III INTERNATIONAL CONFERENCE
TRANSPORT SYSTEMS TELEMATICS TST`03

ZESZYTY NAUKOWE
POLITECHNIKI ŚLĄSKIEJ 2003
TRANSPORT z.51, nr kol. 1608

line block, axle counter, programmable controller

Jerzy ŁUKASIK[1]
Jakub MŁYŃCZAK[2]

TECHNICAL ASPECTS OF LINE BLOCK CBL2002

The purpose of this paper is to present a technical realization of requirements formulated for Digital Line Block 2002. Line block CBL 2002 is realized on the basis of digital programmable controllers PLC and cooperates with the axle counter constituting an integral part of the system. Sources of requirements for line blocks CBL2002 are requirements contained in the railway regulations and instruction concerning railway traffic (srk) control equipment and traffic management regulation provisions effective on railways.

TECHNICZNE ASPEKTY BLOKADY LINIOWEJ CBL2002

Celem artykułu jest przedstawienie technicznej realizacji wymagań sformułowanych dla Cyfrowej Blokady Liniowej 2002. Blokada liniowa CBL2002 jest realizowana na bazie programowalnych sterowników cyfrowych PLC oraz współpracuje z licznikiem osi stanowiącym integralną część systemu. Źródła wymagań dla blokady liniowej CBL2002 stanowią wymagania zawarte w przepisach i instrukcjach kolejowych dotyczących budowy urządzeń srk oraz przepisach prowadzenia ruchu na kolejach.

1. SHORT CHARACTERISTICS OF A DIGITAL LINE BLOCK CBL2002

CBL – digital line block
ACS 2000 – axle counter system
PSB – programmable block controller
BL – block relay
Jt – line track occupancy relay

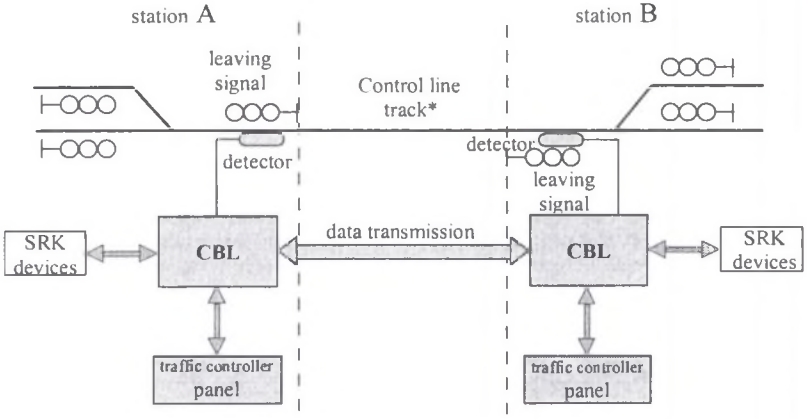
The bock is designed to ensure a safe management of train traffic within the block distance between two stations (signal boxes). It is a bi-directional line block. Basic status of the block is neutral. In this condition, the block renders impossible entrance to the trunk line track from either of signal boxes. In order to manage the traffic on the given trunk line it is

[1] Z.U.H Sig-Mont, Przemysłowa 10, 40-020 Katowice, jluk@polsl.katowice.pl
[2] Chair of Automatic Control in Transport, Faculty of Transport, Silesian University of Technology, Krasińskiego 8, 40-019 Katowice, Poland, jmly@polsl.katowice.pl

required to set a direction in the block (setting of block). Control of block equipment i.e. switching on for the specific direction, release or change of direction set may take place only from signal boxes responsible for traffic safety on the trunk line track in question. Line block devices, besides assuring safety of traffic management on the trunk line, handle also transfer of information to the signal boxes bordering the trunk line about the traffic situation concerning the trunk line track in question.

1.1 . GENERAL STRUCTURE OF CBL2002 EQUIPMENT

Fig.1 presents a general structure of the line block. Exchange of information between the bloc and *srk* devices at the station takes place through an interface „ SRK equipment ⇔ CBL". Information about occupancy of line track is obtained dbase upon detection of a wheel entering the trunk line by a detector working in team with an axle counter where from the information about line track status is handed over to the line block equipment. Data about the statuses of line block devices on the mated stations (bordering the controlled trunk line) are transmitted through a connection – data transmission. Moreover, line block equipment has a connection with the traffic controller panel, where the traffic controller controls the block and where the information about block devices statuses is transmitted. The traffic controller panel may be a domino panel, a LED or LCD with a keyboard.



*Range of controlled line track is determined by location of detector installation

Fig.1. General CBL structure

1.2 . THE BASIC MODULES OF CBL

Fig.2 shows the main modules and elements of CBL for one station. On a mated station the equipment structure is similar. System of axle counter constitutes an integral part of line block devices. For the block purposes only information about line track condition and one of counting system modules (DIOB board) are used for communication of line block on the mated signal-boxes. The axle counter based upon signals from the detector and information

about status of axle counter on the neighbour station (bordering the line track at the other end), yields an information about occupancy/non-occupancy of line track. It controls the Jt relay, whose contact transfers the information about status of the line track to the block controller. The block controller, based on its input data, i.e. line track status, status of block devices on the mated station, status of *srk* devices on the station and traffic controller commands (use of block pushbuttons) assumes corresponding internal statuses and prepares corresponding signals handed over to other modules. Among other it controls the block relay BL through a fail-safe comparator, and through the DIOB board of axle counter it communicates with a counterpart block controller on the neighbour station. Moreover the block controller yields information for the traffic controller panel informing about the present status of line block.

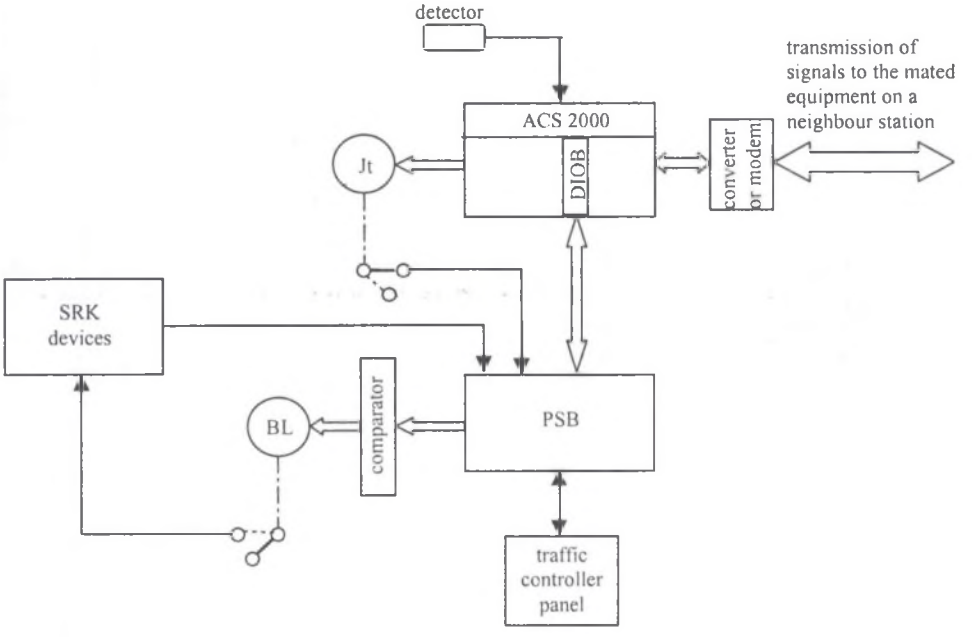


Fig.2. Main modules and elements of line block

2. BLOCK LINKS WITH SRK EQUIPMENT

Generally, for connection of CBL equipment with external interlocking systems of *srk* equipment, relay contacts are provided. For the signals related with safety one contact of N class relay is required in the case of lack of relay operation control. When the relay operation is controlled in other circuits and its malfunction is discovered immediately or in the next operating cycle of *srk* equipment, C class relay contact may be used. For information signals no requirements are used for class of relay whose contact is to be used.

2.1. INTERFACE SRK DEVICE ⇒ CBL

Information about the status of *srk* devices checked during controlling of line block equipment it is information about the fact that no leaving route to the line is being realized. Information about the status of signal relays is contained in the relay contact Pml that is excited in the case of excitation of any leave signal relay to the line track.

When releasing line block, it is checked whether the home signal to the station is back to its basic status after realized entrance route to the station and whether no route is realized on the emergency signal. In this solution it is checked by controlling the following contacts: of red light control relay, signal relay and signal relay for emergency signals. In addition, for information purposes information about lighting up a clearance signal on the home signal at the station is sent to the mated station.

2.2. INTERFACE CBL ⇒ SRK DEVICE

Information about the status of line block is transferred to the *srk* station equipment though the BL contact of line block relay. This relay is controlled by the failsafe comparator on the basis of signals issued by the line block controller.

2.3. POWER SUPPLY TO CBL DEVICES

Line block devices will be supplied with a digital voltage 24 [V] from a power supply with battery support, supplied with alternate voltage 220 [V]. This power supply constitutes an integral part of the line block devices. The power supply is used because of axle counter and line block in reference to the stability of power supply voltage parameters.

3. FUNCTIONAL REQUIREMENTS

3.1. GENERAL REQUIREMENTS

The line block should fulfill the following conditions:

1. In the basic condition the line block remains in the neutral status, where neither of directions is switched on.
2. Switching on of line block for one direction should disable setting of clearance signal on the leaving signals for the opposite direction.
3. Setting of clearance signal on the signal light (lights) set at the beginning of block depends of setting of traffic direction and of occupancy condition of the block.
4. The clearance signal on the signal light (lights) set at the beginning of block may be set only after leaving of this block by the train and protection of the train with a "STOP" signal on the signal light located at the end of block.
5. The clearance signal on the signal light (lights) set at the beginning of block may be set. Only once until the leaving of this block by the train and confirmation (through block equipment) of its arrival to the signal box located at the end of the block.

6. Setting of a „STOP" signal at the light signal located at the beginning of the block should take place automatically, after the first axle of the train entering the interaction equipment..
7. Operation of devices enabling release of block should take place after the last axle of the train leaves the interaction equipment set for this purpose.
8. Change of line block direction is possible only when the block is free and no clearance signal is present at the leaving signals to the line and the leaving route is not being realized.
9. Transition of line block to the neutral condition takes place when the block is free and the mated signal box has confirmed arrival of the train.
10. Condition of line block should be communicated to the equipment service personnel.
11. In order to ensure cooperation of line block devices between the signal boxes a separate cable line, separate telecommunication connection, optical wire connection or radio connection may be used.
12. The line block shall be additionally equipped with devices enabling its operation in the case of interrupted operation of interlocking equipment.
13. The line block devices should be resistant to the errors of operation on one or simultaneously both signal boxes bordering the line.
14. Line block equipment should be fail-safe i.e. any malfunction or incorrect operation (random or resulting from improper human behaviour) will not result in hazard to human life, health and property and in such case equipment is stable in a predefined safe condition.
15. Line block devices cannot "leave" the safe condition by themselves. „Leaving" of such state by the equipment is possible only as a result of action of competent persons (technical services) after completion of strictly defined actions.
16. The principle of line block operation for both directions shall be the same..

3.2. LINE BLOCK OPERATION STATUSES

Line block operation has to fulfill the requirements concerning above all the safe management of train traffic and high reliability.

The statuses of normal operation of the equipment include:

- Neutral status;
- Traffic direction setting status:
  - Clearance request,
  - Clearance granted;
- Status of set traffic direction:
  - Clearance granted,
  - Leaving the signal box,
  - Travel along the line,
  - Entrance to the neighbour signal box;
- Status of release of the traffic direction set (return of clearance).

The device operation statuses in particular cases include:

- Lack of possibility of direction request,
- Lack of clearance for switching on the line block for one direction of traffic,
- Return of clearance without train travel,
- Cancellation of train leave,
- Leave of signal bock on particular command or emergency signal,

- Entrance to the neighbour signal bock on particular command or emergency signal.

The line block statuses include also failsafe status that the line block should assume in the case of malfunction of line block devices or disturbance influencing its safety of operation. The failsafe condition is recognized when the line block devices render impossible train management on the trunk line without restrictions. Line bock devices cannot leave the failsafe condition by themselves. In addition, the failsafe status may appear at any moment of the line block operation, contrary to the remaining statuses whose order is specifically defined.

3.3. OPERATION DURING MALFUNCTIONS AND DISTURBANCES

The expected emergency situations are as follows:

- Lack of power supply or transmission,
- Line occupancy when the direction s not set,
- Line occupancy after the train's entrance to the station and failure to release the line block,
- Line occupancy after use of pReset pushbutton at one station,
- Short-circuiting (holding) of a pushbutton on the panel for 30 s.,
- High signal on the contradictory outputs of the controller
- Line occupancy and clearance signal at the leaving light signal (not extinguished leaving signal),.

Such events cause the transition to emergency condition and lighting up of signals „Entrance" and „Leaving" in continuous red. Leaving the emergency condition is possible exclusively in the case of line non-occupancy and the pReset pushbuttons have been used on both stations. Use of pReset pushbutton results in change of signal colour from continuous red to continuous yellow. Return of line block to the neutral condition takes place after acknowledgement.

4. TRANSMISSION AND REACH OF LINE BLOCK

For the purpose of communication between line block devices located at the neighbourhood signal boxes the transmission applied for the axle counter is used. The axle counter besides transmitting its own signals using the DIOB board enables a safe transmission of additional signals, which was used for the line block purposes. The axle counter transmission ensures Hamming distance 6 and complies with the requirements of standard EN 50159-1 concerning safety of data transmissions in the closed loop systems which is confirmed in the axle counter documentation.

The manufacturer of axle counter does not impose the type of converter or modem, thus the line block range depends of selection of these elements. Moreover no type of transmission carrier is imposed, so for the purposes of line block a separate cable line, separate telecommunication connection, optical wire connection or radio connection may be used.

A typical reach of line block is defined for 20 km, but having the above assumptions in mind and especially a possibility of selection of converters and modems it is expected that the reach ay be extended to 50 km.

5. DESCRIPTION OF COMPUTER PANEL

5.1. CONSTRUCTION OF COMPUTER PANEL

As computer panel a liquid crystal LCD display was used of PROVIT 2000 type, Bernecker&Rainer manufacturing.

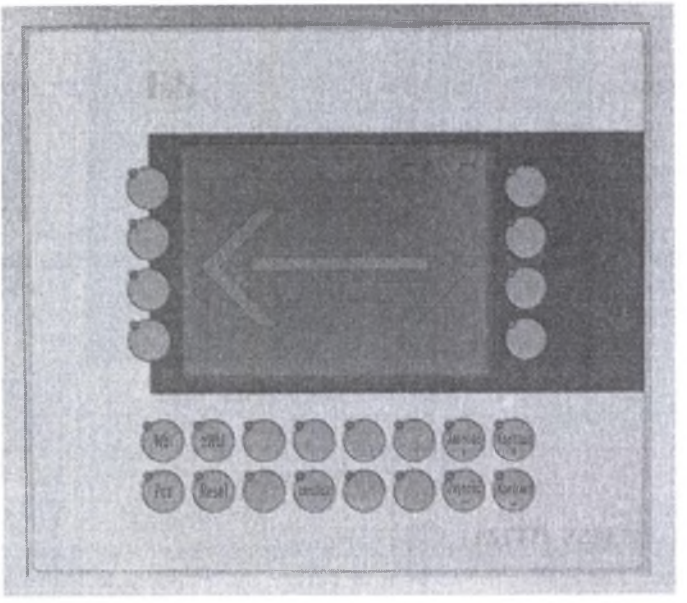


Fig.3. Layout of the computer panel

Pushbuttons to the line bloc operation (Wbl. Poz, zWbl, Reset) and for zeroing of the axle counter (zerolicz) and screen operations (brightness +/-, contrast +/-) are located on the computer panel.

Not marked and system pushbuttons are blocked and not used in the line block operation.

Pushbutton Wbl serves the purpose of switching on the line block in the direction of leaving the station.

Pushbutton zWbl serves the purpose of switching off the line block in the case of withdrawal from setting the train on the line, but only for the leaving of this particular station, independently of the fact whether the neighbour station has given the entrance clearance and that the clearance signal is set on the line leave signal (after previous switching off of the signal with appropriate pushbutton).

Pushbutton Poz serves the purpose of giving clearance for release of the train to the neighbour station.

Pushbutton Reset serves the purpose of resetting the line block, in the case when line shows the non-occupancy status and in spite of this fact the block does not function properly (for example after a break in the transmission between the stations or after a break in the poser supply to the system)

Pushbutton zerolicz serves the purpose of issuing a comment to zero the axle counter at the moment when it erroneously shows the occupancy of the line. Axle counter zeroing procedure is restricted by separate regulations in the ACS2000 system's O&M (DTR) manual.

Pushbuttons Jasność +/- i Kontrast +/- serve the purpose of changing the display's parameters depending of the needs of the service personnel.

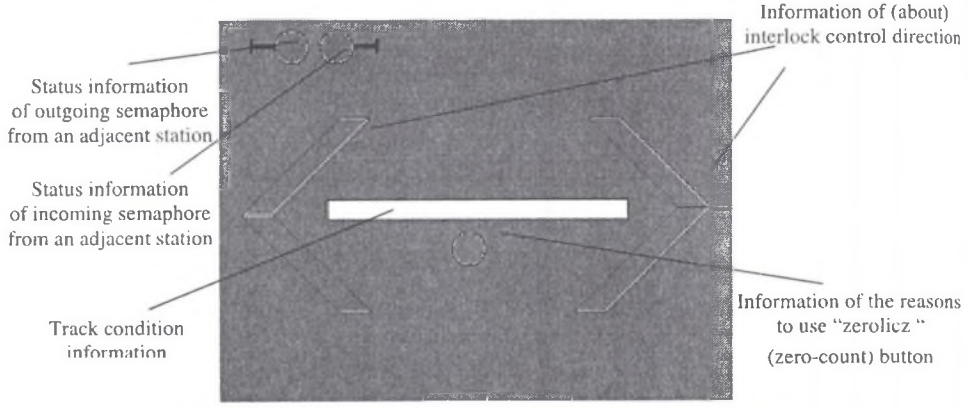


Fig.4. Layout of the panel in its basic state

6. CONCLUSIONS

Line block concept presented in this article demonstrates new approach to the problems of single-distance line block. On account of energy-consumption, technical solutions were aimed to eliminate any relay implementations (except safe comparator). Digital line block is energy-saving solution, as well as safe and ergonomic for operating staff. Application of high quality components with fully tested safety parameters improves the safety of railroad trails. Appropriate software and complete registration of events additionally protect the line block from the possibility of abuse caused by operating staff.

BIBLIOGRAPHY

[1] Cyfrowa Blokada Liniowa 2002 – Specyfikacja wymagań (Digital line block 2002 – Specification of requirements), Z.U.H Sig-mont, Katowice 2003.

[2] Wymagania bezpieczeństwa dla urządzeń sterowania ruchem kolejowym (Requirements of safety for the railway traffic control equipment), Zakład Sterowania Ruchem Kolejowym CNTK, Warszawa luty 1998.

[3] Instrukcja WTB-E10 – Wytyczne techniczne budowy urządzeń sterowania ruchem kolejowym w przedsiębiorstwie Polskie Koleje Państwowe (Instruction WTB-E10 – technical guidelines of construction of railway traffic control equipment in the Polish State Raiways company), PKP General Management, Warsaw 1996.

[4] Instrukcja o prowadzeniu ruchu pociągów na PKP - R1 (Instruction on train traffic management at PKP – R1), Polskie Koleje Państwowe, Warszawa 1998.

Reviewer: Prof. Zbigniew Ginalski