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THE AXLE COUNTING SYSTEM ACS2000 WITH FAIL-SAFE DATA TRANSMISSION

The article includes informations about axle counter system ACS2000. The system allows block mode or isolated operation. Block mode is used where long track sections require supervision.

SYSTEM LICZENIA OSI ACS2000 Z BEZPIECZNĄ TRANSMISJĄ DANYCH

Nowoczesny licznik osi ACS2000 oprócz kontroli niezajętości odcinków stacyjnych i szlakowych umożliwia ponadto przesyłanie 16 dodatkowych informacji (meldunków, poleceń, itp.). Komunikacja pomiędzy dwoma współpracującymi licznikami jest możliwa tylko podczas pracy licznika w trybie blokowym i jest realizowana za pomocą połączenia modemowego. Odległość pomiędzy dwoma współpracującymi licznikami zależy od rodzaju zastosowanej transmisji (kablowa, optyczna, radiowa) i może sięgać kilkunastu a nawet kilkudziesięciu kilometrów. Licznik osi ACS2000 składa się z modułów, których rozbudowa jest prosta i nie wymaga zmian oprogramowania. Koncepcja bezpieczeństwa oparta jest na dwukanałowym przetwarzaniu i komparacji dwóch niezależnych sygnałów wytworzonych w każdym czujniku koła. Dodatkowo licznik osi posiada rozbudowane funkcje diagnostyczne i kontrolne przez co określany jest mianem urządzenia „fail-safe".

1. FUNCTIONAL OVERVIEW

1.1. PURPOSE

The Axle Counting System ACS2000 is used for fail-safe track vacancy detection (points, group of points, track sections) at station and on the open track.

Railway operations must ensure safety. Safety installations provide protected track sections, where trains can run safely. The basis for the safe operation of the axle counting system ACS2000 is the microprocessorsystem specially designed for this application, which verifies all safety-relevant data and processes them using two channels. The microprocessor system comprises two channels that are independent from each other, use different software (EIB-OK), but are identical in their hardware design. Both channels are supplied in parallel with the same input data and, due to their identical design, always process the same data so that the output data are provided in two channels. Two comparators that are independent from each other, will only allow a track clear indication provided both outputs are the same. Direct relays are used to output the track vacancy and occupancy detection.

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1.2. FUNCTIONAL PRINCIPLE

At each start and end of a track section there is a wheel sensor, together with the evaluation board EIB-OK, operates as counting head detecting all wheels of the trains traversing this section as well as the driving direction by means of two electronic sensor systems. Each wheel sensor is connected to an evaluation board EIB-OK by means of a four wire signalling cable. This cable powers the wheel sensor and allows it to transmit the axle detection data to the evaluation module.

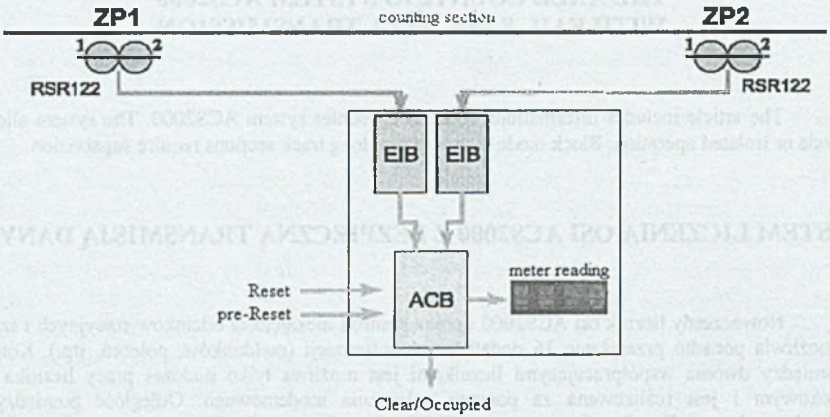

Fig.1. Functional principle

The axle counting board ACB of the axle counting system compiles the axle detection data received from the counting heads into an overall result. Considering the operating conditions, the axle counting system ACS2000 deduces a track clear or track occupied indication for the track section. Direct relay outputs relay this message.

For the reset defined for the axle counting system, axle counting board ACB features inputs to connect 2 axle count reset buttons. For the purpose of reset release, the front panel of the axle counting board ACB features an auxiliary axle count reset button (pre-Reset). Upon commissioning or in case of maintenance works the counter reset as defined starting position of the axle counting system has to be operated by means of these buttons.

The axle counting board ACB is capable of evaluating up to 6 independent counting head informations supplied by evaluation boards of type EIB-OK. By parallel connection of counting heads (no more than 2 per counting head input), it is possible to have up to 12 counting heads, provided simultaneous traversing of the counting heads connected in parallel can be excluded. In case of adjacent counting sections, double usage of the counting head at the separation joint is possible.

The system allows block mode or isolated operation.

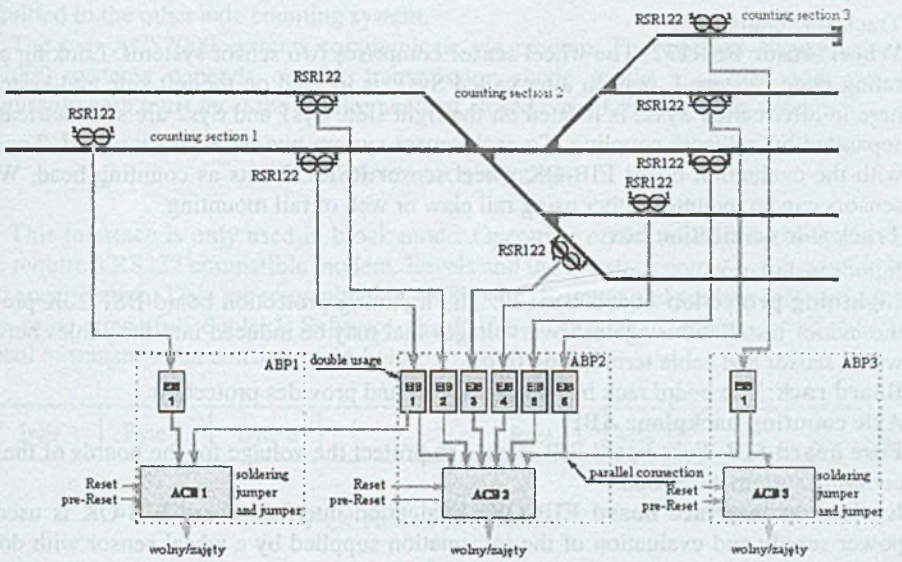

Fig.2. Block diagram for isolated operation of ACS2000 (example)

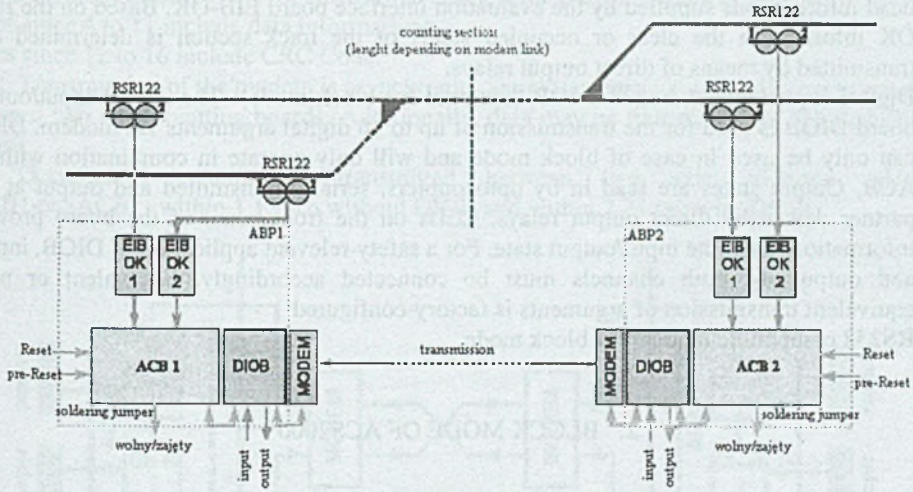

Fig.3. Block diagram for block mode of ACS2000 (example)

The axle counting system ACS2000 is of modular construction and comprises the following components/boards:

- Track side equipment
- **Wheel sensor RSR122**: The wheel sensor comprises two sensor systems. Looking at the rating plate, system 1, here in after called Sys1, is located on the left side and system 2, here in after called Sys2, is located on the right side. Sys1 and Sys2 are symmetrical and separated by galvanic coupling. To each sensor system two wires are assigned. Together with the evaluation board EIB-OK wheel sensor RSR122 acts as counting head. Wheel sensors can be mounted either using rail claw or web of rail mounting.
- **Track side connection box**
- Indoor installation
- **Lightning protection board BSI120**: The lightning protection board BSI120K protects the indoor installations against overvoltages that may be induced into the cables between wheel sensor and cable terminating frame.
- **Board rack**: The board rack houses the boards and provides protection.
- **Axle counting backplane ABP**
- **Fuse board SIB**: Fuse board SIB is used to protect the voltage for the boards of the axle counting system ACS2000.
- **Evaluation interface board EIB-OK**: Evaluation interface board EIB-OK is used for power supply and evaluation of the information supplied by a wheel sensor with double sensor system. Output signals are transmitted to the axle counting board ACB via axle counting backplane ABP.
- **Axle counting board ACB**: Axle counting board ACB is used to process the counting head informations supplied by the evaluation interface board EIB-OK. Based on the EIB-OK information the clear or occupied status of the track section is determined and transmitted by means of direct output relays.
- **Digital input/output board DIOB** (optional for block mode): The digital input/output board DIOB is used for the transmission of up to 16 digital arguments via modem. DIOB can only be used in case of block mode and will only operate in combination with an ACB. Output states are read in by optocouplers, serially transmitted and output at the partner device by direct output relays. LEDs on the front panel of the board provide information about the input/output state. For a safety-relevant application of DIOB, inputs and outputs of both channels must be connected accordingly. Equivalent or non-equivalent transmission of arguments is factory-configured.
- **RS232** compatible modem for block mode.

2. BLOCK MODE OF ACS2000

2.1. FIELD OF APPLICATION

Axle counting system ACS2000 is used for block mode where long track sections (limited by mode of transmission) require supervision. Additionally, up to 16 arguments (e.g. informations, messages, commands, ...) can be transmitted between the two ACS2000 systems used in the block mode. Arguments are read in by optocouplers, separated by galvanic coupling and output at the partner device by direct relay outputs.

Operation of the two ACS2000 systems used in the block mode is equivalent and synchronous. If one of the ACS2000 systems count a wheel in, this axle information is transmitted to the other axle counting system.

The two ACS2000 systems communicate via modem. The distance between the two ACS2000 systems depends on the transmission mode (optic, ...). However, the data transmission path must meet the requirements of closed circuit transmission system.

2.2. INTERFACE "MODEM"

This interface is only used in block mode. Operation of the ACS2000 system in block mode require a RS232 compatible modem. Levels and the interface comply with the RS232-C (V24) specification. Data are transmitted at 4800 baud. Sending and reading informations are in the same time (full duplex). Software check if transmission is correct in all time. The protocol of transmission consists of 16 bytes.

Fig.4. Protocol of transmission

Byte 1 includes informations about channels and cards.
Byte 2 includes informations about protocol's code (jumpers settings).
Byte 3 includes informations for software to check if the transmission was succesfully or not.
Bytes since 4 to 11 include data informations.
Bytes since 12 to 16 include CRC Code.

Transmission of the modem is asynchronic. Serial transmission is used to exchange data between two axle counting boards. Additionally, data may be transmitted by optional DIOB boards.

Occupancy detection is transmitted between two axle counting systems (ACB1<=>ACB2) within 1.12 sec without DIOB and within 2.24 sec with DIOB.

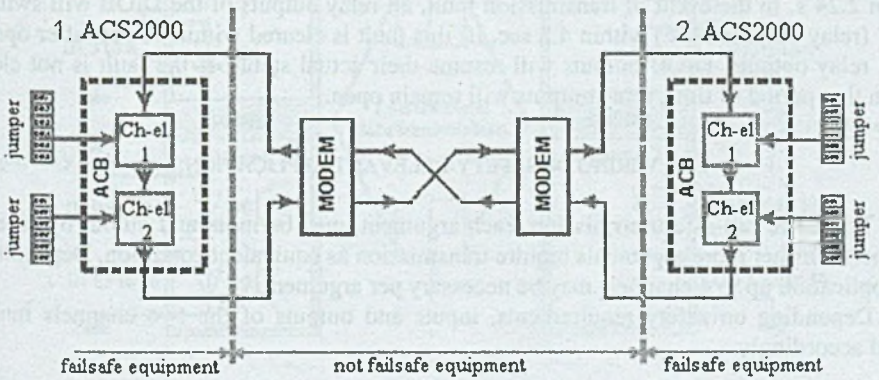

Fig.5. Communication between two ACS2000 in blockmode with minimal configuration

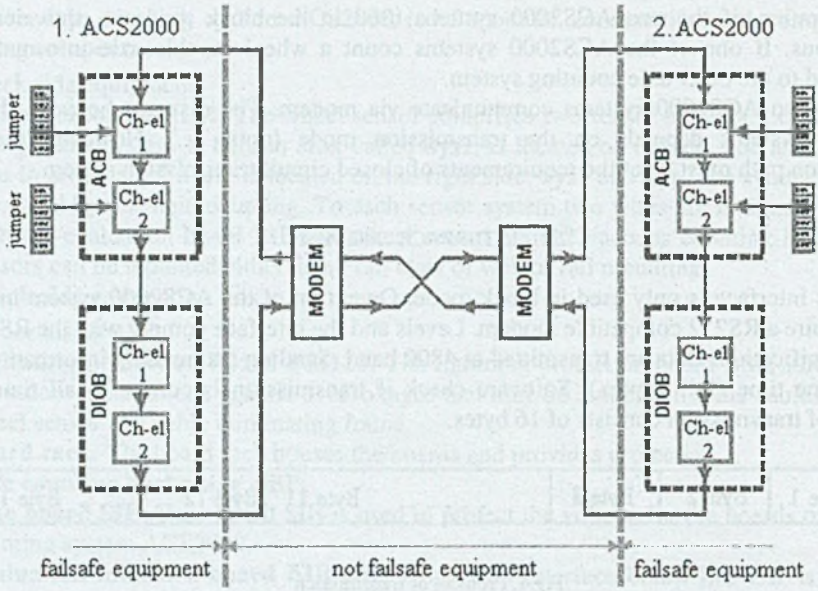

Fig.6. Communication between two ACS2000 in blockmode with maximal configuration

In the event of transmission fault, occupancy detection will occur after 4.2 sec. If this fault is cleared within 10 sec after occurrence of the occupancy detection, outputs FREE and OCCUPIED will resume their actual status. If the fault is not cleared within that period of time, the system will consider a minor error.

Between the two channels of an axle counting board, occupancy detection will also be exchanged by means of dialog lines. In block mode, failure to match will cause a fault within 750 ms, respectively within 30 ms for isolated operation.

Arguments are exchanged between two axle counting systems (DIOB1<=> DIOB2) within 2.24 s. In the event of transmission fault, all relay outputs of the DIOB will switch to LOW (relay outputs open) within 4.2 sec. If this fault is cleared within 10 sec. after opening of all relay outputs, DIOB outputs will resume their actual status. If the fault is not cleared within that period of time, relay outputs will remain open.

2.3. WIRING OF SAFETY-RELEVANT APPLICATIONS

To ensure fail-safe transmission, each argument must be input and output by at least 2 channels. Further more arguments require transmission as equivalent condition. Depending on the application up to 4 channels may be necessary per argument.

Depending on safety requirements, inputs and outputs of the two channels must be linked accordingly.

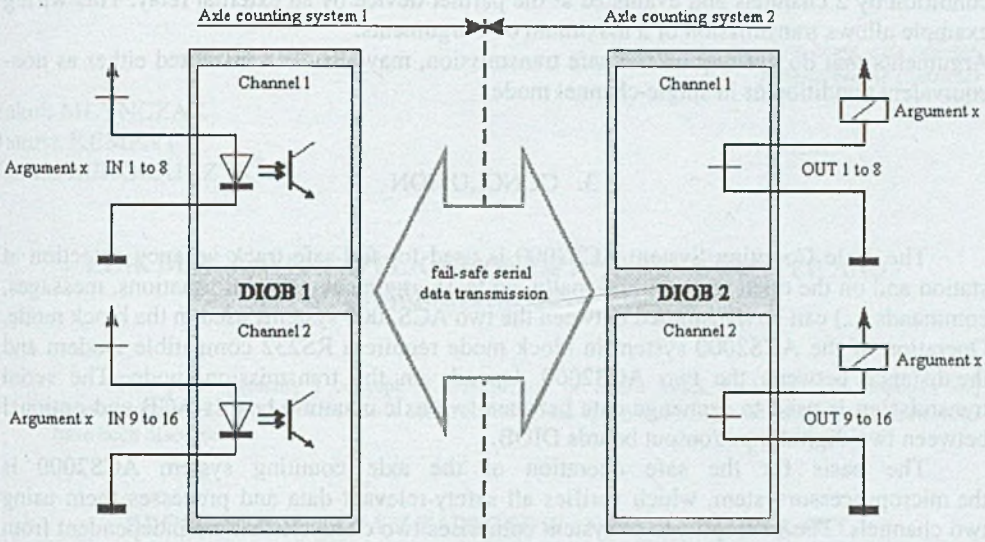

Fig.7. 2 channels 2 x equivalent (example)

In this wiring example, the argument to be transmitted is read in as equivalent condition by 2 channels and evaluated at the partner device by 2 external channels. This wiring example allows transmission of a maximum of 8 arguments.

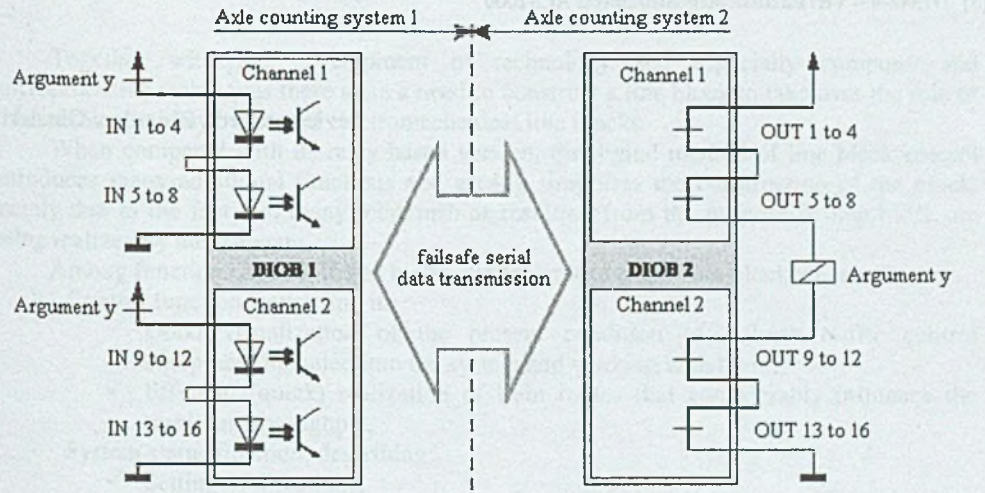

Fig.8. 2 channels 4 x equivalent (example)

In this wiring example, the argument to be transmitted is read in 4 times as equivalent condition by 2 channels and evaluated at the partner device by an external relay. This wiring example allows transmission of a maximum of 4 arguments.
Arguments that do not require fail-safe transmission, may also be transmitted either as non-equivalent condition or in single-channel mode.

3. CONCLUSION

The Axle Counting System ACS2000 is used for fail-safe track vacancy detection at station and on the open track. Additionally, up to 16 arguments (e.g. informations, messages, commands, ...) can be transmitted between the two ACS2000 systems used in the block mode. Operation of the ACS2000 system in block mode require a RS232 compatible modem and the distance between the two ACS2000 depends on the transmission mode. The serial transmission is used to exchange data between two axle counting boards ACB and optional between two digital input/output boards DIOB.

The basis for the safe operation of the axle counting system ACS2000 is the microprocessorsystem, which verifies all safety-relevant data and processes them using two channels. The microprocessor system comprises two channels that are independent from each other, use different software, but are identical in their hardware design.

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Reviewer: Prof. Zbigniew Ginalski