Review Paper for Analysis of Semi-Circular Slotted Microstrip Patch Antenna For Wireless Applications

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Abstract-*In this paper an antenna is presented for single band at 2.4 GHz for ISM Band wireless applications. The proposed antenna will be designed by using semicircular slot in rectangular type patch for coaxial probe feed. In this paper we will try to minimize the return loss and will find out the best VSWR value. The Paper will give a better understanding of design parameters of an antenna and their effect on return loss, S-Parameters, smith chart, radiation pattern, bandwidth, VSWR and resonant frequency. Finally simulation will be done by using design software HFSS.*

Keywords-Single band, Coaxial probe feed, Semicircular Slot, Rectangular microstrip patch, S-Parameters, smith chart, radiation pattern, bandwidth, VSWR, HFSS.

I. INTRODUCTION

Presently rapid growing of wireless communication and is the fastest growing segment of the communication field. Wireless communication systems have been growing as the application of mobile phones and systems are booming in use. For such wireless systems the crucial component to emit and collect signals is the antenna. Antenna is not active device; they are passive that only guides the signal energy in a peculiar direction in connection with isotropic antenna. They act as bridging links between transmitter, free space and the receiver. Some of the alluring characteristics of antenna include low profile, radiation emitted from the antenna should be less, less bulkier, high gain, fabrication should be done in an uncomplicated manner and its overall cost be less and it need to have certain amount of compatibility with looped surfaces. But, stability is still one of the important properties of coming up application. Microstrip patch antenna is the most suitable and prevalent type of antenna in use today, their effective frequency range is in between 1GHz to 6 GHz.

Since 1970s this antenna has been flourishing, where its size and performance were very effective as conversation entity was required at these frequencies. The architecture of the microstrip patch antenna consists of the substrate of which below is the ground plane and above is the patch. These antennas find applications in mobiles instruments, receivers using GPS technologies and other wireless and wired products reason being there high values of dielectric constant and additional size reduction. Since this antenna has flat profile and is light in weight also makes them suitable for applications like airborne and spacecraft. Advances in wireless communications have introduced tremendous demands in the antenna technology. It also paved the way for wide usage of mobile phones in modern society resulting in mounting concerns surrounding its harmful radiation [1-6].

Microstrip patch antenna has attractive features such as low profile, low cost, light weight, easy integration with integrated circuits and ease of fabrication. There are varieties of techniques to enhance the bandwidth of patch antenna such as using of a foam or a thick substrate material, cutting rectangular and circular slots or notches like U slot, M-shaped, H-shaped, Z- shaped, E-shaped patch antenna, initiating the parasitic elements either in stack configuration or coplanar and changing the shape of the radiating patch by setting up the slots. In [7-10], a wide-slot antenna with a microstrip line is proposed to enhance the bandwidth using a fork-like tuning stub.

Many applications including aviation (aeronautical radio navigation and radio navigation satellite), satellite communication and maritime aviation (space operation, mobile satellite and earth exploration satellite), wireless communication (mobile except aeronautical mobile and broadcasting satellite), private land mobile (space research), fixed microwave devices, ISM equipment, personal land mobile, personal radio and amateur radio utilize the microstrip patch antennas that have a radiating patch mounted on a dielectric layer (substrate) supported by a ground plane. These microstrip patch antennas provide significant performance with an appreciable bandwidth. Several recent microstrip patch antennas have been studied in this literature review. In yet another work, maximum attained gain is 3.4 dBi. Also both of and slotted rectangular patches in offer a peak gain less than the proposed antenna. Even the triangular slot microstrip patch antenna for wireless communication as in offers a much less gain[17].

International Telecommunication Union's (ITU) Radio Regulations(RR),fixed-satellite service (abbreviated as

FSS and alternatively termed as fixed-satellite radio communication service) is defined as a radio communication service between earth stations at given positions, when one or more satellites are used. The given position may be a specified fixed point or any fixed point within specified areas; in some cases this service includes satellite-to-satellite links, which may also be operated in the inter-satellite service; the fixed-satellite service may also include feeder links for other space radio communication services. In addition to private land mobile applications including the fixed satellite services and mobile except aeronautical mobile, the microstrip patch antennas also get used for aviation applications including radio location and aeronautical radio navigation. These microstrip patch antennas have caused a tremendous revolution in the field of space technology owing to their promising. The microstrip patch antennas provide for an appreciable quality performance over a wide range of frequencies and require minimum installation setup. The various recent literatures exhibit a much less gain as compared to the proposed prototype.. The novel design is formed by considering a triangular patch and making a rectangular and circular slots in the patch. The designed structure, thus, provides an efficient reflection coefficient, gain and considerable bandwidth[18]

II. LITERATURE SURVEY

Joseph Costan Tine et al. [2011] A new multi-band antenna design has been presented. The design consists of joining a rectangular and a triangular patch together in one patch, and inserting several forms of slots. The new idea behind this design also includes the insertion of rectangular slots following a Chebyshev distribution around a central rectangular slot, in addition to a triangular slot inserted into the triangle, I which has the same area as the rectangular patch. The concept of inserting slot arrays following a known antenna-array distribution has proven to give remarkable functionality to an antenna. It causes 1it to be highly radiating in different frequency ranges, using only one single feed, represented by a 50ohm SMA connector, where the position has been optimized. The antenna has many applications, such as GSM, GPS, Wi- Fi, Wi-Max, video wireless communication, and Bluetooth applications, in one single instrument, using this type of antenna[4].

Nasser Ojaroundi et al [2012] proposed to design a monopole antenna with dual band characteristics for UWB applications. It consisted of s square radiating patch with q modified T- slot and a ground plane with an E- slot and a W-shaped conductor backed plane. in order to generate single band notched characteristics, the W=shaped backed plane is used. The measured results reveal that the proposed antenna offers a very wide bandwidth with two notched bands, covering all 5.2/5.8 GHz wireless local area network, 3.5/5.5 GHz, WI-MAX and 4GHz C bands.[9]

Zuhura Juma Ali et al. [2014] This paper presents a miniaturized planar circular disc UWB antenna design for wireless communications. Printed on a dielectric substrate and fed by 50Ω microstrip line with truncated ground plane, the proposed antenna has been demonstrated to provide an ultra wide 10dB return loss bandwidth with satisfactory radiation properties. The special structure reduces the spatial volume and it is used to realize the miniaturization of the antenna. Ansoft High Frequency structure Simulator (HFSS) software tool has been employed for obtaining the simulation results. The return loss, voltage standing wave ratio (VSWR), radiation patterns and current distributions of the antenna are discussed.[11]

Udit Raithatha,S.et al. [2015], Abstract: This paper represents the design of Swastika shaped microstrip patch antenna for Industrial Scientific and Medical (ISM) band applications. The design has four slots as same as Swastika shape into it. Feeding method used for this design is Inset feed. Gain, Bandwidth, Return loss, Voltage Standing Wave Ratio (VSWR) and Directivity are investigated[13].

Sumeet Singh Bhatia [2015], Abstract: A microstrip patch antenna is presented for wireless communication system. In this paper two different feeding techniques of microstrip rectangular patch antenna like direct line feed and proximity coupled feed is designed for the same dimensions of patch, feed and substrate. The designed antennas are resonating at the frequency of 7.5 GHz which is desired frequency for X-band applications[14].

Gurpreet Kaur et. al [2016] Abstract: In this paper an rectangular patch with parasitic stub whose edge have been cut , with two slots near the feed line has been proposed. The antenna is designed using HFSS software. The designed antenna shows wideband characteristics having simulated bandwidth of 96 %.The overall dimension of the antenna are 35×35×1.6 mm3.This antenna obtained maximum gain of 9.55dB having VSWR is less than 2 [15].

Ranjan Mishra, Raj Gaurav Mishra, Piyush Kuchhal [2016] Abstract: This research paper presents a simple design consideration of Ultra-Wide Band (UWB) Microstrip antenna using a centrally loaded rectangular slot. An analytical study of the effects of different size and shapes of slots on the performance characteristic of UWB Microstrip antenna is presented. Insertion of slot and the changes in dimension of ground plane has a high impact on the behavior and parameter of the patch antenna. To improve the bandwidth of the patch antenna, proper insertion of slot on the planer patch structure has been used [16].

Anamika Banwari et Al [2017], This paper reported a design of a semicircular slotted microstrip patch antenna which has low loss and high gain, also suitable for ISM band applications. The antenna is fed through the coaxial probe and resonates at ISM band frequency of 2.4 GHz. The dimension of microstrip slotted patch is 8.3×7.1×0.16 cm3. This slotted patch is designed on the Rogers RT/Duroid substrate with relative permittivity of 2.2. The designed antenna is simulated using High-Frequency Structural Simulator software which gives the result with a return loss of – 39.5782 dB, VSWR of 1.0212 at 2.4 GHz and the total gain of 7.67dB. It is very compact and very easy to fabricate. The proposed slotted antenna is highly suitable for wireless communication of various ISM band applications like as W-LAN, WiFi, ZigBee, and Bluetooth etc.

Jaiverdhan et Al [2017], A dual band double slot loaded microstrip antenna with a diagonal coaxial feeding is proposed. Rectangular patch is used as radiator over which two narrow slots are created. These slot and feed position make antenna both frequency and polarization reconfigurable. The bandwidth of this slotted antenna is 550 MHz and 180 MHz at 4.0 and 4.9 GHz respectively. This bandwidth is sufficient for many applications like satellite and radar communication. The antenna is analyzed and simulated using HFSS V.17.0. The 10:1 gain bandwidth of the simulated antenna with respect to center frequency is 12.5% at 4.9 GHz and 4.7% at 4 GHz. The proposed work provides 7.8dBi gain at frequency 4.9 GHz and 7.1dBi at 4 GHz. The proposed antenna provides circular polarization (both LHCP and RHCP). This antenna having an overall dimension of 60 x 60 x 3.8 mm3 and the dimension of slots created over patch is 18 x 1 mm which is very compact compared to the conventional antenna.

III. FEEDING TECHNIQUES USED

Microstrip Patch antennas can be fed by a variety of methods. These methods can be classified into two categories – contacting and non-contacting . In the contacting method , the RF power is fed directly to the radiating patch using a connecting element such as a microstrip line. In the non-contacting scheme , electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch .The four most popular feed techniques used are the microstrip line, coaxial probe(both contacting schemes), aperture coupling and proximity coupling (both non-contacting schemes).

Coaxial Probe Feed

The Coaxial feed or probe feed is a very common technique used for feeding Microstrip patch antennas. The inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane. The main advantage of this type of feeding scheme is that the feed can be placed at any desired location inside the patch in order to match with its input impedance.

However, its major drawback is that it provides narrow bandwidth and is difficult to model since a hole has to be drilled in the substrate and the connector protrudes outside the ground plane, thus not making it completely planar for thick substrates.

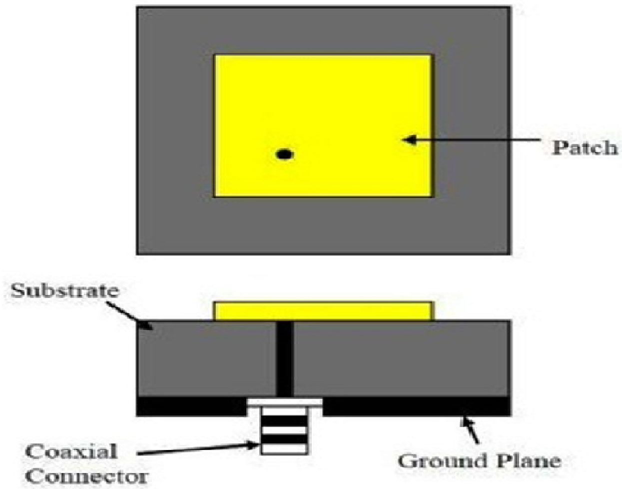

Figure 1 Coaxial Probe feed rectangular microstrip patch antenna[2]

A Probe Fed antenna consists of a microstrip patch fed by the center conductor of a coaxial. The outer coaxial conductor is electrically connected to the ground plane. Due to the absence of a microstrip feed line, the substrate thickness and permittivity can be designed to maximize antenna radiation.

However, the probe center conductor underneath the patch causes undesired distortion in the electric field between the patch and ground plane and produces undesired reactive loading effects at the antenna input port [1,2]. The undesired reactance can be compensated by adjusting the probe location on the patch.

IV. METHODOLOGY & CONCLUSION

The length of the patch is denoted by L and width of the patch is denoted by W. Because the dimensions of the patch are finite along the length and width, the fields at the edges of the patch undergo fringing. Since some of the waves travel in the substrate and some in air, an effective dielectric constant $\varepsilon reff$ is introduced to account for fringing and the wave propagation in the line.

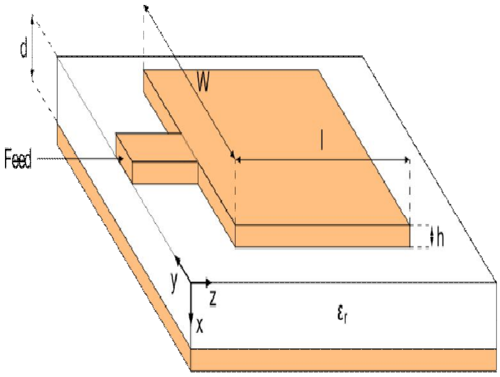

Figure 2 Basic Geometry of Microstrip Patch Antenna

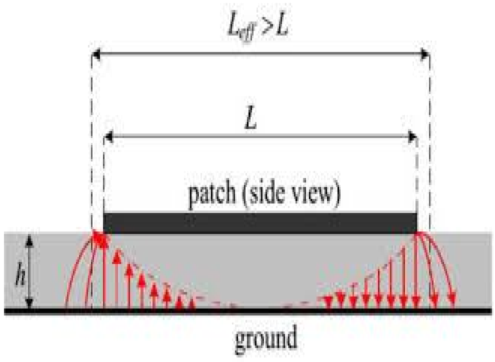

Figure 3. Effect on length due to Fringing

The dimension the patch along its length has been extended by a distance ΔL due to the fringing field which is a function of effective dielectric constant. Hence the effective length is increased by 2ΔL.

Various formulas for designing a microstrip patch antenna are written below.

Calculation of effective dielectric constant, εreff, which is given by

$$:\varepsilon_{reff} = \frac{(\varepsilon_r+1)}{2} + \frac{(\varepsilon_r-1)}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}}$$

Calculation of the length extension ΔL, which is given by:

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)}$$

For efficient radiation, the width W is

$$W = \frac{\lambda_0}{2\sqrt{(\epsilon_r + 1)/2}}$$

Now to calculate the length of patch becomes:

$$L = \frac{\lambda_0}{2\sqrt{\epsilon_{reff}}} - 2\Delta L$$

Length and width of the ground is:

$$L_{g=}6h + L$$
$$W_g = 6h + W$$

V. CONCLUSION

A single band Microstrip patch antenna for wireless application will be designed and simulated using HFSS V13 software. Rectangular Antenna is designed using semi-circular slot in patch for the purpose of minimizing the return loss and find out near about ideal VSWR value.

A simulation will made in terms of bandwidth, return loss, VSWR and patch size and smith chart. So, we can see that selection of the feeding technique for a microstrip patch antenna is an important decision because it affects the bandwidth and other parameters also. A microstrip patch antenna excited by different excitation techniques gives different bandwidth, different gain, different efficiency etc. The performance properties will be analyzed for the optimized dimensions.

The proposed antenna will be designed by coaxial probe. We can also conclude that by changing the feed point where matching is perfect, the high return loss can be achieved at the resonant frequency.

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