For over 25 years, dynamically progressing miniaturization of electrical devices has been observed in electrical engineering. As a result of this process, many designers strive for their constant miniaturization while building new transducers, while trying to maintain their high power and high efficiency. The process of miniaturization of modern transducers would not be possible if the non-progressive development of new types of magnetic materials as well as the development of power electronics, and above all the associated increase in the frequency of the power source signal. It is thanks to the increase of the frequency value of power source that the designers have managed to develop new types of electromagnetic transducers working with frequencies reaching tens and hundreds of kilohertz (kHz) and even megahertz (MHz). One of the most commonly used electromagnetic transducers that currently co-work with higher frequency sources are HF transformers. One of the most commonly used electromagnetic transducers that co-work with high frequency signals are the high frequency transformers. These transformers are usually powered from higher frequency sources through the use of advanced power supply systems applied in switched-mode power supply, inverters or resonance inverters. In the majority of researches described in generally available literature sources, to analyze the operating states of such systems, simplified circuit models with lumped parameters are used. The benefits of circuit models include lower computational complexity and thus short calculation time; however, due to the number of imposed assumptions, the accuracy of these models remains unsatisfactory - especially for needs of design of systems with HF transformers. In order to increase the reliability of circuit models, some designers use simple two- or three-dimensional field models to determine the parameters of equivalent circuit-model of the transformer. Typically, the parameters of the considered systems are calculated for given current or voltage values and for a preset operating frequency value of the power source. It should be noted that in the case of taking into account of the eddy currents in the magnetic circuit of transformer, the values of lumped parameter of circuit model should be considered as functions of frequency of the power source. The use in HF transformers calculations values of circuit model parameters determined for a single power source frequency may lead to low reliability of the obtained results. Currently, there is a lack of comprehensive approaches and professional engineering software on the market that allows the analysis of HF transformers supplied from higher-frequency sources, in which, beside induced and conductive currents, the displacement currents should also be taken into account. Therefore, it seems necessary to develop new models of HF transformers taking into account the occurrence of the above-mentioned currents in the studied systems. As part of the proposed project, it is planned to develop an integrated computer system for modeling and analysis of operating states of low-power transformers supplied from higher frequency sources. It is planned to develop a computer system combining Author developed software for field computations of the considered systems, Author developed software for determination of lumped parameters of magnetic circuit elements of HF transformers, i.e. parameters dependent of power source frequency and HF transformers operating states analysis software using equivalent Foster and Cauer circuits (so-called multi-branch circuits). The first stage of the work will be the implementation of Finite Element Method (FEM) based software for the determination of the electromagnetic field distribution taking into account the influence of induced, conductive and displacement currents enabling determination of the characteristics describing the impedance of individual branches of equivalent circuit-model of HF transformer as a function of the power source frequency. Then, the author's software will be developed allowing for the selection of optimal values of the HF transformers equivalent circuit parameters based on the obtained impedance characteristics in the frequency domain. For determination of equivalent circuit parameters, the applicant will use methods for determining values and eigenvectors for large systems of matrix equations formed on the basis of FEM. In the work, the methods will be also considered, in which the equivalent circuit parameters can be determined on the basis of singular values. The last element combining the above programs will be software to analyze the operating states of the considered HF transformers.

The developed computer system will contribute to a better understanding of the design and analysis of low-power transformers supplied from higher frequency sources and will enable computing their performance in a shorter time than by using complex three-dimensional field models. The work carried out will contribute to the development of research related to the analysis of steady and transient states of low-power transformers supplied from higher frequency sources, as well as allow for deeper analysis of phenomena in the considered types of transformers, especially during the design process.