Customer-specific solution for level crossings based on wheel detection with relay outputs

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It is estimated that there are more than 250,000 level crossings throughout the world. Despite the construction of new at-grade rail and road crossings having been prohibited for years in many countries due to the hazards they pose, more level crossings are still springing up every day. Many countries do not have any technical systems in place to protect crossings. Even existing level crossing protection systems offer considerable potential to increase availability and above all to ensure a high level of safety, thanks to technological advancements. There are multiple types and varieties of technical solutions for level crossing safety. Level crossings protected by technical systems are switched on and off by including them in signal dependency and by train movements. In the latter case, track circuit and track loop technology is still widespread, but is increasingly losing importance in this regard. These days, the focus is on wheel detection, which is often combined with axle counting technology for synergistic effects. With modern wheel detection systems, on and off switch points for level crossings can now be implemented using individual wheel sensors. The complexity, as well as diversity, of the various technical designs of level crossing protection systems and the general requirements that vary between countries often call for individually customised wheel detection and axle counting systems. This is where the global experience and extensive product portfolio of Frauscher Sensortechnik GmbH come into play, meaning that the company is able to adapt its software and hardware components on an individual basis. This article describes one customer-specific problem and how it was solved using a modified evaluation board with relay interface.

1 Customer requirements

Low availability and critical incidents concerning safety at level crossings led a railway operator to renew its level crossing protection systems. Current protection systems are controlled using on and off signals that depend on the direction of travel and are determined on the basis of track circuits.

One essential requirement of the contractor was to use existing infrastructure and system components to the fullest extent possible in order to keep modernisation costs down. The motto was: modify rather than replace. Because of a lack of availability, the track circuit systems were to be replaced with wheel detection and axle counting systems. The current outdoor cable system (partly core stranded cable) and the relay circuit for level crossing protection had to be retained.

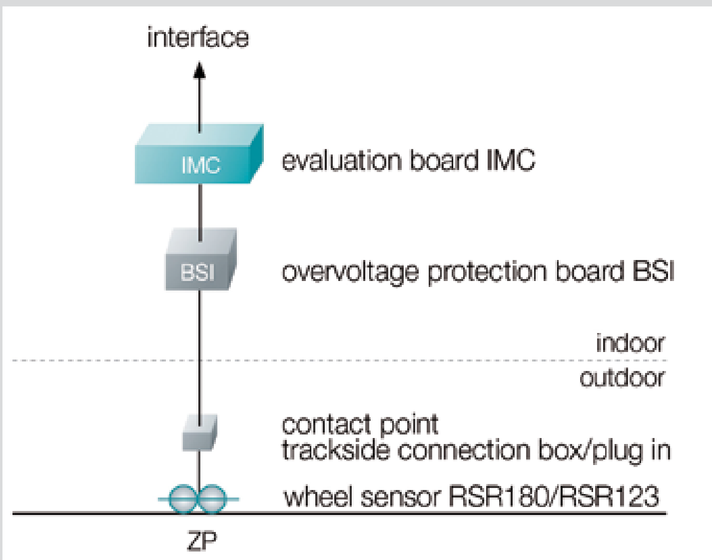

Figure 1: Wheel detection block diagram

2 Frauscher IMC evaluation platform

When traversing, the wheel flange of an axle damps the RSR180 or RSR123 wheel sensor mounted to the rail side of the wheel flange side with a rail claw. Consisting of two sensor systems, this wheel sensor generates an analogue signal aspect that is proportional to the dampening. This analogue current is transferred via a trackside connection box (clamping unit), the outdoor cable system and the BSI overvoltage protection board to the IMC evaluation board. This initiates the evaluation and creates corresponding digital pulses [1, 2].

The task of the IMC evaluation board is to emit fail-safe system pulses (Sys1 and Sys2) that indicate the presence of an axle (Figure 2 and 3). The output of the direction of traversing is critical when used with modern level crossing protection systems. Depending on this, the barriers must be closed and/or the warning lights activated. The IMC evaluation platform offers two different types of direction pulses in this case.

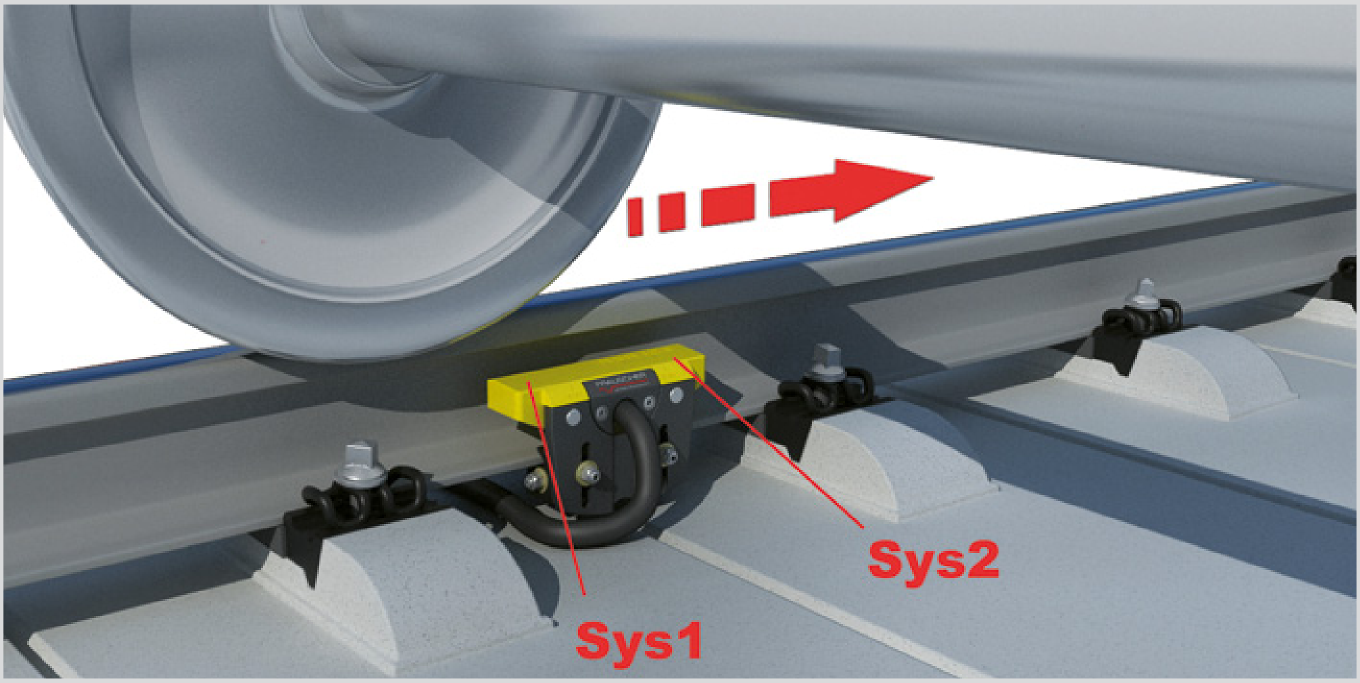

Figure 2: Start and end of traversing

2.1 1-edge direction pulse (1-Ri)

Figure 3 above shows the pulses from both wheel sensor systems (Sys1 and Sys2), which are generated when an axle traverses. Overall, the pulses contain four digital edges. The 1-Fl-Ri Imp is emitted with the first edge, i. e. at the beginning of the traversing. For safety reasons, the 1-edge direction pulse is also emitted by the IMC evaluation board if there is a fault (such as wire break, overcurrent, etc.). This type can be used for switching on level crossings and for other uses.

2.2 4-edge direction pulse (4-Ri)

In contrast to the 1-edge direction pulse, the 4-edge direction pulse is only emitted after traversing is complete. Therefore, it can be assumed that the axle has completely traversed the wheel sensor and the train is moving in this direction. The 4-edge direction pulse is not used in the event of a fault. The type of pulse is used to trigger occupied status or reset a level crossing protection system, for example.

2.3 Customer-specific adaptations

The IMC evaluation platform offers the signals described above as standard via electronic switching contacts (optocoupler). These are compatible with electronic inputs such as PLCs or electronic interlocking, but not with the relay circuit required. The optocoupler interface cannot be used as the driver current is too low. That is why Frauscher modified an existing IMC evaluation board and replaced the optocoupler outputs with relay contacts. These relays handle voltages of up to 100 V and currents of up to 1 A.

Moreover, the duration of the direction pulses was adapted to existing protec-

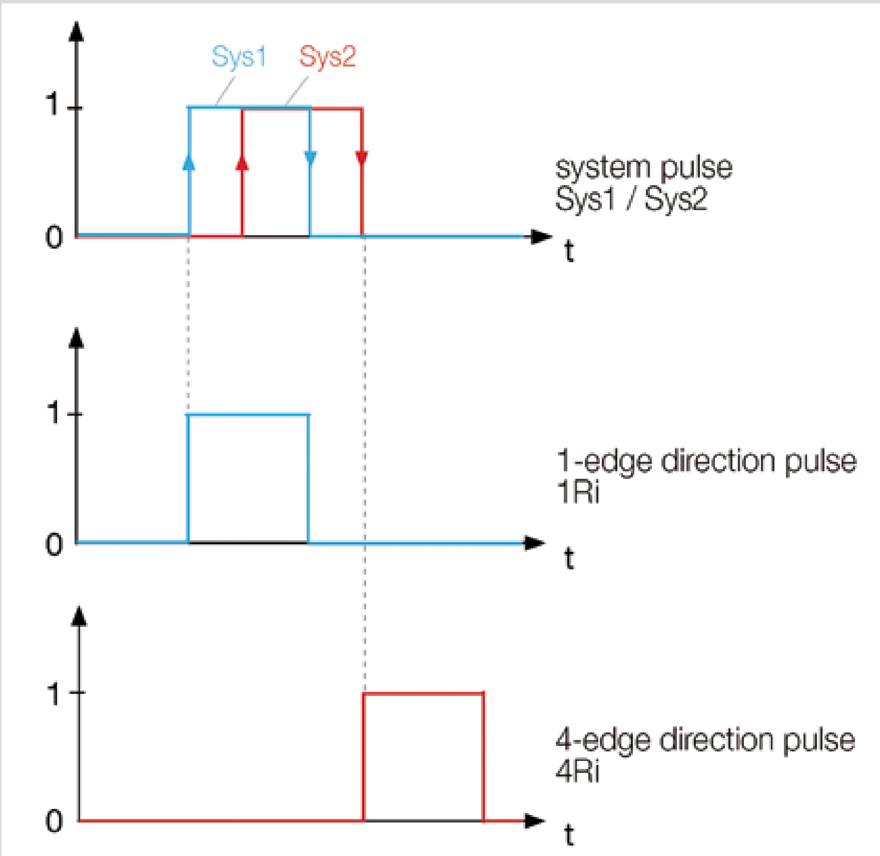

Figure 3: Wheel sensor system, 1-edge and 4-edge direction pulse

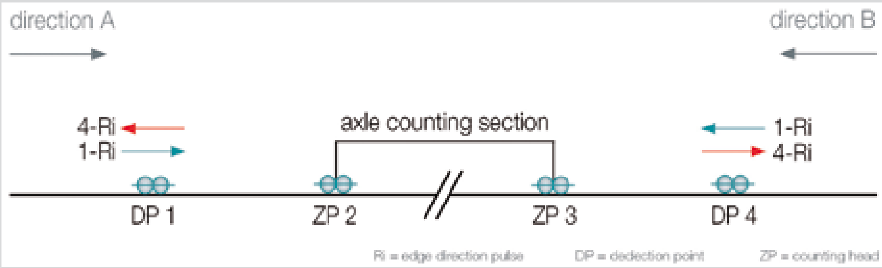

Figure 4: Level crossing protection system with wheel detection and axle counting

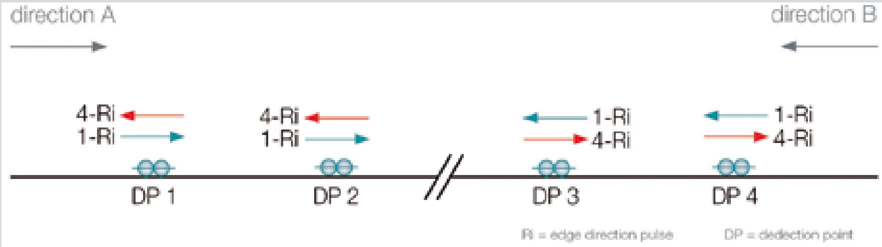

Figure 5: Level crossing with wheel detection for switching on and off

tion systems. This ensures that downstream relay wiring, which is rather lethargic compared to electronic contacts, interprets a train moving at high speed as such, and not as so-called relay 'chattering'.

3 Examples of a driving direction-dependent system control

There are a great many design possibilities when it comes to on and off switching and resets for level crossing protection systems. The universal and easy-to-adapt IMC evaluation platform forms the optimum basis for different types of solutions. The following section deals with two examples of possible configurations to respond to the customer requirements described above.

3.1 Combination of wheel detection and axle counting with on and off switches

Figure 4 shows a configuration of wheel detection and axle counting used in combination with each other. Detection points (DP) 1 and 4 act as wheel detectors, and counting heads (ZP) 2 and 4 represent a track section. When a train approaches in direction A, a 1-edge direction pulse is emitted when wheel sensor DP 1 is traversed. This pulse triggers the closure of the barriers and/or the activation of the warning lights.

The train continues in direction A and occupies the axle counting section, which is laid over the level crossing. When the train passes the axle counting section completely, i.e. it has fully crossed the level crossing, the axle counting section indicates that it is 'clear'. This clear indication means that occupied status can be lifted.

When continuing in direction A, the train passes wheel sensor DP 4, which also acts as the switching on point for the opposite direction at the same time and is therefore designated as an opposite switching point. As this detection point does not lead to the system being switched on again, the fail-safe output of the direction of travel is necessary for the switching logic.

DP 4 emits a 4-edge direction pulse and therefore also indicates that the train has cleared the level crossing. This means it can remain open and the system will reset itself again.

3.2 Wheel detection as an on and off switch

Figure 5 shows a configuration of wheel detection as a switching on and off element. DP 1 and 4 wheel sensors are only used as detection points in this case. When a train approaches in direction A, a 1-edge direction pulse is emitted from DP 1 when traversed. This pulse switches the system on and blocks the level crossing.

The train continues in direction A and passes wheel sensor DP 2, which emits a 1-edge direction pulse once again. If the level crossing has not yet been activated, this will happen at this point at the latest. When the train leaves the level crossing area, it passes the next wheel sensor, DP 3. This emits a 4-edge direction pulse, which can then be used to deactivate occupied status.

The train then passes DP 4, which emits a 4-edge direction pulse again in traversing direction A. This confirms that the train has cleared the level crossing and that the protection system can be reset.

If a train traverses in direction B, the system control in the two case studies will naturally function in the same way, but in the reverse order.

Figure 6: Frauscher systems deliver a safe basis for control.

4 Outlook

The aforementioned IMC evaluation board with relay outputs is now in the assessment stage, following a successful two-month field test. The relevant safety case and certification for the CENELEC SIL4 standard are expected shortly.

It is expected that it will become increasingly common to adapt level crossing protection system controls to customer needs and that enhanced functionality will be offered in the future. On the one hand, this relates to the fact that due to general requirements, for example train frequency, various safety requirements exist and railway operators are therefore developing and implementing individual design types and forms of control logic.

On the other hand, technological advancements, such as train speed detection, go hand in hand with level crossing control. This means protection systems can operate with more precision and waiting times at level crossings can be reduced to a minimum.

Using the IMC evaluation platform in combination with the high-quality Frauscher wheel sensors forms a flexible and safe basis for managing the different types of level crossing protection system controls.

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[2] Grundnig, G.: Die Herausforderungen an Raddetektion und Achszählung in der Zukunft – Teil 2 (The demands on wheel detection and axle counting in the future – Part 2), SIGNAL+DRAHT, 12/2011

ZUSAMMENFASSUNG

Kundenspezifische Bahnübergangslösung auf Basis Raddetektion mit Relaisausgängen

Die Komplexität sowie die Vielfalt der technischen Gestaltungsvarianten von Bahnübergangssicherungsanlagen und die länderspezifischen Rahmenbedingungen erfordern oftmals individuelle Anpassungen der Raddetektions- und Achszählsysteme. Für diese Anwendungen verfügt die Frauscher Sensortechnik GmbH über weltweite Erfahrung sowie ein breites Produktportfolio und ist in der Lage, ihre Soft- und Hardwarekomponenten individuell anzupassen. Dieser Artikel beschreibt eine kundenspezifische Aufgabenstellung sowie deren Lösung mittels einer modifizierten Auswertebaugruppe mit Relaisschnittstelle.