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APPLIED ON POLISH RAILWAYS THE COMPARATIVE ANALYSIS OF MODERN SYSTEMS OF AUTOMATIC OF THE LEVEL CROSSING

The railway crossings are vulnerable to incidence of high number of accidents often deadly. In order to face this problem, the modern systems of automatic of the level crossing have been introduced. These systems are based on Programmable Logic Controllers, which allow the designers to exploit self-control mechanisms, events acquiring, technical diagnostic which in turn enable remote control and acquisition of faults.

ANALIZA PORÓWNAWCZA NOWOCZESNYCH SYSTEMÓW SYGNALIZACJI PRZEJAZDOWEJ STOSOWANYCH NA KOLEJACH POLSKICH

Przejazdy kolejowe są jednymi z najbardziej newralgicznych miejsc na kolei, na których corocznie dochodzi do wielu tragicznych w skutkach wypadków, również śmiertelnych. Wychodząc temu problemowi na przeciw do eksploatacji na kolei wprowadzono nowoczesne systemy samoczynnej sygnalizacji przejazdowej (ssp). Systemy te funkcjonują w oparciu o sterowniki mikroprocesorowe, z zastosowaniem rozbudowanych mechanizmów autokontroli, rejestracji zdarzeń i diagnostyki technicznej, umożliwiającej zdalne uzyskiwanie informacji o zdarzeniach oraz rodzajach usterek.

1. INTRODUCTION

An application of modern information technology and more effective microprocessor systems has a large influence on development of railway traffic control systems.

At the beginning of 90, three modern level crossing systems based on microprocessor controllers have been introduced. These systems possess sophisticated self-control mechanisms, events recording, technical diagnostic allowing remote capturing information concerning events and faults. These systems are made by: Bombardier ZWUS Katowice, Scheidt&Bachmann and Siemens. Later the group of level crossing systems providers was enlarged about KOMBUD S.A. manufacturer supplying RASP-4 system.

In this paper the main leverage has been put on issue concerning level crossing systems, application of microprocessor controllers and remote control of level crossing devices.

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2. LEVEL CROSSING SYSTEM SPA-4 MADE BY BOMBARDIER ZWUS KATOWICE

Automatic level crossing system SPA-4 is microprocessor's system automatically protecting traffic on railway crossing. It is based on PLC controllers consisting solely of contact less elements. This system has two channels architecture, in which separable electrically controlling and supplying channels A and B execute independently operational algorithm [1].

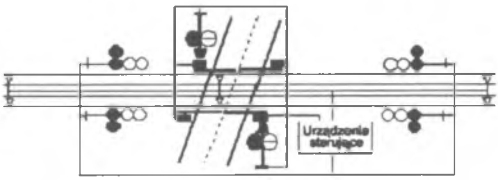

Fig.1. Placement of device of the level crossing

Irrespective of the type of SPA-4, its principal of operation depends on type of railway sensor being used (EON-3S or CTI-3). Three railway sensors for each railway placed in the zone of movement of the train allow the device to determine the direction of movement of the trains. Two of them placed on both ends of zone serve to switch on level crossing system and one placed on railway crossing serves to switch its off. The distance of their placement depends on allowable velocity of train on this railway line. PLC controller basing on railway sensors signals recognizes the direction of the train movement. The command from one controller is sufficient to switch on the device (safety principle 1 from 2), whereas in order to switch off the device two consistent commands from both controllers (principle 2 from 2) are necessary.

2.1. CONTROLLING SYSTEM

Controlling system of SPA-4 consists of two identical controlling channels. Each channel consists of PLC controller, interfaces allowing receiving of input signals and amplifiers of output signals amplifying these signals to level required by output devices.

Level crossing system exploits MINICONTROL controllers manufactured by Bernecker & Rainer. Each controller checks the state of toll gate and warning signal lights. The goal of controllers is generation of safe controlling signals of level crossing system and output devices based on incoming controlling signals of railway sensors. The information about the state of level crossing system is transmitted in cycling manner to the remote control unit. The software (subsequent modules) contains function testing all elements of level crossing system [1],[3],[4].

In order to synchronize the operation of both controlling channels and detect presumable errors of their parallel operation, controllers are connected with the use of TTY connector.

2.2. REMOTE CONTROL DEVICE

SPA-4 are fitted with ERP-6 remote control device being overriding device on railway traffic post. Its task is visualization, recording of faults and operation, and sending of commands to chosen level crossing system. Remote control system can be hooked up to 1÷8 level crossing systems of SPA-4 (up to 16 MINICONTROL controllers) placed on the distance not longer than 10 km from railway traffic post. This device is based on Intel microcontroller 80537. Any PC computer using to visualize SPA-4 can be placed in the service center located on the any distance from railway crossing. Transmission of data between these two devices is carried out with the use of modem or standard phone line [3],[4].

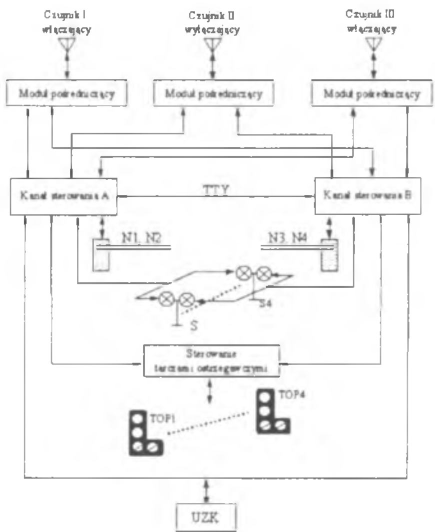

Fig.2. Operational flow chart of SPA-4

3. LEVEL CROSSING SYSTEM NE BUE 90E MADE BY SIEMENS

Microprocessor controlling system of NE BUE 90E has many advantages, for example: high reliability, simple modular construction, easy maintenance and simple adaptation to actual conditions.

NE BUE 90E use the following railway sensors:

- device of switching on double loops switching on signal lights in the case of train movement to railway crossing and device of single loop causing blocking signal lights in the case of train movement from railway crossing,
- device of switching off double loops.

Signals from both single and double loops are independently given to every controlling system. This level crossing system can also collaborate with other type of railway sensors.

Control of NE BUE 90E devices are performed with the application of two safety principals:
- the safety principal 1 from 2 are exploited at the passage from awaiting to warning states (closing),
- the safety principal 2 from 2 are exploited at the passage from warning to awaiting states (opening).

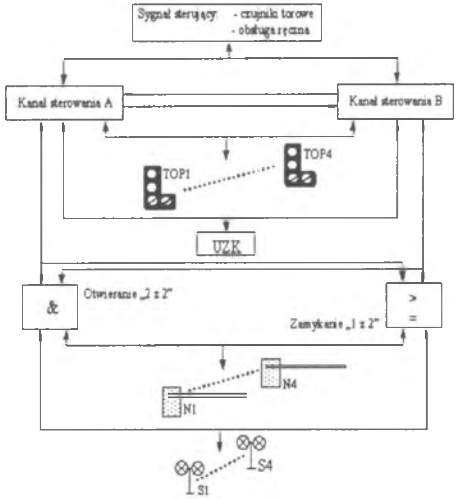

Fig.3. Operation flow chart of NE BUE 90E

3.1. CONTROLLING SYSTEM

Controlling system of NE BUE 90E is based on Siemens SIMATIC S5 PLC controllers. Controlling system consists of two independent controlling channels TAI and TAII executing the same program. Each channel is fitted with CPU 103 microprocessor controller with RAM of 10240 instructions. Every controller can collaborate with 28 I-O boards steering output devices and railway sensors. The number of sensors depends on configuration of level crossing system and devices used to protect its. [3], [4].

Controlling devices are connected to each other with the use of parallel connector. This connector realizes checking of proper realization of functions (difference of states and synchronization of controlling programs).

3.2. REMOTE CONTROL DEVICE

NE BUE 90E is fitted with SIDIAS remote control device being built with the use of elements of Siemens automatic system. The task of remote control device is supervising, monitoring, diagnostic and recording of operation and faults of one or several (up to 12) level crossing controlling systems located up to 6 km away from remote control device. At the longer distance, it is necessary to apply intermediate devices amplifying of sending signals.

Remote control device realizes following functions:
- showing the current state of all connected level crossing systems,
- presenting the current state of chosen level crossing system,

- recording of events and faults together with time and date of their occurrence (possibility of printing of 196 messages recorded in memory of each level crossing controlling systems).

4. LEVEL CROSSING SYSTEM MADE BUES 2000 BY SCHEIDT&BACHMANN

Controlling of operation of level crossing system BUES 2000 is carried out in three levels. These levels are:
- diagnostic level,
- supervising level,
- executing level.

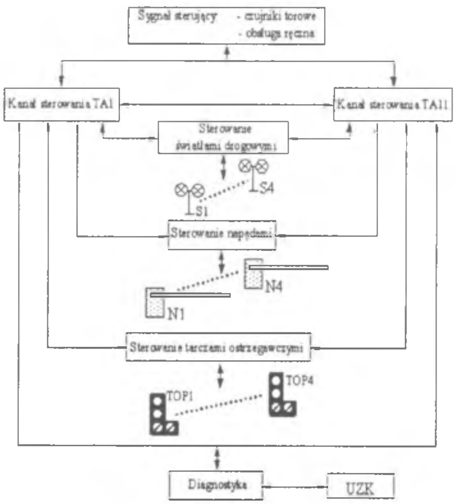

Fig.4. Operation flow chart of BUES 2000

Control in these levels are performed in two channel fashion. Passing of information between levels and channels in one level are performed with the use of two data bus devices.

Inductance loops are utilized to recognize the presence of train in the zone of operation of level crossing system. Circuits of switching on and off loops consists of two loops operating with 60 kHz and 80 kHz frequencies. Such solution allows determining the direction of the train movement. In circuit of switching on loop, the loop of 60 kHz is always first towards the direction of the train movement to railway crossing. However in circuit of switching off the loop, it is the first for proper direction of movement on given railway line. Signal loop is given to both controlling devices. [5]

Steering of warning devices of BUES 2000 corresponding to the change of the state from awaiting (closing) and contrary is carried out with the use of safety principle 2 from 2.

4.1. CONTROLLING SYSTEM

Steering of level crossing system is performed in two channel fashion using channels TAI and TAII. Each channel consists of central unit, lights and barrier module, diagnostic module and railway module. Software of modular processors has an influence on the increase of the system safety.

Central module realizes overall controlling functions and oversees all centralized tasks of protection process of level crossing system. Module of light/toll gate realizes controlling process of signal lights and toll gate drivers and checks their proper operations. Railway module is responsible for the development of information incoming from railway sensors and checking their operations. Diagnostic module allows service staff to access swiftly to information about faults. In order to ensure the safety and correct realization of functions, the information exchange among modules is realized in two channel manner.

Such solution allows on easy control of program executed in each module. Both of control channel realize the same program.

4.2. REMOTE CONTROL DEVICE

Remote control device is a central diagnostic hub, to which hundreds of level crossing systems placed several kilometers away from railway traffic post have been connected. From practical point of view the number of transmitted messages should not exceed 30. Thanks to an application of components of diagnostic device complying with PC standard, it is possible to use software and operational systems available on the market.

Diagnostic hub reads messages being sent by level crossing systems. Messages about fault states of level crossing systems are read by software installed in diagnostic hub through modem.

5. LEVEL CROSSING SYSTEM RASP-4 MADE BY KOMBUD RADOM [2]

RASP-4 (RASP-4F) is designed to protect the railway crossings of category B and C. It is additionally an automatic level crossing system on railway crossing of category A. The structure of system has been split through the placement of the outputs and interfaces blocks near outdoor objects.

System RASP-4 contains railway sensors of type EOC. Its operation is based on counting the number of trains, and operation of RASP-4F is based on counting the number of axles determined with the use of wheel sensors RSR-180 made by Frauscher.

5.1. CONTROLLING SYSTEM

Control of level crossing system is performed with the use of PLC controllers 90-30 manufactured by GE FANUC. Controllers have central unit IC693CPU350. Their operation is based on information exchange and synchronization of the work through two channels of data bus.

Channels A and B being fitted with controllers STER1 and STER2 collaborate with duplicated I-O blocks through two independently operating buses. Each bus is simultaneously connected to two controllers. Modules installed in two chests create two independently operating controllers with mutual exchanging of data and synchronizing of buses M1 and M2. In the case of damage of the controller or any device connected to one of buses, the other controller detects the system error and takes over the control on all I-O devices through the second bus. Thanks to it, the device returns to the safe state. Central units of both controllers operate synchronously and check mutually their presence. In concerns logic states elaborated in the ce (faults of sensors, drivers, supplying) and physic state generated from I-O blocks determining incorrectness of their inputs or outputs (for example, discontinuities of electric circuits, overloads, short-circuits).

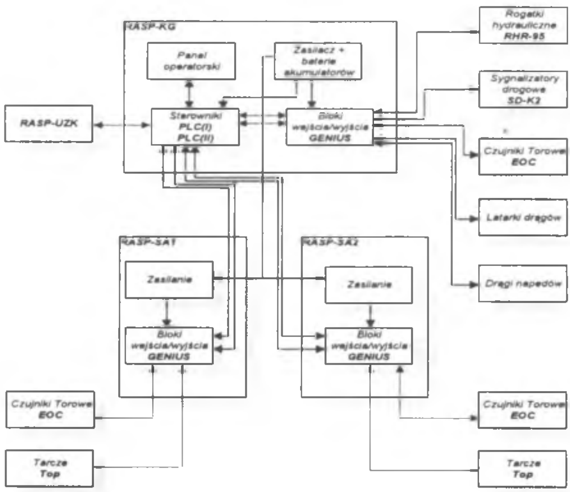

Fig.5. Operation flow chart of RASP-4

5.2. REMOTE CONTROL DEVICE

The state of level crossing systems is supervised by remote control device RASP-UZK, which is overriding controller overseeing the operation of up to 8 level crossing systems. It is industrial PC computer, what ensures easy upgrade and replacement. Remote control systems communicates with each level crossing system with the use of RS-232 and modems. Two pairs of wires of phone cable is used to communication. One pair serves to transmission of messages and second one to transmission of commands.

6. CONCLUSIONS

Introduction of microprocessors and microcontrollers to railway traffic control systems contributes to arise new generation systems, which ensure high efficiency and safety. Manufactures, whose products include such solutions are Bombardier ZWUS Katowice (SPA-4), Scheidt&Bachmann (BUES 2000), Siemens (NE BUE 90E) and KOMBUD Radom (RASP-4).

Software of railway traffic control systems allows taking into account different user's requirements and strict matching the operation of system to local conditions.

The principle of operation of all devices are very close, but the main difference ties in the kind of sensors being used (SPA-4 and RASP-4 – zone and dot sensors, NE BUE 90E and BUES 2000 – induction loops).

Presented level crossing systems can collaborate with remote control device placed on railway traffic post. Presented remote control devices possess different construction characterizing through different ways of relaying information about states of devices and different ways of their visualization on the display or monitor.

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