13-th NATIONAL CONFERENCE
WITH INTERNATIONAL PARTICIPATION

ELECTRONICA 2022

PROGRAMME

19 – 20 May 2022
Sofia

National Science and Technical Centre
108 Rakovski Str.
&
Virtual room

XIII NATIONAL CONFERENCE WITH INTERNATIONAL PARTICIPATION "ELECTRONICA 2022"

Organized by:

The Union of Electronics, Electrical Engineering and Telecommunications (CEEC),

Technical University of Sofia (TU-Sofia),

IEEE Bulgarian Section,

and Faculty of Electronic Engineering and Technologies (FEET)

"ELECTRONICA 2022" is technically co-sponsor by IEEE *(Conference record # 55578)*

and is part of the "Science Days of TU-Sofia" forum

In cooperation with:

Federation of the Scientific and Technical Unions in Bulgaria (FNTS),
Bulgarian Academy of Sciences (BAS),
University of Applied Sciences - Offenburg,
Riga Technical University,
VDE – Germany and
Leading Electronics Companies.

XIII NATIONAL CONFERENCE WITH INTERNATIONAL PARTICIPATION ELECTRONICA 2022

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XIII NATIONAL CONFERENCE WITH INTERNATIONAL PARTICIPATION "ELECTRONICA 2022"

	Hour	Event
Wednesday 18 May	16.00-18.00	**Registration of participants & test the system** (Hall 3 & Virtual room 1) Webex software
Thursday 19 May	9:00 – 10:00	**Registration of participants** Hall 3
	10.00-10.30	**Opening Session** Hall 3 & Virtual room 1
	10.30-12.00	**Scientific Session 1** **Circuit and systems, Biomedical Engineering** Hall 3 & Virtual room 1
	12.00-13.00	Lunch break
	13.00-14.30	**Invited papers & Workshop** Opportunities for cooperation within the framework of the European University of Technology (EUt+) and business needs Hall 3 & Virtual room 1
	14.30-15.00	Coffee break
	15.00-17.00	Education in Electronics and business needs. Discussion with leading companies in electronics. Hall 3 & Virtual room 1
	17.00-18.00	„Alumni meeting"- Informal discussion Hall 3
Friday 20 May	09.00 -11.30	**Scientific Session 2** **Information and Communication Technologies** Hall 3 & Virtual room 1
	11.30 -12.00	Coffee break
	12.00 -13.30	**Scientific Session 3** **Micro and nanoelectronics, Advanced materials** Hall 3 & Virtual room 1
	13.30 -14.00	Lunch break
	14.00-16.30	**Scientific Session 4** **Power electronics, Industrial electronics** Hall 3 & Virtual room 1
	16.30 -16.45	Coffee break
	16.45 -18.00	**Scientific Session 5** **Instrumentation and Measurement, IoT** Hall 3 & Virtual room 1
	18.00 -18.15	Coffee break
	18.15 -19.00	**Scientific Session 6** **Mechatronic systems, Innovation management in electronics** Hall 3 & Virtual room 1
	19:00	Closing Session Hall 3 & Virtual room 1

https://e-university.tu-sofia.bg/e-conf/?r=28

Virtual room 1 -
https://technicaluniversityofsofia.my.webex.com/technicaluniversityofsofia.my/j.php?MTID=m592244163a5731612cd50e6ddc0d3f3e

Opening Session 10.00 - 10.30

Hall 3 & Virtual room 1, **Thursday 19 May 2022**

Scientific Sessions 1 10.30 -12.00

Hall 3 & Virtual room 1, **Thursday 19 May 2022**

Workshop 13.00 – 14.30

Hall 3 & Virtual room 1, **Thursday 19 May 2022**

Opportunities for cooperation within the framework of the European University of Technology (EUt+) and business needs

- Assoc. Prof. Elica Gieva – Technical University of Sofia, Bulgaria
- Dr. Kaspars Kroics – Riga Technical University, Latvia
- Assoc. Prof. Anna Litvinenko - Riga Technical University, Latvia
- Prof. Marius Neag – Technical University of Cluj-Napoca, Romania
- Prof. Marius Purcar - Technical University of Cluj-Napoca, Romania
- Dr. Christophe Couteau - University of Technology of Troyes (UTT), Troyes, France
- Prof. George Angelov - Technical University of Sofia, Bulgaria
- Assoc. Prof. Maria Aleksandrova – Technical University of Sofia, Bulgaria
- Assoc. Prof. Vladimir Dimitrov – Technical University of Sofia, Bulgaria

Discussion 15.00-17.00

Hall 3 & Virtual room 1, **Thursday 19 May 2022**

Education in Electronics and business needs. Discussion with leading companies in electronics.

Discussion on scientific projects.

Scientific Sessions 2, 3, 4, 5 and 6 9.00-19.00

Hall 3 & Virtual room 1, **Friday 20 May 2022**

Closing Session 19.00

Scientific Session 1

Circuit and systems, Biomedical Engineering

Hall 3 & Virtual room 1, **Thursday 19 May, 10.30 – 12.00**

Chairpersons: Ivo ILIEV, Ivo PANDIEV

1.1 3D Modeling of Magnetic Stimulation of Cochlear Nerve

Valentin Mateev, Martin Alajov, Iliana Marinova

Here is presented 3D modeling of outer magnetic stimulation of cochlear nerve in realistic human head model. Transient Finite element method (FEM) modeling has been used. FEM model represents the anatomically precise geometrical model of human head with known tissue electrical conductivities. Induced voltages and flux densities in the cochlear nerve are determined due to stimulation coil distance and electric current. These data will be used for advanced stimulation coil design, with possible application for direct human-to-machine interface.

1.2 Field Oriented Approach in Wireless Power Transfer

Valentin Mateev, Iliana Marinova

Here is proposed a wireless power transmission system modeling based on electromagnetic coupling. Description of main system blocks, operational limitations, efficiency and environmental issues are discussed. Transmission is based on resistive induction coils coupling with ferromagnetic concentrators. Electromagnetic field modeling is performed by a 3D finite element method model. Provided results are analyzed from electromagnetic field oriented point of view approach in wireless power transfer for obtaining optimal transmission power under various conditions such as distance, alignment, mutual inductance, frequency and output load.

1.3 Chaotic System based Pseudo Random Bit Generator and Post-processor Design for Image Encryption

Barış Karakaya

This paper presents an implementation of both continuous and discrete time chaotic systems based pseudo random bit generation by using three dimensional Lorenz system and one dimensional Logistic map. As the chaotic systems are preferred in random number generator applications, two different chaotic systems are used as entropy source in the proposed design to make the design more secure. The electronic circuit equivalences of chaotic systems are designed and simulated on Orcad-Pspice environment to obtain values of state variables in fractional number format and input to proposed post-processor algorithm. The generated random bit stream is tested by using NIST 800.22 statistical test suite to demonstrate the randomness of proposed system statistically. Also, an image encryption application is executed using pseudo random bit stream. The results of statistical tests and image encryption show that the proposed pseudo random bit generator is suitable and can be preferred in secure image/media transmission/communication systems.

1.4 Fractional and Integer Order Chaotic Systems based Pseudo Random Bit Generator for Secure Image Encryption

Esra İnce, Barış Karakaya and Mustafa Türk

This paper presents an implementation of continuous-time chaotic systems based pseudo random bit generation by using fractional order Chen-Lee and integer order Lorenz systems. As the chaotic systems are very popular in random bit generator applications, both fractional and integer order chaotic systems are used in the proposed design. The electronic circuit equivalence of chaotic systems are designed and simulated on Orcad-Pspice environment to apply as an entropy source to proposed a new post-processor algorithm. The generated random bit stream is tested by using NIST 800.22 statistical test suite to demonstrate the randomness of proposed system statistically. Also, an image encryption application is executed using pseudo random bit stream. The results of statistical

tests and image encryption show that the proposed pseudo random bit generator is suitable and can be preferred in secure image/media transmission/communication systems.

1.5 Laboratory Systems for Measuring Static and Dynamic Parameters of The Basic Circuit Configurations Employing Op-Amps

Ivailo M. Pandiev

This paper presents the structure and techniques for the use of two laboratory systems developed for the study of the basic small-signal DC and AC amplifier circuits employing operational amplifiers (op-amps). One of the two laboratory systems includes two electronic circuits of direct-coupled or dc amplifiers – inverting and non-inverting configuration, and for non-inverting configuration it is possible to set the voltage gain in different values. The second laboratory system is designed to study the two basic AC inverting and non-inverting amplifier circuits, using coupling and bypass capacitors. For both laboratory systems, a A741C general-purpose op-amp was used as the active building component, which provides in the transition band of the frequency response the gain rolloff equal to –20 dB/decade at a unity-gain bandwidth of 1 MHz and open-loop gain 105, respectively. In addition, the A741C op-amp provides the possibility of external adjustment of the input offset voltage, which can be performed by the students, as well as the internal structure includes many numbers of interesting microelectronic techniques that are important to study and validate by the students during the process of the experimental testing. The developed systems are intended for electronic education with second-year students on the Bachelor's degree program of "Electronics" and as well as "Automotive electronics" at the Technical University of Sofia.

1.6 Device for Electrical Acupuncture Stimulation

Ivanka Veneva, Pavel Venev, Dimitar Chakarov, Georgi Katsarov

The aim of this paper is to present the design and development of a multi-electrode device for electrical acupuncture stimulation. The system includes a control unit and a multi-electrode matrix for stimulating various acupuncture points on the legs or arms by applying electrical impulses. A graphical interface with interactive communication has been created to adjust the strength and duration of electrical pulses. The designed system provides real-time visualization, adjustment and feedback, guiding the operator in the steps of the therapeutic procedure, which makes rehabilitation therapy more adaptable to the patient's personal characteristics without creating inconvenience.

1.7 Improved Approach for Measuring Mains Interference

Georgy Mihov, Dimiter Badarov

The article presents a method for measuring the frequency and amplitude of the 1st and 3rd harmonics of mains disturbances. The first harmonic of the mains interference is removed from the signal using a basic band-pass filter. Simultaneously with the subtraction, the deviation of the mains frequency from its rated value is determined and the current correction of the band-pass filter is performed. The third harmonic is removed from the signal by means of an additional band-stop filter, the transfer coefficient of which is also continuously adjusted, together with the transfer coefficient of the main filter. After subtracting the harmonics from the signal, the ratio between the amplitudes of the third and the first harmonic is calculated. Results of research in the MATLAB environment are presented.

Scientific Session 2

Information and Communication Technologies

Hall 3 & Virtual room 1, **Friday 20 May, 9.00 - 11.30**

Chairpersons: Seferin MIRCHEV, Gabriela ATANASOVA

2.1. Connectivity Negotiation as a Service in Future Railway Mobile Communications

Evelina Pencheva, Ivaylo Atanasov, Ventsislav Trifonov

Future Railway Mobile Communication System (FRMCS) is defined as a telecommunication system for the railway sector. It is considered as a key factor for rail digitalization. The challenging requirements of FRMCS applications for ultra-high reliability and availability, low latency, safety, and security can be satisfied by fifth generation (5G) mobile networks. Writing applications that use specific telecommunication protocol to access connectivity management functions provided by the 5G network elements requires a high degree of network expertise. In this paper, the design of RESTful Application Programming Interface (API) for dynamic connectivity negotiation is presented. The API functionality is illustrated by typical uses cases, supported resources and data types. Modeling and implementation issues are discussed.

2.2. Use of Business Information Systems to Achieve Competitiveness

Serafeim A. Triantafyllou

The continuous flow of information and the rapid development of technology in today's times make business' survival a rather difficult and complex task. It is therefore necessary for the specialized organization and administration of each company to differentiate and strengthen its competitive advantages. All of these are prerequisites for operating in the long run. Traditional management is no longer effective unless it is combined with information management. Information systems can manage information from both the internal and external environment of the business and can help to increase its efficiency and competitiveness.

2.3. On the Suitability of Cloud Computing as an Information Aggregating Environment from Monitoring Systems

Emil Delinov, Anita Stoyanova, Ivanka Marasheva

The advantages of Cloud Computing are indisputable, when fast and efficient solutions are sought with flexible, scalable access to specialized resources (technologies, systems, etc.) and the predominance of operating costs over capital ones. Their careful and correct application would lead to competitive advantages in business. In this article are presents some results from one approach to the application of Cloud Computing for connectivity tests of monitoring systems for material objects. It is clear from them that cloud technologies are suitable as an information aggregation environment from such systems.

2.4. An Approach for an Application of Cloud Computing in Testing Connectivity of Monitoring Systems

Emil Delinov, Anita Stoyanova, Ivanka Marasheva

The rapid development of Cloud Computing makes them one of the most widely used technologies in the process of digital transformation. Consideration of their features and capabilities would be a prerequisite for success in implementation and use. Thus, their implementation would lead to competitive advantages in business. This article presents an approach to the application of Cloud Computing for connectivity tests of monitoring systems for monitoring of material objects.

2.5. IoT, Cloud, Consumers, Challenges for Smart Appliance Manufacturers

Anita Stoyanova

The development of Smart Appliance is mediated and supported by the constant expansion of both basic and related functionalities, as well as the market expansion of two modern technologies - IoT and Cloud Computing. This article also looks at the challenges that smart home appliance manufacturers typically face as they try to incorporate IoT and Cloud technologies into their innovative, modern-looking, customer-friendly products. They are related not only to the technological aspects, but also to the perceptions, attitudes, desires and even fears of consumers.

2.6. FPGA Based Edge Detection: Integer Division Algorithm with a Constant Divisor

Dimitre Kromichev

Proposed is an integer division algorithm with a constant divisor. It is to be used in the Gaussian filtering computations of FPGA based edge detection. The algorithm is explored for mathematical accuracy, maximum operating frequency and minimum number of clock cycles on the basis of ten Intel (Altera) FPGA families.

2.7. Helium Network - Integration of Blockchain Technologies in the Field of Telecommunications

Pavel Dzhunev

Helium is a P2P decentralized global wireless network targeting the Internet of Things segment using its own protocol, blockchain and cryptocurrency Helium (HNT). By deploying a sufficient number of Helium Network devices in an urban agglomeration, ubiquitous high-speed wireless Internet access can be provided with the quality inherent in WiFi coverage.

2.8. Android Content Providers in Mobile Distributed Computing

Gergana Mateeva, Dimitar Parvanov, Ioan Dimitrov, Iliyan Iliev, Todor Balabanov

Distributed computing and volunteer computing became very popular in the last two decades. Both are used for problems easily separable for simultaneous calculations on many heterogeneous machines. The only difference is that volunteer computing has been done on a donated calculating power. With the rise of smart mobile devices, volunteer computing appeared in the world of mobile distributed computing. With its capabilities, Android OS became an attractive environment for such computations. Android's Content Providers became a valuable tool for information transfer in mobile distributed computing applications.

2.9. Cloud Service Projects to Support Small and Medium-Sized Businesses and Approaches to Their Commercialization

Ademi Ospanova, Lazzat Kussepova, Berik Tuleuov, Gulmira Shakhmetova, Moldir Sabyrova, Nazira Zharaskhan

The paper discusses projects of cloud services for small and medium-sized businesses: "A WEB platform for automating the organization and maintenance of business events and information and analytical services with the EDS service" and "A cloud service for monitoring and protecting computer networks with intelligent hardware and software clients and effective virtualization technologies". The projects are promising both because of the possibility of developing and implementing new scientific and practical approaches, which are described in the work, and for optimizing the activities of small and medium-sized businesses due to the potential commercializability of project results; they represent a single object for organizing a consortium of research organizations and business enterprises of a separate country. It was told about the backlog for projects, features and new scientific and practical approaches to their implementation, as well as the prerequisites for the commercialization of project results.

2.10. Characterization of the Electromagnetic Properties of Materials for Wearable Antennas

Gabriela Atanasova, Nikolay Atanasov, Gergana Savova

Results of measurements of complex permittivity of the non-textile and textile materials, which can be used for an efficient design of wearable antennas are presented. Measurements of the electromagnetic properties of the materials were done at a single frequency of 2.56 GHz by the cavity perturbation method. The results show that non-textile materials (leather, paper, plastic from 3D DLP printing) have real part of the complex permittivity (ε_r') in the range of 2.0–3.0, while ε_r' of textile materials is in the range of 1.0–2.0. The results also showed that fabric structure (woven, knitted, or non-woven) has a direct effect on the ε_r', while the type of fibers (natural or synthetic) has a direct effect on the imaginary part of the permittivity and loss tangent.

2.11. Numerical and Experimental Evaluation of a Textile Wearable Antenna for On-body Communications

Nikolay Atanasov, Gabriela Atanasova, Blagovest Atanasov, Manol Avramov, Nikolay Hristov

This paper presents results from investigations of the parameters and characteristics of a fully textile wearable antenna with a shielding element in its structure for on-body wireless communications. Numerical simulations and experimental measurements of S-parameters were performed in the frequency range of 2.3 to 2.6 GHz for line-of-sight and non-line-of-sight scenarios using a homogeneous flat phantom. Specific absorption rate (SAR) generated by the fully textile wearable antenna is also assessed, and SAR distributions in several planes are presented.

2.12. Inventory Modeling for Resource Optimization

Todor Stoilov, Krasimira Stoilova

This research derives a quantitative model for the management of the amount of available working capital for the current payments of a husbandry. The optimal amount of the needed financial resources is evaluated, which have to cover daily the wages of labor workers. The optimal moment for taking a loan to maintain working capital has been determined, taking into account the time delay from incoming funds to cover the loans. The optimization model is based on formal relations, which originated from the theory of inventory modeling and management. Numerical simulations and results are presented, which use current available financial data from the domains of agricultural and animal husbandries.

2.13. Comparison of Bi-Level And Nonlinear Optimization for Urban Traffic Control

Krasimira Stoilova, Todor Stoilov

The goal of the research is improving the traffic behavior at urban network of crossroads by decreasing the waiting vehicles in the network. The implementation of this goal is by bi-level optimization, which has significant advantages compared to the classical optimization. The added value in this research is the analytical formalization of the optimization problem. The problem gives advantages to the values of the outgoing flows in comparison with the incoming traffic flow at each direction of the network, which benefits the decrease of waiting vehicles. The research applies control rules of predictive control at each traffic light cycle by the bi-level optimization. This gives additional adaptation of the green light and cycle durations towards the traffic flows. The bi-level solutions are numerically evaluated and compared with the classical (one-criterion) optimization. The assessment of this comparison gives advantages to the bi-level optimization.

Scientific Session 3

Micro and nanoelectronics, Advanced materials

Hall 3 & Virtual room 1, **Friday 20 May, 12.00 - 13.30**

Chairpersons: George ANGELOV, Valentin KAMBUROV

3.1. Overview and Comparison of Methodologies for Design in Deep Submicron CMOS Processes

Aleksandar Petkov Radev

The paper gives an overview and comparison of three popular methodologies used for design and sizing of analog CMOS circuits in deep submicron technologies. The following methodologies are considered: design with models, based on the threshold voltage; design with simplified EKV models; design with the gm/ID methodology. The goal of the paper is to evaluate the use of these methodologies and their accuracy when used for hand calculations in the early stage of the design. For this purpose, the application of these three methodologies is demonstrated in the design of current mirror OTA in 45nm CMOS technology. The results from the sizing and the simulation of the circuit are analyzed and summarized.

3.2. Overview and Comparison of Methodologies for Extraction of the Specific Current of MOS Transistor

Aleksandar Petkov Radev

The paper presents an overview and comparison of four methodologies used for empirical determination of the specific current IS of MOS transistor. The goal of the paper is to evaluate the accuracy of these methodologies and whether the obtained results could be used for hand calculations in the early stage of the design of a CMOS circuit. For this purpose, the methodologies are applied for the extraction of the specific current of NMOS transistor in 45nm CMOS technology. The obtained results for IS are used to calculate the transfer characteristics of the transistor and are compared with transfer characteristics obtained with SPICE simulation to verify the accuracy of the methodologies.

3.3. Estimating Efficiency of Vibrational Piezoelectric Harvester for Human Accessory Integration

Rumyana Stoyanova

Abstract – Energy harvesting is a promising technique that can help produce renewable and clean energy and improve sustainability of the human society. The harvested electrical energy can be enough in theory for powering wireless sensors, others low consumption devices or even to replace the classical methods for electricity generation.

3.4. Electrical Characterization of Multisensor Elements with Ferroelectric Nanocoatings

Mariya Aleksandrova, Georgi Dobrikov

In this paper are presented the fabrication technology and main sensing characteristics of multisensor elements responding to force and temperature variation simultaneously. The sensors are based on silicon membranes with different size and pattern, coated with LiTaO3 ferroelectric thin film. It was found that the meander patterned membrane with size of 65 μm exhibited the most favorable piezoelectric and pyroelectric behavior, producing piezoelectric coefficient of 9 pC/N with a linearity error of 0.14 % and sensitivity of 0.41 pC/N. It is also characterized with pyroelectric voltage of 228 mV for the dynamic range up to 48 oC. The proposed element could be easy integrated with the conventional microfabrication technology, by applying a low number of photomasks, making it simple and low-cost. In addition, there is a negligible variation of the sensor

array's parameters across the wafer. Possible application of the device could be fluids level and temperature measurements for different industrial needs.

3.5. Electroless deposition of Cu-Ni-P Alloy Coatings on a Dielectric Surface for Application in Electronic

Mihaela G. Georgieva

In the present work, the influence of the concentration of nickel sulfate and the thickness of electroless deposited Cu-Ni-P alloy coatings on their uniformity is investigated. The obtained alloy are compared with electroless deposited copper and nickel coatings and characterized by AFM, XRF, adhesion, roughness and sheet resistance were measured.

3.6. Criteria and Approaches When Choosing an Electrode Material to Increase the Wear Resistance of Titanium Alloys by Electro Spark Deposition

Todor Penyashki, Georgy Kostadinov, Antonio Nikolov, Rayna Dimitrova, Valentin Kamburov, Mara Kandeva

Electrical spark deposition ESD is one of the lightest, cheapest and most promising technologies for creating coatings for various purposes on titanium products. However, the use of this method does not always lead to satisfactory results due to the choice of electrode materials unsuitable for the specific products and operating conditions. In this paper the basic criteria, principles and approaches for the selection of suitable materials to increase the surface hardness and abrasion resistance of titanium alloys by electrospark deposition are formulated and presented. The requirements for coatings are defined for different loads and cases of wear and on this basis the requirements for ESD materials are determined. From the numerous materials for ESD, the ones suitable for increasing the hardness and wear resistance of titanium surfaces have been selected and presented. Author's results are given, which illustrate the described approaches and principles. The established approaches provide increase of wear resistance, operational properties, durability and reliability of the modified surfaces and expansion of the scope of application of the titanium alloys.

3.7. Comparison of the Continuous Constrained Double Bending process with Equal Channel Angular Extrusion Conform process by simulation modelling

Valentin Kamburov, Antonio Nikolov

This paper investigates the possibility of creating conditions for severe plastic deformation by continuous constrained double bending with a small relative bending radius Rb⁄T of 0.7 to 0.1 in trapezoidal calibers (CCDB Conform), realized with the combination of two rolls and a bending roller. The process was analyzed and compared with the equal channel angular extrusion (ECAE Conform) using the accumulated effective strains, the workability parameter by SPD, the distribution of mean stresses and strain rates determined by simulation modelling. It is found that the equal channel angular extrusion scheme is a special case of the constrained double bending scheme with a very small relative bending radius ($Rb/T \leq 0.1$).

3.8. Existence and Uniqueness of a Periodic Solution of 3-Conductor Transmission Line System with Nonlinear Resistive Loads

George Angelov

This paper analyzes the electromagnetic compatibility characteristics of lossless transmission lines terminated by nonlinear loads suggested by C. Paul. The nonlinearities of the resistive loads are of polynomial type. We examine the mutual interaction between the two lines without neglecting the impact of the receptor line, which enables a more general mathematical model contrasted to the C. Paul model. We articulate a mixed problem for a system corresponding to 3-conductor transmission line. After that the hyperbolic system is transformed to a diagonal form and it is reduced to an initial value problem on the boundary. We obtained a system of two functional equations and two neutral equations for four unknown functions.

Scientific Session 4

POWER AND INDUSTRIAL ELECTRONICS

Hall 3 & Virtual room 1, **Friday 20 May, 14.00 - 16.30**

Chairpersons: Nikolay HINOV, Dimitar ARNAUDOV

4.1. Study of Power GaN MOSFET Gate Drivers
Dobroslav Dankov, Petko Marinov

This paper examines the properties and benefits of two types of control drivers for GaN MOSFET transistors. A comparative study of the drivers has been done with regard to turn-on and turn-off times of different types of transistors and also with regard to the quantity of the losses in the drivers at different frequencies.

4.2. A Study of a Phase-Shifted Full-Bridge LLC Resonant Converter Operating in Continuous Conduction Mode with ZVS
Tsvetana Grigorova, Aleksandar Vuchev

This paper discusses commutation mechanisms of power switches observed when phase-shift modulation is applied to control the output voltage in a full-bridge LLC resonant converter operating above resonant frequency. Its focus is on operation modes that allow ZVS commutation for all power devices from the two bridge legs. The results of a simulation study, which confirm the theoretical examinations, are also presented.

4.3. Analysis of Continuous Current Mode of an LLC Resonant DC-DC Converter at ZVS
Aleksandar Vuchev, Tsvetana Grigorova, Stoyan Vuchev

A theoretical analysis of a resonant LLC DC-DC converter operating in continuous current mode with zero voltage switching (ZVS) is performed. On the base of modeling the processes in the tank circuit with differential equations, expressions for the fundamental quantities for both step-down and step-up modes are derived. The conditions for the transition to the discontinuous current mode are determined. The boundary of the ZVS operating area is defined. Output characteristics of the converter are plotted graphically for different values of circuit and control parameters.

4.4. A Study of a Phase-Shifted Full-Bridge LLC Resonant Converter Operating at ZVS/ZCS
Aleksandar Vuchev, Tsvetana Grigorova

The present paper considers the switching mechanisms in power transistors when regulating the output voltage in a full-bridge LLC resonant converter by applying phase-shift modulation in continuous conduction mode and discontinuous conduction mode at ZVS/ZCS. The theoretical studies are verified with an OrCad Pspice simulation.

4.5. A Transformerless Rectifier with Power Factor Correction
Andrey Mirev, Yovko Rakanov, Juliana Javorova

This paper presents a new topology for transformerless rectifier for battery charging unit (BCU) with high power factor. The neutral grid terminal is connected to the negative battery terminal and to the ground. This is very suitable for charging batteries, mounted in vehicles with one terminal, connected to the car body because enables transformerless operation of the rectifier and safety servicing. The topology has a simple circuit design, which allows a high efficiency, low cost and high reliability. The operating principle is based on the pulse width modulation and the operating mode is buck-boost. In the paper are presented also the simulation model of the proposed rectifier, as well as simulation results.

4.6. Modelling of Dual Active Bridge Converter for Application in EVs Charging Station

Gergana Vacheva, Nikolay Hinov

In modern electric vehicles, more and more attention are being paid to recuperation. This requires the implementation of bidirectional converter topologies. This did not allow the use of a topology for the construction of a charging station with the ability to store energy in the grid or other energy storage element such as a supercapacitor or battery. This would improve the energy efficiency and optimal use of the power electronic converter. In the current research a mathematical model of dual active bridge converter for charging station application is presented. The model is realized in PSIM environment. This environment is oriented towards the design of different electronic circuits and allows various simulation studies.

4.7. Review of Methodologies for Life Cycle Assessment of Power Electronic Devices

Plamen Stanchev, Gergana Vacheva, Nikolay Hinov

In the current paper a review of the basic methodologies for estimation of the life cycle of the different power electronic devices is presented. Such a study is necessary in order to assess the residual life of various machines, systems and equipment with a view to the use of semiconductor components in them. In this way the economic justification for their purchase, modernization or utilization is modeled and optimized.

4.8. Automatic Quality Control of a Connector Assembly Line

Valentin Tsenev

In the present work, an automatic line for the production of connectors for the automotive industry is presented. The development in the introduction of automatic quality control is also considered. Through the use of statistics and machine learning, with the application of intelligent measuring systems, fully automatic quality control of the manufactured connectors has been achieved. The obtained results are analyzed and evaluated in terms of quality management standards for the automotive industry IATF 16949 and VDA 6. Conclusions are made about the achieved and future development, which is a guarantee for continuous improvement and sustainable development in the future.

4.9. Automatic Preparation of Contact Packages for Overmolding using Robots

Valentin Tsenev

The article presents the preparation of contact elements (contact package) with robots for the production of connectors for the automotive industry by overmolding. This is determined by compliance with the requirements of the INDUSTRY 4.0 standard. With the use of statistics, machine learning and the application of intelligent measuring systems, a fully automatic production process has been achieved. The obtained results are presented and analyzed. An assessment has been made in terms of quality management standards for the automotive industry IATF 16949 and VDA 6. Conclusions are made from what has been achieved and future development is recommended.

4.10. Measurement and Analysis of the Peel Strength for Solder Joints in LGA Electronic Assembly Using Statistical Methods

Valentin Tsenev, Nedyalko Peshev

The presented article examines the strong of solders after LGA (Land grid array) soldering. The strонг of the solders is evaluated with the maximum breaking strength. The methodology for measuring the breaking force and the implementation of the intelligent measuring system for this are presented. With the application of intelligent measuring systems and the use of machine learning, results have been obtained that meet the specification of the studied process. The results obtained by statistical processing are analyzed. An assessment has been made in terms of a specific

application. Conclusions are made regarding the achieved and future development for stabilization and guarantee of the soldering process with Hot bar.

4.11. Concept of Inductor with a Virtual Air Gap for Fault Current Capability Increasing in Traction Drive Applications

Kaspars Kroics, Jaroslavs Zarembo

The energy efficiency is important in many applications including electrical drives. DC powered electrical traction drives requires input filter to limit voltage fluctuations, electromagnetic interference, and limit fault currents. The losses into inductor of input filter can be reduced by applying magnetic core and reduction of number of windings. High fault current can lead to saturation of the core thus resulting into substantial inductance reduction. This paper analyzes possibility to introduce virtual air gap to limit core saturation and limit fault current. FEM simulation method is used to analyze magnetic flux in the core. The result shows that proposed method can be useful for such applications, but additional control is required to control current into electrical circuit that creates virtual air gap.

4.12. Energy Flows Management of a Multi-Port DC-DC Converter for an Energy Storage System

Dimitar Arnaudov, Faruk Ahmeti

A multi-port DC-DC converter has been studied in paper. It can be used both in energy storage systems and in power supplying systems with several sources. A high-frequency transformer integrates the converters of the multi-port converter. For converters, circuits with specific characteristics are used - resonant inverters with voltage limitation on the part of resonant capacitor. They can work as bidirectional converter. The paper describes the modes of operation of the converter in different directions of energy transmission. Results of research through simulation models are presented.

4.13. Common Issues Affecting the PV Systems Performance

Teodoros Petroglou, Lyudmila Taneva

The last few years more and more failures occur in old installed systems many of them could have been avoidant. The main problem studied in this paper is the unexpected reduction of electricity production in photovoltaic parks after a few years of operation. In many photovoltaic parks the performance ratio (PR) has fallen below 80% while normally it should be a little over 90%. This reduction in energy production leads to an increase in the payback period of investments. This paper will also explore the causes of reduced production and ways to recover from the problems but also improvements that can be made to increase energy production and reduce the maintenance costs. Firstly, the basic theoretical concepts are presented and in the next part, the paper sheds light on the problems occurred and the existing methods of their resolution.

4.14. Modeling of Small-Scale Hydrokinetic Turbine for Distributed Generation

Hristiyan Kanchev, Bogdan Gilev, Nikolay Hinov

The modelling of a small-scale hydrokinetic energy conversion system connected to a low voltage grid is presented in this paper. The developed model consists of a prime mover driven by low speed water stream, a permanent magnet synchronous generator, a DC-DC converter and grid-connected single phase inverter. The system model and control is implemented in the Matlab/Simulink environment. Maximum power point tracking of the generator is realized by a fuzzy logic controller. The developed model and MPPT controller are validated by simulations with variable water stream velocity. Simulation results confirm proper operation of the system. The developed model can further be used for simulations and studies of hybrid systems comprising several other generators, loads and energy storage devices.

4.15. Conversing to Electrical Car
Dimitar Arnaudov, Valentin Mishev, Hristo Batchvarov

The paper discusses problems in converting a classic car into an electric one. The peculiarities of the construction of the mechatronic system are discussed. Attention is paid to the power converters and the organization of the power system.

Scientific Session 5

Instrumentation and Measurement, IoT

Hall 3 & Virtual room 1, **Friday 20 May, 16.45 - 18.00**

Chairpersons: Marin MARINOV, Georgi NIKOLOV

5.1. Battery Thermal Image Sequence Processing
Sotir Sotirov, Nadezhda Kafadarova, Anna Stoynova, Silviya Stoyanova-Petrova, Diana Stoyanova, Nevena Mileva, Stefan Rizanov

The operating temperature of a lithium-ion battery is one of the key factors significantly affecting its performance. Heat is generated within the battery during the charging and discharging processes. On the other hand, battery internal faults lead to an increase in their temperature. Therefore, monitoring battery temperature can aid the identification of these faults and warn of their presence prior to the occurrence of permanent thermal damaging. When the battery heats up, at best there will be some mechanical distortion of the battery surface or changes in its chemical composition. In the worst case, the battery may burst, explode, or leak electrolytes. This article presents the developed specialized software for the analysis of thermographic images of batteries, via which extraction and visualization of necessary information regarding the resulting temperature changes over the entire battery surface or certain parts of it is made possible. Python version 3.9 was used during the software development. This software can successfully be implemented in systems aimed towards monitoring and controlling the temperature of batteries and evaluating their state of health and remaining useful life.

5.2. GPS Disciplined Numerically Controlled Oscillator Based on Xilinx FPGA
Dimiter Badarov, Georgy Mihov

The high precision frequency standard is important in most of the frequency and time measurements. The accurate frequency standards are expensive and hard to obtain. Most of the GPS receivers provide 1 pulse per second time standard which can be used to accurately discipline a crystal oscillator with a high short-term stability. The following work uses a high frequency unadjustable crystal oscillator followed by a numerically controlled oscillator in order to obtain a high stability frequency based on the 1 pulse per second GPS signal.

5.3. Multi-sensor System for Monitoring in Agriculture
Borislav Ganev, Hristo Hristov, Lyubomir Laskov, Alexander Popov, Marin Marinov

This paper presents the implementation of a system for monitoring some basic environmental parameters, necessary for accurate analysis in plant breeding. The observed parameters are air temperature at three different heights, relative humidity at three different heights, soil temperature, and humidity at two more points located at different depths.

5.4. Improvement Students' Perception for Subject Electrotechnics Through Laboratory Exercises

Mirjana Kocaleva, Zoran Zlatev, Nikolay Hinov

The situation in education is the same in both Macedonia and Bulgaria. Students have difficulty learning technical sciences and have difficulty solving math problems. For that purpose, to help the students, and thus ourselves to be better understood, we decided to offer the students laboratory tasks solutions. The tasks are from the subject Electrotechnics, which is studied in first semester. Laboratory solutions will be displayed using MATLAB and LabVIEW to make student easier to visually understand the material and define the solution to the tasks.

5.5. Research of Automotive Infotainment System and Design it with IoT Connectivity

Neven Nikolov

This paper are describe research of Automotive infotainment system and his design it with IoT connectivity. The idea is to connect the comfort network in the car – VAN bus to send the Telemetry data to the IoT Cloud. The telemetry data are the info messages to the driver, car speed, RPM, engine temperature, oil level and another. To achieve this are used Esp32 microcontroller with IoT connectivity to the internet.

5.6. Using of Batteryless LoRaWAN Ultrasonic Sensor Node for Smart Garbage Collecting

Stanislav Asenov, Dimitar Tokmakov

This paper presents the use of a batteryless LoRaWAN ultrasonic sensor node for the realization of a LoRa-based smart garbage collection, to be employed for waste management in the Smart Cities context. In particular, the article presents the possibility of using LoRaWAN waterproof ultrasonic sensor nodes powered by solar harvester systems to measure the level of waste in the waste bin, as well as to reduce harmful emissions from garbage trucks by reducing the fuel consumption of them by reducing the frequency of the waste collection procedure.

5.7. Information System for Farm Animals and Pastures Surveillance

Irena Valova Tsvetelina Mladenova

There are numerous experiments and systems dedicated on the surveillance of farm animals or pastures. However, many of them are concentrated on only one problem at time – farm animals' health, animals' movement, pastures classifications, animals' predictions, etc. The systems that give solution to some of the problems are few and even they do not cover all of the aspects at once. The proposed information system is a combination of hardware and software components that give the ability to the users, more precisely farmers and vets, to track the whole process of livestock farming. This article is an explanation of the design and development of the software part of the system.

Scientific Session 6

Mechatronic systems, Innovation management in electronics

Hall 3 & Virtual room 1, **Friday 20 May, 18.15 - 19.00**

Chairpersons: Dimitar ARNAUDOV, Stefan PATCHEDJIEV

6.1. Design and Experiments of a Pneumatic Powered Exoskeleton for Rehabilitation and Training

Dimitar Chakarov, Ivanka Veneva, Pavel Venev, Mihail Tsveov

This article includes the development of an exoskeleton of the upper limbs for rehabilitation and training. The aim of the work is to find and evaluate an appropriate exoskeleton solution that provides accurate force feedback and achieves transparency and natural safety. The paper examines the mechanical structure and actuation of the exoskeleton arm. The proposed design with pneumatic drive allows the therapist to achieve its inherent safety and transparency at all stages of the rehabilitation process. Simulations and evaluations of the interaction force between the patient and the exoskeleton are performed. Here, the force of the interaction as a result of the gravity and the elastic properties of the exoskeleton are evaluated. Transparency is assessed in different cases, depending on active or passive control modes. Finally, conclusions and future work are given.

6.2. Study of the Machining Processes in a Type of CNC Lathes

Marin Zhilevski, Mikho Mikhov

The main features of a type of lathe machines with computer numerical control are discussed in this paper. Based on formulated requirements to these machines, a simplified block diagram of the drive system is composed. The machining modes and cutting forces are determined by the machining parameters. The basic ones in turning are the cutting speed, feed and cutting depth. They affect the accuracy, the roughness, speed and the performance of the whole machine. The methodology applied includes a theoretical approach and an appropriate experimental study. The practical application is demonstrated with machining of some workpieces. Based on the developed geometric model the machining parameters and the tool life for different materials are determined. Some machining operations are shown and discussed. The energy consumption of the drive system in the studied machines is also analyzed. The research held and the results obtained can be used in the application of such lathe machines with computer numerical control.

6.3. Using of 3D printing Technologies in the Manufacture of Mechatronic Products

Stiliyan Nikolov, Reneta Dimitrova, Slav Dimitrov

The successful implementation of the new technologies requires their connection with the production goals of the companies and the practices and technologies used by them. The advantages that these technologies provide to the designers of mechatronic products are indicated. The influence of the orientation of the manufactured products in 3D printing using the technology of deposition of molten material on the need to add supporting material and the duration of the manufacturing process has been determined.

6.4. Scaled Agile Framework for Achieving Speed and Customer Satisfaction at A Large Scale

Nikola Gaydarov, Roumiana Ilieva

The main goal of this article is to identify the current challenges each organization is facing and then to address the fact that on a larger scale the issues will only become greater and more complicated. As a solution to those challenges one of the arising frameworks for scaled Agile - SAFe 5.1 was described in detail.

Closing Session

Hall 3 & Virtual room 1

Hall 3 & Virtual room 1**, Friday 20 May, 19.00**

INFORMATION

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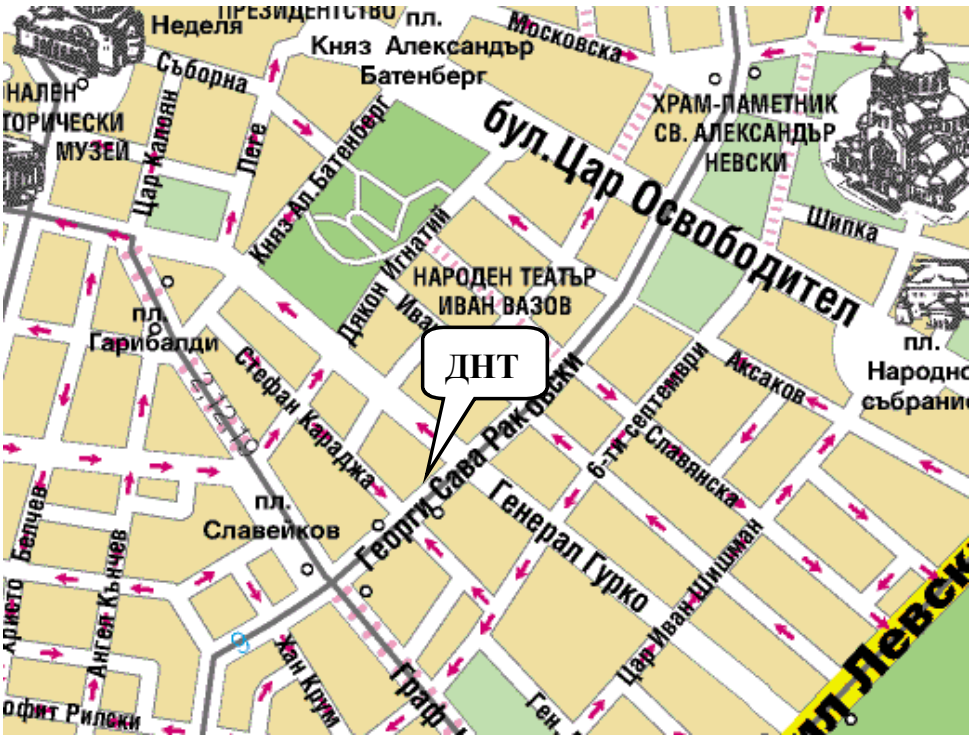

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