



STATE-OF-THE-ART TECHNOLOGY FOR COST-EFFECTIVE RAIL OPERATION

Trainguard Zub automatic train control system

SIEMENS

COMPACT ON-BOARD AND TRACKSIDE EQUIPMENT

Trainguard Zub Automatic Train Control (ATC) system



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 Mobility's intelligent and future-oriented mass transit concepts support operators in successfully meeting these challenges.

Customers are regarded as partners who are supported through work in sustainably developing their urban environment and making their public mass transit both efficient and effective. This boosts passengers' quality of life and the attractiveness of the city as a business location.

System with **cost-effective benefits**

Refinements of train control systems are crucial for new and refurbished rolling stock. They are to be universally applicable throughout the world in 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 (TG Zub) automatic train control system meets the latest requirements for signaling and safety. The new compact onboard unit and energy-efficient trackside equipment, connected to the signals via interface boards, can be easily installed in new signaling systems and retrofitted to existing systems as an overlay train control system.

The TG Zub is a computer-based train control system using the identical vital platform as the TGMT CBTC system. Radio-based communication 2,4 GHz (or 5 GHz) is used at signal locations to provide infill information to prevent unnecessary braking. While radio infill is provided at signal locations, speed supervision is continuously available.

Trainguard Zub 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 is its suitability for mixed operation as both a metro system with exclusive rights-of-way separated from other traffic and a light rail system with shared rights-of-way. This is based on separated block sections with other traffic in city streets or driving-on-sight in low-density areas.

For this purpose, Trainguard Zub provides an integrated backchannel to the track in addition to the fail-safe track-to-train data channel. These backchannels, via coupling coil or radio, permit the control of decentralized electric points, priority switching at traffic lights, or train tracking.

Basic functions of the system

Trainguard Zub 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 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 HMI
- Audible alarm when the target speed is exceeded and automatic brake application
- Train stop at stop signals
- Monitoring of speed restriction sections
- Fail-safe bidirectional transmission of information between track and train

Fail-safe monitoring: the on-board equipment

On-board unit

The compact Trainguard Zub onboard unit forms the heart of the onboard equipment. Its single-tier 19-inch mounting rack requires minimal space. It is equipped with circuit boards of the dual-channel fail-safe Simis TCC microcomputer system and includes a fail-safe emergency brake output for dual-channel electrical brake control. The onboard equipment can be configured for unidirectional or bidirectional operation. Different power supply boards are available for a DC power supply of 24 V or 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 designs to minimize space at the bogie.

Radio channel

The radio channel is used to receive information by the vehicle from the wayside equipment. Depending on available mounting positions, different types of radio antennas are approved.

Odometer pulse generator

The odometer pulse generator supplies data on the direction of travel, distance traveled, and current train speed. Alternatively, onboard pick-ups can be integrated as pulse generators. Depending on the safety requirements, odometry can be configured as single-channel or dual-channel.

Driver's cab equipment (HMI)

A state of the art 10,4" touch display unit is available as HMI in the driver's cab. A speed display section indicates the actual speed, the maximum permissible speed and remaining distance to the next stopping point.

Furthermore, communications between the driver and the control center is supported via optional train data radio channel, e.g. to initiate "proceed-on-order" runs.

A fault switch allows the emergency brake output to be bypassed in the event of an on-board equipment failure.



Driver HMI

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, door side, etc.

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

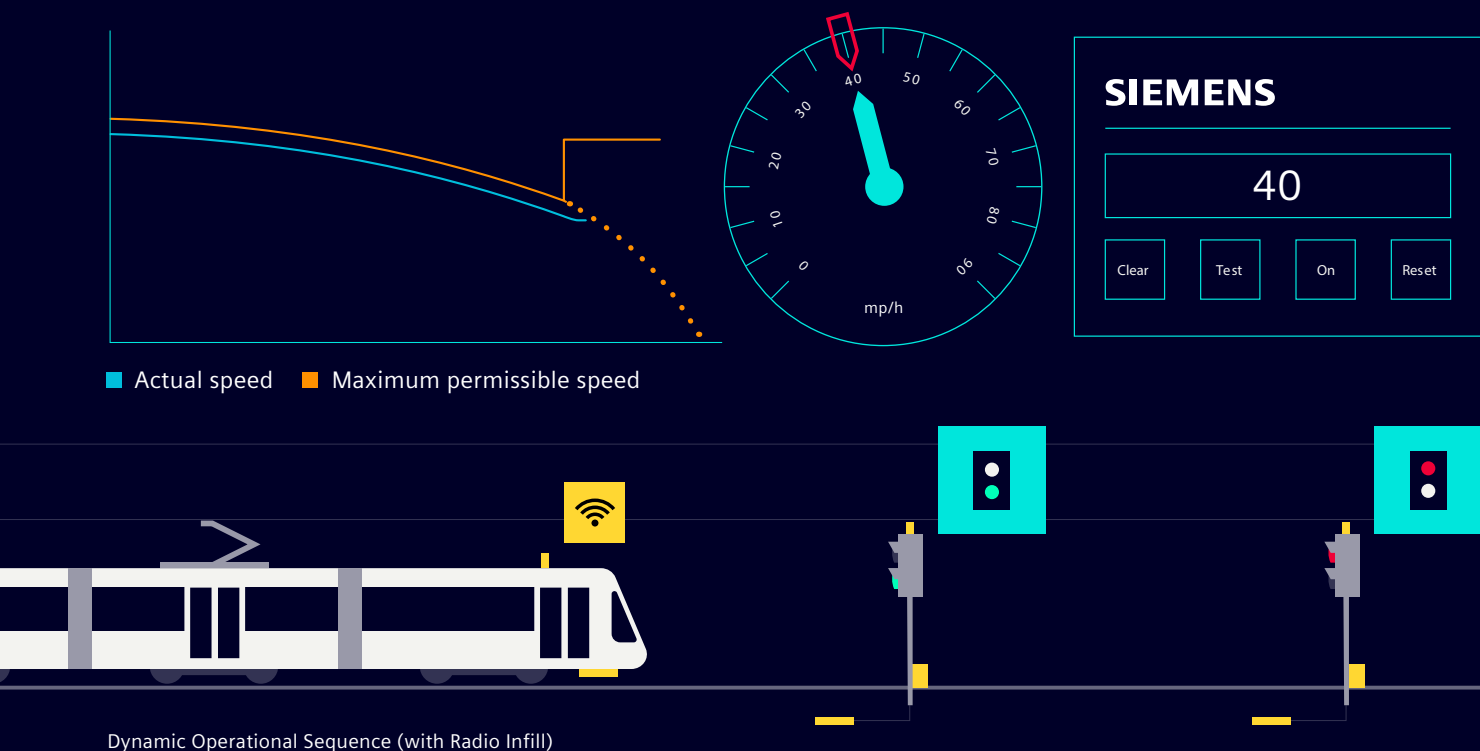
Radio infill facilitates continuous updating of the signal information onboard the vehicle by means of a permanent point-to-point connection. With radio infill, the maximum permitted speed is transmitted to the vehicle and monitored there whenever there is a change of the signal aspect. Trainguard Zub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

Usage of information transmission from train to track

The train-track channel allows information to be transmitted to wayside receivers (e.g. with our Trainguard Imu 100 system).

The information can be the following:

- Switch control
- Train tracking
- Automated route setting
- Initiate street traffic priority
- Activation/deactivation of level crossings



Coming to the point: **fail-safe functions**

The 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. Target speed and the line profile for the section ahead are also transmitted. The onboard unit continuously determines the maximum permissible speed, which must 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 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 automatically brakes the train if the established speed continues to be exceeded.

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

Continuous monitoring

With the help of Trainguard Zub, individual speed restriction section depending on the line profile can be signaled and supervised. Breaking curve to the permissible speed is considered as well as the train length for acceleration at the end of the speed restriction.

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 MT trackside equipment. They can be used both as a train stop and for establishing a temporary speed restriction section.

Safety and diagnostics

Trainguard MT 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. By simply pressing a button, the driver can call up the following via the HMI:

- Number of emergency braking
- Operations triggered by a stop signal
- Number of authorized moves and fault switch operations
- Milage

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 with optional train data radio transmission from HMI to control center.

Trainguard Zub 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 onboard unit in its single-tier mounting rack
- Trainguard Zub trackside does not require installation in equipment rooms, only track balises and signal interface board
- Trackside equipment does not require power supply, coupling coils are passive, signal interface board is powered by signal current
- 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 can be 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

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.



Safety integrity level

SIL 3, SIL 4 (optional)
as per DIN EN 61508 /EN 50129

Temperature range

- 40 °C to + 70 °C /
- 40 °F to 158 °F (on-board equipment)
- 40 °C to + 70 °C /
- 40 °F to 158 °F (trackside equipment)



- 40°C (- 40°F)



70°C (158°F)

Standards

EN 50155, EN 60068, EN 60721, EN 61000-6-2, EN 61000-6-2,
EN 50121-3-2, EN 50121-4

Applications



Speed range

≤ 160 km / h / 99 mph

Transmission

Frequencies: 50 kHz / 100 kHz /
850 kHz / 2.4 GHz

Method: Frequency shift keying

Data rate: 50 kbauds

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 / 16.53 lbs

Dimensions (l x h x w):

225 x 132 x 483 mm

9.06" x 5.2" x 19.02"

(l = excl. front connector)

Max. cable length from on-board unit to:

Odometer pulse generator 60 m / 196 ft

Driver's cab 50 m / 164 ft

Bus interface:

IBIS vehicle bus as per VDV 300

Vehicle coupling coil

Weight: 7.5 kg / 16.53 lbs

Dimensions (l x h x w):

500 x 101 x 172 mm / 19.69" x 3.98" x 6.77"

Odometer pulse generator

Weight: 2.15 kg / 4.74 lbs

Dimensions (l x h x w):

223 x 70 x 140 mm / 8.78" x 2.76" x 5.51"

Pick-ups of vehicle manufacturers (alternative)

Data unit

Weight: 0.9 kg / 1.98 lbs

Dimensions (l x h x w):

164 x 66 x 130 mm / 6.46" x 2.6" x 5.12"

Control and display unit

Weight: 0.6 kg / 1.32 lbs

Dimensions (l x h x w):

135 x 75 x 96 mm / 5.31" x 2.95" x 3.78"

Dual-pointer speedometer

Customer-specific

Trackside equipment

Signal interface board

AC primary side:

Input range 60 to 300 mA

Signal detection 8 transformer stages

Flashing-signal detection max. 2 transformer stage

AC secondary side:

Input range 1 to 2 mA

Signal detection 8 transformer stages

Flashing-signal detection max. 2 transformer stage

DC:

Input range 24 to 58 V

Signal detection 8 inputs

Track coupling coil

Weight: 13.5 kg / 29.76 lbs

Dimensions (l x h x w):

736 x 147 x 202 mm / 28.98" x 5.79" x 7.95"

Radio Unit

Weight: 0.416 kg / 0.917 lbs

Dimensions (l x h x w):

109 x 176 x 33 mm / 4.29" x 6.93" x 1.3"

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