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A Review on Different Diamond Shaped Microstrip Patch Antenna

Yati Chourasia[1], M.P. Parsai[2]
ME Student[1], Professor & HOD[2]
Department of Electronics and Communication
Jabalpur Engineering College, Jabalpur, India

Abstract:
With the advancement in antenna technology, there is a great need of a low profile, multiband and wideband antennas for wireless communication. Microstrip Patch Antenna has inherently narrow bandwidth, so as to enchance bandwidth various approaches are implemented. Microstrip Patch Antenna with various Diamond shaped patches and different slots in it are explained in this paper. It was found that bandwidth extension could be achieved by embedding slots and Defected Ground Structure.

Keywords: Bandwidth, Defected ground structure, Microstrip Patch Antenna, Return loss, VSWR.

I. INTRODUCTION

Microstrip patch antennas are well suited for Wireless, WiMAX, satellite communication systems, military applications, radar systems, mobile communications, global positioning system, remote sensing, etc due to its low cost, ease of fabrication, ease of installation, low sensitivity to manufacturing tolerances. Recently importance has been given to the patch antennas that show broadband properties. Microstrip patch antenna consists of a very thin ($t<<\lambda$) metallic patch placed a small fraction of a wavelength above the ground plane[1]. The radiating patch may be square, circular, elliptical, rectangular or any other shape. For enchancing bandwidth, slots are embedded into the radiating patch[2]. There are many configurations that can be used to feed microstrip antennas. Some of them are microstrip line feed, coaxial feed or probe feed. In microstrip feed line the edge of microstrip patch is connected directly to the conducting strip which is of smaller width as compared to the radiating patch. This method is advantageous due to its simple plannar structure but leads to the undesired cross polarized radiation [3]. In coaxial feed, the outer conductor of coaxial conductor is connected to ground plane while the inner conductor extends through the dielectric and is soldered to the radiating patch. Advantage of this type of feeding is that it can be located at any desired position in the patch in order to match with its input impedence and is most effective for wideband wireless application. But it provides narrow bandwidth and is difficult to model[4].The input impedence of microstrip patch antennas depends on the geometrical shape of the radiating patch, dimensions, the physical properties of the materials involved, the feed type and location. Therefore a subset of antenna parameters can be adjusted to achieve the best geometry for matching of a particular resonance. For most of the practical applications of narrow bandwidth and bandwidth extensions, microstrip patch antennas are the most suited ones. Therefore different approaches have been used to increase the bandwidth. One of the most effective approach is defected ground structure (DGS)[6]. DGS has advantages in microwave filter, transmission line, couplers, dividers, oscillators, microwave amplifiers [7] and microstrip antennas. Different approaches have used to increase the bandwidth such as exponential tapering and triangular tapering [8]. For the input signal of the antenna to radiate freely without any hindrance from the antenna, tapered structures are employed [7]. This feeding technique improves the impedence matching for a broad range of frequency.

II. STUDY OF DIFFERENT DIAMOND STRUCTURE AND THEIR RESULTS

Different diamond shape patch antenna structures and their characteristics are discussed as follows.

DIAMOND-SHAPED MICROSTRIP PATCH ANTENNA

The design of diamond shape microstrip patch antenna is shown in figure1. The radiating patch of the antenna is rotated square shape. This antenna consists of two substrate. The first substrate, above the ground plane is consists of FR4 of dielectric constant 1.07 with height 3.4mm and second substrate with height 1.6mm whose dielectric constant is 4.4 with total thickness of substrate 5mm. A rotated square patch is implemented on this layer and two slots of 30mm ×2mm are inserted into the patch. The coaxial feed is used here for excitation at center position (0.1, 0.1). The ground plane size of 62mm× 62mm is chosen for this design.

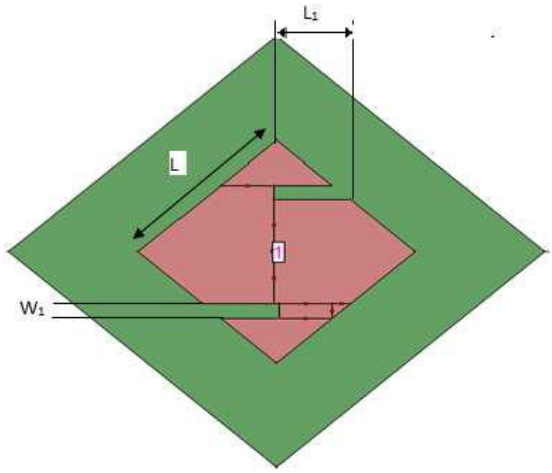

Figure.1. Diamond shaped patch antenna [9]

Result

Return loss is the loss in the power of the signal reflected by the load indicating a mismatch. The bandwidth is the range of frequencies over which return loss is less than -10dB. The measured S11 scattering parameter (return loss) of microstrip Diamond-shaped patch antenna is -19dB and the measured bandwidth of the antenna is 527MHz, which is over 12% for $|S11| \leq 10$ dB ranging from 4.036 to 4.553GHz. The value of VSWR is 1:1.224. VSWR is lie in the range of 1-2 which has been achieved for the frequency 4.3GHz, which is near the operating frequency value. The operating frequency of this antenna is best applicable to modern communication devices and wireless communication frequencies. The impedance for this antenna is 50.05Ω[9].

Diamond shaped patch antenna at 1.6GHz

This antenna is designed to operate at 1.6GHz, having a diamond shape patch 40mm×52mm. The dielectric substrate used is GLASS EPOXY with dielectric constant 4.4, loss tangent .0012 and the height of substrate is 1.6mm. The ground plane size chosen for this design is 54mm×66.6mm. The coaxial feed is used for excitation at the position (13.5,4.8). IE3D is used to carry out the results. The design of antenna is shown in figure 4.

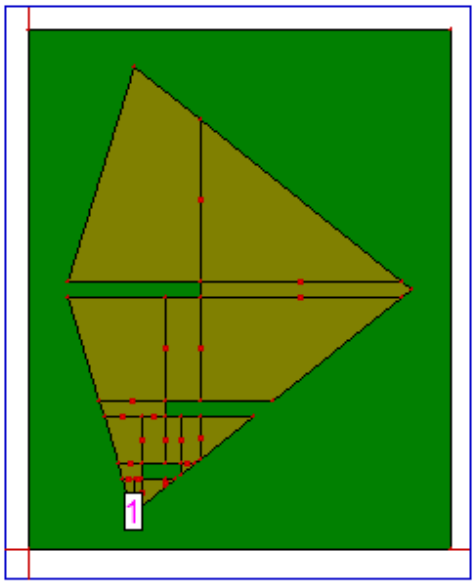

Figure.2. Antenna feeding at (13.5,4.8)[10]

Result

The measured S11 scattering parameter or return loss this antenna is -5dB. The maximum S11 was found to be -23dB at 2.2GHz. The measured bandwidth of antenna is 819MHz over which $|S11| \leq 10$ dB ranging from 2GHz to 2.8GHz. The gain of this antenna is found to be 3.5dB. This antenna is best applicable for Bluetooth application[10].

Irregular diamond shaped slotted patch antenna

This antenna is designed using dielectric substrate GLASS EPOXY with dielectric constant 4.4 and having a substrate height of 1.6mm. An irregular diamond shaped patch is designed to operate at 1.6GHz. In this design structure coaxial feeding is used. The feed point (X_f=49mm,Y_f=33.3mm) is located on the patch. The irregular diamond shaped slotted patch antenna is shown in figure 3.

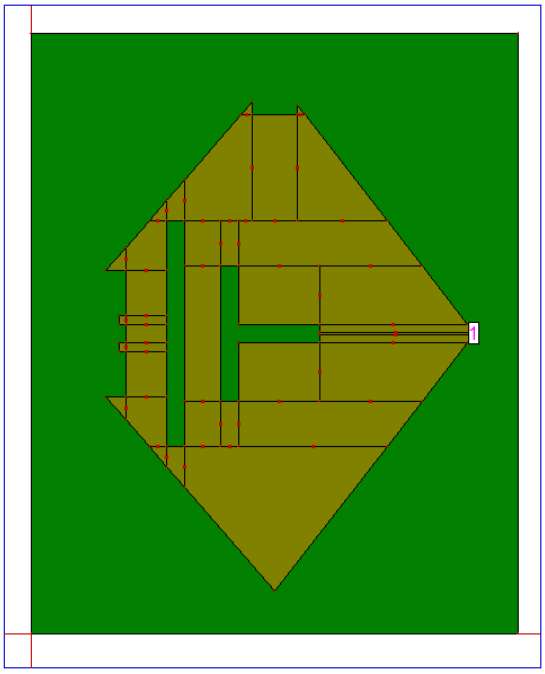

Figure.3. Irregular diamond shaped slotted patch antenna [11]

Result

The measure S11(scattering parameters) of irregular diamond shaped slotted patch antenna at 1.6GHz is found to be -17dB. The results show dual band operation. The range of frequencies for which $|S11| \leq 10$ dB are 1.2GHz to 1.9GHz and 2.1GHz to 2.8GHz. The gain at 1.6GHz is 2.5dB. This antenna is best suited for L band application.

Diamond shaped patch antenna with defected ground structure

The designed MPA and ground plane is shown in Figure 4 and figure 5 respectively. The antenna dimension is 8.4mm×13.3mm and the ground plane is 39mm×40mm. The antenna air thickness is 16mm. The height of ground plane is 0.2mm. This antenna is designed using dielectric substrate FR4, with dielectric constant 4.2 and height of substrate 1.6mm.

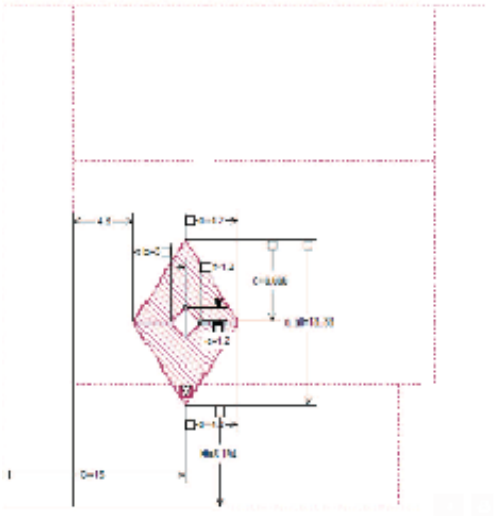

Figure. 4. Designed mpa[12]

Result

In figure 6, S11, the result for input reflection coefficient are shown. The designed antenna has an input reflection coefficient of -14.63dB at resonance frequency of 3.6GHz and an input reflection coefficient of -11.91dB at resonance frequency of 10.35GHz.The bandwidth obtained is 2.8GHz.

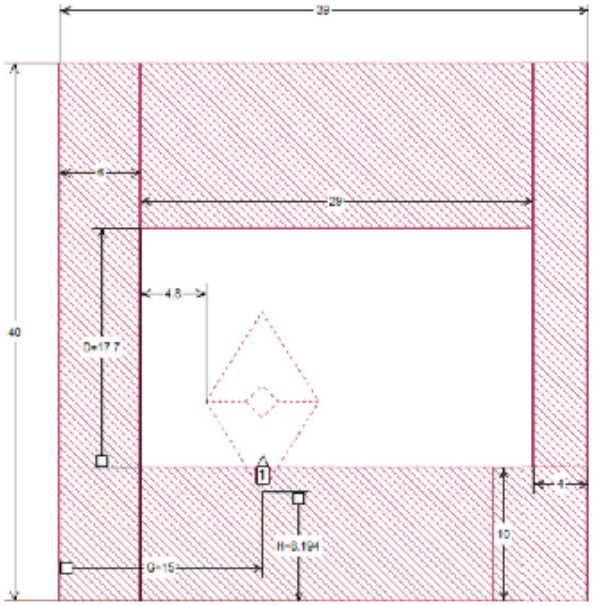

Figure. 5. Ground plane[12]

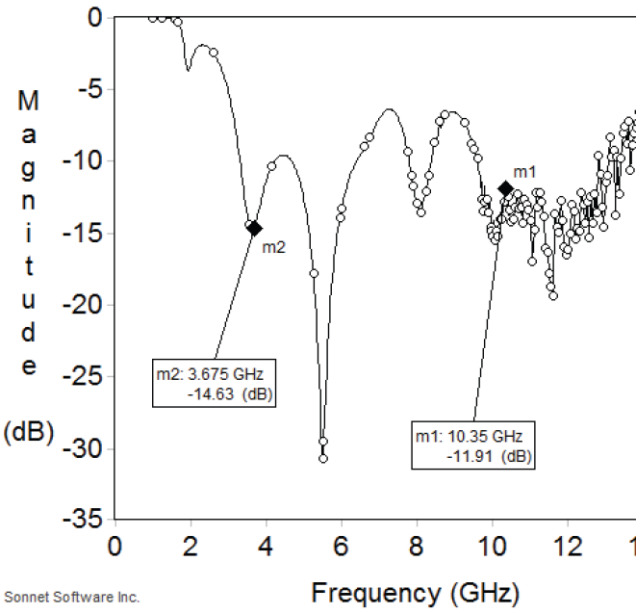

Figure. 6. Input reflection coefficient[12]

III. CONCLUSION

In this paper the performance of different diamond shaped microstrip patch antenna is reviewed on the basis of its characteristic parameters like bandwidth and return loss. In[9] diamond shaped MPA, two substrate were used, which shows return loss values as -19dB and bandwidth 527MHz. In[10], the bandwidth is seen to be 819.2MHz. In[11], slots were introduced which shows dual band operation. In[12] diamond shape MPA defected ground structure is introduce, in which a bandwidth of 2.8GHz was observed. Multiple defects in the ground can be introduced to obtain a further improvement in return loss and bandwidth.

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IV. AUTHORS

Yati Chourasia was born in Katni, Madhya Pradesh in 1992.She completed her B.Engineering in Electronics and Communication in 2014.She started her Master of Engineering from Jabalpur Engineering College, Jabalpur, Madhya Pradesh in 2015. Currently working on Microstrip Patch Antennas and its applictions.

Prof. M.P. Parsai as an Professor and Head of Electronics and Telecommunication Department in Jabalpur engineering college, Jabalpur and having 31 years of Academic and Professional experience. He received M.E. degree in Control system and B.E.in EC. He has guided several students at Master and Under Graduate level. His areas of current research include Image Processing and Pattern Recognition and antennas.