Approximate Antenna Analysis

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Abstract— In this paper, a dual band Microstrip patch antenna using circular upper conducting layer for X-band applications has been proposed. Both conventional and proposed micro strip patch antenna has been designed for 10Ghz.The Conventional antenna has a single band and it resonates at 9.88 GHz and proposed antenna with circular super conducting layer has a dual band it resonates at 9.39 GHz and 11.65Ghz respectively. The proposed antenna also has good gain of 6.10dbi and 7.11dbi.

Keywords: Microstrip patch antenna, X-band, Dual band, Circular Ring, Supper conducting layer

I. INTRODUCTION

In today's wireless communication technology the demand for antenna has been increasing rapidly. We have no of satellite and land based systems for different wireless applications and since subscribers using different systems are increasing there is a need to develop a system with multiband or dual band antenna which can operate at more frequency bands[1].As the systems become smaller due to advancement in technology the antenna size has to be reduced. Microstrip patch antenna are very prominent for this purpose[2].

Microstrip antennas are very popular because it has small size, low profile, ease of installation, low cost for fabrication and light weight. But it has some limitations also like very narrow bandwidth which can also be increased by various technique.[3]. With all these features Microstrip patch antenna operating at two or more frequency bands is a desired feature. Multiple antennas can be reduced using these techniques. Several techniques to obtain dual band has been proposed over a years. A simple technique to obtain dual band is to insert a Upper conducting layer on a patch [4].

Antennas are the main. component in the wireless communication. They can be regarded as the eyes and ears of wireless communication. In the last few decades antenna's has become very famous in cellular telephony. From the Marconi, the concept of antenna developed. When in 1901, he placed the antenna over the kite and transmitted the signal from poldhu, Cornwall to Signal Hill, St.Hohn's, and Newfoundland. The distance between transmitter and receiver was about 3.5km. This was the starting of microwave antenna technology, and after that many designs of antenna like waveguide, reflectors, and horns was developed Working on Microstrip antenna started in the 1950's but in 1970's the Microstrip patch antenna became popular because of its versatility and simplicity.

In 1990's to improve the performance different materials were integrated. These materials were used to optimize the radiating elements. In designing of antenna the meta-materials became very popular. To enhance the data capacity and performance MIMO configurations was used later [9].

Spectrum stands for set of frequencies. In order to use this spectrum, cell phone companies has to pay for it. Bandwidth is the difference between two frequencies. i.e. Higher and lower frequencies. The spectrum is divided into no of frequency bands. And each band is allocated for specific applications. Wider bandwidth can be obtained using higher frequency. ITU regulates the use of these bands [8].

II. METHODOLOGY

Microstrip patch antenna is designed using the parameters frequency (fr), die-electric constant (εr) and thickness of the substrate (h) using analytical formulas.

It is designed using Fr4 substrate with $\varepsilon_r = 4.4$ with thickness of substrate h = 1.6 and operating frequency 10 GHz. The dimensions of proposed antenna are Lg = 18.19 mm, Wg = 16.96 mm, Lp = 6.432 mm, Wp =9.129 mm, Ls = mm, Ws =6.96 mm. The patch is fed with quarter wave transformer with length=3.92mm and width=1mm.The proposed Microstrip patch antenna has a upper circular ring shaped conducting layer with outer circle of radius 4.4mm and inner circle of radius 4mm.

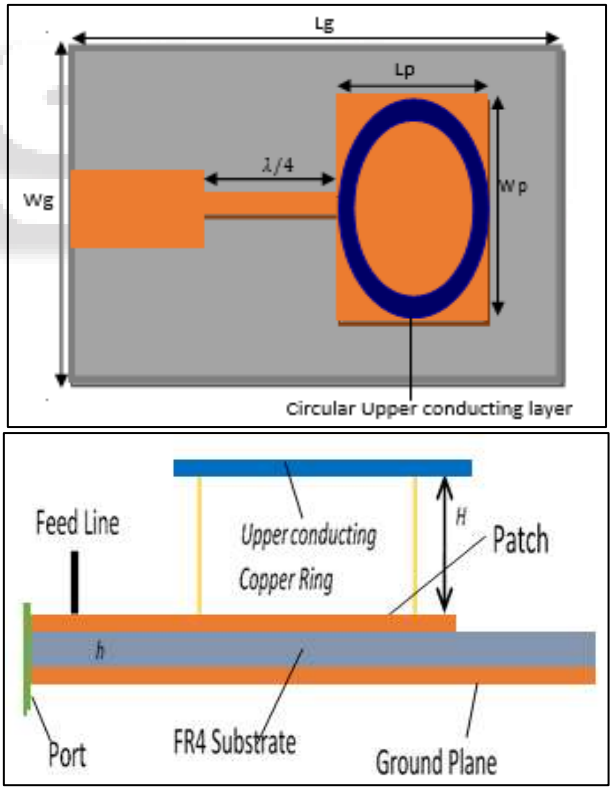

Fig. 1: Proposed Microstrip Patch Antenna with circular upper conducting layer (a) Top view, (b) Side view.

A. Antenna Parameters

1) Reflection Co-efficient

Reflection coefficient shows how much of signal is reflected back when the signal is transmitted. The reflection coefficient should always be negative. There should not be much signal reflected back when the signal is transmitted. In antenna -10

dB is the margin taken for measuring reflection coefficient. Reflection coefficient should always be less. Reflection coefficient may occur due to many factors like due to improper impedance matching, due to some discontinuities and so on.

2) Gain

The antenna gain shows in the Direction of peak radiation how much power is transmitted by taking isotropic source as a reference. Gain is taken in terms of angles sometimes. Gain is related to antenna efficiency and directivity. Gain can be defined s a product of antenna efficiency and directivity. The gain of the antenna should always be high. Depending upon the type of material used for substrate

3) VSWR

VSWR stands for voltage standing wave ratio, it is the ratio of maximum voltage to minimum voltage. It should be ideally one. But in practical cases it can be Upto 2.It is related to reflection coefficient. When there is too much mismatch there exists a large VSWR.

4) Impedance

In order to achieve maximum energy transfer between a wire or coaxial transmission line and an antenna, the input impedance of the antenna must identically match the characteristic impedance of the transmission line. If the two impedances do not match, a reflected wave will be 2 generated at the antenna terminal and travel back towards the energy source. This reflection of energy results in a reduction in the overall system efficiency. This loss in efficiency will occur if the antenna is used to transmit or receive energy.

III. SOFTWARE DESCRIPTION

`The software used to design the antenna and simulate the antenna is HFSS software .HFSS stands for high frequency structure simulator .HFSS is not freely available software. Because of ease of use HFSS is mostly preferred while designing an antenna. There are some more software like CST, ADS, and FEKO, which can be used to design an antenna. It is a product of Ansys Company it is a FEM (finite element method) simulator.

HFSS is a commercial finite element method solver for electromagnetic structures from Ansys. HFSS is one of several commercial tools used for antenna design, and the design of complex radio frequency electronic circuit elements including filters, transmission lines, and packaging. It was originally developed by Professor Zoltan Cendes and his students at Carnegie Mellon University

The ANSYS HFSS simulation suite consists of a comprehensive set of solvers to address diverse electromagnetic problems ranging in detail and scale from passive IC components to extremely large-scale EM analyses such as automotive radar scenes for ADAS systems. Its reliable automatic adaptive mesh refinement lets you focus on the design instead of spending time determining and creating the best mesh. This automation and guaranteed accuracy differentiates HFSS from all other EM simulators, which require manual user control and multiple solutions to ensure that the generated mesh is suitable and accurate. With ANSYS HFSS, the physics defines the mesh rather than the mesh defining the physics.

Each HFSS solver incorporates a powerful, automated solution process, so you need only to specify geometry, material properties and the desired output. From there, HFSS automatically generates an appropriate, efficient and accurate mesh for solving the problem using the selected solution technology. With HFSS, the physics defines the mesh; the mesh does not define the physics. HFSS offers multiple state-of the-art solver technologies based on finite element, integral equation or advanced hybrid methods to solve a wide range of microwave, RF and high-speed digital applications. The software includes a linear circuit simulator with integrated Optimetrics for input and matching network design.

IV. RESULT AND CONCLUSION

The antenna has been designed for 10 GHz using Quarter wave feeding Technique. The Conventional Microstrip Patch Antenna has been designed and it is observed that from conventional Microstrip Patch Antenna without using the Superstrate, only single band is generated. When Superstrate has been placed over the patch Dual band has been obtained. As the Frequency range is between 8 to 12 GHz the antenna can be used for X band applications. Here Only Dual band has been generated using Superstrate Technique. But more no of useful bands can be obtained.

Reflection coefficient (S11) of fig(a) shows how much of signal is reflected back when the signal is transmitted. The reflection coefficient should always be negative. There should not be much signal reflected back when the signal is transmitted. In antenna -10 dB is the margin taken for measuring reflection coefficient. Reflection coefficient should always be less. Reflection coefficient may occur due to many factors like due to improper impedance matching, due to some discontinuties and so on.

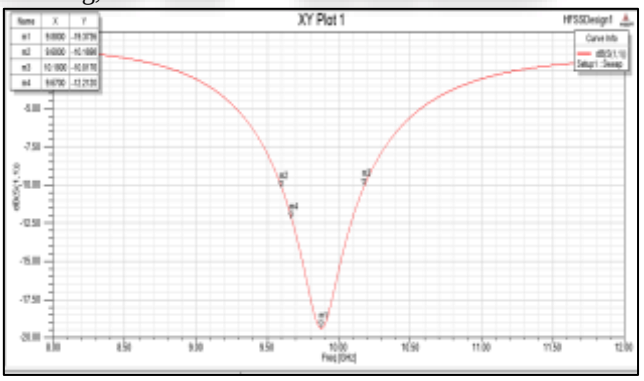

Fig. 1: S parameter of Conventional MPA

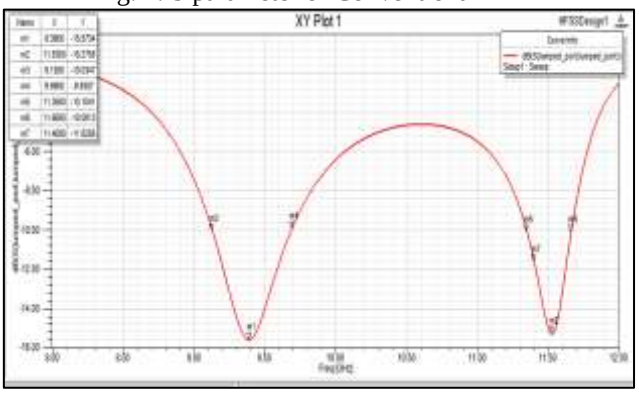

Fig. 2: S parameter of Proposed MPA

Gain of antenna is one of the most important parameter to be observed during analysis, Since it is used to measure the efficiency of the system. From Fig(c) you can observe the gain of Conventional MPA is 4.5389 whereas after the use of Circular Superstrate on the Patch of MPA gain has been changed and increased to a value of 6.0892.This increase in gain indicates that, proposed antenna is more efficient than Conventional MPA

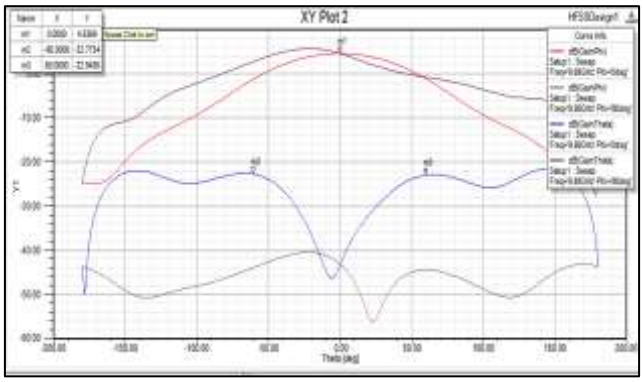

Fig. 3: Gain of Conventional MPA

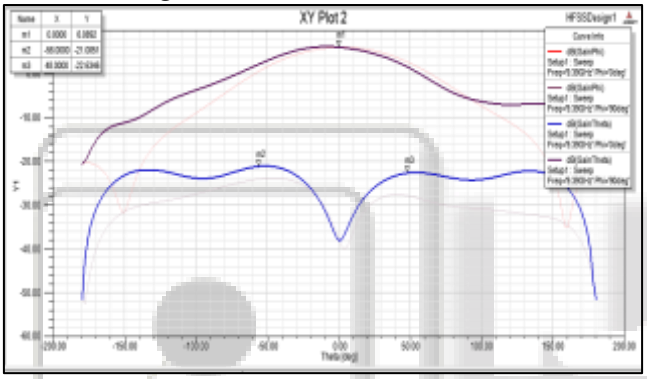

Fig. 4: Gain of Proposed MPA

The antenna gain shows in the direction of peak radiation how much power is transmitted by taking isotropic source as a reference. Gain is taken in terms of angles sometimes. Gain is related to antenna efficiency and directivity. Gain can be defined as a product of antenna efficiency and directivity. The gain of the antenna should always be high. Depending upon the type of material used for substrate, Type of techniques used, Thickness of substrate, the gain of the antenna may vary.

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