12x12 MPA Array Covered with Flat Radome

This application note presents how to use WIPL-D Pro as an efficient tool for full 3D EM simulation of arrays of microstrip patch antennas (MPA).

MPA Array

The array consists of 12x12 elements. Using the symmetry of the problem, problem can be reduced to quarter of the full EM simulation by reducing the modeling and simulation to portion of 6x6 elements. The feature is called Symmetry.

Array is built on 0.5 mm thick FR4 substrate (Er is equal to 4.3 and TgD is 0.02). Spacing between elements is set to 1.5 wavelengths (calculated in dielectric). Operating frequency is 4.4 GHz. Size of the patch is chosen as 0.45 wavelengths for both length and width. Feeding point is moved from the center along the length of the patch for 0.3 x patch length. The array itself is presented in the figure below.

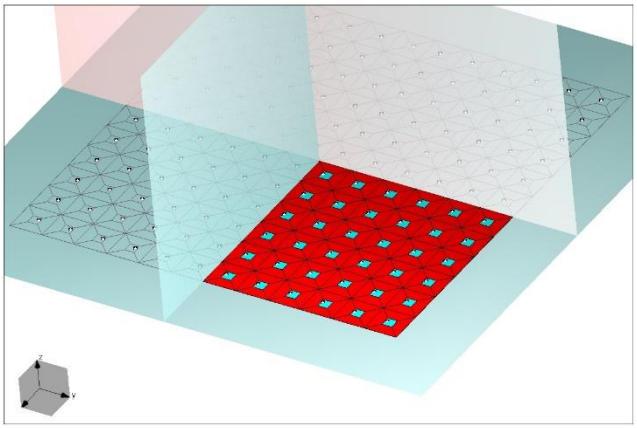

Figure 1. MPA Array Model

In the figure above, patch is placed over infinite PEC plane but it will also be placed above the finite size ground (under the surface of the dielectric). The reasoning behind this is to reduce EM simulation requirements.

In order to obtain correct result, automated edging of all elements is applied via the feature called Edge. The model with finite size and infinite size PEC require 17,508 (simulation time 92 sec) and 10,308 unknowns (simulation time 54 sec), respectively.

The PC used for simulation is regular inexpensive desktop computer equipped with inexpensive GPU card and increased amount of RAM:

Intel i7 7700 CPU (3.6 GHz), 64 GB RAM, Nvidia GeForce GTX 1080 GPU card

Radiation pattern of the array in two principle planes is shown below in Figs 2-3.

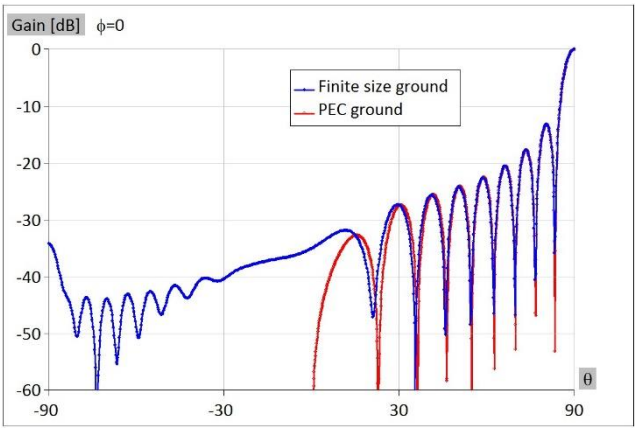

Figure 2. Array Radiation Pattern, Phi 0 degrees

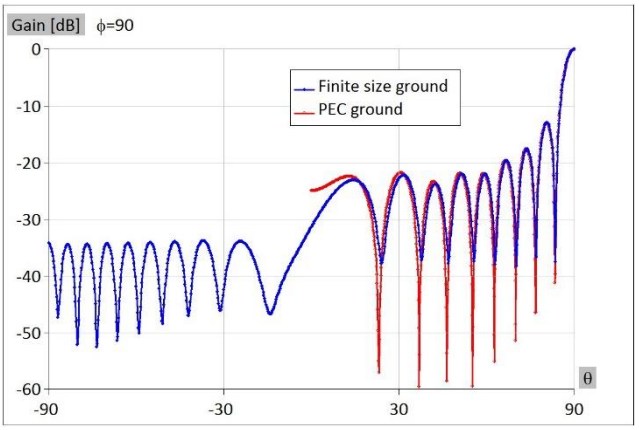

Figure 3. Array Radiation Pattern, Phi 90 degrees

The next step was to cover the antenna with dielectric radome (surface of the radome was flat). Finite ground was extended slightly to 600x600 mm. Radome thickness is 2.3 mm (Er=3.2, TgD=0.025). The radome was placed 0.5 wavelengths away from the surface of the array (calculated in array substrate).

Radome shape is illustrated in the figure below.

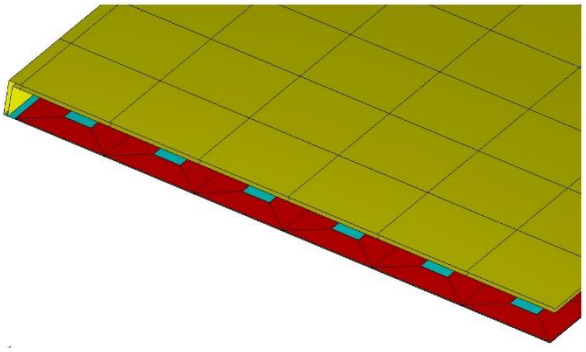

Figure 4. Array Covered with Radome

The influence of the radome is illustrated in the following two figures.

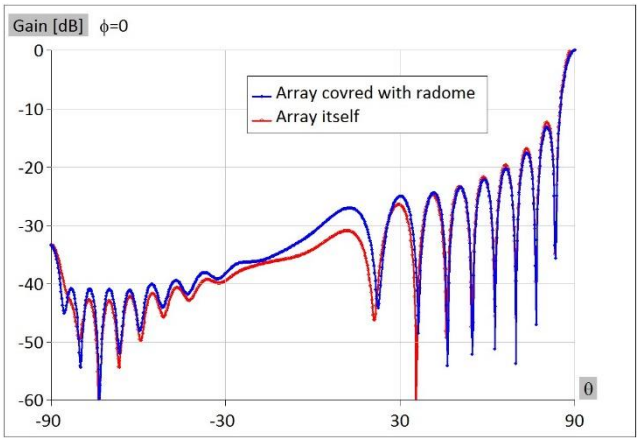

Figure 5. Radome Influence Phi 0 degrees

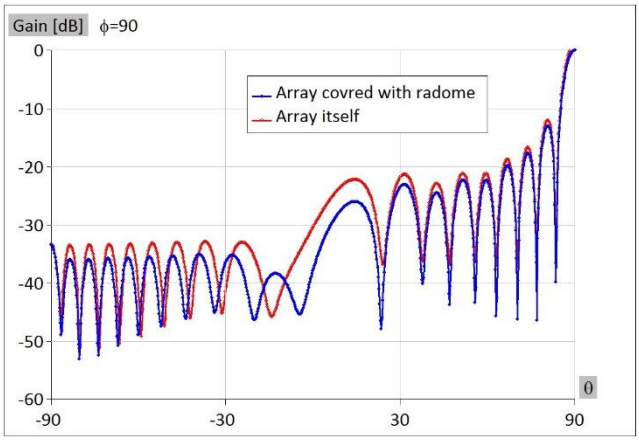

Figure 6. Radome Influence Phi 90 degrees

Final number of unknowns for radome and array is 24,395 and simulation time is 149 seconds.