# Printed Monopole Antenna for 5G Network Frequency Bands

This application note describes an analysis of **an antenna operating in 5G network frequency bands**. A printed monopole fed with a coplanar waveguide has been taken from the literature [1]. The antenna has been modeled and simulated using WIPL-D Software with the main motivation to demonstrate the software strengths when addressing such an important application area.

Three different feeders have been investigated to model the realistic antenna connection. For each of the model S-parameters have been obtained and the results compared. Besides, some details regarding the particularities of the modelling methods which can be very useful for many WIPL-D users when modeling similar structures are presented.

All simulations and the modellings have been carried out using **WIPL-D Pro CAD, 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 CAD software. WIPL-D Pro CAD model of the antenna with some dimensions is shown in Figure 1. The majority of dimensions of the antenna and dielectric properties are defined as in [1]. Figure 1 also displays the antenna after meshing. In the other words, it also displays the antenna converted to WIPL-D native format.

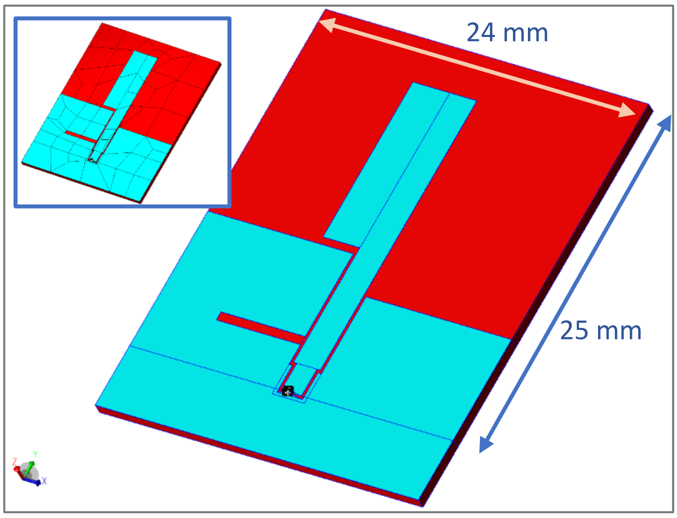


**Figure 1. 5G monopole antenna converted to WIPL-D Pro native format and WIPL-D Pro CAD model with dimensions**

The basic model of the antenna shown in Figure 1 has been simulated with different feeders. The details describing three feeding zones are shown in Figure 2 with sufficient magnifications to expose important details. In the following text the three feeding zones are denoted as: short feeder, long feeder, and coaxial feeder.

Since this antenna represents a planar structure, it is a good example to demonstrate **how planar structures can be built with minimum effort in WIPL-D Pro CAD** using available commands.

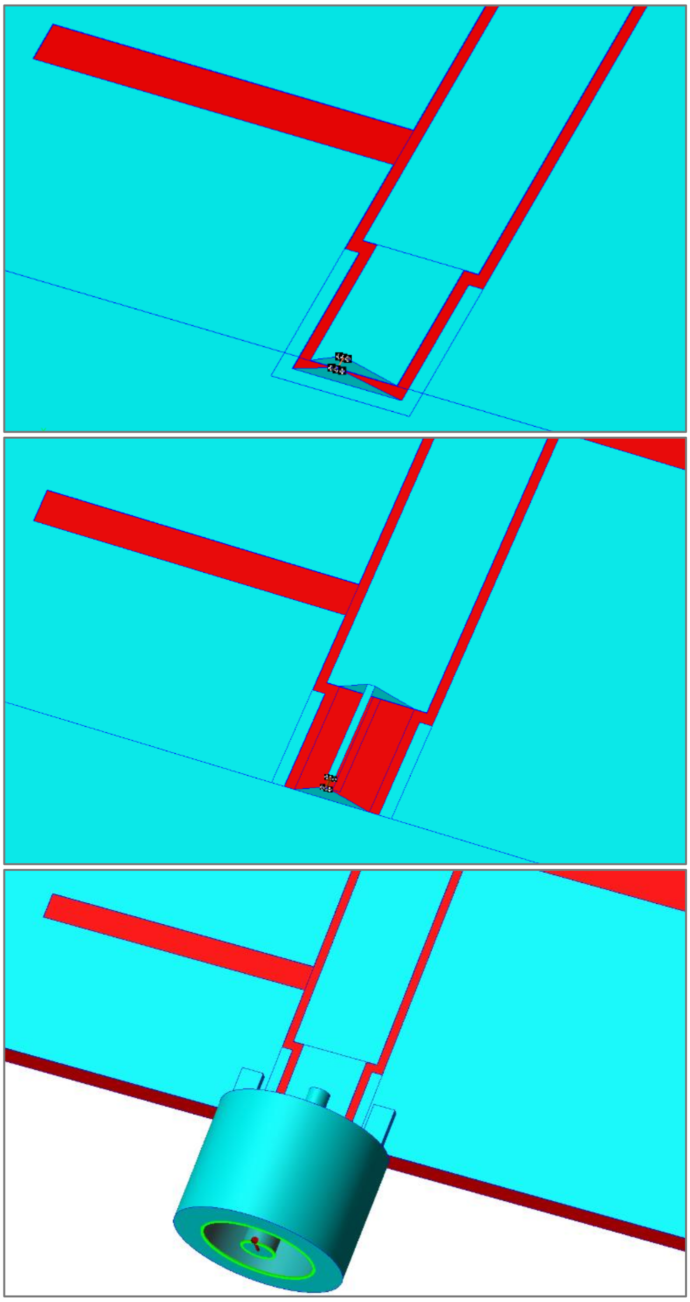

**Figure 2. Feeding zones models in the 5G monopole looking from above: short feeder, long feeder, coaxial feeder**

The antenna conductor pattern (defining the monopole, the slot, the coplanar waveguide with ground) should be built using one infinitesimally thin layer using the sheet bodies. Then, in order to create finite metallization thickness on the top of the antenna and the dielectric below antenna, a **very useful *Copy\Layer*** modification should be used. The metallization thickness was set to 0.017 mm. The substrate dielectric is created in the same manner, i.e. using *Copy\Layer*. In this case the material has the relative dielectric constant $\varepsilon_r$=4.4 and loss tangent tanδ=0.02. Dimensions of the whole model of the antenna are defined by **applying symbols, so that the antenna is fully parametrized** and investigations how antenna performance changes with changes in its dimensions is made easier.

## Simulations and Results

The antennas were simulated from 2 GHz to 10 GHz at 21 frequency points. The antennas modelling and simulations were performed on a laptop. The laptop used for simulations is 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 for three different feeders are compared in Figure 3. 2D radiation pattern results were calculated at 9 GHz, 6 GHz, and 3 GHz for the model with the short feeder. The radiation pattern results are shown in Figure 4.

Number of elements, number of unknowns, and simulation time per frequency are presented in Table 2. "Simulation time per frequency" field does not include time required to calculate radiation pattern. However, since radiation pattern calculations take no more than a couple of seconds, this introduces a negligible difference. Also, simulation time per frequency is obtained as time from running the simulations to the end divided with a number of frequencies. This means that in the case of the antenna with coaxial feeder the calculation of "Simulation time per frequency" actually includes the time required for all pre-de-embedding simulations including coaxial feeder simulations and the whole EM model simulation. The total time is at the end divided by number of frequency points.

## Conclusion

**The antenna which can operate in 5G network frequency bands** has been analyzed in this application note using **WIPL-D Software**. In particular, S-parameters and radiation pattern of a printed monopole antenna fed with coplanar waveguide have been calculated are compared.

All the simulations and the modelling were carried out using **WIPL-D full wave 3D electromagnetic Method-of-Moments based software which applies Surface Integral Equations**. The simulations **are very fast and accurate and in a good agreement with the results presented in [1]**.

It was highlighted that simulated printed monopole antenna can be created efficiently combining WIPL-D Pro CAD modelling features and the built-in symbolic mechanism. All the simulations were carried out with **high numerical efficiency resulting in short simulation times even when a laptop is used for the simulations**.

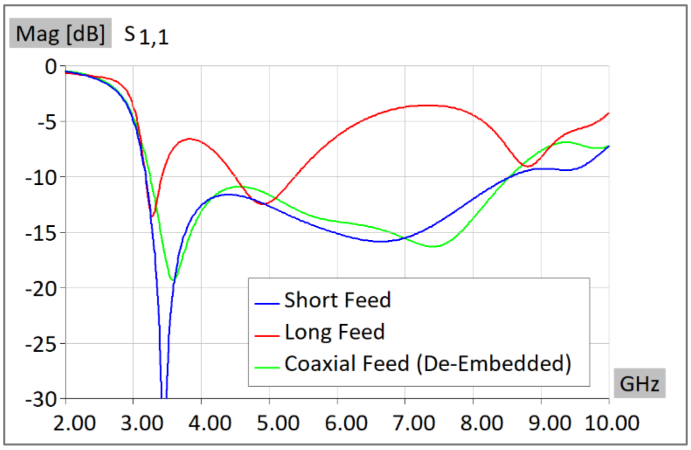


**Figure 3. S-parameters**

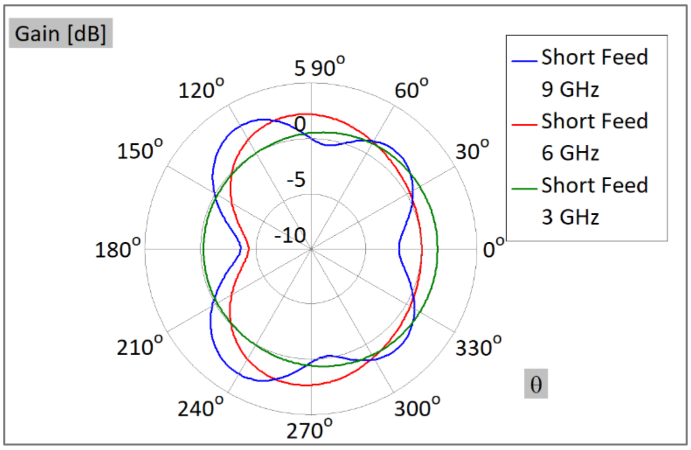


**Figure 4. 2D radiation patterns at 9 GHz, 6 GHz, and 3 GHz. The results obtained for the model with short feeder**

**Table 2. Number of elements, number of unknowns, and simulation time per frequency**

| Model | Number of elements | Number of unknowns | Simulation time per frequency [sec] |
|---|---|---|---|
| Short feeder | 671 | 2,756 | 6 |
| Long feeder | 673 | 2,711 | 6 |
| Coaxial feeder | 1,208 | 3,619 | 10 |

## References

[1] Qiang Chen, Hou Zhang, Xue-liang Min and Lu-Chun Yang, "Compact CPW-Fed Dual-Band Linearly and Circularly Polarized Monopole Antenna for WiMAX and WLAN", Microwave Journal, Vol. 62, May 2019, pp. 68-84.