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Dipole Antenna Radiation Pattern Optimization Using Parasitic Element Size and Location

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ABSTRACT

This work focuses on refining the radiation pattern of a dipole antenna by introducing a parasitic element and carefully adjusting its size and position. A dual-band response emerges when the parasitic element is set to a width of 9 mm. The study explores dimensions of 0.98 Wh, 0.90 Wh, 0.70 Wh, and 0.75 Wh. For the first three cases, the element is placed 9.4 mm away from the dipole antenna. In the 0.75 Wh case, however, the spacing is increased to 11.8 mm, which produces a clear improvement in gain. These results show how subtle changes in geometry and placement can significantly influence antenna performance, offering a straightforward path to achieving dual-band operation with enhanced radiation characteristics.

1. INTRODUCTION

One of the most popular antenna configurations in wireless communication systems is the dipole antenna. They are frequently used for both practical applications and basic antenna research due to their simple design, ease of production, and predictable radiation behavior. An omnidirectional radiation pattern with steady impedance characteristics and moderate gain is produced by a conventional half-wave dipole. Dipole antennas are frequently used as reference elements for assessing and creating more sophisticated antenna designs because of these characteristics. In order to satisfy the increasing demands of contemporary communication and sensing applications, research on dipole antennas has concentrated on enhancing their radiation performance, bandwidth, and adaptability over time. There are various types of dipole antennas like Wired Dipole antenna[1], [2], Microstrip Dipole [3], [4] antenna which are widely used in wireless communication. Researches are still ongoing for dipole antennas. The use of reconfigurable technique [5], [6], Metamaterial technique [7], [8] , and parasitic element technique [9], [10] for dipole antenna is growing rapidly. In particular use of parasitic is famously adopted in dipole antenna to develop Yagi-Uda antenna [11], [12]. Parasitic elements are used as director and reflectors

In this work, Printed dipole antenna is studied withe use of parasitic element. Location and size of the parasitic are carefully analyzed to observe the radiation pattern change on the dipole antenna. This careful study will help to design future pattern reconfigurable antenna.

2. Dipole Antenna design

2.1 Conventional printed dipole antenna

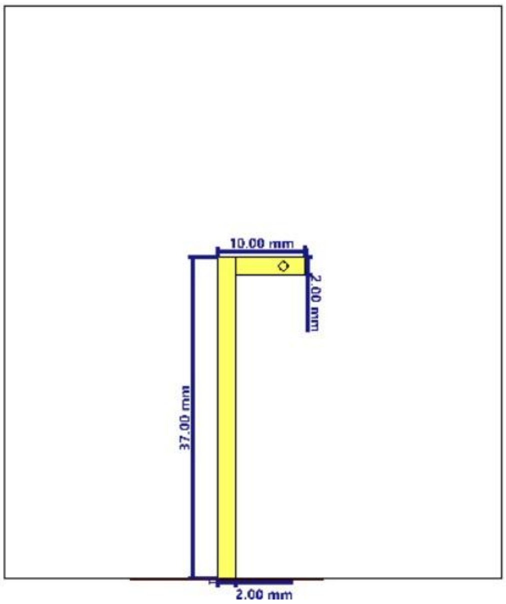


Figure 1. Front view

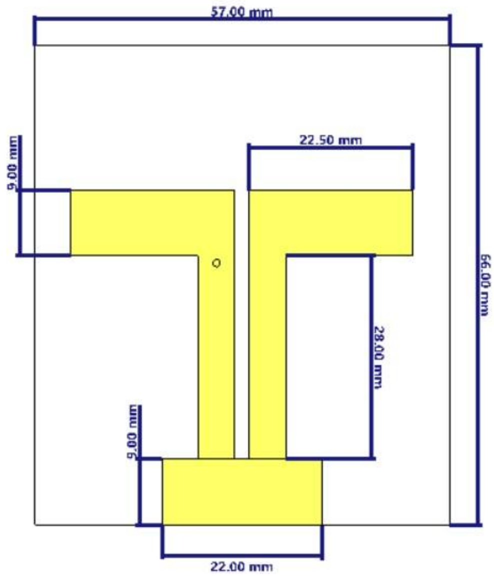


Figure 2. Back View

Figure 1 and 2 shows front and back view of the dimension. The size and dimension of the dipole antenna holds the main key in this design.

2.2 Parasitic element with dipole antenna

Mechanism of parasitic element in Yagi-Uda and in Dipole antenna are the same. Parasitic elements are used as director and reflectors. By changing length of the parasitic element, the radiation pattern goes towards opposite direction. When the parasitic element moves further from Dipole antenna, the gain increases. The Dimension of the parasitic element are 0.98Wh, 0.9Wh, 0.7Wh and 0.75Wh. The distance between parasitic element and the dipole antenna is 9.4 mm during dimension of the parasitic element are 0.98Wh, 0.9Wh, 0.7Wh. Only for dimension 0.75Wh the distance changes from 9.4 mm to 11.8 mm for increasing the gain value. The value of Wh is 47mm.

3. RESULTS AND DISCUSSION

3.1 Conventional printed dipole antenna

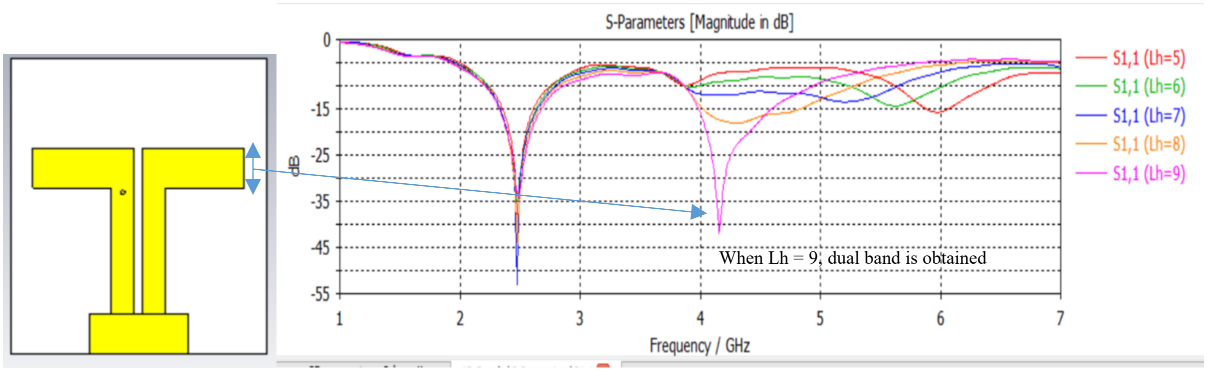
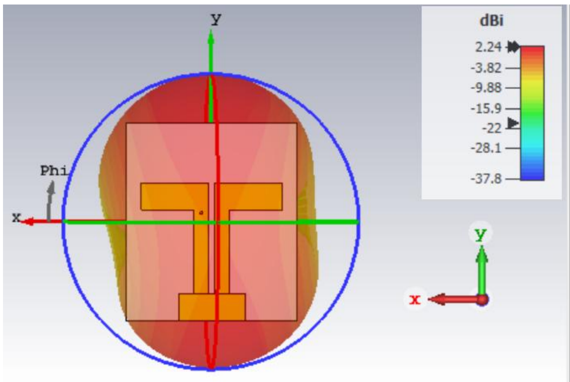


Figure 3. Parameter Sweep for Dipole Antenna achieve dual band



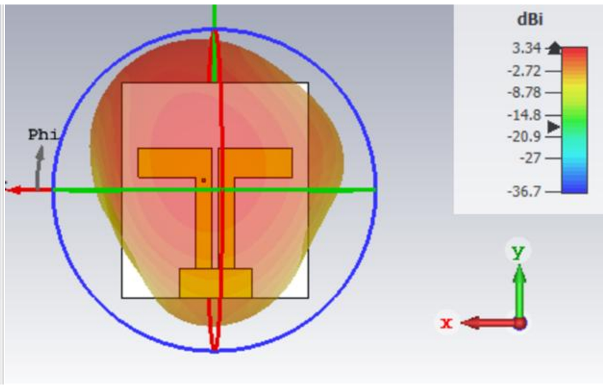


Figure 4. 2.45GHz

Figure 5. 4.16GHz

Parameter sweep done for Dipole antenna for achieving dual band. From the figure 3, it clearly visible when Lh is 9mm the dual band is achieved. The frequencies are 2.45Ghz and 4.16GHz

Figure 4 and 5 shows radiation pattern at 2.45GHz and 4.16GHz frequencies. Both are in omnidirectional state.

3.2 Parasitic element with dipole antenna

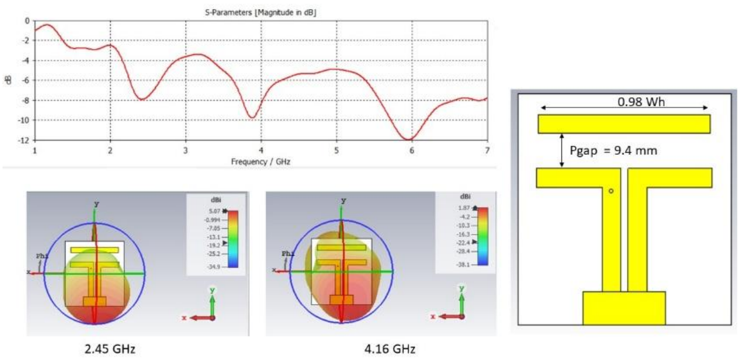


Figure 6. Result during length 0.98Wh & Pgap 9.4mm

Figure 6 shows S11 results when the parasitic element length 0.98Wh and Pgap 9.4mm. The radiation pattern is in omnidirectional state for both the frequencies.

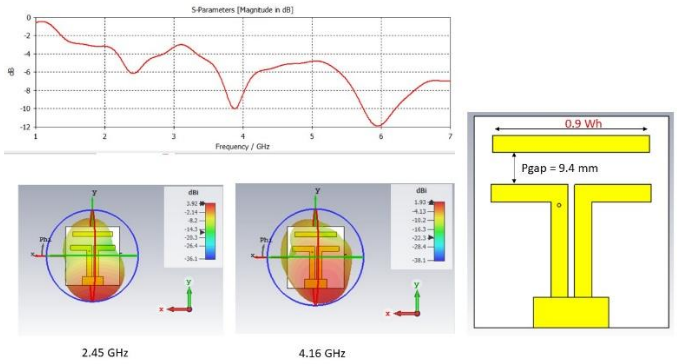


Figure 7. Result during length 0.9Wh & Pgap 9.4mm

Figure 7 shows S11 results when the parasitic element length 0.9Wh and Pgap 9.4mm. The radiation pattern became directional state from omnidirectional state for both the frequencies.

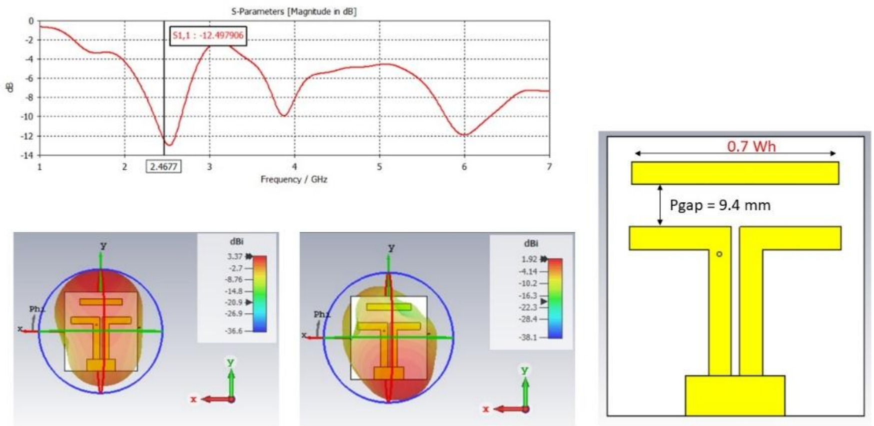


Figure 8. Result during length 0.7Wh & Pgap 9.4mm

Figure 8 shows S11 results when the parasitic element length 0.7Wh and Pgap 9.4mm. The radiation pattern became directional state from omnidirectional state for both the frequencies.

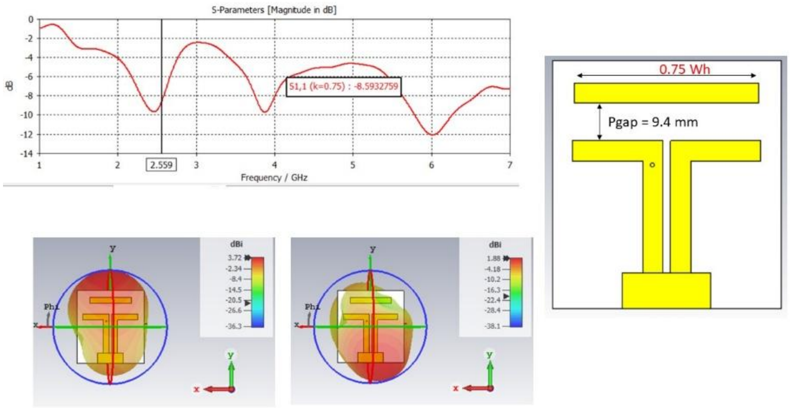


Figure 9. Result during length 0.75Wh & Pgap 9.4mm

Figure 9 shows S11 results when the parasitic element length 0.75Wh and Pgap 9.4mm. The radiation pattern became directional state from omnidirectional state for both the frequencies.

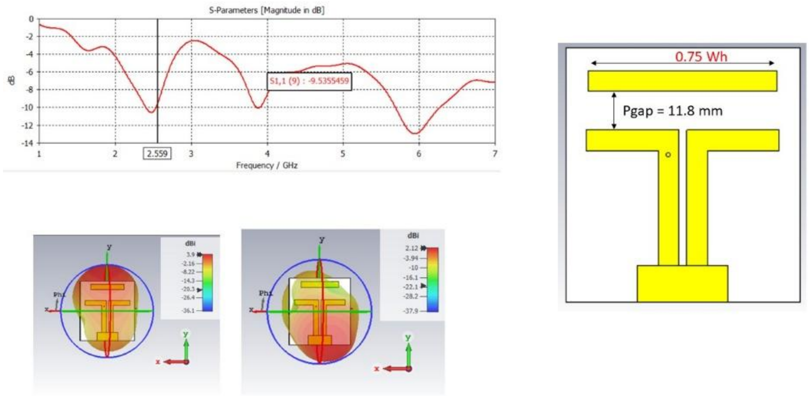


Figure 10. Result during length 0.75Wh & Pgap11.8mm

Figure 10 shows S11 results when the parasitic element length 0.75Wh and Pgap 11.8mm. The radiation pattern became directional state from omnidirectional state for both the frequencies. The increase in gap between Dipole and parasitic element from 9.4mm to 11.8mm due to achieve high gain.

4. CONCLUSION

In this work, radiation pattern optimized using parasitic element for dipole antenna by varying its size and location. The dual band achieved when width of the parasitic element is 9mm. The parasitic element was studied at dimensions of 0.98 Wh, 0.90 Wh, 0.70 Wh, and 0.75 Wh. For the first three sizes, the spacing from the dipole antenna remained fixed at 9.4 mm. With the 0.75 Wh dimension, however, the distance was adjusted from 9.4 mm to 11.8 mm, a change that led to a noticeable increase in gain.

5. ACKNOWLEDGMENT

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