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INVESTIGATION OF PLANAR ANTENNA BY USING THE FEKO

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The calculation algorithm of planar antenna by using the FEKO is shown. The principle of the planar antenna and the basic stages of modeling are considered.

Keywords: planar antenna, the program FEKO, pattern, the input impedance.

Introduction. Planar antennas occupy an important place in modern antenna systems. Their development is described in numerous references and they continue to improve. Planar antennas are widely used in modern electronic equipment due to their compactness and constructive combination with electronic components of devices. As an example, of wide spread use of planar antennas are cell phones, communication systems, GPS receivers, etc. At antenna design the software HFSS [1], CST [2], FEKO [3] and others are used. In all cases it is important to obtain accurate simulation results as well as simulation at electrodynamic level can provide accurate results and replace intermediate experimental verification. Often designers in order to obtain the reliable results calculate the antenna using different software.

Formulation of the problem. Designer of antenna devices should know modeling software packages (HFSS, CST, FEKO etc.). In order to obtain good results of antenna simulation, the designer should not only be fluent in theory of antenna systems, build a proper construction of the antenna, choose materials fabrication and set the necessary parameters to correspond the purpose and goals of antenna system. Designer must also accurately show the knowledge in mathematical modeling. This paper describes the main stages of modeling planar antenna in the program FEKO, which are recommended for students within the curriculum.

Theoretical basis. Patch antennas (planar antennas) have advantages such as technological, high accuracy of reproduction of antennas size and electrodynamic characteristics, constructive simplicity, small size, light weight and low cost, etc. Of course, there are some disadvantages of planar antennas. For example, a small electric strength, and due to it the low level of allowable power, narrow bandwidth, the difficulty in the design of devices with the change of parameters of patch elements. These shortcomings can be removed by a variety of design solutions, which gives space for engineering.

The use of planar antennas are varied. Conventionally, they are divided into these classes:

a) dipole antenna with different methods of excitation;

b) the slot antennas with different methods of excitation;

c) two-dimensional flat – resonant, non-resonant, with distributed excitation;

d) frequency-independent and multifrequency antenna;

e) the active (with non-linear elements).

Mainly patch antennas are used at frequencies from 100 MHz to 30 GHz.

For explaining operational principle of the patch antenna let's consider the model of rectangular radiator (fig. 1).

Radiating element 2, whose length is L, and the width is b, is powered by stripline 1. Radiating element and a strip are made of metallic foil and put on dielectric layer with the thickness d. The bottom side of the dielectric layer is closed by metallic screen 4. It is possible to consider that the element 2 is a segment of stripline. Therefore, the wave that comes from the feeder 1 propagates along the line 2, keeping it's structure with uniform distribution in cross-section (along the axis $0x$). Incident wave reflects from open end (right side of element 2) and resultant intensity changes only along the axis $0y$.

Modeling stages. Modeling of planar antenna in FEKO program can be divided into the following steps:

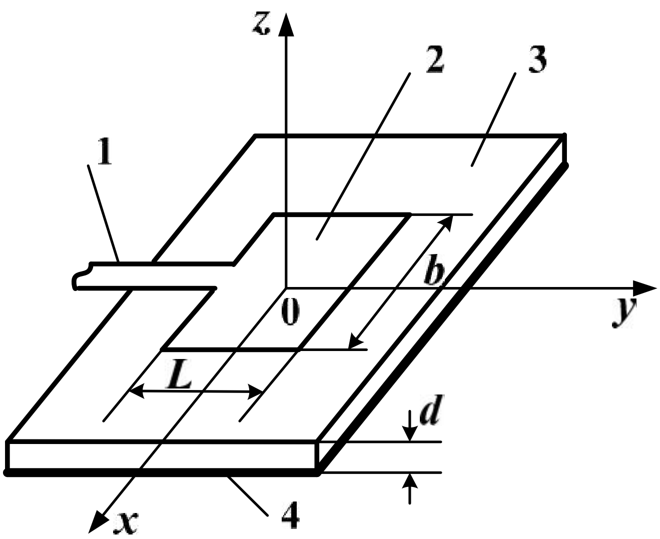

Fig. 1. Model of rectangular patch radiator

1. geometry drawing;
2. creation of voltage source;
3. the initial data;
4. output of calculation results.

Let us consider these steps in detail.

Stage 1 includes the creation of dielectric substrate and metal plate (depending on the antenna design, the metal coating may obtain a different form). At this stage, the geometric dimensions of the dielectric substrate and a metal plate are set. In order to establish the properties of the substrate as a dielectric material it's needed to create a new environment and select it in the properties of the interior part of the box.

A very important moment during development of designs which combine the dielectric and metal components, is their correct division into triangular segments. This component should be selected and combined by command *Unit*. This is a required element in the design.

The result of stage 1 design is shown in fig. 2.

Stage 2 – the creation of voltage source. First, the wire line is created, which serves for further installation the voltage source. It is necessary to specify the place of voltage place location. At first the wire beginning is selected and the voltage source is chosen. The source will be installed in the port. For the grid representation of model it is necessary to unite the line port, a dielectric substrate and a metal plate.

Stage 3 includes setting properties of the antenna surface and the choice of operating frequencies.

To select the antenna surface you must turn on selection bevel. The surface type is chosen with help command *Perfect electric conductor*. Properties for the lower surface of the antenna are set in the same way.

For a frequency at which calculations of the antenna characteristics will be made in frequency paragraph in the project tree, select *Continuous (interpolated)* range and set the frequency value. For example, the lower frequency is 2,6 GHz and the upper is 3.1 GHz.

Stage 4 – output of calculation results – consists of several steps.

Step one – choice of coordinates. In order to find antenna parameters in a far field of radiation it is necessary to choose parameters of the far field (command *Request far fields*). In the window that appears, choose the breakdown in elevation and azimuth, and thus the point at which to calculate the parameters of the far field.

Step two – creation of the grid. The entire antenna design must be covered with grid. For 2 longer edges of the metal plate should be individually set the size of the cells (*Select edges*). When a local partitions are set, the geometry can be combined (*Create Mesh*).

Step three – start of program FEKO (*Run FEKO*).

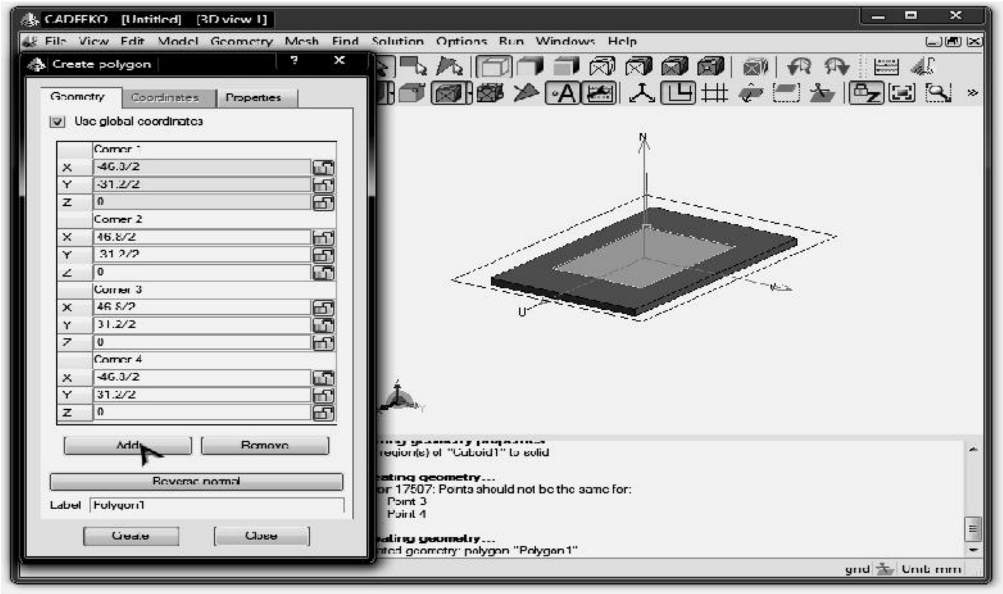

Fig. 2. Creation of metal plate

Click *Add a source data graph* in window interface POSTFEKO and obtain diagram of input resistance. Check the box *Use continuous frequency* and in *Part* select *Real*. In order the diagram of imaginary component, press *Copy series* and in *Part* select *Imag* (fig. 3).

Three-dimensional image of patch antenna pattern (fig. 4) can be viewed by clicking on the left panel *View 3D Far Fields* and tick the boxes *Use continuous frequency* and *Normalize*. If necessary, the two-dimensional patterns in Cartesian (fig. 5) or polar (fig. 6) coordinate systems can be obtained.

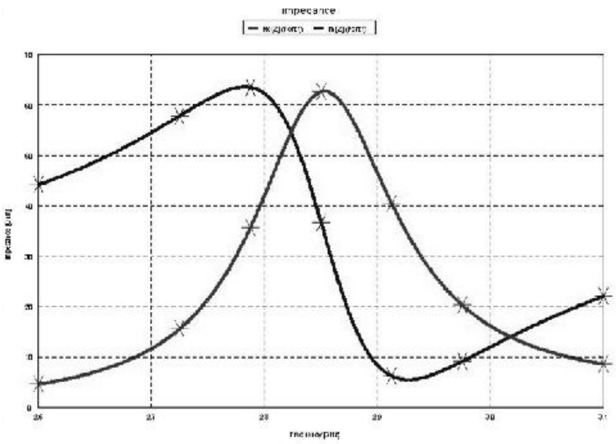

Fig. 3. The frequency characteristics of the input impedance of a planar antenna

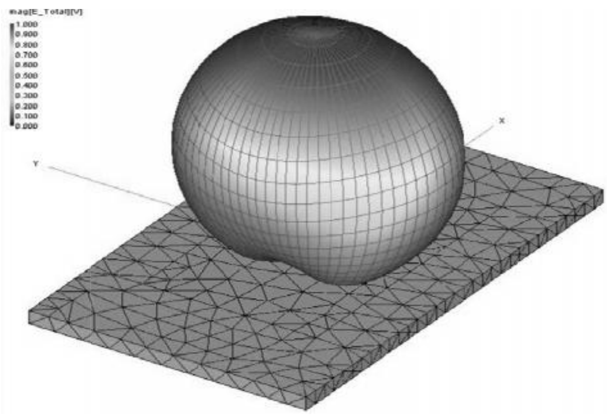

Fig. 4. Three-dimensional pattern of patch antenna

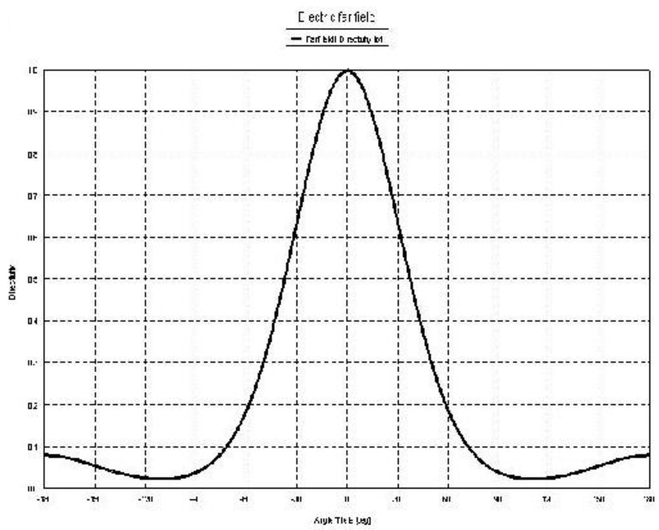

Fig. 5. Two-dimensional pattern of patch antenna in Cartesian coordinate systems

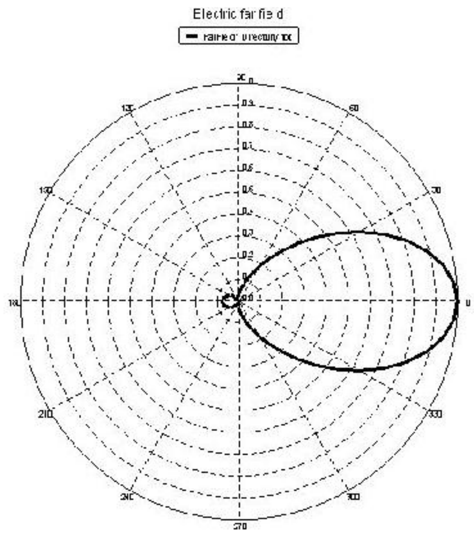

Fig. 6. Two-dimensional pattern of patch antenna in polar coordinate systems

Conclusions. Simulation program FEKO is a good means for investigations of planar antenna parameters and characteristics at changing antenna geometry, substrate, est. and for obtaining required result.

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Дослідження планарної антени за допомогою програми FEKO

Наведено алгоритм розрахунку планарної антени за допомогою програми FEKO. Розглянуто принцип дії планарної антени та основні етапи моделювання.

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Исследование планарной антенны с помощью программы FEKO

Приведён алгоритм расчёта планарной антенны с помощью программы FEKO. Рассмотрен принцип действия планарной антенны и основные этапы моделирования.