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A Novel Microstrip Antenna with Parasitc Ring for Beidou Navigation Satellite System

Prasitha.M[1]
[1] ME-Communication Systems,
Dhanalakshmi Srinivasan Engineering College,
Perambalur, Tamil Nadu,
mprasithabe@gmail.com

Yogeshwaran.A[2]
[2]Assistant Professor,dept of ECE,
Dhanalakshmi Srinivasan Engineering College,
Perambalur, Tamil Nadu,
er.yogesh85@gmail.com

***Abstract*:** A Novel Circularly Polarised Microstrip antenna with parasitic ring is proposed for Beidou Navigation Satellite System. The antenna comprises of a double layer arrangement with Circular patch, rectangular stub and parasitic ring. The Widen Vertical HPBW and high gain at low elevation angle is the demand of the satellite system. Hence vertical HPBW is widened by using FR4 substrate with 1.6 thickness as 140° and high gain at low elevation angle is obtained by using Parasitic Ring is about -1.8dB.

Keywords: *BeiDou, HPBW, FR4 Substrate, Parasitic Ring.*

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1. Introduction

One of the Chinese satellite navigation system is Beidou Navigation satellite system. This satellite system is the first invented satellite system which is called as Beidou-1. While comparing with other satellite system; it consist of only fewer number of satellites. And has it is mainly invented for the purpose of china. Inorder to add some of the features and overcome the disadvantage with the first generation satellite system, the second generation satellite system have been made which is called beidou-2 or compass navigation satellite system.

This system was constructed only with the fewer number of satellites with the count of about 35. Which include 5 geostationary orbiting satellite, 30mnon geostationary satellite. (27 for medium earth orbiting satellit4 and 3 geosynchronous orbit). This satellite will provide the overall coverage of the optic globe. But the structure of the satellite s very complex and the operation is similar to that of GNSS.

The satellite provides two kinds of services as open satellite and authorized satellite. The open service is designed to provide positioning accuracy within 10 meters, timing accuracy within 50 nanosecond, and velocity accuracy within 0.2 meter per second. Whereas authorized service provide the safe velocity, Position and timing services.

The frequency is allocated around four different types of bands as E1, E2, E5B, and E6 which is used to overlap with Galileo. Hence this satellite system is under deep investigation of the world satellite navigation development. On all aspects such as requirement investigation, index determination, project design, system construction and operation management, we shall firmly focus on the application expansion and industry development, not only to complete the building of the system, but rather to guarantee production full use of the system.

Fig 1: Beidou Navigation Satellite System

The test result showed that Compass/BeiDou satellite, monitor station and software handing out is completely normal. The system have been implemented in given time and then will be urbanized into the global constellation on step by step.

To receive the satellite signal quickly the antenna terminal should have wider vertical HPBW and high gain at low elevation angle.

2.Literature Survey

In [1] C.Kilgus presents Shaped Conical radiation pattern Performance of the back fire Quadrifilar Helix

This paper Presents that the Cardioid Shaped radiation pattern is achieved using backfire Quadrifilar helix antenna about 3dB by concentrating the radiated energy into the cone.

In [2] K.P Yang and K.L. Wong presents Dual band Circularly polarized Square /microstrip Antenna. Here the antenna patch size is reduced as large as 36% by using the dual band circularly polarized square microstrip antenna which is achieved by inserting the T shaped slits at the edges of the patch.

In [3] S.Foo and B.Vassilakis presents Dielectric Fortification for wide beamwidth patch arrays. The beamwidth is broaden by using dielectric fortification technique incorporating the thin layer of dielectric walls around the radiator. Hence allows the broadening without any degradation at cross polarized radiation pattern.

In [4] Y.Sung Presents Dual band circularly polarized pentagonal slot antenna. Here the circular polarization is achieved by designing a dual band circularly polarized pentagonal slot antenna by proper loading of feed line in opposite direction.

2. Methodology

3.1Antenna Design

The Antenna is intended with the double layered structure which comprises of two circular substrate, two radiation stub and a parasitic ring. The circular substrate is designed with the radius R. The circular substrate is placed in parallel to each other and corresponding parasitic ring is placed at the top of the upper substrate. Resultant with the radius as R1 and R2 respectively. The upper substrate is single sided and the lower is double sided which has the main radiation patch and the ground plane.

The rectangular stub is placed along the diameter of two substrate. Each of the stub has the width of about W and the distance from the center of the patch is L1. Consequently the gap between the two substrate is h which maintain the low profile characteristics of the antenna.

The main radiation patch is fed with the 50Ω Sub miniature a cable in order to avoid the high power handling capability. And its feed point is located at 45° diagonal of the stub. Hence the current is excited, And it is resolved into two parts one along the rectangular stub and another perpendicular to the stub. Therefore the latter stub is affected.

Circular polarization is achieved by adjusting the length of the stub and the distance between the feed point. Hence high gain at low elevation angle is achieved by using the

combination of both the parasitic ring microstrip antenna and microstrip antenna, because the normal antenna provide high gain at high elevation angle and vice versa. But the parasitic ring fed antenna provide high gain at low elevation angle and low gain at high elevation angle.

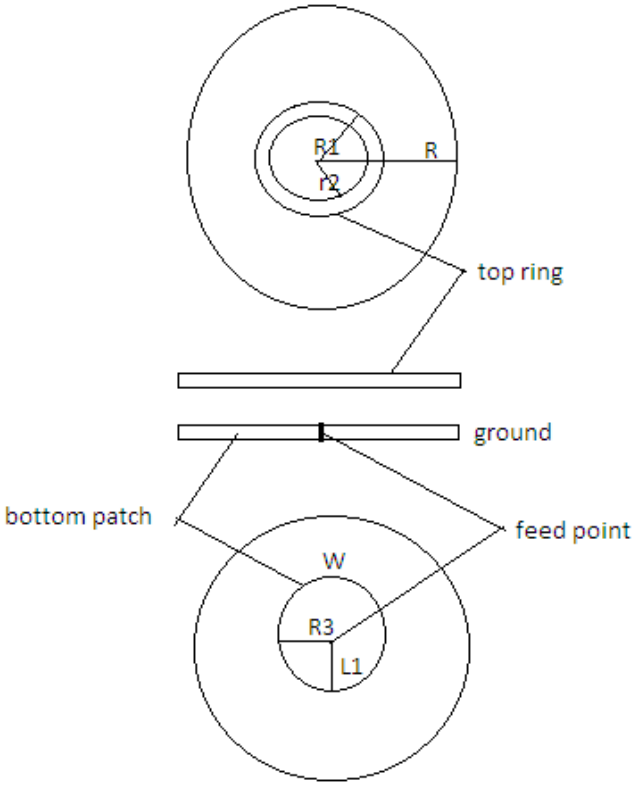

Fig 2: Geometry of the antenna

For the far-field radiation pattern as shown when the elevation angle is 90, the ordinary micro strip antenna has the highest gain, which becomes lower with the decrease in the elevation angle. On the contrary, the far-field radiation pattern of the ring micro strip antenna is similar to tire shape which has low and high gain when the elevation is 90 and 0 respectively. So if the ordinary micro strip antenna is combined with the ring micro strip antenna, the gain for low elevation angle may be improved than before while that of the 90 elevation angle is scarcely affected.

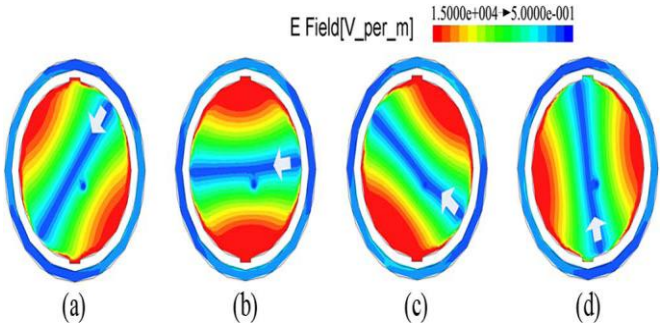

Fig 3: Direction of Current

The vertical HPBW is widen by loading the parasitic ring and by using the high dielectric substrate. Here the Flame

Redardent 4 substrate with the permittivity of about 4.4 and thickness of 1.6mm. Therefore it is used to receive the signal via s band of Satellite system.

3.2 Single Feed Circularly Polarised Microstrip Antenna

In a single feed circularly-polarized micro strip antenna is placed in a semi-closed dielectric wall, which could effectively broaden the vertical HPBW and meanwhile maintain good low-profile characteristics.

But its lateral dimension is large. In a wide-beam circularly-polarized micro strip- dielectric antenna is designed through adjusting the substrate size and the vertical radiation beam width could be widened. Nevertheless, this structure has very strict requirements for the ground size, which may be rather hard to be applied in real environment.

Besides, the half-power vertical beam width of slot antenna could be widened with a cavity, but it will bring in mass waviness in the radiation pattern and the out-of-roundness for the horizontal radiation pattern may become bigger.

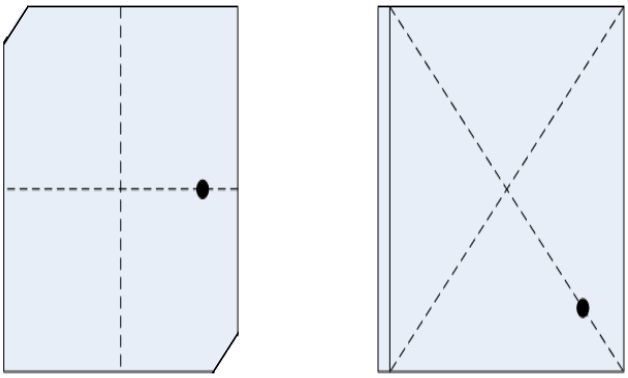

Fig4 Single feed Circularly-polarized Micro strip Antenna

3. GEOMETRIC PSYCHIATRY

The characteristics of proposed antenna are simulated by the software Ansoft HFSS.

Sequentially to attain wide beam and circular polarization operation, a detailed parametric study of the antenna is discussed, including various effects of parasitic ring, outer radius and the distance between twosubstrate.

4.1CONSEQUENCE OF THE PARASITIC RING

It is empirical that, before and after load the leechlike ring, the LHCP gain for 90 height angle are in that order 3.52 dB and 6.58 dB and the understand HPBW are in that order 90 and 131. The average gains for 5 elevation angle are in that order

2.56 dB and 1.45 dB. Therefore the emission pattern similar to tire form generates by the leechlike ring, could reduce the gain for 90 height angle and improve the increase for low elevation angle. In other words, the vertical HPBW of the future antenna is clearly wider with the placing of the leechlike ring.

4.2. CONSEQUENCE OF OUTER RADIUS OF THE PARASITIC RING

The enthused results of total gain for the probable antenna with disparate external radius of the parasitic ring. With R1 improved from 20 mm to 21 mm, the gain for 90 height angles is better while the one for 5 elevation spot is decline. So the decent HPBW of the prospect antenna could be widening by declining the outer radius.

4.3 CONSEQUENCE OF DISTANCE BETWEEN THE TWO SUBSTRATES

By adjusting the distance between the two substrate have been studied. The height is increased about 12mm where the gain increased for 5° elevation angle. Therefore the vertical HPBW is widened.

4. REPLICATED RESULTS

According to the results of the geometric analysis, the optimized parameters of the proposed antenna dimensions are as follows: L1=17mm, L2=3.8mm, R1=20.5mm, R2=18.5mm, R3=16.4mm, w=3mm, h=10mm. The overall size of the proposed antenna is about 67x67mm. And the photo of designed antenna is as follows.

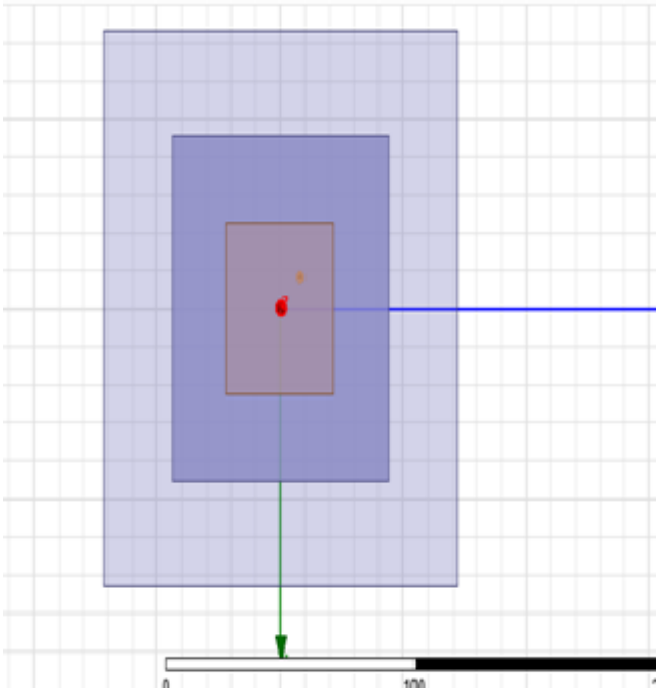

Fig 5. Fabricated Antenna

For the frequency of about 1.54Ghz the gain of -8.23 is obtained as shown below

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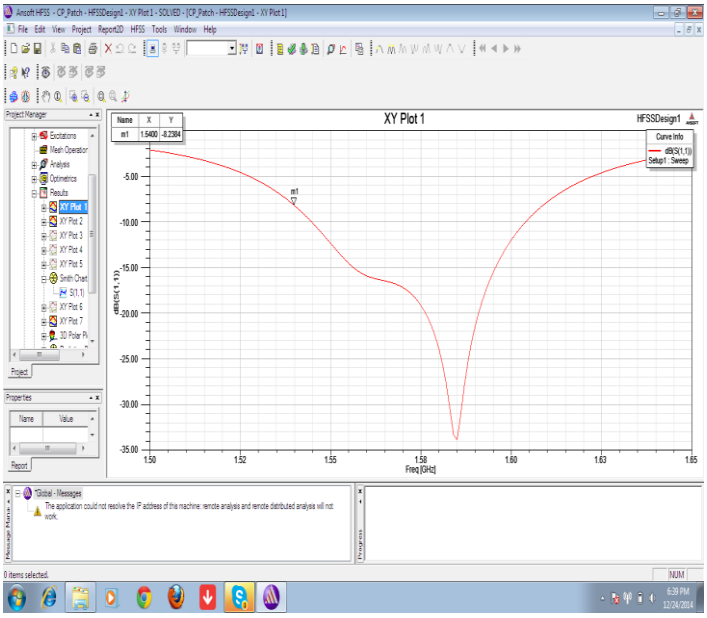

Fig 6. Gain about 5.45Ghz

The distance between the antenna and corresponding substrate thickness is shown. The thickness is measured around 44.4mm

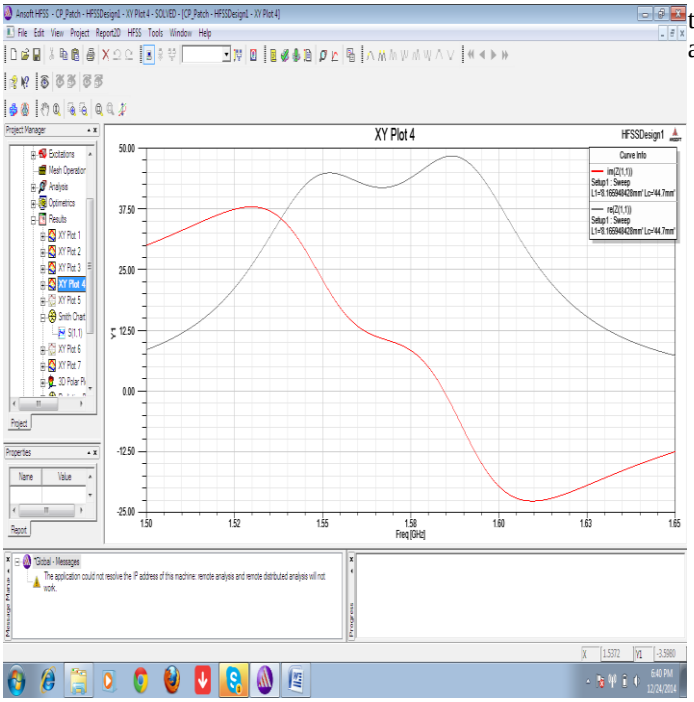

Fig 7. Substrate Thickness

For angle at 121.448 and magnitude of 0.1102, analogous impedence have been calculated as 0.78+0.166 is plotted using smith chart

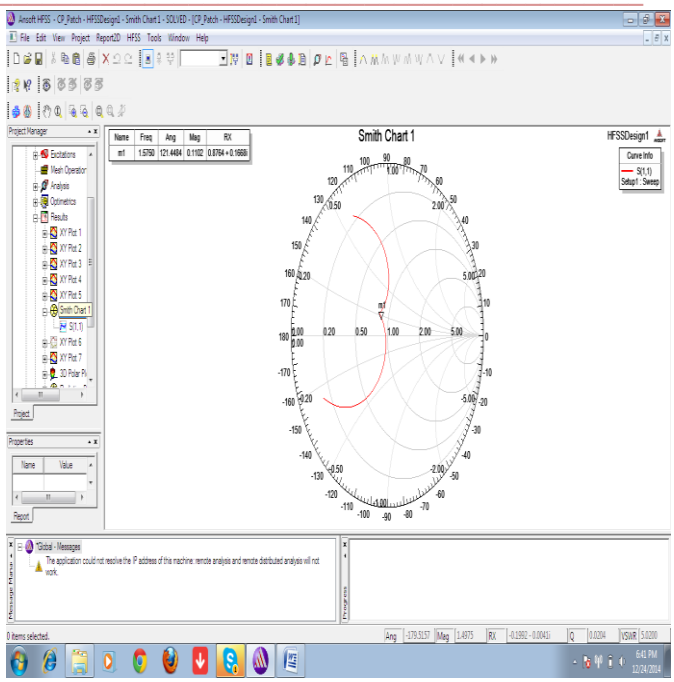

Fig 8. Smith Chart

The ratio of length or magnitude of two axes is specified by the factor Axial ratio. Here the axial ratio of about 3.15 is achieved for 1.54Ghz of frequency.

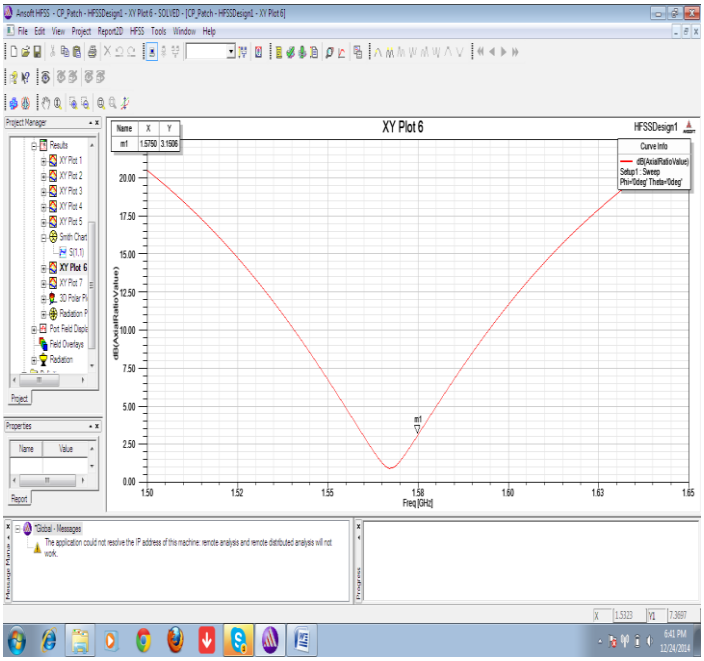

Fig 9. Axial ratio

Inoder to specify the coverage area, polar plot is used where it shows the entire area the antenna covers by its radiation

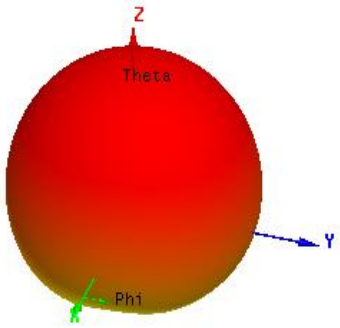

Fig. 10 Polar plot

5. CONCLUSION

A novel microstrip antenna with parasitic ring for Beidou Navigation satellite System is presented here. Hence the quick reception of the signal is maintained by widening the vertical HPBW and achieving high gain at low elevation angle. Nevertheless, the fabrication of the antenna is very simple. It also meet the demand of the satellite system with low cost and minimum size. For the frequency of about 2.492Ghz, antenna is mainly designed foe compass navigation satellite system.

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