Axle Counter System ACS2000 – Efficient and Universal Clear Track Signalling System

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The rationalisation of railway traffic and improvement of transport services require modern technology in many areas of railway operations.
Regarding train protection this leads to automatic clear track signalling systems, which decisively improve safety - the prerequisite to increase efficiency.
For years the market for axle counter systems has had above-average growth. This growth is due to the fact that railway operators, who, formerly, exclusively applied track circuits because of their additional capabilities for signal transmission to vehicles and rail breakage detection, are now opting increasingly for the axle counter system.
It has been acknowledged that reliability and economic efficiency of modern axle counter systems do compensate these missing extra functions and actually offer significant saving potentials, especially regarding maintenance costs.

1 Introduction

As a manufacturer of components and specialist in inductive sensor technology Frauscher GmbH has been delivering axle counting systems of type AZF (Achszählsystem Frauscher) since 1994, which are being used, sometimes in large numbers, by many railway operators.
Based on the experience gained and on wheel sensor RSR122, approved in the year 2000 by the Federal Railway Authority (EBA) in Germany, the new axle counting system ACS2000 was developed specifically for application at German Railway (DB AG). Compared with the proven predecessor system AZF, additional functions, such as fail-safe data transmission between two axle counting boards have been integrated, thereby increasing yet again its economic efficiency. Since April 2002 we have been able to offer a reliable axle counting system that is easy to operate and can be used universally and vendor-free for clear track signalling tasks at DB AG and other railway operators.

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2 System description

The axle counting system ACS2000 comprises the counting heads on the track and the indoor installation equipment (*figure 1*).

2.1 Counting heads

A counting head comprises essentially the wheel sensor RSR122 (*figure 2*), which together with a relay evaluation interface board EIB-R has been used since the beginning of 2001 on the routes of DB AG's ICE 3. The trains are equipped with a cadenced linear eddy current brake to switch the level crossing protection systems (BÜSA) [1]. The reliability thereby achieved is extremely high and confirms its suitability for axle counting tasks.
Wheel sensor RSR122 comprises two independent sensor systems which are separated by galvanic coupling, sealed in the wheel sensor housing, and which detect the wheel flange of the train wheel. The operating principle of the wheel sensor system is based on the loss of energy in an electromagnetic alternating field when damped by metal (wheel flange, rail). Measurement of this interference allows both supervision of correct mounting at the rail and detection of a passing wheel flange. The wheel sensor is fed by a DC voltage supply, being the wheel sensor adjusted to a constant sensor current of 5 mA. The wheel sensor does not suffer any interference from either the cadenced linear eddy current brakes or the electromagnetic rail brakes.
Typical for the wheel sensor is its rational mounting at the inside face of the rail on a rail claw and the complete absence of any other electronic components in the proximity of the rail. Thus, except for an annual check, there are no further maintenance needs in this dangerous and frequently time-consuming work area of the track.
Rail-claw mounting is preferred because it allows precise and quick mechanical adjustment of the wheel sensor. Under special circumstances the wheel sensors can be mounted onto the web of the rail; this however, requires that holes be drilled into the web.
The wheel sensor comes equipped with a fixed moulded four-wire cable set, which is connected in the track connection box via terminal to the main signalling cable connecting to the indoor installation. The wheel sensor complies with protection class IP 67.

2.2 Indoor installation

2.2.1 Lightning protection board BSI120-K

The over-voltage protection concept requires an over-voltage protection at the end of the indoor installation cable run to ensure efficient discharge of the voltage peaks (transients) induced into the cable. The sensor itself is completely insulated from ground to withstand at least 5 kV respecting the rail. Transient over-voltages are thus discharged to the signal box where they are symmetrically (2 wires simultaneously) limited to a maximal 1000 V by the lighting protection board BSI (*figure 3*). Smaller over-voltages are buffered by means of over-voltage protection measures by the evaluation interface boards introduced below.

2.2.2 Evaluation interface board EIB-OK

In the indoor installation, each counting head is connected to its own power supply and evaluation interface board EIB-OK. Several hundred units of this board, in its relay-fitted version, are already in service at DB AG in switch level crossing protection systems (BÜSA). For the specific axle counting application, output of the digital wheel sensor signals uses optocouplers in order to achieve the high switching speeds necessary. Thus, traversing speeds of maximal 450 km/h are possible (lab test). Measurements taken on the track presently confirm 330 km/h.
The board performs a two-channel evaluation of the two wheel sensor system signals of an RSR 122 and uses the evaluation to generate safe digital wheel sensor pulses for further processing by the axle counting system. Evaluation processors of both wheel sensor systems of a wheel sensor are programmed with mutually independent software.

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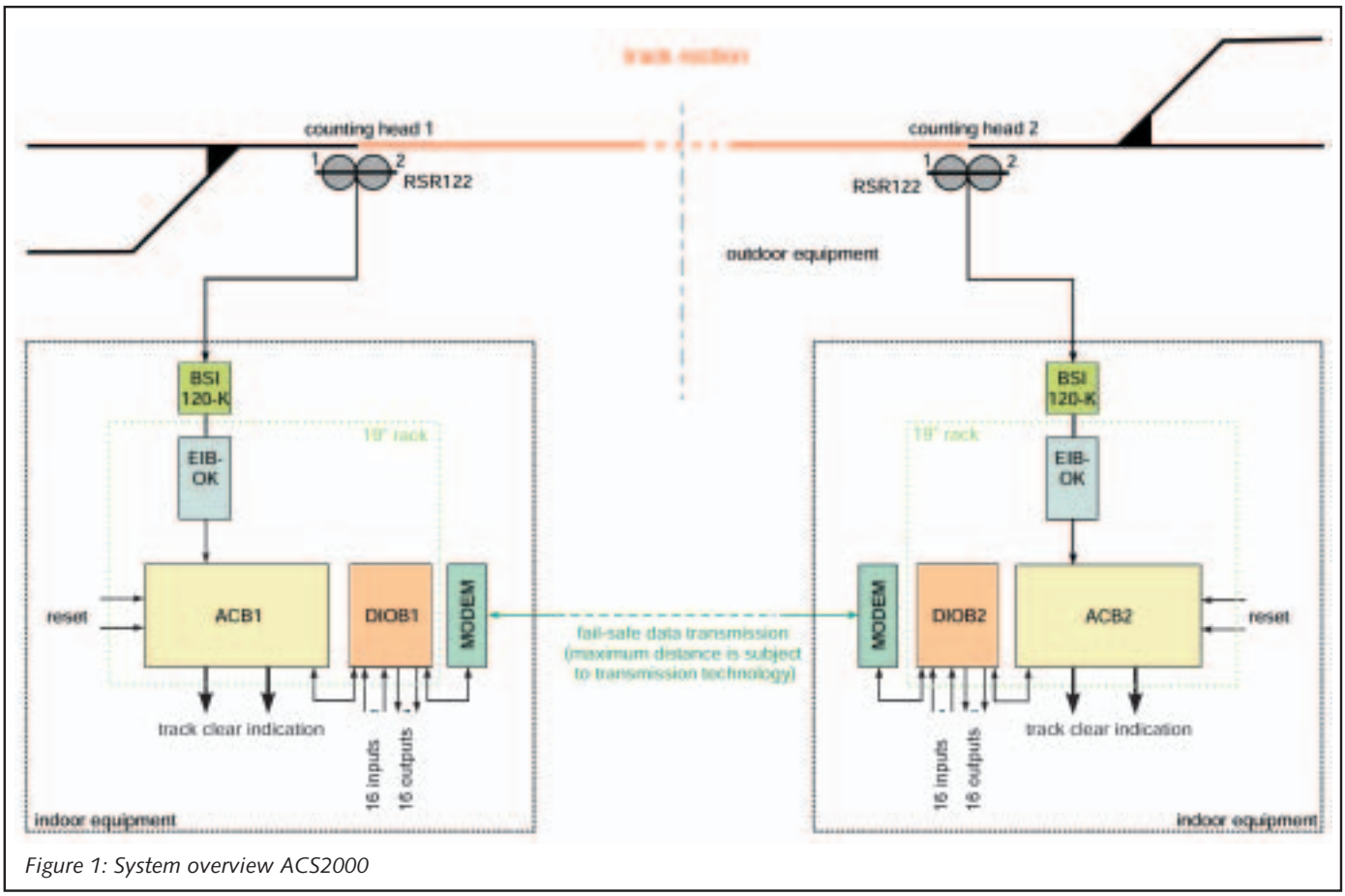

Figure 1: System overview ACS2000

2.2.3 Axle counting board ACB

The axle counting board ACB detects the wheel pulses of the connected counting heads of a track section and generates a fail-safe track clear indication. The microprocessor system of the ACB comprises two independent processing channels. The output information generated by these two channels is only released after two further independent comparators have confirmed that output data are identical. The interface to the signalling system is a two-channel configurable relay interface. One ACB allows simultaneous processing of the signals 6 wheel sensors. For system reset there is a two-channel input. Conditions for reset and reset procedure can be configured according to railway operator needs.

For applications where the safe track clear indication of a track section is to be made available for two operating units, two axle counting board ACBs can communicate by means of a serial connection (RS232 modem). The communication complies with the standard EN 50159-1 regarding fail-safe communication in closed-circuit networks. The distance between the two operating units is only limited by the efficiency of the transmission system.

A second serial interface on the front face of the board allows connection of a standard laptop for read out and evaluation of diagnostics data.

2.2.4 Digital input/output board DIOB

For applications where the track clear indication of a track section is to be made available to two signal boxes, the digital input/output board DIOB allows input of additional 16 one-channel data (optocoupler) and direct relay output at the opposite side. Transmission is bi-directional and is fail-safe (EN 50159-1). For further fail-safe processing by the signalling system,

Figure 2: Counting head with wheel sensor RSR122 mounted on rail claw

Figure 3: Lightning protection board BSI120-K to discharge voltage peaks

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data must be transmitted as equivalent signals by multiple channels.

2.2.5 19" board rack

In compliance with the project, boards EIB-OK, ACB and DIOB are inserted together with a fuse board per counting section into 19" board racks (*figure 4*). The boards of a counting section are electrically connected at the axle counting backplane ABP. Depending on the actual configuration, a board rack with 84 pitch units can accommodate the boards of 4 track sections. All boards comply, without further electrical protection, with the standard EMV EN 50121-4. Thus, the board rack is but a construction element providing protection against mechanical interferences.

Figure 4: Indoor installation of axle counting system ACS2000 – 19" rack to control to two axle counting sections, one with six and the other with two counting heads

3 Application and operating conditions

The regulations of railway operators normally refer to the reset procedure of axle counting systems. In the German-speaking countries reset procedure with reset group button and a reset button assigned to the track section and respective conditions of use are standard features. However, railway operators, who had primarily used track circuits, require a pre-reset. In this case, reset only becomes effective, if, after pressing the reset button, the track section is subjected to a so-called clearing or sweeper run, during which the correct operation of the counting heads is controlled. Reset conditions and reset procedure are configured by the manufacturer using configuration switches.
The advantages of this easy and straightforward structure become clear as early as in the project stage. After definition of the track insulation plan, the axle counting system can be projected within a short period of time. The project-specific board racks are delivered for the signalling system and connected via cable to the counting heads.
Counting heads are delivered pre-mounted on the rail claw and for the respective rail profile, i.e. only mounting at foot of rail and connection to the earth cable run are necessary.
Adjustments on site include electrical adjustment of wheel sensors on the track, testing and, if necessary, correction of counting direction per counting head by means of jumpers in the indoor installation. Commissioning follows a test procedure that re-checks all adjustments made.

4 Application examples

Since the middle of 2001, DB AG has been testing three counting sections at Gunzenhausen on the extremely busy Treuchtlingen - Ansbach route. The official period of observation ended successfully after 15 months in September of 2002.
The axle counting system ACS2000 was deployed for the first time, with safety liabilities, at the Slovenian railway operator on the Murska Sobota - Dankovci - Hodos route. Route Ljubljana - Sezana (12 stations) will also be equipped with the ACS2000 system.
City Bahn Chemnitz GmbH has been using the axle counting system since 15.12.2002 for track vacancy detection on route Chemnitz - Stollberg.
Contracts have been signed for other installation projects in Germany and abroad, and some projects are already under construction.

5 Features

Basic technical data of the electronic axle counting system:
- supervision of track sections with a maximum number of 6 (12) counting heads that can be traversed simultaneously,
- triple usage of certain counting heads for axle counting and switching tasks,
- swing safe evaluation of axles,
- traversing speed of 0 – 330 km/h (lab trials up to 450 km/h),
- safe control of electro-magnetic rail brake and eddy current brake,
- the wheel sensor system allows for distances of 10 km between wheel sensor and evaluation interface board,
- approval of wheel sensor RSR122 and axle counting system ACS2000 by the Federal Railway Authority (EBA) in Germany,
- easy project planning of axle counting system,
- possibility to configure several reset conditions and procedures,
- signal-safe communication and data transmission between two axle counting boards in compliance with EN 50159-1 via RS232,
- in the case of communication of two axle counter boards, distance between the two only depends on the transmission method,
- separate diagnostics interface to read out data.

Literature

[1] Lau, P., Altehage, K.: The RSR Eddy Current Brake-resistant Wheel Sensor Equipment System. SIGNAL+DRAHT, 2002, Issue 9.

ZUSAMMENFASSUNG

Achszählsystem ACS2000 – effiziente und universelle Gleisfreimeldetechnik

Rationalisierung des Bahnverkehrs und Verbesserung der Transportleistungen erfordern in vielen Bereichen der Bahn den Einsatz moderner Technologien.
Für die Sicherung der Zugfahrt bedeutet dies die Verwendung automatischer Gleisfreimeldeeinrichtungen, mit deren Hilfe die Sicherheit als Voraussetzung für Steigerung der Leistungsfähigkeit entscheidend verbessert wird.
Bereits seit einigen Jahren wächst der Markt für Achszählsysteme zur automatischen Gleisfreimeldung überdurchschnittlich. Dies liegt auch daran, dass Eisenbahnen, die früher ausschließlich Gleisstromkreise wegen zusätzlicher Möglichkeiten zur Übertragung von Signalinformationen zum Fahrzeug und zur Schienenbrucherkennung eingesetzt haben, vermehrt Achszählsysteme wählen.
Es ist mittlerweile erkannt worden, dass die Zuverlässigkeit und Wirtschaftlichkeit moderner Achszählsysteme diese fehlenden Zusatzfunktionen aufwiegen und insbesondere unter Berücksichtigung der Wartungskosten wesentliche Einsparungspotenziale vorhanden sind.

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