Design, Simulation and Development of 2x2 Microstrip Patch Array Antenna for Ranging Transponder

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Abstract— Indian Regional Navigation Satellite System (IRNSS) is an independent regional navigation satellite system being developed by India. All the satellite in the constellation is placed in Geo-stationary or Geo-synchronous orbit. All the satellites are visible from the user's location unlike the G.P.S. system. Hence the receive antenna need not be omnidirectional instead of only need of higher directivity and higher gain for the fixed object. By the array antenna we can reduce the beam width of antenna, and this will enhance gain for the antenna and signal strength will be more. Thus receiver system will work more efficiently. The aim of this Dissertation is to design and simulate 2x2 Microstrip patch array antenna for ranging transponder at 3.4 GHz to the receiver side.

Key words: Microstrip patch, 3.4 Ghz, IRNSS, FR_4, ADS

I. INTRODUCTION

IRNSS Refers to Indian Regional Navigation Satellite System. IRNSS is an independent Navigation Satellite System providing services in the Indian Region.

IRNSS is being implemented by the Indian Space Research Organization. The project is being managed by the lead centre viz., ISRO Satellite Centre, Bangalore with support from the other work centres viz., Space Application Centre, Ahmedabad, ISTRAC, Bangalore, MCF, Hassan, VSSC, Thiruvananthapuram. IRNSS provides fairly good accuracy and the whole constellation is seen all the time. There are plans to send integrity and ionospheric correction messages to the user. A variety of applications taking the benefit of above will be catered by IRNSS.

Microstrip patch array used in IRNSS (Indian Regional Navigational Satellite System) and within short period of time it will replace the GPS(Global Positing System).

There are two types of transponder is used in IRNSS: (i) Navigation transponder (ii) Ranging transponder.

II. INTRODUCTION TO PATCH

Microstrip antenna: it consists of a dielectric substrate present in between a ground plane and a patch. Patch antennas are low profile, simple, easy to fabricate. Within these advantages it has disadvantages of low fain and directivity. So Patch antennas are not only used as single element antenna but as arrays also. The dictionary defines array as an orderly arrangement of things. Therefore, proper arrangement of multiple antenna elements results in an array. Arrays are considered to be very versatile and are used to synthesize a required pattern that is difficult to obtain using a single patch. The results also show that patch array help in increasing the directivity, gain and power. The most important parameter for the design of a patch antenna is the operating frequency. In this paper designs of single element operating at 3.4GHz, known as resonant frequency is shown.

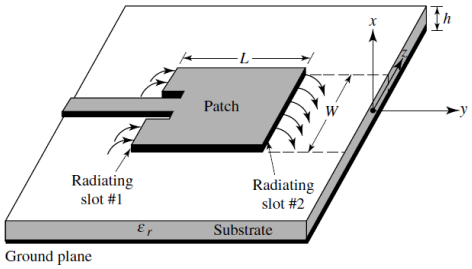

Fig. 1: Single Microstrip patch

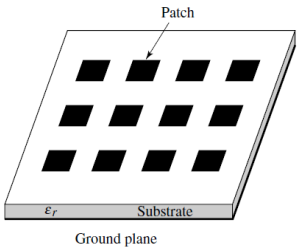

Fig. 2: Microstrip patch array

III. ANTENNA DESIGN

The goal of designing a microstrip antenna at 3.4GHz is to improve gain and directivity for the Ranging Transponder in IRNSS. There are various important steps in designing microstrip antennas. First we design single patch and will analyzing its results such as directivity, gain, return loss at center frequency 3.4 GHz. Selection of a proper substrate is an important parameter in the design process. In this design, dielectric constant is taken as 4.4 and thickness (h) as 1.6mm.

Centre frequency	3.4Ghz
Dielectric constant	4.4
Substrate height	1.6mm
Copper thickness	0.035mm
Loss tangent	0.0019

Table 1: Design specification

A. Geometry of Single Patch

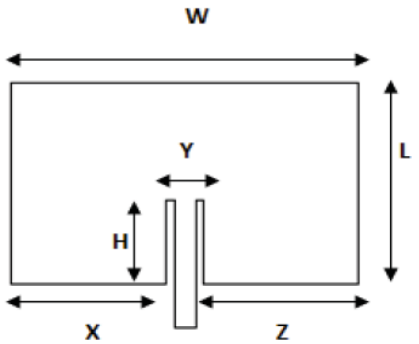

Fig. 3: Geometry of patch

B. Design Equation

Patch width is given by,

$$W = \frac{1}{2f_r\sqrt{\mu_0 \epsilon_0}}\sqrt{\frac{2}{\epsilon_{r+1}}} \quad \text{.....(1)}$$

Effective parameters is given by,

$$\epsilon_{reff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}} \quad \text{.....(2)}$$

$$\frac{\Delta L}{h} = 0.412\frac{(\epsilon_{reff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\epsilon_{reff}-0.258)\left(\frac{W}{h}+0.8\right)} \quad \text{.....(3)}$$

Patch length is given by,

$$L = \frac{1}{2f_r\sqrt{\epsilon_{reff}}\sqrt{\mu_0\epsilon_0}} - 2\Delta L \quad \text{.....(4)}$$

The depth of the feed line in to the patch is given by,

H=0.822*L/2.....(5)

The other dimensions are,

Y=W/5.....(6)

X = Z = 2W/5.....(7)

The Agilent Advanced Design System (ADS) is the software used to design and simulate the patch antenna. Using equation calculated width and length and all the dimensions for single patch. It shown in Table II.

W	26mm
L	20mm
H	8.359mm
Y	5.278mm
X=Z	10.54mm

Table 2: Dimensions

C. Design Layout

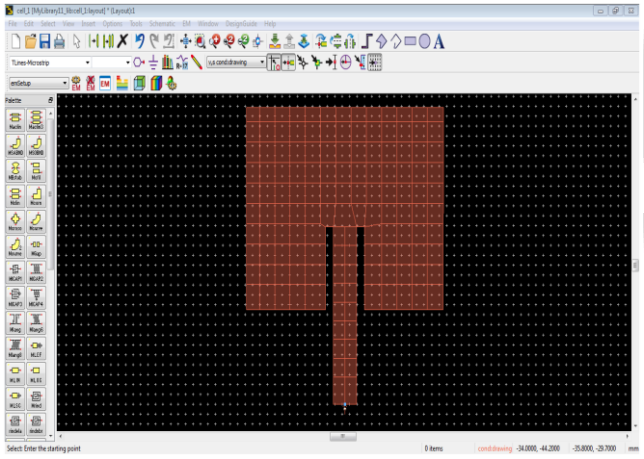

Fig. 4: Patch layout in ADS

D. Simulation Results

1) Return Loss Curve

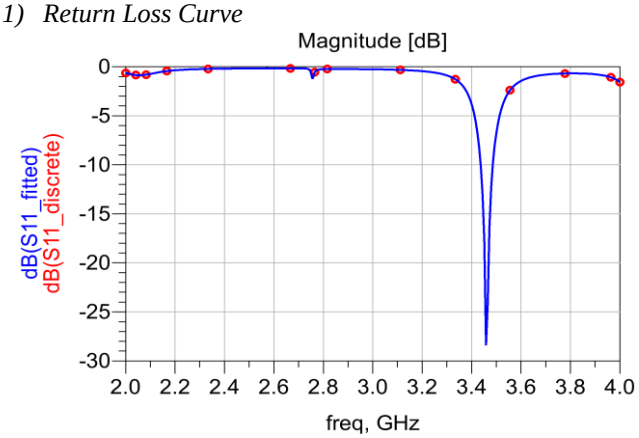

Fig. 5: RL curve of antenna

2) Antenna Parameters

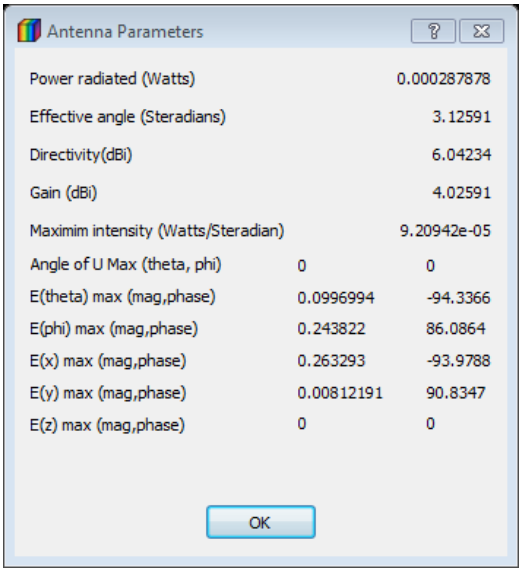

Fig. 6: RL curve of antenna

IV. CONCLUSION

I have designed and simulated single patch for 3.4 Ghz frequency, And result that achieved is, gain of 4dB and Directivity of 6dB. Return loss of -29dB.So as increasing number of patch, we can increase gain as well as directivity.

V. FUTURE WORK

I will design rest of the patch for array design. Then fabricate array antenna. At the and, will test and compare hardware and software result.

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