Sierpinski Multiband Monopole Antenna

Generation of the Sierpinski antennas is based on the Sierpinski triangle – a well-known planar fractal. The Sierpinski antennas are commonly used in applications where operation at multiple frequencies is required. They can be easily fabricated with conventional printed circuit technology. Usually, these antennas can be found in cell phones and various Wi-Fi devices.

The aim of this application note is to present model and simulation results of the Sierpinski antenna using WIPL-D Pro software. S_{11}-parameter calculated using WIPL-D Pro will be compared with measured and simulated values found in [1]. Furthermore, resonant frequencies and radiation patterns calculated at resonant frequencies will be presented.

Model of Sierpinski Antenna

A Sierpinski multiband monopole antenna is modeled and simulated using WIPL-D Pro, a full-wave 3D EM Method of Moments based solver. Geometry of the antenna is found in [1] and presented in Figure 1.

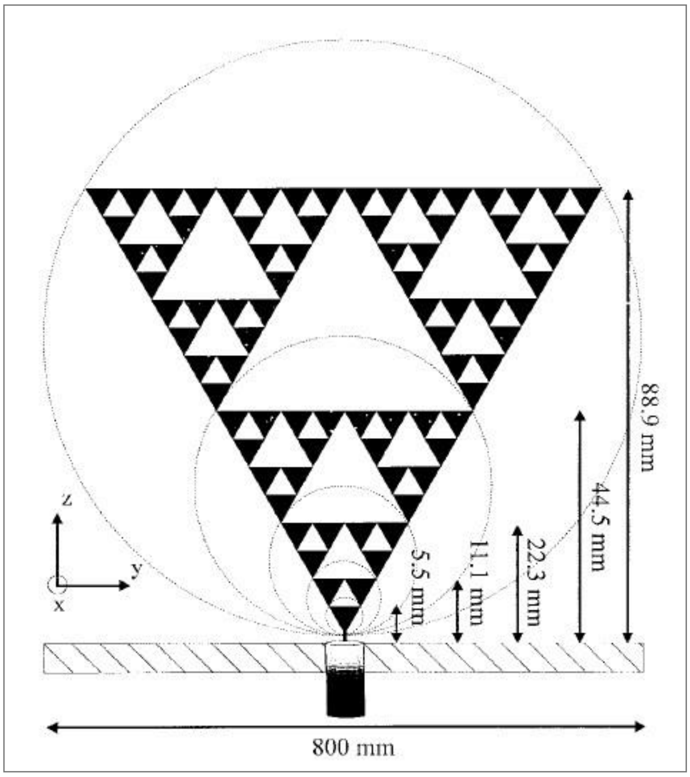

Figure 1. Dimensions of Sierpinski multiband monopole antenna

WIPL-D Pro model of the antenna was created by using geometry presented in Figure 1. The WIPL-D Pro model of the Sierpinski antenna is shown in Figure 2.

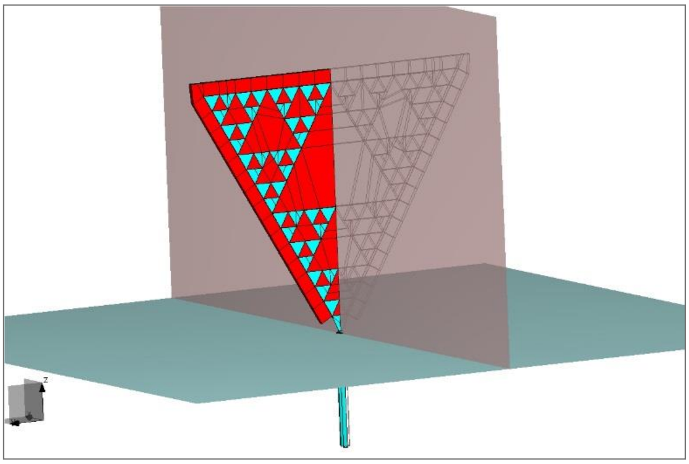

Figure 2. Sierpinski multiband monopole antenna above infinite PEC plane

Sierpinski monopole antenna which is presented in Figure 2 is located above infinite PEC plane. The antenna is fed using 50 Ohms coaxial feeder, located below the PEC plane. The feature allowing such simulation is called apertures in PEC/PMC plane.

The metal parts of the antenna are printed on the dielectric substrate. The parameters of the substrate are frequency independent. Values of real and imaginary part of the dielectric constant are $E_r = 2.5$ and $E_i = -0.0045$.

In order to reduce number of unknowns and computational resources, a symmetry plane is utilized (Figure 2). Thus, only half of the structure needs to be modeled.

The details of the connection between metallic parts of the antenna and the part of the coaxial cable, located above PEC plane, are presented in Figure 3.

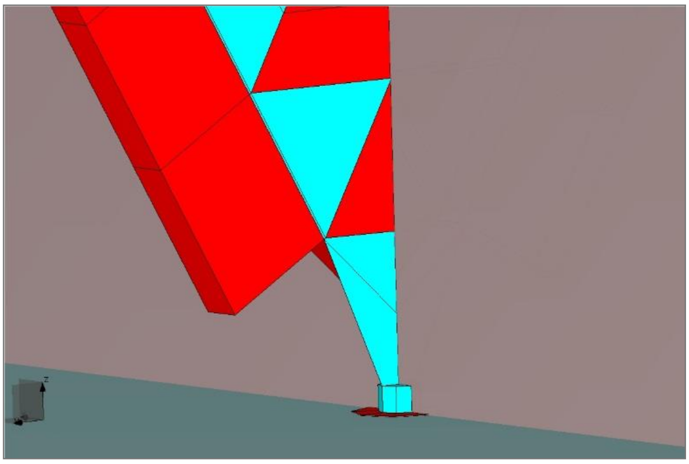

Figure 3. Close up of the modeled connection between coaxial feeder and metallic parts of the antenna above infinite PEC plane

Results

Sierpinski antenna was simulated in frequency domain from 0.1 GHz to 16 GHz in 60 frequency points. This simulation was performed using WIPL-D Pro (Method of Moments based) solver. The simulated S_{11}-parameter is shown in Figure 4. Measured values of S_{11}-parameter in Figure 4 and the results of the simulations using FDTD method found in [1] are presented in the same figure.

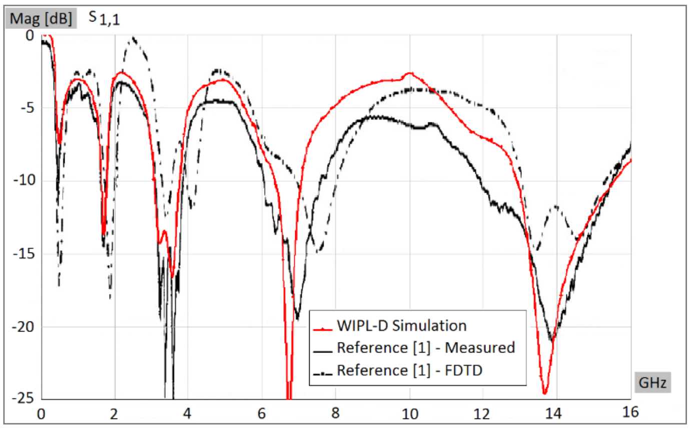

Figure 4. S_{11}-parameters

The markers with markers readouts indicating resonant frequencies (calculated using WIPL-D Pro) are presented in Figure 5.

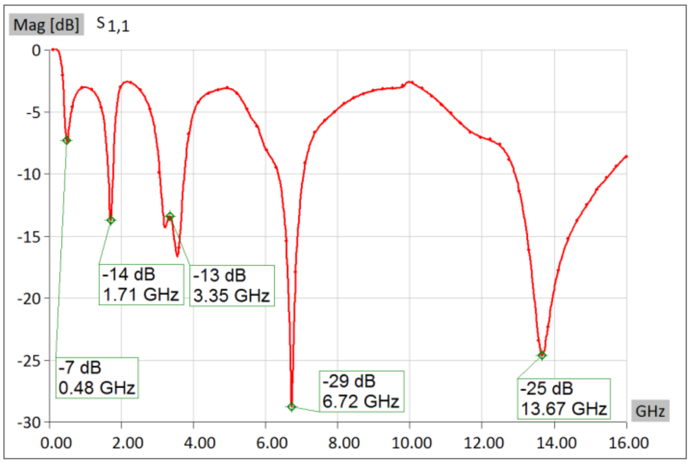

Figure 5. S_{11}-parameter with marker readouts indicating resonant frequencies

In the next step, Sierpinski antenna was simulated at resonant frequencies (1.71 GHz, 3.35 GHz…). Radiation patterns in Phi = 0 plane are shown in Figure 6.

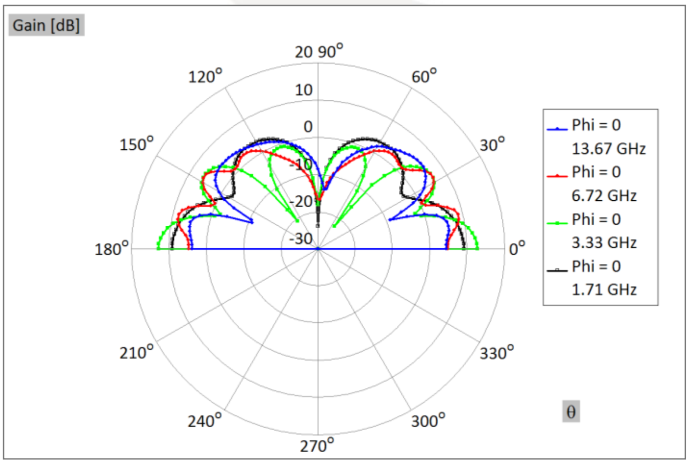

Figure 6. Radiation patterns at appropriate resonant frequencies

Simulation

Computer used for the simulations was Intel® Core® i7-7700 CPU @ 3.60 GHz. CPU is used both for matrix fill and matrix inversion. Number of elements, number of unknowns, computer memory required, and simulation time per frequency are presented in Table 1.

Table 1. Number of elements, number of unknowns, occupied memory and simulation time per frequency.

Number of elements	Number of unknowns	Memory [GB]	Simulation time per frequency [sec]
2,391	6,486	0.313	13.3

References

[1] C. Puente, J. Romeu, R. Pous, A. Cardana, "On the Behaviour of the Sierpinski Multiband Fractal Antenna", IEEE Transactions on Antennas ans Propagation, Vol. 46, No. 4, April 1998