SIEMENS

TRACKSIDE EQUIPMENT

Trainguard

Trainguard Eurobalise S21 and S22 – central modules for ETCS

Ensuring mobility is one of the major challenges facing our society. In order to stay mobile in the future, we need internationally networked transportation and information systems. Only if all modes of transport are properly matched and optimally interoperate, can our mobility requirements be mastered. With "Complete mobility", Siemens is therefore creating integrated transportation and logistics solutions – for safe, economical and environmentally friendly passenger and cargo services.

For track-to-train communications

Trainguard is the Siemens solution for the standardized European Train Control System (ETCS). ETCS is successively replacing the different national train protection and train control systems. Standardized interfaces between the vehicle and the line permit interoperability beyond national borders. As one of the pioneers for ETCS, Siemens offers mature ETCS systems and components with its Trainguard 100 and Trainguard 200 products. Key elements of the ETCS trackside equipment are the Trainguard Eurobalises S21 and S22 which have already proven themselves in countless cases.

Range of applications

Siemens' Eurobalises enable data for position finding and train control to be transmitted to the train wherever required along the track. They are in use in mainline and regional traffic all over the world. Due to their compact size and lightweight design, the Trainguard Eurobalises S21 and S22 are simple to install. They are both immune to weather conditions and maintenance-free. Existing outdoor equipment can be easily expanded with the Eurobalises.

Interoperability

Siemens' Eurobalises ensure smooth, reliable interaction with on-board equipment from different manufacturers. They have been developed, tested and certified in line with the European Union's Technical Specifications for Interoperability (TSI).

Optimum operating conditions

With a height of only 4 cm, the Trainguard Eurobalise S21 is a reduced-size balise in line with the Class B balise defined by UNISIG specifications. The Trainguard Eurobalise S22 is also a reduced-size balise and has a height of 5.5 cm. It complies with the requirements for a Class A balise. Tried-and-tested foam embedding technology and a compact design make both Eurobalise types optimally suitable for use in the track bed.

The Trainguard Eurobalises S21 and S22 are available in two variants and are universally suitable. As fixed balises with a permanently stored telegram, they transmit the same data to the train whenever they are traversed. As transparent balises, they send variable data depending on the signal aspect involved. In this case, this balise variant is controlled by a lineside electronic unit (LEU) via a permanently attached cable without connector.

Benefits

- Cost-effective
- Compact
- Tried-and-tested
- Highly reliable data transmission for train speeds of up to 500 km/h
- Contactless programming


2000

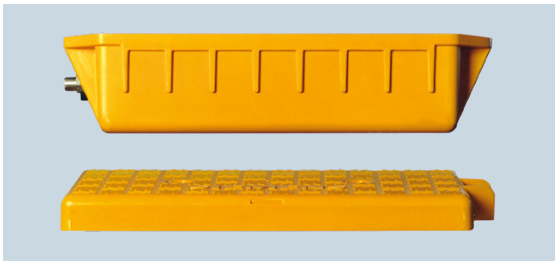
Principle of operation

Trainguard Eurobalises use a standardized transmission method. It is based on inductive coupling and data transmission with frequency shift keying and has, for many years, been successfully used by Siemens for train control.

When a train passes, the on-board balise antenna activates the Eurobalise by emitting a low-power signal. The Eurobalise uses this energy to send its information to the balise/loop antenna. It transmits the data required for train control to the train intermittently. This information is for train supervision by the EVC (European Vital Computer, on-board computer) and, at the same time, serves as a basis for display on the DMI (driver-machine interface) in the driver's cab. Depending on the application involved, fixed or transparent balises of the type Eurobalise S21 or S22 are used.

Programming

Eurobalises are programmed without any cable. Programming is done via the air gap by means of a handheld computer and a test and programming unit (TPG). Using the TPG, line operators can conveniently read out and modify the balise programming at any time.



Balise / loop antenna (top) and Trainguard Eurobalise S21 or S22

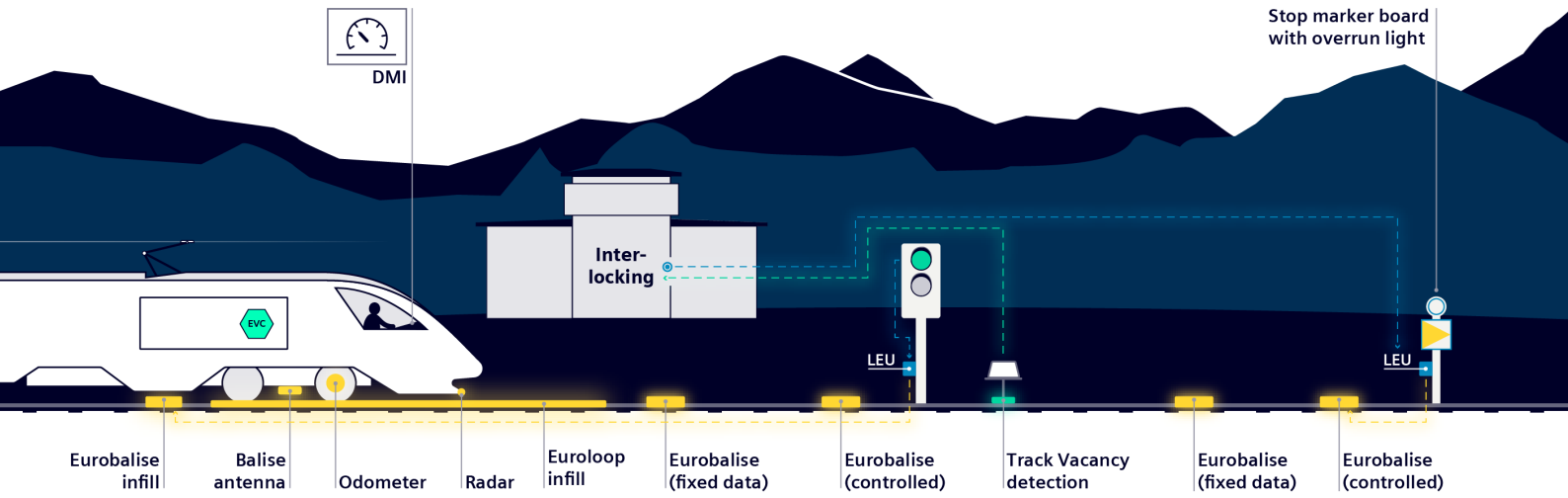
Contactless programming with the TPG test and programming unit

Trainguard Euroloop S21

The Trainguard Euroloop S21 increases line capacity and improves safety.

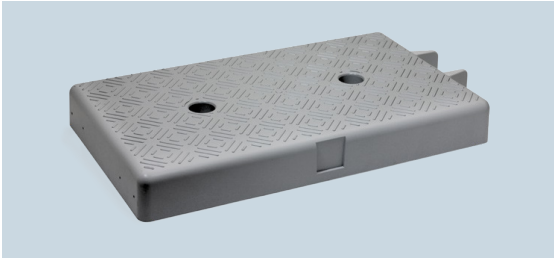
The Trainguard Euroloop S21, a member of the Trainguard 100 family, is a continuous option complementing the Trainguard Eurobalise, which permits semi-continuous data transmission to the train. The on-board balise/loop antenna used for the Eurobalises is also deployed for the Euroloop.

The Trainguard Euroloop S21, an up to 1000 meter-long leaky feeder, is laid at the base of the rail web between the distant and main signals. The advantage of data transfer is that the latest information is fed to the train continuously (infill), not merely at a defined point. With minimal modification to the vehicles, the Trainguard Euroloop S21 allows higher train speeds in the relevant sections with the same high level of safety.



Two for the line

Trainguard Eurobalises S21 and S22 – for universal usage



Trainguard Eurobalise S21 or S22

S21 and S22 fixed balises

As a fixed balise, the Eurobalise sends a track data telegram to the vehicle. The track data telegram is permanently stored in the fixed balise. The user can modify the data at any time if required.

S21 and S22 transparent balises

All the signal codes corresponding to the possible signal aspects and their associated telegrams are stored in a Trainguard LEU S21 (lineside electronic unit) installed at the trackside. In accordance with the signal aspect, the matching telegram is passed to the transparent balise and transmitted from there to the vehicle.

Technical data

Speed range	0 km/h to 500 km/h
Power transmission frequency	27.095 MHz
Data transmission frequency	4.234 MHz
Data transmission rate	565 kbits/s
Type of modulation	FSK (frequency shift keying)
Telegram length	341 bits or 1023 bits (selectable)
Usable data length	210 bits or 830 bits (selectable)
Programming	cableless across an air gap by means of the TPG test and programming unit
LEU S21 – Eurobalise control distance	max. 5000 m
Reliability (MTBF values as per SN 29500)	fixed balise > 800 years transparent balise > 160 years
Dimensions (l x w x h) Eurobalise S21 Eurobalise S22	 480 x 260 x 40 mm 480 x 260 x 55 mm
Weight	4 kg without cable (fixed balise), 10 kg with 9.6 m cable (transparent balise)
Ambient temperature	-40 °C to +70 °C (without solar radiation)
IP rating	IP67
Type	reduced-size balise
Trainguard Eurobalise S21 debris class	Class B
Trainguard Eurobalise S22 debris class	Class A
Conformity	The Eurobalises S21 and S22 fully comply with [TSI ZZS 2015] and UNISIG's [Subset-036-BL2] and [Subset-036-BL3], Versions V2.4.1 and V3.0.0.

TPG Eurobalise V2 Web
test and programming unit

WLAN-based test and programming unit for local maintenance

The TPG Eurobalise V2 Web test and programming unit is a logical refinement of the current version and enables Siemens' Eurobalises S11, S21 and S22 to be tested and programmed via WLAN both easily and fast.

Using commercial off-the-shelf operator control units such as a tablet or notebook, the user communicates with the TPG at a distance of up to 50 m from the track area, wirelessly via 15 – 25m and outside the danger zone.

In environments where WLAN must not be used, a cable-bound USB connection between TPG and operator control unit is available as an alternative.

A positioning aid is located underneath the housing to enable the TPG to be safely placed on the balise.

A robust tablet suitable for outdoor applications under snowy, rainy and sunny conditions is available on request. The battery life of the tablet is sufficient for more than one shift. The tablet can also be operated when wearing gloves. A shoulder bag is available for transport along the track.

Benefits

- Cableless testing, programming and ETCS-conformant telegram data read-out at a safe distance from Siemens' Eurobalises (up to 50 m)
- Programming of more than 200 balises with one battery charge
- Operator control with commercial off-the-shelf WLAN operator control units such as a tablet or notebook
- Additional cable-bound USB connection option
- Positioning aid for placing the TPG on the balise
- No software installation required on the operator control unit
- Storage and transportation in an easy-to-carry backpack (overall weight approx. 7 kg)

Technical data
Specifications and application conditions

Weight	approx. 6.5 kg
Dimensions (h x w x d)	157 x 488 x 346 mm
Connection between an operator control unit and the TPG	– via WLAN (802.11 b.n): up to 50 m – USB 2.0 cable connection
Operating temperature range	–20 °C to +55 °C
IP rating	IP54 (if the mains connection socket and other sockets are provided with covers)
Mains power supply	– external power pack: 110 V/230 V, 50 Hz/60 Hz – TPG base unit: 12 V to 15 V, 3 A
Operating life with one battery charge at 20 °C	programming of at least 200 balises
Rechargeable battery	12 V NiMH
Menu languages	German, English, French, Italian
Balise programming	cableless across an air gap
Radiation	27.095 MHz, 9 MHz
Reception (data received from the balise)	4.237 MHz ± 200 kHz

Recommended mobile operator control units and requirements

Tested and recommended operator control units	Important requirements
– Toughpad FZ-G1 and Toughpad FZ-M1 tablets (from Panasonic)	– WLAN interface (802.11 b.n)
– Algiz 7 (from handheld)	– Display with 1024 x 600 pixels (min. 7" widescreen recommended)
– Notebook/laptop with Windows 7 and Internet Explorer 10 and 11	– File system for storage of programming files and logs
	– Tested browsers: Internet Explorer, FireFox (other browsers may function but have not been tested)

Supported balises

– Trainguard Eurobalise S11
– Trainguard Eurobalise S21
– Trainguard Eurobalise S22

All necessary data is programmed in the memory of Siemens' Eurobalise in the form of a telegram across the air gap.

The operator control unit which can be ordered as an option enables the TPG Eurobalise V2 Web test and programming unit to be operated.
As an alternative, operator control is also possible via a different tablet (according to customer specifications) or a notebook/laptop.

Trainguard LEU S21 – unlimited safety with ETCS Level 1

The central trackside component for ETCS Level 1

The Trainguard LEU S21 (lineside electronic unit) is the link between existing fixed signals and track-side ETCS components, Eurobalises and Euroloops of the S21 type. The Trainguard LEU 21 has proved to be extremely reliable in more than 15,000 instances in different countries.

Principle of operation

An ETCS-equipped transmission point usually comprises one fixed balise and one transparent balise. The telegrams are transmitted intermittently by means of the Eurobalise and, if required, semi-continuously by the Trainguard Euroloop S21 F. The indicated signal aspect is extracted by the Trainguard LEU S21 and the associated telegram is selected and continuously transmitted as a serial data stream via a standardized interface to the transparent balise(s) or the Euroloop modem. If an ETCS-equipped train traverses the balise, the ETCS telegram is transmitted to the train and evaluated by the EVC (European Vital Computer, on-board computer). All configuration data, signal codes and telegrams belonging to the signal are stored in the Trainguard LEU S21. If the Trainguard LEU S21 detects an invalid signal aspect, a fault telegram is output.

Programming and diagnostics

A handheld computer is the central component for programming and diagnostics of the Trainguard LEU S21. The data generated during configuration is transmitted by the handheld computer and safely stored in the Trainguard LEU S21 memory. The displays on the Trainguard LEU 21 and the handheld computer also offer easy-to-use diagnostic options.

Installation

The entire wiring and the connectors for the external connections are integrated into the mounting rack and accessible from the front. The Trainguard LEU S21 is normally housed in the signal cabinet of the signal to be equipped. It is directly connected via the cable feeder from the interlocking to the signal or via the lamp circuit.

Benefits

- Compliance with all relevant European standards
- Modular structure
- Accommodation in concrete equipment houses, apparatus cabinets or relay rooms
- High-reliability data transmission
- No maintenance required
- High level of availability
- No software installation required
- Low power consumption

Benefits of Trainguard
LEU S21

Compact design
The Trainguard LEU S21 can be installed in almost all conventional apparatus cabinets. All connectors are accessible from the front, thus simplifying equipment replacement and cutting down on modification costs.

Safe current tapping
A low-resistance transformer enables the Trainguard LEU S21 to be looped into an existing signal circuit without affecting the control distance. Lamp tapping with a current transformer is failsafe in line with SIL 4.

Absence of interaction
Due to the special characteristics of the current transformer, the absence of interaction can be easily demonstrated. This has already been done for various signaling systems.

Cascadability
A modular Trainguard LEU S21 with a signal tap provides up to three simplified cascaded LEUs with the signal aspect. This means that up to eight outputs are available for balises/loops.

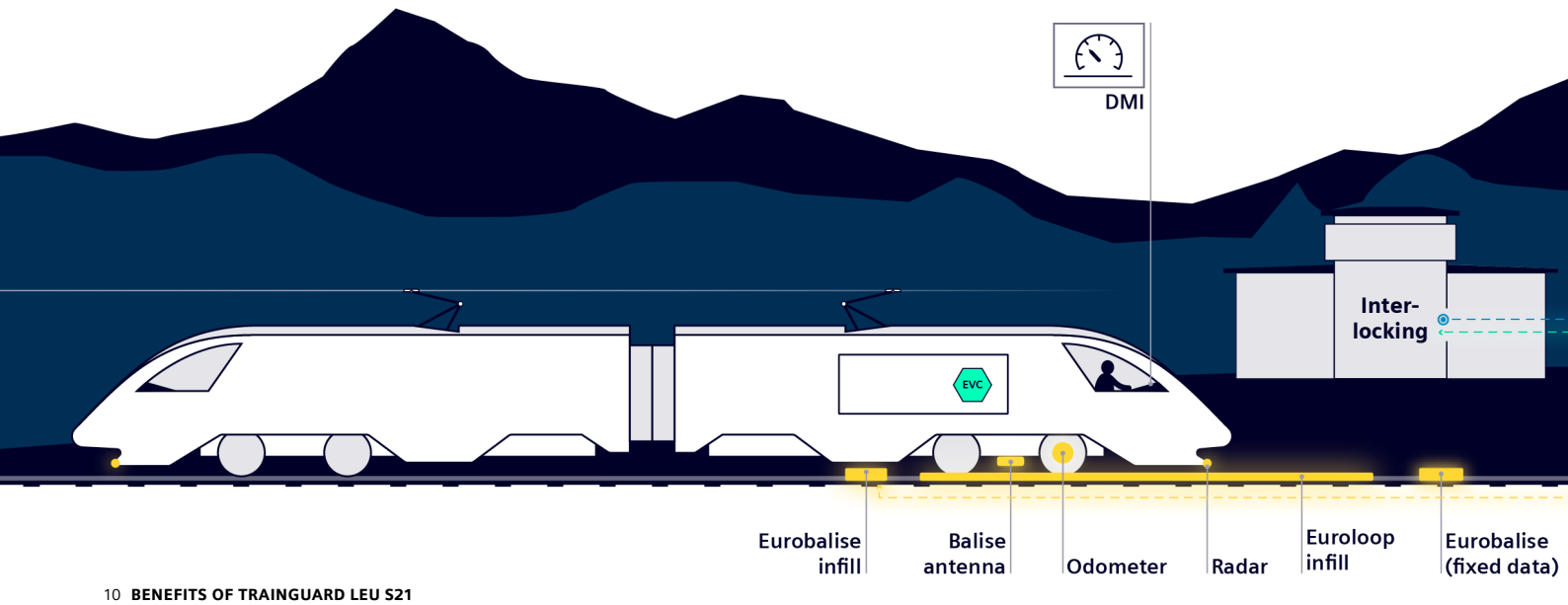
Patented programming method
This method is patented and ensures data transmission between the handheld computer and the Trainguard LEU S21 in line with SIL 4.

Three-stage diagnostic concept
Rough diagnostics are possible in two stages without any tools:
• LEDs (operating state)
• seven-segment display (fault cause)
Detailed diagnostics with a handheld computer also permit records to be made over long periods of time (in the event of temporary faults).

Maximum availability
The Trainguard LEU S21 deactivates the outputs for Eurobalises/Euroloops in the event of faults and reactivates them as soon as the relevant fault has been rectified.

Monitoring functions
Smooth operation is ensured by monitoring functions, considerably boosting the availability of the trackside equipment and minimizing the deployment of maintenance staff.

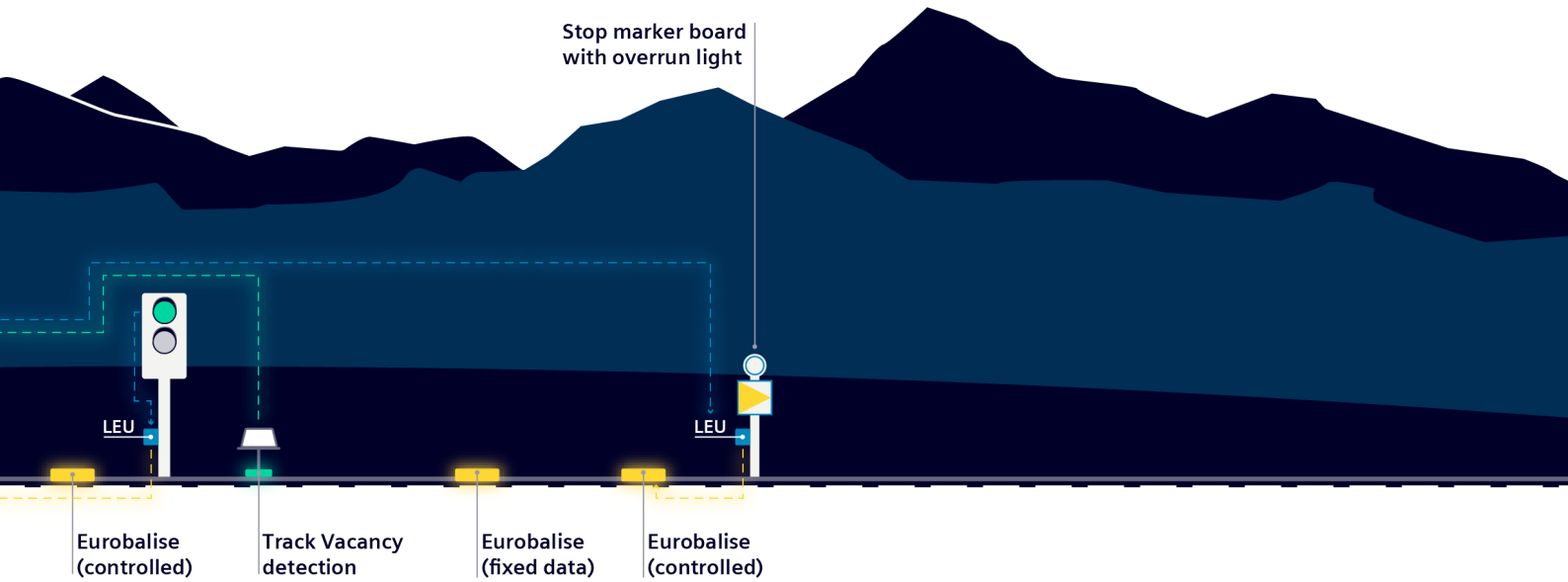
Maintenance-free operation
The Trainguard LEU S21 is maintenance- free; no regular inspections need to be performed.



Technical data	
Reliability (MTBF as per SN 29500)	> 31.7 years
Dimensions (h x w x d)	185 x 190 x 286 mm
Weight	3.8 kg
Ambient temperature	-40 °C to +70 °C
IP rating	IP20 (installation in housing with min. IP54)
Current inputs	
Number of inputs	up to 16 inputs configurable
Input range	30 mA to 4 A (15 Hz to 440 Hz)
Flashing detectors	configurable at up to four inputs
Voltage inputs	
Number of inputs	up to eight inputs configurable
Input ranges	0 Vrms to 181 Vrms AC (15 Hz to 66 Hz); 0 V to 181 V DC
Flashing detectors	2 inputs configurable
Power supply	
Input ranges	88 Vrms to 264 Vrms AC (15 Hz to 90 Hz); 34 V to 177 V DC
Telegram generator/outputs	
Outputs	two transparent balises, two Trainguard Euroloops or combined
Extension	with cascaded Trainguard LEU S21 extendable to eight outputs
Interface signal ‚C'	in line with UNISIG Subset 036 FFFIS for Trainguard Eurobalise
Interface signal ‚CL'	in line with UNISIG Subset 044 FFFIS for Trainguard Euroloop
Number of telegrams	1023 telegrams per output
Telegram length	341 bits or 1023 bits (selectable)

Trainguard LEU S21 with extension LEU S21

Two Trainguard LEU S21 in a trackside cabinet

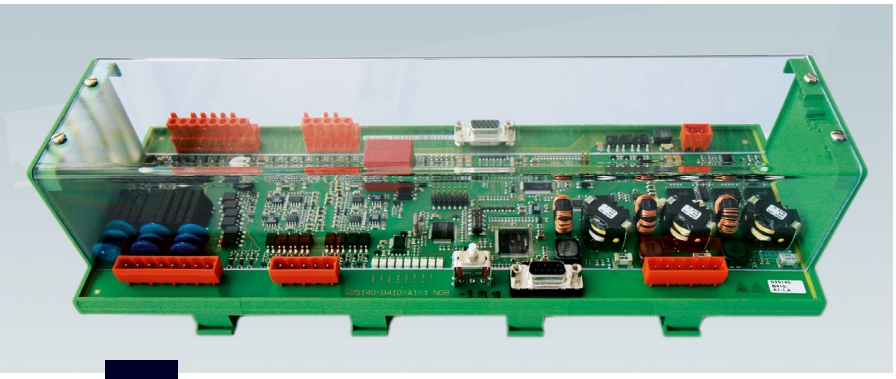


MiniLEU
S15

Interoperability for European railways

The Trainguard MiniLEU S15 is intended for use in mass transit and mainline services for ETCS Level 1 Limited Supervision (L1 LS). Comparable applications are possible (e.g. TBL1+, ZBS).

The Trainguard MiniLEU S15 can be used to upgrade a line already equipped with a national train protection system to L1 LS. The existing train protection systems (e.g. track magnets) can remain on the track and are supplemented by a cost-optimized ETCS solution (Trainguard MiniLEU S15 and Trainguard Eurobalise S21).



The Trainguard MiniLEU S15 connects the Trainguard Eurobalise S21 to the lineside signals. The indicated signal aspect is read in by the Trainguard MiniLEU S15 via the PZB contacts and generates a pointer which, in turn, activates one of the configured telegrams per balise output and transmits it to the transparent balise(s), thus ensuring a minimum need for modification.

The Trainguard MiniLEU S15 offers the fast, cost-optimized conversion of transmission points and considerably reduces installation and cabling costs due to an integrated contact multiplier for the control of PZB magnets and earth-leakage monitoring of the PZB cables.

Benefits

- Compliance with European standards
- Simplification of signal-interlocking configuration
- Reduction of the scope of equipment along the track
- Migration of the existing national systems to ETCS
- Further usage of existing outdoor equipment
- Very low power consumption
- Possibility of autonomous solar power supply
- Low life-cycle costs
- Reusability after alterations
- Simple evidence of absence of any interaction

The Trainguard MiniLEU S15 complies with European railway standards (EN 50129 ff) in adherence to the specifications of Subsets 036, 085 and 091. Adherence to the requirements stipulated by UNISIG ensures that the group of constituents (Trainguard MiniLEU S15 and Trainguard Eurobalise S21) interacts with the components of other vehicle manufacturers.

Applications

Signal-guided L1 LS

The PZB 90 system operated in Germany is used for this purpose. Track magnets are available along the line which are directly connected to the different signaling systems via a standard interface.

The contact information of the national PZB 90 train protection system is read into the Trainguard MiniLEU S15 and provided again via a contact multiplier to control the relevant track magnets. At the same time, the telegram is sent via the Trainguard Eurobalise S21 to the ETCS on-board units.

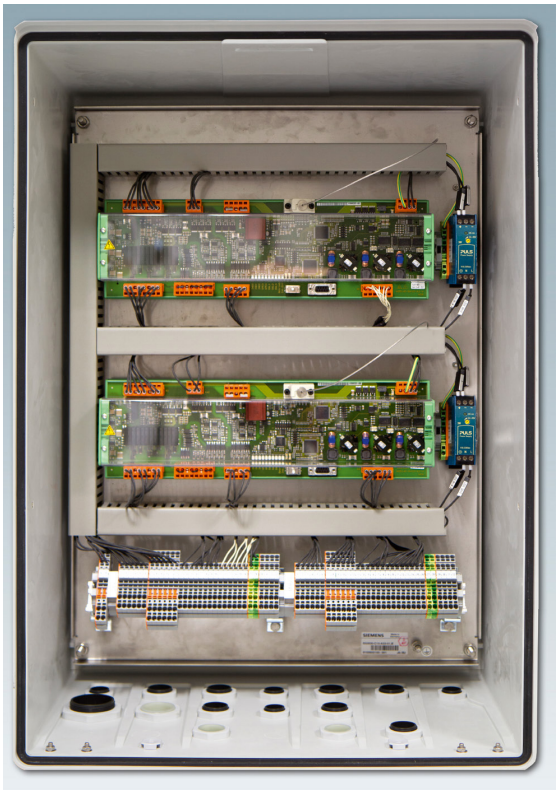
TBL1+ train control system

On the Aachen – Belgian border line, the MiniLEU S15 with TBL1+ function has been implemented in addition to the existing PZB intermittent train control system. In the TBL1+ upgrading phase, signals continue to be used for train operation. The train control function is performed by the Belgian TBL1+ system and in parallel by German Railways' PZB system. Hence, both trains with PZB on-board equipment and trains with TBL1+ on-board equipment can run on the line.

The information for the TBL1+ system is obtained from the existing PZB infrastructure and forwarded to the MiniLEU S15 as input information. However, Eurobalises are used as in the ETCS for information transmission from the track to the train.
This enables mass transit trains coming from Belgium to run with their TBL1+ train control system as far as Aachen Central Station. The section from the Belgian border to the Hammerbrücke junction on the Belgian side is equipped with ETCS Level 1 and TBL1+.

Technical data

Number of telegrams	10 telegrams per output
Number of outputs	3 Trainguard Eurobalises S21
Number of inputs	5
Power consumption	< 2000 mW
Operating voltage	4 V to 60 V DC 110 V to 230 V AC



Trainguard MiniLEU S11 – simple and ecological extension with ETCS Level 1 LS

ETCS-safe and sustainable throughout:
Siemens is supplying 5000 solar-powered MiniLEUs for Swiss Federal Railways' network

ETCS Level 1 Limited Supervision (L1 LS)

The Trainguard MiniLEU S11 has been developed for rail customers who wish to upgrade their existing systems with ETCS fast, cost-effectively and ecologically, whether for enhanced safety or for interoperability. In combination with the new ETCS Level 1 Limited Supervision mode, roll-out is possible without causing performance to be diminished or making extensive adjustments to the operating rules.

Benefits

- Solar power supply for self-sufficient operation of the MiniLEU S11
- No need for cabling, adjustments to circuits, installation of fuses, UPS, etc.
- Due to the plastic housing, no complex cabinet installation and the otherwise usual earthing measures
- Programming less than two minutes

ETCS installation both fast and uncomplicated

Development of the MiniLEU S11 focused on full-coverage installation with ETCS within the shortest possible time and with minimum investment. With this in mind, we have minimized the costs involved, from configuration and installation through to commissioning.

Minimum lifecycle costs

The following measures have reduced the lifecycle costs to a minimum:

- automatic indication of faults or low battery charge levels, obviating the need for preventive maintenance
- extremely high mean time between failures (MTBF), reducing intervention costs which would be incurred in the event of a failure
- status LEDs on the front panel of each board, enabling diagnostics without auxiliary tools; necessary measures can be initiated and implemented within a very short period of time
- due to local configuration, no reprogramming required if boards are replaced

Smart combination for the ETCS safety standard: Trainguard MiniLEU S11 and Trainguard Eurobalise S11


89R
89S
190

Balises installed in the track bed communicate with the on-board computer via the air interface and with the trackside MiniLEU by cable.

ETCS Level 1 Limited Supervision

This is a modified version of ETCS Level 1 (L1). Limited Supervision (LS) entails simplified background monitoring without cab signaling. The driver continues to observe trackside signals and thus largely drives the train in line with the current operating processes.

ETCS L1 LS monitors in the background and only as many parameters as required at any particular location. ETCS L1 LS has been adopted into Baseline 3 of the ETCS specifications.

The MiniLEU S11 allows ETCS L1 LS to be implemented in existing signaling and safety systems without any major modifications, thus enabling costeffective migration to the ETCS standard.

Market data

Technical data

Weight of MiniLEU S11	6.8 kg (incl. housing)
Dimensions	300 x 300 x 300 mm
Ambient conditions	
Operating temperature	- 40 °C to + 70 °C
Cooling	not required
Storage classes	1K2, 1Z2, 1B1, 1C2, 1S2, 1M2
Storage temperature	-25 °C to + 70 °C
IP rating	IP54 in housing
Humidity	in line with EN 50125-3, climate class T1
Vibrations	in line with EN 50125-3, application 1 to 3 m next to the track edge
Pollution degree	4C3, 4B1, 4S3 (applicable outside on the housing)
EMC	EN 50121-4, EN 61000-6-2, EN 61000-6-4
Insulation coordination	EN 50124-1
Service life	25 years
Safety integrity level	SIL 2 as per EN 50129

References

More than 2.500 installed and in operation in Swiss Federal Railways' network

Homologation

Operation in Switzerland

Installed ETCS systems ensure cross-border interoperability.

Trainguard 200 RBC

Radio block center for fail-safe monitoring of ETCS operations

The Trainguard 200 RBC (radio block center) transmits all the information required for safe train operation within a particular line section by radio from the interlocking to the train. This information is indicated on the cab display. For data transmission, the digital Global System for Mobile Communications – Railways (GSM-R) is used. For position finding, Eurobalises serve as reference points.

The Trainguard 200 RBC supports the parallel connection of two mobile services switching centers (MSC) to the RBC. If a connection to one of the MSCs fails, undisrupted operation can be maintained via the second MSC. Circuit switched and packet switched connections are provided.

Benefits

- High-availability, fail-safe computer system
- Compact design with a proven platform
- Optimal integration of relay interlockings or other manufacturers' interlockings
- Control of ETCS Level 1 balises
- Modular extension
- Baseline 3.4.0, 3.6.0 and Baseline 2.3.0d available
- Low power consumption
- Use in a wide temperature range; less need for air-conditioning

Principle of operation
The ETCS trains moving in the line area controlled by the Trainguard 200 RBC locate themselves independently and cyclically transmit their positions to the Trainguard 200 RBC. The Trainguard 200 RBC is continuously supplied with the current process image from the connected interlockings and sends movement authorities to the trains by radio data transmission.

Range of applications
The Trainguard 200 RBC can be integrated into existing infrastructures without any complex adaptation since interlockings are connected via standard interfaces. This means that different interlocking types are supported. In the migration phase, the Trainguard 200 RBC also offers mixed operation in combination with other ETCS levels.

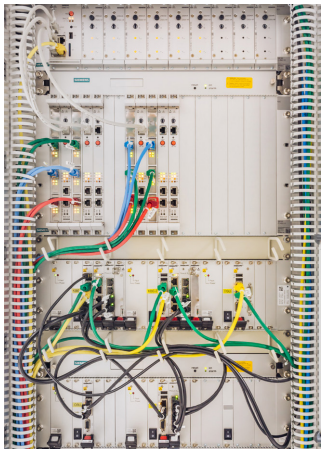
The Trainguard 200 RBC can also assume the tasks of a central lineside electronic unit (LEU), enabling mixed Level 1 and Level 2 solutions. Level 1 and Level 2 are configured in the same way, which means that the level can be simply changed over. This also enables temporary speed restrictions to be entered for Level 1 vehicles via the operator console and movement authorities to be issued for several sections even in Level 1. Standardized interfaces allow the Trainguard 200 RBC to communicate with other Trainguard 200 RBCs or other manufacturers' RBCs:

- **Eulynx interfaces**
  SCI-RBC to IXL and SCI-CC to TMS system available
- **KMC**
  Interface according to Subset 114 and Subset 137 is available

Integration into relay interlockings and other manufacturers' interlockings
The use of standardized interfaces means that the Trainguard 200 RBC can be connected to other manufacturers' interlockings. Furthermore, relay interlockings can communicate with the Trainguard 200 RBC via interface computers.

Operator console for Trainguard 200 RBC
Temporary speed restriction, for example, are entered via the Trainguard 200 RBC operator console. The operator console can be installed locally or integrated into a higher-level operator and operations control system.

Flexible migration
The Trainguard 200 RBC supports migration from national train control systems to ETCS. Migration can involve mixed operation with the relevant national systems or different ETCS levels.



CENELEC and safety

The Trainguard 200 RBC complies with the CENELEC standards and meets safety integrity level SIL 4. The Trainguard 200 RBC works on the basis of the well-known, reliable Simis principle and features a high level of availability.

Compact design

The Trainguard 200 RBC has a compact, modular design. Depending on the number of vehicles to be monitored or connected interlockings, the Trainguard 200 RBC can be modularly extended. The Trainguard 200 RBC can also assume the tasks of a central LEU and control ETCS Level 1 balises.

Baseline 3 and baseline 2 available

The UNISIG functionality of the Trainguard 200 RBC corresponds to Baseline 3 SRS 3.6.0. The version can be set by configuration so that the Trainguard 200 RBC can also be used e.g. as Baseline 2 SRS 2.3.0d. The interface to other RBCs provides Baseline 2 and baseline 3 RBC.

Low power consumption

The Trainguard 200 RBC has a power consumption of less than 200 W. If trackside signals are not used, considerable energy is additionally saved. This means that the Trainguard 200 RBC contributes to environmentally friendly railway operations.

Technical data

Number of monitored vehicles	60
Power consumption	< 200 W
Number of interlockings per RBC	8 (standard), optionally extendable
Number of interfaces to adjacent RBCs as per UNISIG Subset 039	6

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Order No. MORI-B10009-00-7600