Review Paper For PLUS Shaped Slotted Microstrip Patch Antenna For Wireless Bands

Ritika[1], Ravinder S. Bisht[2]
[1]Dept of ECE
[2]Assistant Professor, Dept of ECE
[1, 2] RPIIT Technical Campus, Karnal

Abstract- *In this review paper an antenna is presented for multi-band wireless applications using PLUS shaped slot in patch. Aim of designing of microstrip rectangular patch antenna as a dual band or multiband is to define an antenna for multipurpose for many different wireless applications and to evaluate the all parameters of antenna as like return loss, VSWR, radiation pattern, smith chart, gain and etc. The main challenge in designing of microstrip rectangular patch antenna is to design a single antenna for different-2 wireless application using any feeding technique.*

Keywords- Multiband, Plus-Slots, Rectangular Microstrip patch antenna, S-Parameters, Smith chart, Radiation pattern, Bandwidth, VSWR, HFSS

I. INTRODUCTION

Though microstrip antenna has many advantages, it has some limitations too. Researchers are putting their efforts to minimize these limitations. Microstrip antennas are widely applicable for Global Positioning System, wireless local area network, mobile communication system, microwave sensors, etc. Various advantages of Microstrip antenna include slight weight, low profile, easy fabrication [1].Microstrip antennas are basically realized by cutting slots on patch. A slot cut Microstrip antenna depending on the used frequency range results bandwidth in between 20%to 45%. The gain can be increased by using some specific geometry of the slots. Moreover it also results broader bandwidth. Slot does not introduce any extra mode but reduces the resonance frequency of higher order modes and also effect the fundamental patch mode. However introduction of these slots pause a modification of the surface current distribution at modes of higher order. These results a broadside radiation pattern distributed over an entire bandwidth. As mentioned earlier microstrip antenna has some limitations like narrow bandwidth, low power handling capability, low gain, low efficiency and extraneous radiation from feed. However these limitations can be minimized by using techniques like cutting slot, loading Gunn or Tunnel diode, shorting wall & pin and gap coupling. Many researchers have used the mentioned technique for analysis of different Microstrip antenna. Different feeding techniques are used for the analysis of microstrip antenna. It includes aperture coupled feeding, co-axial feeding [2], proximity coupled feeding and microstrip line feeding.

The advancements in microstrip antenna technology ensued its start in the late 1970s. Basic microstrip antenna elements and arrays in term of design and modeling had been utilized at fair level by the early 1980s. In the last decades printed antennas have been largely analyzed owing to their merits such as light weight property, miniaturized size, lesser cost, conformability and the easy integration with active device over other radiating systems. The conducting materials such as copper and gold due to their better conductivity and adhesive property to substrate are generally used on the outer surfaces of the substrate for the purpose of patch and ground. The radiating patch and the feed strip lines are usually photo etched on the dielectric substrate. Electromagnetic wave radiation from microstrip patch antennas occurs primarily by the reason of the fringing fields between the patch edge and the ground plane[2].

The antenna used in such devices should be small also but the cost should not be increased. Similarly if we want to place an antenna in space, any aircraft, parabolic reflector antenna or Yagi antenna that have high bandwidth and gain can be placed in that place but, it will affect highly on the space and aircraft because of their 3D structure, hence it becomes inefficient to plant those antenna structure on the space and aircraft. The solution is to use planner or 2D antenna configuration to this type of difficulties. These antennas can be easily mounted on the surface of any such equipment. In this case, the microstrip patch antenna plays an important role. Also, in the today's environment, technology demands antennas which can operate on different wireless bands and should have different features like low cost, minimal weight, low profile antennas that are capable of maintaining high performance over a chromatic spectrum of frequencies. This technological trend has much focused in the design of Microstrip patch antennas.

In its most basic form, a microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate, which has a ground plane on the other side as shown in Figure 1.

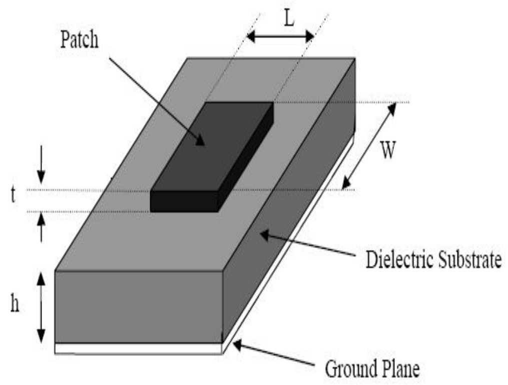

Figure 1:- Structure of a microstrip patch antenna.[1]

The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate.

In order to simplify analysis and performance prediction, the patch is generally square, rectangular, circular, triangular, and elliptical or some other common shapes. Rectangular patches are probably the most utilized patch geometry. It has the largest impedance bandwidth compared to other types of geometries, and is the main research interest in this project. Circular and elliptical shapes are slightly smaller than of rectangular patches. Thus it will have smaller bandwidth and gain. This circular geometry patches were difficult to analyze due to its inherent geometry.

II. LITERATURE SURVEY

Zuhura Juma Ali [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], 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[9].

Sumeet Singh Bhatia [2015], 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[10].

Gurpreet Kaur et. al [2016], 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 [11].

Ranjan Mishra, Raj Gaurav Mishra, Piyush Kuchhal [2016], 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 [12].

R.Er-rebyiy et. Al [2017] The concept of Defected Ground Structures (DGS) has been developed to improve the characteristics of many microwave devices. For this purpose the DGS is also used in the microstrip antenna for some advantages such as antenna size reduction, mutual coupling reduction in antenna arrays etc... In this paper the defected ground structure (DGS) has been employed to miniaturize a microstrip patch antenna and to shift the resonance frequency from an initial value of 10 GHz to a final value at 3.5 GHz, without any change in the dimensions of the original microstrip patch antenna. This antenna is designed on a FR- 4 substrate with dielectric constant 4.4 and thickness 1.6 mm and its size is 27 X 30 mm^2[13].

G.Sreedhar Kumar et. Al [2017] Design of an adapted E-shaped microstrip patch antenna for dual-band operation is presented in this paper. Tuning of the resonant frequencies is achieved by using an adjustable air-gap. The proposed patch consists of Roggers RT/duroid 5880 substrate suspended on air-gap above the ground plane. By varying the height of air-gap, the resonant frequencies of the patch are tuned between 1.99 GHz – 2.634 GHz. Tuning is done for variable heights of air-gap and at different values of thickness of duroid substrate. The patch is excited by a coaxial probe. Good input impedance matching, return loss and a gain of 9.86 dB is achieved in the results over the tuned frequencies. Ansoft HFSS 13 Tool is used for design and simulation of the E-shaped patch. The designed MSA in terms of resonant frequency, return loss, bandwidth and gain for different values of air gap and substrate thickness. For different values of the heights, it is shown that the dual frequencies of the MSA are tuned with good return loss and gain.[14]

Abhinav Srivastav et. Al [2017] In this paper, we have investigated a unique design of microstrip antenna with three PLUS-slot of equal area. The geometry is such that three PLUS symbol at an angle of 0º, 45º and 90º. Simulation has been made using HFSS software. Results of proposed antenna proves it to be a good candidate for Bluetooth and WiMAX applications. Good bandwidth, uniform radiation pattern, VSWR value nearly equal to 1 gives excellent impedance matching and better gain of the antenna are achieved. First, the dimension of patch antenna with PLUS-slot is calculated at 2.45GHz using the formulas. Then the PLUS-slot is incorporated on the patch and the new dimensions of the feed position are obtained for desired resonance frequency, VSWR, bandwidth and gain using HFSS software. Substrate employed for designing the proposed antenna is Rogers RT/duroid 5880(tm). The dielectric constant value for this substrate is 2.2, Antenna has been optimized to operate at a frequency 2.45GHz.[15]

M.M.Ali [2017] In This, a compact dimension with microstrip fed line has been chosen to fulfill the necessities of a portable device. The antenna was built on a 1.5-mm thick FR4_epoxy substrate with a loss tangent of 0.02 and a permittivity = 4.4. The substrate dimensions are 22 mm × 20 mm. A rectangular patch of dimensions Ws × Ys with a half circle cut out placed middle on the substrate. The patch is fed by 50 ohm microstrip line. The proposed antenna gives wider bandwidth along with Omni-directional radiation pattern. The antenna achieves a wide bandwidth with wide impedance matching due to its reduced size.[16]

III. FEEDING TECHNIQUES USED

Feeding Techniques are classified into two categories, one is contacting (microstrip line feed, coaxial probe feed) and second type is non-contacting (proximity coupled feed and aperture coupled feed). As we are using coaxial probe feed that is a type of contacting so first of all we will discuss all feeding techniques as follows.

A. *Microstrip Line Feed*

Microstrip line feeding is a technique in which a conducting strip is connected directly to the edge of the microstrip patch. The width of conducting strip is smaller as compared to the patch. This type of feeding arrangement has the advantage that the feed and patch can be etched on the same substrate to provide a planar structure.

However as the thickness of the dielectric substrate being used increases, surface waves and spurious feed radiation also increases, which hampers the bandwidth of the antenna. The feed radiation also leads to undesired cross polarized radiation. This method is advantageous due to its simple planar structure.[1]

B. *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.[1]

C. *Proximity coupled Feed*

This method uses electromagnetic coupling between the feed line and the radiating patches, printed on separate substrates [1]. Two dielectric substrates are used such that the radiating patch is on top of the upper substrate and feed line is between the two substrates. The advantage of this coupling is that it yields the largest bandwidth compared to other coupling methods, it is somewhat easy to model and has low spurious radiation. This feeding method also provides choices between two different dielectric media, one for the feed line and one for the patch to optimize the individual performances. Matching can be achieved by controlling the width-to-line ratio of the patch and length of the feed line. The major disadvantage of this feeding scheme is that it is difficult to fabricate because of the two dielectric layers which need proper alignment. Also, the overall thickness of the antenna also increases.[1,2]

D. *Aperture coupled feed*

In this type of feed technique, the radiating patch and the microstrip feed line are separated by the ground plane. Coupling between the patch and the feed line is made through a slot or an aperture in the ground plane and variations in the coupling will depend upon the size i.e. length and width of the aperture to optimize the result for wider bandwidths and better return losses. The coupling aperture is usually centered under the patch, leading to lower cross-polarization due to symmetry of the configuration. Since the ground plane separates the patch and the feed line, spurious radiation is minimized.
Aperture coupled feeding is attractive because of advantages such as no physical contact between the feed and radiator, wider bandwidths, and better isolation between antennas and the feed network. Furthermore, aperture-coupled feeding allows independent optimization of antennas and feed networks by using substrates of different thickness or permittivity.[1,2]

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.

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.

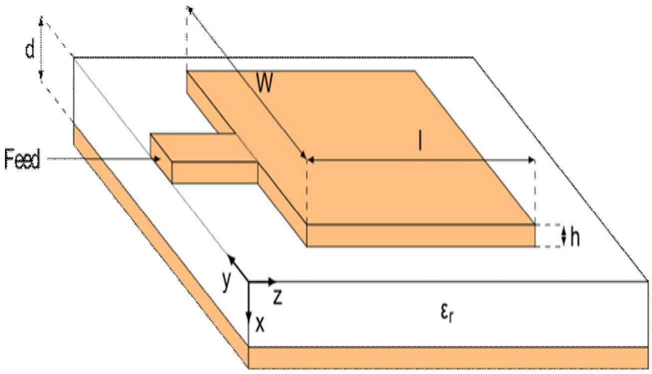

Figure 2 Basic Geometry of Microstrip Patch Antenna[1]

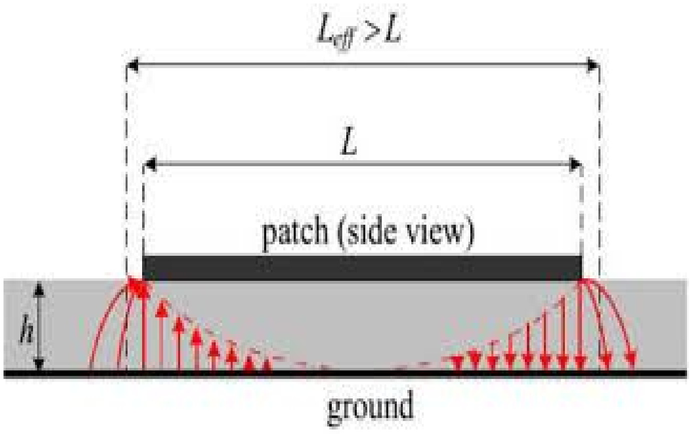

Figure 3. Effect on length due to Fringing[1]

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 Δ*L, 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

Designing of Rectangular slotted Microstrip Patch Antenna for wireless implicated antenna using coaxial feeding technique will be used. Design Parameters of Antenna like Bandwidth, Return loss, Smith Chart, Radiation Pattern, VSWR, Impedance Matching, Gain and resonant Frequency will be optimized. 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 are analyzed for the optimized dimensions.

REFERENCES

[1] Ramesh Garg, PrakashBhartie, InderBahl, ApisakIttipiboon, "Microstrip Antenna DesignHandbook", Artech House Inc. Norwood, MA, 2001, pp. 1-68, 253-316,.

[2] C.A. Balanis, "Antenna Theory (Analysis and Design)", Second Edition, John Wiley & son Sons.

[3] Ahmed Fatthi Alsager, (2011) "*Design and Analysis of Microstrip Patch Antenna Arrays*", M.Tech Thesis in Electrical Engineering– Communication and Signal processing, University College of Boras School of Engineering, SE-501 90.

[4] Joseph Costan Tine1, Karim Y. Kabalan, Al EI-Hajj, (2011) "*New Multi-Band Microstrip Antenna Design For Wireless Communications*" Vol. 49, No. 6, 2011.

[5] Abdel Fattah Sheta, Ashraf S. Mohra, And Samir F. Mahmoud (2011) "*Modified Compact H-Shaped Microstrip Antenna For Tuning Multi-Band Operation*", *Radio Science Conference*, pp. 1-6, 2011.

[6] L. M. Si And X. Lv (2012), "*CPW-Fed Multi-Band Omni-Directional Planar Microstrip Antenna Using Composite Metamaterial Resonators For Wireless Communications*" Pier 83, 133–146, 2012.

[7] P.Mythili, Philip Cherian, S.Mridula, Binu Paul (2012) "*Design Of A Compact Multiband Microstrip Antenna", International Conference on Emerging Technologies (ICET), pp. 1-6.*

[8] Zuhura Juma Ali, "A Miniaturized Ultra Wideband (UWB) Antenna Design for Wireless Communications" International Journal of Scientific & Research Publications, Vol 4, Issue 7, July 2014.

[9] Udit Raithatha, S. Sreenath Kashyap & D. Shivakrishna, May 2015, "Swastika Shaped Microstrip Patch Antenna for ISM Band Applications" international journal IRJET.

[10] Sumeet Singh Bhatia, Jagtar Singh Sivian, Manpreet Kaur, "Comparison of feeding techniques for the design of microstrip rectangular patch antenna for x-band applications", International Journal of Advanced Technology in Engineering and Science, Volume No.03, Special Issue No. 02, 2015.

[11] Gurpreet Kaur, Er. Sonia Goyal, "Effect of Height on Edge Tapered Rectangular Patch Antenna using Parasitic Stubs and Slots'', International Journal of Engineering Trends and Technology (IJETT) – Volume 34 Number 8- April 2016.

[12] Ranjan Mishra, Piyush Kuchhal, "Analytical Study on the Effect of Dimension and Position of Slot for the Designing of Ultra Wide Band (UWB) Microstrip Antenna" International Conference on Advances in Computing, Communications and Informatics (ICACCI) IEEE, Sept. 21-24, 2016, Jaipur, India.

[13] R. Er-rebyiy, J. Zbitou, A. Tajmouati, "*A new design of a miniature microstrip patch antenna using Defected Ground Structure DGS,*" *2017 International Conference on Wireless Technologies, Embedded and Intelligent Systems (WITS)*, Fez, 2017, pp. 1-4.

[14] G.Sreedhar Kumar, (2017) "*Dual-Band Tunable Adapted E-Shaped Microstrip Patch Antenna*", 2017 2nd IEEE International Conference On Recent Trends in Electronics Information & Communication Technology (RTEICT), May 19-20, 2017, India

[15] Abhinav Srivastav, Sourabh Chandra, (2017) "*Design of PLUS-slot Microstrip Patch Antenna for Bluetooth and Wi-MAX applications"*, 2nd IEEE International Conference On Recent Trends in Electronics Information & Communication Technology (RTEICT), May 19-20, 2017, India.

[16] M.M.Ali (2017) "*Rectangular with Half Circle Cut-out MPA for C-Band Application*"**,** Proceedings of the 2017 4th International Conference on Advances in Electrical Engineering (ICAEE) 28-30 September, Dhaka, Bangladesh.