# ANALYSIS OF SETUPS OF THE CONTROL OF RAIL MICROPROCESSOR SYSTEMS

**M. Kornaszewski [1], Z. Łukasik[2]**

[1] Technical University of Radom, Faculty of Transport, Malczewskiego 29, 26-600 Radom, Poland
*e-mail: mkornasz@pr.radom.net*
[2] Technical University of Radom, Faculty of Transport, Malczewskiego 29, 26-600 Radom, Poland
*e-mail: z.lukasik@pr.radom.pl*

**Summary** In the article will have been introduced possibilities following from the application of the microprocessor technology in rail systems of the control of traffic will remain for example of modern signalling on railway crossings. Introduction to microcomputer and microprocessor systems of rail devices will permit to eliminate and to replace disused relay devices with them and raising safety on railway and increasing reliability of used devices.

## 1. INTRODUCTION

Since the beginning of existence of railway lines, devices allowing for safe control of traffic have been applied. Development of devices progresses continuously. Requirement pose them steady increasing as well as needs and expectation of their users. However the major purposes of applying these devices – the safety and efficiency of traffic, remain unchanged. New microprocessor systems meet these requirements.

An application of modern information technology and more effective microprocessor systems has a large influence on development of railway transport. They are deciding generally that computer technologies are determining the standard and trends of progress of the technique of the traffic control systems.

## 2. TECHNOLOGICAL EVOLUTION OF AUTOMATIC OF THE LEVEL CROSSING OF POLISH RAILWAY

Systems of automatic of the level crossing being used in Polish railway lines are realized in different technologies. Systems of automatic of the level crossing can be divided with respect to technique of implementation of controlling function into three groups: relays, hybrid (electronic and relays) and microprocessors. About 27% of devices are devices being built on the basis of relays, 59% of devices are devices being built on the basis of hybrid technique and 14% of them are built on the basis of microprocessor.

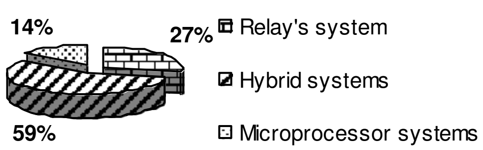


*Fig.1. Percentage division of crossing levels in Poland with respect fabricating technology*

Technology of systems of automatic of the level crossing should allow to introduce new elements during exploitation of systems without violations of determined system's functions.

In the group of devices being built on the basis of relays, two solutions can be distinguished: channel devices being built from relays of N class and channel devices using magnetic and teletechnique relays.

Systems being made in hybrid technology contained more and more digital circuits, and the number and the role of relays are diminished. Synchronizing functions were more and more sophisticated, and the need of synchronization of operation of controlling channels arose.

The newest microprocessor systems (SPA-4, NE BUE 90E, BUES 2000, RASP-4) require application software adjusted to particular situation on railway crossing. An application of PLC controllers allowed for increasing controlling functions. Important innovation is recording the events occurring at the work of system of automatic of the level crossing.

## 3. COMPUTER SYSTEMS OF AUTOMATIC OF THE LEVEL CROSSING

As a rule, computer systems of railway traffic control should be executed as "fail-safe", what means that a single damage (of equipment, software) or interference cannot cause a dangerous situation, assuming negligibly small probability of double (multiple) damage occurrence. Additionally, single errors are assumed to be detected in a relatively short time and the damage detected by an appropriate system's response to the fact. The SIL 4 (Safety Integrity Levels) included in the norms of the European Committee of Normalization in CENELEC Electrotechnics is another important criterion. SIL 4 is the highest safety level and determines the damage intensity (the probability of damage occurrence in a unit time) for a single system element 10E-11.

For computer systems of railway traffic control it is necessary to consider issues of safety and reliability on two levels:

- of technical devices, creating the infrastructure of railway traffic control system;
- of system software.

To meet the requirements of safety the system has to consist of two computers linked together in a suitable structure, which at least performs appropriate data processing and mutual check-up possible, etc. There are also other systems, based on one unit. For obtaining required conditions of safety the other computer is utilized as the hot reserve.

Appropriate software operations are executed for the safety of single-channel systems. They are relying on encoding and converting data through two programs in one unit which are testing each other. The best situation is when applications are written by different groups of programmers.

Multi-channel systems, most often two-channel or three-channel, are named “2 out of 2” and “2 out of 3” respectively, which safety is ensured by redundancy of hardware and software. In solutions with two computers results are compared, and according to safe work condition of system “2 out of 2” only full compatibility effects of all calculations are obtained on output of active channels. In the “2 out of 3” system the negative result of compare makes switch to action/operate the third computer, which result of converting is taking under consideration alike previously on two computers (fig. 2).

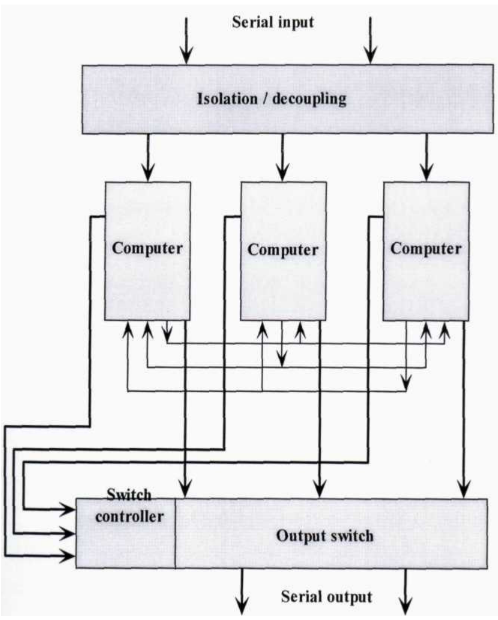


*Fig.2. Save work of computer system “2 out of 3” (SELMIS)*

The redundancy of control programme is the most often encountered method of safety assurance in computer systems from the software point of view. A change to the emergency control programme of the control application is a method in case of damage detection (both methods are operating on the system level, they respond to hardware and software errors themselves this way).

## 4. ANALYSIS OF SETUPS OF THE CONTROL OF THE LEVEL CROSSING MICROPROCESSOR SYSTEMS

### 4.1. 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 (fig. 3).

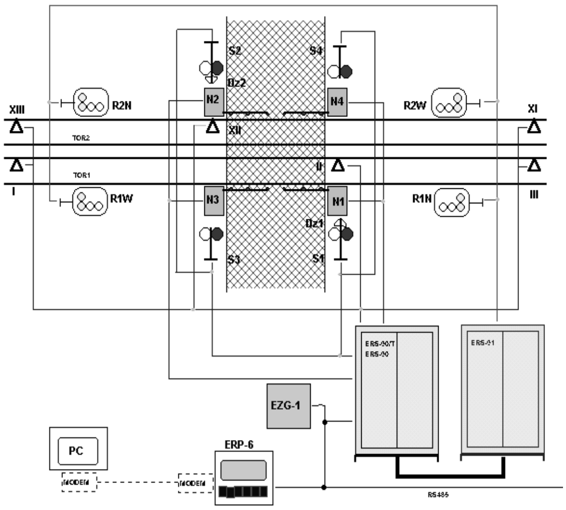


*Fig.3. The Layout of devices of automatic of the level crossing SPA-4 type*

Level crossing system exploits MINICONTROL controllers manufactured by Bernecker & Rainer. 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. Drivers are linked with the use of a TTY interface, which also assures synchronization of two channels operation. Detection of the lack of parallelism is treated as a signalling failure.

Control application originates from the activation of PROSYS system supplied by the manufacturer of drivers. The programme is executed in the sequential mode. The software was written on the level of processor 6303 assembler. In PLC drivers there is a possibility of automatic conversion from the level of the internal language to the level of logical diagrams.

### 4.2. Level crossing system NE BUE 90E

Controlling system of NE BUE 90E is based on Siemens SIMATIC S5 PLC controllers (fig. 4). Controlling system consists of two independent controlling channels executing the same program. Each channel is fitted with CPU 103 microprocessor controller. The program is fetched from EPROM and copied to RAM memory. It prevents from memory errors and program interference.

Controlling circuits are conjugated with the use of parallel interface using to send data. In care of error detection, difference in states and synchronization the proper loggers are sent.

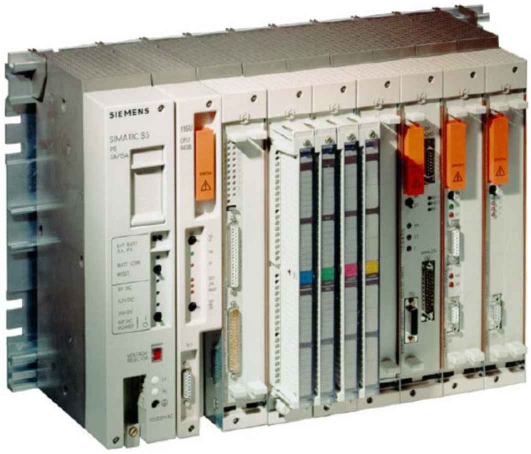

*Fig.4. The view of controller SIMATIC S5*

### 4.3. Level crossing system BUES 2000 made by Scheidt&Bachmann

Steering of level crossing system is performed in two channel fashion. Each channel consists of central unit, lights and barrier module, railway module and diagnostic module. Each module has the own doubled processors, which processes independent fragments of program in real time. During start of system the program is loaded to the memory. Application of proper software allows for the safety increase. The device is resilient, it means, it accepts errors not having the influence on the realization of basis functions.

In microprocessor's level crossing system type BUES 2000 typical module processor's have been applied. All processors are universal, each of them can realize functions of central units, railway, or lights. Sort of function being executed by processor depends on its placement in the system. 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.

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

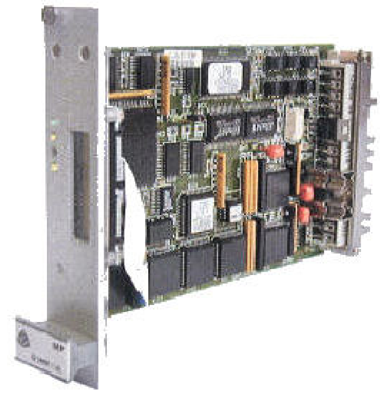

*Fig.5. View of modular processor (with display) using in management level*

### 4.4. Level crossing system RASP-4 made by KOMBUD Radom

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.

Both of channel being fitted with controllers 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. 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 GENIUS determining incorrectness of their inputs or outputs.

In Controllers of series 90-30, controlling program written by the user (used to control the process) are services by the special coprocessor.

*Fig.6. Modular construction of level crossing system type RASP-4*

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.

## 4. CONCLUSION

Among from all types of railway traffic control systems, systems of automatic of the level crossing degrade very vastly. It is caused by steady increasing traffic dense. Irrespective of the type of system and exploitation time, the safety level has to be appropriately high.

Introduction of microprocessors and microcontrollers to railway traffic control systems contributes to arise new generation systems, which ensure high efficiency and safety. Most of present controlling systems have been built basing on relays. Relay's devices have numerous drawbacks such as large material consulting and power consumption. Due to there drawbacks. Recently, due to drawbacks, there devices are replaced by microprocessors devices.

Bigger safety of the automatic systems of the level crossing results from the type of applications of modern technologies (of programmable drivers), is based on two control channels, diversity of applications in channel A and B, possibilities of immediate faults detection in devices and applications (self-testing), and also on the possibility to carry out monitoring of the system work by both registration of all events and of failures.

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