

# Axle Counting System ACS2000 – New Components and Functionalities

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The widespread use of the ACS2000 axle counting system for both short- and long-distance traffic gave rise to a number of new requirements, which have been integrated taking advantage of a comprehensive product review. As the new development of components was based on the nowadays generally accepted CENELEC standards, users have at their disposal an axle counting system affording flexible configuration options for all kinds of operating conditions. The standardized safety certification further allows efficient compliance or certification of compliance with national and customer specific requirements regarding railway safety.

## 1 Development Strategy for 1998

At the end of the nineties, when the ACS2000 axle counting system was being developed, the purpose was to create a high quality track vacancy detection system affording a variety of project options for long-distance traffic, targeted specifically at deployment in the network of Deutsche Bahn [1]. At the time, this implied two essential consequences for the development of the axle counting system:

- Due to the planned implementation of the linear eddy current brake (LWB) as service brake, the track circuits had to be compatible with that type of brake, i.e. the strong magnetic fields generated by the LWB could not interfere with the operation of the counting head. Thus, the then available RSR122 wheel sensor was chosen as wheel sensor for the counting head.
- Development and certification was to be based on the guideline "Mü8004", "Technical principles for the licensing of safety installations".

After conclusion of the development, the German Federal Railway Authority (EBA) Berlin granted a limited type certification in 2001, which was followed, after successful trial operation, by an unlimited type certification in 2005. Meanwhile, a large num-

ber of ACS2000 systems using this configuration are successfully operating with DB AG and other railway operators.

## 2 Strategy Adjustment in 2004

The widespread use of the system showed early on that due to different operating conditions of the different rail operators, other features had to be provided:

The system was not only to be used for long-distance traffic, but also for short-distance traffic. This required the axle counting system to be able to operate, safely and reliably, irrespective of special rail profiles and location of the wheel sensors (like grooved rails used in road traffic areas (Figure 1) as well as special wheel profiles and bogies with underfloor components (e.g. electro-magnetic rail brake).

In addition to the RSR122, the proven RSR180 and the new RSR123 wheel sensors are to allow for connection to the ACS2000 system. On one hand, this accommodates the constantly increasing electromagnetic loads on the track; on the other hand, the connection options, especially considering maintenance by customers themselves, allow for the deployment of the sensor type which best matches the existing operating conditions.

Further functional expansions in the indoor installations comprise interfaces for operator control, signal boxes, power supply and communications. They also include improved diagnostics that are necessary both locally and centrally.

One requirement of the axle counting system, although not very widespread as yet, is to switch counting heads to a status of insensitivity towards unexpected influences precisely when there is definitely no train approaching them. This feature is to be used especially at locations where expected or unexpected influences on wheel sensors frequently cause faults.

Standardization efforts and customer requirements, therefore, call for the use of the relevant CENELEC standards. As the development is not based on a special application nor on a customer specific risk analysis, it was decided to implement technical measures that meet SIL4 and to define a maximum hazard potential in compliance with 10E-08.

## 3 Counting Heads with RSR180 or RSR123

### 3.1 General

There are essentially two arguments in



Figure 1: Wheel sensor RSR180 mounted to grooved rail claw (without rubber cap)

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Figure 2: Integrated microcontroller board IMC

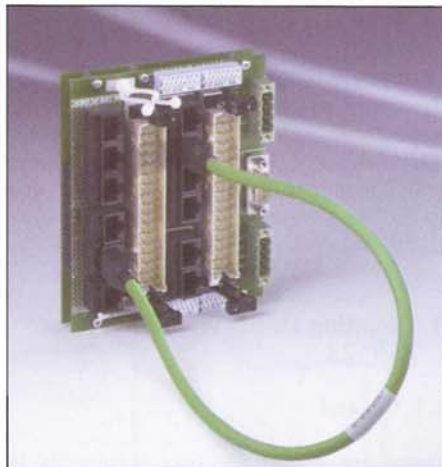


Figure 3: Axle counting backplane ABP with RJ45 cabling

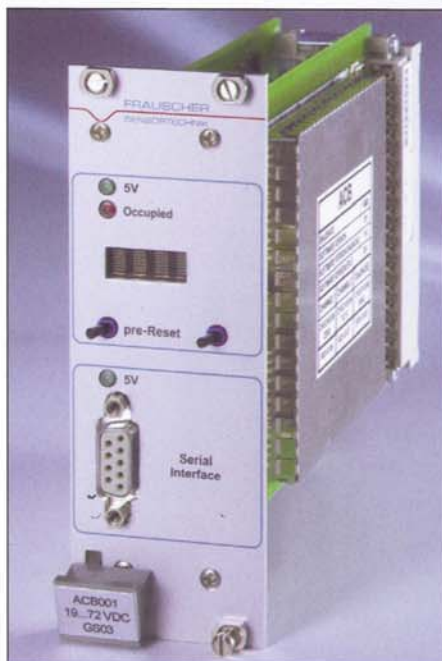


Figure 4: Axle counting board ACB

favour of the alternative use of the proven RSR180 wheel sensor for applications where no strong magnetic fields (for instance due to LWB) are to be expected:

- RSR180 does not require any electrical adjustment at the track.
- RSR180 is extremely immune to maximum track return currents and HF fields, including harmonics, the frequencies of which are close to the natural frequency of the sensor.

Thus, the ACS2000 configuration with RSR180 is an attractive alternative not only for a lot of long-distance traffic, but especially for short-distance traffic (including trams). The mounting possibilities at the grooved rail as well as the low sensitivity to steel belt tyres allow the mounting of wheel sensors in the crossroads area of road and rail traffic.

The RSR123 wheel sensor has already and most impressively proven in many tests its extraordinary resistance against known electromagnetic influences in the track area [2]. Thus, this sensor is especially suitable for application where strong magnetic fields are to be expected (e.g. with LVWB).

### 3.2 Connection of Wheel Sensors

The AMC supplies selectively RSR180, RSR122 or RSR123 with the required operating current and simultaneously evaluates the analogue wheel sensor signals. Considering other demands already mentioned and specifically standard EN50129, a comprehensive review was definitely in order. Summary of the most important features:

- Observance of EN50126, -28, -29 for SIL4,
- Admissible hazard potential < 10E-08,
- MTBF > 200,000 h,
- Possibility of application close to the rail. (i.e. allowing for larger temperature ranges and dynamic loads occurring in such ranges),
- Two-channel design with high-capacity microprocessors, modular design and SMD technology,
- Parameterizable digital inputs and outputs,
- Serial interface for safe and non-safe communication,
- Possibility to connect any of Frauscher's wheel sensors,
- Multiple usage of counting head, safe direction pulses,
- Safe inputs (e.g. to change sensor response rate),
- Wheel centre detection by means of precise-time definite pulse output or generation of a position-related measurement gate for hot box and hot wheel detection system,
- Possibility to filter signals (e.g. electromagnetic rail brake),
- Automatic adjustment of RSR180.

Development and evaluation of the board in compliance with requirements of the CENELEC procedure are practically com-

plete. So as to show the increased functionality range in the designation of the board, it is now referred to as Integrated Microcontroller Circuit Board (IMC) (Figure 2).

However, the RSR123 wheel sensor can also be connected to the axle counting system using the proven evaluation interface board EIB.

### 3.3 Overvoltage Protection Board BSI

Usage of the RSR180 wheel sensor requires secure control of a special feature of the wheel sensor: The two wheel sensor systems are independent from each other, but not separated by galvanic isolation. Thus, it is necessary to ensure the independence of the two sensor systems by means of another component. To that effect, a special circuit is implemented in the overvoltage protection board, which ensures the function for a period of 30 years. Compared to the previous models, box dimensions were reduced to allow for easier and more economic mounting and a fuse for immediate failure detection was mounted.

## 4 Optimized Interfaces

### 4.1 Power supply – Fuse board SIC

The existing SIB fuse board comprises supply voltage monitoring so that in case of a voltage rise above the threshold value, the axle counting system will change automatically into a safe status. Thus, no other measures are necessary to monitor the input voltage of ACS2000 provided by the power supply or by other signalling devices. Polarity reversal protection, excess-current releases and voltage stabilizing capacitors for short-time stabilization remain.

### 4.2 Cabling of ABP axle counting backplane

A new cabling technique was implemented for the ABP axle counting backplane. Internal ACS2000 connections (e.g. for multiple usage of counting heads, reduction of sensor sensitivity) are now implemented using standardized patch cables with RJ45 connectors (Figure 3). Cabling cost is thus significantly reduced. Other enhancements:

- All counting heads are now designed for triple usage.
- Track clear indication and test relay contacts were doubled.
- Configuration settings are made using DIP switches instead of jumpers.

### 4.3 Operation – ACB and DIOB processor boards

New processors on the ACB axle counting board (Figure 4) and on the DIOB digital I/

O board improve efficiency. The transmission rate in transmission mode can now be set to 4800 or 9600 Baud. Parameterizable settings in the ACB software furthermore allow:

- different reset procedures (e.g. restricted reset, pre-reset),
- timing adapted to the signalling system for changeovers from "clear" status to "occupied" status and from "occupied" status to "clear" status,
- different responses in case of incomplete traversing (partial traversing),
- direction-dependent occupancies (e.g. for level-crossing applications).

#### 4.4 Diagnostics – Communication interface boards and PC-Tool

A diagnostics facility with laptop and corresponding evaluation program have been available for quite some time. To improve comfort, diagnostics functions were detailed down to the counting head level. New communication interface boards now allow the diagnostic data of up to 128 counting sections to be acquired and forwarded over a serial interface to a maintenance centre for evaluation (Figure 5).

### 5 Configuration Possibilities of ACS2000

#### 5.1 Counting head with RSR180 and IMC board

The application of the proven RSR180 wheel sensor combined with the IMC board affords vast application possibilities for long-distance and short-distance traffic, provided there are no extraordinarily strong magnetic fields, as in the case of LWB.

The development of the new components was based on the requirements for SIL4, so that the maximum hazard potential for the overall ACS2000 system complies with  $1 \times 10^{-8}$ . Presently, the system is being tested by an independent, approved expert for signalling safety installations. The conclusions are scheduled for September 2006 [3].

#### 5.2 Counting head with RSR123

The development of the RSR123 wheel sensor is also nearing completion. As this wheel sensor type is extraordinarily immune to magnetic influences, it will in the medium term, if proven after widespread application, replace the RSR122. Depending on functional requirements, RSR123 can be connected using EIB or IMC boards.

The safety certification procedure for the ACS2000 configuration will be commenced immediately after completion of the wheel sensor development. Thus, a safety certification for the overall configuration can be expected by mid 2007.

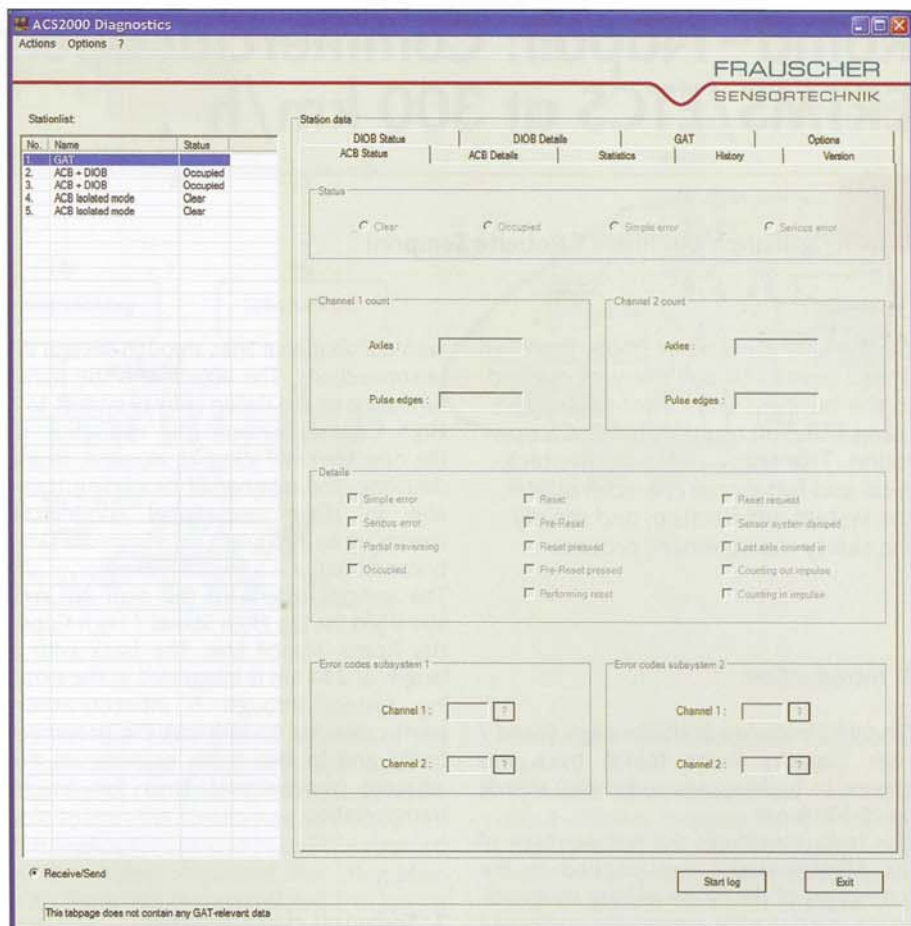


Figure 5: Diagnostics software

### 6 Outlook

The ongoing development of consistent modularised system components which can be used to create requirement specific systems will continue. As a result of the continuous reduction of hardware, increasingly the succeeding safety critical technical systems are incorporated in the task distribution. The objective is to create jointly with manufacturers of signalling installations axle counting solutions using Frauscher components, i.e. products which

will enhance the competitiveness of the railways.

#### Bibliography

- [1] Axle Counting System ACS2000 – Efficient and universal track vacancy detection technology, Klaus Altehege, Signal+Draht 04/2003
- [2] From track switch to inductive wheel sensor using a variety of technologies, Josef Frauscher, Signal+Draht 01-02/2006
- [3] Migration of the certification procedure from Mü 8004 to CENELEC based on axle counting system ACS2000, Torsten Uhlig / Lars Wenzek, Signal+Draht 05/2006

### ZUSAMMENFASSUNG

#### ACS2000 – Neue Komponenten und Funktionalitäten

Durch die weitverbreitete Verwendung des Achszählsystems ACS2000 in Nah- und Fernverkehrssystemen sind vielfältige neue Anforderungen bekannt geworden, auf die bei einer umfassenden Produktüberarbeitung Rücksicht genommen wurde. Da bei der Neuentwicklung der Komponenten die heute allgemein akzeptierten Standards der CENELEC verwendet wurden, steht den Anwendern damit ein flexibel konfigurierbares Achszählsystem für unterschiedliche Betriebsbedingungen zur Verfügung. Der standardisierte Sicherheitsnachweis ermöglicht es darüber hinaus, effizient die Erfüllung der nationalen und kundenspezifischen sicherungstechnischen Anforderungen zu berücksichtigen bzw. nachzuweisen.