LODZ UNIVERSITY OF TECHNOLOGY

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Abstract of PhD Thesis

Correction of the metrological properties of traction watt-hours meters

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In the doctoral dissertation an attempt is made to demonstrate the suitability of the fuzzy logic controller for an error correction in a railway traction electricity meters which is a cause of big dynamics of its current supply drive unit, an electric multiple unit (EMU). This correction is the appropriate selection of the current path of the solid processing counter, taking into account the effective value and the rate of change of this parameter and the current distortion of the power drive unit.

The reason for the deformation of the current flowing in the catenary is the use of the modernized electric multiple unit, energo-electronic bridge converters to power the induction motors. The literature shows the waveforms of the input current of such converters. Using these waveforms and a diagram of the traction converter, the author of this dissertation has developed its simulation model. This model was used to evaluate the suitability of the developed correction circuit processing constant, input current path counter. An analysis of the results of the computer simulation of the measured values of the input current of the inverter shows that during the movement of a train, (from the start to end) the voltage range of an analog-to-digital converter in a microprocessor system is used.

The accuracy value of the electricity consumed by the electric drive unit of a train depends on a number of factors. One of these factors is the structure of the counter. In the chapter "Traction electricity meters" it has been shown that to measure the electricity of the traction of a train, dedicated electro-energy power counter circuits cannot be used.

Modern measuring systems are based largely on software engineering. Designers of the systems set them up in accordance with the idea of object-oriented programming (OOP), through the use of design patterns and data encapsulation using the word “class”. The software language used to build the program in real-time embedded systems is not similar to the natural (understood by humans) language due to the lack of

use of encapsulation (one of the main goals of object-oriented programming). Most of the microprocessor systems are based on a structural programming language – “ANSI C”. The structural language’s disadvantage is the large amount of code subdivided into modules communicating through well- known interfaces. Working with the same code establishes an inflexible system which is difficult to refactor. Only the use of the fuzzy logic controller based on expert knowledge, gives the system characteristics similar to natural language. It is simple and presents a clear record of fuzzy logic rules. The advantage of using fuzzy logic in procedures for correction of the input signal gain is the ability to use non-mathematical modeling system to obtain an estimate of the value measured.

The author of the paper proposed a new adaptive procedure parameter input current path of the active power converter and the traction electric meter for measuring the processed signals, based on fuzzy logic. The introduction of adaptive selection of a constant current circuit minimizes the processing of the measurement error count released by the input signals with low current effective values. The main task of the adaptation constant of the processing of the current path is to use the entire range of the analog-digital converter output appearing on the track.

The system uses a software correction cascading fuzzy logic controller implemented in a software’s microprocessor system memory counter. An input signal of the first cascade controller is: the effective value of the supply current drive unit complex of the train and a derivative thereof. In this controller, based on predefined heuristic methods of the proceeding approximate value of the constant processing (gain) the counter current path is determined. The output of the first driver is transmitted directly to one of two inputs of the second controller. The second input of this driver is a rotational sliding speed of an induction motor drive of the electric locomotive. The use of this parameter allows you to take into consideration, when determining the gain of the path of the current meter, the electrical operating conditions of the train set

(EMU). The separation of the tasks between the two drivers were applied due to the multidimensionality of the procedures for designating an optimal value of the current circuit processing counter, due to the use of thorium processing range. The developed fuzzy logic controller uses two inference models: Mamdani and Takagi-Sugeno model.

The controller input responsive to the RMS current and its derivative has been designed by the author based on the model of Mamdani (M) characterized by many rules where IF and THEN parts use fuzzy logic. The accuracy of the hyper-construction input / output of this driver is determined by the number of points of its support. The number of credits depends on the timing of the procedure, which maps the Mamdani controller numerically. Due to the limited number of these points, the controller output signal indicates the approximate value of the constant current circuit processing counter. The cascade output driver which is built on the model of Takagi-Sugeno (TS) was used to increase the accuracy of determining the value of this constant. Unlike in the Mandani model, database rules of the TS driver only in part of the IF is fuzzy logic, and THEN is described as determined functional dependence. As a result, the output driver does not contain the block defuzyfikat, which by reducing computational complexity greatly simplifies the mapping controller operation and improves the system performance of a microprocessor counter.