# Design and Analysis of Co-Planar Waveguide fed Micro Strip Patch Antenna for UWB

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***Abstract*—**A Microstrip Patch Antenna (MSPA) is a compact, lightweight and an easy to manufacture structure. However, its common limitation is low bandwidth or low gain or both. The following paper presents an Ultra-wideband (UWB) applicable Microstrip Patch Antenna which is designed using the coplanar technique to enhance its bandwidth. The rectangular patch is given the shape of a spanner with four slots on the inner edge and two hexagonal cuts. It is designed using Taconic TLY tm substrate having a dielectric constant 2.2 and dielectric loss tangent of 0.0009. The simulated model of antenna in ANSOFT HFSS 13.0 gave an impedance bandwidth of 2GHz for 9GHz resonant frequency and S11 of -19.2dB. The proposed antenna was also analysed using parameters including return loss, VSWR, gain and radiation pattern.

***Keywords*–*CPW, Feed gap, MSPA, UWB.***

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## I. INTRODUCTION

The wireless communications is the fastest growing section of the communication industry, antenna being a very basic and important part of it. With the revolution of technology the size of antenna is becoming smaller and smaller. A microstrip patch antenna (MSPA) is widely used in compact and portable applications due to its low profile, light weight and low cost. But MSPA cannot satisfy the requirement of large bandwidths in its pure form. Therefore, some changes in the form of cuts, slots or additional patches is necessary. The bandwidth and gain of MSPA is very closely related to the size of the radiating patch. As the size decreases the gain or bandwidth might also reduce. Hence, it is important to place each and every slot or cut strategically for providing enhanced bandwidth. For this reason, miniaturization and bandwidth enhancement has become an important design consideration for researchers' interests.

Catering to the needs of the modern communication world UWB technology has been regarded as one of the most promising wireless technologies. In February 2002, the Federal Communications Commission (FCC) licensed the UWB frequency range from 3.1-10.6 GHz, allocating it a very large bandwidth to support high data rate wireless communication. This band has low transmission power (-41.3 dBm/MHz) so the antenna for this system needs to be very sensitive. Also the UWB systems requires antenna with omni directional radiation patterns, large bandwidth and non-dispersive behaviour. This is where the MSPA comes into picture along with its bandwidth enhancement methods.

Several techniques have been deployed in the literature in past years to achieve bandwidth enhancement like extending corrugations from top of a flat ground plane [4] or cutting band notches in the patch [6] and combining multiple patch strips of different resonating frequency to get wide bandwidth [1]. Conventional rectangular shape has also been changed like by making two convex circled corners , use of centre parasitic patch [7], partial ground plane removal [5,9,10].A comparative study of bandwidth improvement techniques is presented in [8].

The objective of this paper is to design and analyze an Ultra Wide Band Microstrip patch antenna. The inspiration of this work came from the fact that UWB systems have opened up a new dimension of antenna design and present new challenges. In order to meet these challenges the bandwidth of familiar antenna architectures has been extended. In this paper, a small microstrip patch antenna is designed to satisfy UWB requirements. It is fed with 50 Ω microstrip line through coplanar technology. This makes the fabrication easier and antenna bandwidth wider. The antenna provides good frequency domain performance (less than -10dB return loss), good gain and nearly omni directional radiation pattern. The parameters of the designed structure are investigated using finite element method based electromagnetic solver, HFSS. The rest of the paper is organised as follows: section 2 describes the design details of the proposed antenna, section 3 gives the results and discussions with the graphs and section 4 concludes the paper.

## II. ANTENNA DESIGN

Figure 1 and 2 shows the geometry of the proposed antenna that consists of a rectangular patch which was modified to be a spanner shaped figure. The dimensions of the patch were taken as 14 mm x 16 mm. Further, four rectangular slots and two hexagonal cuts were made to improve bandwidth and return loss. Table 1 gives the dimensions of the whole antenna design. The substrate material was chosen to be Taconic TLY-5 tm with dielectric constant 2.2 and dimensions of 30 mm x 28 mm x 1.575 mm. Feed lines of 12 mm length and 3 mm width were taken with coplanar ground plane of 11.8 mm x 13.1 mm. A gap of 0.2 mm was left between the radiators and ground plane. The resonant frequency for this design was chosen to be 9 GHz. The slots were cut to increase the path length of the surface currents to reduce the resonance frequency. Figure 1 and 2 shows the design of the spanner and the whole proposed antenna.

TABLE 1. DIMENSIONS OF PROPOSED ANTENNA

| Parameter | Description | Dimension |
|---|---|---|
| L1 | Length of substrate | 28 mm |
| W1 | Width of Substrate | 30 mm |
| L2 | Length of partial ground | 11.8 mm |
| W2 | Width of partial ground | 13.1 mm |
| L3 | Length of feed | 12 mm |
| W3 | Width of feed | 3 mm |
| L4 | Length of patch | 14 mm |
| W4 | Width of patch | 16 mm |
| S1 | Length of side of hexagonal cuts | 1 mm |
| S2 | Width of lower slot | 2 mm |
| S3 | Length of lower slot | 1 mm |
| S4 | Length of upper cut | 2 mm |
| S5 | Width of upper cut | 1 mm |

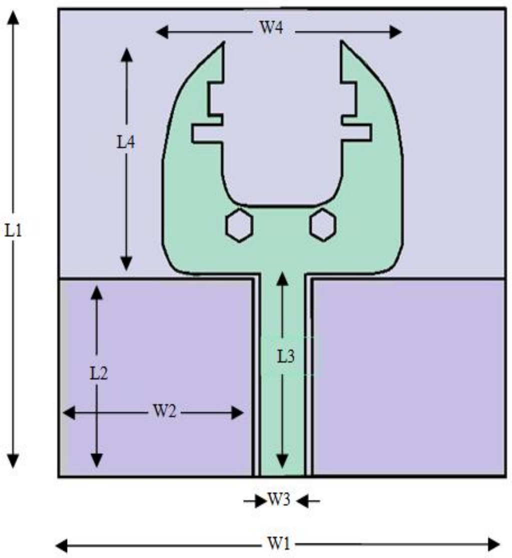


Figure 1. Geometry of the proposed antenna

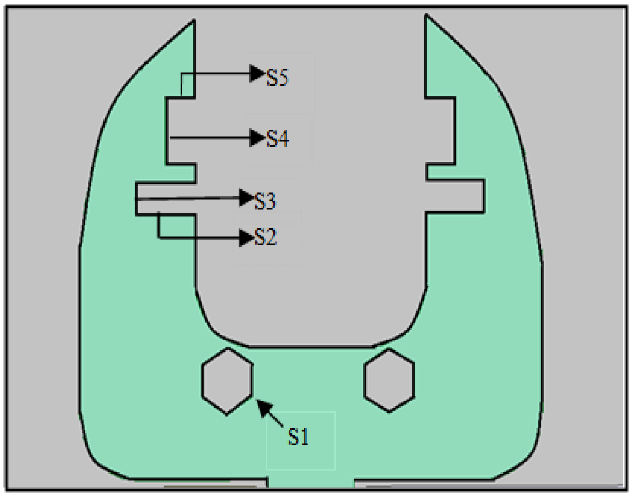


Figure 2. Dimensions of the spanner in the proposed design

## III. RESULTS AND DISCUSSION

The following parameters were analysed in the results: S11 parameter, VSWR, gain and radiation pattern. Figure 3 illustrates the S11 parameter of antenna which shows the curve well below -10 dB with maximum S11 of -19.2 dB at 8.6 GHz. It provides an impedance bandwidth of 2 GHz i.e. from 7.7 to 9.7 GHz. This band comes under the upper UWB band range. The spanner shape was cut into the patch along its non radiating edge with four smaller cuts to increase the surface current path. This increased resonant length resulted in lower resonance frequency.

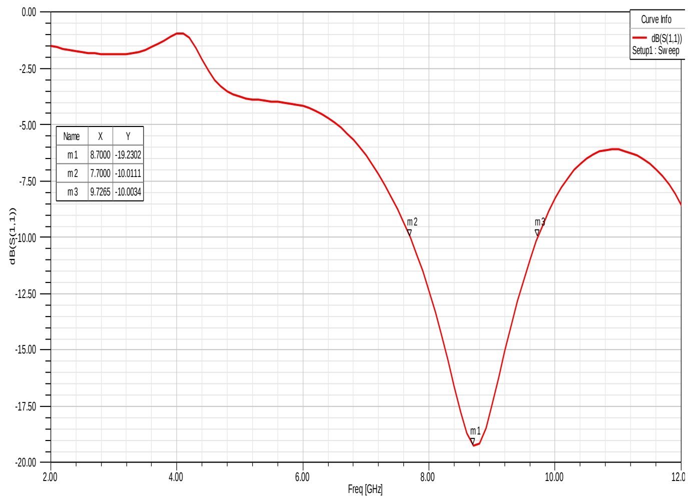


Figure 3. Simulated S11 characteristics of proposed antenna

Figure 4 shows the VSWR for the antenna which is found to be less than 2. The parameter VSWR describes how well the antenna is impedance matched to the radio or transmission line it is connected to. The VSWR for this design is found to be 1.90 dB at 8.7 GHz. Figure 5 shows the total gain of the antenna which is almost constant. The maximum gain attained was 4.03dB at 2.3 GHz. However, within the range of UWB the maximum gain obtained was 3.7dB at 6.1GHz.

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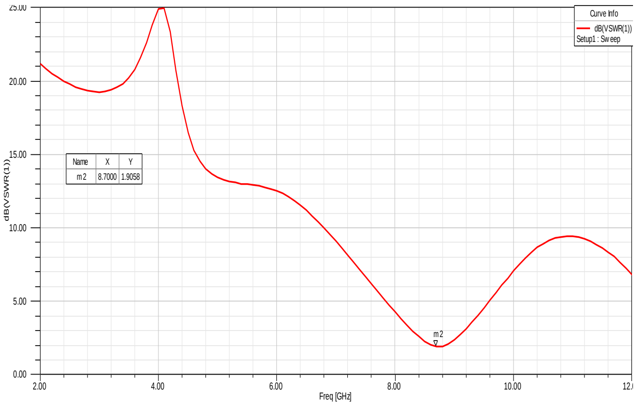


Figure 4. Simulated VSWR for the proposed antenna

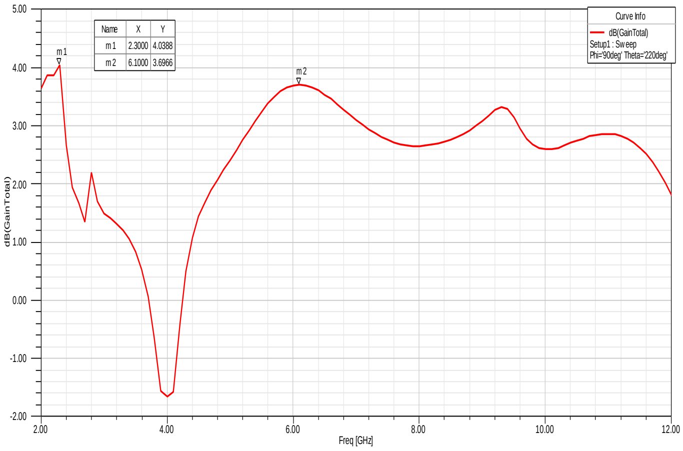


Figure 5. Total gain of proposed antenna

Figure 6 shows the radiation pattern of the proposed antenna along E and H planes. From the figure it is clear that radiation pattern of antenna is almost omni directional for most of the frequency in the desired frequency band. However, the E plane radiation pattern was split into a few radiation beams and was not omni directional. This is because impedance matching is function of frequency and it is very difficult to maintain impedance match and desired radiation pattern. The H plane radiation pattern was found to be almost omni-directional.

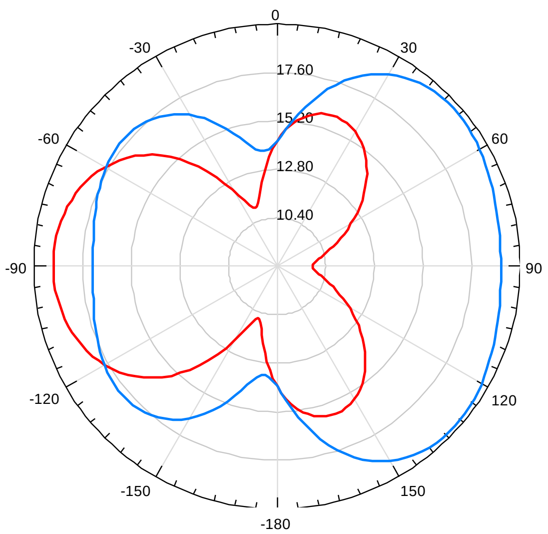


Figure 6. Radiation Pattern of proposed antenna at 9Ghz

## IV. CONCLUSION

A spanner shaped coplanar waveguide fed microstrip patch antenna achieved an impedance bandwidth of 2 GHz and a return loss of 19.2 dB at 8.6 GHz with a good gain. The simulated results of the proposed antenna satisfy the requirement for UWB as defined by the FCC. Slots and cuts were made to provide a wider bandwidth. Since the bandwidth is 22% of its resonant frequency the antenna can be considered as an Ultra-Wideband antenna. The analysis of simulated results for the proposed antenna suggest that the antenna is suited for wireless systems operating in the upper band of the UWB band. For future works, the design and architecture of the antenna can be further modified or the substrate material can be changed for analysis and better results.

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