# Validating IFA Design via Measurement

## Introduction

This application note describes the complete design of a printed IFA antenna carried out by WIPL-D consulting team. In the first step the antenna, which is an integral part of an RFID reader was designed according to the specifications received from a customer. WIPL-D software suite has been used as a design tool. The test samples of the antenna have been fabricated and the design was verified with measurements carried out at the facilities of School of Electrical Engineering in Belgrade.

## IFA Antenna Design

The entire antenna design process was carried out in WIPL-D Pro CAD environment. The environment includes a CAD modeler, an importer of CAD files and an in-house developed mesher. The modeler includes various predefined building blocks which can be uses for antenna modeling. A number of Boolean operations and geometry manipulation commands are available to aid the preparation of the model structure for the simulation. Accordingly, WIPL-D CAD environment allows efficient modelling of parametrized antennas, circuits, scatterers etc. Furthermore, realistic geometries, such as platforms, housings, human body parts etc., can be imported and made simulation ready through model healing or similar commands which is very important when simulations of the interaction between various EM devices and neighboring objects is a goal.

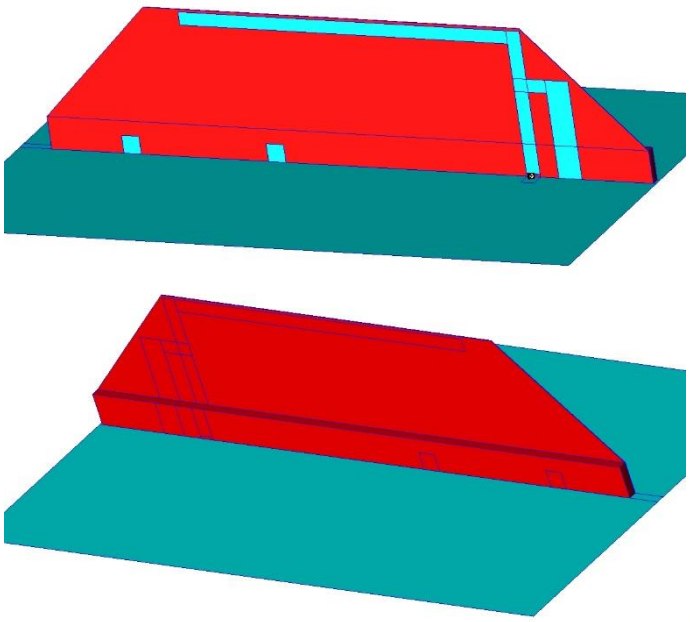

**Figure 1. IFA antenna in WIPL-D Pro CAD.**

After an EM model has been created, the automated quad mesher is invoked to yield EM projects, particularly suitable for simulation using WIPL-D Pro. This highly advanced MoM based EM simulation tool allows simulation of complex EM devices in seconds or minutes on inexpensive regular desktop or laptop configurations.

The specific problem described in this application note is the design of a proprietary printed IFA antenna. The specifications include the operational frequency of 900 MHz, required radiation pattern and gain, PCB material and, most importantly, specifies a particular housing and neighboring environment around the antenna including a large, metallic battery and various slots or metallic objects above the large ground plane.

The antenna model built in the CAD package is shown in Fig. 1 while the photographs of a fabricated sample is presented in Fig. 2. The antenna is printed on very thin (100 um), flexible dielectric substrate. Such thin dielectric films are often challenging for EM simulators. In order to firmly connect thin and flexible substrate to large metallic ground, a rectangular part of FR4 substrate is glued to the bottom part of the flex substrate and then fixed to the metallic ground. This enables fixed vertical position of the antenna.

## Verification via Measurement

The measurements of the fabricated prototype was done at School of Electrical Engineering in Belgrade. The agreement between the measured and the simulated $S_{11}$ is given in Fig. 3.

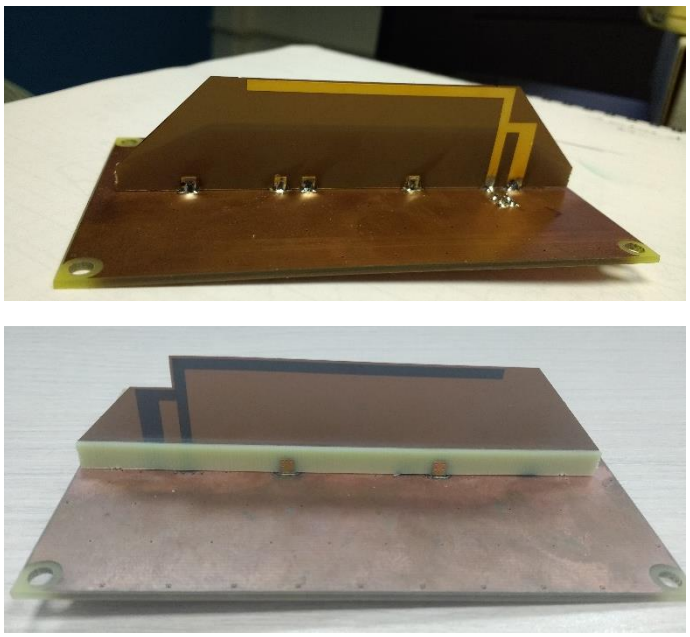

**Figure 2. Antenna prototype ready for verification.**

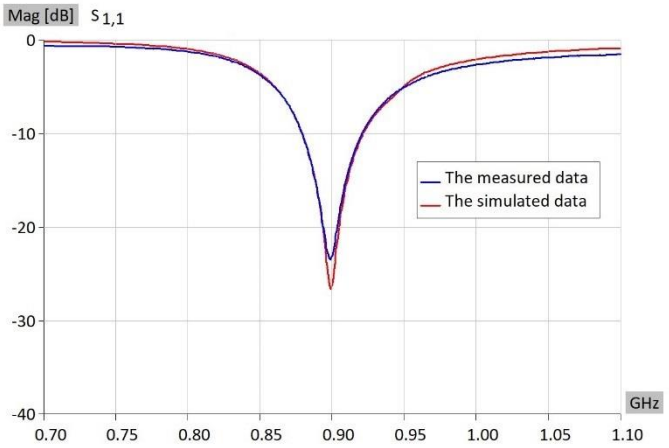


**Figure 3. Comparison of the measured and simulated data**

The simulated antenna radiation pattern satisfies the required shape and provides the range as specified for the RFID reader.

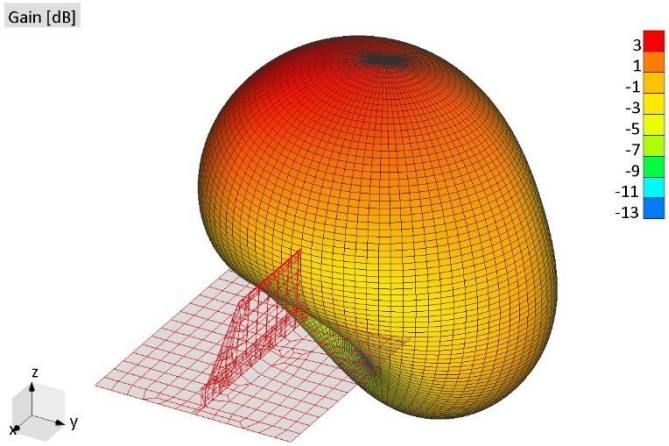


**Figure 4. Antenna radiation pattern**

The simulation was carried out at regular desktop PC (Intel(R) Core (TM) i7-7700 CPU @ 3.60GHz). The simulation requires only 4,752 unknown coefficients and runs in 53 seconds per frequency point. Having in mind a typical simulation time for the printed IFA, the simulation time as given above seems considerably longer. A prolonged simulation time is due to the fact that the antenna is printed on very thin substrate.

## Conclusion

This application note presents a complete design of a printed IFA antenna used in an RFID reader. The antenna was built and simulated using WIPL-D Pro CAD environment. All the EM effects including neighboring metallic objects were taken into the account. The simulation is carried out on a regular desktop PC in approximately one minute per frequency point. The simulation time is higher than the expected owing to very small thickness of the flexible substrate (100um) used to fabricate the antenna, and the complex details of a realistic environment surrounding the antenna.

The antenna was prototyped to verify compliance with the customer specification. The measurement was carried out at the School of Electrical Engineering, University of Belgrade. The measurements are in excellent agreement with the simulated data. The good agreement and successful fulfilment of all design requirements have resulted in the antenna becoming a part of a commercial RFID product.

Besides the core business of the WIPL-D company which is the development of the state-of-the-art full wave EM simulation tools, the consulting services are also the important asset of the company. This is the result of high competence and expert knowledge gained over the years and accumulated throughout customer support, continued education, collaboration with the universities, literature surveys, involvement in many consulting services and collaborative projects etc.