Simulation of a CDI digital ignition module

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Abstract.

The article focuses mainly on the assumptions made in order to conduct a simulation of the CDI ignition system in such a way so as to assess the possibilities of its optimization with respect to the following aspects: energy efficiency, manufacturing costs and reliability.

I. Introduction

The CDI (Capacitor Discharge Ignition) ignition systems are characterized by the ability to quickly collect the energy necessary for spark discharge that guarantees the ignition of the air fuel mixture. This fact was the basis for the development of multi-spark systems that generate multiple discharges in the period of time needed for a single discharge in the IDI systems and in the ignition systems in which the size of the ignition device plays an important role and in which the small size of the high voltage coil is used.

A combination of the features mentioned above makes it possible to create energy-efficient systems which, balancing on the limit of generating the minimum amount of energy necessary for the ignition of the mixture, consume a relatively small amount of energy from the power source.

II. DC/DC converter circuit

There are many construction solutions of a DC/DC converter increasing the voltage that is used to charge the capacitor that stores energy. Starting from self-excited generators through solutions in which the converter is combined with a voltage multiplier to digitally controlled solutions. A very important aspect for the appropriate functioning of the CDI ignition module is the time needed for the converter to charge the capacitor to the required voltage level.

Considering the parameters and the character of the load, a typical system (Fig.2.1) whose digital control makes it possible to achieve the required capacitor charging time was used to conduct a simulation of the ignition module.

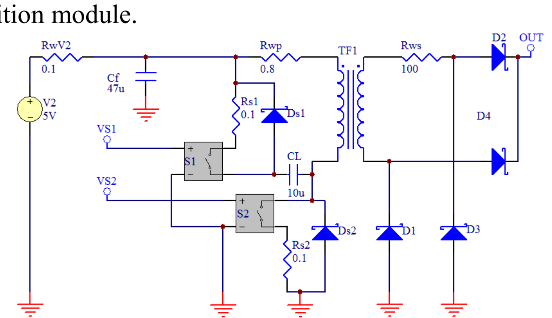

Fig.2.1. A fragment of the simulated system – DC/DC converter

The selection of the appropriate implementation of the control cycle of the S1 and S2 keys makes it possible not only to achieve the appropriate operational parameters of the converter, but also to change them dynamically, controlling the capacitor charging process.

III. Thyristor circuit

The most frequently used element contacting the high-potential capacitor terminal with the primary winding terminal of the ignition coil is the thyristor. It is only in the solutions of the multi-spark type that MOSFET transistors where the only important factor is the switching speed are used. For the purposes of the simulation, a system with a thyristor was used (Fig.3.1), similarly as in the voltage converter digitally controlled by means of a common MCU (rys.3.2).

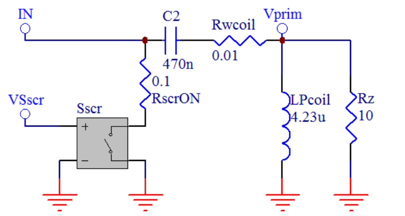

Fig3.1. A fragment of the simulated system – thyristor circuit

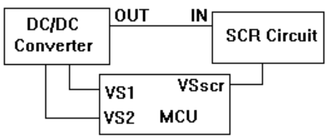

Fig3.2. Block diagram of the connections with MCU

This solution makes it possible to fully control the whole process starting from the activation of the system up to the discharge of the energy stored in the primary winding of the ignition coil in the capacitor.

IV. Conclusion

The simulations of the CDI system constructed on the basis of a microcontroller that have been conducted revealed the possibilities of system optimization. Visible effects were obtained by controlling the voltage to which the capacitor storing the energy was charged. Maintaining the voltage at the constant level for the full rotational speed range of the engine resulted in a decrease of power consumption for low and medium rotation levels, at the same time stabilizing the spark discharge energy for the whole range.

V. Works cited

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