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Concept of measuring force adjustment of crossover drives

Abstract: As part of the project in the Department of Control Systems in Transport it has been developed a system for automatic data collection and automatic forecasting the status of railway signalling devices. In the frame of the project it was also developed a prototype system for wireless measurement of currents in drive motor together with parameters of environment. The system will be used for the automatic diagnosis of crossover drives.

Keywords: Crossover drives; Force adjustment

System for automatic inference about device status

A characteristic feature of the objects of railway automation is that they can stay in a variety of operational reliability, diagnostic states, etc. Long-standing experience with exploitation of rail traffic control systems (SRK) confirms the relationship of their proper functioning with the reliability of systems and components making up the technical structures of the systems. The task of operating services is gathering information about the operation process of the examined objects and their transfer to a body coordinating the study. Application for Polish railways more modern SRK systems made on the basis of microprocessor and microcomputer technology cause the need of analysis and assessment of their performance, interoperability and forecasting exploitation consequences, including the renewal process, resulting from the implementation of these systems.

The system supporting the analysis of reliability and safety of railway automation systems designed in the Department of Control Systems in Transport will be particularly useful when evaluating systems SRK realized in microprocessor technology, as required by international institutions recommended by the CENELEC EN 50129, 50128. These guidelines defined by the European standardization committees (CENELEC) and the railway organizations (UIC, IRSE) bring to European railways obligation to designate and control the reliability indicators for computer systems SRK ensuring proper and safe operation. Data on the number of accidents on the railways also confirm the urgent need to improve diagnostic systems SRK. In terms of the number of accidents in Europe in 2012, Poland is the first with 327 events (for comparison: 152 in Germany, 100 in Romania). More than 80% of all accidents are related to the operation of rail traffic. An important factor in the growth of rail safety movement is also improving methods of making exploitation (reliability-maintenance) decision in systems SRK, the planning of the systems and methods of response in emergency situations.

Operational research is for devices SRK, the most effective source of information necessary for determining the numerical values of reliability indicators. These studies allow to get complete information about the behaviour of the system under exploitation conditions (use

and renewal). They are not only the basis for improving the design of technical facilities and production process, but also allow to obtain reliable information necessary for process controlling exploitation, including renovation, proper organization of service-repair infrastructure as well as forecasting and determining exploitation costs.

Application more modern systems SRK in Polish railways made on the basis of microprocessor and microcomputer technology causes the need to analyse and assess their performance, interoperability and forecasting operational consequences, including the renewal process, resulting from the implementation of these systems.

Forecasting the exploitation reliability of the SRK is to determine the reliability indicators, taking into account the working conditions and environmental influences. This action requires the collection and analysis of information about:

- the reliability model of the system,
- working conditions and environmental conditions,
- reliability characteristics of applied elements, components and software

The aim of the research work carried out in ZSSwT is to develop a system of automatic data acquisition and expert system to conclude about the status of devices. This will be achieved by the development of methods for analysing data from diagnostic devices SRK of railway automation.

The founded objective of the project will be implemented by:

- The construction of a new research laboratory with devices controlling traffic (and integration with existing laboratories at the Department),
- The design of automatic data collection system about equipment status. The construction of the reliability model of railway automation devices.
- The collection and preparation of data concerning equipment of SRK. The preparation of simulating model for typical and emergency conditions of working SRK devices.
- The preparing a database to gather information about the SRK devices.
- The preparation of procedures for determining characteristics.

The expert system will contain basic data relating to processes using SRK systems and their reliability and renewal for six major modules (subsystems of SRK):

- a general description of technical, exploitation and economic characteristics,
- linear lock devices,
- adjusting devices,
- devices of railway crossings,
- devices of impact track-vehicle,
- remote control devices.

The results obtained on the basis of exploitation research and diagnostic devices SRK kept up to date can be used not only as a basis for improving the construction of technical facilities and production process, but also as one of the possibilities to obtain reliable information necessary for controlling exploitation process, including renovation, proper organization of service-repair infrastructure, and the forecasting and determination of exploitation costs.

Electrical crossover drives

In preliminary studies (conducted at the Faculty of Transport and Electrical Engineering) we used the drive EEA-5, because the authors have access to it in the laboratory of SRK system. The switch machine EEA-5 is designed for adjusting the crossover with external closures and switching movable beak. The drive EEA-5 is of a modular design. Its individual modules, listed below, are interchangeable units:

1. assembly of the plate base,
2. closing module,
3. steering-controlling module,
4. force holding clutch with the adjusting slider,
5. the module of switch crank,
6. sliding module,
7. engine module,
8. system of control sliders,
9. lower engine cover.
10. drive cover.

Additionally, with the drive are supplied:

- crank for manual adjustment of drive,
- key to adjust the overload clutch,
- technical-movment documentation

1. Construction of drive EEA 5

Technical specification of the drive EAA-5:

- jump of adjustment slider: 125 to 260 mm;
- adjustment force: 2 – 10 kN;
- force holding non-ripped drive:100 kN;
- ripped force of ripped drive: 8 – 12 kN;

- maximum resistance of crossover adjustment: - non-ripped drive: 8 kN;
- ripped drive: 6 kN;
- switching time: 4 – 6 sek.;
- weight: 160 kg.;
- temperature range: from – 40 to + 80°C;
- level of security: IP 54
- durability: 1 mln actions;
- dimensions: 1123 x 412 x 274 mm;
- supply voltage: - 3 x 380V 50Hz,- 1 x 220V 50Hz,
- rated current:
- for 3 x 380V 50Hz: 2,3 A;
- for 1 x 220V 50Hz: 3,6 A;
- engine power: 435W;
- resistance of wires: to 54 W;
- resistance to shock: 30 g;

The construction of the measuring system

In the framework of the project it has been developed a measuring system, which will be used in exploitation research. When designing microprocessor measuring system, the following assumptions were made:

1. The system will be recorded as follows (current parameters):

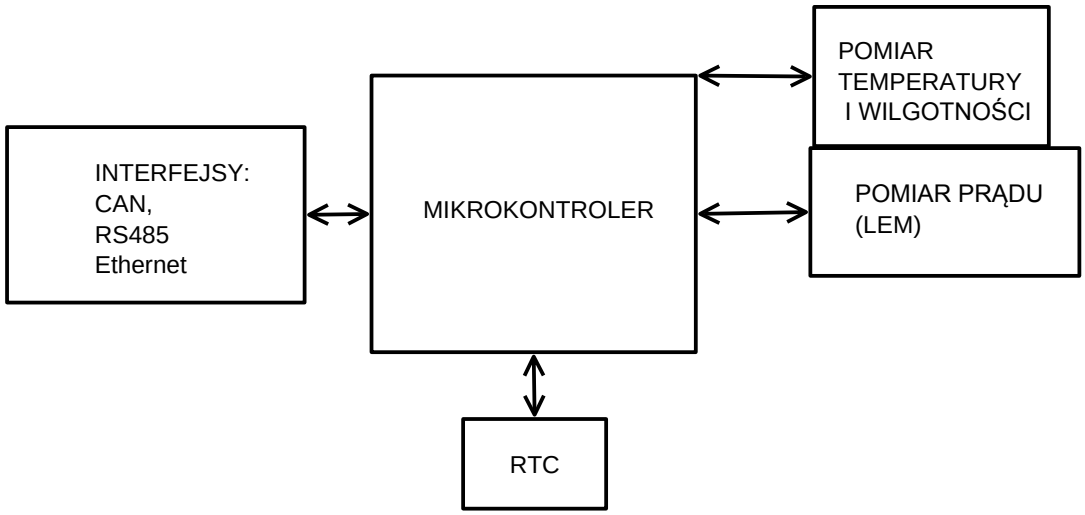
- motor current,
- adjustment time (based on the measured current),
- temperature of environment,
- humidity,
- the time (date, hour).

2. Given the need to ensure the safety of all measurement, circuits will be galvanically isolated from electrical circuits of the drive.

3. The measurement system may communicate with the diagnostic system via interfaces:

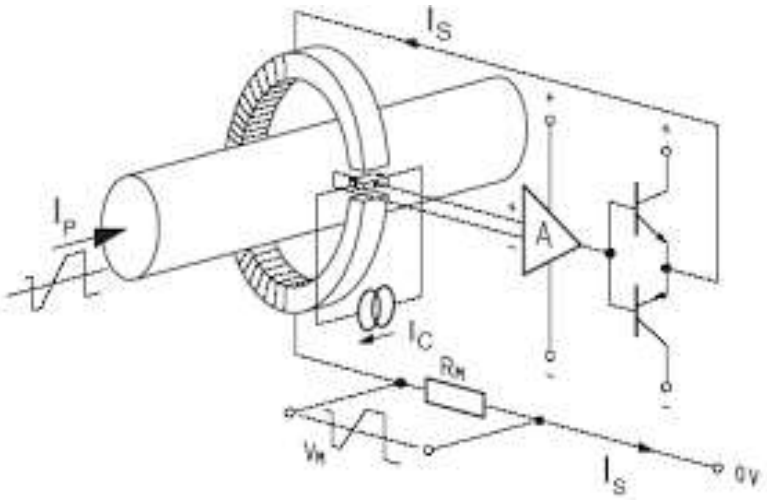
- RS-485,
- CAN,
- Ethernet.

A block diagram of the system is shown in Fig. 2



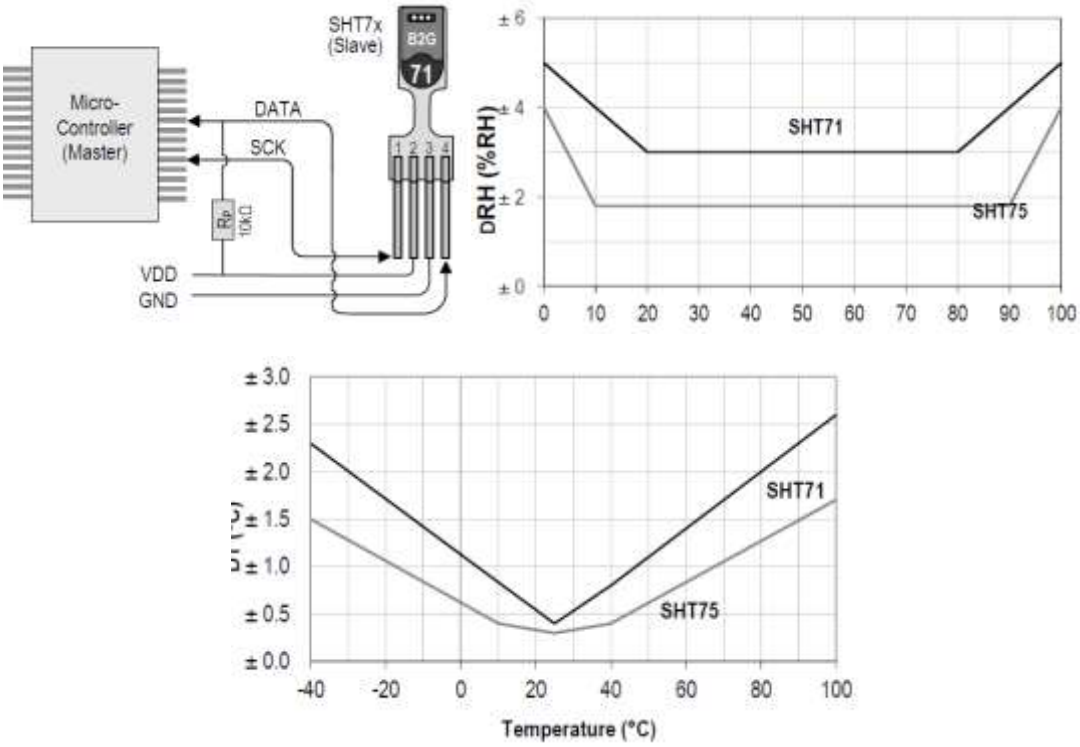
2. Scheme of the measuring system

For measurement of motor currents are used transducers LEM. LEM Company is a leading manufacturer of sensors for measuring current and voltage. Transmitters are characterized by galvanic separation of the primary from the secondary circuits. LEM is an author of several patented technologies measuring current and voltage, i.e. open-loop of feedback (open loop O/P), closed loop feedback, etc. Measuring element in the electrical transducers is mainly Hall's board. Principles of operation of transducer for closed-loop are shown in Fig. 3. The current transducers LEM measure the currents from unity mA to several tens of kA at frequencies from the DC component to several hundred kHz. Voltage or current output signals can be proportional both to the instantaneous value of the measured current as well as the effective value. The current and voltage transducers LEM are used to measure currents and voltages in electrical systems, processes and devices i.e. converters, inverters, voltage converters, robots, power supplies, welding machines, traction drives, electric and traction substations and others.



3. Principles of operation of transducer LEM [8]

The measurement of humidity and temperature are realized by means of a sensor chip of company Sensirion SHT75 [2]. The system communicates with the microcontroller via a digital interface. Fig. 4 presents the characteristics of the sensor and how to connect the sensor to the microcontroller.



4. Characteristics of sensors SHT71 and SHT75

Conclusions

Presented in the article system, designed to measure and record motor current of crossover device will allow the current diagnostics of the drives (in the period between maintenance intervals). Simultaneous registration of environmental parameters (temperature, humidity) will enable the prediction of future changes of the drive (and crossover) in the parameters under particular conditions.

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Source materials

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