

Discone Antenna

In this application note, four models of the discone antenna will be simulated. All models will be considered as demonstrative. The aim is to get closer to the real-life problems where discone antennas operate in real-life environment. This means, for example, that the dielectric support, radome covering the antenna, losses in materials and frequency depended characteristics of used dielectric materials should be included in simulations.

Discone antenna is a wide band structure. Nevertheless, it can be simulated very fast and very accurately by using WIPL-D. WIPL-D Software, as Method of Moments (MoM) code based on Surface Integral Equations (SIE), is suitable and efficient tool that can be used for simulating various models of discone antennas.

In order to reduce simulation time and amount of occupied computer memory, two symmetry planes will be used in the simulations of each model. Each model will be simulated starting from 0.5 GHz to 10.5 GHz in 55 frequency points. All models will be created using WIPL-D Pro CAD, a CAD modeler which includes Boolean operations. Materials modeled in the projects will be highlighted using WIPL-D Pro.

Discone Antenna Models

The first simulated model is discone antenna shown in Figure 1.

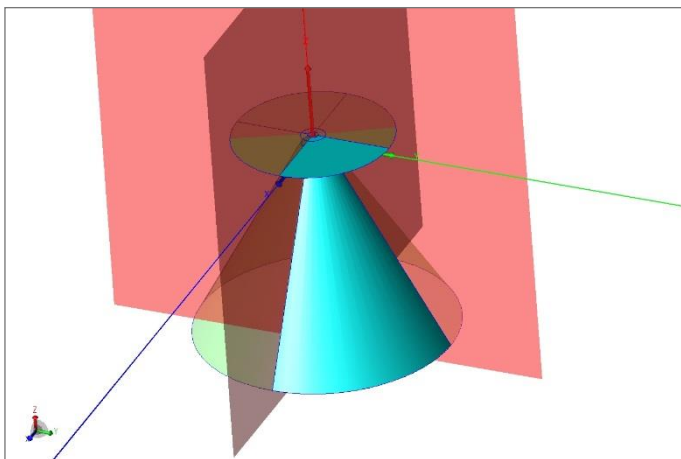


Figure 1. Discone antenna

Figures 1-3 and Figure 5 are obtained by exporting preview from WIPL-D Pro CAD modeler as image.

The second simulated model of discone antenna is created with holes included. The holes are included in order to allow protrusion of dielectric masts. Model of discone antenna with holes is shown in Figure 2.

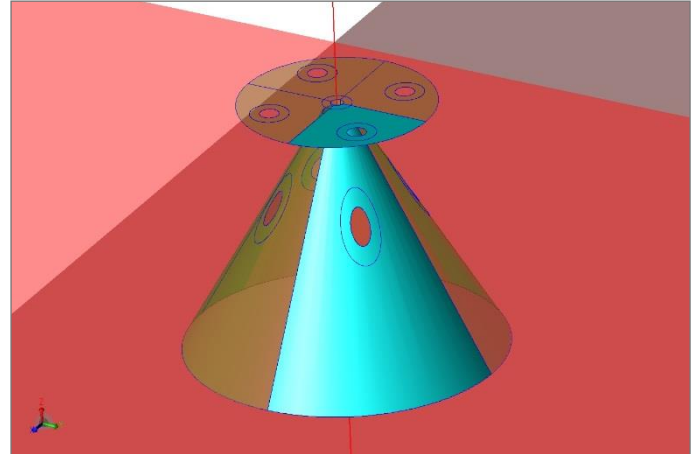


Figure 2. Discone antenna with holes

The third simulated model of antenna is shown in Figure 3. It consists of discone antenna with holes and a dielectric support. The dielectric support is modeled using dielectric masts and a dielectric pedestal.

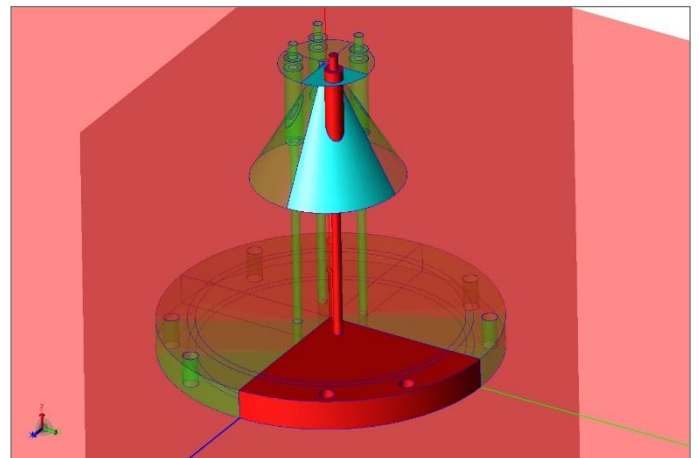


Figure 3. Discone antenna with holes and dielectric support

Since different materials are used in the third model, they will be highlighted using different colors (Figure 4). Metallic parts are colored light blue. Dielectric masts are modeled using a dielectric which will be named Dielectric 1. The masts are colored dark blue. Dielectric pedestal is modeled using a dielectric which will be named Dielectric 2. The pedestal is colored yellow.

Dielectrics presented in Figure 4 are highlighted within WIPL-D Pro after process of meshing. This means that, Figure 4 is obtained by exporting preview from WIPL-D Pro.

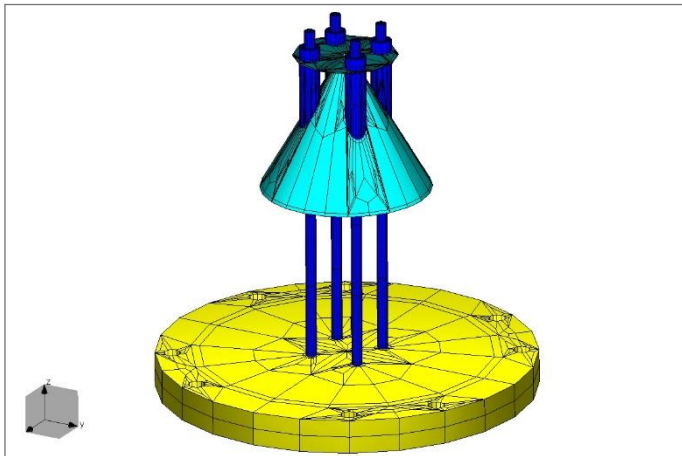


Figure 4. Materials used in the third model of antenna

It is assumed that parameters of the used dielectrics vary with frequency. Table 1 shows how relative dielectric permittivity (further: Er) and loss tangent (further: TgD) depend on frequency.

Table 1. Relative dielectric permittivity and loss tangent

Frequency [GHz]	Dielectric 1		Dielectric 2	
	Er	TgD	Er	TgD
1	3.14	0.0064	2.17	0.0009
2	3.10	0.0065	2.15	0.0009
3	3.02	0.0067	2.10	0.0010
4	2.97	0.0071	2.08	0.0011
5	2.90	0.0073	2.07	0.0011
6	2.88	0.0079	2.06	0.0013
7	2.81	0.0081	2.03	0.0014
8	2.67	0.0086	2.03	0.0015
9	2.55	0.0089	2.01	0.0015
10	2.51	0.0092	2.01	0.0016
11	2.43	0.0094	2.00	0.0017

The fourth model is obtained by adding the radome to the third model (Figure 5). Radome is modelled using Dielectric 2.

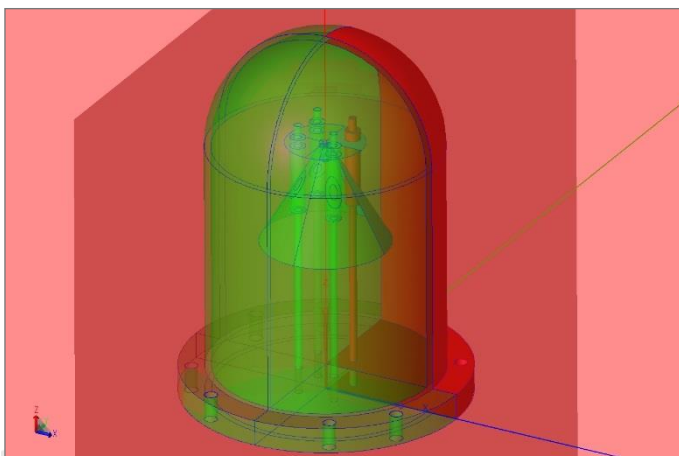


Figure 5. Discone antenna with holes, dielectric support and radome

Similar as in Figure 4, fourth model of discone antenna is shown in Figure 6. Figure 6 is obtained after process of meshing, by exporting preview from WIPL-D Pro. In Figure 6, in order to present interior of the structure, radome is shown as transparent.

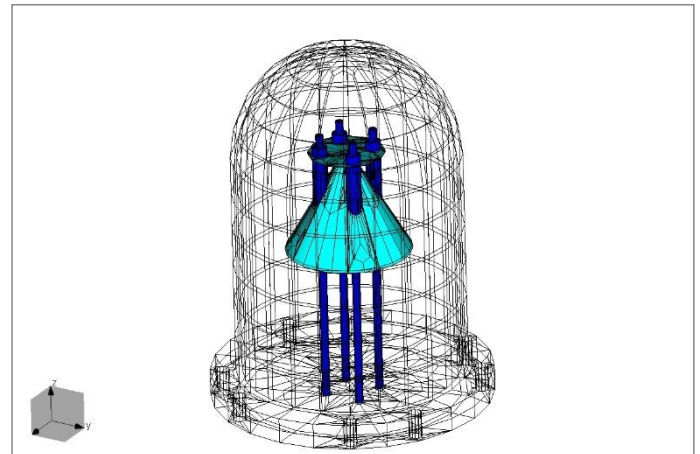


Figure 6. Materials used in the fourth model of antenna

Results

Convergence of the results was tested with increasing number of unknowns, modifying mesh of the model and increasing *Integral accuracy* parameter. After the convergence tests, it was concluded that initial, default simulation settings can be used for obtaining results which are accurate enough.

S-parameters of the four antennas were compared and presented in the Figure 7.

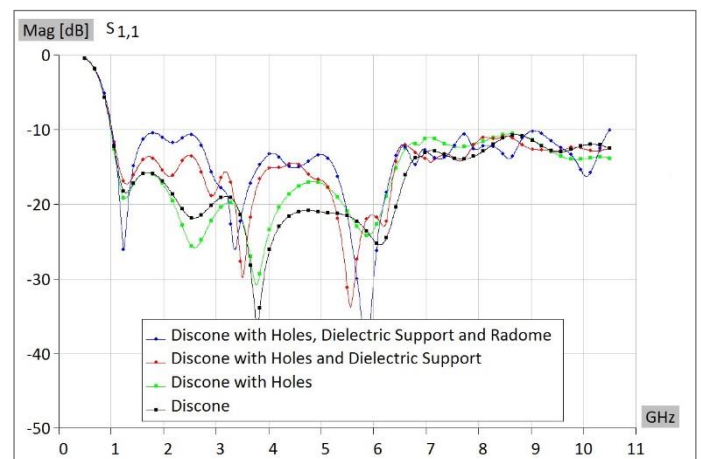


Figure 7. S-parameters

Radiation pattern was calculated at 5.5 GHz (center of frequency band). The calculation was performed in $\phi = 0$ [Degrees] cut. Radiation patterns of the four simulated antennas are presented in Figure 8.

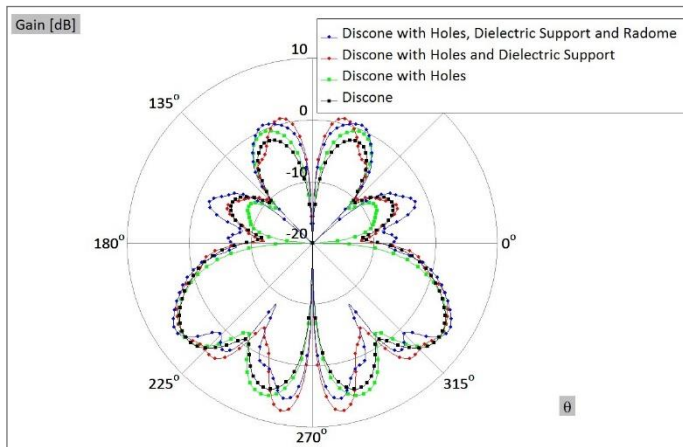


Figure 8. Radiation pattern in $\phi = 0$ [Degrees] cut.

Simulations

Computer used for these simulations is Intel® Core™ i7 CPU 7700@3.60 GHz with NVIDIA GeForce GTX 1080 GPU card. CPU is used for matrix fill. GPU is used for matrix inversion. The configuration represents a regular desktop PC, equipped with a GPU card.

Number of elements, number of unknowns, occupied computer memory and simulation time per frequency are presented in Table 2. Simulation time per frequency consists of time spent in matrix fill-in and time spent in matrix inversion. Time necessary for calculation of radiation pattern was not included in the simulation time per frequency.

Table 2. Number of elements, number of unknowns, occupied memory and simulation time per frequency for all simulated models.

Model	Number of elements	Number of unknowns	Memory [GB]	Simulation time per frequency [sec]
Discone antenna	252	466	0.0016	0.8
Discone antenna with holes	1,336	1,327	0.0131	2.2
Discone antenna with holes and dielectric support	4,602	12,908	1.2414	47.1
Discone antenna with holes, dielectric support, and radome	5,154	22,208	3.6746	84.1