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New Wideband Notch Antennas for Communication Systems

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Abstract

Wireless communication industry is in rapid growth in the last years. Due to the huge progress in development of communication systems in the last decade development of wideband communication systems is continuous growth. However, development of wideband efficient antennas is one of the major challenges in development of wideband wireless communication systems. Low cost compact antennas are crucial in the development of communication systems. Printed notch antennas and miniaturization techniques are employed to develop efficient compact notch antennas. Fractal technology is used to improve the electrical performance and efficiency of notch antennas. Design tradeoffs, computed and measured results of wideband notch antennas with high efficiency are presented in this paper. All antennas are analyzed by using 3D full-wave software. The paper presents new compact Ultra-Wideband notch antenna 1 GHz to 6 GHz, a wideband notch antenna 2.1 GHz to 7.8 GHz and a 5.8 GHz to 18 GHz fractal notch antenna.

Keywords

Notch Antennas, Fractal Antennas, Printed Antennas, Wireless Communication

1. Introduction

This paper is a research on new wideband notch antennas for communication systems. Compact printed antennas are crucial in the development of communication systems. However, compact printed antennas suffer from narrow bandwidth and low efficiency. Fractal technology is used to improve the electrical performance and efficiency of notch antennas. Design tradeoffs, computed and measured results of wideband notch antennas with high efficiency are presented in this paper. The paper presents new compact ultra-wideband notch antenna 1 GHz to 6 GHz and a wideband notch antenna 2.1 GHz to 7.8 GHz. A fractal antenna is an antenna that uses antenna design with similar fractal segments to maximize the antenna effective area. Fractal antennas are also referred as multilevel structure with space filling curves. The key aspect lies in a repetition of a motif over two or

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more scale sizes or "iterations". Fractal antennas are very compact, multiband or wideband, and have useful applications in cellular telephone and microwave communications. Several fractal antennas are presented in books, papers and patents, see [1]-[15]. Compact printed antennas are presented in journals and books, see [16]-[22].

2. New Fractal Compact Ultra-Wideband, 1 GHz to 6 GHz, Notch Antenna

Fractal geometries may be applied to design antennas and antenna arrays. The advantages of printed circuit technology and printed antennas enhance the design of fractal printed antennas and microwave components. The effective area of a fractal antenna is significantly higher than the effective area of a regular printed antenna. Fractal antenna may operate with good performance at several different frequencies simultaneously. Fractal antennas are compact multiband antennas. Directivity of fractal antennas is usually higher than directivity of a regular printed antenna. The number of element in a fractal antenna array may be reduced by around a quarter of the number of elements in a regular array. A fractal antenna could be considered as a non-uniform distribution of radiating elements. Each of the elements contributes to the total radiated power density at a given point with a given amplitude and phase. By spatially superposing these line radiators we can study the properties of a fractal antenna array. **Figure 1** presents Hilbert fractal curves which can be used as space-filling curves.

A wideband notch antenna with fractal structure has been designed. The antenna is printed on RT-DUROID 5880 dielectric substrate with dielectric constant of 2.2 and 1.2 mm thick. The notch antenna is shown in **Figure 2**. The notch antenna dimensions are 74.5 × 57.1 mm. The antenna center frequency is 2.75 GHz. The antenna bandwidth is around 200% for S11 lower than −6.5 dB, as presented in **Figure 3**. The notch antenna VSWR is better than 3:1 for frequencies from 1 GHz to 5.5 GHz. The antenna beam width is around 84˚. The antenna gain is around3.5dBi as presented in **Figure 4**. H plane radiation pattern of the wideband notch antenna with fractal structure is presented in **Figure 5**.

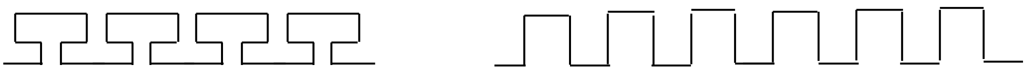

Figure 1. Hilbert fractal curves which can be used as space-filling curves.

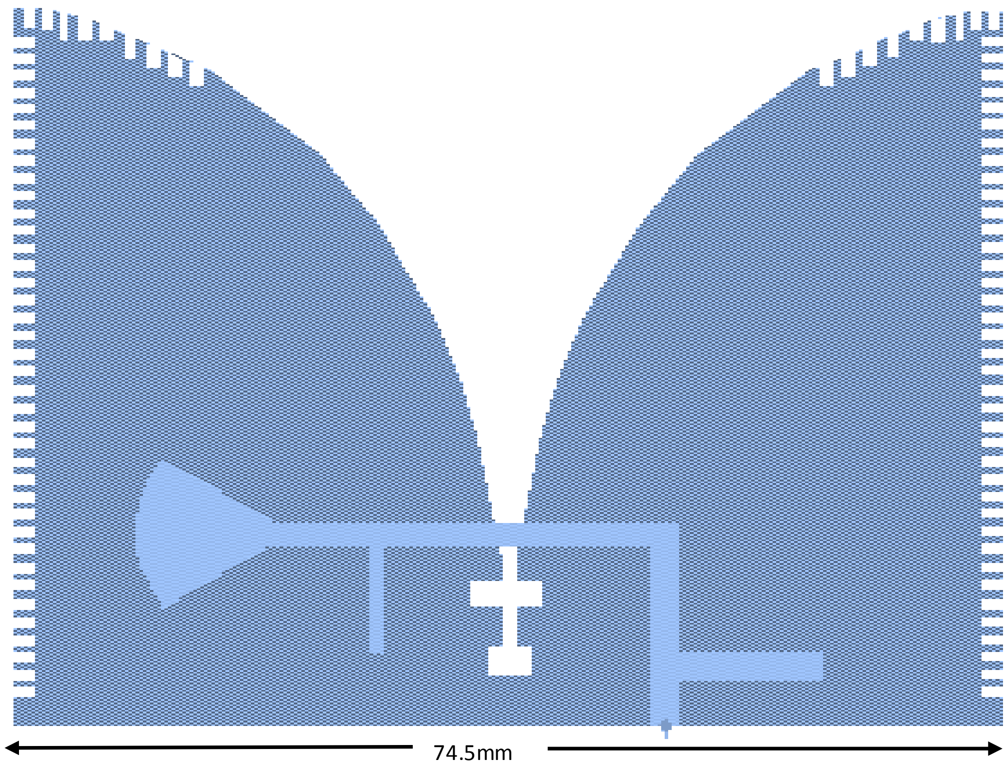

Figure 2. A wideband notch antenna with fractal structure.

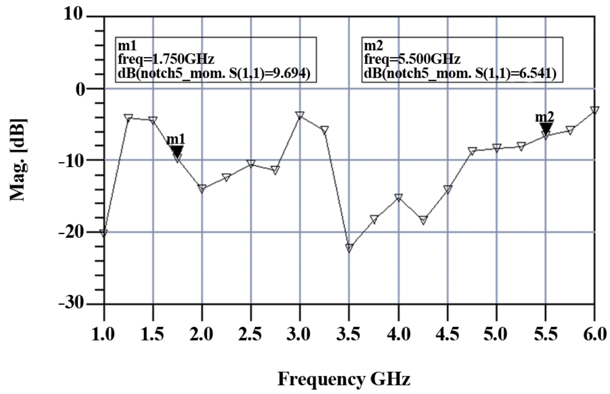

Figure 3. A wideband notch antenna with fractal structure, computed S11.

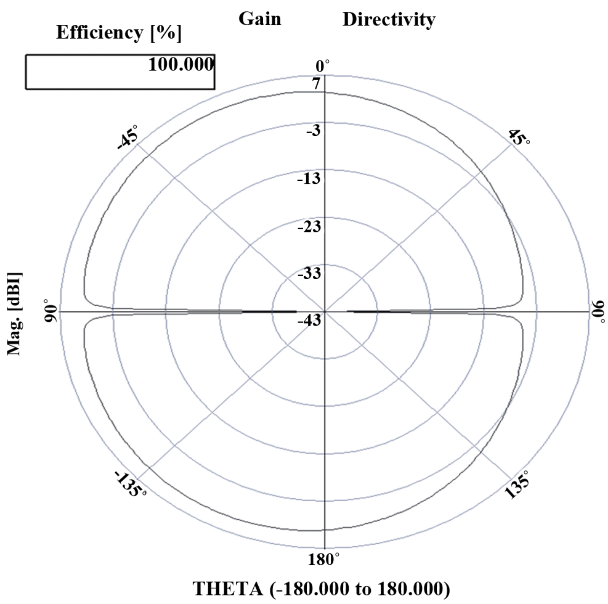

Figure 4. E plane radiation pattern of the wideband notch antenna with fractal structure.

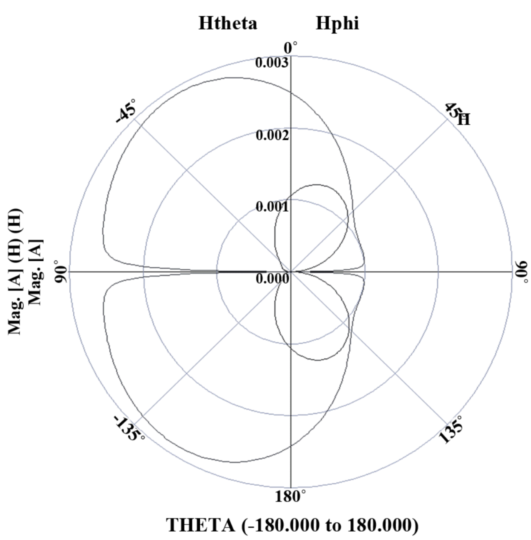

Figure 5. H plane radiation pattern of the wideband notch antenna with fractal structure.

3. New Compact Ultra-Wideband Notch Antenna 1.3 GHz to 3.9 GHz

A wideband notch antenna with fractal structure has been designed. The antenna is printed on RT-DUROID 5880 dielectric substrate with dielectric constant of 2.2 and 1.2 mm thick. The notch antenna is shown in **Figure 6**. The notch antenna dimensions are 52.2 × 36.8 mm. The antenna center frequency is 2.7 GHz. The antenna bandwidth is around 100% for S11 lower than −6.5 dB, as presented in **Figure 7**. The notch antenna VSWR is better than 3:1 for frequencies from 1.3 GHz to 3.9 GHz. The antenna beam width is around 84˚. The antenna gain is around 3.5 dBi.

4. Wideband Notch Antenna 2.1 GHz to 7.8 GHz

A wideband notch antenna has been designed. The antenna is printed on RT-DUROID 5880 dielectric substrate with dielectric constant of 2.2 and 1.2 mm thick. The notch antenna is shown in **Figure 8**. The notch antenna dimensions are 116.4 × 71.4 mm. The notch antenna dimensions with fractal structure are 52.2 × 36.8 mm. The antenna center frequency is 5 GHz. The antenna bandwidth is around 100% for S11 lower than −6.5 dB, as presented in **Figure 9**. The notch antenna VSWR is better than 3:1 for frequencies from 2.1 GHz to 7.8 GHz. The antenna beam width is around 84˚. The antenna gain is around 2.5 dBi. **Figure 10** present the radiation pattern of the wideband notch antenna at 3.5 GHz.

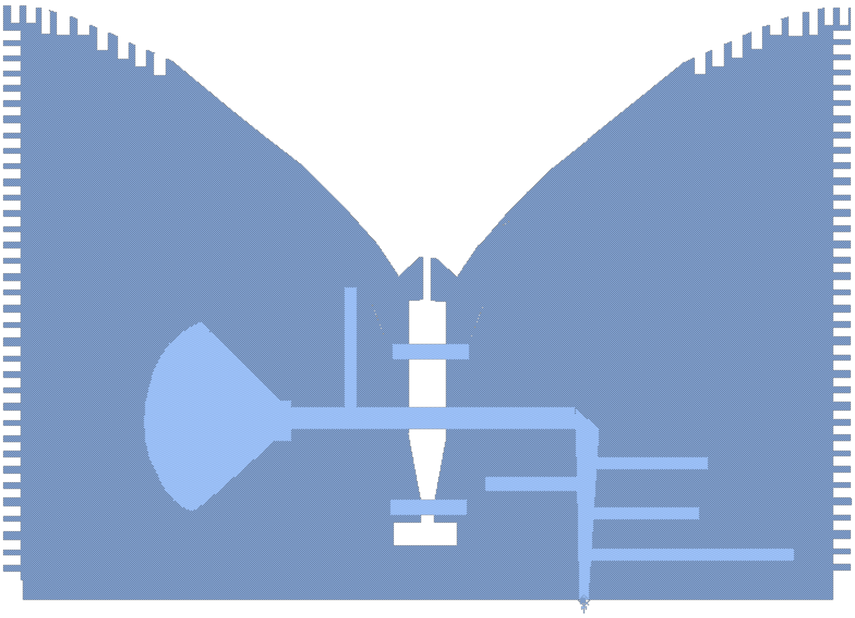

Figure 6. A wideband 1.3 GHz to 3.9 GHz notch antenna with fractal structure.

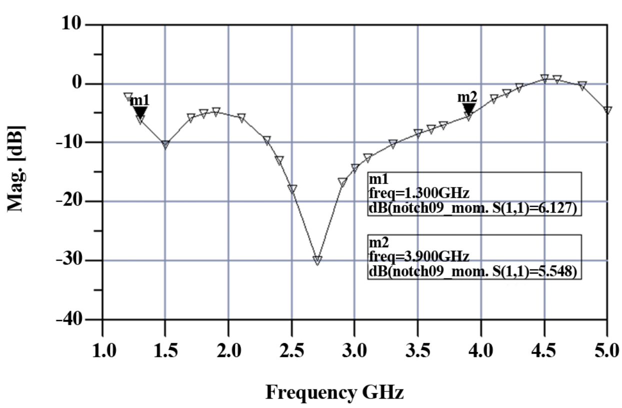

Figure 7. A wideband 1.3 GHz to 3.9 GHz notch antenna with fractal structure, S11 results.

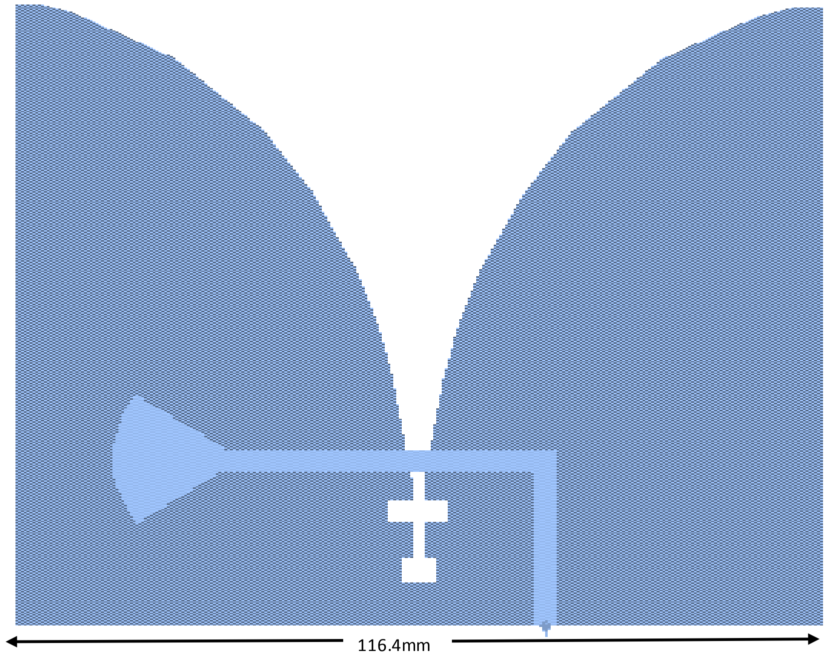

Figure 8. A wideband 2.1 GHz to 7.8 GHz notch antenna.

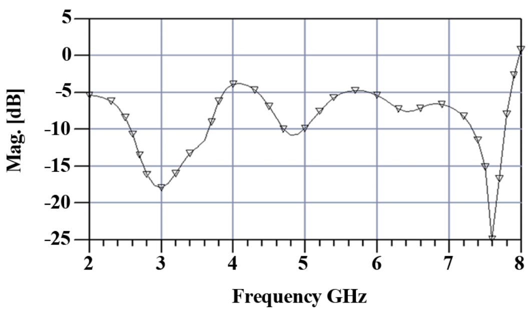

Figure 9. A wideband 2.1 GHz to 7.8 GHz notch antenna, computed S11.

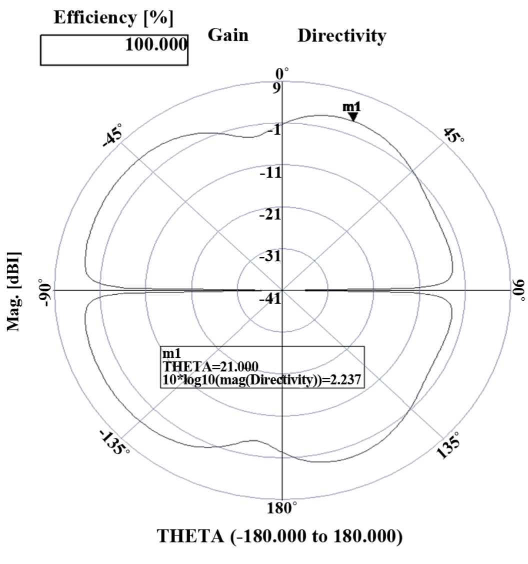

Figure 10. Radiation pattern of the wideband notch antenna at 3.5 GHz.

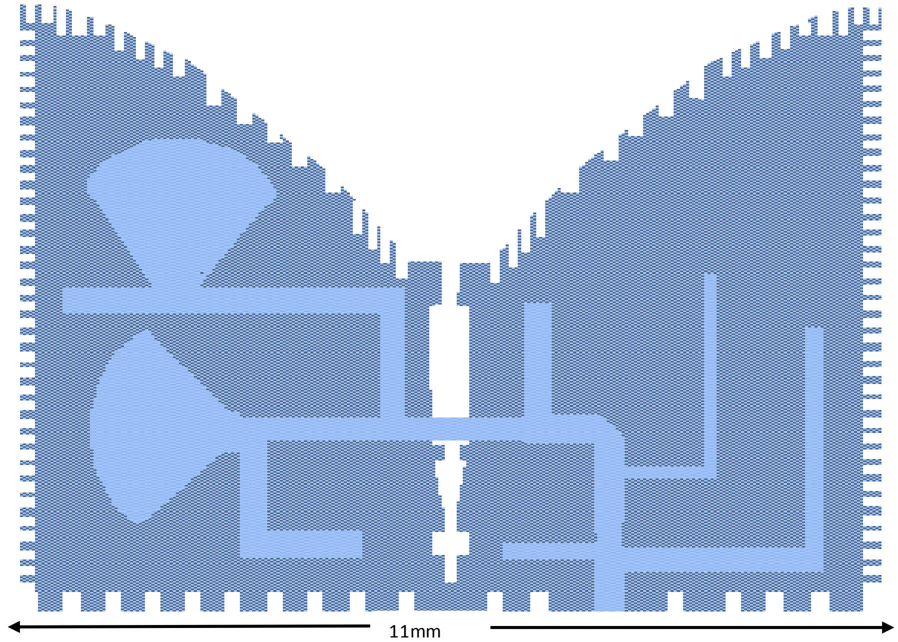

Figure 11. A wideband 5.8 GHz to 18 GHz notch antenna with fractal structure.

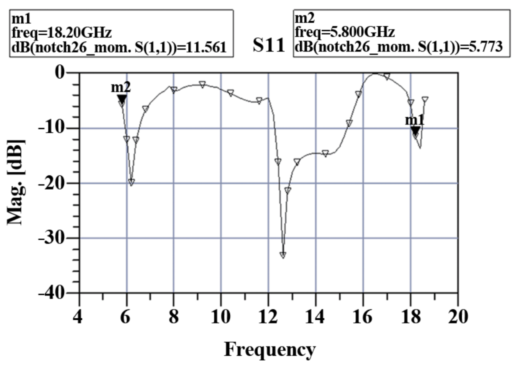

Figure 12. A wideband 5.8 GHz to 18 GHz notch antenna with fractal structure, S11 results.

By using fractal structure the notch antenna length and width was reduced by around 50%.

5. New Compact Ultra-Wideband Notch Antenna 5.8 GHz to 18 GHz

A wideband notch antenna with fractal structure has been designed. The antenna is printed on RT-DUROID 5880 dielectric substrate with dielectric constant of 2.2 and 1.2 mm thick. The notch antenna is shown in **Figure 11**. The notch antenna dimensions are 11 × 7.7 mm. The antenna center frequency is 12 GHz. The antenna bandwidth is around 100% for S11 lower than −5 dB, as presented in **Figure 12**. The notch antenna VSWR is better than 3:1 for more than 90% of the frequency range from 5.8 GHz to 18 GHz. The antenna beam width is around 84˚. The antenna gain is around 3.5 dBi. **Figure 13** presents the radiation pattern of the wideband notch antenna with fractal structure at 8 GHz.

The antenna matching network was optimized to get better S11 results at 16 GHz to 18 GHz. The length and width of the stubs were tuned to get better S11 results at 16 GHz to 18 GHz.

6. Conclusion

The paper presents new compact ultra-wideband notch antenna 1 GHz to 6 GHz and a wideband notch antenna 5.8 GHz to 18 GHz. Space filling technique and Hilbert curves are employed to design the fractal notch

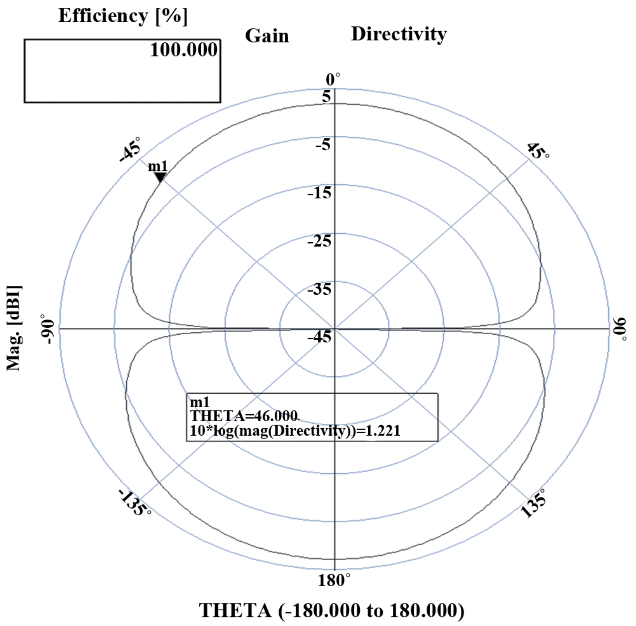

Figure 13. Radiation pattern of the wideband notch antenna with fractal structure at 8 GHz.

antennas. The fractal notch antennas are analyzed by using 3D full-wave software. The antenna bandwidth is around 100% with VSWR better than 3:1. The antenna gain is around 3.5 dBi with efficiency higher than 90%. By using fractal structure, the notch antenna length and width can be reduced by up to 50%.

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