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Report 2. Simulation and Measurement of Planar Structures and Antenna Deformation

Maciej Jasiński
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1 Introduction

The subject of first part of the report is the comparison of simulation and measurement results of various planar structures. This work has to be done in order to validate software design procedure. The second part describes the work upon deformation of planar structures and simulation of curved antenna.

2 Planar structures simulation and measurement

The simulations were made using following software: InventSim, ADS Momentum and HFSS.

2.1 Inset feed antenna

Antenna structure

The structure of this antenna is described in the previous report. It is patch antenna with inset feed on Isola substrate. The antenna was not fabricated correctly due to designing mistake and the feeding line of the antenna has to be made of copper strip with adhesive layer on one side. It means that the dimensions of antenna model from software and the actual fabricated antenna may differ more than it could be expected only from etching process.
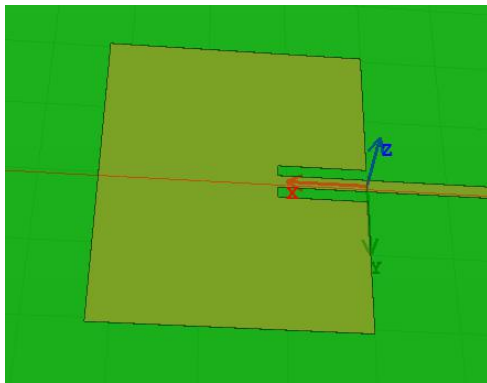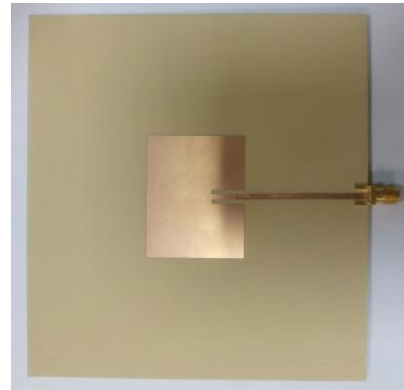

(a) InventSim model   (b) Fabricated antenna
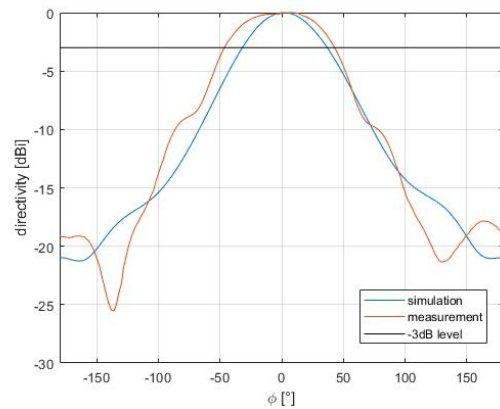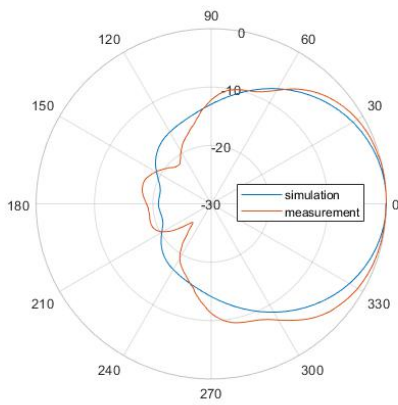
S11 parameter

The results of S11 parameter from simulations and measurement differs only slightly. It could be effect of measurement, numerical errors and inaccuracy of fabrication. Table below presents differences between results, where reference value is from measurement.

Data	Resonance frequency shift [MHz]	10 dB bandwidth difference [MHz]
ADS Momentum	9.3	8.3
HFSS	7.1	7.2
InventSim	3	6.2
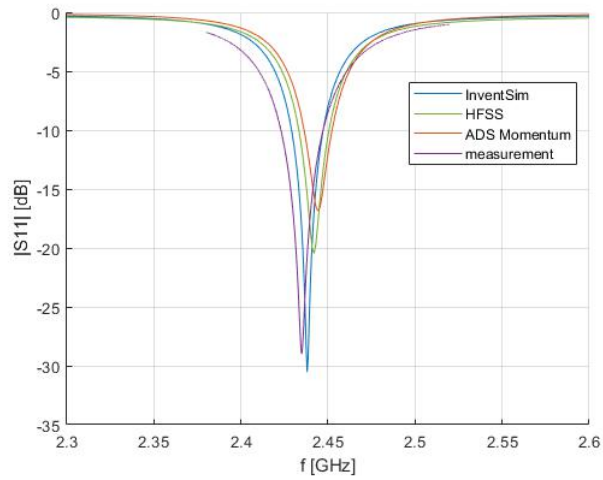
Radiation pattern

The 3 dB beam for simulation (InventSim) is from -31° to 38°, when the result for measurement is wider: from -43° to 45°. For simulation and measurement the maximum of directivity occurs at $\phi=0°$ and in both cases there is significant attenuation of back lobe.
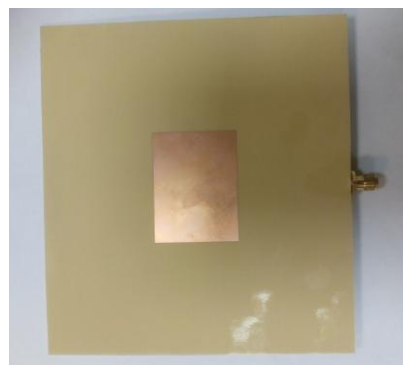

2.2   Coplanar antenna

Antenna structure

The structure of this antenna corresponds to the coplanar antenna from previous report.
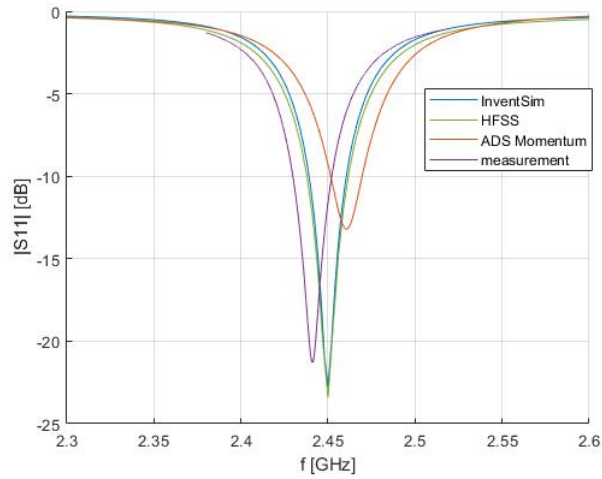

(c) Bottom side of the antenna   (d) Top side of the antenna
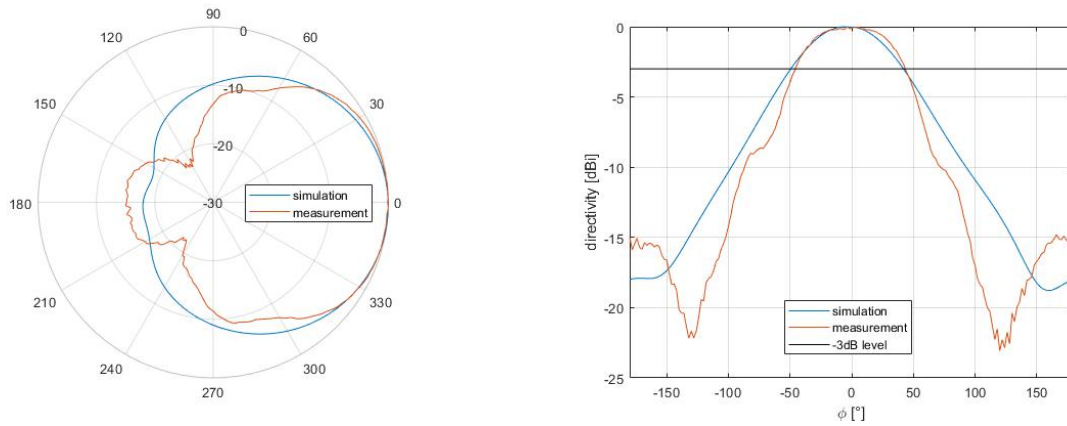
S11 parameter

Data	Resonance frequency shift [MHz]	10 dB bandwidth difference [MHz]
ADS Momentum	20	3.8
HFSS	9.1	1.7
InventSim	9.1	0.3

The obtained characteristics are very close to each other. Results from InventSim and HFSS are nearly the same, because these software use the same method to calculate S parameters.
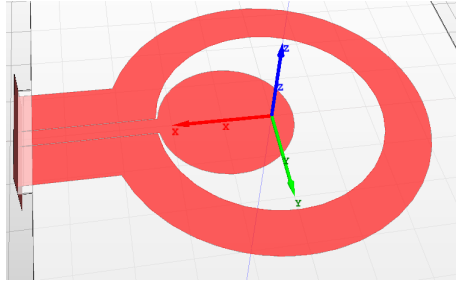

Radiation pattern

In this case, 3 dB beam for simulation from InventSim is from -49° to 42° and from -43° to 43° for measurement. The shape of radiation pattern also are similar: maximum radiation at $\phi=0°$ and back lobe attenuation.

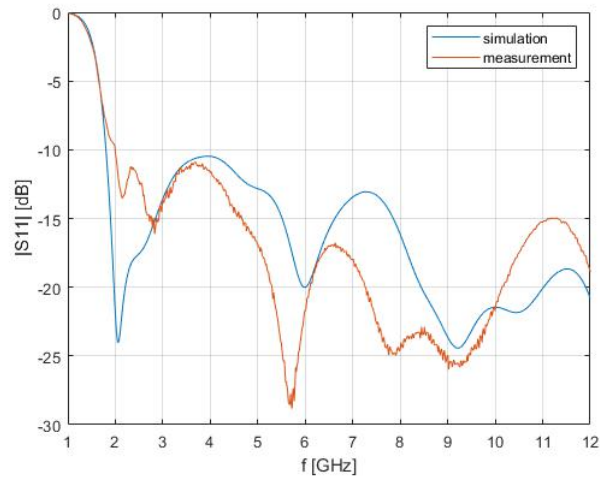## 2.3 UWB antenna

Antenna structure

It is an ultra wideband antenna, based on [1].

S11 parameter

The simulation was performed in InventSim. The characteristics from simulation software and from measurement differs significantly. It could be caused by insufficient number of mesh nodes in simulation model. Further work is required in order to investigate source of this divergence.
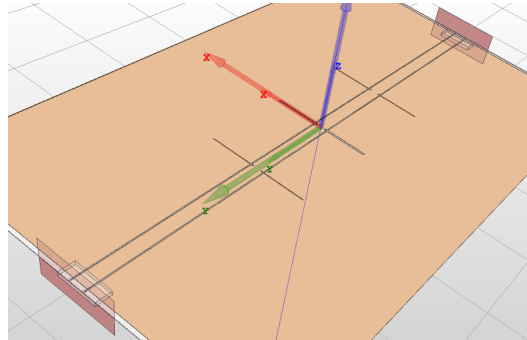
Radiation pattern
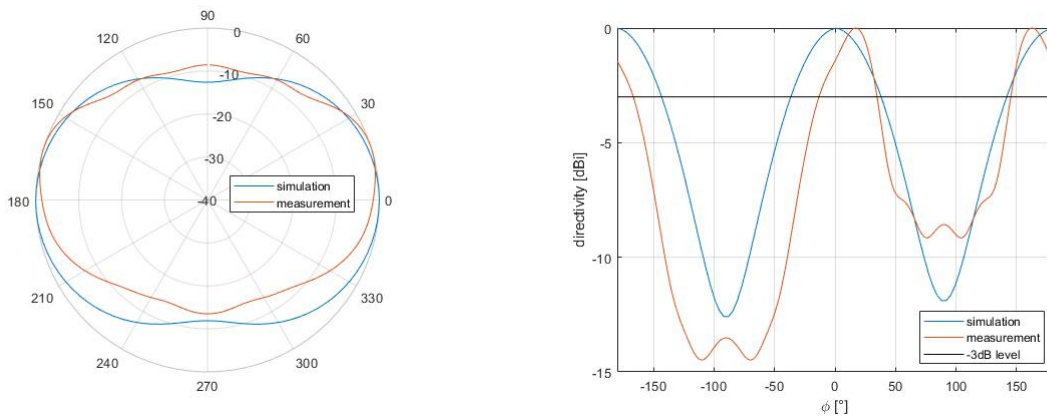
The radiation pattern has two main lobes at $\phi=0°$ and $\phi=180°$. The differences between simulation and measurement for -3 dB level for those lobes are following: $27°$ and $26°$.
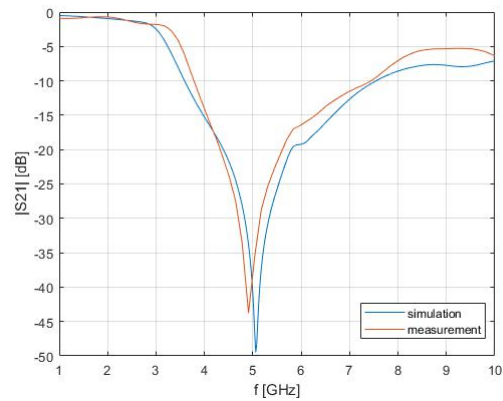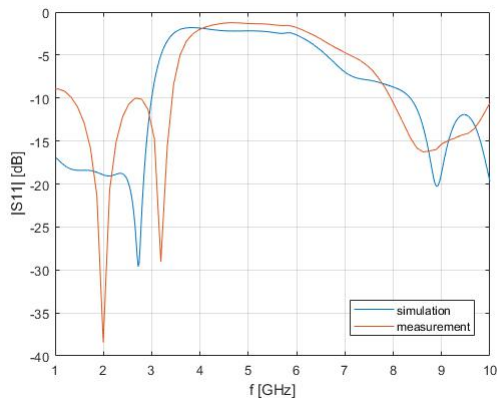
2.4 Filter I

Filter structure

The structure of this filter is based on [2]. The dielectric loss of paper substrate was not known, therefore it was assumed that is equal to 0.07.
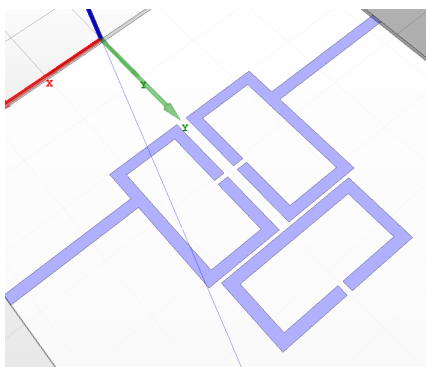

S parameters

The resonance peak shift for |S21| between simulation in InventSim and measurement is equal to 95 MHz. The simulated stopband (where |S21|<-10 dB) is wider by 290 MHz than measured. It could be caused by fact, that the dielectric loss was not known. To minimize that error, the dielectric loss of paper has to be measured.
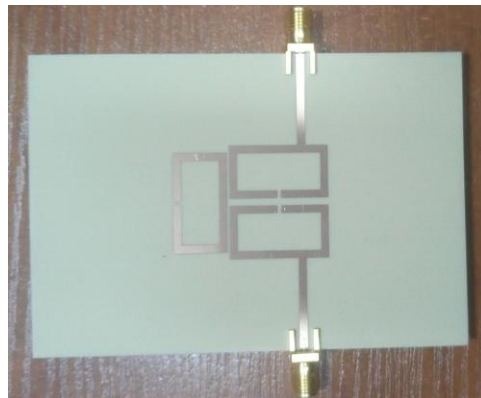
2.5 Filter II

Filter structure

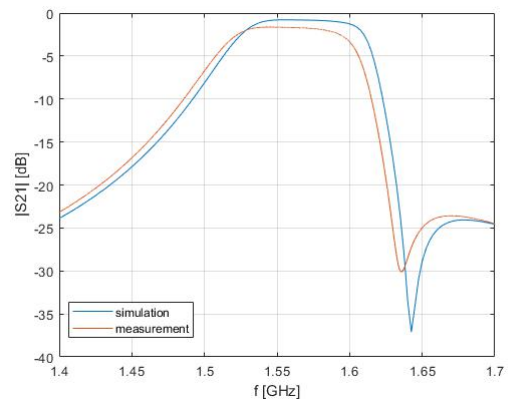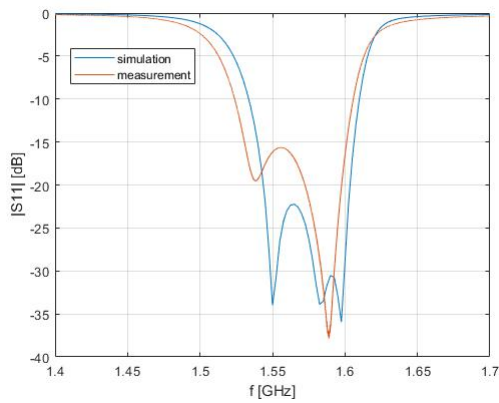This is a passband filter on Isola substrate.


(a) Model from InventSim

(b) Fabricated structure

S parameters

Simulation results were obtained from InventSim, and there are differences between them and measured characteristics. The resonance frequency peak shift of |S21| is equal to 8 MHz. The difference in bandwidths (where |S21|<-10 dB) is 26 MHz. This could be effect of calibration process used in measurement, because connectors were not included in calibration procedure. To solve this problem, measurement with proper calibration has to be done.

3 Antenna deformation
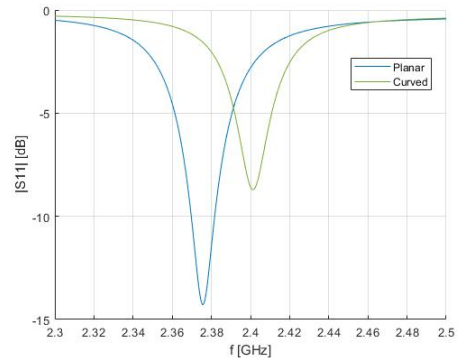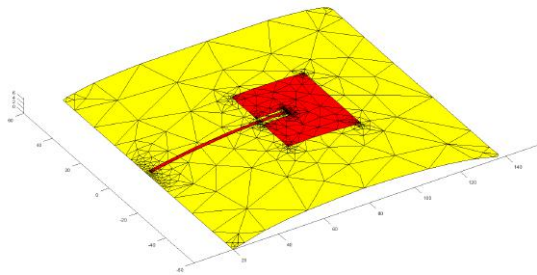
The projection algorithm is improved by involving an additional low order polynomial in projection formula. It results in that, the quality of projection is the same as in previous version of algorithm, but the number of radial basis functions to achieve it is smaller.

The antenna was projected onto side of a cylinder. Then, the curved structure was simulated in InventSim and result was compared with S parameter of unbent antenna. Both characteristics should differ only slightly. In that case the resonance shift is 25 MHz and value of |S11| differs by 6 dB, because mesh density of model was very low to reduce computation time. In order to achieve more accurate results, simulation will be performed with denser mesh.

4 Further work

The divergences between simulation and measurements in some results have to be investigated. The next step will be focused on simulations of curved structures and comparing the results to the reference data. The method of fabricating the curved antennas have to be found.

References

[1] R. Lech, W. Marynowski, A. Kusiek, "Finite ground CPW-FED UWB antenna over the metallic cylindrical surfaces", Progress In Electromagnetics Research, Vol. 140, pp. 545-562, 2013.

[2] R. Lech, W. Marynowski, A. Kusiek, J. Mazur "Coplanar Waveguide-Fed Broadband Microwave Devices with (or without) a Thin Dielectric Substrate for Use in Flexible Electronic Systems", International Journal of Antennas and Propagation, vol. 2014, Article ID 379379, 9 pages, 2014.