Ultra-Wide Band Elliptical Antenna

Ultra-wide band elliptical (UWB elliptical) antenna is electrically small, simple, lightweight and inexpensive printed antenna used in UWB transmitters.

Theoretical Characteristics

UWB antenna topologies are derived from circular and elliptical disc monopoles, aiming to operate as broadband antenna.

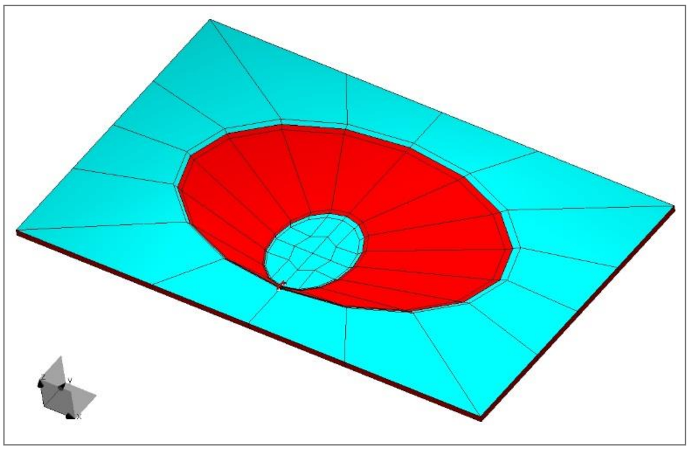

Figure 1. UWB elliptical antenna

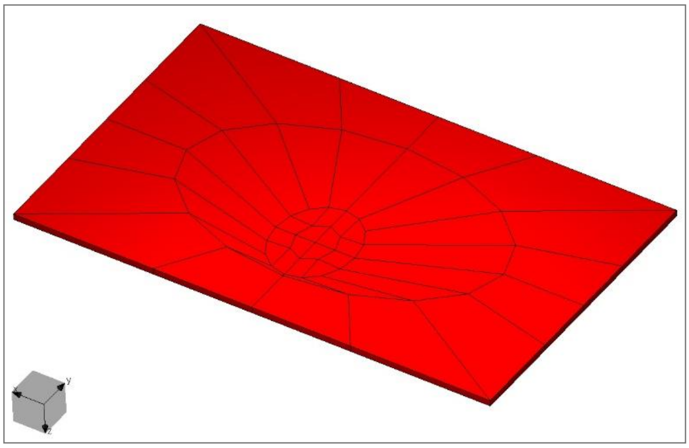

Figure 2. UWB elliptical antenna. Bottom side

WIPL-D Simulations

In WIPL-D, metallic plates are colored cyan by default, while other colors are reserved for dielectric surfaces (in this case red). Thus Fig. 1 shows that the given antenna is printed on a dielectric substrate and has no ground plane (Fig. 2). As a consequence, we expect a high level of back-radiation.

In WIPL-D software, UWB elliptical antenna simple geometry can be easily modeled by using built-in primitives (Circle, Body of Connected Generatrix-BoCG, and Body of Constant Cut-BoCC). Symmetry can be applied (Fig. 3).

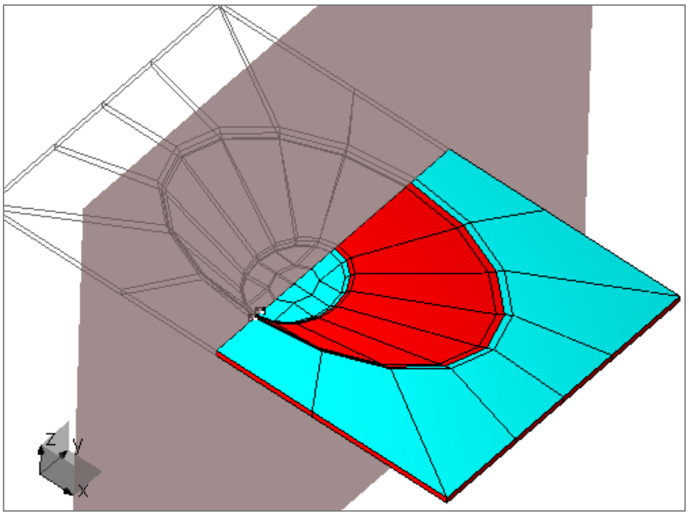

Figure 3. UWB Elliptic antenna – half model

The antenna is analyzed in the frequency range from 2 GHz up to 20 GHz. The s11 parameter is calculated, as it determines antenna operating band and quality of matching. We also present radiation pattern and near field at the chosen frequency where the antenna is well matched. Computer used for these calculations is based on Intel® Core(TM) i7 CPU 7700@3.60 GHz.

Return loss is shown in Fig. 4. Operating antenna band is from 4 GHz up to 14 GHz (where s11 is less than -10 dB).

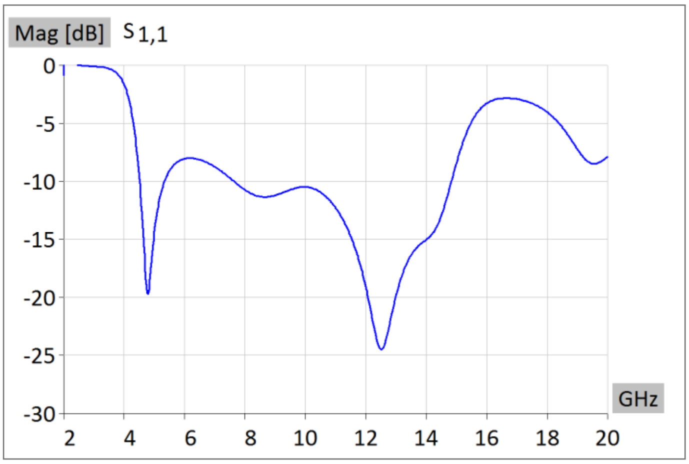

Figure 4. Antenna return loss (s11 in dB)

Antenna gain (3D pattern) is shown in Fig. 5. We can see that gain is low (maximum is about 4.5 dB). Also, antenna is quasi omni-directional. Radiation pattern shows nulls only in directions near xOy plane. Radiation in backward directions is significant because reflector is not used.

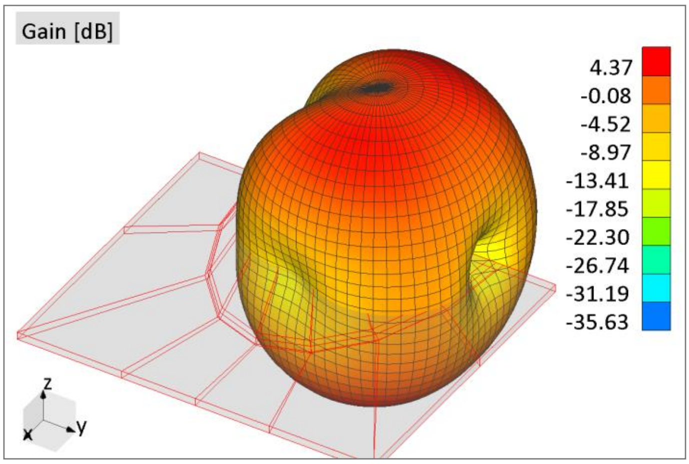

Figure 5. Radiation pattern in 3D

Simulated near field is shown in Fig. 6. We can see EM wave transition from standing wave to free space EM wave.

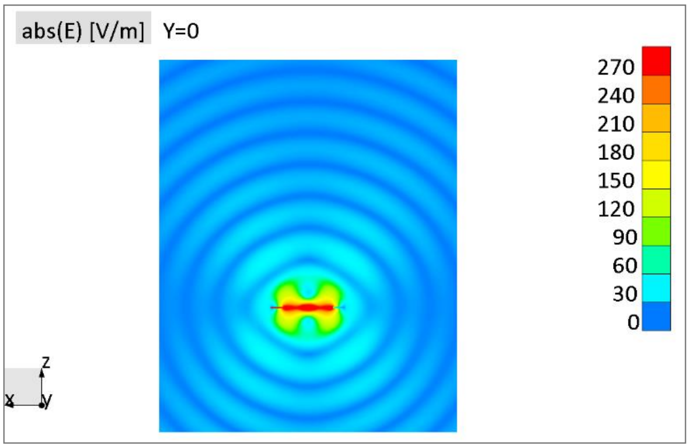

Figure 6. Near field

Number of unknowns and simulation time are given in Table 1. WIPL-D uses powerful interpolation method for fitting of YZS parameters. Thus the simulation was performed only in 21 frequency points, despite the wide frequency range (10:1 ratio between stop and start frequency). Entire simulation time is 63 seconds.

Table 1. Simulation details

Number of unknowns	Simulation time per frequency point [sec]
2 647	3

Conclusion

WIPL-D is a frequency-domain software while the simulated antenna is broad-band (the operating band is from 5 GHz up to 14 GHz). In general, simulation of UWB devices is more demanding in the frequency-domain simulation software, owing to the fact that larger number of frequency points should be simulated.

Several features are used to improve simulation time and requirements. WIPL-D simulation is based on the Method of Moments, with unique application of higher order basis functions. Symmetry is applied so that number of unknowns is halved (simulation time being decreased as well). This is particularly important for electrically large models. In addition, number of frequency points needed for simulation is minimal due to built-in interpolation of results.

The UWP elliptical antenna is electrically small structure and requires very low number of unknowns. The code execution is efficiently parallelized on multicore CPUs, using the hardware capabilities to the full extent. In this case, simulation is performed on regular desktop quad core CPU.

As a consequence, the simulation time is very low per frequency point, as well as the overall simulation time having in mind the wide frequency band of the simulation. The simulation can be performed by using regular desktop PC, without the need for any expensive hardware configuration.