

OPINION

by Assoc. Prof. Dr. Eng. Nikolay Lyuboslavov Hinov, in the academic position of "Associate Professor" at the Technical University - Sofia, in the professional field

5.2. Electrical engineering, electronics and automation

of the materials submitted for participation in the competition for holding the academic position "Associate Professor" in the field of higher education - 5. Technical sciences, in the professional field - 5.2. Electrical engineering, electronics and automation, specialty - "Industrial Electronics" (Reliability of electronic systems, Design and technology of electronic equipment, Design of communication equipment).

In the competition for associate professor, announced in the Official Gazette, issue 68 from 31.07.2020 and on the website of the Technical University - Gabrovo for the needs of the Department of Electronics at the Faculty of Electrical Engineering and Electronics, as the only candidate involved Assistant Professor Dr. Eng. Prodan Ivanov Prodanov.

1. Overview of the content and results in the presented works

After the analysis of the scientific works, which Assistant Professor Prodan Prodanov, presents for participation in the competition for the academic position of "Associate Professor" they can be grouped in the following thematic areas:

- Analysis of the reliability of power electronic elements

The following publications can be referred to this direction: [B4.3, B4.5, B4.7, B4.8, B4.10, D7.4, D8.5, D8.11, D8.22, D8.23] The main part of these papers presents research and based on their analysis of the applicability of various methodologies for calculating the failure rate of electronic components. The main methods for forecasting the failure rate of electronic elements and the related analysis of the influence of electrical and thermal regimes of the elements on their reliability are considered. A new classification of the methodologies is proposed, with an additional branch added to it, to which the methodologies in mixed models should be assigned. Essential from a practical point of view is the ability to determine the limit values of thermal regimes of a whole class of powerful semiconductor elements - transistors, diodes and thyristors. With this approach, at a given level of reliability, the following are found: the maximum values of the cooling medium temperature (coolant or air), the maximum losses and the maximum thermal resistance of the cooling system. Results from the analysis of the reliability indicators of supercapacitors are presented by a method for analysis based on models that take into account the aging processes in the elements. An operating model of the supercapacitors has been created, and at a given level of reliability the permissible values of: temperature, operating voltage and equivalent series resistance are determined.

Based on these studies, conclusions and recommendations have been made regarding the operating modes of power electronic elements

- *Analysis and modelling of the reliability of power electronic systems*

This thematic group includes publications with the following numbers: [C.4.1, C.4.2, C.4.4, C4.6, C.4.9, C.4.11, D.8.1, D.8.3, D.8.6, D .8.9, D.8.15 and D.8.16]. Modelling and analysis of the reliability of power electronic systems is an important factor in ensuring the operation of the devices and according to modern trends in power electronics is a key tool in the design, prototyping, production and operation. On the basis of conducted probabilistic analysis and determination of time for preventive prophylaxis, researches on reliability of electronic converters for realization of induction technologies have been carried out, by combining different methods for reliability modelling such as: "Markov analysis", "Failure

tree" and "The theory of preventive prevention." Several probabilistic models are proposed, which determine: the type and impact of electronic protections; the intervals and the volume of preventive prophylaxis, the need to reserve separate modules and systems.

Using an analysis of the impact of operating conditions on the reliability of power supplies for induction technologies, the impact of a combination of environmental factors was assessed. A three-dimensional mathematical model is proposed, which determines the reliability of a certain power electronic system in relation to temperature, humidity, vibration and mechanical shocks.

Based on the research and analysis, specific measures are proposed to increase the reliability and correct determination of the warranty period of the studied systems.

Modelling and research of circuits and processes in power electronic systems

In the works [D.7.1, D.7.2, D.7.3, D.8.2, D.8.7, D.8.16, D.8.17, D8.18, D.8.19, D.8.21 and D8.20] have found a place the candidate's achievements related to modelling of electro thermal devices such as: the "inductor-detail" system in the processes of induction heating and power circuits of electronic converters of electric energy. I was well impressed by the practical focus of much of the work, such as the construction of working models and stands, as well as the reconstruction and improvement of the performance of existing technical solutions. Current research related to the introduction of new generations of SiC MOSFET transistors for the needs of induction heating of steel parts are proposed.

Modelling, construction and research of position drives

The works [D.8.4, D8.8, D8.10, D8.12 and D8.13] are related to modelling, analysis, design and implementation of electronic control systems for stepper and servomotors. The research in this direction is related to the modelling of the mechanical characteristics of stepper motors and on this basis the realization of highly efficient control, through the improvement of the electronic converters and the synthesis of control.

2. General characteristics of the candidate's activity

2.1. Educational and pedagogical activity

Assistant Professor Dr. Prodan Prodanov has a long teaching career in the Department of Electronics at TU-Gabrovo (currently over 10 years). He teaches 4 subjects for Bachelor's degree and two for Master's degree. To participate in the competition, the candidate has submitted 2 textbooks and 2 teaching aids.

In the latter, under the leadership of the candidate, they have successfully defended over 50 graduates of Bachelor's and Master's degrees. Prodan Prodanov is the author of teaching programs in 9 subjects and has built three training laboratories at the Department of Electronics at the Technical University of Gabrovo.

The candidate has very good computer literacy and is fluent in English.

2.2. Scientific and scientific-applied activity

The candidate has participated in 7 research projects at the UCNIT of TU - Gabrovo, and one of them was the head. In addition, he is a participant in 3 projects funded by various Operational Programs and in a project of the Research Fund. The thematic focus of the contracts with the participation of Prodan Prodanov is related to the study of the reliability of electronic elements and devices and the use of electronic systems in industry.

2.3. Implementation activity

The candidate has presented 4 official notes regarding his implementation activities related to: improving the operation of volumetric heating machines for forging and pressing technologies, implementation of intelligent drives for the needs of 3D printers and the production of electric motors.

The review of the materials submitted for participation in the competition gives me reason to convincingly claim that Assistant Professor Dr. P. Prodanov has excellent qualifications and very good achievements in the field of guaranteeing the performance of

power electronic converters based on analysis of operating conditions and research and improvement of reliability.

3. Contributions (scientific, scientific-applied, applied). Significance of contributions to science and practice

I accept a large part of the contributions, formulated by the author on the basis of the publications, for participation in the competition for AD "Associate Professor" - a total of 38 scientific articles and reports. In essence, they are mainly of a scientific-applied nature. They can be summarized as follows:

- A classification structure and analysis of the applicability of the existing methods for analysis of the failure rate of electronic elements used for the implementation of power electronic devices and systems;

- A new model-based approach for analysis of the reliability of MOSFET transistors and supercapacitors has been proposed and verified, through which the limit values of the thermal regimes of power semiconductor elements have been determined;

- A three-dimensional mathematical model has been developed to determine the field of reliable operation of power electronic devices and systems, as a function of operating conditions and operating modes. With the help of the model, reliability characteristics and warranty period are found, the effectiveness of the protection schemes is analysed and specific recommendations are given for increasing the reliability;

- Operational models of electronic energy converters have been synthesized with applications in industry and in energy storage systems taking into account the time for preventive maintenance, functional connections for reliability, redundancy, protective conditions, planned prevention and repair, and based on them, researched and implemented power electronic devices and systems with improved functional capabilities and guaranteed indicators;

- Simulation models of systems for: induction heating of metals, including power electronic converters and the system "inductor - part" and intelligent electric drive are proposed, through which results are obtained, serving to improve the operating modes and control synthesis.

4. Assessment of the personal contribution of the candidate

Assistant Professor Dr. Prodan Prodanov is a long time lecturer and researcher with research related to the topic of the competition. After acquaintance and analysis with his developments and achievements presented in his scientific works, I believe that the candidate has a serious personal contribution and leading participation in them.

5. Critical remarks and recommendations

My general impression of the materials submitted for participation in the competition is very good. On the other hand, I would like to make the following remarks and recommendations, which generally consist of the following:

- The contributions presented in the author's reference largely reflect the results achieved and it is good that they are specific. In my opinion, they should be summarized and edited in such a way as to better highlight the author's claims and to avoid duplication, as they are essentially quite close to the main areas of activity presented above;

- with the good awareness and degree of mastery of modern software products shown by the author, a natural continuation and confirmation of his research is the performance of modelling and simulation research with the packages ORCAD, PSIM, PLEX, MATLAB / Simulink and others.

- I recommend the candidate to participate in other international scientific conferences in Bulgaria and Europe, as well as to publish in journals with impact factor (IF) and / or impact rank (SJR).

6. Personal impressions

I know the candidate from his participation in scientific forums in the country. The reports presented by him have aroused interest and as a result have provoked in-depth discussions in the guild of specialists in Industrial and Power Electronics. The materials presented for participation in the competition give me reason to claim that Assistant Professor P. Prodanov has an excellent qualification and is a well-known specialist in the field of industrial electronics, in particular: reliability of power electronic devices and systems and construction and technology of electronic equipment.

7. Conclusion:

Having in mind the above, I propose Assistant Professor Dr. Eng. Prodan Ivanov Prodanov to be elected "Associate Professor" in the field of higher education - 5. Technical sciences, professional field - 5.2. Electrical engineering, electronics and automation, specialty - "Industrial Electronics" (Reliability of electronic systems, Design and technology of electronic equipment, Design of communication equipment).

16.12.2020

Jury member: /signature/

/ Assoc. Prof. Dr. Eng. Nikolay Hinov /