KRZYSZTOSZEK Konrad[1]
NOWAKOWSKI Waldemar[2]

MOR-3 computer based interlocking system

MOR-3 system, computer based interlocking system, safety requirements

Abstract

Railway domain is a safety critical domain, where safety is given utmost importance. The most important part of the railways to carry out operations like safe movement of trains and communications between different entities is "signalling". The railway signalling is governed by a concept called "interlocking". Interlocking systems are implemented in different technology, one of them are information technology. Such systems are called "computer based interlocking systems". This article presents the MOR-3 system that is economical and high performance computer based interlocking system produced by Z.A. KOMBUD S.A.

SYSTEM KOMPUTEROWYCH URZĄDZEŃ ZALEŻNOŚCIOWYCH MOR-3

Streszczenie:

Kolej to obszar działalności, w którym zapewnienie bezpieczeństwa jest bardzo ważne. Istotnym elementem tej struktury, umożliwiającym bezpieczny ruch pociągów, są urządzenia sterowania ruchem kolejowym, w tym w szczególności urządzenia zależnościowe. Urządzenia te wykonywane są w różnej technologii, jedną z nich jest technologia komputerowa. Mówimy wówczas o komputerowych urządzeniach zależnościowych. W artykule przedstawiono system MOR-3, produkowany przez Zakłady Automatyki KOMBUD S.A., który jest ekonomicznym systemem komputerowych urządzeń zależnościowych.

1. INTRODUCTION

Relays technology used to form the logic circuits in railway interlocking systems are replaced by computer technology. The field inputs are collected using digital input cards and outputs are given using digital output cards. The processing is done by a processor where the software variables are evaluated using the interlocking equations, which are now in digitized form either as algorithms, boolean equations or state charts in the processor memory. These algorithms now being executed by the processing unit take appropriate action. One of the such solutions examples is the MPR-3 system, described in this article.

2. GENERAL CHARACTERISTIC OF THE SYSTEM

The MOR-3 computerised station equipment system fulfils the station interlocking system functions and takes up a central position in the railway signalling equipment system on the traffic control post. Along with cooperating systems and equipment, it provides efficient and safe train traffic and shunting control. The MOR-3 place in the traffic control equipment system is shown on the figure 1.

[1] Technical University of Radom, Faculty of Transport and Electrical Engineering, 26–600 Radom, Malczewskiego 29, e–mail: k.krzysztoszek@pr.radom.pl
[2] Z.A. KOMBUD S.A., 26–600 Radom, Wrocławska 7, e-mail: waldemar.nowakowski@kombud.com.pl

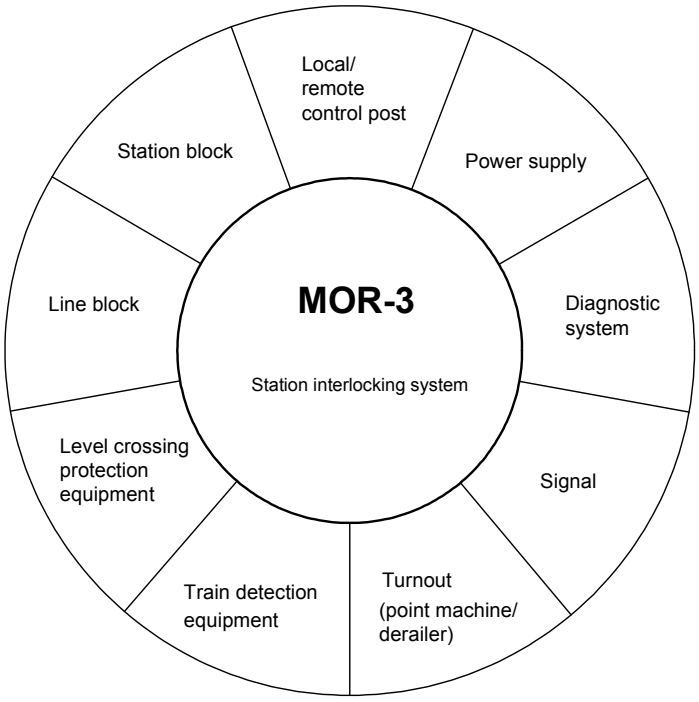

Fig. 1. Context diagram – MOR-3 position in the railway traffic control system

MOR-3 system is adjusted:
- to control from local computerised control desk and for remote control;
- for operation of turnouts and derailers by electric point mechanisms;
- for operation of signals on the trackside signals of the light signalling system binding in Poland.

MOR-3 system is adjusted to cooperate with relay inputs and outputs of:
- train detection equipment – insulated track circuits, jointless track circuits, axle counters;
- line blocks (and possibly station blocks);
- level crossing protection equipment.

MOR-3 system may control train traffic in the area under control with up to 1000 elements (turnouts, signals, train detection circuits etc.). The MOR-3 system is prepared for cooperation with operation post computerised systems and railway traffic remote control and management systems. MOR-3 system cooperates with MOR-1 or MOR-2zs board, which is universal, autonomous system applied in relay and electronic interlocking equipment. MOR-3 system is prepared for cooperation with any kind of electronic control desk.

3. FUNCTION PERFORMED BY A SYSTEM
3.1 Interlocking function

The "interlocking functions" term should be understood as all functions performed by MOR-3 system which ensures transferring interlocking orders to executive signalling equipment for execution only after predispositions checking (only after fulfilling traffic safety related conditions), matching the track layout features, traffic situation and traffic operation rules.

MOR-3 system performs:
- train traffic and shunting route setting;
- automatic route releasing;
- emergency route releasing;
- signals setting;
- automatic change of "proceed" signal aspect to "stop" signal aspect after train pass or equipment state change;
- individual signalling control orders (e.g. point position setting, special-purpose signals setting, bursting open of points signalisation cancelling etc.);
- point position settings while insulated train detection supervision is switched off;
- line block controlling (e.g. line block direction change).

MOR-3 system is transferring the movement authority or "stop" order to vehicles through signals on trackside signals. To ensure safety train run or shunting movement of the rolling stock through their routes MOR-3 system:
- interlocks "proceed" signal aspect with appropriate position of points and derailers, free state of certain tracks and turnouts, required state of blocks, protected state of level crossings end exclusion of contradictory routes;
- ensures stable position (state) of route elements by locking them;
- supervise route elements during its realisation;

– ensures automatic change of “proceed” signal aspect to “stop” signal aspect (train protection).

3.2. Recording functions

These functions ensure data collection and recording according to accepted archive documentation creation rules. Recording will include:

– all orders admitted by the computer for execution;
– emergency events occurrence.

The recorder content is not lost when the computer turns off. The recording covers approx. 2 weeks period.

3.3 Diagnostic functions

MOR-3 system is equipped with diagnostic devices which perform the following functions:

– displaying the current state of the selected system element (signal, turnout, etc.);
– controlling the current in signal lights circuits;
– archived data review;
– displaying the software version and application data used on this railway object.

4. OPERATION PRINCIPLE OF THE SYSTEM

According to the railway signalling equipment general operation principle, MOR-3 system ensures bidirectional communication between operator’s post (user interface) and controlled railway signalling equipment (e.g. turnout, semaphore) and processes received data concerning railway equipment state and current traffic situation according to traffic operation rules for the traffic post described in the route combinations diagram or in the route charts.

To ensure the system safety requirements, MOR-3 computerised station interlocking equipment is built as two computer’s (A and B) set with different result code which carries out the same interlocking functions. Customising the equipment (application) to a specific object is carrying out by exchange of the data defining routes interlocking, applied signalling type (with turning off semaphores or not) etc.

Output signals from both computers are compared in a safe comparator. The comparator ensures generation only if control signal from both computers are in conformity. In addition, computers are checking one another and negative checking cause safety state of the system (figure 2).

Fig.2. Block safe comparators and interlocking computers of MOR-3

Report signals used for interlocking purposes are being red independently by both computers (from galvanic separated input circuits). These signals include not only controlled railway signalling equipment, but also comparators outputs state. Correct detection and interpretation of report circuits and output signals comparators fail state is ensured by logical signals dynamic state in form of pulses sequence.

Station equipment is prepared for local control from electronic control board and for computerised remote control.

Computerised station equipment (MOR-3) is prepared for cooperation with any train detection equipment type. It cooperates with typical track circuits or with another kind of train detection equipment (axle counter) which generates typical track occupation signal.

5. SYSTEM SAFETY

The interlocking computer is built in "2 of 2" configuration in order to fulfil safety requirements in accordance to the rules which ensures SIL-4.

Information (orders and reports) transferred between computers and trackside objects are divided into two classes: critical and non-critical information. Critical information is such that misinterpretation of it may result in traffic or personnel safety risk. The orders to turn on "proceed" signal aspect or point position report are the examples of the critical information. The order to change a point position is an example of non-critical order. Wrong order to change a point position is not creating the risk for the traffic because an inappropriate point position will prevent to turn on a "proceed" signal aspect. If such an order concerns the point locked in a route, its position would not be changed due to a gap in the point control circuit, which is controlled by a critical order generated by the interlocking computers.

All reports and orders concerning another equipment than railway signalling one belong to non-critical information class (except of the order to turn off the point switching voltage). Critical information is processed by the interlocking computers while non-critical information by the selecting computer.

6. CONCLUSIONS

The MOR-3 computer based interlocking system provides an economical solution for interlocking systems in main-line and regional traffic and for industrial railways. Thanks to its modular design, this new interlocking generation can be adjusted quickly and easily to local conditions and the operational requirements of the particular railway company. Having the highest safety integrity level SIL-4 in accordance with the CENELEC standards, MOR-3 complies with all safety requirements.

7. BIBLIOGRAPHY

[1] Z.A. KOMBUD S.A.: *"System MOR-3 Technical and Operational Documentation"*. Radom 2007.
[2] Dyduch J. (red.): *Innowacyjne systemy sterowania ruchem*, Monografia nr 147, ISBN 978-83-7351-417-1, Wydawnictwo Politechniki Radomskiej, Radom 2010.
[3] Krzysztoszek K., Nowakowski W.: *"Integracja diagnostyki systemów automatyki transportu kolejowego"*, Transport Miejski i Regionalny, Nr 12, Grudzień 2009r.