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Microstrip Patch Antenna for WLAN Applications

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Abstract: In the recent years the development in communication systems requires the low cost development, low weight, low profile antennas that are capable of maintaining high performance over a wide spectrum of frequencies. By the use of this technological trend has to focus much effort into the design of a Micro strip patch antenna. The work is focuses on the square patch Micro strip antenna have been designed and analyzed. The main objective of this project is to design, fabrication and testing of the square microstrip patch antenna using coaxial feeding technique. The other job is to improve the bandwidth of the microstrip antenna upto the wide band level and improve the gain by cutting slots on the single layer antenna. To design a Microstrip patch antennas for a specific resonating frequency, accurate dimensions of patch, the substrate with efficient dielectric constant and height is required. Therefore, it becomes necessary to use simulation programs to test the performance of the antenna before fabrication. For the modelling and simulation of patch antennas, here we are using electromagnetic (EM) simulation packages namely HFSS.

Keywords: Antenna, electromagnetic, polarization, protocols application, WSNs.

1. INTRODUCTION

Wireless communication is the fastest growing segment of the communication industry. It has captured the attention of the media and the imagination of the public [1]. Over the last few decades cellular systems have experienced exponential growth and there are currently around two billion worldwide users

1.1 Antenna is a Vital Part of the Wireless Communication System

Wireless networking devices consists of different components and that are essential components because without them we cannot do the access to the network from the wireless networking device. An antenna can be defined as any conductor or wire, which carries a pulsing or alternating current [3]. Antennas transmit or receive electromagnetic waves by converting electromagnetic radiation into electric current or vice versa. Such a current will generate an electromagnetic field around the wire and that field will pulse and vary as the electric current does. If an another wire is put nearby, then the electromagnetic field lines that cross this wire will induce an electric current that is a copy of the original current with lesser amplitude . If the wire is relatively long, in terms of wavelength then there will be a radiated field over distances. They transmit and receive radio waves and are widely used for radios and televisions as also for point-to-point communication, wireless LAN, Mobile phones, Satellite spacecraft communication and radar. Different types of antennas are used for different applications – for radar systems, televisions, and radios [2]. Antennas are built for transmission of different frequencies and so they can be categorized by different frequency types.

2. MICROSTRIP PATCH ANTENNA

Due light weight, conformability and low cost the Microstrip antennas are more attractive and popular. These antennas can be integrated with active devices and printed strip-line feed networks. For antenna design engineering it is a relatively new area. The radiation properties of micro strip structures have been known since the mid 1950's[8]. For a variety of array configurations Rectangular and circular micro strip resonant patches have been used extensively. Electronic circuit miniaturization is a major contributing factor for recent advances of microstrip antennas which bring revolution by developments in large scale integration. Although Conventional antennas are often bulky and costly part of an electronic system but the microstrip antennas based on photolithographic technology are seen as an engineering breakthrough. A microstrip antenna generally consists of a dielectric substrate sandwiched between a radiating patch on the top and a ground plane on the other side as shown in Figure 2.1. for making a patch generally we use conducting material such as copper or gold and it can take any possible suitable shape. Usually photo etched dielectric substrate is used for making the radiating patch and the feed lines.

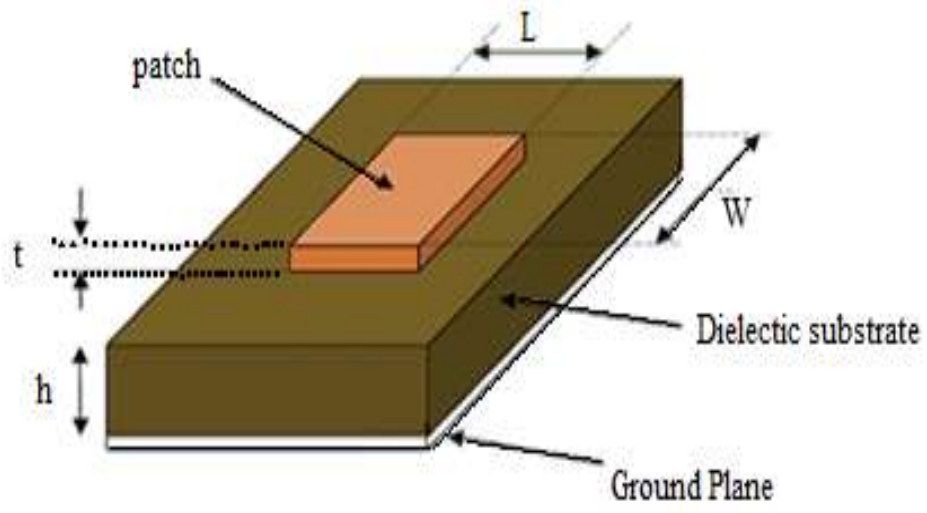


Figure 2.1: Structure for a Microstrip Patch Antenna [7]

For simplicity of analysis, the patch is of various shapes like square, circular, rectangular, triangular, and elliptical or some other common shape. For example, a rectangular patch, the length L of the patch is usually in between the range of 0.3333 λ_0<L< 0.5 λ_0, where λ_0 is the free space wavelength. And the patch is selected to be very thin such that t<<λ_0 (where t is the patch thickness). The height h of the substrate is usually0.003 $\lambda_0 \leq$ h $\leq$ 0.05 λ_0. The dielectric constant of the substrate ϵr is typically in the range 2.2 $\leq \epsilon r \leq$ 12.

3. DESIGN, SIMULATION OF THE SQUARE MICROSTRIP PATCH ANTENN

3.1 Design Specifications:

Size of the patch antenna: The patch is square in shape having dimensions as(32×32)mm.

Dielectric constant of the substrate (ε_r): The dielectric material selected for our design is Rtduroid/ 5880 which has a dielectric constant of 2.20. A high dielectric constant substrate has been selected as it reduces the dimensions of the antenna.

Height of dielectric substrate (h): as the microstrip patch antennas are mostly used for cellular phones by keeping in this in mind it is essential to keep the antenna small inphysical size. Due to this, the height of the dielectric substrate is selected as 4.2 mm.

Frequency Range: The frequency range is selected is 1Ghz-6Ghz.

3.2 Design of Square Patch Microstrip Antenna for Circular Polarization using HFSS Simulator:

1. Dielectric constant (ε_r) = 2.20
2. Height (h) = 4.2 mm.
3. Velocity of light (c) = 3×108 ms-1.
4. Practical width (W) = 32 mm.
5. Loss Tangent (tan δ) = 0.0009.
6. Practical Length (L) = 32 mm.

Table 3.1: Parameters of Proposed Antenna Design.

s.no	Antenna parameter	Specification
1.	**Length of substrate**	**80mm**
2.	**Width of substrate**	**80mm**
3.	**Length of patch**	**32mm**
4.	**width of patch**	**32mm**
5.	**Height of substrate**	**4.2mm**
6.	**Gain**	**-14dB**
7	**Bandwidth**	**.2161Ghz**

3.3 The Feed Point Determination

As there feed type has been specified and the parameters are calculated. As the design process goes the calculation of the parameters are done above and with the dimensions the rectangular patch antenna has been designed by Co Axial Feed Technique.

3.4 Patch Antenna Design Specification:

32*32 square patch antennas, divided in tow part by 1mm slot. The upper part L=32mm, W=16 and the lower part L=32mm, W=16mm.

3.5 VSWR

The VSWR is measured and examined when transmitting antennas are installed and tuned. When a transmitter is connected to an antenna through feed line, then impedance of the antenna and feed line must match exactly for maximum energy transfer from the feed line to the antenna as possible [4]. The tuner can be installed in between the transmitter and the feed line or it can in between the feed line and antenna. Both installation methods will allow the transmitter to operate at low VSWR, Ideally VSWR must lies in the range of 1-2 which is achieved in fig 3.1 for the frequency 4.87GHz near the operating frequency value.

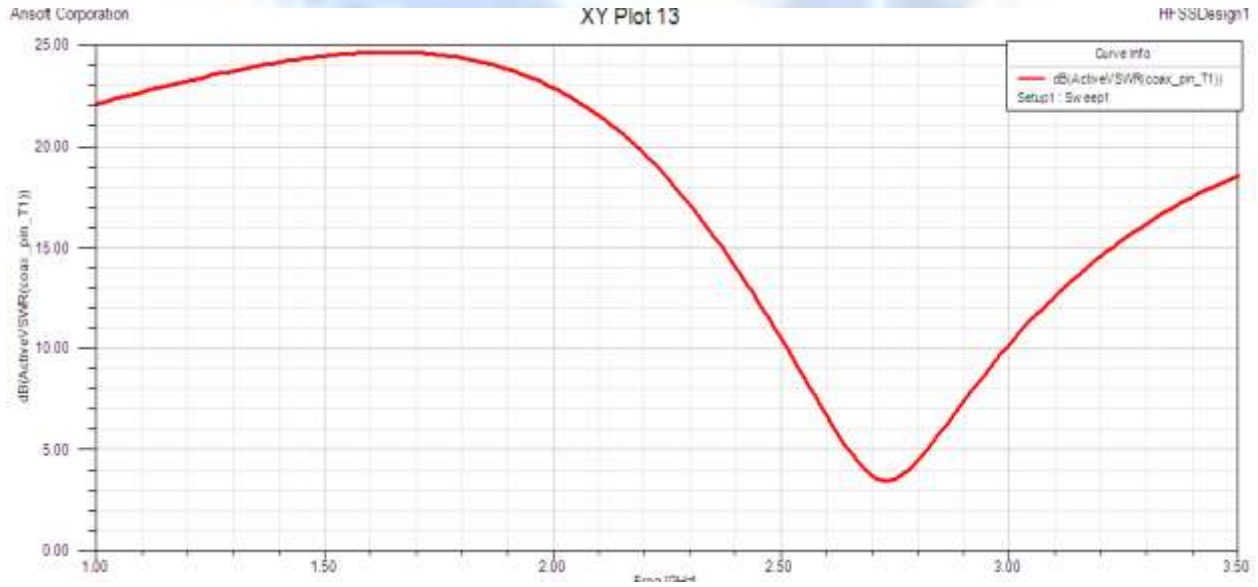


Figure 3.1: VSWR Vs Frequency

5.5 Smith Chart

The smith chart plot represents that how the antenna impedance varies with frequency. The size of the locus of the smith chart is controlled by the Slot length. As the slot length increase, the size of the locus increase[6]. For proper matching the locus must large enough that it passes through the centre of the smith chart. As it can be seen from the figure that the circle cuts the resistive parts thus matching.

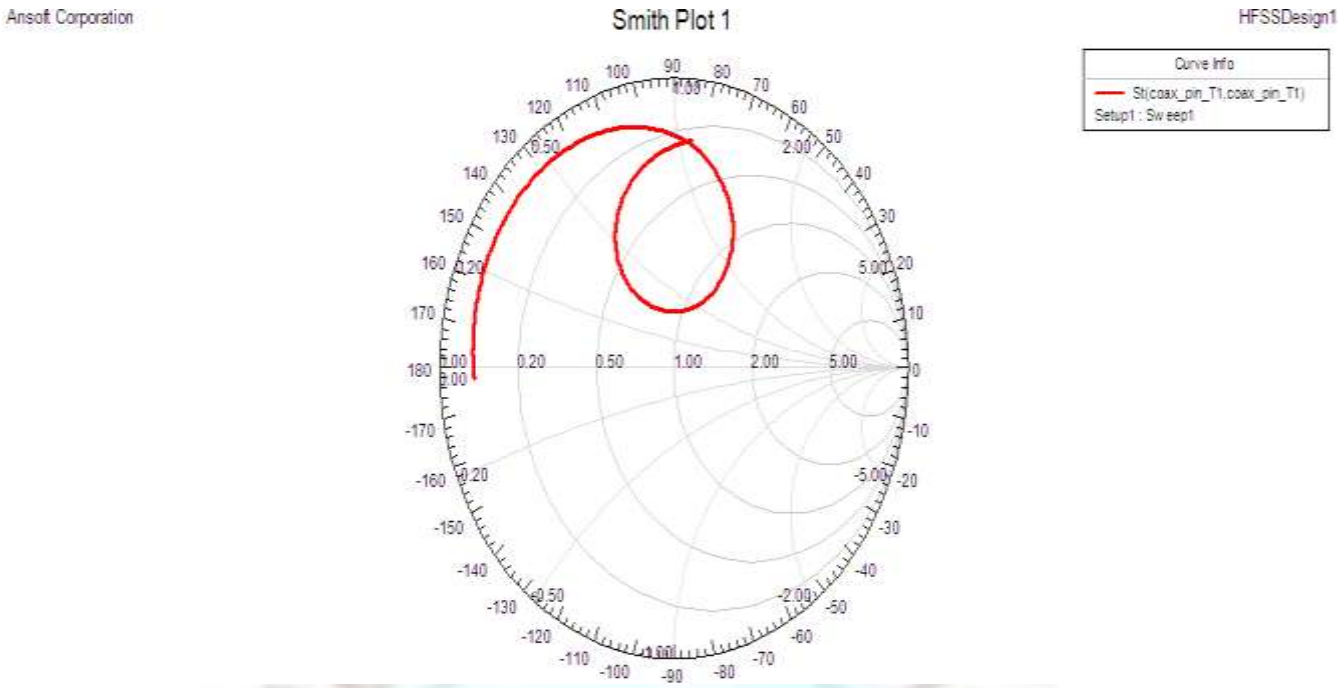


Figure 3.2: Smith-Chart

4. RESULT

1. For S11 parameter graph (Return loss)

View-> Project manager -> Results(Right Click) ->Creat Terminal solution Report -> Rectangular Plot ->(Category) Select Terminal S Parameter ->(Function)dB -> (Click on) New Report.

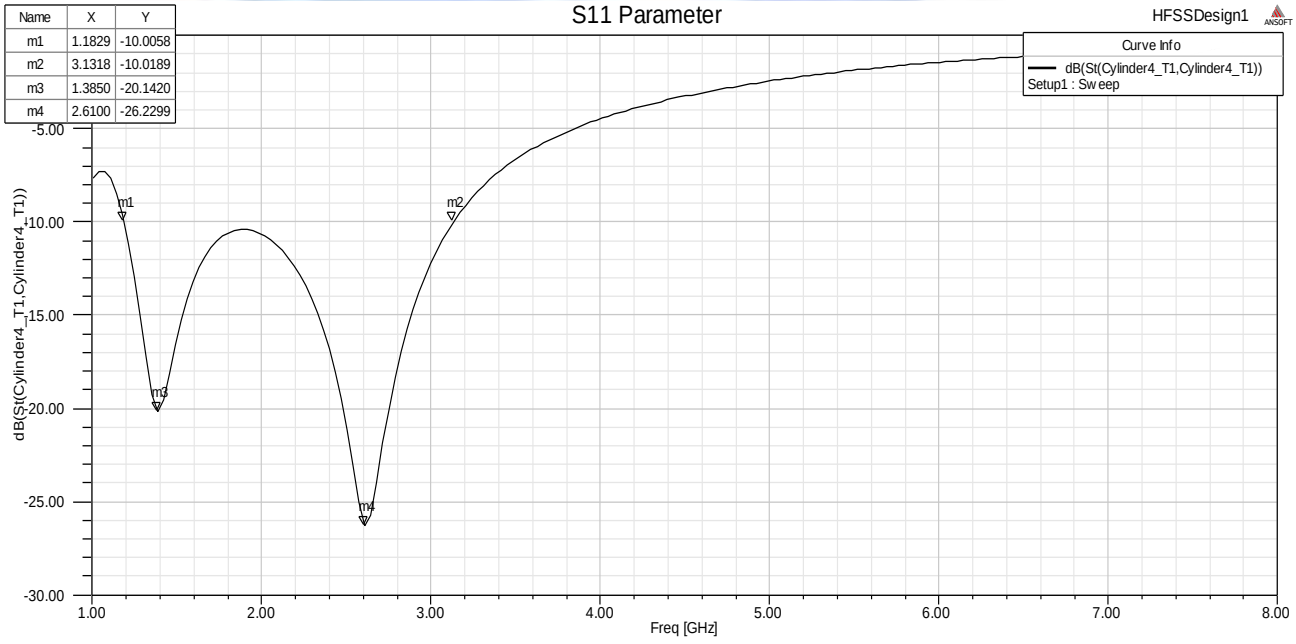


Figure 4.1: S11 parameter of multiple Slotted antenna

2) For VSWR graph:

View-> Project manager -> Results(Right Click) ->Creat Terminal solution Report -> Rectangular Plot ->(Category) Select Terminal VSWR ->(Function)dB ->(Click on) New Report.

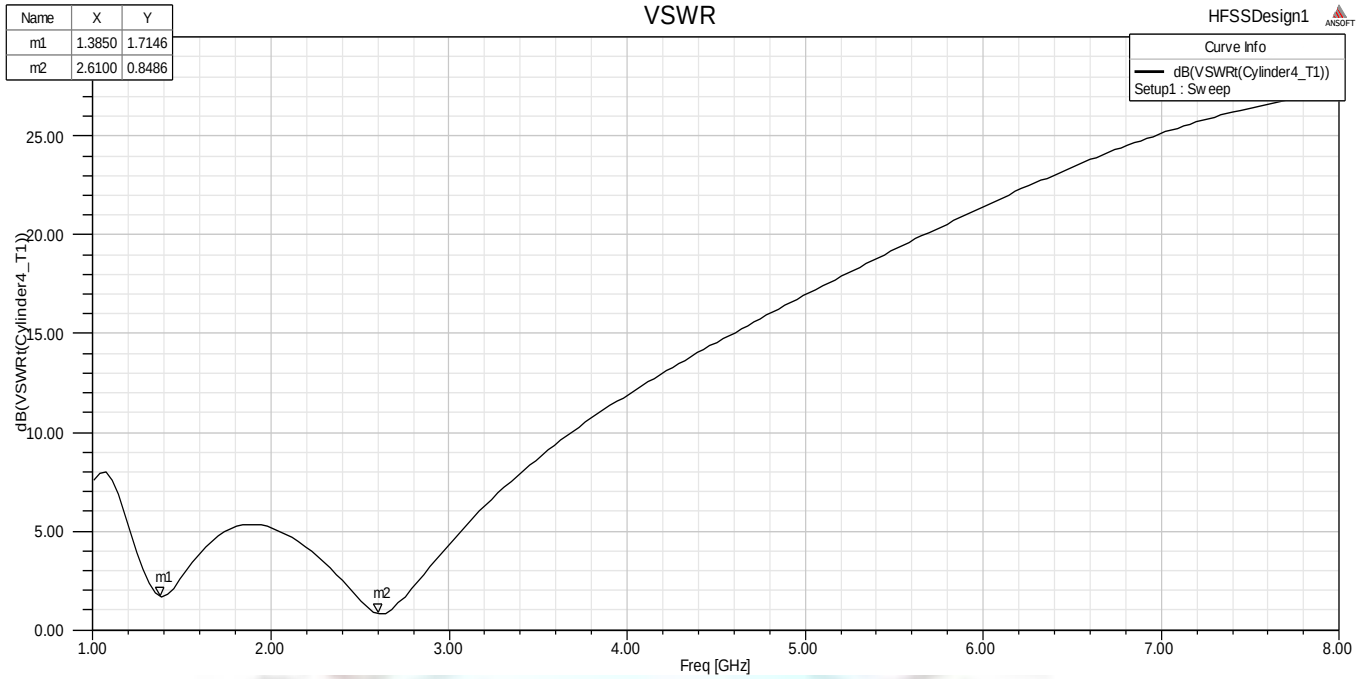


Figure 4.2 : VSWR of multiple Slotted antenna

3. For Peak Gain:

View-> Project manager -> Results(Right Click) ->CreatFar Field Report -> Rectangular Plot ->(Category) Antenna Params ->Quantity (Peak Gain)-> (Function)dB ->(Click on) New Report.

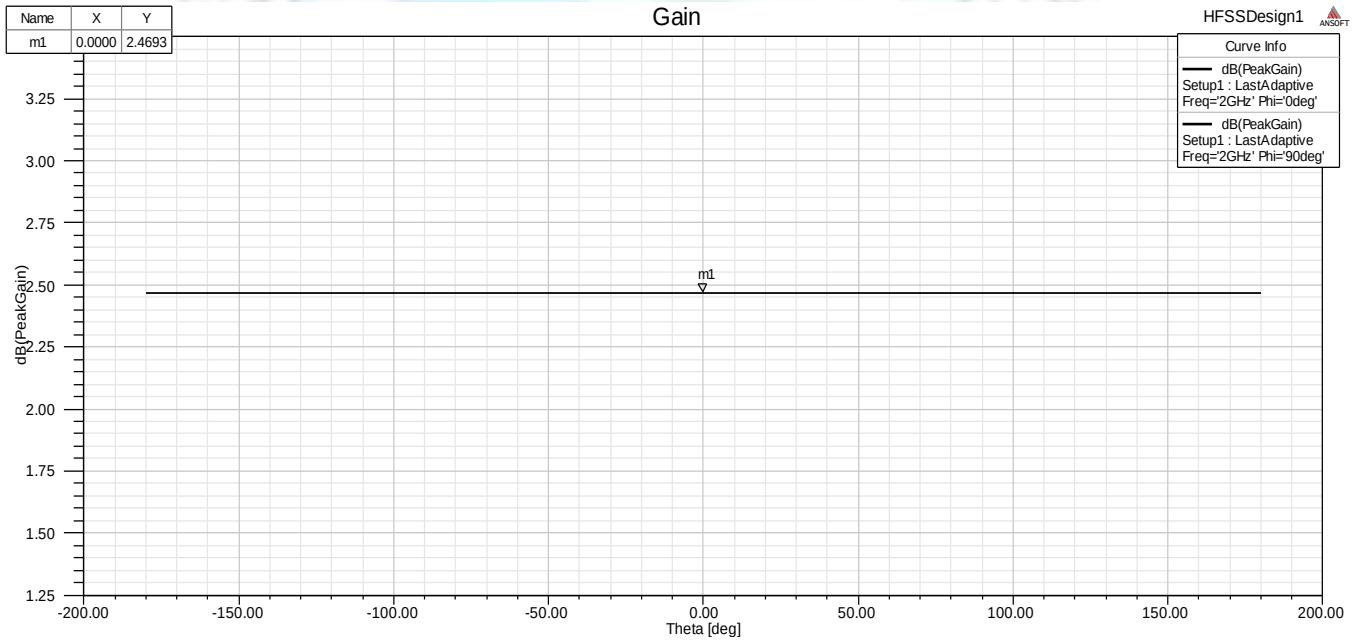
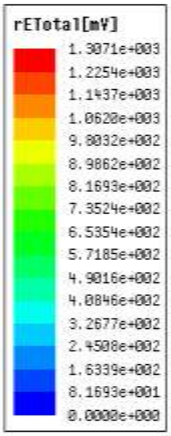


Figure 4.3: Peak Gain of multiple Slotted antenna

4. For 3D polar plot:

1) View-> Project manager ->Radiation (Right click)->Insert Far Field Setup ->Infinite sphare->Window open-> click OK.
2) HFSS -> Validation Check
3) HFSS ->Analyze All
4) View-> Project manager -> Results(Right Click) ->Far Field Report -> 3-D polar Plot ->(Click on) New Report.



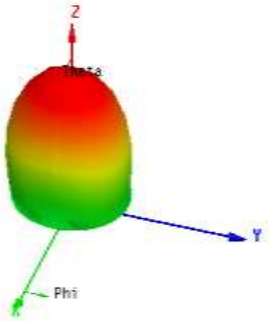


Figure 4.4: 3-D polar of multiple Slotted antennas

CONCLUSIONS

In this paper a single layer square patch wide band Microstrip antenna for modern wireless communication has been designed and study the responses and the radiation properties of the same had explained. In this thesis an antenna has been designed successfully by using probe feed technique. For the design, an antenna has been designed with the dimensions as Length – 32mm, width - 32mm, height –4.2mm, with a dielectric constant of 2.20(Rtduroid/ 5880), which has a loss tangent of 0.0009..The antenna efficiency is taking all this in to consideration we can say that there are many aspects that affect the performance of the antenna. The Operating frequency, Selection of the substrate, Dimensions and also feed technique can take their position in which effects the performance.

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