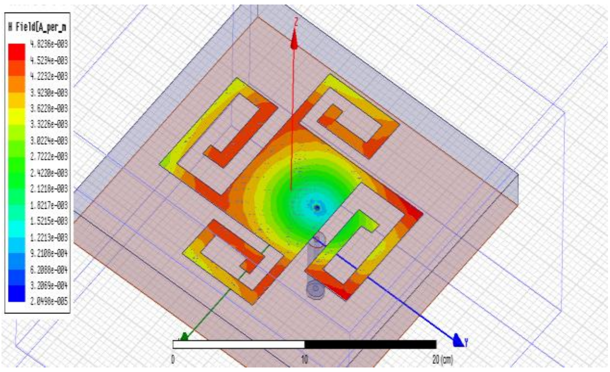

Fig.7: H-Field distribution

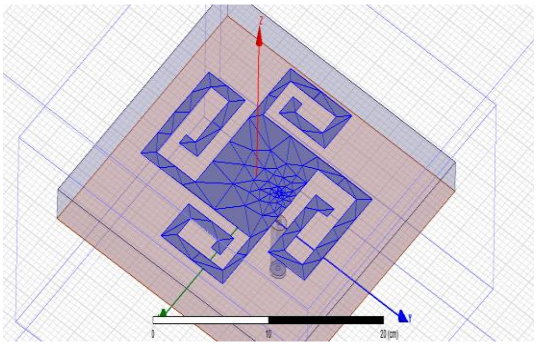

Fig.8: Mesh generation

The simulation time and accuracy will be influenced by the mesh. Fig.6, Fig.7 and Fig.9 shows the E-field, H-field and mesh generation for the proposed antenna. The current distribution concentration can be indicated by using triangulated zones in the mesh. Average current distribution of the cross section will give the information about s-parameters.

V. CONCLUSIONS

This paper presents the design and detailed results of the Spiral Antenna with the selection of RT DURIOD substrate material. The antenna has a 4x4 aperture, and consists of four spiral elements. Spiral antenna is able to receive upper hemisphere satellite signals. This antenna is showing remarkable performance over the frequency L5 (1175 MHz) with high gain of 9 db and high directivity. The array has four elements allowing for spatial nulling of interfering signals necessary for INRSS applications. Spiral antennas are useful for microwave direction-finding.

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