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Improving an UWB Antenna Gain by Using Metallic Plates

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Keywords
UWB Antenna, Metallic Plates.

Abstract
In this study, gain of an ultra-wideband CPW antenna working in 3.1-10.6 GHz frequency range is enhanced using metallic plates attached to its surface edges and patch part in a certain distance. The designed antenna is performed numerically with CST Microwave Studio 3D program. The return loss (S_{11}), gain and radiation patterns of the antenna are obtained to evaluate antenna performances. Thereby, the simulation results for the antenna and the antenna having metallic plates are compared. From the simulation results, it was observed that metallic plates did not change the radiation angle of the antenna but enhanced antenna gain especially at the lower frequency range (3.1-6 GHz). Metallic plates increased the gain of the antenna approximately 2-2.5 dB in its lower frequency range extending from 3.1 GHz to 6 GHz.

1. Introduction

Ultra-wideband (UWB) is a technology that can use very low energy for short range as well as high-bandwidth(>500 MHz)communications over radio spectrum [1]. A bandwidth between 3.1GHz and 10.6 GHz was allocated to unlicensed operation of UWB devices by Federal Communications Commission (FCC) in 2002[2]. UWB systemsoperating within the bandwidth of the 3.1-10.6 GHzhave been considered for some applicationssince this date.Most recent applications have includedapplications of the target senor data collection, radar imaging, precision location and tracking [1-5].

The design of high performance UWB antenna is important in UWBapplications. High gain antennas likehornshave a wide-bandwidth and high gain over operating bandwidth.But these antennas are too bulky and need a balun feed. Another class of the UWB antennasincludes printed monopole antennas. These antennas have usually low gain at lower frequency region of the operating bandwidth.Thereby,

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gain improvementespecially at lower frequency region of the operating bandwidth is a challenging task for UWB systems.

In this work, the effectsof the using metallic plates called short horns [3]-[4]on the gain of a CPW-fed microstrip antenna[5] are investigated numerically using a commercial CST Microwave Studio Solver. C. Numerical results will show that the metallic plates contributeto the gain of the antenna especially over its lower frequency range extending from 3.1 GHz to 6 GHz.

2. Simulations and Results

Aim of this study is to examine the effects of the placement of metallic plates on the performance of abasic microstrip UWB antenna. During this study, the antenna given in [5] is used as the basic antenna. A perspective view of the basic antenna is given in Figure 1(a). Three different placements of the metallic plates are studied. During the all simulations, the height and width of metallic plates are taken as 30×75 mm.The metallic parts are considered as PEC.

2.1. Effects of the Placing Metallic Platesclose to the Antenna Edge on the Antenna Performance

Firstly, two metallic plates are positioned next to antenna with 45° angle as seen in Figure 1(b). The distance between the antenna and metallic plates along x direction,d_x,are chosen to be 0 mm, 0.5 mm and 3mm.

Figure 1a. The basic antenna

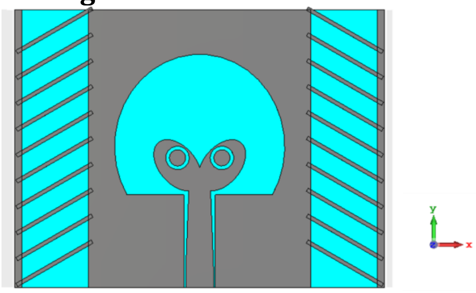


Figure 1b. The antenna with two metallic plates.

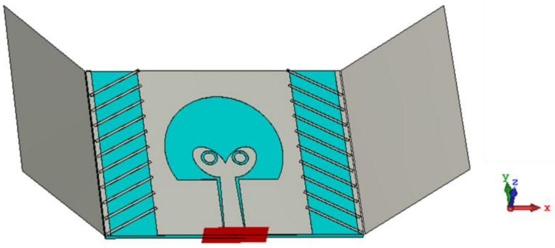
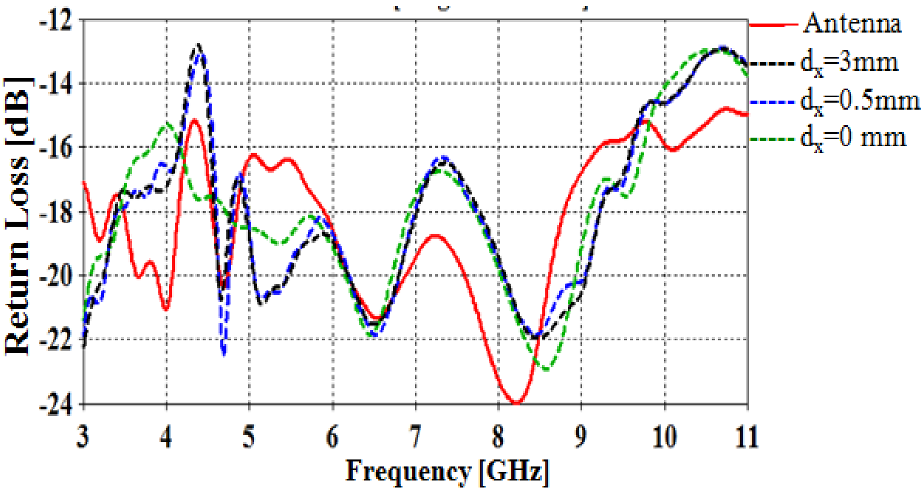
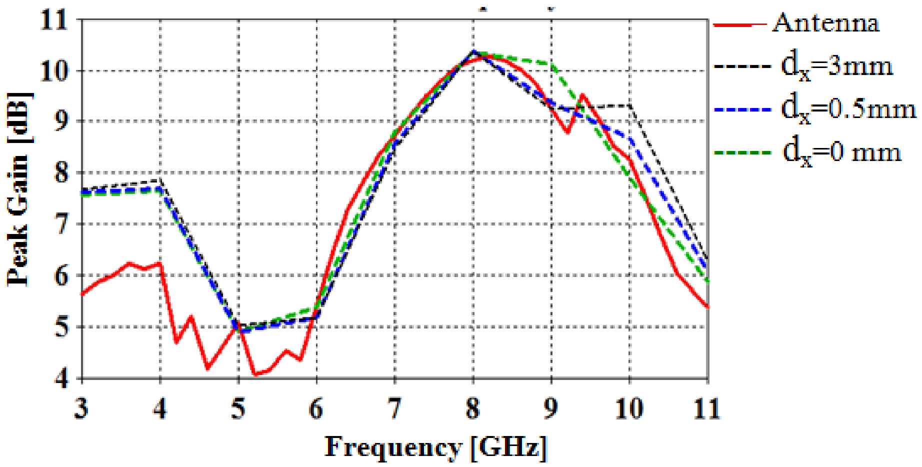


Figure 2. Return loss values of the antennas



The simulated return loss and peak gain values of the antenna are demonstrated for varying d_x values in Figure 2 and Figure 3, respectively. As seen in the Figure 2, the antenna is well matched to the 50Ω source for all cases. The placement of the metallic plates increases the peak gain of the antenna especially at the frequencies changing from 3.1 GHz to 6 GHz as seen in the Figure 3.

Figure 3. Peak gainvalues of the antennas in dB.



2.2. Effects of the Placing Metallic Plates on thepatch of antenna on the Antenna Performance

Secondly, two metallic plates are placed on the patch of the antenna with 45° angle as seen in Figure 4. Here, the d_z is the distance between the antenna and metallic plates along z direction, d_z, are chosen to be 0 mm, 1.5 mm and 3mm.

The simulated return loss and peak gain values of the antenna are demonstrated for varying gap distances in Figure 5 and Figure 6, respectively. As seen in the Figure 5, the antenna is well matched to the 50Ω source for all cases. For this case, the placement of the metallic plates increases the peak gain of the antenna especially at the frequencies changing from 4.5 GHz to 6 GHz as seen in the Figure 6.

Figure 4. Antenna with two metallic plates placed on the patch of the antenna.

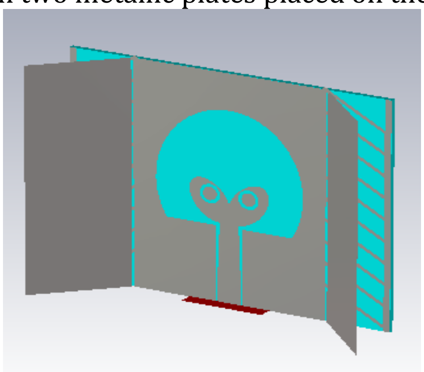


Figure 5. Return loss values of the antennas.

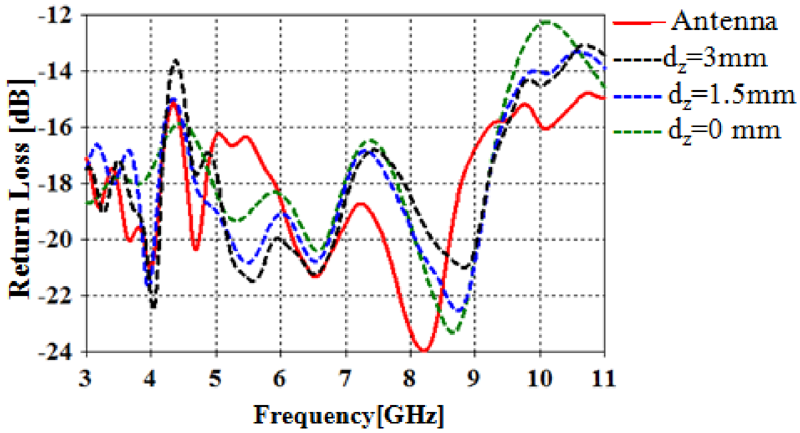
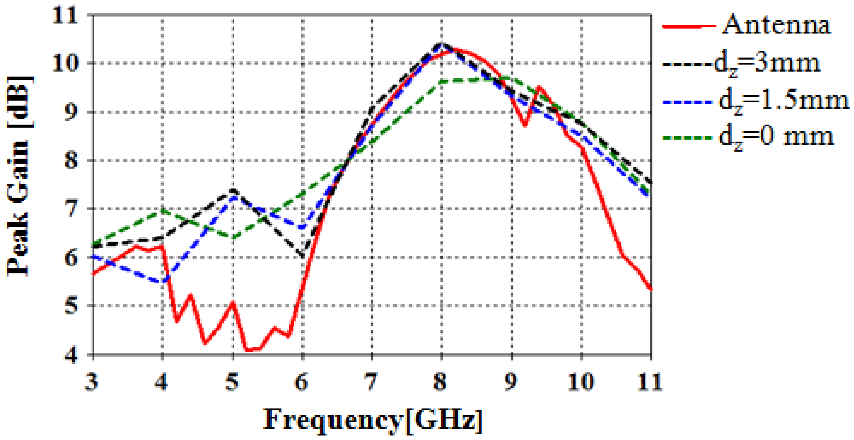


Figure 6. Peak gain values of the antennas in dB.



2.3. Effects of the Placing Metallic Plates on the patch of antenna as well as near to the edge of the antenna on the Antenna Performance

For the final case, besides positioning two metallic plates next to antenna with 45° angle, the same plates are placed on the patch of antenna to obtain a combined structure as seen in Figure 7.

Figure 7. Combined antenna configuration

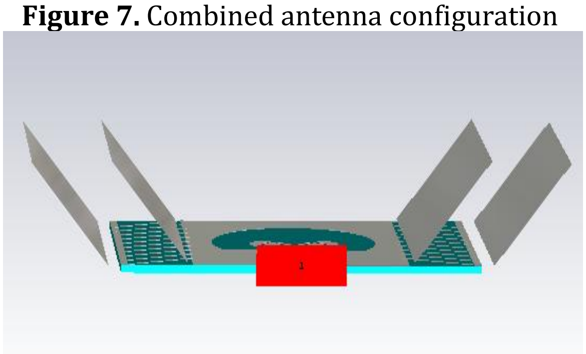


Figure 8 and Figure 9 demonstratethe simulated return loss and peak gain graphs of the basic and combined antenna configurations, respectively.The Figure 8 shows that both ofthe antennas are well matched to the 50Ω source. The Figure 9 shows that the combined antenna configuration provides considerable amounts ofgain improvement especially at the lower frequency range extending from 3.1 GHz to 6 GHz as compared to the basic antenna.

Figure 8. Return loss values of the antennas.

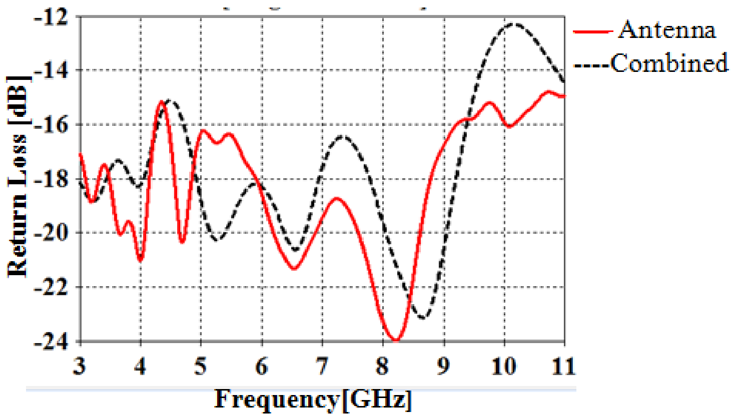


Figure 9. Peak gain values of the antennas in dB.

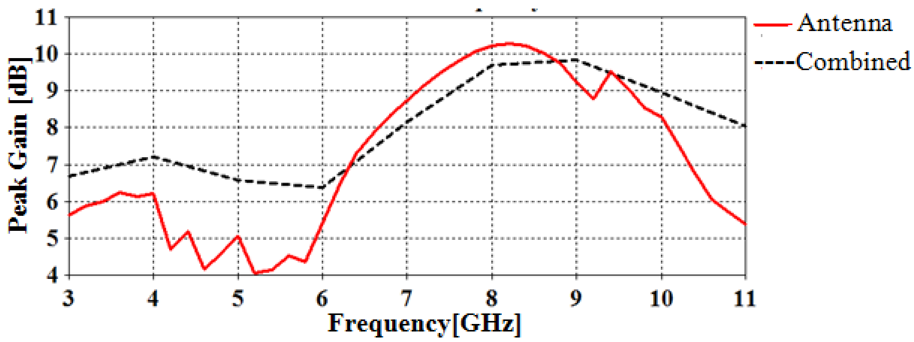


Figure 10 represents the gain pattern of the basic and combined antenna configurations at 4 GHz, 6 GHz and 9GHz in the xz (phi=0°) and yz (phi=90°) planes. The Figure 10 shows that the combined antenna configuration provides more directive pattern compared to the basic antenna.

Figure 10a. Gain pattern of the antennas at 4 GHz, 6 GHz and 9GHz (a) in the xz (phi=0°) and (b) yz (phi=90°) planes.

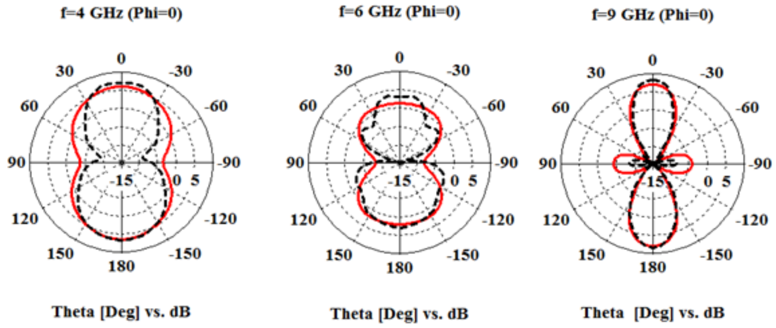
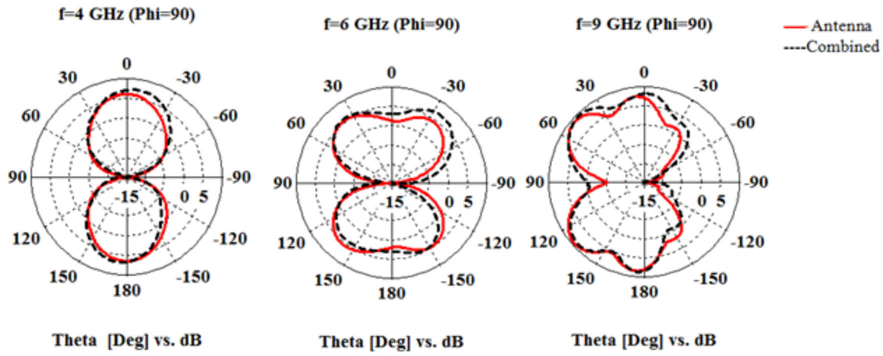


Figure 10b. Gain pattern of the antennas at 4 GHz, 6 GHz and 9GHz (a) in the xz (phi=0°) and (b) yz (phi=90°) planes.



3. Conclusion

In this study, gain enhancement of a microstrip antenna is presented for an ultra-wideband CPW microstrip antenna working in 3.1-10.6 GHz frequency range using metallic plates. Numerical trials are performed for different scenarios of the placement of the metallic plates. The numerical trials showed that metallic plates did not change the radiation angle of the antenna but enhanced antenna gain especially at the lower frequency range (3.1-6 GHz). Metallic plates increased the gain of the antenna approximately 2-2.5 dB in its lower frequency range extending from 3.1 GHz to 6 GHz.

4. Acknowledgment

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References

[1] Federal Communication Commission: First Report and Order, ‘Revision of part 15 of the commission’s rules regarding ultra-wideband transmission systems’. FCC 02-48’, Apr. 2002, [Online]. Available: https://apps.fcc.gov/edocs_public/attachmatch/FCC-02-48A1.pdf.

[2] Win, M. Z., Dardari, D., Molisch, A. F., Wiesbeck, W., andJinyun Zhang, W.,‘‘History and applications of UWB.’’*Proceedings of the IEEE*, Vol. 97, No. 2, February 2009

[3] Ranga Y., Verma A. K., Esselle K. P., and Hay S. G., "An ultra-wideband quasi-planar antenna with enhanced gain." *Progress In Electromagnetics Research C,* Vol. 49,pages:59-65, 2014

[4] Ranga Y., Esselle K. P., Weily A.R. and VermaA. K.,"A compact antenna with high gain for ultra wide band systems." *IEEE European Microwave ConferenceEuMC*, 2009.

[5] Hotami K., Dikmen C. M., Cakir G., Kocakaya A. and CimenS.,‘‘Partialgain increase at desired frequency range for UWB microstripantennas using band stop FSS.’’*International Conference on Advanced Technology and Sciences ICAT'17,* Istanbul,Turkey,May 2017