Design, Simulation and Testing of Broadband Flexible Triangular Wedge Centred Bow-Tie Antenna

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ABSTRACT: *This paper explains the Design, simulation and testing of different models of flexible bow-tie antennas. The return losses and radiation patterns of the antennas are simulated with CST Studio and the results are compared, for bow-tie elements mounted on flat and curved surfaces. The antennas are fed by a micro strip-to-coplanar feed network balun. The reduction of the metallization is based on the observation that the majority of the current density is confined towards the edges and at the central part of the of the regular bow-tie antenna. Solid bow-tie and outlined bow-tie are designed first and find similarities in the patterns. Hence, the centres of the triangular parts of the conventional bow-tie antenna are removed without compromising significantly its performance. Another efficient design of bow-tie "Triangular wedge centred antenna" is introduced utilising the concept of centrally distributed current on the wings of bow-tie. An investigation of the different models of the bow-tie antenna on the effect of the design to the return loss and radiation patterns had been carried out, finally compare the results.*

Keywords: Bow-tie antenna, broadband antenna, flexible antenna, micro-strip-to-coplanar feed network balun, reduced metallization.

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1. Introduction

The Bow tie antenna structure is efficient design regarding its radiation pattern and wide frequency ranges. Design of ûexible antennas, as a part of fexible electronic circuits, may have a very wide spectrum of applications in military and civilian wireless communication, which can allow people to wear antenna structures instead of carry them. Hence, ûexible and ûuidic antennas have a great potential [3]. In this paper, the design, simulation and measurements of a bow-tie antenna with a ûexible substrate is discussed. The flexibility of antenna makes it useable in different wide frequency range electronic devices and in Wireless communications.

Smaller components and more compact devices are becoming popular. Due to the increasing need for ûexible and light-weight electronic systems, our aims to develop materials and structural platforms that allow ûexible backplane electronics to be integrated with display components that are economical for mass-production [2].

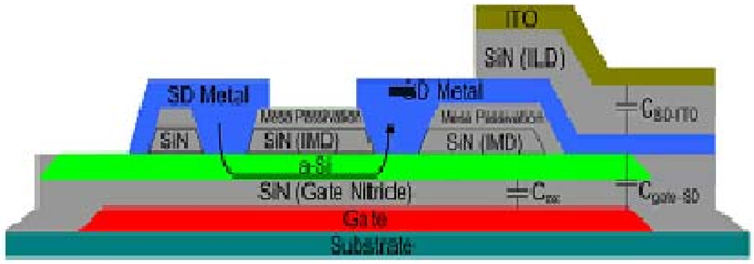

Figure 1. Cross section schematic of the Flexible Display Center low temperature a-Si:H TFT process

The paper is consisting of following sections.

The first section illustrates the composition and the selection of flexible substrate. The second section is the designing of solid, outlined and centred horizontal line bow-tie antenna with micro-strip to coplanar feed network balun. In the third section a new bow tie antenna ‘Flexible triangular wedge centred bow-tie’ is designed.

2. The Flexible Substrate

The display technology of FDC is mainly based on amorphous silicon (a-Si:H) TFT that can be fabricated on plastic substrates. Traditionally, displays have been fabricated on glass with high temperature deposition processes, which is a mature technology.

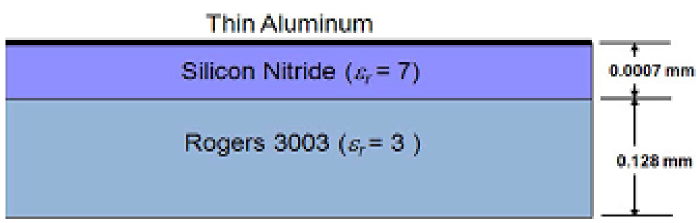

Figure 2. Flexible substrate which best approximates the electrical properties of the actual substrate

3. Antenna Design

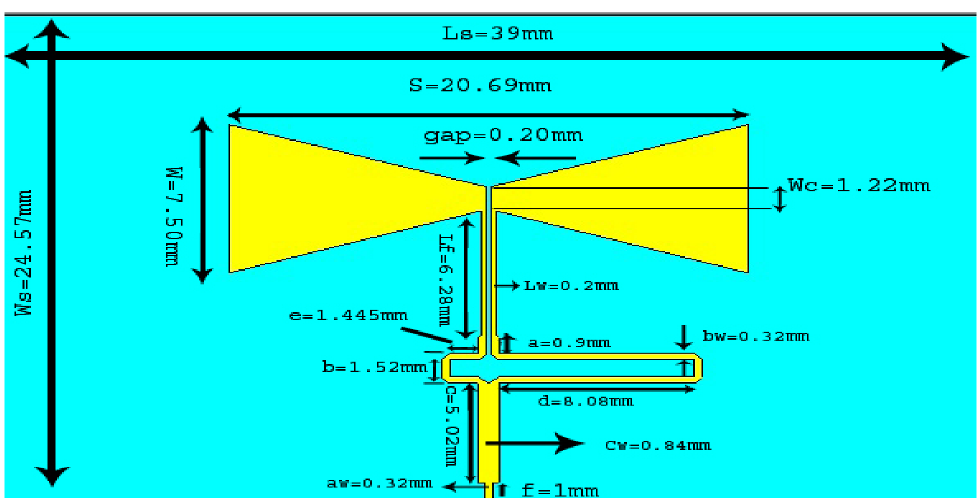

Figure 3. Design model and geometry of Solid bow-tie antenna

Antenna design using flexible substrates is a latest research topic. A bow-tie antenna is chosen first because of its simplest geometry and design. The directive properties are better than the traditional dipole antennas. In order to properly feed the bow-tie antenna, amicrostrip-to-coplanar feed network (CPFN) transition is necessary. For this purpose a microstrip-to-CPFN balun was designed which provides an odd mode in the coupled microstrip line while suppress- ing the even modes [6][7]. This balun introduces a 180^0 phase deference between the coupled micro strip lines near the centre frequency. The substrate is thin plastic (heat stabilized PEN), allowing the antenna to be flexibile which is covered with a very thin silicon nitride layer [8] and the conducting material used for the feed network, balun and the antenna element is aluminium. Figure 2 shows a model for the flexible substrate which best approximates the electrical properties of the actual substrate by using the materials in the CST studio.

The solid bow-tie is designed on CST studio and its radiation parameters are evaluated.

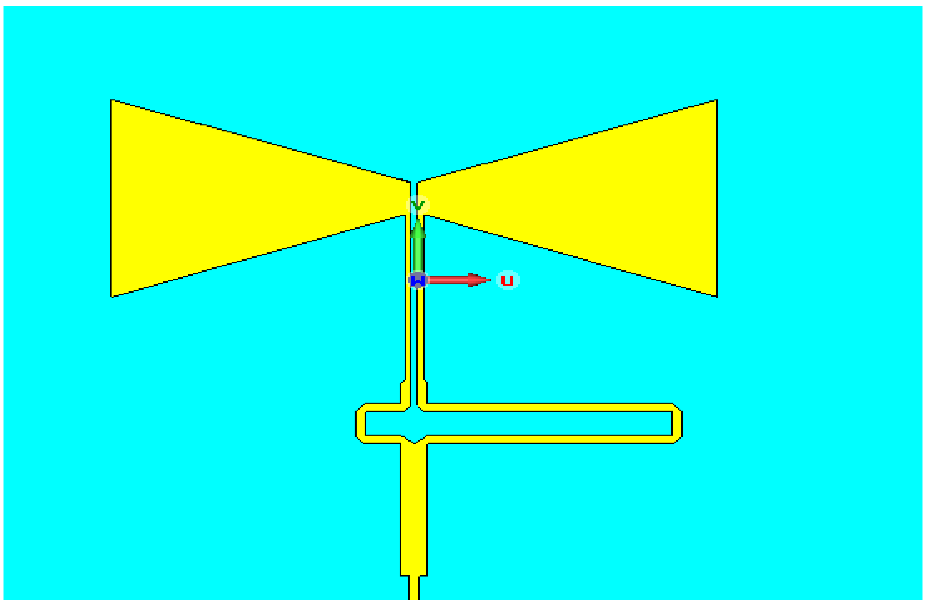

Figure 4. CST studio model and geometry of Solid bow-tie antenna

Since the maximum current flow on the edges of the bow-tie so the reduced metallized models are simulated and compare the reults.

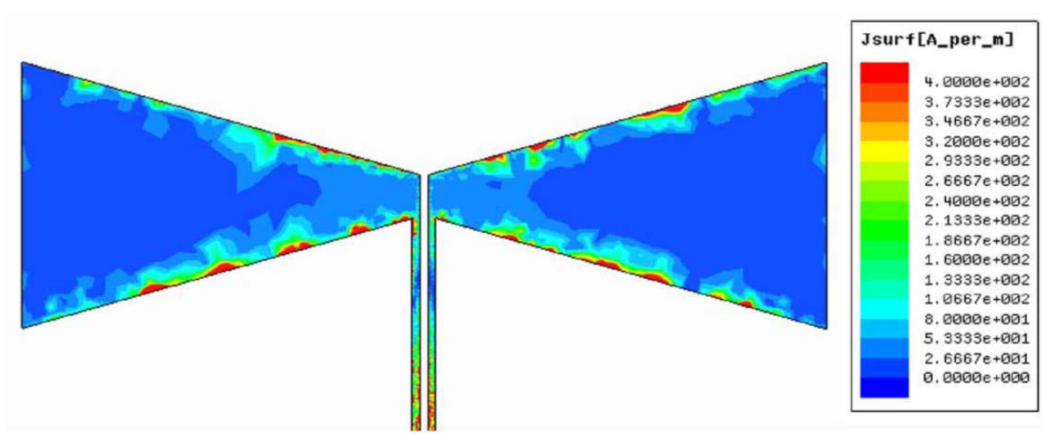

Figure 5. Current intensity over the surface of solid bow-tie, maximum at the centre and the edges of the wings

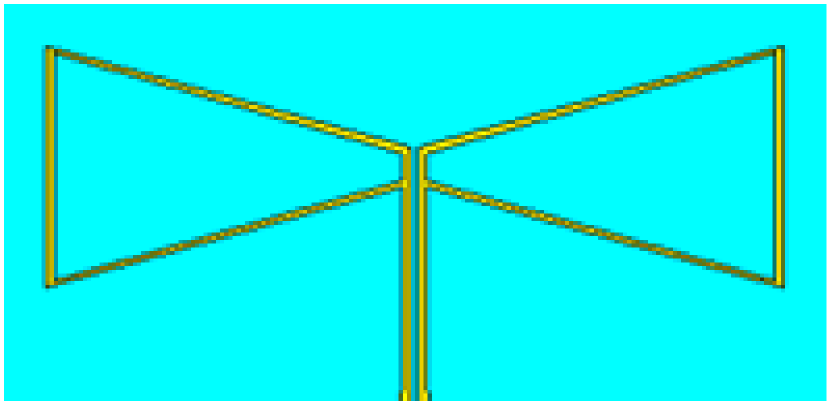

Figure 6. Outlined bow-tie antenna having 0.2mm width

For outlined antenna we cut all the material keeping only 0.2mm of its outlined boundary. For triangles, horizontal and vertical lined and crossed antenna we determined the mid points of the wings of bow-tie antenna and changed the different models. Then we chamfered the edges by a factor 0.2 mm.

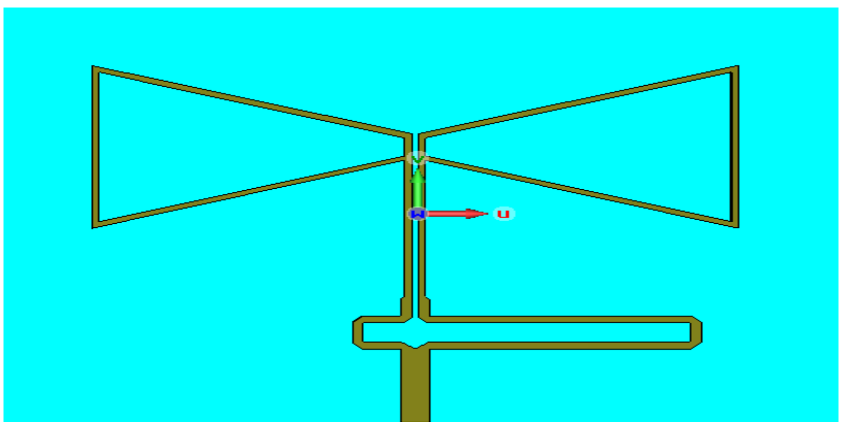

Figure 7. Outlined bow-tie antenna having 0.2mm width with strip balun

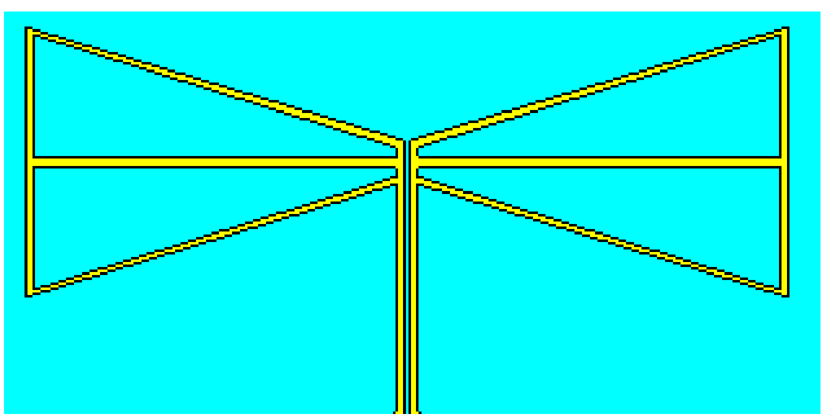

Figure 8. Bow-tie antenna having horizontal line passing through the midpoint of the wings of bow tie

Now utilizing the concept of the maximum current distribution we proposed a new design of bow-tie antenna ‘Triangular wedge centred antenna’.

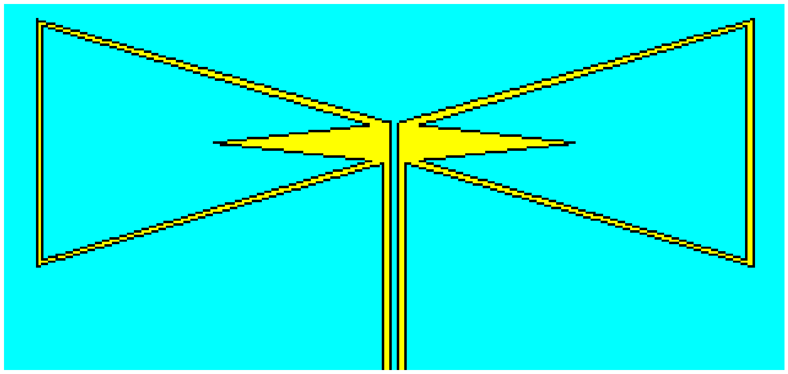

Figure 9. Triangular wedge centred antenna

4. Simulation and Measureemnt Results

Now we simulate our all antennas one by one and compare the results of all antennas one by one at CST Studio.

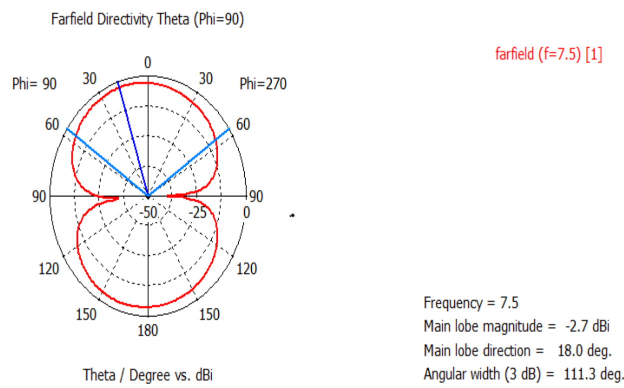

Figure 10. Polar graph of directivity of solid bowtie antenna

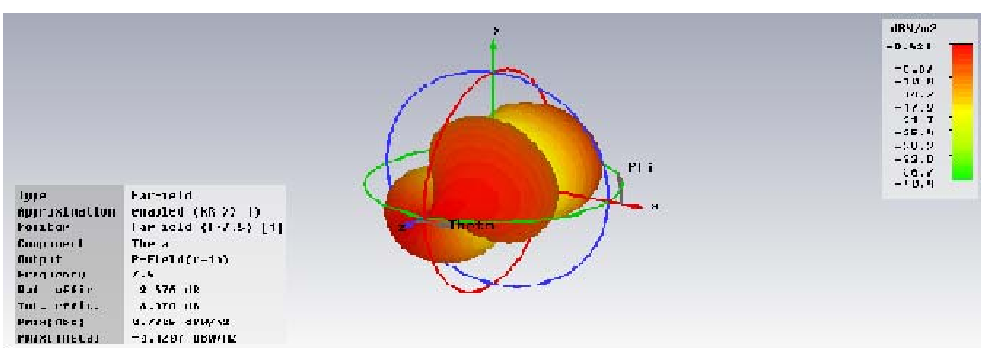

Figure 11. 3D Graph of power pattern of the solid bowtie antenna

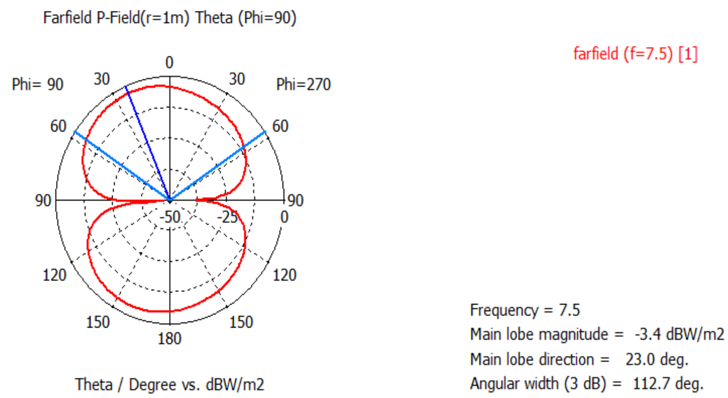

Figure 12. Polar graph of directivity of outlined bowtie antenna

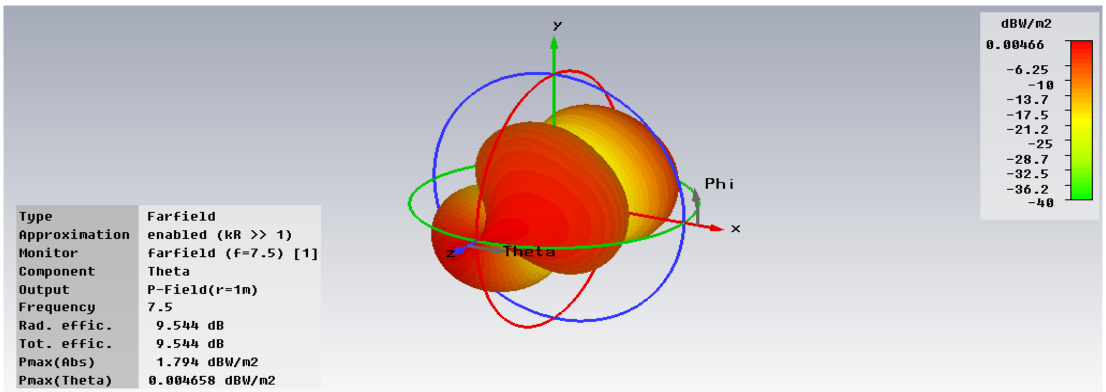

Figure 13. 3D graph of power pattern of outlined bowtie antenna

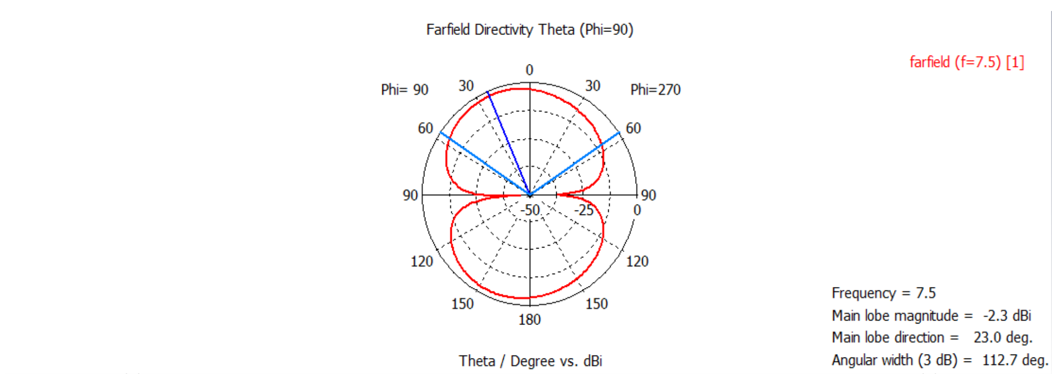

Figure 14. Polar graph of directivity of bowtie antenna which have a horizontal line at the mid of its wings

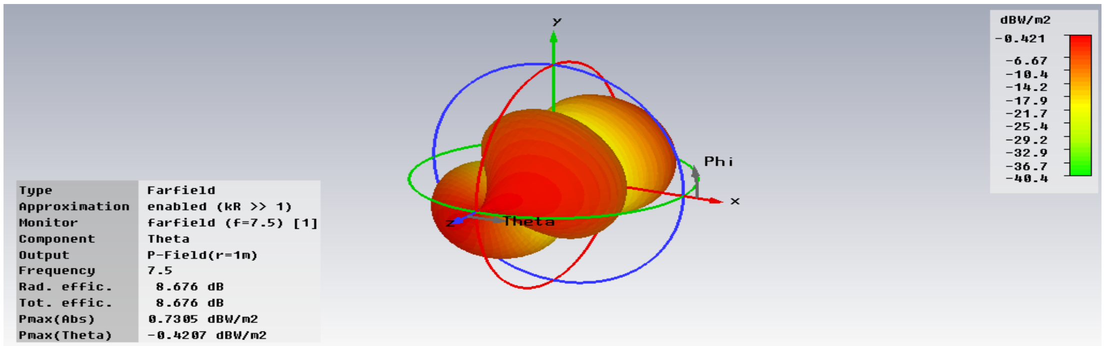

Figure 15. 3D graph of power pattern bowtie antenna which have a horizontal line at the mid of its wings

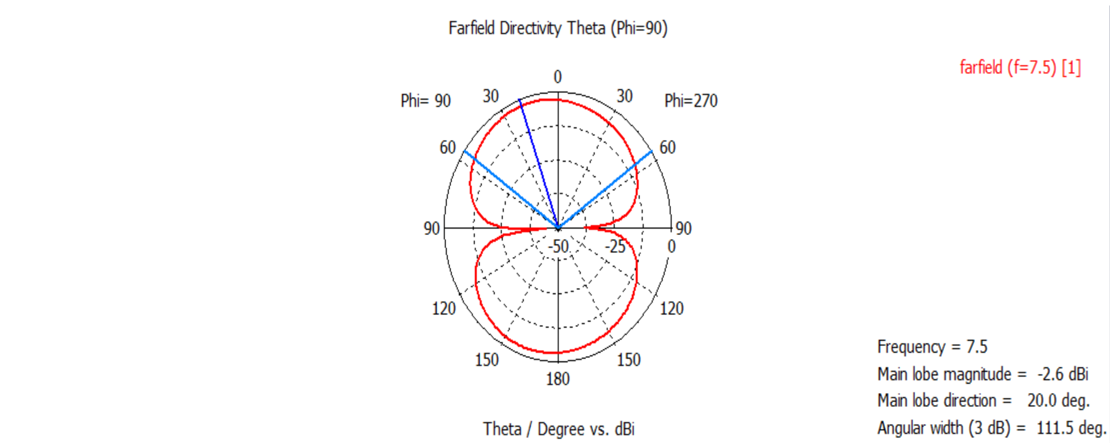

Figure 16. Polar graph of directivity of a Triangular wedge centred antenna

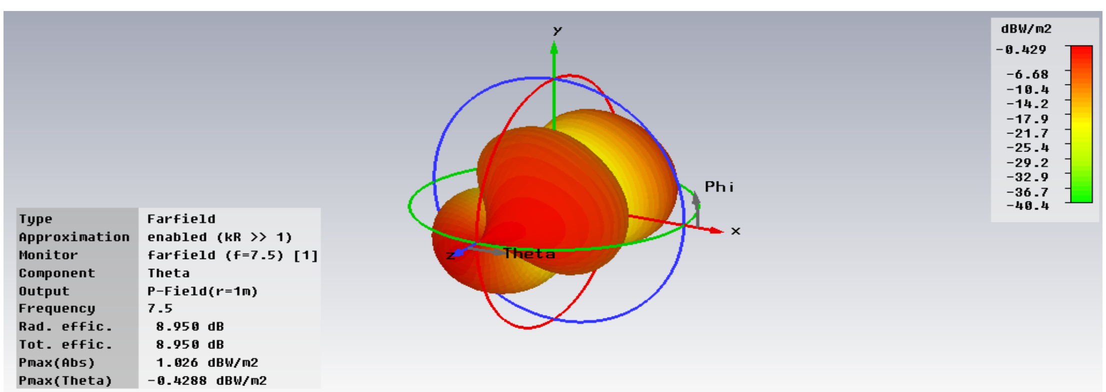

Figure 17. 3D graph of power pattern a Triangular wedge centred antenna

5. Comparison of S-Parameters

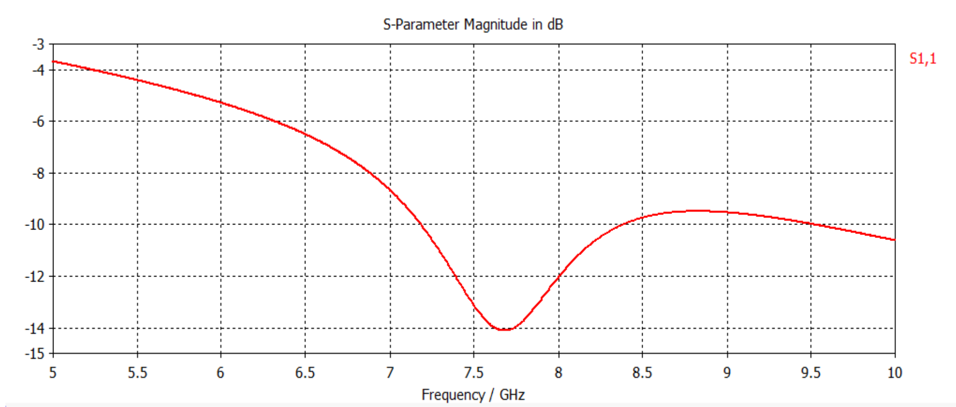

Figure 18. S-parameter of solid bow-tie antenna

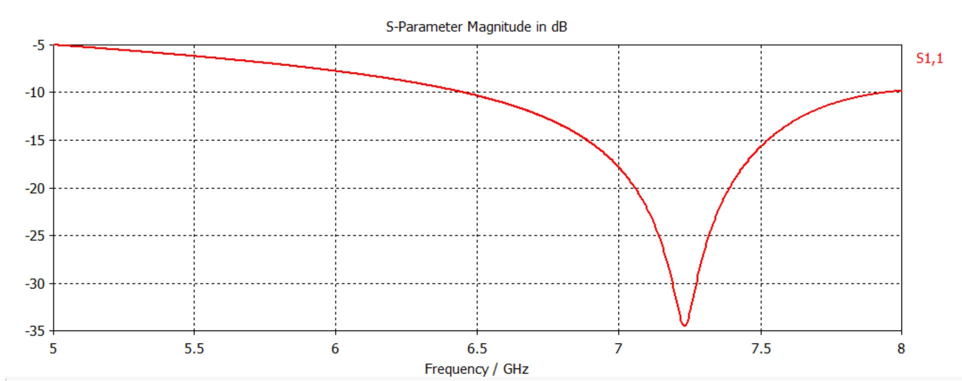

Figure 19. S-parameter of outlined bow-tie antenna

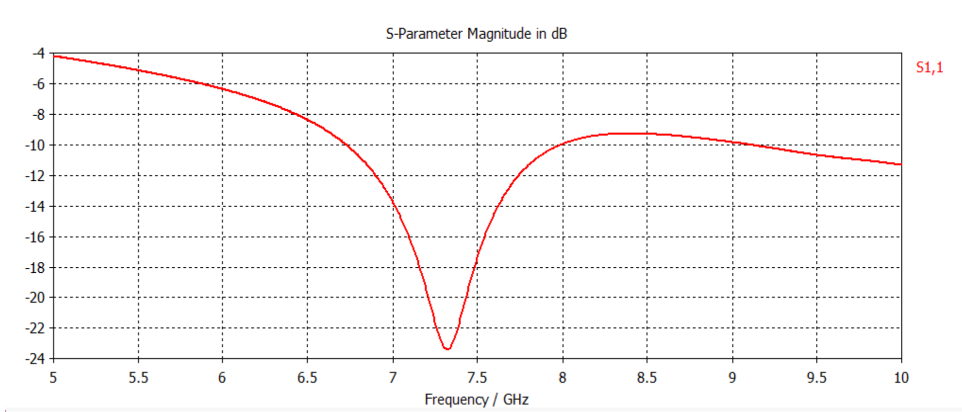

Figure 20. S-parameter of bowtie antenna which have a horizontal line at the mid of its wings

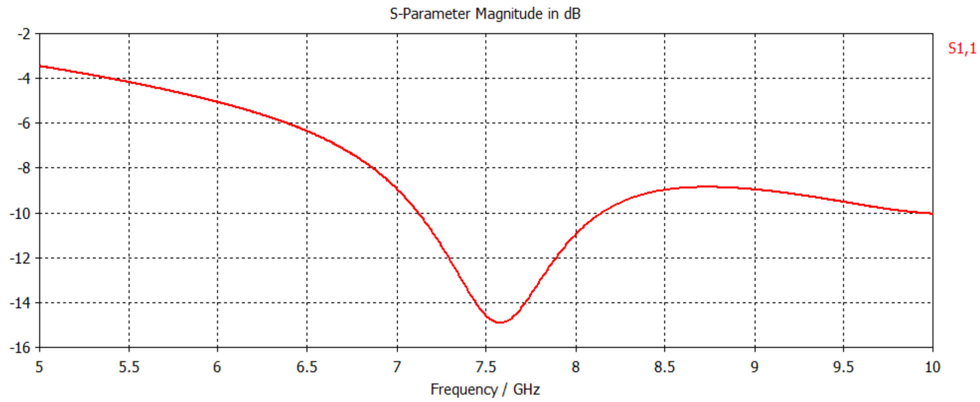

Figure 21. S-parameter of a Triangular wedge centred antenna

6. Conclusion

Different Models of flexible bow-tie antenna were designed and simulate and introduce a new bow-tie antenna 'Triangular wedge centred antenna' using the concept of maximum current distribution.

The radiation patterns return loss and absolute gain comparisons showed that the measurements and the CST Studio simulations are in very good agreement. These affirmative indications of the initial research on flexible substrates. The resonant frequency of the outline bow-tie was lower than that all of the other bow-tie antennas because of its increased electrical length. The gain of the outline bow-tie turned out to be smaller than the gain of all the other bow-tie antennas. However, the modified antenna can be prototyped more rapidly with serial printing techniques. Hence, there is a trade-off between the gain and the reduced metallization of the antenna. The slight decrease in the gain is acceptable for some applications where less metallization and rapid prototyping are desired. The performance of the antennas can be improved by using a thicker conductor in the fabrication process. It is also proved that the triangular wedge design and outlined design of the bow tie antenna is better than all the other designs of bow tie antenna discussed in this paper because its s-parameter, directivity and power pattern are better than other designs.

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