International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 05 | May 2020 www.irjet.net p-ISSN: 2395-0072

DESIGN AND ANALYSIS OF MICROSTRIP PATCH ANTENNA SUITABLE FOR Ku BAND SATELLITE COMMUNICATION

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Abstract - *This paper represents the well formed rectangular shape truncated micro strip patch antenna. The proposed antenna is simulated using High-Frequency Structure Simulator (HFSS) tool. The purpose of this paper is to design the rectangular micro strip patch antenna and concentrating on the effect of antennas radiation pattern and gain. By considering the parameters of relative dielectric constant (), substrate material and thickness, length& width of the patch. Conducting patch is formed by using rectangular configuration. Microstrip patch antennas are low cost, small size and easy to fabricate and they play a dominant role in wireless communication .The antenna is designed at Ku band frequency(17.5 GHz) with multiple slots on the rectangular patch. These slots on the patch shift the resonant frequency to the lower side and also affect various antenna paramaters. The antenna is designed by using RT duroid material that has relative permittivity of 2.2 and loss tangent 0.0009.*

Key Words: HFSS, Microstrip, RT duroid, Relative permittivity, Satellite communication.

1. INTRODUCTION

1.1 ANTENNA

Antenna is an electrical device which converts electrical power into radio waves and vice versa without an efficient antenna, EMF (electro magnetic energy would not be radiated and wireless communication over the long distance would be impossible. Antennas can be designed to transmit and receive radio waves in all horizontal directions equally (omnidirectional antenna), or preferentially in a particular direction called directional or high gain antennas. Radio waves are electromagnetic waves which carry signals through the space or air at the speed of light with almost no transmission loss.

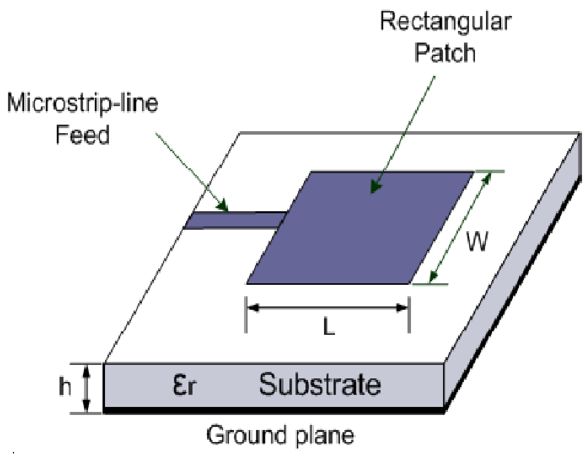
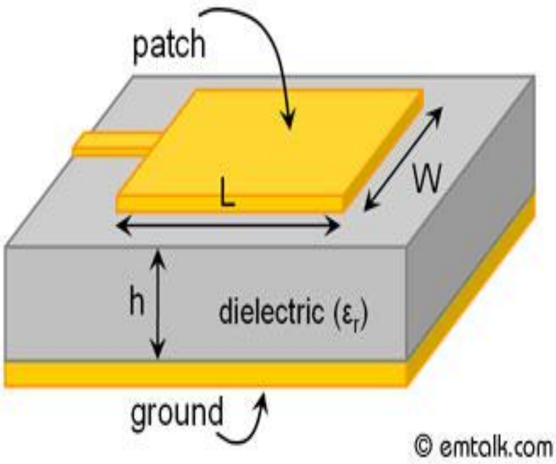


Fig.1.Microstrip Patch Antenna

1.2 MICROSTRIP PATCH ANTENNA

A microstrip antenna (also known as printed antenna) usually means an antenna fabriciated using microstrip techniques on printed circuit board (PCB). It is a kind of Internal Antenna. They are mostly used at microwave frequencies. The most common type of microstrip antenna is the patch antenna. Antennas using patches as constitutive elements in an array are also possible. A patch antenna is a narrowband, wide-beam antenna fabricated by etching the antenna element pattern in metal trace bonded to an insulating dielectric substrate, such as a printed circuit board, with a continuous metal layer bonded to the opposite side of the substrate which forms a ground plane. Common microstrip antenna shapes are square, rectangular, circular and elliptical, but any continuous shape is possible. Some patch antennas do not use a dielectric substrate and instead are made of a metal patch mounted above a ground plane using dielectric spacers; the resulting structure is less rugged but has a wider bandwidth. Because such antennas have a very low profile, are mechanically rugged and can be shaped to conform to the curving skin of a vehicle, they are often mounted on the exterior of aircraft and spacecraft, or are incorporated into mobile radio communications devices.It is used as telecommunication.



The most commonly employed microstrip antenna is a rectangular patch which looks like a truncated microstrip transmission line. It is approximately of one-half wavelength long. When air is used as the dielectric substrate, the length of the rectangular microstrip antenna is approximately one-half of a free-space wavelength. As the antenna is loaded with a dielectric as its substrate, the length of the antenna decreases as the relative dielectric constant of the substrate increases. The resonant length of the antenna is slightly shorter because of the extended electric "fringing fields" which increase the electrical length of the antenna slightly. An early model of the microstrip antenna is a section of microstrip transmission line with equivalent loads on either end to represent the radiation loss. The advantages of Microstrip Antennas like Light weight, lnxpensive and robust, Easy to fabricate (use etching and phototlithography), Easy to feed (coaxial cable, microstrip line, etc.) Easy to use in an array or incorporate with other microstrip circuit elements, Dual frequency antennas can be made easily, Compatible with MMIC (Microwave monolithic Integrated circuit design.), Feed lines and matching networks are fabricated simultaneously with the antenna structure.make them Suitable for numerous applications [9].

2. EXISTING SYSTEM

Since decades microstrip antennas are being developed andday to day their application is also being raised continuously[1-2]. The growth of this microstrip technology has a vast risein the field of wireless communication. It is printed onRT duroid substrate having relative permittivity 2.2, losstangent 0.0009 and thickness of h= 1.6mm.Patch dimensionsare calculated from the equations (1) and (2), ground planedimensions are calculated from the equations (6) and (7), andthe length of feed line from the equation (9). The feed given isinset feed and the input given has an input impedance of 50ohms. The rectangular patch has four slots on it which areequally spaced. The dimensions of the proposed antenna arelisted in table 1. All the slots are given same dimensions withlength 2mm and width 0.5mm, and they are placed parallel to each other and symmetric to the patch. The proposed antenna is designed to work at 15 GHz.

Slots are designed on the radiating patch to improve the antenna performance. The wavelength for the proposed design is 20mm, and the size of the antenna is given less than half of the wavelength for better radiation efficiency. The simulated structure is shown in figure4 with two slots placed on top of the patch and remaining two at the bottom of the patch.

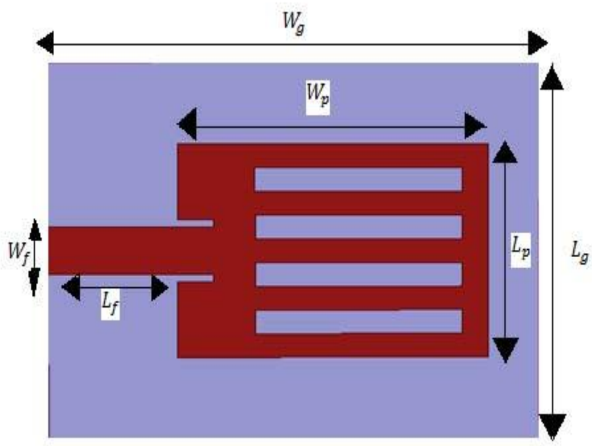


Fig.2.Geometry of proposed antenna with slots

2.1 Proposed antenna

The proposes an antenna that works at 15 GHz with multiple slots placed on the radiating patch. The proposed design includes two slots on the upper half and two slots on the lower half of the patch. Etching of slots affects various antenna performance characteristics like return loss, gain, bandwidth and shift the resonant frequency [8-9]. The proposed antenna is specified to work for satellite communication at 15 GHz.

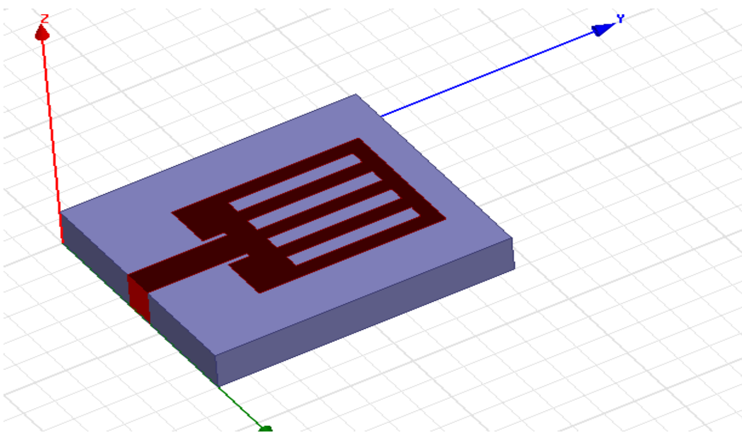


Fig. 3. Simulated structure

PARAMETERS	DIMENSIONS
Substrate length(Lg)	8mm
Substrate width(Wg)	9.5mm
Substrate thickness(h)	1.6mm
Patch length(Lp)	6mm
Patch width(Wp)	4.5mm
Feed line length(Lf)	3.2mm
Feed line width(Wf)	1mm

2.2 Software

HFSS

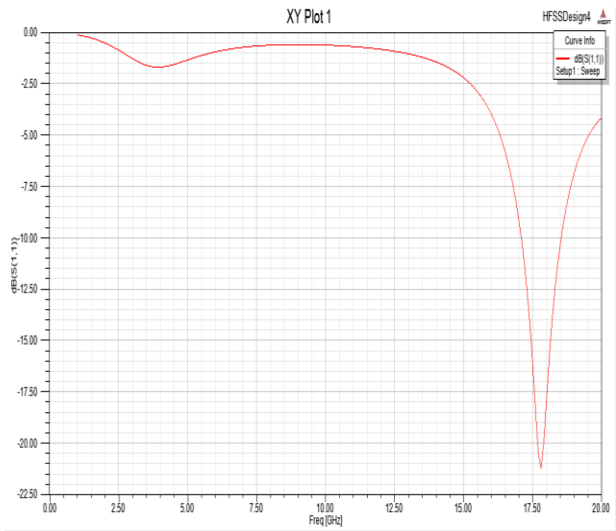
HFSS-Transient is a 3D full wave EM field solver based on the discontinuousGalerkin time domain method (DGTD). The finite element transient solver creates an unstructured mesh which incorporates HFSS adaptive meshing. Some typical applications include pulsed ground penetrating radar (GPR), electrostatic discharge, time domain reflectometry, transient field visualization and determining scattering centers for radar cross section (RCS).A plane electromagnetic wave impinges upon the aircraft at an oblique angle and various scattering interactions can be observed as a function of time and position.

2.3 High Performance Computing in HFSS

High performance computing (HPC) enables a range of different technologiesin HFSS that allows efficient simulation of extremely large and complex problems. HPC leverages multiple cores through matrix multiprocessing, distributed frequency points (called spectral decomposition method or SDM), domain decomposition (DDM), parallel hybrid FEM/IE solving or the finite antenna array DDM. In addition hierarchical HPC solving is possible where frequency points can be distributed with each frequency point using multiple cores or machines for large scale DDM analysis at each frequency point, all in parallel.

3. Proposed work Result

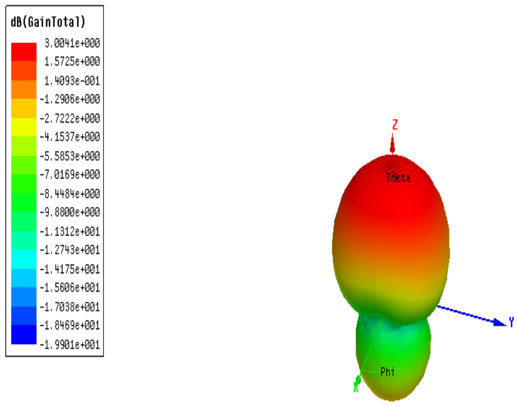
The proposed antenna is analyzed using HFSS software. The Return loss obtained for the simulated design is -21.2 db at 17.5GHz frequency. Since the obtained return loss is very minimum the reflection coefficient is relatively good and hence it can be conclude that a little power is reflected back. The return loss plot is against frequency is shown in fig(a).



Figure(a)Return Loss

3.1 Gain

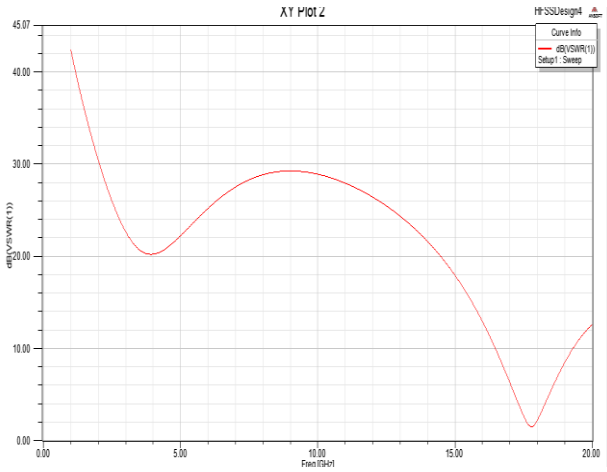
For the proposed antenna, the gain obtained is 3db. Since efficiency of the antenna is the ratio of gain it is observed the efficiency of antenna obtained is 95.62% the plot of gain is shown in fig(b)



figure(b)Gain

3.2 VSWR

VSWR is one way to find it and it is the ratio of maximum voltage and minimum voltage. When a system is perfectly matched the VSWR is equal to 1. From the fig(c) it is observed that the proposed design has VSWR is 1.06 hence it can be said that almost the feed and patch are perfectly matched.



figure(c)VSWR

4. CONCLUSION

A new structure based on the addition of slots which are equally spaced on the rectangular patch for satellite communication is proposed. The size of proposed design is 0.8cm length so, it is lightweight and flexible and moreover the statement that the better radiation efficiency can be achieved for the antenna having the size less the half wavelength is satisfied. It can be concluded that better bandwidth, return loss and VSWR can be achieved by etching slots on the radiating patch, and also these slots shifts the resonant frequency. For both the uplink and downlink process in satellite communications, this antenna can be used. The conception and simulation of rectangular microstrip patch antenna that operates in Ku frequencies was successfully designed using advanced design system. From observing the return loss, VSWR, it is very clear that this antenna works on the designed Ku frequency range. This research, detailed the designing of our Ku rectangular antenna in the Advanced Design System and High frequency structure simulator.

As the outlook work, we may extend our research to study a various slot antenna in affects the resonance frequency and the bandwidth.

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