Abstract doctoral dissertation M.Sc. Roman Sabat

The method of controlling LED light sources in railway signaling

The aim of the work was to develop a method for the control of spot light sources with LED diodes in the signal light circuits in existing classic railway and road signaling devices. Signals with matrices composed of many LED diodes, which also eliminate optical ophthalmic devices, require significant modification of the systems or complete replacement of components. Due to the large number of classic lens indicators operated in the railway network, it was justified to undertake efforts to develop a method for controlling LED light sources and to carry out the necessary analyses of the implementation of this method using LED light sources in this element of the railway infrastructure. One possibility is to replace a traditional incandescent light source in lens constructions of signal and road lanterns (adapted to filament bulbs), another - a more effective light source, improves the visibility of the signals by improving light parameters and achieving greater reliability of devices by selecting a source with significantly higher durability and less intensity of damage .

In order to achieve the basic objective of the work, the following sub-objective was adopted: conducting analyses of the implementation of LED light sources for the needs of railway signaling with lens systems.

Based on the analysis of the state of knowledge and the stated goal, the following thesis of the dissertation was defined: there is a possibility to develop a method for controlling LED light sources in railway signaling systems with lenticular optical systems of signal lanterns. The following assumptions were made when realising the goal and documenting the thesis:

- analysed issues related to existing (operated and manufactured) track-side signaling devices for railway and road signaling with optical systems with Fresnel lenses (internal color and colorless outer), constructionally adapted to 12 V / 24 W signal bulb as primary light source and 12 V / 12 W in as a reserve source;
- the light source with LED diodes is white, equally implemented in lens systems of signaling devices with lenses of different colors;
- verification of lighting parameters of the lantern with LED sources was carried out comparing with incandescent light sources based on laboratory tests of a typical signal head with attestations and type approval certificate;
- studies on the lighting parameters of the signals and light sources were carried out with instruments calibrated against a source of incandescent light with a colour temperature of 2854 K - as for currently used signaling devices with incandescent lamps;
- the analysis assumes that the intensity of damage to the system and components of the source is a constant factor - independent in the function of time and the probability distribution of correct work is exponential;
- for a light source with LED diodes, a model of a fail-safe control system has been developed, the implementation of which can be implemented without the need for any changes in the lighting circuits of control systems of station, line and level-crossing systems of various types;

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- verification of the developed method of LED source control based on theoretical analysis and results of computer simulation of the control system model;
- a light source with LED diodes should meet the same requirements for power supply conditions and parameters for signal bulbs and allow operation in both DC and AC circuits.

In order to achieve the goal and to document the truth of the presented scientific thesis, the results of analyses, research and descriptions in an orderly form with the division into subsequent chapters of the work are presented.

The first, second and third chapters contain the introduction, analysis of the state of knowledge and formulated the goal, thesis and assumptions of the dissertation.

The fourth chapter reviews rail signaling systems. It contains: technical requirements for signal bulbs, construction of the light head of the railway and road signaling device. Also included is the configuration of light circuits in stationary railway signaling systems, electrical parameters of railway signal lights, signaling in crossing systems and signaling systems with LED sources.

The fifth chapter analyses the implementation of LED light sources for the needs of railway signaling, defining the technical requirements for the light source, specifying the initial selection of LED light sources and parameters of reliability of light sources.

In the next part of the text, the parameters of LED light sources were selected and verified in laboratory tests with the measurement of light parameters of signal lanterns with signal bulb. The measurements of light parameters of signal lanterns with LED sources, comparison of light parameters of signal lanterns and traffic lights and LED light parameters as sources lights in signaling were also covered.

Chapter seven is a description of an innovative method of controlling LED light sources in railway signaling systems and includes a topology of the LED source control system. A description of the control method and system operation and verification of the adopted method, including results of mathematical analyses and computer simulation are given.

The eighth chapter contains the summary and conclusion confirming the implementation of the objective and documenting the thesis of the dissertation. The application effects of implementing the method of controlling LED light sources in signaling systems and determining the subject and scope of further research are covered here.

The ninth part of the work contains a bibliography. In the final part, there are lists of drawings, charts and tables. Attached to the dissertation are results with measurements of signal parameters of signal lanterns included in 54 statements.