PhD Thesis Abstract

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Title: „Solid state, resonant, high voltage pulse generator for non-thermal plasma generation"

Presented dissertation is focused on the design and development of a modern, high voltage pulse generator for supplying non-thermal plasma reactors. This specific kind of load is characterized by high variability of it's equivalent circuit parameters and possible short circuits of its electrodes during operation. Nonlinear, capacitive nature of this load causes high values of reactive power flows between the load and the output circuit of high voltage power supply. High amplitude and short rise time of applied voltage pulses in combination with even smallest values of parasitic elements of the power supply are sources of high frequency and high energy electromagnetic fields which usually means EMC (ElectroMagnetic Compatibility) problems.

Main idea behind this work is the proposal of the high voltage power supply topology that will be insensitive to wide range changes of load parameters and short circuits in the load. This feature also increases the universality of proposed topology, which will be able to supply different types of non-thermal plasma reactors; both DBD (Dielectric Barrier Discharge) reactors and barrier-less PCD (Pulsed corona Discharge) reactors. Resonant type of operation and unique transformer design results in significantly reduced values of external magnetic fields generated by the high voltage power supply device.

In the introductory chapters of dissertation the topic of non-thermal plasma are discussed and various types of cold plasma reactors as a loads are voluminously presented. a comprehensive review of different methods of supplying non-thermal plasma reactors and the topologies of high voltage power supplies are analyzed along with a discussion of their properties and specifications of currently used devices made on their basis.

In main part of the work a solid state topology of high voltage power supply is proposed that includes following, general features: simplicity, versatility and possibility to cooperate with capacitive loads characterized by high variability of parameters and occurrence of short circuits. In following chapters the details of subsystems of proposed topology are discussed – the high efficiency resonant capacitor charger as the circuit that cumulates energy for pulse generation purposes and output pulse shaping unit that utilizes the principle of Tesla coil transformer and natural resonance of the circuit created by the transformer's inductances and a capacitive load. Principles of operation of proposed circuits and presented and analyzed: used electrical models, analytical description, simulations and their results. Performed simulations include magnetic field analysis and comparison of proposed high voltage transformer designs with exemplary constructions used to discuss advantages of proposed high voltage transformer construction..

In order to practically verify proposed topology a prototype was designed and build. The results of laboratory tests and two practical application of the prototype are presented in the final chapters of the work. Acquired simulated and experimental data proves that proposed topology meets the initial assumptions and requirements for high voltage power supplies for non-thermal plasma technology.