ABSTRACTS

of scientific papers of eng. Angel Stanimirov Marinov, PhD submitted for application– posted at ДВ бр. №93/26.11.2019 г - for associate professor in professional field 5.2. "Electrical engineering, electronics and automation" for the course of Power electronics at the department "Electronics and microelectronics", Faculty of "Information technologies and automation".

For the application a total of 50 peer-reviewed scientific papers are presented. A short summary of the papers is shown in Table 1.

Table 1. *Scientific papers*

Type	Number
Papers	50
Papers indexed in the SCOPUS data base	21
Papers indexed in the IEEE eXplore data base	15
Papers indexed in the Web of Science data base	8
Papers with full authorship	6

The presented scientific papers are categorized into three groups – В4, Г7 and Г8. This categorization is based on the "Minimal national requirements"

[Indicator B4] Scientific work for associated professor - publications indexed in internationally recognized databases

[B.4.1.] Dimitrov B., M. Streblau, **A. Marinov**, *An approach for designing a complex inductor-workpiece system for induction heating*, TEM Journal, ISSN: 2217-8309, Vol. 3, No3, 2014, pp. 244-249

The paper discusses an approach for design of a complex electromagnetic system – workpiece-inductor, when developing an industrial system for induction heating. The approach is based on known methodologies and includes digital methods for modeling. Using the approach, allows for inductor design based on the specific size of the workpiece. The approach can be applied in order to obtain uniform thermal filed and to improve the quality of the process of heating while increasing energy efficiency.

The suggested approach is presented graphically, where its execution includes several well defined steps: (1) Input of work data; (2) Selection of the construction of the system workpiece-inductor; (3) Initial design of the system workpiece-inductor; (4) Development of an electromagnetic model of the system workpiece-inductor; (5) Synthesis of a multi-physical model of the system workpiece-inductor; (6) Verification of the results from the model using an experiment.

Each step is described in details as equations and dependences are presented. In addition, an example model to complement the description is included. The example model includes: (1) Workpiece – a hollow cylindrical object that has to be heated to 580 ^{o}C with tolerance of $\pm 10^{o}$C; (2) Uniformly winded inductor – from copper tube, that allows water cooling. For the example model results from application of the approach are presented. The results show the graphical thermal distribution within the workpiece. When executing the last step – 6, for the presented example a prototype was developed. The prototype was tested, where the temperature distribution is presented using a thermographic camera.

Based on the obtained results the following conclusion can be made: (1) The study shows that the combined usage of analytical and digital methods allows for improvement of the efficiency of the specific design and provides better efficiency and quality of the thermal process; (2) The suggested approach is suitable for the development of new equipment as well as for improvement of existing one.

[B.4.2.] Van den Bossche A., N. Dukov, **A. Mari**nov, V, Valchev, R. Stoyanov, *Analytical simulation and experimental comparison of the losses in resonant DC/DC converter with Si and SiC switches*, International Conference on Power Electronics and Motion Control (PEMC2016), ISBN: 978-150901798-0, Varna, Bulgaria, 2016, pp. 934-939

The paper studies the possibility for utilization of modern electronic components when developing a specialized power electronic converter (PEC) for an electric vehicle (EV) battery charger. The presented study is based on a comparative analysis between semiconductor switches – MOSFET from either Si or SiC technology. The main aspect of the study is the evaluation of the losses in the PEC and the possibility of their reduction by the utilization of SiC technology.

A PEC, developed in previous studies of the authors is presented – a half bridge resonance DC/DC converter with nominal power of 1500W. Two specific transistors are included in the study: (1) Specialized MOSFET based on FRED technology – the transistor is with ultra-fast anti-parallel diode; (2) A CREE SiC MOSFET. The studies include: (1) Calculation of the losses of the two transistors based on their technical documentation; (2) Determining the losses in the circuit based on a series of simulation done using a dedicated model; (3) Experimental evaluation of the losses in the transistors of the converter.

The presented results from the analysis include: (1) Waveforms and table data for the current, voltage and power in the studied switches – derived from the model and experiment; (2) The ratio between the losses in the transistors compared to the rest of the components in the converter; (3) Temperature on the studied transistors from the losses.

Based on the presented results the following conclusions can be made: (1) The presented model of the converter has results comparable to those of the experimental study – this makes the model suitable for use in further studies and evaluations of the used topology; (2) The use of SiC transistors leads to minor improvement of the losses and the overall efficiency of the circuit, which from economical perspective is inapplicable for the studied topology.

[B.4.3.] Dimitrov B., **A. Marinov**, A. Cruden, *Modelling, analysis and verification of a resonant LLC converter as a power supply for the electromagnetic driving mechanism of an electromagnetic contactor*, International Symposium on Electrical Apparatus and Technologies (SIELA), ISBN: 978-146739522-9, Bourgas, Bulgaria, 2016

The paper suggests and studies a specialized power electronic converter based on an LLC topology used to develop a highly efficient power supply for the driving mechanism of an electromagnetic contactor. The suggested topology is presented in details, where major aspects for its design are given. A model and a prototype of the topology and its implementation are developed.

Based on the model a series of simulation for evaluation of the resonant circuit are made. Based on the prototype the operation of the converter in the frames of the suggested application is evaluated, where: (1) The process of the commutation of the contactor with the suggested converter is presented; (2) The efficiency of the converter is evaluated. Results are presented in the form of waveforms and oscillograms.

The results allow for the following conclusions: (1) The suggested circuit operates in the suggested application and allows for fast switching times of the contactor and for reduction of the voltages on the winding of the driving system; (2) The efficiency of the of the converter and the contactor is evaluated as 95% - which is improvement for the system compared to other conventional solutions.

[B.4.4.] Marinov A., A. Van den Bossche, A. Georgiev, B. Dimitrov, *Modelling, analysis and comparison of heatsink designs with improved natural convection*, International Symposium on Electrical Apparatus and Technologies (SIELA) , ISBN: 978-146739522-9, Bourgas, Bulgaria, 2016

The paper expands on a previous development of the authors. An improved heatsink structure that utilizes natural convection based on chimney effect is studied. The development is aimed at maintaining the work temperature of semiconductor switches in power electronic converters (PEC). A total of seventeen heatsink variances of the topologies are included in the study. They include: (1) Conventional construction with fins oriented in parallel to the air flow caused form the natural convection – this variance is used for test and verification; (2) Construction with ventilation holes; (3) Construction that utilizes the chimney effect; (4) A construction that utilizes both ventilation holes and the chimney effect. For each of the presented variances based of a specialized software a model using FEM was developed.

Based on the models a comparative analysis for the topologies is made. Each of the topologies is studied for three different powers generated by the element, which temperature is maintained, namely: 10W, 20W and 30W. The studied powers are based of real possible losses for modern transistors used in switching low to medium powers. The obtained results from the simulations are presented graphically. For a selected number of topologies an experimental verification was done. The results from the verification are presented graphically.

Based on the results the following conclusions can be made: (1) The previous studies are expended upon; (2) The topologies with best results in term of temperature on the heatsink are identified; (3) A partial verification is made of the developed models.

[B.4.5.] Rosenov E., D. Kovachev., **A. Marinov**, N. Nikolov, Comparison between passive and active voltage probes in power loss measurements for power electronic components, International Symposium on Electrical Apparatus and Technologies (SIELA), ISBN: 978-146739522-9, Bourgas, Bulgaria, 2016

The paper presents a study and a comparative analysis of six topologies for voltage probes used in measurement of losses in electronic components in power electronic converters (PEC). Three active and three passive voltage probes are studied. The main aspects of the study include the evaluation of: (1) The performance of the probes in the frequency domain – a wide frequency band is sought; (2) The performance of the probes in the time domain – minimum phase delays are required; (3) The possibility of scaling the probe ration for the measured voltage; (4) The possibility of matching the resistance of the probe with the following measurement devices – oscilloscopes, data logging systems, etc. For each probe a model based on modern computer simulation software is developed – ORCAD/PSPICE. For the realization of the models of the probes – conventional electronic components are used. For two of the probes – based on their performance in the simulations, a prototype is developed. The prototypes are used for a series of experiments used for verification.

Simulation results included in the paper include: (1) The frequency characteristics of the active and passive probes; (2) A study in the time domain, where a square wave is used – phase delays are presented. The experimental results from the developed prototypes are also presented.

Based on the obtained results the following conclusion can be made: (1) The evolution of the results allows to identify the best performing probe; (2) The developed models are partly verified and can be used in a following developments of the studied voltage probes.

[B.4.6.] Stoyanov R., **A. Marinov**, O. Stanchev, Vencislav Valchev, *Optimising selection of power switches in PFC boost converters by MATLAB/Simulink pretesting*, International Symposium on Electrical Apparatus and Technologies (SIELA), ISBN 978-619-160-648-1, Bourgas, Bulgaria, 2016, pp. 193-194

The paper presents a computer based model for selection of semiconductors used for the development power electronic converters (PEC) in topologies for power factor correction (PFC). The development of the model and the selection of the semiconductors is aimed at reduction of the switching losses in the electronic switches and improvement of the over efficiency of the PEC. The converter is part of a system for electric vehicle battery charging.

A specialized model for computer simulation that allows comparison of the electronic switches in the frames of the studied PEC is presented. The model is developed in the MATLAB/Simulink environment and includes: (1) Boost converter; (2) A control block, presented in details and reflecting a real control circuit; (3) All feedback connections and peripheral interfaces circuitry required for the operation of the converter. In addition to the model a specialized algorithm/script was developed. The script was used for an automatic simulation and swapping to different switches in order to speed up the study.

An example analysis that demonstrates the operation of the model is presented. The analysis includes five semiconductor switches – MOSFETs. Four of the switches are Si based and one of them is SiC based. The main characteristics of the switches are presented in table form. The losses on the transistors are mathematically analyzed, where the steps of the analysis are presented.

The results from the model are presented in tables together with those obtained from the mathematical analysis. In addition, for the SiC MOSFET, experimental verification was done.

Based in the obtained results the following conclusion can be made: (1) There is consistency between the results from the model, the mathematical analysis and the experiment; (2) The use of the model significantly accelerates the switch selection for the presented topology; (3) For the studies, there is advantage when using SiC technology for the switches, in terms of reduced losses and overall efficiency increase for the studied topology.

[B.4.7.] Marinov A., E. Bekov, D. Bozalakov, *Improved heat sink structure by utilizing chimney effect*, Power conversion and Intelligent Motion (PCIM), ISBN: 978-3-8007-3431-3, Nuremberg, Germany, 2012, pp. 1328-1332

The paper suggests an improved structure of a heatsink for maintaining the work temperature of semiconductor switches for power electronic converters. The suggested heatsink structure utilizes chimney effect in order to obtain better natural convection. This allows for better heat transfer to ambient and a reduction of the temperature difference on the switch while maintaining the size of the heatsink.

The suggested structure is developed and experimentally verified. A comparative analysis is presented. The comparison is between a conventional heatsink and the suggested structure – where different chimney sizes and ventilation holes are used. The analysis is conducted in the same conditions. A semiconductor switch is attached to the tested heatsink. The temperature rise of the heatsink due to the losses in the switch is measured using a thermographic camera. Thermographic images form the different structures in the thermal steady state are compared. Temperature rise is presented in graphic form.

Results from the comparison show that using the suggested structure leads to a 10^{o}C reduction of the temperature relevant to a conventional heatsink. The biggest improvement is noted when a chimney with height of 9cm and a heatsink with ventilation holes is used. Based on the results, a suggestion for design and implementation of the proposed structure are formulated.

Based on the presented study the following conclusions are made: (1) The suggested structure allows for reduction of the heatsink temperature, while maintaining the same size of the heatsink; (2) The results show possibility of further study and improvement.

[B.4.8.] Bossche A., **A. Marinov**, Yankov, E. Bekov, *Automated methodology for adjustment of component values in passive converter circuit for wind turbine generators*, International Power Electronics and Motion Control Conference and Exposition (EPE-PEMC), ISBN: 978-1-4673-1971-3, Novi Sad, Serbia, 2012, pp. DS2d. 4-1 – DS2d. 4-4

The paper presents a specialized algorithm for automated setting of the values of the components of a passive power electronic converter (PEC) for a wind turbine. The passive PEC is object of study of previous papers of the authors. It includes two three phase rectifiers and three external inductors. The passive converter is used for wind turbines with synchronous electrical generators with permanent magnets. When correctly designed the passive PEC uses the natural commutation of the rectifier diodes in order to form different configuration of the circuit, for different wind speeds, in order to extract maximal energy from the generator. A main problem in the previous studies was the relative difficulty when sizing the external inductors in relation to the specific parameters of the generator and wind turbine.

The suggested algorithm is based on an optimized procedure that utilizes a variable step, where the optimized parameter is the output power extracted from the generator. The optimization procedure is applied to a model of the system – PEC and wind generator. The procedure aims to fit the curve of the system to the maximum power curve of the generator. When the curve is fitted data for the values of the inductors are taken.

The optimization procedure and the model, are respectively developed based on a software procedure and a computer simulation in the MATLAB/Simulink environment. The suggested algorithm and model are presented in details in the publication. Graphical results from the operation of the model are presented. Experimental verification of the application of the procedure is presented. Results of the experiment and the algorithm are consistent.

Based on the studies the following conclusions can be made: (1) The suggested algorithm is operational and allows for a fast design of the components of the passive PEC, for optimal results; (2) The algorithm can be successfully applied to other types of circuits with similar structure.

[B.4.9.] Marinov A., E. Bekov, A. Bossche, *Two wire position signal conversion for Brushless DC motors*, Power conversion and Intelligent Motion (PCIM), ISBN: 978-3-8007-3431-3, Nuremberg, Germany, 2012, pp. 1658-1661

The paper presents a specialized structure for coding information from a system of sensor for detecting the position of the rotor of a permanent magnet synchronous machine. The main aim of proposed structure is the reduction of the number of wires that connect the sensors to the controls while maintaining a minimum number of components.

The suggested structure codes the information from the sensors as different levels of current trough a measurement resistor. This allows for two conductors, that at the same time provide power for the sensors and data transfer. In comparison a conventional connection system has five wires – two for power supply and three for digital data transfer.

The suggested structure is experimentally tested. Oscilloscope waveforms are presented. The measurements show the voltages on the outputs of the sensors in comparison the voltage on the measurement resistor. The time delays between the outputs of the sensors and measured voltage levels of the coded signal are presented.

The suggested structure for codding is implemented and tested as a part of system for digital control of a permanent magnet synchronous machine.

[B.4.10.] Dimitrov B., H. Nenov, **A. Marinov**, *Comparative analysis between methodologies and their software realizations applied to modeling and simulation of industrial thermal processes*, International Convention on Information & Communication Technology Electronics & Microelectronics (MIPRO), ISBN 978 953-233-074-8, Opatija, Croatia, 2013, pp. 1129-1132

The paper presents a comparative analysis of computational methods for study of thermal processes, when developing computer simulation and using specialized software. The discussed processes take place in electro resistive furnaces, where the specific accent of the study are chamber, shaft and blast furnaces.

The comparative analysis involves different process using the finite element method and the method with system of differential equations. Using the two methods, problems related to the control of the heating during quenching, melting and cooling, are solved. The usage of the two methods for adjusting PID and hysteresis regulators for heating control is discussed.

The models build for the different numerical methods are described and presented. The models are verified with experimental tests with the modeled equipment.

Based on the comparative analysis the following conclusions can be made: (1) Using each of the methods provides sufficient modeling accuracy; (2) The differential equation method allow application with reduced computing power, which makes it suitable for studies that involved problems with reduced input data.

[B.4.11.] Nenov H., B. Dimitrov, **A. Marinov**, *Algorithms for computational procedure acceleration for systems differential equations in MATLAB*, International Convention on Information & Communication Technology Electronics & Microelectronics (MIPRO), ISBN 978 953-233-074-8, Opatija, Croatia, 2013, pp. 2658-1132

The paper presents solutions related to improved algorithms for compiling software code when calculating systems of differential equations. The presented solutions are based of the MATLAB environment, where the main aim is the reduction of the computer time required for the solution of the equations.

The problems related to the computation efficiency when solving differential equations are analyzed. The possibilities for optimization of the software code and reduction of the computing time are discussed. Improved solutions are suggested. Those solutions include: (1) Improved distribution of the system memory; (2) Vectorization; (3) Application of parallel processing; (4) Using the graphical processor.

The suggested improvements in algorithms are applied to a computation procedure related to simulation of a thermal process in an electro-resistive furnace. A comparison between the required times for simulation using the improvements and a conventional solution are presented.

As a result of the study, the following conclusion can be made: (1) The suggested improvements in the software algorithms allow for significant improvement in the time for simulations – in the presented example the improvement was up to ten times; (2) The suggested improved software algorithms were successfully applied when solving thermal process in electrical-resistive furnaces.

[B.4.12.] Nikolaev N., Y. Rangelov, **A. Marinov**, *Algorithm for indirect load recognition in domestic power consumption*, Power conversion and Intelligent Motion (PCIM), ISBN: 978-3-8007-3405-1, Nuremberg, Germany, 2013, pp. 1241-1246

An algorithm for indirect recognition of energy consumed from household electrical appliances is suggested. The main principle of the algorithm includes the application fuzzy logic to the relative integral change of the normalized consumed power of the household. When forming the conditions for the logic a database with the existing devices needs to be used.

The algorithm is applied to a mathematical model. The model includes several blocks presented in the paper. The blocks include: (1) Block for compensation of the voltage; (2) Control block; (3) Main block for signal processing; (4) Fuzzy logic. The model is formed, so it allows easy integration in software for simulations and further implementation in an embedded system.

The presented algorithm is tested using the suggested model and computer analysis based of the MATLAB\Simulink environment. The analysis includes three loads with different consummation (865W, 414W and 112W) switched in different combinations. In order to improve the simulation, the supply used for the testing includes: (1) Injection of 5% from the 3^{rd} and 5^{th} harmonic; (2) Voltage amplitude alternation with 13V and frequency 1Hz.

The analysis confirms the suggested algorithm as it demonstrates the possibility to recognize loads. The paper includes waveforms, showing the work of the algorithm.

Based on the results obtained from the work, future work is suggested – including implementation in a microcontroller system.

[B.4.13.] Nikolaev N., Y. Rangelov, V. Valchev, **A. Marinov**, *Technique for indirect analysis of domestic power consumers based on power pattern recognition for smart energy metering*, International Convention on Information & Communication Technology Electronics & Microelectronics (MIPRO), ISBN 978 953-233-074-8, Opatija, Croatia, 2013, pp. 1243-1246

The paper presents a new algorithm for indirect recognition of electrical consumption of appliances connected to the household electrical grid. The algorithm detects the change of power in the main line and determines which devices has been switched.

The developed algorithm is based on data obtained by a central measurement device connected in electrical junction box of the consumer. The data from measured values of the current and the voltage are fed to the input blocks of the algorithm, where the power consumed by the household is calculated. Using a block for voltage amplitude compensation, a stabilization of the measured power is done. This is required as passive electrical devices change their power in a square law based on deviation in the voltage amplitude. After this processing the resulting signal is fed to a controller with fuzzy logic and is compared to patterns of existing devices. This allows to categorize the devices and determine which device has been switched. This provides means to consider the contribution to power consumption for each device.

The algorithm is tested using a computer simulation that imitates the switching of three electrical devices with different power. The test also includes a 10% tolerance to the loads.

The presented algorithm is tested and works sustainably despite interferences introduced in the grid. Using the algorithm, passive electric consumers can be recognized.

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[Indicator Г7] Scientific publications indexed in internationally recognized databases

[Г.7.1.] Marinov A., *Study of power loss reduction in SEPR converter for induction heating through implementation of SiC based semiconductor switches*, TEM Journal, ISSN: 2217-8309, Vol3 No3, 2014, pp. 197-201

The paper presents an approach for reduction of losses in a power electronic converter (PEC) part of a system for induction heating, by the utilization of silicon carbide (SIC) based semiconductor switches. The presented study is in the frames of a single ended parallel resonance (SERP) type converter. Those type of converters are suitable for output powers up to 1500W and a flat inductor.

Two types of electronic switches are compared: (1) Bipolar transistor with isolated gate (IGBT); (2) SiC based MOSFET. The comparison is made based on: (1) An analytical approach based on a model of the studied converter and a simulation; (2) Experimental study, that includes loss measurement and thermal analysis of the converter. Both studies are made on the same topology and circuitry, where no specialized driver is used for the control of the SiC MOSFET.

Results from the studies show: (1) Commensurability between the results obtained through simulation and the results obtain trough experiment; (2) Reduction of the total losses when using SiC MOSFET ($P_{total}=42,96W$) compared to using a specialized IGBT ($P_{total}=59,65W$) – the most significant reduction is for the turn-off losses and the conduction losses; (3) Reduction of the temperature of the heatsink used in the converter. The average temperature on the heatsink when SiC MOFET is used is $T_{avrage}\approx 38^oC$, while for the IGBT was $T_{avrage}\approx 49^oC$ – considering a constant ambient temperature of 25^oC.

Based on the obtained results, the following conclusions can be made: (1) The consistency between the results from the developed computer simulation and the conducted experiment suggest that the model can be further used for the study of that type of converters – more specifically in the selection of semiconductor switches; (2) Reduction in the losses for SiC MOSFET, suggests that those type of transistors can be used in modification of the studied SERP converter for induction heating – when this is justified economically; (3) During the studies a conventional driver was used for the SiC transistor – the use of a specialized driver can even further improve the loss reduction.

[Г.7.2.] Stanchev O., **A. Marinov**, E. Bekov, *Model of Piezoelectric Polymer Energy Harvesting System*, TEM Journal, ISSN: 2217-8309, 2016, Volume: 5 Issue: 3 Pages: 401-405

The paper presents the development of complex model of a system for harvesting energy from polymer piezoelectric elements. The main aim of the model is to allow for the study of the discussed energy harvesting systems and the amount of generated energy, with: (1) Different mechanical interactions – variable frequency, amplitude and direction on the piezoelectric element; (2) Different geometries of the piezoelectric element; (3) Different thicknesses of the used piezoelectric elements. The model is developed in the software environment MALAB/Simulink.

All of the functional blocks of the model are presented, as well as their operational principles and the basis used for their synthesis. The functional blocks include: (1) The piezoelectric element presented as a control voltage source, in two separate cases based on the direction of the applied force; (2) A bridge rectifier; (3) Synchronous buck converter; (4) Control;

Using the suggested model, a series of computer simulations are made. The results from the simulations are presented as waveforms, where the output reaction based on different mechanical stresses is depicted.

Based on the model, a test setup is composed. The test setup is used to verify the models, where results from the experiments are presented.

Based on the studies and the obtained results the following conclusions can be formulated: (1) The developed model can be applied when polymer piezoelectric elements studied within the frames of energy harvesting systems; (2) The model and the prototype can be a basis for future work on the topic.

[Г.7.3.] Marinov A., *Specialized power electronics convertor for channel-type industrial induction heating furnaces*, International Symposium on Electrical Apparatus and Technologies (SIELA), ISBN 978-1-4799-5816-0, Bourgas, Bulgaria, Volume 1, 2014, pp. 123-128

The paper presents and evaluates the development of a specialized power electronic converter (PEC) for an induction channel type furnace. The presented PEC aims at improving conventional low frequency induction channel type furnaces powered directly from the electric grid, by controlling the current through their primary winding. The suggested structure of the PEC includes three main blocks: (1) Input rectifier; (2) Specialized current protection – discussed in details in previous works of the author; (3) Bridge voltage inverter.

The studies presented in the papers are completely based on an experimental prototyping and include: (1) A verification of the operation the converter in the context of the presented application – including a study on the suggested current protection; (2) Evaluation of the possibility to regulate the current in the primary winding of the transformer, part of the furnace; (3) Evaluation of the efficiency of the studied converter, when two types of transistors are used – IGBT and a SiC based MOSFET. The obtained results are presented using tables and waveforms.

Based on the study and the obtained results, the following conclusions can be made: (1) The analyzed circuit show the possibility to use it in the suggested technological context; (2) The suggested current protection functions and protects the transistors from overcurrents; (3) The efficiency is evaluated and shows the advantage of using SiC MOSFETs, due to their general lower conduction losses.

[Г.7.4.] **Marinov A**., K. Bliznakova, I. Buliev, H. Bosmans, N. Padovani, S. Christofides, *Application of advanced techniques for online presentation of educational material for education and training developed within the EUTEMPE-RX project*, European Conference of the International Federation for Medical and Biological Engineering (MBEC), ISBN 978-3-319-11127-8, Dubrovnik, Croatia, 2014, pp. 769-772

The paper presents the possible ways to presented complex educational materials related to Medical Physics and Biomedical engendering using modern electronic and online mediums. The problems and solutions during the development of the electronic presentation materials in the aforementioned fields are demonstrated and explained. As a result, a multi-platform application is developed. The application can be integrated for PC and mobile devices and can be used for remote and distance studies. The application is used in the development of the EUTEMPE-RX project.

Solutions to several problems related to the development of electronic education materials are presented. Some of the main key points of paper include: (1) Development of interactive images; (2) Development of a multimedia application, with differentiated sections in order to consolidate a large volume of presentable information; (2) Development of complex interactive solutions based on (1) and (2); (4) In order to maintain compatibility between different platforms the application is developed using HTML5; (6) An example for interactive application is made – the application presents classification of biomedical phantoms and is a part of an existing course. A comparison between the different means to present educational materials is made.

[Г.7.5.] Marinov, A., D. Ivanov, Z. Bliznakov, H. Bosman, I. Buliev, K. Bliznakova, *Application of computational phantoms and their 3D print-outs for educational purposes*, International Conference on Nanotechnologies and Biomedical Engineering (ICNBME), ISBN 978-981-287-735-2, Chisinau, Republic of Moldova, 2015, pp. 493-496

The paper discusses the development of software anthropomorphic phantoms and the implementation of a number of operations for the processing of images aiming at the preparation of a digital copy of the phantom suitable for 3D printing. This development is used for electronic education of medical physicians in the frames of the EUTEMPE-RX project. The presented approach includes: (1) Generation of mathematical anthropomorphic phantoms; (2) Program code, specially developed for the conversion of the mathematical phantoms in a suitable form for 3D printers; (3) 3D printed model of the mathematical phantom.

The presented approach for the development of the aforementioned educational materials can be summarized in the following steps: (1) Generation of computational model using a specialized software – "Breast Simulator"; (2) Loading the model in MATLAB; (3) Processing the model – improving its characteristics; (4) Converting the processed model in a printable STL form; (5) Inputting the model into CAD/CAM software for 3D presentation and consecutive prints; (6) Inputting the model into a 3D modelling software so educational 3D based visualizations and animations can be developed. For the purposes of the paper two different phantoms are generated, animated and 3D printed. The models vary in complexity.

In conclusion it can be said that a complete approach for education in the field of mathematical phantoms is developed. The approach allows to generate modern educational materials – 3D visualization and animations and 3D printed models. In addition to generation of breast phantom models, a suggestion how the approach can be used for different anatomic parts is presented.

[Г.7.6.] Rangelov Y., **A. Marinov**, N. Nikolaev, *Measurement and data logging system for specialized high voltage equipment*, International Symposium on Electrical Apparatus and Technologies (SIELA), ISBN: 978-146739522-9, Bourgas, Bulgaria, 2016

The paper presents the development of a specialized system for measurement and data acquisition for evaluation of installations and equipment for high voltage. The presented measurement system is implement as part of an experimental complex of a laboratory for high voltages. The main function of the suggested measurement system is to measure and record the currents and voltage in the primary and secondary winding of a boost high voltage transformer. The transformer is used for testing high voltage equipment – isolators, breakers, etc. - during partial and full electrical dischargers. Based on the suggested application the following specifics toward the system are formulated: (1) Measurement of voltages up to 700V – a capacitive divider is used to lower the voltage on the transformer - and currents up to 20A; (2) Galvanic isolation of the measurement unit; (3) Speeds of measurement and acquisition that would allow observation of transients in the current and voltages, related the studied equipment; (4) Possibility of computer connection and development of specialized software.

Based on the formulated specification a structure of the measurement unit is suggested. Each of the blocks of the structure is presented in details as specifics are described in details. For the suggested system a prototype is developed. The prototype is tested when a voltage breakdown in a breaker is studied. The results from the tests are presented as waveforms.

Based on the studies the following conclusions can be made: (1) The development of a specialized measurement unit is presented – the unit can be used for renewing and updating high voltage laboratory equipment; (2) The suggested measurement system is tested, the system is operational and its parameters satisfy the required accuracy.

[Г.7.7.] Stanchev O., **A. Marinov**, E. Bekov. *Experimental analysis of energy transfer of piezoelectric polymer transformers*, XIX International Symposium on Electrical Apparatus and Technologies SIELA, ISBN 978-619-160-648-1, Bourgas, Bulgaria, 2016, pp.179-180 (Digest)

The paper presents experimental analysis of energy transfer in polymer based piezoelectric transformers. The analysis includes a study of several different constructions. Each construction is evaluated and comparison between then is made. The resonance frequencies of all constructions are defined. A specific application for the polymer based piezoelectric transformers is suggested.

The paper discusses the modelling of the constructions based on equivalent circuitry. For the different constructions prototypes are developed and tested in specialized experimental setups. Based on the prototypes an experimental analysis is made. The analysis includes a study on the voltages, powers and efficiencies of the studied transformers. The results from the experimental analysis is presented in the forms of tables and graphics.

Based on the obtained results, the following conclusions can be made: (1) The transformers have very low efficiencies and relatively low energy transfer; (2) The possibility of develop transformers with different sizes and volumes with improved mechanical parameters allows for the use in specialized applications – such as solutions in medical electronics.

[Г.7.8.] Bekov E., **A. Marinov**, V. Valchev (2012), *PVDF based Rain Sensor for Weather Assessment relevant to renewable Energy Sources*, Power conversion and Intelligent Motion (PCIM), ISBN: 978-3-8007-3431-3, Nuremberg, Germany, 2012, pp. 1658-1661

The paper presents a specialized sensor for measurement and registration the quantity and intensity of rain. The sensor uses the piezoelectric effect of the material polyvinylidene fluoride (PVDF).

The structure of the sensor is presented and analyzed. The sensor includes a fundament and PVDF patch. In construction, based on the piezoelectric effect the kinetic energy of the raindrops is converter into electrical energy. The amplitude of the voltage on the piezoelectric element is proportional to the power of impact that the rain drop makes. Thus the output voltage will be proportional to the size for the raindrop.

For the studied sensor a dedicated test setup is developed. The test setup includes all required analogue and digital interface circuitry. An algorithm for digital processing is suggested.

Based on the test setup an experimental study is performed. The experimental study includes: (1) Measurement of the output voltages on the sensor with controlled raindrop; (2) Evaluation of the complete operation of the system using controlled raindrop.

Based on the experimental analyses the following conclusions can be made: (1) The studies show the functionality of the sensor; (2) The results show the possibility of further studies in real conditions and the integration of the sensor in a more complex system.

[Г.7.9.] Marinov A., E. Bekov, V. Valchev, *PVDF Based Wind Direction and Speed Sensor for Weather Assessment Relevant to Renewable Energy Generation*, International Power Electronics and Motion Control Conference and Exposition (EPE-PEMC), ISBN: 978-1-4673-1971-3, Novi Sad, Serbia, 2012, pp. DS1d. 4-1 – DS1d. 4-4

The paper presents a sensor for measurement of wind speed and direction. The sensor is based on piezoelectric conversion. The suggested sensor utilizes a piezoelectric element based of the polyvinylidene fluoride (PVDF) material.

The construction of the sensor is presented and described. The construction includes a cross shaped fundament where on each sides a PVDF piezoelectric strip is glued. In this way there are total of eight piezoelectric strips. When exposed to airflow the piezoelectric elements convert kinetic energy to electrical. Higher voltages are observed on the strips facing the airflow.

For the suggested sensor a specialized test setup is developed. Using the test setup an experimental analysis is conducted. The experimental analysis includes: (1) Studies for the operation of the sensor at different wind speeds; (2) Study of the operation of the sensor with constant speed and varying direction ($0^o \div 180^o$) of the airflow compared to the sensor. Results from the study are presented graphically.

Based on the studies the following conclusions can be drawn: (1) The advantages of the suggested sensor are evaluated – a reliable cost effective solution for wind speed and direction measurement; (2) The positive results suggest that the given application can be further studied and can be implemented in a more complex measurement setup.

[Г.7.10.] Valchev V., **A. Marinov**, E. Dimitrova, *Self powered current acquisition system with wireless data transfer*, International Convention on Information & Communication Technology Electronics & Microelectronics (MIPRO), ISBN 978 953-233-074-8, Opatija, Croatia, 2013, pp. 121-125

The paper presents a structure of a specialized intelligent unit for measurement of electrical energy. The structure includes multitude of units and allows remote measurement of the electrical energy consumed by variable devices. The novelty in the suggested study is the topology used to for the development of the remote units. The remote unit allows the measurement and transmission of data without the need of separate power supply, instead using power from the current transformer used as a sensing device for the current. This simplifies the circuitry as no complex power supply is needed.

For the suggested structure a computer based model is developed. Using the model, a number of simulations are performed. For a better verification the model is fed with real data that includes current values of different consumer devices. Based on the performed simulations it can be concluded that suggested structure is functional and allows for sufficient accuracy.

[Г.7.11.] Marinov A., Or. Stanchev, E. Bekov, *Application of charge amplifiers with Polyvinylidene Fluoride Materials*, International Convention on Information & Communication Technology Electronics & Microelectronics (MIPRO), ISBN: 978 953-233-078-6, Opatija, Croatia, 2014, pp. 97-101

The paper discusses a specialized charge sensitive amplifier – interface for the development of measurement units based on polyvinylidene fluoride (PVDF) piezoelectrics.

A detailed analysis of the specifics and characteristics of the PVDF based piezoelectrics is presented. The main dependencies that characterize the charge and voltage, generated by the PVDF piezoelectrics on mechanical interactions are discussed. Based on those dependencies a comparison between conventional and charge sensitive amplifiers is made. The advantages of charge sensitive amplifiers are described. A detailed methodology for design of the charged amplifiers used with PVDF based piezoelectrics is presented.

For the presented amplifiers an experimental setup is made. A series of experiments are conducted using the setup. The results from the experimental analysis are presented in the time and frequency domain.

Based on the studies the following conclusions can be made: (1) Due to the capacitive type of the PVDF based piezolectrics, the use of charge sensitive amplifiers is an advantage; (2) The suggested design methodology is verified trough an experiment.

[Показател Г8] Scientific publications indexed in non-indexed journals and proceedings

[Г.8.1.] Marinov A., *Dual band current probe for smart energy metering applications*, Journal of Computer Science and Communication, ISSN: 1314-7846, Volume 3, № 2, 2014, pp. 10-16

The paper presents the development of a precise current transformer for an intelligent measurement system for household energy consumption. The main aspect of the current transformer is the possibility to measure small and large currents while maintaining resolution trough switching the transfer ration of the transformer. The aim is to allow for similar accuracy for small (less then 1A) and large (up to 16A) currents without the need of specialized amplifiers with variable gain or high resolution analog-digital converters.

Two electronic circuits for the dual band transformer are suggested, where the burden resistor connected at the output of the transistor is switched based on the measured current. For small currents a high resistant burden is connected, while for larger currents a low resistance burden is connected. The burden resistors are designed so they will provide two distinct current ranges with similar output voltages at the maximum measured current. For the first suggested circuit the switching between the burden resistors done through non controlled switches – diodes, while for the second circuit the switching is done by controlled switches – MOSFETs.

In order to verify the two suggested circuits, models based on the PSIM environment were developed. Using those models, a series of simulations were performed. For the simulations two types of tests were performed: (1) One for small currents – maximum amplitude value of 0.2A ($I_{low}=0.2A$) – a current usually associated with the standby consumption of devices; (2) One for high currents – amplitude value of 20A – current associated with high power consumers operating in nominal mode. Results from the simulations are presented as waveforms. A comparison between the suggested dual band current probes and conventional probes –designed for small or large current - is made.

The studies show that the suggested device is functional and provide information on their qualities that is prerequisite for further studies and development as well as for additional experimental verification.

[Г.8.2.] Marinov A., *Interactive multimedia applications for online education in power electronics,* Journal of computer science and technologies, ISSN 1312-3335, Year XII, Number 2, 2014, pp. 47-52

The paper presents a set of interactive, internet based applications, that can be used for presentation as part of an educational course or a tool for distance learning. The main aspect of the study includes: (1) Analysis of the problems related to presented content for distance learning – including content specifics of power electronics; (2) Comparison between the main tools that could be used to develop applications, interactive and animated educational content; (3) Development of a sample interactive application that can be used for education and training in power electronics. As a general based on the aforementioned study, the possibility to improve education quality in power electronics, using modern interactive means is discussed.

In the paper an example application for education in power electronics is developed and presented. The application includes three basic circuits of controlled rectifiers. The possibility for interactive presentation that will allow for a clear viewing and description of the different states of the circuit components is studied. Based on animated samples that utilize a simplified program code that models the operation of the circuit, the following can be presented: (1) Equivalent circuit of the studied controlled rectifier; (2) Waveforms that describe the operation of the controlled rectifier; (3) Relations that describe the operation of the controlled rectifier. All elements and parameters a color coded for easier presentation.

The main aspect of the application includes, interactive presentation of the influence of the phase angle of the SCRs on the circuit. This parameter has significance for the circuit and its operation. Its specific for the operation of the circuit and it is difficult to describe using static images. In the application the angle can be set by the user and its effects can be observed by the interactive animations.

Based on the obtained results the following conclusions can be made: (1) Based on the analysis on modern tools for electronic education, an interactive application for education in power electronics is developed; (2) The application solves problems related to presentations of complex information using modern multimedia techniques. The application is tested and integrated as part of lecture course on power electronics in the Technical University of Varna.

[Г.8.3.] Marinov A., *Computer Based Modelling of DDS with Polynomial Approximation*, Journal of Computer Science and Communications, ISSN: 1314-7846, Volume 3, № 2, 2014, pp. 3-9

The paper presents the implementation of direct digital synthesis (DDS) based on series on a sinus function of the fifth order with reduced set of mathematical operations. The main aspects of the study include: (1) Development of a model of the calculation procedure when realized with a microcontroller; (2) Demonstration of the implementation of the algorithm of DDS with the developed model; (3) Modelling the influence of the operational frequency on the process and parameters of the suggested application of DDS; (4) Modelling the influence on the resolution of the digital to analog converter (DAC) on the parameters on the suggested applications for DDS.

The developed model is implemented using modern computer software – MATLAB/Simulink. When testing the model experimental data is used as an input.

Results from the computer simulation with the model are presented. They include: (1) Graphical presentation on the steps that form the sinewave in the time domain, where 80MHz is used as processor frequency; (2) A study in the frequency domain and a comparison of the dynamic ranges when the clock frequency of the microcontroller is varied. Results for the variability of the dynamic range of the resolution of the digital to analog converter are also presented.

Based on the obtained results the following conclusions can be made: (1) The results allow for evaluation of the developed model – this evaluation shows the exact influence of each parameter related to the microcontroller on the quality of the output signal; (2) The developed model can be used for development and testing of different DDS algorithms without the need of experimental realization; (3) The algorithm and the model can be used for precise studies of systems based on the suggested algorithm.

[Г.8.4.] Marinov A., *Improved simulation approach for analysis of electronic switches in power electronic converters*, Eastern Academic Journal, ISSN: 2367-7384, Volume 2, 2016, pages 62-68

The current paper suggests a detailed approach for transient computer simulation aimed at electronic switches in power electronic converters. The approach is applicable to studies of the parameters of electronic switches – including processes of turn-on and turn-off where longer simulation times are needed. The main purpose of the suggested approach is to significantly reduce the time need for simulation completion, while maintaining small and prices calculation step.

The suggested approach is based in on a variable simulation step and is based on the following algorithm: (1) Two models of the suggested circuit are developed – one using ideal and one using real (based on real parameters) models of the electronic switches; (2) The model with ideal switches is simulated for the whole simulation time using a relatively large simulation step – currents trough the inductors and voltages on the capacitors are recorded; (3) The number of simulation – n, that are to be conducted with the real switches is selected. Based on this number, time intervals are calculated; (4) For each interval the corresponding inductor currents and capacitor voltage obtained from the first simulation are loaded as initial conditions. Based on this initial conditions – short simulations with precise step are made; (5) Results from the simulation are processed and presented on top of the complete simulation time, made in step 2.

In order to verify and evaluate the suggested algorithm was applied to a sample circuit – a boost converter. For this converter the settle time and the losses in the switch are calculated. For the sample case the suggested algorithm for the same condition is compared to a conventional simulation with small step size. Based on the comparison, the suggested algorithm allows for similar results but at almost tenfold time reduction required for the simulation.

The following conclusions can be made from the obtained results: (1) The suggested approach is functional and allows for a significant simulation time reduction; (2) The approach is suitable only for computation products that allow for programmable simulations – such as MATLAB/Simulink.

[Г.8.5.] Valchev V., P Yankov, **A. Marinov**, *Comparison of systems for control of wind turbines with active or passive converter***,** Annual proceedings of the Technical University of Varna, ISSN: 1311-896X, volume 1, 2009, p-p. 108-111

The paper presents a comparative analysis of different topologies of power electronic topologies for conversion of energy from electrical generators in wind turbines with variable rotation speed. Two main types of topologies are included in the study, namely active and passive converter types. The comparative analysis includes evaluation based on: economic efficiency, electromagnetic compatibility, power, efficiency and reliability.

The paper analyses the application of passive converters as their main advantages compared to the active converters are explained and justified. Based on the analysis the following can be listed: (1) Passive converters have lower price than active converters as only diode switches are used; (2) Passive converters generally have lower number of components (no control block in the topology), which significantly increases their reliability; (3) There is no high frequency switching, which will generally provide better EMC compared to active converters. The main disadvantage of the passive type converters is their inability to provide control dynamics and allow for optimal efficiency at wider range of wind speeds.

In addition to the afore mentioned analysis a comparison between fully controlled converters (using modern transistors IGBT, MOSFET as switches) and converters with partial control (based on SRCs) is also made. Advantages and disadvantages are listed and justified.

The main conclusions for the presented study can be summarized as: (1) The utilization of passive converters is justifiable in systems with low and medium power, when a higher initial economic efficiency is required as well as better reliability and low levels of EMC; (2) Systems using fully controlled power electronic converters are suitable for medium and high power, when maximum efficiency in conversion is required.

[Г.8.6.] Stoyanov R., E. Rosenov, **A. Marinov**, V. Valchev, *Modelling, simulations and design considerations for Inrush Current Limiting Topologies*, Annual Journal of Electronics, ISSN 1314-0078, Volume 8, 2014, pp. 227-231

The paper studies and compares electronic interfacing topologies for limiting of the inrush current of DC link capacitors for single phase switch mode power supplies. The base topologies are object of this study, namely: (1) A topology based on a thermistor with negative temperature coefficient connected in series to the charged circuitry; (2) Current limiting resistor connected in series with the charged circuitry and switched off by the parallel connected contacts of an electromagnetic relay; (3) MOSFET connected in series to the charged circuitry – working in active mode during initial charge and in saturation mode after the capacitors are charged.

For the studied cases, based on a specialized software – MATLAB/Simulik –a series of models for computer simulations were made. Each of the circuits is analyzed for parameters and component selection specific for four different load currents – 1A, 5A, 10A and 15A – in order to provide results for wider range of possible output powers. The following processes were studied: (1) The process of charging the DC link capacitor and currents related to the charge; (2) The electrical losses in the charging circuitry for the time the capacitor is being charged; (3) The electrical losses in the charging circuitry after the capacitor is charged.

Based on the obtained results the following can be formulated: (1) Direction for selection between the analyzed topologies; (2) Classification of the analyzed circuitry so the most appropriate circuit based on electrical losses for the specific load current can be selected; (3) The use of the developed models was verified for designing and analyzing topologies that may include the studied inrush current limiting topologies.

[Г.8.7.] Marinov A., E. Rosenov, R. Stoyanov, *Modelling and Simulation of an Improved Microcontroller Based Desaturation Current Protection*, Annual Journal of Electronics, ISSN 1314-0078, Volume 8, 2014, pp. 231-234

The paper presents and studies a specialized electronic circuit for current protection of bipolar transistors with isolated gate (IGBT). Parts of the studied electronic circuit is presented in previous works of the authors. The protection circuit monitors for overcurrents in the protected transistor by detecting possible desaturation. When an overcurrent is detected the protection is activated and the driver power supply is lowered – tripping the UVLO integrated in the specialized driver that is used – this leads to transistor turn-off. The protection resets after a given hold time. The microcontroller integrated in the suggested current protection allows for digital setting of the reset time the protection current. This makes the protection more flexible and easily adjustable.

A model and computer based simulation was developed for testing and analyzing the proposed current protection. The protection was modeled using MATLAB/Simulink. Based on the model a series of computer simulations were made – generating a set of waveforms that describe the operation of the protection. In order to verify the model results from the simulation are compared to previous experimental results. Based on the model and simulations, a software algorithm and a graphical interface were developed for designing and adjusting the protection.

The following conclusions on the suggested protection can be made: (1) The developed model was verified based on previous experimental studies; (2) The suggested model, graphical interface and software algorithm simplify the design, analysis and adjustment of the suggested current protection; (3) Properties of the current protection such as – precision, speed, ect are evaluated.

[Г.8.8.] Nikolov G., B. Dimitrov, **A. Marinov**, *Using nanocrystalline soft magnetic materials for improving efficiency in induction heating*, Journal of Nanoscience & Nanotechnology: Nanostructured materials application and innovation transfer, ISSN: 1313-8995, Issue 14, 2014, pp. 162-172

The paper discusses the use of modern magnetic materials for the development of power electronic converters used in systems for induction heating. Based on a comparative analysis the possibilities of improving transformer technologies using conventional ferities and nanocrystalline materials are studied. The main part of the analysis evaluates and quantifies the core losses of two transformers based of the two materials

Two ferrite materials – 3F3 and N67 are compared against two nanocystalline materials – Finemet FT-3M and Vitroperm 500F. The studies made in the paper include: (1) Comparative analysis based on the technical documentation of the core materials; (2) Analytical study based on mathematical models; (3) Experimental study of a sample of magnetic cores – using specialized test setup for loss measurement; (4) Practical realization and study of two transformers, the first one based on 3F3 material and a E80/38/20 core shape and the second based on Finemet FT-3M material and F3CC0010 core shape.

Results for the losses in the four suggested studies as well as the mass and the sizes of the transformers were summarized in table form. Based on the summary, the following conclusions can be made: (1) When practically realizing the transformers an increase in efficiency can be noted for nanocystalline materials – the increase is slight around 12%, which reflects to 0.11% for the whole induction heating system; (2) For the developed transformers the usage of nanocystalline materials leads to a significant reduction of mass and size; (3) Due to the high price of nanocystalline material cores the use of such material for transformer development has to be economically justified.

[Г.8.9.] Nikolov G., **A. Marinov**, P. Yankov, *Application of planar transformers in power electronics*, Third Scientific Congress – 50 years of Technical University of Varna, ISBN: 978-954-20-0551-3, Varna, Bulgaria, Volume 2, 2012, pp. 140-143

The paper presents the application of modern planar construction for the development of magnetic components with improved parameters, used for the purposes of power electronics. The studies presented in the paper include a comparative analysis between transformers, developed with conventional magnetic core and transformers developed with planner magnetic cores. The main criteria in the comparison is the size of the designed component, where it is expected that the planner technology will allow for a significant improvement.

For the purposes of the study two transformers are designed, studied and analyzed. For the design and development of the transformers, two specialized methodologies were used, where additional steps required for the design of the planner transformers were done by the authors. The two transformers include: (1) Transformer developed using conventional magnetic core type EE55/28/21; (2) Transformer based on a magnetic core developed on planner technology – E64+PLT64. The results from the design are presented in table form. The designed transformers are practically realized and compared. Comparison results are presented. Guidance related to the design of planer transformers are formulated and presented.

Based on the studies and their results the following conclusions can be formulated: (1) The use of transformers based on planner technology significantly reduces height; (2) Modification to methodologies used for design of conventional transformers are presented so they can be successfully applied for planner devices.

[Г.8.10.] Valchev V., P. Yankov, **A. Marinov**, *PMSM/BLDC as generators in renewable energy conversion systems*, Annual Journal of Electronics, ISSN 1313 1842, Volume 3, Number 2, 2009, pp. 141-142

The paper discusses the main characteristics when using permanent magnet synchronous machines (PMSM) for generation of energy from renewable sources. Advantages of PSMS are discussed as well as the power electronic circuits required for their application. Certain applications of PMSMs are given and summarized.

The main advantages of PMSMs are described. A comparison between PMSMs and conventional AC machines is presented. The main advantages of PMSMs are summarized - those include: (1) Reduced losses in conductors; (2) Smaller overall losses and less requirements to cooling; (3) Better power density; (4) Improved control due to the smaller ripple in the angular momentum; (5) High angular momentum at low speeds.

The specific advantages of PMSMs when used in renewable energy applications include: (1) Reduced size and weight; (2) Improved efficiency; (3) High reliability.

Based on the comparison an improved circuit for sensorless control of an PSMS for renewable energy generation is presented.

[Г.8.11.] Shotova M., H. Nenov, **A. Marinov**, *Algorithm for image recognition and processing for student examination in electronic based education*, Journal of Computer Science and Technologies, ISSN 1312-3335, Year XII, Number 2, 2014, pp. 53-58

The paper presents a set of algorithms for recognition of images, that can be used in electronic educational materials for examination or self-examination of students. The main aspects of the algorithm include: (1) Comparison of images – graphics, waveforms, drawn by the user – to a prerecorded set; (2) Based on defined thresholds it is determined if the image provided by the user is correctly drawn or not. This allows for a more complex and complete examination technique.

The presented algorithm is described in details as all of its steps are discussed. They can be categorized into two main parts: (1) Processing of the image drawn by the user; (2) Comparison of the given thresholds to the provided originals. (1) contains conversion of the image in binary data, detection of the boundaries of the image and calculation of the Euclidean distance to the abscise of the graphic. (2) Compares the pixel distances and calculates the average deviation and error, which are then compared to the given thresholds and a decision if the drawn graphics is incorrect ca be made.

The algorithm is tested with different graphics, where in the paper an example with the volt ampere characteristic of diode is made. The algorithm is developed using the MATLAB environment, due to its simplicity however the algorithm can be easily implemented in other software environments as well.

Based on the obtained results, the following conclusions can be made: (1) The presented algorithm is functional and operational; (2) Graphics can be recognized and compered with variable degree of accuracy; (3) The algorithm can be applied in electronic education for technical sciences, where there is often a requirement to test students for their knowledge and graphics and diagrams.

[Г.8.12.] Marinov A., Or. Stanchev, P. Yankov, *Development of a specialized power supply for a pulser/receiver block for ultrasound transducers,* Annual proceedings of the Technical University of Varna, ISSN: 1311-896X, том 1, 2014, стр. 71-74

The paper presents the development of a specialized power supplied aimed at providing operational voltages required for a system – pulser/receiver for ultrasound transducers.

A detailed analysis of the typical structure of a pulser/receiver is presented. Based on this structure, the required supply voltages are characterized as their required parameters are defined – stability, nominal current, galvanic separation, etc. A structure of power supply is proposed. The structure of the power supply is synthesized so a compact design can be obtained – this is done through the utilization of PCB mount modules.

For the proposed structure a model for computer simulations was developed. The model utilizes the MATLAB/Simulink environment and allows for fast evaluation of the stability of the output voltage, when various external interferences are present, such as input supply instability. Based on the model a series of simulations were made. Results from the simulation are presented in tables.

For the discussed power supply a prototype is developed. Results related to the stability of the voltage in nominal operation mode are presented. Results from the experimental study and the computer model are compared.

Based on the obtained results the following conclusions can be made: (1) The developed model allows results consistent with the studies made with the prototype – the model can be used for analyses of similar power supplies; (2) The suggested power supply is validated experimentally and can be used for suppling pulser/receiver systems for ultrasound transducers.

[Г.8.13.] Bekov E., **A. Marinov**, M. Hristov, *Some aspects of computer modelling and data processing for PVDF based ultrasound transducer using MATLAB*, Journal Acoustics, ISSN 1312-4897, issue 16, 2014, pp. 110÷114

The paper presents some aspects related to computer modelling and processing of data when studying PVDF based transducers. The modelling utilizes the MATLAB/Simulink environment.

A complex structure for ultrasound studies is presented, as a specific accent is put on its application for medical diagnostics. The specifics related the use of PVDF based transducers are formulated. Based on the structure and the specifics a consolidated approach is formulated. The approach allows for computer simulations and experimental studies – the two unified by a common work environment. The approach is presented graphically as a block diagram, where all its separate steps are presented.

Examples for the development of the different blocks of the model in the MATLAB/Simulink environment are presented. Special attention is placed on the modeling of PVDF based transducers and their puser circuits. Based on those examples, directions for the synthesis of the models and settings of the computer simulations are formulated. The ways how the different blocks connect and interact is described.

An experimental setup of an ultrasound scanner – developed by the authors – is presented. The experimental setup can be connected to the developed models. The connections between the models and the experimental setup is described.

[Г.8.14.] Stanchev O., **A. Marinov**, E. Bekov, *Comparison of piezoelectric transducers for wideband pulseecho medical imaging*, Journal Acoustics, ISSN 1312-4897, issue 16, 2014, pp. 106÷109

The paper presents an experimental comparative analysis between piezoelectric transducers for wide band pulse-echo medical imaging diagnostics. The main aspect of the analysis is the comparison between transducers based on PZT and PVDF materials

The main parameters that characterize wide band transducers for pulse-echo medical imaging diagnostics are presented. Based on this analysis a series of experimental studies with PZT and PVDF transducers are conducted. The control frequency in the experimental studies is 1MHz. The presented results include: (1) Waveform of the reflected signal; (2) The spectral components of the reflected signal.

The comparison between the obtained results allows for the following conclusions to be formulated: (1) Despite the lower echo, returned from the PVDF transducer, it demonstrates a wider frequency band related to the PZT transducer; (2) PVDF transducers are more suitable for systems based on harmonic tissue analysis.

[Г.8.15.] Valchev V., G. Nikolov, **A. Marinov**, *Improved methodology for design of magnetic components*, International Scientific Conference on Information, Communication and Energy Systems and Technologies (ICEST), ISBN: 978 86 6125-033-0, Nis, Serbia, volume 1, 2011, pp. 906-910

The current paper presents an improvement on an already existing methodology for design of magnetic components – Fast Design Approach. The presented improvements have two main aims: (1) To encompass a larger range of soft magnetic materials; (2) To allow for different means of heat dissipation techniques for the designed transformers.

The suggested improvements presented in the paper are based on the following : (1) Analysis of the volumetric construction of the magnetic components, taking in account the two ways of heat dissipation – convection and radiation; (2) The equations for heat transfer from convection and radiation are presented as values for the equivalent surfaces of commonly used magnetic components; (3) An improved equation for the length of the boundary layer is used for the heat transfer from convection; (4) Analysis of the heat dissipation capability of magnetic materials with forced cooling – presented as a detailed equation for the coefficient for convection including the speed of the cooling fluid.

Based on the presented analysis an improvement on the step that evaluates the heat dissipation capabilities of the core is made. The improved approach step is applied in calculating the dissipation capabilities of commonly used core shapes – where ferities and nanocystalline materials are considered. Due to the limited size of the paper only the results for nanocystalline cores are presented.

The statistical difference when calculating the allowed dissipated power of magnetic components based on the proposed improved step is evaluated. The difference is in the range of ±2%.

A second improved step for the Fast design approach is also suggested, where the work value of the magnetic inductance is determined using mathematical model.

The experimental verification of the suggested improved steps is presented in another work of the authors.

[Г.8.16.] Nikolov G., V. Valchev, E. Bekov, **A. Marinov**, *Verification of improved methodology for design of magnetic components*, International Scientific Conference on Information, Communication and Energy Systems and Technologies (ICEST), ISBN: 978 86 6125-033-0, Nis, Serbia, volume 1, 2011, pp. 933-937

The paper presents a verification of the suggested improvements in the methodology for design of magnetic components – Fast Design Approach. The improvements in the methodology are presented in a previous paper of the authors. The improvements include the possibility to include a wider range of soft magnetic materials as well as the possibility to include cooling in the design. Different approaches to cooling are presented – natural as well as forced.

For the purposes of the presented verification several transformers are designed and developed. The transformers are analyzed based on their specific application – namely a power source for an arc welder. The transformers for the experimental study are designed based on: (1) Magnetic core based on nanocystalline material; (2) Magnetic core based on conventional ferrite.

All the steps for the development of the transformer as well as the ways to improve the obtained result are presented. Detailed results are presented for each of the improved steps. When comparing designs for the different ferrite transformers based on several criterial one of the designs is selected for prototyping.

For the design of the nanocystalline based transformer the improved steps are also applied. Due to the limited volume of the paper only the data for the optimal nanocystalline based transformer is presented.

The selected transformer designs are prototyped and tested with a series of measurements of the losses using two independent approaches – calorimetric and with digital oscilloscope.

Obtained results show that the real losses are 3% less than the calculated losses. The minimal deviation between the calculated and the real losses show the accuracy of the suggested improved approach.

[Г.8.17.] Dimitrov B., **A. Marinov**, V. Valchev, *Experimental based selection of a structure of a power electronic converter for control of silicon carbide electric heater*, International Symposium on Electrical Apparatus and Technologies (SIELA), ISSN 1314-6297, Bourgas, Bulgaria, Volume 1, 2012, pp. 82-89

The paper presents the selection of a structure of a power electronic converter for control of silicon carbide heaters used in electro resistive furnaces. Based on an initial evaluation as an object of the study a total of four structure are selected. Those include: bridge and two transistor forward converter with or without rectifier at their output.

The selected circuits are experimentally studied using a specialized experimental setup. The control of a 2kW silicon carbide heater is studied. For each of the circuits, analysis of the current and the voltage on the primary and secondary of the transformer is made. The possibility to regulate the power on heater is also studied. Results from the study are presented as waveforms.

The analysis shows the following results: (1) All of the four circuits allow precise current and voltage regulation on the heater, where there is no significant difference between AC and DC output; (2) When using DC output, peaks in the secondary voltage of the transformer are observed; (3) For the two transistor converter higher peak currents are observed, which are related to higher switching losses.

The following conclusions are made for studied circuits: (1) Direct connection of the heater to the converter allows for better parameters; (2) The bridge circuit allows for better results in terms of semiconductor switch behavior.

[Г.8.18.] Marinov A., D. Bozalakov., P. Yankov, *Virtual analysis of a power electronic converter with passive control for gird interface of a wind turbine*, International Symposium on Electrical Apparatus and Technologies (SIELA), ISSN: 1314-6297, Bourgas, Bulgaria, Volume 1, 2012, pp. 218-225

The paper presents a study of system of power electronic converters, that allow the connection of a synchronous machine with permanent magnets working in generation mode to the single phase electrical grid. The application of the suggested system is aimed at wind turbines with low power. The specifics of the study are in the structure of the discussed structure, namely the suggested by the authors: (1) Specialized passive electronic converter for extracting maximum power from the generator at variable wind speeds; (2) Specialized electrical break. The two circuits are presented in details in previous studies of the authors – the current paper only presents their operation in the context of a complete solution that will allow the energy to be injected into the grid.

For the system a model for computer simulation is developed. The model is developed in the environment of MATLAB/Simulink. The model includes: (1) Electrical generator; (2) The passive power electronic converter presented by the authors; (3) Electrical break; (4) A single phase bridge inverter and a filter for electrical grid connection; (5) Control block for the single phase inverter. When using the model, a series of results are obtained. Those are presented in the paper and include several operation modes of systems, including an emergency one.

Based on the results the following conclusions are made: (1) The presented system includes two author's circuits and its partly verified by the presented studies; (2) The developed models are operational and can be developed in further studies.

[Г.8.19.] Stoyainov R., G. Nikolov, **A. Marinov**, *Battery charger with output power of 1500W for ultra-light electric vehicles*, International scientific conference UNITECH, ISSN 1313-230X, Gabrovo, Bulgaria, 2013, p-p. I 216 I-219

The paper presents a system of power electronic converters for development of a specialized power supply for charging of batteries used in electric vehicles. The main aspects of the discussed systems are its small size, weight and high efficiency. Its main blocks include: (1) A rectifier with electronic circuit for soft start of the device; (2) A boost converter for power factor correction; (3) Resonant half bridge DC/DC converter. Each block is presented and analyzed separately and as a whole system. A block diagram for the device with physical sizes and suggested mountings of the converter is presented.

The device is practically realized as a prototype. The prototype is studied and results are presented as waveforms. The results include: (1) Experimental study of the operation of the system for soft start; (2) The combined operation of the system for start and the power factor correction converter.

Based on the results the following can be concluded: (1) The complete design process and development of the system allows for low consumption in standby mode and general operation efficiency; (2) The circuit for soft start and its protections allow safe operation during short circuits and overloads as well for voltage drops – this is experimentally confirmed; (3) The converter for power factor correction consumes sinewave current – power factor is near unity and THDs are within norms for nominal loads.

[Г.8.20.] Dimitrov B., D. Dimitrov, **A. Marinov**, G. Nikolov, *Increasing the energy efficiency of vacuum contactors for medium and low voltage*, International scientific conference – 50 years of department "Electrical engineering and electrical technologies", ISSN 1311-896X, Varna, Bulgaria, 2013, pp 67-72

The main object of study presented in the paper is a power supply for driving the DC electromagnetic system of a contactor. The contactor is controlled by its own operational circuitry. This for example is the case for various vacuum contactors for low and medium voltage. The study aims to present a solution that can be used for retrofitting existing system that rely on ballast resistors for their power supply. This retrofit should significantly reduce the losses in the power supply.

The studies in the paper are done for contactor type KV-10-400. In order to specify the required parameters for the supply of the contactor, initial experimental studies that include the commutation process are presented in the paper as waveforms. Based on this experimental study two power electronic converter topologies are synthesized. The topologies differ in the way they switch the voltages that control the contactor. For the topology that switches the voltage by controlling the converter an electronic circuit is presented. For this circuit an example design is developed. The circuit is realized as a prototype and experimentally studied. Results from the experiments are presented as waveforms.

Based on the experimental studies the following conclusions can be formulated: (1) Retrofitting the contractor system with suggested circuits significantly reduces system losses; (2) The experimental studies show that converter topologies different than the one presented in the paper can also be used – for example half bridge or full bridge – if higher power is required; (3) Using the proposed converter allows for system efficiencies above 90%.

[Г.8.21.] Marinov A., E. Rosenov, D. Kovachev, *Computer and experimental set-up for evaluation of power losses in MOSFETS and IGBTS*, International conference on Electrical Machines, Drives and Power Systems (ELMA), ISSN 1313-4965, Varna, Bulgaria, pp. 108-113

The paper presents the possibility to develop a complementary system of model for computer simulations and experimental setup for evaluation of the losses of modern semiconductor switches – IGBT and MOSFET. The aim of the study is the development of an approach for fast and automated evaluation of switches based on computer simulations that can be verify by control experiments. The presented experimental setup is developed so minimum parasitic inductance and capacitance is present. The experimental setup allows for studies for: (1) Voltages up to 600V; (2) Currents up to 50A; (3) Frequencies up to 1MHz. The computer model is developed in the environment of MATLAB/Simulink in such a way so a maximum accuracy and similarity to the experimental setup can be achieved – parasitics are considered for the model.

The studies in the paper present a comparison between the model and the experimental studies. The comparison is made for the losses in a MOSFET at different conditions, such as: (1) Supply voltages of 50V, 75V and 100V; (2) Frequencies of 25kHz, 50kHz, 75kHz and 100kHz. The results from the analysis are shown as waveforms and tables.

Based on the results the following conclusion can be formulated: (1) The study of the model and experimental setups allows for comparability of the results between the two; (2) The model and experimental setup are additionally verified using other metering devices – calorimeter.

[Г.8.22.] Dimitrov B., E. Bekov, **A. Marinov**, *Study of supply installation for ozonation system of wind generators*, International Scientific Conference on Information, Communication and Energy Systems and Technologies (ICEST), ISBN: 978 86 6125-033-0, Nis, Serbia, volume 1, 2011, pp. 802-806

The paper presents the possibility for development of an ozonation system powered by a renewable energy source. The studied system includes: (1) Renewable energy source based on a wind turbine; (2) Boost transformer for high voltage; (3) System of electrodes for ark discharge formation. The main accent of the paper is the evaluation of the possibility for the system to work by direct connection of the transformer to the wind generator.

For the studied system an experimental setup is developed. The setup includes all of the aforementioned blocks. Based on the setup series of experiments are performed. The results from the experiments are presented as waveforms and tables. The experimental studies include: (1) Characteristics of the wind turbine recorded for one day; (2) The current trough the transformer with different electrode configurations; (3) The voltage on the primary winding of the transformer in function of time.

Based on the obtained results the following conclusion are made: (1) The studies allow for matching between the generator and ozonation system; (2) When designing the system, it is required to select the output voltage of the generator in such way so no overload in the boost transformer can occur; (3) The experiments provide a general characteristic of the operational modes of the system.

[Г.8.23.] Bekov E., B. Dimitrov, **A. Marinov**, *Analyses of characteristics and efficiency of fuel cell*, International Scientific Conference on Information, Communication and Energy Systems and Technologies (ICEST), ISBN: 978 86 6125-033-0, Nis, Serbia, volume 1, 2011, pp. 802-806, pp. 806-808

The paper presents a general study for the characteristics of a fuel cell with proton exchange membrane. A main accent is placed on the evaluating the efficiency of the fuel cell.

Experimentally the following parameters are studied: (1) Volt-ampere characteristic of the cell during electrolysis; (2) Volt-ampere characteristic of the cell during energy generation; (3) Load characteristics of the cell. The results from the study are presented in a graphical and table way.

Based on the studies the following conclusions are formulated: (1) The minimal voltage required for starting the process of the electrolysis of water is determined; (2) The energy generation potential is determined for the fuel cell; (3) Future studies on the topic are suggested – those studies are related to the increasing the maximal energy by connecting groups of cells.

[Г.8.24.] Dimitrov B., H. Tahrilov, **A. Marinov**, *Improving energy efficiency of industrial grade furnaces with electrical resistance heaters and comparative model-experiment analysis*, International Scientific Conference on Information, Communication and Energy Systems and Technologies (ICEST), ISBN: 978-619-167-003-1, Veliko Tarnovo, Bulgaria, volume 2, 2012, pp. 548-551,

The paper presents a methodology for optimization of industrial furnaces with electro resistive heaters, trough coordinated selection of isolation materials. The optimization function allows for minimal losses, weight and size.

The suggested methodology is presented step by step, where the main positions include: (1) The data base includes parameters of different thermal insulations and refractory materials for the different layers of the furnace; (2) Determining the geometric sizes and are of the studied furnace; (3) The initial calculations of the construction; (4) Development of an interactive model of the furnace; (5) Analysis if the data and selection of suitable materials based on the optimization function. Based on the suggested steps the relations required for obtaining minimal weight, size and losses are determined.

The optimization procedure is developed based on the scanning method and is applied to the calculation of an example furnace. The results from the calculations are presented as tables and graphs. For the given example, for verification purposes an experiment is conducted. Results from the experiment are compared to the calculations from the optimization procedure.

Based on the studies the following conclusions can be made: (1) The suggested methodology allows for design of new equipment and reconstruction of existing one using modern refractory and isolation materials in order to get minimal losses, weight and size; (2) A comparison between results from the procedure and its experimental verification show accuracy of the procedure between 3% and 7%.

[Г.8.25.] Nikolov G., A. Marinov, Experimental setup for testing stepper motors, International scientific conference UNITECH, ISSN 1313-230X, Gabrovo, Bulgaria, 2013, pp. I-154 I-159

The paper presents a setup for studying low power stepper motors operating at different work modes and loads. The main aim of the setup is to allow for evaluation of the characteristics and practical capabilities of a given stepper motor, where the technical data is incomplete. The setup allows for the development of algorithms that provide means to study the different motor parameters that are required for the given application. Using different loads, the characteristics of the given motor can be compared to those of existing devices so replacements can be found.

For the setup a block diagram is suggested. For each of the blocks a circuit and detailed description is provided. The setup is prototyped and series of experiments are performed. Specialized graphical interface is developed. The interface allows for visualization of the parameters of the studied motors.

[Г.8.26.] Nenov, H., G. Hristova, B. Dimitrov, **A. Marinov**, *Influence of the content and the structure of the Matlab code on the performance in GPU using*, International Symposium on Electrical Apparatus and Technologies (SIELA), ISSN 1314-6297, Bourgas, Bulgaria, Volume 1, 2014

The paper presents a comparative analysis for calculation procedures using different computer architectures. The main object of the study is a software code developed in the MATLAB environment, used for solving systems of differential equations.

Two modern architectures are object of the study – GCN, AMD and CUDA Nvidia. An analysis for their principle of operation is made. The results from the analysis verify that the graphical processors allow for better computational capabilities compared to the main processor.

A series of experiments with studied architectures is made. The results show better performance with the Nvidia processor.