DESIGN AND SIMULATION OF U-SHAPED MICROSTRIP PATCH ANTENNA WITH BANDWIDTH ENHANCEMENT AND SIZE REDUCTION

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Abstract
The concept of microstrip radiators was proposed in 1953. However, 20 years passed before practical antennas were fabricated. Development during the 1970s was accelerated by the availability of good substrates with low loss tangent and attractive thermal and mechanical properties, improved photolithographic techniques, and better theoretical models. Since then, extensive research and development of microstrip antennas and arrays, aimed at exploiting their numerous advantages such as light weight, low volume, low cost, conformal configuration, compatibility with integrated circuits, and so on, have to diversified applications and to the establishment of the topic as the separate entity with in the broad field of microwave antennas. [1]
The paper provides a detailed study of how to design and fabricate a microstrip-fed U-shaped microstrip patch antenna using IE3D software and study the effect of antenna dimensions length (L), and substrate parameters relative dielectric constant (εr), substrate thickness(t) on the radiation parameters of bandwidth and beam-width. In this dissertation design and simulation of U-Shaped microstrip patch antenna with bandwidth enhancement and size reduction with small size, low cost, light weight, and high performance is presented.

I. Introduction
Microstrip Patch Antenna Microstrip antennas are popularly investigated due to their properties such as low profile, low cost, conformability and ease of integration with active devices. Reduction of antenna size becomes extremely important in wireless communications and hence it is desired to bring down the size of antenna while achieving the same performance of the large size antenna.[2] Though there is a lower limit to the size of any antenna for a given resonant frequency, other important metrics like Gain and Bandwidth are drastically affected for small size antennas. Hence the idea is to balance between Gain and Size of the antenna.

II. Microstrip Line Feed
In this type of feed technique, [3-4] a conducting strip is connected directly to the edge of the microstrip patch as shown in figure 2.10. The conducting strip is smaller in width as compared to the patch and this kind of feed arrangement has the advantage that the feed can be etched on the same substrate to provide a planar structure. The purpose of the inset cut in the patch is to match the impedance of the feed line to the patch without the need for any additional matching element. Hence this is an easy feeding scheme, since it provides ease of fabrication and simplicity in modelling as well as impedance matching.

Coaxial Feed:
The Coaxial feed [5] or probe feed is a very common technique used for feeding microstrip patch antennas. As seen from figure 2.11, 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. The coaxial probe feed is also easy to fabricate and match, and it has low spurious radiation. However, it also has narrow bandwidth and it is more difficult to model. [6-7]
Aperture Coupled Feed:
In this type of feed technique, the radiating patch and the microstrip feed line are separated by the ground plane as shown in Figure 2.12. Coupling between the patch and the feed line is made through a slot or an aperture in the ground plane. The amount of coupling from the feed line to the patch is determined by the shape, size and location of the aperture.[8-9]

Since the ground plane separates the patch and the feed line, spurious radiation is minimized. The major disadvantage of this feed technique is that it is difficult to fabricate due to multiple layers, which also increases the antenna thickness. This feeding scheme also provides narrow bandwidth.

III. Design of U-Shape Microstrip Patch Antenna

The U-Shape Microstrip patch antenna is approximately a one-half wavelength long section of rectangular Microstrip transmission line. When glass epoxy is the antenna substrate, the length of the rectangular Microstrip antenna is approximately one-half of a free-space wavelength. As the antenna is loaded with a dielectric as its substrate, the length of the antenna decreases as the relative dielectric constant of the substrate increases. The resonant length of the antenna is slightly shorter because of the extended electric "fringing fields" which increase the electrical length of the antenna slightly radiating [10].

IV. Design Layout

The design layout on paper for the fabrication of U-shape microstrip patch antenna in many steps as shown in Figure 4. The first step towards fabrication on an antenna is to generate a layout on the design software such as CAD, AUTOCAD or Express PCB. The only problem being that even though very small dimensions can be generated on such design software efficiency is a problem while printing it. So as scaled version of the layout by a suitable factor X (i.e. X=10) is prepared and printed on suitable paper. [11-12]

Figure 2. Probe fed rectangular microstrip patch antenna

Figure 3. Aperture-coupled feed

Figure 4. Typical U- Shaped patch antenna

Figure 5. Design of U-Shape Patch Antenna on PCB
V. Simulation Results

![Figure 6](image1.png)

Figure 6. Return loss plot for U-Shaped Patch Antenna

![Figure 7](image2.png)

Figure 7. VSWR plot for U-Shaped Patch Antenna

VI. Conclusion

U-Shaped microstrip antenna offers better bandwidth as compared to other conventional shapes of patch. The microstrip antenna are widely used in a number of antenna system because of their low profile, light weight, low price, compactness, mass productivity, etc. The aim of this thesis was to design a U-shape patch microstrip antenna and to study the responses and the radiation properties of the same. In this thesis an antenna has been designed by the microstrip feed-line technique with the dimensions as Length = 60mm, Width = 40mm, Height = 1.6mm, with a dielectric constant of 4.2 (glass epoxy), which has a loss tangent of 0.0013 at 5GHz. The simulations are carried out using IE3D software (version 12.32). The U-Shaped microstrip antenna has been fabricated and demonstrated theoretically and experimentally. Having gone through the results it happened to be a bit difficult to decide the optimized design of the antenna, as there are different aspects that are involved in the design of patch antenna.

It is good to see that the return loss has a negative value in all the cases which states that the losses are minimum during the transmission. The simulated and the experimental return losses are -47.4dB and -43.5dB respectively. The proposed antenna has an improved bandwidth of 76.36%. The VSWR for the design performed in the project has a good value of less than 2.0. The performance of U-shaped microstrip antenna is far better in comparison to that of a conventional rectangular antenna. The antenna designed comes in C-Band and it can be used for WLAN. The antenna length and width has been optimized so that it works in wireless device band. The final measured results show satisfactory performance and good agreement with the simulated result.

References