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Broad Band Micro strip Patch Antenna Design- A Critical review

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ABSTRACT *- Microstrip Patch Antenna (MPA) is generally used in modern communication devices, and a large part of day-to-day communication is done through it. Study of the literature of past few year shows that, the progressing work on MPA is focused on designing compact sized broadband microstrip antenna. But inherently MPA have narrow bandwidth, so to enhance bandwidth various techniques are used. This review paper describes some commonly engaged techniques to fabricate MPA with broader-bandwidth since last few decades. One of the advantages of microstrip patches over conventional antennas is their small size. However, there are many present day applications where even these small radiators are too large. A microstrip antenna incorporated with a single shorting pin is found to provide reduction in overall area with respect to a conventional patch. The compact circular polarized patch antennas can be achieved by slot loading on patch. In this paper the review on various techniques of compactness by Conductive bias, planar meta-material unit cell and slot loading on microstrip antenna are presented which are reported in literature.*

Keywords: Compact patch, Pin loading, S-shaped impedance matching network with planar meta-material unit cell, Conductive .

1. Introduction

A Microstrip Antenna in its simplest form consists of a radiating patch on one side of dielectric substrate and ground plane on other side. Microstrip Patch Antennas are popular for their well-known attractive feature, such as a low profile, light weight, and compatibility with Monolithic Microwave Integrated Circuits (MMICs). Modern Communication System, Such as those for satellite links (GPS, Vehicular, etc.), as well as emerging applications, such as Wireless Local Networks (WLAN), offers antennas with compactness and low-cost, thus rendering planar technology useful, and sometimes unavoidable. Conventional microstrip patch antennas has some drawbacks of low efficiency, narrow bandwidth (3-6)% [1,2]of the central frequency, its bandwidth is limited to a few percentage which is not enough for most of the wireless communication system[3]. There are several designs have been investigated and reported to decrease the size of antenna [4] and to improve the bandwidth of antenna [5,6].

It has many applications in military, radar systems, mobile communications, global positioning system (GPS), remote sensing etc. In this review paper discuss on various techniques of compactness by pin and slot loading on microstrip antenna. A microstrip antenna incorporated with a single shorting post at proper position and size is found to provide reduction in overall area with respect to a conventional patch antenna. Also, the compact Circular polarized patch antennas can be achieved by slot loading on patch. The load of the slots or slits in the radiating patch can cause meandering of the excited patch surface current paths and result in lowering of the resonant frequency of the antenna, which corresponds to a reduced antenna size and compared to a conventional circularly polarized microstrip antenna at the same operating frequency. The size of the microstrip patch antenna is inversely proportional to the operating frequency of the antenna and the Bandwidth of the microstip patch antenna is directly proportional to the substrate thickness and inversely proportional to the square root of the dielectric constant of the substrate. Mostly low dielectric constant is used because it has a very high water absorption capability. Higher dielectric constants are used in microwave circuits because they require tightly bounds fields to minimize radiation and coupling and lead to smaller element sizes.

Practically bandwidth of a Microstrip Patch Antenna is narrow but, today wireless communication systems requires higher operating bandwidth, such as about 7.6% for a global system for mobile communication(GSM;890-960 MHz), 9.5% for a digital communication system(DCS;1710-1880 MHz), 5% for a personal communication system (PCS;1850–1990 MHz)And 12.2% for a universal mobile telecommunication system (UMTS;1920-2170 MHz)

2. The Literature Review

The construct of microstrip antenna with conducting patch on a ground plane separated by insulator substrate was undeveloped till the revolution in electronic circuit

shrinking and large-scale integration in 1970. After that several mortal have drawn the radiation from very cheap plane by a insulator substrate for numerous configurations. Various mathematical analysis models were developed for this antenna and its applications were extended to several numerous fields. The little strip antennas unit is today's antenna designer's selection. Throughout this section, the microstrip antenna literature survey is mentioned. "Nasser Ojaroudi" has proposed a compact antenna with multi-resonance characteristics UWB/Omni-Directional Microstrip Monopole Antenna with multi-resonance characteristic has been projected for microwave imaging systems leads to compact antenna with smart omni-directional radiation characteristics for projected in operating frequencies. The fictious antenna satisfies the VSWR<2 demand from 2.95 to 14.27 GHz so as to reinforce information measure frequency, two pairs of formed slits and parasitic structures in the ground plane area unit used and therefore abundant wider electrical phenomenon with an ordinary square radiating patch and small size of 12×18mm2[1,2,5,7,8].

"T. Suganthi" has researched that, the size of the antenna is obtained with the help of parametric analysis. As the designed antenna meeting the requirements of GSM application, it could be highly useful for mobile application. In this paper, design and Analysis of the Microstrip Patch. An antenna for GSM application is represented by. Antenna parameters such as Return Loss, VSWR of the designed antennas are -29.21dB, 1.0717 respectively [3, 10]. "Ramna" has proposed Design Of Rectangular Microstrip Patch Antenna by Particle Swarm Optimization. In this Particle swarm optimization is a popular optimization algorithm used for the design of microstrip patch antenna. He was presented design using soft computing technique, particle swarm optimization (PSO) of probe fed rectangular microstrip patch antenna for WCDMA. For the design of microstrip patch antenna a substrate with dielectric constant of 4.4 and height 1.588 mm has been used. To optimize the parameters like patch length, width and feed position at center frequency of 1.95 GHz using Sonnet13.52,PSO has been used. Microstrip patch antenna resonated at 1.95GHz more.PSO saves time as compared to the design of patch antenna without optimization algorithm and also PSO restricts the variation from center frequency [4,6]. "Jyoti Ranjan Panda" has researched that A Compact Printed Monopole Antenna(PMA) for Dual-band RFID and WLAN Applications. From 9-shaped folded antenna, dual-band operation is achieved which is printed on a non-conductor backed dielectric. Impedance bandwidth 33.13% at 2.43 GHz and 36.43% at 2.43GHz is measured of the PMA. The proposed antenna exhibits broadband impedance matching, consistent omni directional radiation patterns and appropriate gain characteristics (>2.5 dBi) in the RFID and WLAN frequency regions [11].

"Mohammad Ojaroudi" has presented a novel, compact printed monopole antenna (PMA) for UWB applications. The antenna designed and then fabricated meets out the requirement of an ideal antenna at -10 db.The feed-gap distance, the sizes of Tshaped notch, and the sizes of two rectangular slots in the antenna's patch is used to obtain the wide bandwidth have been optimized by parametric analysis. This antenna exhibits good radiation behaviour within the UWB frequency range. [12]. " Y. Chen", has proposed Design And Analysis Of Wideband Planar Monopole Antennas Using The Multilevel Fast Multipole Algorithm. In this to analyze the impedance bandwidth and radiation performance of the monopoles a full-wave method of moment (MoM) based on the electric field integral equation (EFIE) is applied. Meanwhile, to reduce the memory requirements and computational time, the multilevel fast multipole algorithm (MLFMA) is employed. Two wideband planar monopoles attached to finite sized ground planes are designed, analyzed, and fabricated. Both of the simulated and measured results shows that the two monopoles are capable to cover the AMPS, GSM900, and DCS band. In the whole operating frequency, both of the monopoles can provide a nearly omni-directional radiation pattern in the azimuth plane [13]. "Nakchung Choi" has proposed a notch-frequency band for a UWB antenna which can be embedded into laptop computers with an I-shaped parasitic element. This novel band-notched UWB antenna has the capability to provide easy tuning of the notch-frequency function and bandwidth with good stop band rejection [14,15, 16].

Ajay Singh and S. C. Gupta have studied the different broad band techniques. The authors have discussed briefly the different design methods to enhance the broad band characteristics. Narrow bandwidth of microstrip patch antenna is its major limitation; to improve/enhance bandwidth many bandwidth enhancement techniques are used. This paper shows the review and survey of various such techniques used for enhancing the bandwidth of micro strip patch antenna. Out of all techniques specified above in this paper Multi-layered Technique and Stacked Multilayered Technique yield maximum bandwidth. [18] Priyanka kakriya and Rajesh Neema, have briefly reviewed the design methods of compact broad antenna. the microstrip patch antenna used in these devices should have compact size, as the bandwidth of microstrip patch antenna depends upon the size of antenna, so smaller the antenna size, smaller is the bandwidth achieved. For enhancing the bandwidth

by keeping the small size different techniques like Shorted Patch, Stacked Shorted Patch, Slot-Loading Technique and Slotted Ground Plane Technique are used by manufacturers. In shorted patch technique radiating patch of microstrip antenna is shorted by a shorting pin through ground via substrate material. This short circuit may be complete, by wrapping a copper strip around the edge of the antenna, or it may be simulated by shorting post. It is easy to construct a shorting post than wrapping a copper strip around the edge. Position of shorting pin depends on the target application. The other method discussed in the paper is the use stacked shorted patch.

By using two stacked shorted patch and make both patches radiate equally as possible and making radiation quality factor as low as possible, one can achieve enhance impedance bandwidth for fixed antenna volume. The innovative technique of creating the defect in the ground plane. In this technique a slot is made on ground plane of microstrip antenna. By increasing the length of slot impedance bandwidth can be increased. As slotted patch increases the current path length same can be applied to the ground plane. Design of a compact and broadband microstrip patch antenna with slotted ground was proposed by J. S. Kuo. Here three identical slots are made on ground plane aligned with equal spacing.[19] Mitesh Purohit and Shailesh Khant have reviewed and surveyed various Bandwidth enhancement techniques of Microstrip Patch Antenna. If one of any above mentioning techniques Bandwidth of Microstrip Patch Antenna is used, it can be improved significantly which will overcome the limitation of Microstrip Patch Antenna such as narrow Bandwidth. Out of all the techniques Multilayered Technique yield maximum bandwidth. The authors have investigated four methods of improving the broad band performance of the antenna. 1. Multilayered configuration of Broadband MPA. 2. Stacked Multiresonator MPA. 3. Modified Shape Patch Broadband MPA. 4. Planar Multiresonator configuration of Broadband MPA. Out of all mentioned techniques Multilayered Technique yield maximum bandwidth.[20]

The success of this research lies in investigating the different configuration of the multi-layered antenna. The stacking is tested followed by changing the shape of the reonating patch. In the end the authors have

Narrow bandwidth is always a constraint on MSA. So different broadband techniques are used to enhance it. In this paper some of these techniques are reviewed and discussed. Out of all techniques Multilayer structure yields a maximum bandwidth. But it also increases the size of antenna as well due to more than one patch. Also slot loaded techniques and L probe feed are provides the bandwidth enhancement up to 30% and 40% respectively which has an advantage of size of antenna is remain small. Using shorting pin and shorting wall reduces the size of antenna significantly at the expense of bandwidth.[21] Ali A. Dheyab et. Al in this paper have presented the use of transmission line method to analyze the rectangular micro strip antenna [5]. RMPA operating of resonance frequency (2.4GHz) for TM10 mode, with the coaxial probe feed used the antenna is matched by choosing the proper feed position. A micostrip patch antenna has the advantages of low cost, light weight, and low profile planner configuration. However, they suffer from the disadvantage of low operating bandwidth [1-2]. Bandwidth improves as the substrate thickness is increased, or the dielectric constant is reduced, but these trends are limited by an inductive impedance offset that increases with thickness. A logical approach, therefore, is to use a thick substrate or replacing the substrate by air or thick foam, the dielectric constants are usually in the range of ($2.2 \leq \varepsilon r \leq 12$) [22]

Atser A. Roy et.al in this work have worked , three different geometry shapes, the U, E and H are developed from a rectangular patch of the width (W) = 32mm and length (L) = 24mm. The proposed antennas are simulated using Sonnet software and the results compared with the conventional rectangular patch antenna. The results obtained clearly show that, bandwidth of conventional rectangular microstrip antenna can be enhanced from 4.81% (100MHz) to 28.71% (610 MHz), 28.89% (630MHz) and 9.13% (110MHz) respectively using U, E and H-patch over the substrate. The E-shaped patch antenna has the highest bandwidth followed by U-shaped patch antenna and Hshaped patch antenna. The substrate material used for the proposed antennas is Alumina 96%, with the dielectric constant of 9.4 and loss tangent of 4.0e-4. The proposed antennas may find applications in Wireless Local Area Network (WLAN). In this work, the aim was targeted at improving the bandwidth of microstrip antennas constructed with dielectric material with higher dielectric constant. We have selected three different patch antennas and the simulated results compare with the conventional microstrip patch antenna. The results obtained clearly show that bandwidth of conventional RMSA made with dielectric substrates having higher dielectric constants can be improved using U and E-shaped patch antenna. We have observed that E-shaped patch antenna has the highest bandwidth follow by U-shaped patch antenna and H-shaped antenna. [23]

3. Conclusion

Communication plays a very important role in today's world as the switching of communication systems from "wired to wireless" has been very rapid. Antenna is one of the most important elements of wireless communication systems allowing the tranmission and reception of electromagnetic waves in free space. The design of an efficient, small size antenna providing large operating bandwidth for recent wireless applications is a major challenge. Thus, antenna design has become one of the most important and demanding aspect in the field of wireless communication. One of the most popular and frequently used in modern world antenna in this field is microstrip patch antennas. Microstrip antennas are widely used for its low profile, easy manufacturability, simple structure, low cost and omni directional radiation patterns[1].These features have much more advantage over the traditional ones. But the drawback of this kind of antenna also sometimes confine their applications, especially the narrow bandwidh. So, new technologies is invented to overcome these shortcomings. One such technique that can be used to overcome these limitations is Defected Ground Structure (DGS). Recently there has been an increasing in the use of DGSs for performance enhancement of microstrip antennas. These structures are realized by etching off a simple shape defect from the ground plane of microstrip patch antenna [2]

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