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THE ACCOUNT OF INFLUENCE STRAY PARAMETERS AT THE ANALYSIS OF MICROWAVE DEVICES

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In article there are new possibilities of the Applied Wave Research ACE software that were demonstrated. The examples of possible using for simplification and optimization of the designing were given. Using this technologies enlarges the velocity of the analysis in comparison with usual the electronic modeling methods. This method can be used for modeling microwave device.

Keywords: electronic modeling, ACE technology, frequency-dependent scheme, topology trace, microwave device.

Introduction

Using standard facilities of designing in certain events the problem arises: prototyped giga hertz analogue or gigabit digital payments answer the set characteristics, and the experienced model absolutely does not work.

The same problem arises at modeling of difficult interconnections in a range of ultrahigh frequencies (UHF). Here because of high degree of integration of the schemes it is impossible to present in the form of usual RLC equivalent circuits, therefore it is necessary to use electrodynamics modeling. From this the economic inefficiency of the given device follows.

In package Microwave Office 2007 Design Suite of company Applied Wave Research (AWR) there is a new technology of extraction equivalent circuits, which will increase economic efficiency of the creation of the modern telecommunication equipment. Module ACE application (Automated Circuit Extraction) reduces time of modeling of difficult configuration conductors to several second. Also the module allows to model interconnections at the first design stages, where there is a possibility to define an error and to correct them without use of other facilities. Then designing process is facilitated and the developed equipment will manage more cheaply [1].

Extraction equivalent circuits in Microwave Office it is made by means of the topological models. The structure is divided into some parts, and then approximated by means of is defined the models. Topological features are thus considered. Such methods approaches for area of UHF, in which usual scheme technical models do not provide qualitatively modeling conductors, and for high density printed-plate, where for close located conductors superficial effects are shown.

Given ACE technology can be used both for digital, and for analogue projects, providing speed several times more in comparison with usual electronic modeling (EM) methods, since more effectively makes splitting and has in the library the expanded set of models of the distributed and multirelationship lines. Here are applied the scheme technical elements, modeled with use optimized EM of the calculator, and it leads more than high action.

What is difference between the ACE technologies from traditional technologies?

The basic achievement of ACE technology consists in a combination usual scheme technical the approach and the distributed models of geometrical elements, which it is good enough, recommended it in UHF projects.

As at modeling it is necessary to define very define ways of currents of return, and a bottom-frequency technology of an extract of schemes lower concept "earth" and ways of currents of return define directly developer. Therefore the data turns out or not absolutely exact, or in general unrealistic. The ACE technology allows estimating correctly ways of currents of return,

automatically makes dynamic change if necessary for the same integrated scheme for various configurations of a substrate.

The ACE technology allows creating frequency-dependent scheme technical models, without solving the equation of Maxell, and from geometrical model of the set structure. As an example we shall analyze the connected lines located on different layers depending on length and width, a thickness of layers and a different arrangement of separate segments of lines rather each other (fig. 1).

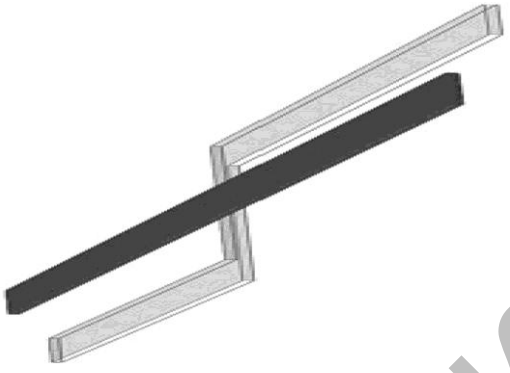

Fig. 1. Topology of the connected lines

In system the certain list of connections of the equivalent scheme, where take into account every possible interactions between conductors, i.e. heterogeneity, relationships of between lines, transitive apertures and independent segments of conductors is developed. As the decision becomes by means of simplification of complexity of structure, speed increases more than in 1000 times in comparison with 2D or 3D methods of the direct decision of system of the equations of Maxwell. Such simplified structure it is possible modeled by means of optimized the EM calculator.

Depending on correctness of a choice of criteria of selection (the maximum distance on which an interconnection, the minimum length of a line, etc.) and comparisons of models to structures defined accuracy of the decision is searched. These models can be used further at modeling in frequencies and time areas by means of other programs, such, as, for example, HSPICE [2].

Advantages of the ACE technology

1. The equivalent scheme is made out as the UHF project: all interconnections are described, in each of models parameters (lengths, corners etc.) are set according to topology, at the analysis as a first approximation are not considered stray communications and parameters. As in process designs it is necessary to enter for the account of all stray communications additional segments conductors and it essentially influences primary results.

2. The scheme in the form of the distributed elements is not described, and the topology which assumes a great number resource capacious iterations EM modeling. Expected that stray parameters of the passive metalized elements of topology not a render of essential influence on scheme work. In this case the scheme does not contain models with portioned parameters. The quantity of considered stray communications increases, the preliminary analysis passes faster.

AWR ACE program simplifies representation of the microwave scheme in the form of strip and micro strip objects, automates algorithm of conductors taking into account all spottiness.

As the primary goal of the elements which have remained on the simplified scheme consists in exact representation of geometry of conductors, the scheme remains still encumbered. And if in topology will be also the connected elements, it will be very difficult to describe it by means of models of the connected lines as it is difficult to present where there is any communication.

Applying iNet technology which was developed by company AWR, it is possible to simplify and automate topology of conductor, representing it on the scheme in the form of the simple communication line. For this purpose we simply choose "rubber" communication on topology and we start it to trace (fig. 2), clicking on communication between two components and specifying

characteristic points of connection vertical and horizontal conductor segments. The width of a conductor is automatically traced most system. If transition to other layer to a conductor transitive apertures (fig. 3 will be added) is carried out.

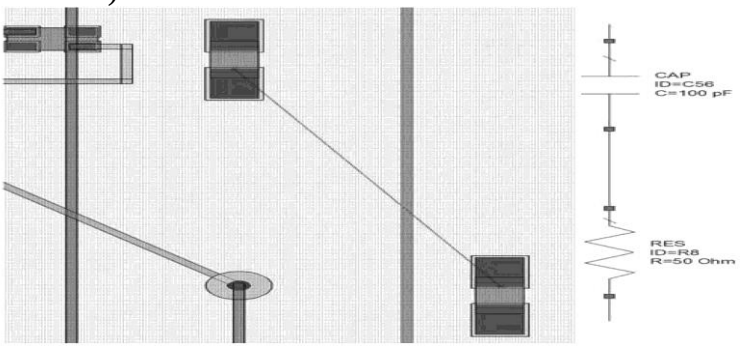

Fig.2. Type of communication on the scheme and not dissolved topology

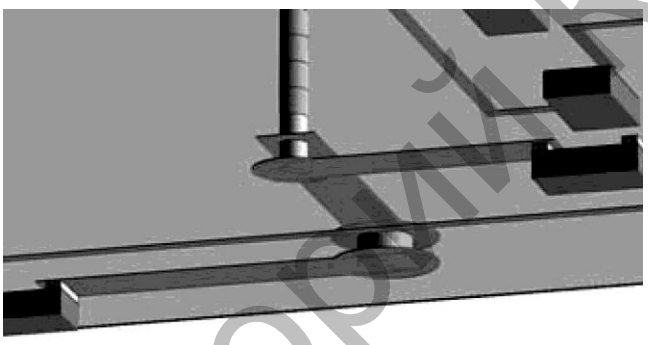

Fig. 3. Type of communication after topology trace

Parametrical cells in which options are applied specific DRC, I different depending on manufacturing techniques (RFIC, MMIC, LTCC or usual printing plate), generate transitive apertures. If to compare the detailed description of topology by means of separate models of lines, bends, crossings and connections and by means of use the iNet elements we will receive economy of time in 10 times big, and in comparison with manual trace of conductors to addition of transitive apertures – in 2 times [3].

The ACE method is universal and can be used for any variant: for separate lines, for all projects (fig. 4), for any intermediate variant. It also it is possible for the use and at any design stage of the scheme. Here it is not necessary to have completely finished the scheme and topological the project, separators of a power supply or a management line it is possible analyzed separately, and then together with remained most parts of the project. For acceleration process modeling of definitive verification of the project all ACE structures can be analyzed by means of any popular EM the calculator of the general purpose connected by ambience designs through interface AWR EM Socket. As a result the operating time over the project is considerably reduced.

One more advantage of ACE technology is a flexibility of used models. To reach necessary accuracy and speed of calculation, it is possible to carry out any way transformation of geometrical structure to the scheme with certain models in software ACE.

The maximum gain in time turns out, if in the project there is no model, requiring application built in the EM calculator. Here it is necessary to use usual analytical models of the micro strip and strip connected lines.

The ACE program to for modeling of the connected micro strip lines of any configuration uses a special set of models, and it raises accuracy of calculations, but lowers speed. By means of the built in quasi static EM the calculator a problem dares in cross-section section on one frequency, and then the decision is distributed on all range of frequencies. By means of is given the technology it is possible to receive very exact decision if to use a set of models which apply a method of final elements to the decision (FEM) on each frequency of a range.

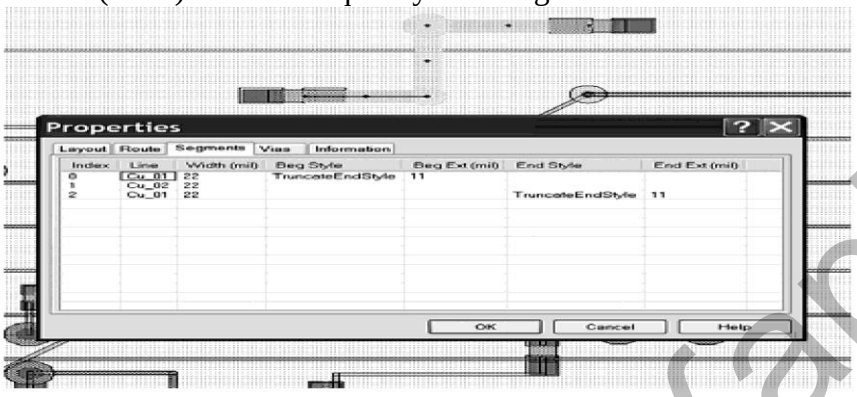

Fig. 4. Adjustment of parameters of transitive aperture for the communication, presented by means of iNet technology

Some geometrical structures are processed by more simple methods. It can be places of connections of conductors or heterogeneity which can be described with the help analytical models. At insufficient accuracy of the decision it is possible to address to X-models which are received on the basis of interpolation of tables of the data for certain values of key parameters and types dielectric certain structure.

For interlaminar connections it is possible to use files of S-parameters, which are received by means of measurements or modeling for any type of apertures. The ACE program defines structure and the set of S-parameters, and function iNet correlates to it corresponding allows modeling various types of transitive apertures for any combination of layers. On the basis of the geometrical data about the form of contact platforms, diameter of an aperture and a configuration of a stack of layers it is possible is use and analytical models of interlaminar transitions. If not to set a set of S-parameters or analytical model the program to ACE will use simple RLC model.

If to use more exact set EM models at decomposition analyzed EM structures on separate elements of the small size speed of work of software ACE increases in thousand times. As an example it is possible to specify that calculation of a simple configuration of the parallel conductors placed on sixteen layers to the printed-plates from material FR4, shown on fig. 5, with the help 3D systems EM of modeling on the basis of a method of the moments (MOM) in 200 frequency points proceeds 4 hours, and by means of software ACE is executed less than for 10 seconds.

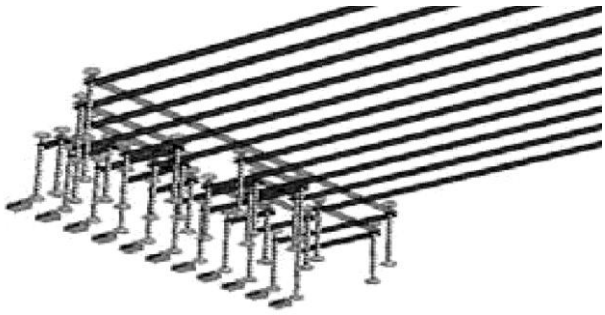

Fig. 5. Structure of 16 layers FR&4

As in process of project approach to end the raised accuracy is required to a modeling fast extraction stray parameters here it is not comprehensible. As the program to ACE uses the interpolated X-models and EM models with built in optimized EM calculators (model of the distributed elements) necessary accuracy of modeling for higher frequencies can be provided only at late design stages. For instance, inaccuracy of modeling of structure from the connected micro strip lines, shown on fig. 6, does not exceed 0,1 % in a range of frequencies from 0 to 20 GHz (fig. 7). Analysis time thus not exceed several seconds.

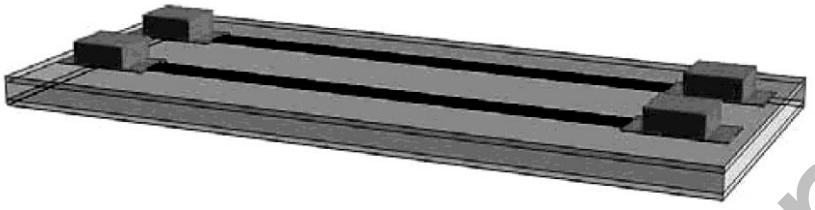

Fig. 6. Test structure of two liaison lines on a four-layer plates

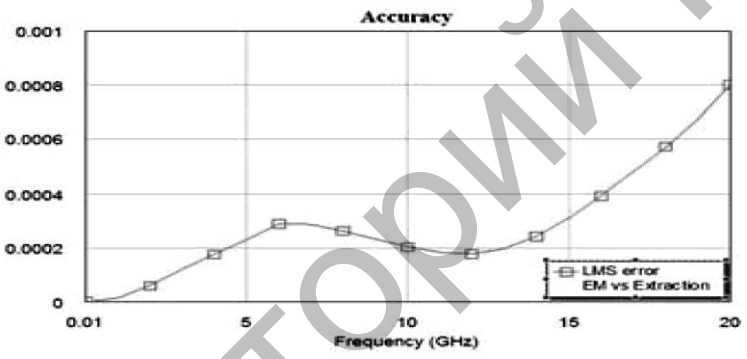

Fig. 7. Inaccuracy of modeling of the structure, shown on fig. 6

By means of the ACE technology it is possible to solve following problems:

1) Working out of topology of microcircuits on the basis of silicon, arsenide of gallium, etc.;

2) Modeling of projects where the topology has no initial detailed description of all of stray communications;

3) Modeling of projects where parameters of elements dominate over parameters of communications between them [4].

As on frequencies above 1 GHz parameters of interconnections start to influence both on features separate elements, and scheme functioning as a whole before designing it is necessary to consider it. By means of the ACE technology can consider all stray effects both quickly and precisely to a modeling work of the scheme taking into account a topological configuration of all connections between elements in process of their addition. In comparison with modeling by means of files of S-parameters directly before generation of masks this method is more preferable. On fig. 8 showed an example of interlaminar transition in which software ACE has revealed two stray of communication (fig.9). As in amplifiers of capacity or in reception paths for mobile equipment it is required - to consider their dimensions configurations of conductors in topology of hybrid modules have certain restrictions. Therefore for calculation of a combination of communications between signal paths, lines of a power supply and lines of management of these devices it is expedient to use the ACE technology.

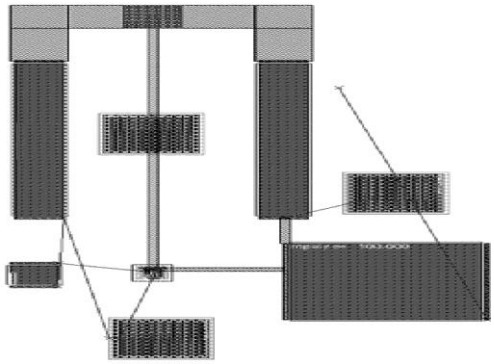

Fig. 8. Topology of interlaminar transition on an initial design stage of a crystal

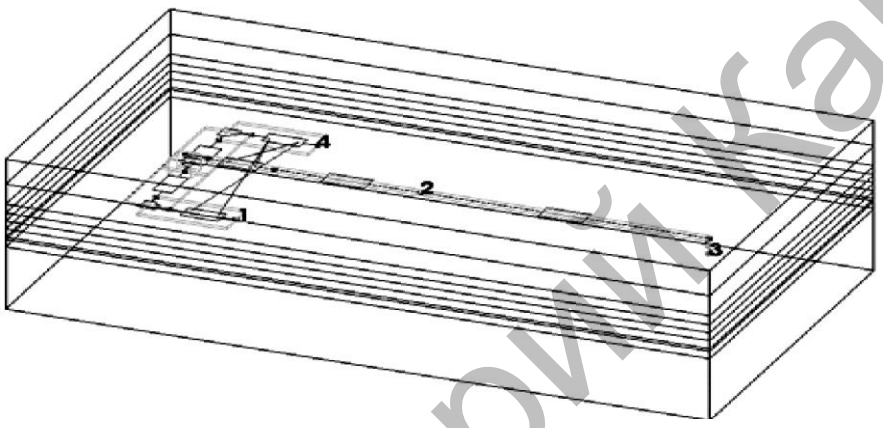

Fig. 9. Extraction stray communications of interlaminar transition by means of the ACE technology

On fig. 10 is brought example of the amplifier of capacity, which for the greatest coordination with correspondence has inductance of an order of several nanohenry is resulted. For this connection it is possible to develop special ACE model, to estimate its parasitic communications with the located operating lines (fig. 11) and to consider their influence on value of total inductance (fig. 12).

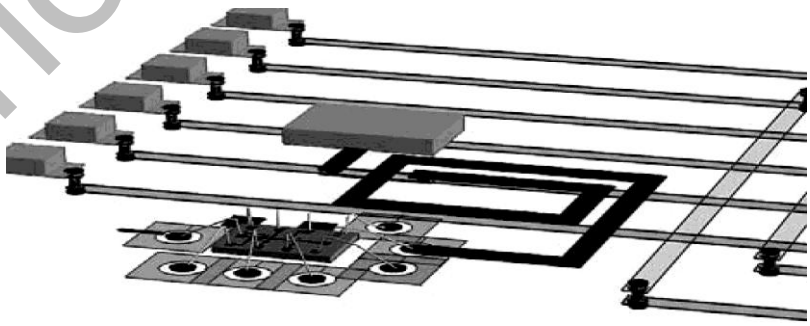

Fig. 10. Topology of the amplifier of capacity with the planar coil of inductance

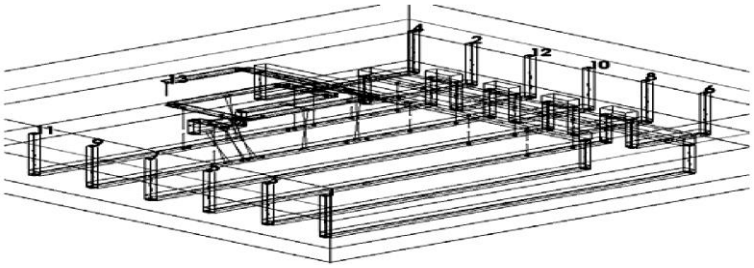

Fig. 11. Stray communications of the coil of inductance with management lines

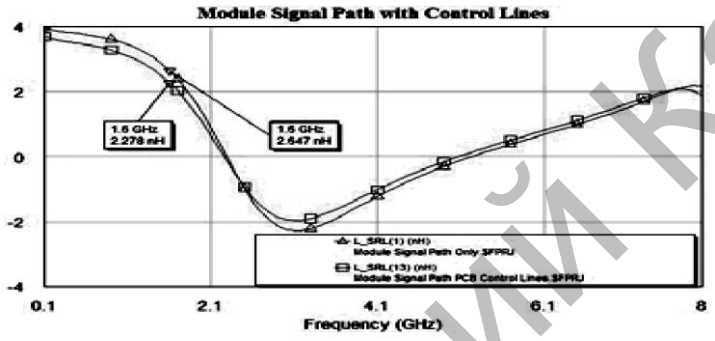

Fig. 12. Influence of lines of management for value of inductance of the coil

The EM analysis of the multilayered printed-plate is very much resource capacious a problem, especially when in a stack of layers of a different thickness from different materials with unequal value of dielectric permeability are used. Therefore by working out of printed-plates expediently use to the ACE technology. For example, on fig. 13 is shown the sixteen layers payment which signal pro-water-transport workers are on two top layers, and at once under them is located continuous the earth layer of metallization serving the screen from lines of management, laid on 14 and 15 layers.

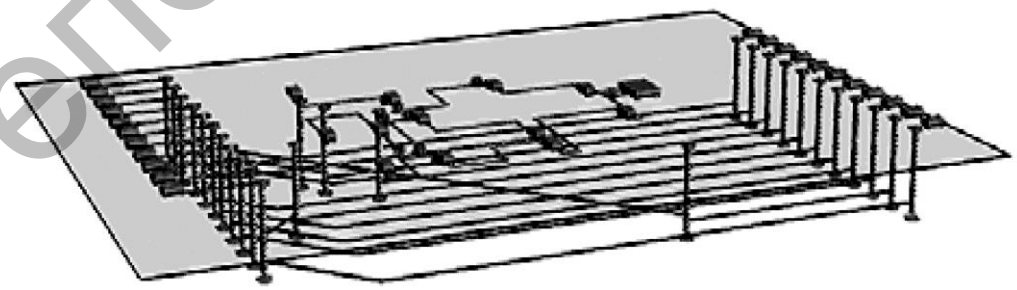

Fig. 13. Example of screening of signal conductors by means of a metallization inside layer

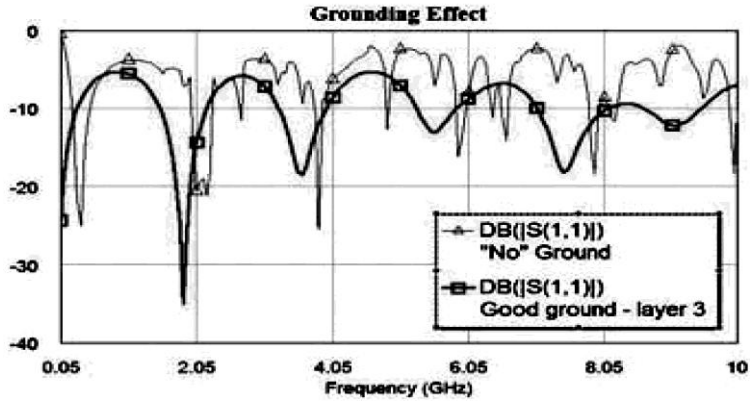

Fig. 14. Influence of management lines on value of inductance of the coil

Interlaminar transitions are formed of the through, deaf and latent transitive apertures. On fig. 14 is shown frequency dependence of returnable losses of an entrance chain of the coordination at presence an ear thing layer and without it. It is the main advantage of the ACE technology [4].

References:

1. *Miracco Ted A., Nakamura Lloyd, Edwards Malcolm*. Simulation and Modelling Techniques for Compact LTCC Packages, materials of company AWR.
2. *Versleijen Martin* Design Technology Challenges for RF Modules. // Proceeding of International Microwave Symposium. - 2003. – p.10.
3. *Bandler John* Design Optimization of Interdigital Filters Using Aggressive Space Mapping and Decomposition. / IEEE Transactions On Microwave Theory And Techniques. - 1997, **Vol. 45** No. 5, p.p.5-7.
4. *V.V. Lipaev* Institute of system programming of RAS. Standards, regulating life cycle of difficult complexes of programs of informational systems. / Electron magazines «Engineering Educate», 2005, №8, p.13.