A High Power Planar Triode Oscillator Designed By Using FEM Modeling

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Abstract

The key requirements for a power source used in power applications are efficiency, low cost, power, and reliability. Here, a planar triode which is connected to a resistor RL or to two parallel plates as its load for heating the woods and other heating applications (Figure 1). The quality of the heating process is highly dependent on the uniformity of EM field distribution.Therefore, the two parallel plates as a cavity is a good choice for creating a uniform EM field inside the cavities. The computer models to predict device behavior before performing an experiment is needed. These models reduce the number of experimental revision. We note that traditionally design of microwave heating systems is done in large measure by empirical means. A method for identifying vacuum tube spice model parameters using computerized optimization was presented by [1]. In this work, inter-electrode capacitance, grid current, etc. cannot be considered. In this summary, we model a planar triode and its load by FEM using COMSOL Multiphysics 3.5 software linked to spice circuitry to design an oscillator. The principal theory of the vacuum tube and the space charge has been discussed in details in [2]. Here, we apply a 2-D finite elements time domain method to design a planar triode. In this analysis, we present the triode and the load shown in Figure 1, which are separately analyzed by FEM and connected through a Spice circuit. In the case of the triode, the planar electrodes are assumed to be semi-infinite in extent to avoid edge - effects and only the variation in x and y direction needs to be considered. This work deals only with the triode and transposes the solution of fields into the knowledge of an equivalent conductivity at each point x and y which is stored in a text file. In this study, we apply as boundary conditions the value of the conductivity on cathode, grid and anode. Here, the conductivity plays more or less the same role as characteristics curves. Then, the Spice circuit is linked to the FEM descriptions of the triode and the load. Now, we can design an oscillator using this planar triode as an active component, and we chose a colpitts oscillator (Figure 2). The first thing to do in the design process was to obtain the oscillation with spice simulator. In order to optimize the output power oscillation a long process of simulation has been performed for choosing the final component values of the colpitts oscillator circuit. We demonstrate on Figure 3 the voltage oscillation on 50 ohms load. We can notice on this graph that the amplitude of output signal is about 3500 V, which has an output power of 122.5 KW at a frequency about of 13.58 MHz. Figure 4 shows the voltage signal between grid and cathode of the planar triode. We can deduce from Figure 3 and Figure 4 that this active device gives a voltage gain of 90. This summary proposes a model to design a new generation of high-power planar triode and its load by FEM linked to spice circuitry to design an oscillator using COMSOL Multiphysics software. In contrast to empirical methods, the proposed method offers a strong performance for

design and conception of high power generator and also, for observing the electrical characteristics of the load during of heating process.

Reference

1. Mithat F. Konar, “Vacuum tube parameter identification using computer methods”, Biro Technology, 81 W. Golden Lake Road, Circle Pines, MN 55014 USA, 1998.
2. John Allison, ”Electronic engineering materials and devices”, McGRAW-Hill Book Company, 1971.

Figures used in the abstract

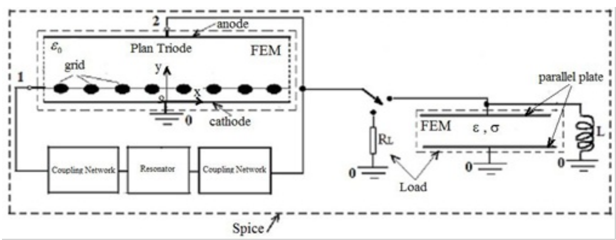

Figure 1: Planar triode with its load.

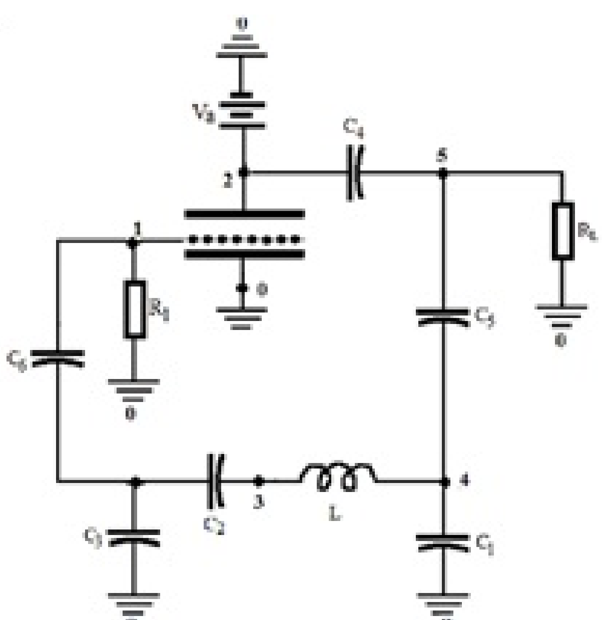

Figure 2: Colpitts oscillator circuit.

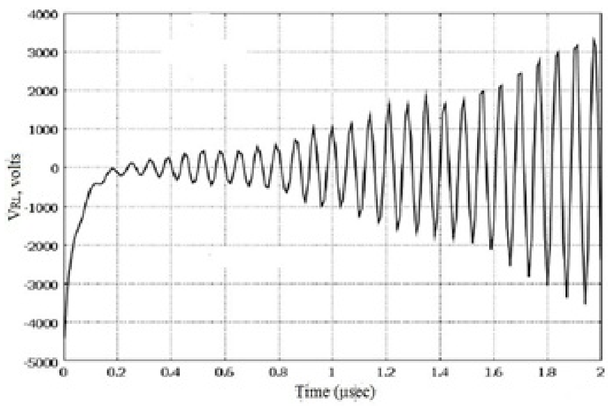

Figure 3: Voltage signal on the 50 ohms load.

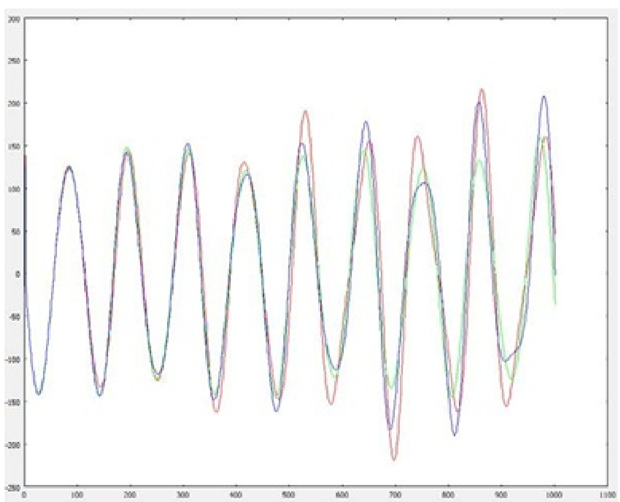

Figure 4: Current in the capacitance load for different values of the permittivity.