

DEFINITION OF THE BASIC ASPECTS BY DEVELOPMENT OF UNIVERSAL INTERFACES BETWEEN RELAY AND MICROPROCESSOR SYSTEMS

MIKROPROCESORA UN RELEJU VADĪBAS SISTĒMU INTERFEISU IZSTRĀDEI PRIMĀRO ASPEKTU NOTEIKŠANA

ОПРЕДЕЛЕНИЕ ОСНОВНЫХ АСПЕКТОВ ПРИ РАЗРАБОТКЕ УНИВЕРСАЛЬНЫХ ИНТЕРФЕЙСОВ РЕЛЕЙНЫХ И МИКРОПРОЦЕССОРНЫХ СИСТЕМ

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I. Introduction

Perfection of railway technologies leads to exchange relay techniques for microprocessor. Substitution existing system for modern simultaneously is not possible it shall be phase by phase. Such substitutions way need to build interface between new system and old one. Purpose of this research is to generate interface model for systems interconnection. The article based on detailed studying railway microprocessor and relay technologies [1,2].

Present time in Latvia running infrastructure renovation projects with in EU financial support. Existing Relay based technologies is worn out and outdated equipment, they are replaced with microprocessor based. There appears a gap between microprocessors technologies and relay based technologies. Microprocessors technologies will supply new systems with large database, high capacity diagnostic systems which available maintenance staff with remote access, working places is more ergonomic to operating staff.

In a moment does not exist complete technical solutions for interface connection between microprocessor based interlocking and relay based automatic block systems on the Open Lines what is will not be replaced in near future.

The technical solutions to solve this problem are under construction. Purpose of this research is investigate possibility to develop model of algorithm's of interface connection between different type of Automatic Block on the Open Lines (Single Automatic Block, Double Automatic Block) and microprocessor interlocking for future usage in infrastructure renovation projects.

Problem solution based on research of microprocessor technologies software functional conditions and relay Auto Block technologies. Detailed studying of two systems works precede plays a key role in getting answer how to build the model. Simple schematic drawing of software structure indicates method of information handling to fulfil functional requirements systems interconnections. In this work is not described Automatic Block system has very old history and described a lot of times in special literature. The article foresee integration possibility to microprocessor interlocking supervision functions of "Scheme Change direction on the Open Line", object state monitoring, control of Automatic Block as a part to ensure normal functionality of electronic interlocking (EIL) [4,5]. Task will be executed with software possibilities of existing microprocessors technologies. Input data from relay system to microprocessors will be provided with interface relay contacts.

That kind of principles to input data to interlocking is used in microprocessor systems of different producers – Siemens, Thales, Bombardier. All this microprocessors interlocking producers works with infrastructure modernisation in Baltic regions (Siemens – Estonia, Lithuania, Thales – Latvia, Bombardier – Latvia).

Algorithm's model will keep all functional interdependences and ensure highest safety level of nowadays – EN 50126 SIL4 by European institutions of standards for electrotechnics (CENELEC).

Result of research can be used for integration relay technologies and microprocessor technologies. The model will give a possibility to keep all functionalities in same manner what they are exist in presents and will have advantages of microprocessor technologies.

The work described the algorithm's structure. For better understanding it's represent in Bulla algebra. The model use messages and commands, messages – read in information about states of system, commands will transfer signals to supervised devices. The model of interface shall ensure high level of safety there fore the input information read in to interlocking by two channels, only by coincidence two signals on two channels the system will interpret information like true.

The interlocking will send and receive signals with interface relay of 1 CLASS safety. In the model represents universal elements of software, this elements use for different command type and checking safety conditions. Universal elements also responsible to transfer signals to visualisation system (MMI)

The document has following structure:

- described command algorithms construction from MMI to interface circuits;
- described inputs signals from EIL to interface relay, which are with universal elements, will be further elaborated in software;
- described universal elements, which are used for safety conditions checking and command configuration;
- described inputs outputs assignment in microprocessor interlocking IOM;

- described inputs circuits with unique name and relay, which are, perceive commands from MMI.

II. Situation overview

Railway transport up to recent time was used only electromagnetic relay as element of system construction [3]. Train movement supervision and control automatism remains very conservative for switching to computer technologies. Technical solutions for relay interlocking developed in 1960-1980th. The relay as main element of interlocking is old fashioned now. Attempts to improve quality all systems functionality leads to enlarging amount of relays, increase energy consumptions, rising maintenance cost and value of design work as well. All this indicators shows reasons to substitute with microprocessor interlocking. Advantages of such interlocking type compare to relay is obvious, there is some of them:

- 1) High system flexibility for station tracks changes easy to add additional functions, realizing with relay technique can be only with increasing numbers of relays.
- 2) Implemented diagnostic system.
- 3) Not necessary to add additional devices for station CTC supervision.
- 4) Low maintenance cost

World experience about railway signalling system construction shows that for cost and development time reduction important to have unification for software/hardware base. Significant achievements in this research field were done by Bombardier Company in Russian railway market, but solution is suitable just Bombardier company. Microprocessor systems have common principles of handling information. From outdoor equipments (points, signals) information via objects controllers or inputs/outputs module will be read in to interlocking logic. Information from outdoor will be elaborated with software elements. These elements will be specified for two groups:

- inputs from outdoor equipment – messages;
- outputs to outdoor equipment – commands.

In the software with universal elements can be set different parameters and dependences for input and output signals dependently from system functionality. The figure 1 below shows common principal for information elaboration for different type of microprocessor interlocking. Messages can be active – high level of signal “1”, not active – low level of signal “0”, state undefined – no information from input. Command can be active – high level of signal “1”, not active – low level of signal “0”, dynamic – signals appears for certain period of time. From logic can be send commands: safety critical, not safety critical.

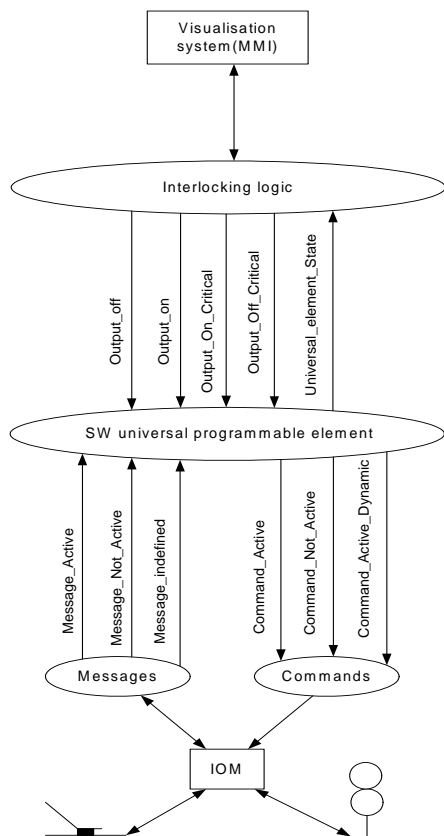


Fig. 1. Software input/output information handling structure

III. Interface developments to the Single Automatic Line Block

Interval train movement on the Single-track line realized with Single Automatic Line Block system. Necessary to change traffic direction on Open Line and exclude departure to the Open Line trains coming from the opposite direction. Scheme “change traffic direction on the Open Line” is used for this purpose. There are two possibilities to change traffic direction on the Open Line:

- normal mode (Open Line is free);
- auxiliary mode (Open Line is free, one of track circuits is faulty occupied).

The Functions, which are implemented to EIL, has to fulfilled works in appropriate way and all line objects are under control. EIL with interface circuits provide all dependencies between objects. The EIL receives from Automatic Line Block system binary input signals. EIL has sent to Automatic Line Block system binary output signal. Interface connection between EIL system and Automatic Line Block for a single line ensure following functions:

- interface with scheme changing traffic direction on the Line;
 - interface with Line Block equipment.
- Functions and configuration of the Automatic Line Block implemented to the EIL:
- change direction on the line with control of state (free or occupied), normal mode of changing direction on the line;
 - changing direction on the line if any track circuit on the line is occupied, auxiliary mode;
 - sending a maintenance train to the block line.

Input information for the EIL:

- state of Line Block (track circuits free / occupied);
- information about the running direction on the Line (Odd or Even);
- state of first and second approach/remove sections (free / occupied);
- state of the key-token (key-token available for service train or key-token is protected);
- state that the supervised command is received corresponding interface relay;

– state there is no exit train route on the neighbor station.

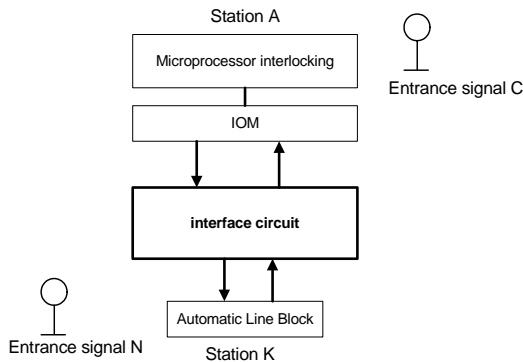


Fig. 2. Interface configuration between Automatic Line Block and interlocking EIL

Automatic Line Block and for neighbour station and read in the input information from adjacent devices. The software objects created with microprocessor interlocking specifics. To ensure high safety level used input/output information by two separate channels. Necessary to have same set of value what is fore seen for those channels, only that sort of information systems perceive as true. Interface relay has equivalent comparison for channels, relays with no connection to interface circuits (directly to EIL) has ambivalent comparison for channels.

Inputs have critical safety statement there fore they will be sent by two channels as well. Each input will have unique name. Only in case if both contacts of interface relays will have same statement than software will receive responsible message.

Only in case if all conditions are fulfilled from EIL via interface circuits will be given command to Auto Block system. Commands are necessary to execute changing traffic direction on the Open Line by station operator or CTC operator order. Each algorithm generated with considering sequences and working proceed of changing traffic direction in different modes. Before command execution will be checked safety conditions and supervision statement In other words who currently operate in station, station operator or CTC operator.

Universal elements used to generate commands and message from/to MMI and transfer from/to hardware. The commands has dynamic character, messages has static character. Dynamic character mean – signal appears for certain time which is necessary for interface circuits operation (the exact time can be defined during interface circuits test). Universal elements used for sending commands from MMI described I two steps:

1. Receiving commands from MMI.
2. Command name in software.

Commands and messages only with software name description don't have any connection to MMI. Software universal elements can elaborated any input/output signal what make system very flexible for any needs. Some sample of this element is shown bellow.

Commands what assignments in the IOM are safety critical there fore will be sent by two independent channels and value of channels shall be equal. Initial state defined level of signal in normal position. Normal position means – no commands > level of signal "0". Command out2XXXEntSg_aspON use inversely logic while Entrance signal has state control all time. When command will be given interface relay ICKBO will be switch off. Commands generated from MMI and after checking opportunity for executions commands will be sent to responsible interface relays.

Messages what assignments in IOM have a safety critical state and shall be read in by two independent channels. Name of inputs written in following meaner – in2XXXDirOut: in2 – inputs by two channels; XXX – station name in project; DirOut –direction Out. Messages used for read in information from outdoor hardware equipment from Open Line and neighbour station. The statement about commands execution also will be read in as messages, they will be named as commands read back (sample rbOut2XXXDirOut).

With Interface circuits signals to read in from hardware. Interface relays read in equivalent statement. The interface relays read in ambivalent statement, interface relays initial state have backed position except inputs of entrance signals current position. Considering functional specification each input from relays

shall have own unique name. Software don't have possibility to add in three ways switcher there fore will be used two interface relays and from each of them have been taken only one contact. Interface relay in model circuit's type is NMSH1/1440, this relay of 1 CLASS safety to ensure all interdependences in high level. All microprocessor systems used in Baltic countries have power supply for relays 24 V.

IV Interface development to the Double Track Automatic block

The Interface EIL with existing Double Track Automatic block consists:

- the interface with devices of the change of direction scheme;
- the interface with line devices of Double.

The scheme of changes a direction will be used one for each line track. If one of line tracks is closed for repair, the second line track is used in both directions. If a train moves in the wrong direction the movement depends on the locomotive signal system and a movement on the closed track is excluded.

For example, the Simis IS interlocking in actual station receives from line Double Track Automatic block equipment binary input signals. EIL send to Double Track Automatic block equipment - binary output signals.

In EIL following functions are integrated:

- change of direction with the vacancy control of the line from local or reserve operation or from CTC;
- permission for taking out a key-token if the station is in reserve or local operating mode and when it is necessary to send the train in preferred direction with stop aspects on the exit signal.

For realisation of these functions EIL provides the following commands:

- set the both-direction traffic on every line track;
- change of direction;
- departure of maintenance train.

For every line track the following information will be transferred from automatic line block to EIL:

- direction of movement (arrival, departure) if one track is used for moving in both directions;
- status of line (is free, occupied)) if one track is used for moving in both directions;
- status of the first and second approach-removal sections on a track with preferred direction (is free, occupied);
- status of the first and second approach-removal sections on a track with non-preferred direction (is free, occupied);
- status of the interface relays (is switched on/off);

Algorithms of change traffic direction on the Double Auto Block Line in different modes with checking safety conditions. Only in case if all conditions are fulfilled from EIL via interface circuits will be given command to Auto Block system. Commands are necessary to execute changing traffic direction on the Open Line by station operator or CTC operator order. Each algorithm generated with considering sequences and working proceed of changing traffic direction in different modes. Before command execution will be checked safety conditions and supervision statement In other words who currently operate in station, station operator or CTC operator.

For example, some universal interfaces decisions for request of moving direction changing, input and output show in table 1.

Table 1.

Some universal interfaces decisions

Output object (Output Type)	Controls relay	Meaning of high Signal
out2XXXDirOut (Request direction OUT,)	ICSN1 ICSN2	<p>DirOut</p>
out2XXXEmIn	ICPV1 ICPV2	
out2XXXEmOut	INOV1 INOV2	<p>EmOut</p>

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Summary

Mareks Mezītis, Olegs Kamenevs Mikroprocesora un releju vadības sistēmu interfeisu izstrādei primāro aspektu noteikšana

Piedāvātais interfeisa modelis ļauj veikt saikni starp mikroprocesora vadības un kontroles sistēmu un automātiskās bloķēšanas sistēmām. Interfeisa

modelim ir visu nepieciešamo funkcionalitātes iespējas, ka arī augstākais drošības līmenis, kas atbilst CENELEC prasībām. Papildu darbības izdevumi nav nepieciešami un līdz ar to integrācijai automātiskās bloķēšanas sistēmā ir pozitīva ekonomiskā ietekme. Interfeisu modelis var viegli būt integrēta citas vilcienu vadības un kontroles sistēmās, kas tiek ekspluatēti vai tika nodoti ekspluatācijā Baltijas valstīs. Secinājumu par saderību ar mikroprocesoru vadības un kontroles sistēmu veikts, pamatojoties uz detalizētu pētījumu par programmatūras un aparatūras spējām.

Mareks Mezitis, Olegs Kamenevs Definition of the basic aspects by development of Universal Interfaces between relay and microprocessor systems

Represented interface model give a possibility to make interconnection between microprocessors interlocking and Auto Block systems. With in interface model will be kept all functional interdependences and safety level. Absence of running cost for interface integration to Auto Block has positive economical effect. Interface model can be easy integrated to any interlocking type what is constructed or under construction in Baltic countries. Conclusion about compatibility interface model with microprocessors interlocking based on detailed research of software and hardware possibilities.

Марек Мезитис, Олег Каменев Определение основных аспектов при разработке универсальных интерфейсов релейных и микропроцессорных систем

Представленная модель интерфейса дает возможность сделать взаимосвязь между микропроцессорной системой управления и системой автоматической блокировки. Модель интерфейса обладает всеми необходимыми функциональными возможностями и требуемым уровнем безопасности. Отсутствие дополнительных эксплуатационных расходов для интеграции в системы автоматической блокировки имеет положительный экономический эффект. Модель интерфейса может быть легко интегрирована в другие системы управления движением поездов применяемых и вводимых в эксплуатацию в Балтийских странах. Заключение о совместимости предлагаемой модели интерфейса с системами микропроцессорной централизации сделано на основе детального изучения программных и аппаратных возможностей.