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Trainguard Zub 222c automatic train control system

State-of-the-art technology for cost-effective rail services

Compact on-board and trackside equipment

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Cities are becoming increasingly larger and more complex. This also imposes increased requirements on mass transit systems. Their operators have to cope with rapidly growing traffic flows and passengers' rising expectations. Their success is measured against factors such as safety, punctuality, convenience and environmental friendliness. Siemens' intelligent and future-oriented mass transit concepts support operators in successfully meeting these challenges.

We regard our customers as partners who we support through our work in sustainably developing their urban environment and making their public mass transit just as efficient and effective. They thus boost their passengers' quality of life and the attractiveness of their city as a business location.

System with cost-effective benefits
Refinements of train control systems are crucial for new rolling stock. They are to be universally applicable all over the world in the future and, in particular, to be capable of being integrated both simply and cost-effectively.

With its wide range of functions and its modular design, the Trainguard Zub 222c automatic train control system meets the latest requirements for signaling and safety. The new compact on-board unit and energy-efficient trackside equiment, connected to the signals via interface boards in Eurocard format, can be easily installed in new signaling systems and retrofitted to existing systems.

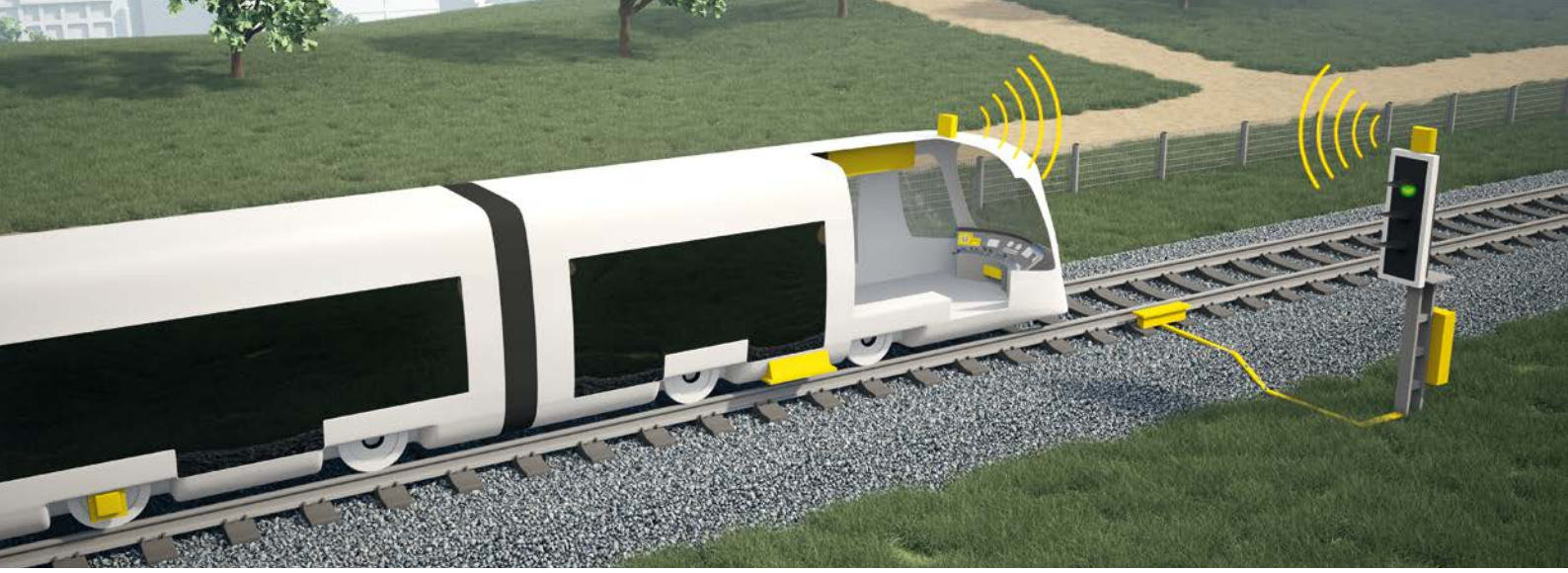
Trainguard Zub 222c ensures cost-effective, easy-to-maintain operations. It places no specific requirements on the signaling system of the railways to be protected, and can be individually configured and thus adapted to any application.

A special feature of Trainguard Zub 222c is its suitability for mixed operation as both a heavy rail system with exclusive rights-of-way separated from other traffic and a light rail system with shared rights-of-way together with other traffic in city streets.

For this purpose, Trainguard Zub 222c provides an integrated back-channel to the track in addition to the fail-safe track–train data channel. These back-channels (coupling coil or radio) permit the control of decentralized electric points, priority switching at traffic lights, or train tracking, as well as diagnostic and status data.

Basic functions of the system
Trainguard Zub 222c works with intermittent data transmission from the track and ensures continuous monitoring of a speed profile. This type of monitoring with target braking curves significantly reduces overlaps, thus optimizing line throughput. Thanks to this feature, Trainguard Zub 222c is a low-cost-alternative to continuously transmitting systems and supports the driver by means of numerous automatic functions:

- continuous and reliable monitoring of speed and braking
- display of the target and actual speed in the driver's cab
- audible alarm when the target speed is exceeded and automatic brake application
- train stop at stop signals
- monitoring of speed restriction sections
- non-fail-safe bidirectional transmission of information between track and train



Fail-safe monitoring: the on-board equipment

On-board unit
The compact Trainguard Zub 222c on-board unit forms the heart of the on-board equipment. Its single-tier 19" mounting rack requires only little space. It is equipped with circuit boards of the dual-channel fail-safe Simis 3116 microcomputer system and comprises a fail-safe emergency brake output for dual-channel electrical brake control.

The on-board unit can be configured for unidirectional or bidirectional running. Different power supply boards are available for a DC power supply of 24 V to 110 V from the vehicle battery.

Vehicle coupling coil
The vehicle coupling coil is used for bidirectional data transmission between the track and the train. It is available in both normal and compact design.

Radio antenna
The radio antenna is used to transmit information to the vehicle and retransmit diagnostic messages to the trackside equipment.

Odometer pulse generator
The odometer pulse generator supplies data on the direction of travel, distance traveled and current train speed. Alternatively, on-board pick-ups can be integrated as pulse generators.

Control and display unit
A compact control and display unit is available for information output in the driver's cab. A dual-pointer speedometer indicates the monitoring and actual speed and the maximum permissible speed.

A control unit with buttons and indicators is also available. A fault switch bypasses the emergency brake output in the event of an on-board unit failure.

Data unit
The data unit is used for serial information transmission between the on-board unit and the control and display unit in the driver's cab over a distance of up to 50 m.

Fail-safe transmission: the trackside equipment

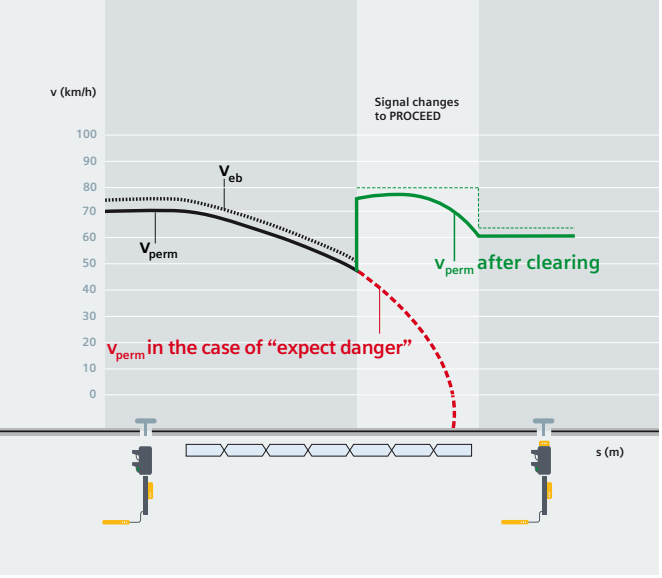
Track coupling coil
The track coupling coil is the central element of the trackside equipment. It is installed at the signal location and controlled in accordance with the signal aspect by a signal interface board.

Depending on the active signal aspect, the track coupling coil transmits the speed profile for the section ahead to the train. It can also transmit a fixed data telegram at specific information points such as speed restriction sections.

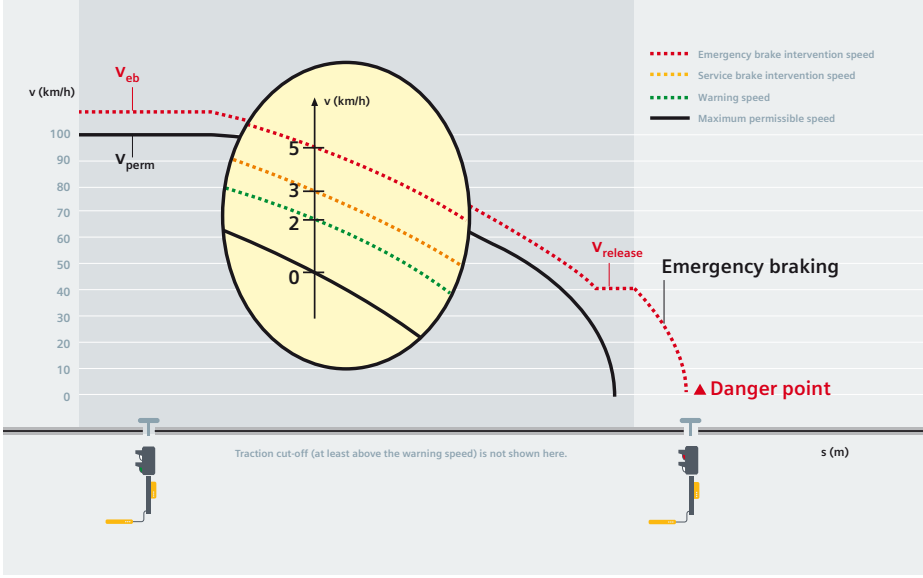
Signal interface and radio transmission board
The trackside components for signal aspect extraction and optional radio-based clearing are installed in a signal apparatus case. The signal aspect is extracted from the lamp circuit intrinsically safe and without any interaction. AC and DC signals can be interfaced. The signal aspect information is updated in the track coupling coil using the associated data record.

Radio infill
Radio infill facilitates continuous updating of the signal information onboard the vehicle by means of a permanent point-to-point connection. With radio infill, the maximum permitted speed is transmitted to the vehicle and monitored there whenever there is a change of the signal aspect. Trainguard Zub 222c can be used to increase line throughput by braking curve intervention.

Usage of information transmission
If the train-track back-channel is used, the information sent by the vehicle is to be recorded on the trackside. Indicating information can be forwarded to the control center via Trainguard Imu 100 or the Z-Radio channel.



Early acceleration through radio-based clearing



Monitoring levels

Coming to the point: fail-safe functions

The intermittent automatic train control system provides exact information on the line ahead. The track coupling coil installed at the signal transmits the information on the relevant signal aspect (proceed, warning or stop) to the passing train. The speed and route profile for the section ahead belonging to the signal aspect is also transmitted. The on-board unit continuously determines the maximum permissible speed v_{perm} which may not be exceeded by the train.

If the vehicle passes a warning signal, the system reduces the maximum permissible speed as a function of the train's position – and does so in accordance with the braking capacity of the train.

The stopping point is always in front of the corresponding next signal or danger point. If the target speed is exceeded, the driver is given a visual and audible warning.

Should the driver not react, Trainguard Zub 222c automatically brakes the train if the established speed continues to be exceeded: first by cutting off traction, then by service braking. When reaching the v_{eb} profile permissible in accordance with fail-safe signaling principles, the train is emergency-braked.

On the last section of the line immediately before the stop signal, the system maintains a constant maximum permissible speed. This speed, called release speed $v_{release}$, allows the train to move forward to the signal. The driver can pass the signal if it is showing a proceed aspect. The release speed is individually determined by Trainguard Zub 222c depending on the braking capacity of the train and on the overlap. If the vehicle passes a stop signal, Trainguard Zub 222c reliably stops the train within the overlap just before the danger point.

Precise monitoring

With the help of Trainguard Zub 222c, special points in the line profile such as speed restriction sections can be signaled and the speed monitored. The maximum permissible speed is indicated in advance at a sufficient distance from the beginning of the speed restriction section. The service braking curve, and thus the monitoring curve as well, correspond to the braking capacity of the train up to the beginning of the speed restriction section.

After that, the target speed remains constant until the last car – in accordance with the train length – has left the speed restriction section.

Flexible adaptation

Additional track coupling coils for the protection of temporary construction sites can be integrated at any time without having to modify the existing Trainguard Zub 222c trackside equipment. They can be used both as a train stop and for establishing a speed restriction section. All necessary information is incorporated into monitoring by the on-board equipment.

Safety and diagnostics

Trainguard Zub 222c automatically initiates self-diagnostics before the start of a trip. The system checks the most important processing functions and activates the driver's cab displays. At the press of a button, the driver can call the following:

- number of emergency brakings triggered by a stop signal
- number of authorized moves and fault switch operations
- mileage

A static electronic memory records all important events. They can then be read out and evaluated using a diagnostic PC. This diagnostic feature is available both locally (vehicle, diagnostic PC) and centrally (WinCC OA).

The benefits speak for themselves

System overview

Robust, flexible, innovative
The high technical standard of automatic train control systems is based on many years of experience in the field of signaling and control systems and on continuous improvement of the equipment. The proven Trainguard Zub 222c automatic train control system can be used for the following applications:

- light rail rapid transit
- regional railways
- metros / light rail transport

Trainguard Zub 222c is distinguished by the following system benefits:

- robust design to cope with the high levels of mechanical shock and vibration load as per EN 50155
- flexible installation due to low space requirement of the compact on-board unit in its single-tier mounting rack
- optimum adjustment of the monitoring profile to the physical line conditions through the telegram-based transmission of signal aspect, speed profile and speed restriction sections in the section ahead
- easy extension of existing installations since the trackside equipment is powered by the signal lamp current; the track coupling coil is supplied with power from the vehicle coupling coil when the train passes over
- contactless transmission immune to any ambient interference between the on-board and trackside equipment by means of inductively coupled resonant circuits
- selectivity to information carriers on the adjacent track, on its own track and to equipment in the opposite direction of travel
- fast and simple troubleshooting using a state-of-the-art diagnostic system
- suitability for train speeds of up to 160 km / h
- bridging of an air gap between 130 mm and 200 mm in the case of a lateral deviation of the system of ±50 mm

Technical data

System data	Safety integrity level	SIL 3 as per DIN EN 61508 / EN 50129	
	Standards	EN 50155, EN 60068, EN 60721, EN 61000-6-2, EN 61000-6-2, EN 50121-3-2, EN 50121-4	
	Temperature range	– 30 °C to + 70 °C (on-board equipment) – 30 °C to + 70 °C (trackside equipment)	
	Transmission	Frequencies 50 kHz / 100 kHz / 850 kHz / 2.4 GHz Method Frequency shift keying Data rate 50 kbauds	
	Speed range	≤ 160 km / h	
On-board equipment			
On-board unit	Supply voltage	24 / 36 / 72 / 110 V DC, + 25 % / – 30 %	
	Power consumption	approx. 100 W	
	Weight	approx. 7.5 kg	
	Dimensions (l x h x w)	290 x 132 x 444 mm (l = incl. front connector)	
	Max. cable length from on-board unit to	– Odometer pulse generator 60 m – Driver's cab 50 m	
	Bus interface	IBIS vehicle bus as per VDV 300	
Vehicle coupling coil	Weight	7.5 kg	
	Dimensions (l x h x w)	500 x 101 x 172 mm	
Odometer pulse generator	Weight	2.15 kg	
	Dimensions (l x h x w)	223 x 70 x 140 mm	
	Pick-ups of vehicle manufacturers (alternative)		
Data unit	Weight	0.9 kg	
	Dimensions (l x h x w)	164 x 66 x 130 mm	
Control and display unit	Weight	0.6 kg	
	Dimensions (l x h x w)	135 x 75 x 96 mm	
Dual-pointer speedometer	Customer-specific		
Trackside equipment			
Track coupling coil	Weight	13.5 kg	
	Dimensions (l x h x w)	736 x 147 x 202 mm	
Signal interface board	AC primary side	AC secondary side	DC
Input range	60 to 300 mA	1 to 2 A	24 to 58 V
Signal detection	8 transformer stages	8 transformer stages	8 inputs
Flashing-signal detection	max. 2 transformer stage	max. 2 transformer stages	
Loop amplifier board	DC	AC primary side	
Input range	18 to 72 V	60 to 420 mA	
Loop length	up to 650 m depending on permanent way		

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