

## OPINION

by Dr., Eng. Todor Stoyanov Djamiykov, Professor at the Technical University - Sofia for a dissertation for the award of the educational and scientific degree " Doctor " in the field of higher education 5 Technical Sciences, professional field 5.3. Communication and computer technology, doctoral program "Automation of areas of non-material sphere (medicine, education, science, administration, etc.). ".

Author: mag. Eng. Stanislav Mitkov Assenov, Topic: "Design, research and optimization of wireless sensor nodes with low power consumption." Supervisor: Assoc. Prof. Dr. Dimitar Mihailov Tokmakov - PU "Paisii Hilendarski".

### **1. General presentation of the procedure and the doctoral student**

Presented by Mag. Eng. S. Assenov set of materials on paper is in accordance with Article 36 (1) of the Regulations for the development of the academic staff of PU. Includes following documents: an application to the Rector of PU disclosure procedure to protect disulphur and discriminatory labor, CV, record of the preliminary discussion of the department council dissertation, abstract thesis on Bulgarian and English, a list of scientific publications, copies of scientific publications, list of observed citations and declaration of originality and authenticity of the attached documents.

### **2. Relevance of the topic**

The use of more and more electronic devices to increase the comfort and safety of mankind leads to a multiple increase in electricity consumption. This problem is painful when the devices are wireless, and battery powered. The object of the dissertation is the analysis of the possibilities of the existing sensor hardware (microcontroller) and software platforms for work with less energy and the offer of new solutions for reduction of consumption. This goal is an urgent task both for the country and worldwide. Regardless of the results achieved, the problem of reducing the electrical consumption of autonomous sensor and communication devices will remain in the future.

### **3. Knowledge of the problem**

The doctoral student is very well acquainted with the issues related to the low-energy power supply of sensor units. Publications and scientific achievements of current authors, on which the claim for novelty and originality in the dissertation is based, are critically analysed. The material used from 165 literature sources was creatively interpreted, and an analysis of the ways to reduce the energy consumed by the sensor unit was performed. A modern element base was used for the realization of the experiments.

### **4. Research methodology**

To achieve the goal of researching and designing and optimizing wireless sensor units with low power consumption, an energy efficient model of LoRaWAN sensor unit with low consumption, sensor unit architecture based on hardware and software solutions with powerful low-energy microcontrollers has been proposed as well as harvester systems without battery power. I believe that in the dissertation work a research methodology has been chosen correctly, which fully corresponds to the set goal and ensuing tasks.

### **5. Characteristics and evaluation of the dissertation and contributions**

The dissertation has a total volume of 165 pages, of which the author's text on the topic is developed on 149 pages. The first chapter reviews and analyses the architectures of wire-

less sensor units, power supplies, energy efficiency indicators and energy consumption models. As a result of the analysis and the equation, at the end of the chapter a goal is set correctly and the resulting 4 tasks for solving are formulated. In the next 3 chapters, consistency, logical connection, and methodology are achieved in the presentation of the new important, regarding the contributions theoretical and practical solutions.

The contributions presented in the dissertation correspond to its purpose from the implementation of the set tasks. 4 scientifically applied and 6 applied contributions are formulated. The personal contribution of the author mag. Eng. S. Assenov is convincing.

## **6. Evaluation of the publications and personal contribution of the doctoral student**

In the present dissertation, the doctoral student participates with a total of 8 scientific publications. 6 publications are indexed in Scopus, all of them co-authored. One publication is in 2019, 3 (three) in 2020 and 2 (two) in the current year for which a note has been submitted that they have been accepted for publication. (2) two publications in peer-reviewed scientific journals are also presented. One of the publications is independent. All publications are made on forums in Bulgaria. The co-authored publications are only with the supervisor, which gives me reason to believe that the personal contribution of the magician. Eng. S. Assenov is essential. The attached publications reflect a significant part of the dissertation. The fact that the publications are in the last 3 years shows the topicality and the current level of work and the achieved results. This is confirmed by the presented list of 8 citations of the 2019 publication.

## **7. Abstract**

The review of the dissertation abstract shows full compliance with the requirements for its preparation, as well as the adequacy of reflecting the main points and contributions of the dissertation. The abstract can reasonably be evaluated and characterized as a synthesized version of the dissertation, correctly showing its content, the achieved theoretical and practical results and the defined contributions contained in the full text of the dissertation.

## **8. Recommendations for future use of dissertation contributions and results**

I have the following notes to the dissertation for ONS "Doctor", which do not reduce the significance of the obtained results, but rather can be considered as recommendations for the future creative activity of the mag. Eng. S. Assenov.

1. Of an editorial nature regarding the distribution of the volume of work in the separate chapters. Instead of the first analytical part being the largest with 165 literature sources used, the largest is Chapter 3. The figures and graphics in the work are not in one standard and format, some are of low quality. In some places there are sentences that are difficult to understand in terms of engineering.
2. The paper presents the results of measuring low levels of energy consumption. There is no data or comment on the accuracy with which the measurements were made and whether there are any factors that affect it.
3. For the sensor nodes selected for consideration, it is not clear how the physical quantities to be measured and the specific sensor element, integrated sensor or intelligent sensor are selected. The interpretation of the data received from the integrated radiation sensor TSL2591 (pages 68, 69) is incorrect. Will the consumption change if additional processing is required to present the data received from the sensor?

## **CONCLUSION**

The dissertation contains scientific-applied and applied results, which represent an original contribution to science and meet the requirements of the Law for development of the academic staff in the Republic of Bulgaria (ZRASRB). The dissertation shows that the doctoral student mag. Eng. Stanislav Mitkov Assenov has in-depth theoretical knowledge and professional skills, demonstrating qualities and skills for independent research.

I confidently give my positive assessment of the research, presented by the above-reviewed dissertation, abstract, results and contributions, and I propose to the esteemed scientific jury to award the educational and scientific degree "Doctor" to Mag. Eng. Stanislav Mitkov Assenov in the field of higher education: Technical sciences, professional field of Communication and Computer Engineering, doctoral program "Automation of areas of the intangible field (medicine, education, science, administrative activities, etc.)".

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Prepared the opinion.....  
(Prof. Dr. Eng. Todor Djamiykov)