Wideband Monopole Antenna Simulated with Rotational Symmetry Option

This application note presents two approaches to model and simulate a wideband monopole antenna. The first approach deals with a model of the complete antenna structure for simulations, while the second approach exploits rotational symmetry of the antenna to reduce the model geometry used in simulation. The reduction becomes possible with WIPL-D built in feature *Rotational Symmetry*.

The results of interest in this work are S-parameters and 2D radiation pattern of the two models. Besides, the details regarding the monopole modelling and the particularities related to *Rotational Symmetry* setting are presented.

All the simulations and the modellings have been carried out using **WIPL-D Pro, a full wave 3D electromagnetic Method-of-Moments based software** which applies Surface Integral Equations.

WIPL-D Models

The monopole antenna was modeled using WIPL-D Pro software. The full model (the complete antenna model without any simplification arising from symmetry) is shown in Figure 1. The model consists of circular ground plane, a wideband monopole and a coaxial feeding zone. WIPL-D Pro built-in objects *Body-of-Rotation* and *Circle* were used to create a model in a few straightforward steps.

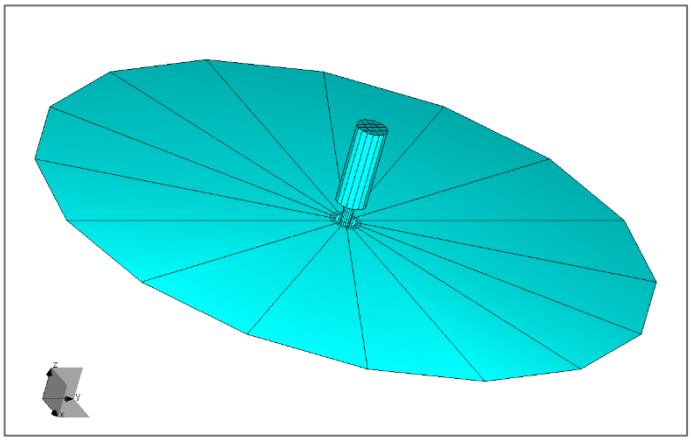

Figure 1. Full model of wideband monopole in WIPL-D Pro

On the other hand, the same structure can be created using just a part of an original structure and applying *Rotational Symmetry* option as the complete antenna and the excitation are rotationally symmetrical with respect to a basic coordinate axis. Only n-th part of the structure and the excitation should be defined. The rest of the structure is obtained in n-1 rotations. Each rotation is performed through an angle of 360/n degrees, where n is specified in the *Rotation* edit field. However, such kind of a reduced modeling is restricted to purely metallic structures, only.

The n-th part of the antenna structure, or more precisely, one eighth of the model, is shown in Figure 2. The reduced model comprises one eighth of each, the circular ground plane, the wideband monopole and the coaxial feeder.

The *Symmetry* window where the *Rotational Symmetry* settings are performed is shown in Figure 3. It can be noticed that the entry regarding the *Z* field is set to *Rotation* value while the value 8 is inserted into the *Rotation* field.

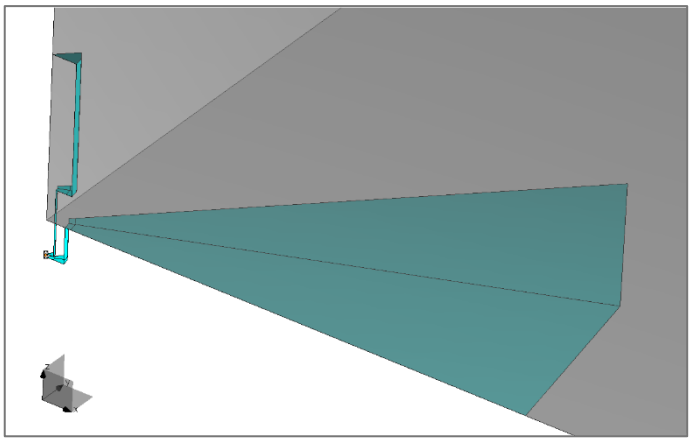

Figure 2. One eight of the model of wideband monopole in WIPL-D Pro

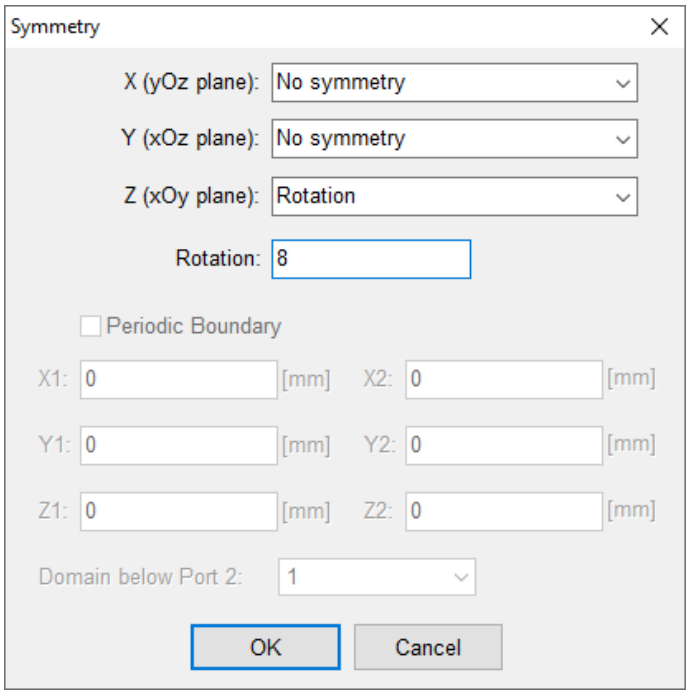

Figure 3. Defining *Rotational Symmetry*

Simulations and Results

The models of the antenna (full model and the model with *Rotational Symmetry* applied) were simulated from 0.1 GHz to 1.5 GHz at 29 frequency points. The modelling and simulations were performed on a laptop with hardware specifications presented in Table 1.

Table 1. Laptop used for the simulations.

Hardware	Description
Processor	Intel® Core™ i7-8750H CPU @ 2.20GHz 2.21GHz
RAM	16 GB

Calculated S-parameters are presented and compared in Figure 4. Radiation pattern results calculated at 0.6 GHz are presented and compared in Figure 5. Number of elements, number of unknowns, and total simulation times are presented in Table 2.

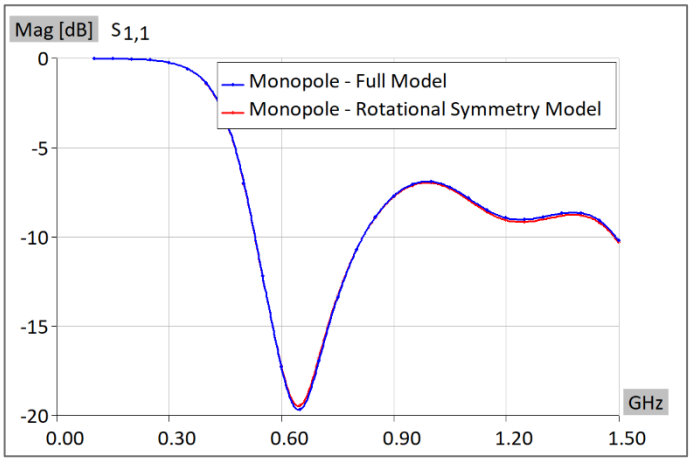

Figure 4. Compared S-parameters

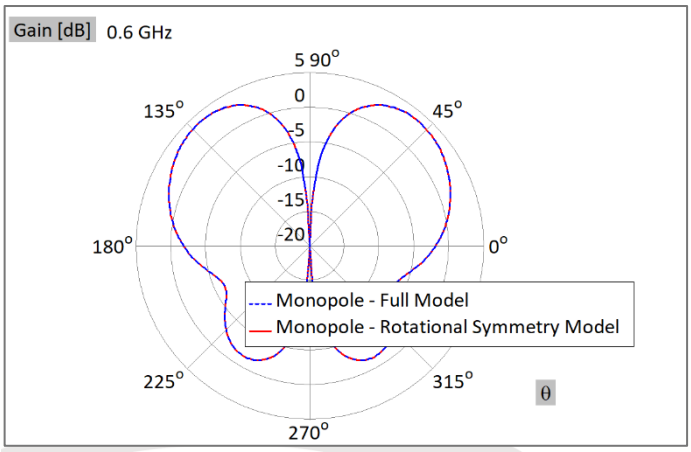

Figure 5. Compared radiation pattern results

Table 2. Number of elements, number of unknowns, and total simulation time

Model	Number of elements	Number of unknowns	Simulation time [sec]
Full model	225	880	25
Eight model	203	89	7

Conclusion

Two models of the wideband monopole antenna have been simulated using **WIPL-D Pro Software**. In particular, S-parameters and radiation pattern at 0.6 GHz of the monopole antenna were calculated and compared. The first calculation being carried out without any simplifications applied, and the second calculation is performed with rotational symmetry applied through *Rotational Symmetry* option. The comparison has confirmed that the simulations carried out using *Rotational Symmetry* option provide highly accurate results in much shorter time.

The modeling and the simulations were carried out using **WIPL-D full wave 3D electromagnetic Method-of-Moments based software which applies Surface Integral Equations**. The simulations **are very efficient even when simulating on a laptop computer.**