Design and Optimization of CPW-Fed Bow-Tie Slot Patch Antenna

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Abstract. In this article, a mirror edged bow tie slot antenna is modelled and fed by a CPW fed with a finite ground plane. This design is calculated and its material properties such as its substrate FR4 is utilized which is easily available and less cost of fabrication. The height of the substrate is 2.96mm, with εr=2. The operating frequency is set at 2.45GHz which is ISM frequency band of operation. The antenna was simulated using CST Microwave suite and its results are inferred. The resonating frequency is at 2.581 GHz. This antenna is used for Wi-Fi applications.

Keywords: Bow tie, CPW, FR4, Wi-Fi, CST Microwave.

1. Introduction
Since the term micro strip talks about the strip of the metallic is in μ- meter range it describes some popular antenna which is conformal and simple in planar structure[5]. It is used for communication between wide range in circuit board which consists of base substrate and radiating patch in line with the elements [1]. It has a trending features with gain, size constraint, radiation phenomenon with various genres [2]. In recent developments which is light weight design at higher frequencies in contract with substrate and patch height suitable for low profile and cascaded applications [3]. Bowtie antenna in recently presents a compact nature with different patch shapes, which is increases development in industrial product design and research worldwide [15] With a low side band lobe an effective technique that maintain for high gain antenna with low side lobes [4]. A fractal shape such as geometries such as self-similarity led to a multiband applications result in spaced approximation at a factor of 2 with a blended truncation on sides’ results in band advancement [6].

2. Design Formulation of Bow Tie Antenna
From Figure 1, [10] the dimension of antenna is at cm with angle of length depends on length and width of antenna which varies along with impedance network and resonating frequency [7]. The various models of design perspective are arranged in each categorization [8].

\[ fr = \frac{Ck_{ua}}{2\pi Ter} \]  

(1)
\[
fr = \frac{2c\sqrt{kmn} + \sqrt{mn + c^2}}{3a\sqrt{\varepsilon r}}
\]  

(2)

Where
- \(fr\) - resonance frequency
- \(kmn\) - Modes that resonate
- \(m, n\) - Number of various modes
- \(c\) - Light velocity in free space.
- \(a\) - The length of the side of the bow tie strip

This expression is valid in a perfect magnetic wall surrounded by a triangular resonator. [12] The impact of a magnetic wall on the full recurrence can be remembered for an observational style for simple count [9].

Various suggestions can be made for how to adjust the exact face of a triangle microstrip antenna array that is not protected by a specific knowledge magnetic wall [11]. Several of the recommendations are related to supplanting the wall thickness with an off expression and keeping the dielectric substrate untouched, [14] resulting in TM10 mode characteristics and it’s given as.

At dominant mode:
\[
f_{10} = \frac{2c}{2fr\sqrt{\varepsilon r}}
\]  

(3)

Its side length \(a = f_{10}\)
At effective length of side length is:
\[
a_{eff} = a + \frac{h}{\sqrt{\varepsilon r}}
\]  

(4)

For \(mn\) mode, the resonant frequency is:
\[
f_{mn} = f_{10}\sqrt{m^2 + mn + n^2}
\]  

(5)

3. Simulation and Experimental Results
The 2 dimensional top view and side view of the antenna is shown in Figure 2 and Figure 3. Design values are listed in Table 1. The graph of input impedance versus the frequency is shown in Figure 4. [13] The Figure 5 shows the graph of reflection coefficient and Figure 6 shows the smith chart of input.
impedance. The 2 dimensional polar plot and 3 dimensional gain plot of far field is shown in Figure 7 and Figure 8.

![Figure 2: 2D Top View](image)

![Figure 3: 2D Side View](image)

![Figure 4: Input Impedance V/S Frequency](image)

![Figure 5: Reflection Coefficient](image)
Table 1: Design values

| Name | Description       | Value     |
|------|-------------------|-----------|
| La   | Arm length        | 37.08 mm  |
| Wa   | Arm width         | 27.61 mm  |
| θ f  | Flare angle       | 40°       |
| Lp   | Plate length      | 138.2 mm  |
| Wp   | Plate width       | 121.2 mm  |
| Lg   | CPW length        | 87.88 mm  |
| Wgi  | CPW inner width   | 6.353 mm  |
| Wgo  | CPW outer width   | 7.372 mm  |
| εr   | Relative permittivity | 2        |
| H    | Substrate height  | 2.596 mm  |

Figure 6: Smith Chart - I/P impedance

Figure 7: Far filed - 2D polar plot
4. Conclusion
In this article, with the variation from 300 to 450, a bow tie cpw feeding antennas is built and further optimized, where 300 successful compromise results have been plotted and discussed at a higher gain of 15 dBi at a bandwidth ratio of 1:4. The simulated results can be further optimized at variation at length and width of bow tie such that it doesn't affect the parameters.

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