Trainguard

Full interoperability for rail traffic
Siemens – we offer our customers optimized ETCS solutions

One of the major challenges faced by society is to ensure mobility. To remain mobile in future, we need networked traffic and information systems. It is only when all modes of transport are suitably harmonized and perfectly interact that our mobility requirements can be handled. That is why Siemens is creating integrated transport solutions – for safe, cost-effective and environmentally friendly passenger and freight transport.

Europe is growing together and the world is opening up
With its decision to opt for ETCS, Europe has paved the way for a future of cross-border rail traffic. Promoted by politicians and driven by railway operators and leading suppliers such as Siemens, a network of ETCS-equipped lines will be bringing Europe’s conurbations and key logistics centers closer together.

The European Train Control System (ETCS) is successively replacing Europe’s different national train protection and control systems and has evolved into a worldwide standard. Standardized interfaces between vehicles and lines enable operational and technical interoperability. As a result, cost-intensive multiple on-board equipment and the inefficient change of locomotives at national boundaries will soon become a thing of the past.

As one of the pioneers of ETCS, Siemens’ Trainguard solution is providing sophisticated, field-proven systems and products for individual applications. Like no other supplier, this means that Siemens has a scalable system of lineside, on-board and communication equipment for all ETCS applications: Trainguard is the name of the solution for the standard European Train Control System.
Siemens – your reliable partner in launching ETCS

Success starts during the planning phase
As system provider with a firm worldwide customer base, Siemens has unique planning and implementation competence in the international rail automation market. Based on this experience, Siemens can provide operators with specific advice already during the planning phase and mutually define suitable, futureproof solutions.

Optimum migration and overall operating concepts
As partner for infrastructure and vehicle operators, Siemens offers customer-oriented solutions which can be used to equip both existing and new lines as well as vehicles with ETCS step by step. This creates the basis for successful migration to ETCS and serves as protection against investment losses. Leading rail companies are already putting their trust in this competence worldwide.

Competent, reliable implementation
Siemens controls projects from the word go through to final completion. Our services range from specification and project management through to implementation, approval and maintenance. Siemens has proved itself as a competent, reliable partner for the entire life-cycle in numerous rail automation projects.

Economic success
With Siemens as a partner, operators enjoy economic success thanks to high-level operating performance and low life-cycle costs. Siemens offers its customers scalable implementation. State-of-the-art systems engineering, tailor-made installation solutions and customized migration concepts for both lines and vehicles make customers’ operations futureproof.
## Trainguard – the solution from a competent source

### ERTMS from a single source
In addition to its Trainguard product portfolio for ETCS, Siemens also offers GSM-R and TETRA radio systems for rail projects worldwide. As an integrated-package supplier for ERTMS (European Rail Traffic Management System), Siemens has unique competence in the rail sector on a global scale.

### Centers of competence
From its ETCS centers of competence in Madrid, Berlin, Chippenham and Braunschweig, Siemens controls the entire range of its ETCS activities. This is where its experts implement Trainguard for customers throughout the world.

### Test and training centers
At Siemens’ test centers, the systems to be delivered are subjected to testing before being put into use. These tests run under live conditions considerably reduce both project durations and commissioning times.

Lineside and on-board components can be either simulated or actually integrated. Siemens’ engineers also have the possibility of accessing the real line configuration data of other ETCS suppliers and joining up with other manufacturers’ ETCS laboratories to set up interoperability (IOP). In this way, an on-board computer can cost-effectively run along different lines in the laboratory before starting tests on the real system. To this effect, a unique infrastructure is available, enabling train runs to be shown under real-life conditions. This emulator is also used for training our customers.

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<th>Lineside Components</th>
<th>On-board Components</th>
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<td>Trainguard LEU</td>
<td>EVC (on-board computer)</td>
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<tr>
<td>Fixed balise</td>
<td>DMI (driver-machine interface)</td>
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<tr>
<td>Transparent balise</td>
<td>Odometer pulse generator</td>
</tr>
<tr>
<td>Trainguard Euroloop</td>
<td>Radar</td>
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GSM-R (optionally TETRA)

Distant signal  Main signal  Track vacancy detection

Section 1 = TVDS 1

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1. Trainguard LEU
2. Fixed balise
3. Transparent balise
4. Trainguard Euroloop (optional)
Interoperability
ETCS is the basis for interoperability between the on-board and lineside equipment of different rail operators. The Trainguard product family ensures unrestricted interoperability across national borders. Siemens has already impressively demonstrated the real-life interoperability of its on-board equipment with other manufacturers’ lineside equipment in different combinations. Trainguard is based on a high-performance platform which also features reserves for future applications.

High safety standard
The Trainguard system meets topmost safety requirements and complies with the Technical Specification for Interoperability (TSI). Trainguard has successfully proved itself in day-to-day practice.

Trainguard – futureproof solutions for safety and interoperability

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<th>Trainguard</th>
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<td>Compact design</td>
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</tbody>
</table>

7 EVC (on-board computer)  
8 DMI (driver-machine interface)  
9 Odometer pulse generator  
10 Radar

1 Trainguard LEU  
2 Fixed balise  
3 Transparent balise  
4 Trainguard Euroloop  
5 Balise/loop antenna  
6 Receive-and-forward unit
The Trainguard train control system can be used on lines
• which are to be equipped with intermittent train control for operational reasons,
• where cross-border or interoperable traffic is to be enabled,
• where the safety level has to be increased,
• where legacy systems are to be gradually phased out,
• where intervention in existing signaling systems is to be minimized.

Infills permit semi-continuous train control so that the currently indicated signal aspect becomes effective before the train passes the signal involved. This is done either intermittently by means of Eurobalises or continuously with the Euroloop. Migration takes place concurrent with the existing legacy systems (Class B systems).

The cab display (DMI) continuously shows the driver the permitted speed and the line profile ahead. The driver is provided not only with graphic information on the driving strategy for the line section ahead but also with information about speed restrictions and other operational and ETCS-specific data.

When exceeding the maximum permitted speed, the driver is initially warned both visually and audibly. If he fails to respond, the train is braked to the permitted speed.

Prior to reaching any hazard points, the Trainguard system causes graded braking (service braking, emergency braking) when the braking curve is exceeded.

When Baseline 3 comes into force, the new Limited Supervision (LS) mode will be introduced, enabling a low-cost migration to ETCS as ETCS Level 1 LS.
As the governing feature of ETCS Level 2, all information which is required for safe running on a certain line section is transmitted by radio from a radio block center (RBC) and displayed on the DMI. The GSM-R digital mobile radio system for railways (optionally TETRA) is used for this purpose. Eurobalises serve as reference points to determine the position of the vehicle.

Trainguard uses the information provided by the route elements of connected interlockings. Signals can continue to be used for mixed operation or as a fall-back level, although they are no longer required for purely Level 2 operation. Information about signal aspects and point positions is sent from the associated interlocking to the RBC which uses this information to generate the movement authority and forward it to the driver.

Line throughput is considerably boosted. Running "on electronic sight" over several section blocks enables trains to operate at maximum speed and headway.

Considerable savings in infrastructure can be obtained due to the fact that wayside signals can be optionally dispensed with.

The technical compatibility of Trainguard systems for Level 1 and Level 2 ensures interoperability beyond system boundaries and national borders.

**Trainguard – solutions for ETCS Level 2**

**High-performing, efficient and futureproof**
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Trainguard Futur 1300
Level 1 ERTMS solution
Within the range of the Trainguard Futur family of train control systems made by Siemens, Futur 1300 is the Level 1 solution which provides great performance for operation and enhanced maintenance features for railway operators around the world.

Harmonized community transport policies are essential in a European Union of 28 countries. The ability to circulate from one member state to another using interoperable driving systems is becoming a fundamental requirement.

Achieving a single automatic driving system is crucial for the optimization of rail transport efficiency not only on a European scale but also for other countries outside the European Union (i.e. Saudi Arabia, Kazakhstan, etc.) which are considering this standard as a basis for their railway operation.

In order to develop such a system, it is necessary to establish common standards for on-board systems, the connection and communication interfaces between the different elements and the development of common procedures. In order to fulfil these requirements, the European Rail Traffic Management System (ERTMS) has been developed and is now being deployed worldwide.

Siemens has developed a full range of ERTMS equipment and systems, all of which are designed to deliver interoperability with the highest safety standards: the Siemens ERTMS solution is Trainguard Futur 1300.

Trainguard Futur 1300 complies with the latest versions of the technical specifications for interoperability, functionality requirement specifications (FRS), system requirement specifications (SRS) and all UNISIG-related specifications.
Key features
The Level 1 Trainguard Futur 1300 ERTMS system has the following features:

Operability
Trainguard Futur 1300 allows dynamic management of temporary speed restrictions (TSRs). Operator posts are used locally and at central and zone levels, thus enhancing system availability.

Modularity
Modularity in both hardware and software components makes enhancement of the system an easy task for future updates.

Connectivity
Interfacing with the interlocking may be done either in series via a safety integrity level (SIL) 4 data link, or in parallel through discrete fail-safe indications.

Reliability
The components employed in the Trainguard Futur 1300 system have been selected because they comply with the highest levels of reliability. They include components that are widely available, which means manufacturer support is available throughout the system’s lifetime and updates to newer versions are easier to implement.

Maintainability
Maintainability is provided through a maintenance assistance system allowing real-time access to system data – either locally or centrally.

Safety
The Trainguard Futur 1300 design adheres to the European standards CENELEC EN 50126, EN 50128 and EN 50129.

Localization
National functions and local requirements can be easily integrated with the Trainguard Futur 1300 equipment.

Architecture
The serial Trainguard Futur 1300 system can be based on centralized or distributed LEU architecture. LEUs are either located in the SER or along the line and are connected to a centralized LEU controller (usually an interlocking). This ensures great flexibility, providing high performance especially with regard to temporary speed restriction (TSR) management.

Serial interfaces are implemented through a TCP/IP network for communication with other systems – local and central ERTMS controls, temporary speed restrictions (TSR) management system, MAS, etc.

Very high availability is achieved through the design of architecture by means of a hot-stand-by configuration. The number of transparent-data balises controlled by each LEU is limited to four, so that in the rare event of a LEU failure the affected area is reduced to the minimum.

LEUs are based on a 2-out-of-2 architecture, with diversity at each processor.

System operation
Trainguard Futur 1300 is made up of:
• line equipment unit (LEU)
• fixed-data and transparent-data Eurobalises
• temporary speed restrictions manager (TSRM)
• ETCS local control panel (LCP)
• central ERTMS control (CEC)
• interface control (PCI)
• maintenance terminal (MaT)
• juridical recorder unit (JRU)

Trainguard Futur 1300 is a complete automatic train control (ATC) system which is based on information being sent to the train when passing over balises. Each balise receives telegrams containing the corresponding movement authority from the LEU associated with it.

To define the movement authority, the LEUs analyze the status of the outdoor elements – whether centralized via a link to the interlocking or by obtaining direct fail-safe inputs from points and wayside signals.
Centralized architecture

The Trainguard Futur 1300 system consists of the following basic elements:

**LEU – line equipment unit**
The LEU sends the movement authority to the balises. It is a redundant computer working in a 2-out-of-2 architecture with distributed software.

Each LEU is capable of controlling up to four balises. Signaling information comes from the interlocking, temporary speed restriction information comes from the TSR manager.

**LCP – ETCS local control panel**
The LCP is the subsystem allowing the operator to safely operate the Trainguard Futur 1300 system and to manage the temporary speed restrictions (TSRs).

For this purpose, the operator uses a mouse and keyboard. All commands are registered in the juridical recorder unit (JRU) and all relevant information is displayed to the operator.

**TSRM – TSR Manager**
A specific system is used to handle all temporary speed restrictions, whether static or dynamic. Distributed software is used to create the tables with the messages containing the TSRs for the LEUs.

**PCI – interface PC**
A PCI machine is used to manage communications between the local equipment and the central ERTMS control (CEC) via the real-time operating network (RTON). This provides total isolation of the private signaling network to which the LEUs and CLCs are connected. A hot-standby configuration is used to guarantee communication availability.

**JRU – juridical recorder unit**
An accident-resistant “black box” unit is allocated to a number of LEUs, permanently recording all messages to and from each LEU, including faults and incidents related to the LEU and its communications. There is also a JRU associated with each LEC.

**CEC – central ERTMS control**
This subsystem manages all functionality available at ERMTS Levels 1 and 2 from a single control center.

Temporary speed restrictions are set safely via the CEC and then sent to the trains via the CLCs and TSRM.

A CEC may work independently or integrated within an operations control center (OCC). Any particular railway line may be split between several CECs, the transfer of commands between them being another available functionality.

The CEC is designed in a modular architecture for both hardware and software, allowing easy upgrades in the future.

**MaT – maintenance terminal**
The LEUs send maintenance information to a system designed for data storage and maintenance assistance, including fault location and communications health monitoring.

The MaT system is common to both Level 1 and Level 2 systems, providing real-time communication with maintenance staff through automatic e-mails, SMS, pop-up windows (to name just a few).

**Temporary speed restrictions (TSRs)**
Trainguard Futur 1300 includes an advanced system to manage temporary speed restrictions on the line. TSRs can be established and canceled by an operator simply and safely.

The system allows the operator to choose the TSR based on distance or track circuit location. Available speeds are set from 0 to 300 Km/h in increments of 5 km/h.

TSRs may be established through requests from several operating posts: ERTMS central and local units and OCCs. This provides a high degree of flexibility to the operator, allowing efficient and coordinated network management.
Trainguard Futur 1300 includes a powerful tool for testing and simulations in the test environment. This tool allows data validation for both Level 1 and Level 2. Tests in the field are then limited to correspondence tests between data and actual hardware.

Tests with this tool can be automated, thus saving engineering hours and testing times in the field. The system also proposes alternative solutions to the initial settings, thus enhancing final performance of the system and improving line utilization.

Data previously programmed at the LEUs – or RBCs – may also be checked and verified in a controlled environment.

The simulator is also capable of emulating several types of rolling stock and their corresponding characteristics, thus improving system performance.
The information in this document contains general descriptions of the technical options available. The required features should therefore be specified in each individual case at the time of closing the contract. For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action and integrate each component into a holistic, state-of-the-art security concept. Third-party products that may be in use should also be considered.
Trainguard Futur 2500
Level 2 ERTMS solution
Within the range of the Trainguard Futur family of train control systems made by Siemens, Trainguard Futur 2500 is the Level 2 solution which provides great performance for operation and enhanced maintenance features for railway operators around the world.

Harmonized community transport policies are essential throughout the European Union. The ability to circulate from one member state to another using interoperable driving systems is becoming a fundamental requirement.

Achieving a single automatic driving system is crucial for the optimization of rail transport efficiency not only on a European scale but also for other countries outside the European Union (i.e. Saudi Arabia, Kazakhstan, etc.) which are considering this standard as a basis for their railway operations.

In order to develop such a system, it is necessary to establish common standards for on-board systems, the connection / communication interfaces between modules and the development of common procedures. In order to fulfil these requirements, the European Rail Traffic Management System (ERTMS) has been developed and is now being deployed worldwide.

Siemens has developed a full range of safe and interoperable ERTMS equipment which is already being used successfully in various applications. Trainguard Futur 2500 is Siemens’ ERTMS Level 2 train control solution.

Key features
The Level 2 Trainguard Futur 2500 ERTMS system has the following main features:

Operability
The entire functionality of Trainguard Futur 2500 has been tested in several projects with different railway operational concepts. Futur 2500 has been certified according to UNISIG 2.3.0d. Regarding upcoming specifications, Futur 2500’s updating path to UNISIG Baseline 3 has already been defined.

Modularity
Trainguard Futur 2500 has a modular structure. Each element executes a clear functionality. This facilitates maintenance and improves reliability by employing specialized hardware for the different functions. Moreover, it permits equipment evolution since each element may be modified independently without affecting others.

Connectivity
The system provides excellent connectivity with other systems through serial interfaces – established using the TCP/IP protocol. It facilitates access to different types of networks used in railway environments (i.e. GSM-R, TETRA).

Reliability
The components employed in the Trainguard Futur 2500 system have been selected because they comply with the highest levels of reliability. They include components that are widely available throughout industry in order to extend availability during the system’s lifetime and to facilitate updating to new versions.
Availability
All safety-related subsystems of Trainguard Futur 2500 have been developed as a two-out-of-three system (2oo3). Communication equipment offers the possibility of being deployed in a hot-standby configuration, thus ensuring high levels of availability.

Maintainability
Maintenance and diagnostic operations can be carried out either locally or from the central control system – granting real-time access to all parameters of the system.

Safety
The Trainguard Futur 2500 design methodology follows the European standards CENELEC EN 50126, EN 50128 and EN 50129.

High performance
The system employs already proven techniques in order to reduce both costs and the size of the hardware and also to increase process speed. Any later modifications to functionality and response time requirements of the chosen system are guaranteed by the selected platform.

Temporary speed restrictions (TSRs)
Trainguard Futur 2500 includes an advanced system to manage temporary speed restrictions (TSR) on the line.

TSRs may be established and canceled in an operator-oriented, safe and simple manner. The proposed system allows the TSR to be chosen either within any kilometric range of the line or using track circuit allocation. Available speeds are set from 0 to 350 km/h in steps of 5 km/h.

TSRs may be established through requests from several operating positions: ERTMS central, local or OCCs. This operator interface is valid for both Level 1 and Level 2 ERTMS and provides a high degree of flexibility to the operator and maintainer of the line, allowing efficient and coordinated management.

Representative projects
Siemens has successfully implemented its ERTMS solution in several projects with different railway concepts:

- high-speed lines (i.e. Córdoba–Málaga, Madrid–Levante, Mecca–Medina, Ankara–Konya, etc.)
- metropolitan areas (i.e. Madrid commuter lines, Marmaray)
- metropolitan areas with ATO (i.e. Thameslink)

The Trainguard Futur 2500 ERTMS Level 2 equipment is applicable for several exploitation scenarios – from high-speed lines up to 500 km/h to commuter lines with high degrees of occupancy, all accompanied with all those particular requirements defined by railway operators.

System operation
The Trainguard Futur 2500 system is a complete train protection system based on the interchange of bi-directional continuous information with the train through the use of GSM-R Euroradio.

According to the infrastructure state and the situation of the trains on the line, the radio block center (RBC) calculates the movement authority (MA) and sends it along with the track data to each train. This information is generated by the RBC using each train’s localization as given by the relevant interlocking. The train’s position is given by the GSM-R/TETRA as well as through track occupancy.

The on-board equipment provides continuous supervision of the train’s speed in order to avoid overrunning the MA given by the RBC.

The Trainguard Futur 2500 system has been installed and put into service to provide the route with ETCS Level 2 in accordance with the Unisig 2.2.2 specifications. In addition to the usual control and monitoring functions for their respective areas, the two installed Trainguard Futur 2500 RBCs implement the complex functionality in relation to “train handover”.
Architecture
The Trainguard Futur 2500 system consists of the following basic elements:

CEC – central ERTMS control
This subsystem manages all functions included in ERTMS Levels 1 and 2 from a single control center.

Command and control of all RBCs on a line is the main function of the CEC. Temporary speed restrictions (TSRs) are set safely from the CEC and are then sent to the trains through the RBCs.

A CEC may work independently or be integrated into an operations control center (OCC). Any particular railway line may be split between several CECs, the transfer of command between them being another available functionality.

The CEC is designed as a modular architecture, in terms of both hardware and software, thus granting adaptability to future functional requirements.

LEC – local ERTMS control
The LEC is the subsystem allowing the operator a safe introduction of commands for the RBC, including temporary speed restrictions (TSR).

The operator has a mouse and keyboard interface to use the LEC. All commands are registered in the JRU and all relevant information is displayed to the operator.

MAS – maintenance assistance system
Each RBC has equipment allocated for data storage and maintenance assistance, including fault location and communications health monitoring.

The MAS is common to both Level 1 and Level 2 systems, providing real-time communication with maintenance staff by SMS.

ICE – interface control equipment
An ICE machine is used to interconnect the RBCs with the CEC through the real-time operating network. This provides total isolation for the private signaling network to which the RBCs are connected.

A hot stand-by configuration is used to guarantee total communication availability.
Trainguard Futur 2500 includes a powerful tool for tests and simulations in the lab. This tool allows data validation for both Level 1 and Level 2. Tests in the field are then limited to correspondence tests between the data and the actual hardware.

Tests with this tool may be automated, thus saving engineering hours in the lab and testing times in the field. The system also proposes alternative solutions to the initial settings, thus enhancing final performance of the system and aiding exploitation management of the line.

The simulator is also capable of emulating several types of rolling stock with the correspondent dynamical behaviors. Application data of the ERTMS equipment may be therefore better adjusted.
The information in this document contains general descriptions of the technical options available. The required features should therefore be specified in each individual case at the time of closing the contract. For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action and integrate each component into a holistic, state-of-the-art security concept. Third-party products that may be in use should also be considered.
Trainguard® is the Siemens solution for a 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 for ETCS Level 1 and Level 2 operations with its Trainguard 100 and Trainguard 200 products.

Trainguard 200 RBC (Radio Block center) transmits all the information required for a safe run within a particular stretch of track by radio from the interlocking to vehicles. This information is indicated on the cab display. For purposes of transmission, the digital Global System for Mobile Communications – Railways (GSM-R) is used. For position finding, Eurobalises are used as reference points.

Trainguard 200 RBC supports the parallel connection of two mobile switching centers (MSC) to the RBC. If one connection fails, operation can be maintained without interruption via the second MSC.

Benefits of Trainguard 200 RBC

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<tr>
<th>Benefits</th>
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<tbody>
<tr>
<td>High-availability, fail-safe computer system</td>
</tr>
<tr>
<td>Compact design with a proven platform</td>
</tr>
<tr>
<td>Reduction of the scope of configuration and preventive maintenance work when used in Simis interlockings</td>
</tr>
<tr>
<td>Optimal integration of relay interlockings or other manufacturers’ interlockings</td>
</tr>
<tr>
<td>Control of ETCS Level 1 balises</td>
</tr>
<tr>
<td>Modular extension</td>
</tr>
<tr>
<td>Updatable to Baseline 3</td>
</tr>
<tr>
<td>Low energy consumption</td>
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<tr>
<td>For use in a wide temperature range; less air-conditioning required</td>
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</tbody>
</table>
Mode of operation
The ETCS trains moving in the line are controlled by Trainguard 200 RBC locate themselves independently and cyclically transmit their positions to Trainguard 200 RBC. Trainguard 200 RBC continuously receives the current process image from the connected interlockings and, via radio, sends the movement authority to the vehicle.

Range of applications
Trainguard 200 RBC can be integrated into existing infrastructure without any complex adaptation since interlockings are connected via standard interfaces.

This means that different interlocking types are supported. In the migration phase, Trainguard 200 RBC offers mixed operation in combination with other ETCS levels.

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 approach also enables temporary speed restriction sections 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 Trainguard 200 RBC to communicate with other Trainguard 200 RBCs or other manufacturers’ RBCs.

Optimal integration into existing Simis interlockings
Trainguard 200 RBC is based on the proven Simis® platform and can be easily integrated into existing Simis interlockings. By using the same hardware platform, benefits result for preventive and corrective maintenance, e.g. due to the fewer spare parts stocked, reducing the lifecycle costs.

Both systems use the same diagnostic system, thus reducing the complexity of corrective maintenance. Due to the joint configuration of both the interlocking and Trainguard 200 RBC, optimum project durations are achieved.

Integration into relay interlockings and other manufacturers’ interlockings
The use of standardized interfaces means that Trainguard 200 RBC can be connected to other manufacturers’ interlockings.

Furthermore, relay interlockings can communicate with Trainguard 200 RBC via interface computers.

Operator console for Trainguard 200 RBC
Speed restriction sections, for example, are entered via 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
Trainguard 200 RBC supports the phase for migrating from national train protection systems to ETCS. Migration can involve mixed operation with the relevant national systems or different ETCS levels.

CENELEC and safety
Trainguard 200 RBC complies with the CENELEC standards and meets safety integrity level SIL 4.

Trainguard 200 RBC works on the basis of the well-known, reliable Simis principle and features a high level of availability.

Compact design
Trainguard 200 RBC has a compact, modular design. Depending on the number of vehicles to be monitored or connected interlockings, Trainguard 200 RBC can be modularly extended.

Trainguard 200 RBC can also assume the tasks of a central LEU and control ETCS Level 1 balises.

Ready for Baseline 3
The UNISIG functionality of Trainguard 200 RBC corresponds to SRS 2.3.0d. The future Baseline 3 has been taken into account in the design of Trainguard 200 RBC. Hence, a software update to Baseline 3 is a straightforward issue.

Low energy consumption
Trainguard 200 RBC has a power consumption of less than 600 W. Since it does not need lineside signals, considerable energy is also saved. This means that Trainguard 200 RBC makes a noticeable contribution to environmentally friendly railway operations.

Technical data

<table>
<thead>
<tr>
<th>Metric</th>
<th>Details</th>
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</thead>
<tbody>
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<tr>
<td>Power consumption</td>
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<tr>
<td>Number of interlockings per RBC</td>
<td>8 in standard practice, optionally extendable</td>
</tr>
<tr>
<td>Number of interfaces to adjacent RBC</td>
<td>4</td>
</tr>
<tr>
<td>in line with Subset 039</td>
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</table>
Trainguard® is a registered trademark of Siemens AG.

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The European Train Control System (ETCS) is the train control system of the future. During the next few years, it will replace the national systems in Europe. Thanks to its standardized technology, it will enable rail vehicles to be used beyond network boundaries. ETCS on-board equipment produced by different manufacturers functions with the ETCS trackside equipment of other manufacturers in different countries on an interoperable basis. Their control and display and their system functions are identical for train drivers in any country.

Siemens has been heavily involved in the technical standardization of ETCS from the very beginning. Siemens has contributed this ETCS competence with more than 70 years of experience in the field of train control to development of the Trainguard® 100 and Trainguard 200 interoperable on-board equipment in line with TSI (technical specification for interoperability).

The use of ETCS reduces the number of train control systems required onboard vehicles in cross-border traffic. This involves a major cost-cutting factor for rolling stock operators. Special significance is then attached to the question about how well ETCS technology can be integrated into the relevant tractive unit.

ETCS has also become a worldwide standard for modern train control. Siemens has implemented many projects worldwide.

Benefits

- Compact design (19” mounting frame)
- One multi-system antenna for all balise-based systems
- Bi-standard Zub 262ct and PZB
- Baseline 2 and Baseline 3 on the same hardware – for protection of your investment
- Open communication architecture (Ethernet, USB, GSM, MVB, PROFINET, PROFIBUS)
- Optimized maintenance and diagnostic concepts for low life-cycle costs
- Optional with ATO functions
- Supports GSM-R and TETRA radio
- Optimal for retrofitting due to its small size and standardized interfaces
Trainguard 100 and 200 on-board equipment comprises:

European Vital Computer (EVC)
- ETCS Level 1 functionality (Trainguard 100)
- ETCS Level 1 and Level 2 functionality (Trainguard 200)
- ETCS Version Baseline 2 or Baseline 3, NoBo-certified including MR1 and L1/LS
- Tried-and-tested Simis® computer platform for safety-critical functions
- CompactPCI® PC board for diagnostic, communication and additional functions
- Integrated tool chain for maintenance and diagnostics
- Fail-safe and reliable distance and speed measurement
- Flexible integration into any train operations control system

Balise channel and antenna
- Integrated BTM for a compact design
- External BTM for extended functions:
  - KER interface for operation in Finland, Sweden, Norway and France
  - 19” design also for installation in a cabinet
  - IP54 package for flexible installation in the vehicle
- Multi-system antenna for all balise systems: ETCS (balise and loop), KER systems (France, Scandinavia), Zub, SCMT, TBL1+
- Small and light-weight balise antenna

Driver-machine interface (DMI)
- ETCS cab signaling and operator control
- Operator control of national systems
- Adaptable to specific customer requirements
- DMI also available as double display unit

Juridical Recorder Unit (JRU)
- Reliable recording of train running data, also of national systems

Efficient, compact design
- Compact integrated ETCS on-board equipment
- On-board computer with EVC, balise channel, input / output interfaces, communication and diagnostic unit and GSM-R mobile radio terminals in a six unit high 19” design (483 x 264 x 235 mm), power consumption < 200 W
Integration of Class B systems
- Integration of Class B systems as a bi-standard approach
- Reception of balise information via a multi-system antenna for all balise-based train control systems: ETCS balise and loop, KER systems (France, Scandinavia), Zub, SCMT, TBL1+ 
- Pre-integration of all European train control systems
  - Trainguard Basic Indusi (PZB) as a bi-standard including TLH4 transition
  - LZB 80E and LZB80/16 including transition according to TLH4 specification
  - Zub 262ct and Zub 262ce as a bi-standard
  - TBL1+ including Memor
  - STM DK, ZUB 123
  - SHP
  - ASFA
  - EVM120, LS90 (MIREL)
  - ATC-2, JKV
  - ATB
  - TPWS / AWS
  - SCMT
  - KVB*
  - TVM*
  - CONVEL*

*) planned

Future-oriented and open technology
- Hardware platform with sufficient reserves for future requirements
- Optimized maintenance and diagnostic concepts for low life-cycle costs
- Open system architecture with future-proof communication interfaces (Ethernet, USB, GSM, MVB, PROFINET, PROFIBUS)
- Tool chain flexibly adjustable and integratable into existing maintenance systems
- Optional integration of ATO functions for energy-optimized and / or automatic train operation

Extensive operating experience
- More than 50 million kilometers of operation
- Commercial operation since 2004
- Highly reliable operation on high-speed lines in Spain, Switzerland, China and further countries as for example in Austria, Belgium and Saudi Arabia
- Even highest availability requirements are met

Standardized Interface
- Easy connection over the standardized connection box
- Completely pretested entity – avoidance of installation errors in the vehicle
- Delivery of complete assortments such as cables, connectors and mounting materials
- Easy integration into cabinet
- Support of all common voltage versions
The information in this document contains general descriptions of the technical options available. The required features should therefore be specified in each individual case at the time of closing the contract. For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action and integrate each component into a holistic, state-of-the-art security concept. Third-party products that may be in use should also be considered.
In competition between rail and road, Europe is now moving towards a high-capacity, multinational railway system. This entails cost-effective trainborne equipment which complies with the new requirements of a changing market. A new requirement particularly involves connecting the world of classic automatic train protection technology, such as Indusi (inductive intermittent system) for example, with that of the new standard, the European Train Control System (ETCS).

With the introduction of Trainguard® Basic Indusi, Siemens is presenting a new generation of the Indusi/PZB 90 (PZB – intermittent automatic train control) trainborne automatic train protection system which meets the new European conditions.

**Benefits**

- Modular upgradability to ETCS with investment security
- Complete PZB 90 functionality
- User-friendly control and display by means of a simple or multifunction display unit with train data input on the driver's console
- Simple installation due to its compact size (six units high 19" design)
- Standardized terminal box with a connector interface
- Maintenance-free
- Diagnostic system which can be integrated into the central vehicle diagnostic facility
- MVB (multifunction vehicle bus) architecture, resulting in
  - less cabling work
  - possibility of connection to the train operations control system
  - interface to the EVC for the STM functionality
- Short multiple-unit trains needing only one set of trainborne equipment
With a view to the future, the functionality of the national Indusi/PZB 90 automatic train protection system is being implemented on the basis of the following trainborne ETCS components:
- on-board computer based on the European Vital Computer (EVC)
- Driver-Machine Interface (DMI)
- data recorder, upgradable to the Juridical Recorder Unit (JRU)

Communication from track to train is by means of classic Indusi magnets. ETCS-compatible odometer pulse generators are used for distance and speed measurement. The PZB operator actions “Release”, “Override” and “Acknowledge” are performed by means of the classic PZB operating buttons.

**Trainguard Basic Indusi – three key features in one unit**
- *Trainguard*
  Modern platform for mass transit and mainline train control systems from Siemens
- *Basic*
  Modular basis for ETCS
- *Indusi*
  Indusi/PZB 90 functionality using classic Indusi magnets

**ETCS pre-equipping solution**
Due to its compact, modular design, Trainguard Basic Indusi is the optimum solution for modern tractive units which are to be pre-equipped with Indusi/PZB 90 as a first step and upgraded to ETCS during their service life. Trainguard Basic Indusi is the solution for migration from Indusi to ETCS with investment security.

Indusi, the inductive automatic train protection system, which is one of the most frequently used systems in Europe, will probably continue to be used for the next 20 years before being replaced by ETCS throughout Europe. In the mid-term, the focus in Germany is initially on equipping rail corridors with ETCS. Hence, when equipping new Indusi-fitted rolling stock, vehicle manufacturers are urgently recommended to check that cost-effective upgrading to ETCS is ensured already at this stage.

**Trainguard Basic Indusi as an ETCS pre-equipping solution**
It is precisely here that Trainguard Basic comes into action. Thanks to its modular structure and the fact that it is part of the Trainguard product family, it is optimally prepared for ETCS. The level of pre-equipping can be determined by the classic or standard variants. While the standard variant uses ETCS components consistently, the classic variant represents a low-cost solution nevertheless permitting easy upgrading at a later point in time.

**Trainguard Basic Indusi Classic**
- Display by means of classic indicator lamp units and train data input device on the driver’s console
- Low-cost data recorder for PZB data

**Trainguard Basic Indusi Standard**
- Display by means of DMI, upgradable to ETCS
- Data recorder, upgradable to ETCS

**Migration through optimized upgrade concept**
Trainguard Basic is designed so that, by expanding the hardware (boards and peripheral elements) and updating the software, it can be converted into an ETCS trainborne equipment with integrated Indusi functionality.

The following upgrade levels are distinguished:
- Trainguard Basic Indusi (PZB 90)
- Trainguard Basic Indusi Semi-STM PZB
- Trainguard 100 Bi (ETCS Level 1 with integrated Indusi/PZB 90)
- Trainguard 200 Bi (ETCS Level 2 with integrated Indusi/PZB 90)
Trainguard Basic Indusi Semi-STM
By a software update, Trainguard Basic Indusi Standard is expanded to Semi-STM PZB which includes the transitions in accordance with German Railways’ ETCS System Requirement Specifications 4. All functions required in Germany for a running transition between PZB and ETCS are thus offered.

Trainguard 100 Bi
Trainguard Basic is expanded to Trainguard 100 Bi by using Eurobalise receiver boards and the Eurobalise antenna. By connecting additional odometry detectors, position-finding is upgraded to the high-level requirements governing precision and availability.

The ETCS Level 1 functionality is added by a software update. Of course, the bistandard solution also performs all transitions in accordance with German Railways’ ETCS System Requirement Specifications 4.

Trainguard 200 Bi
Trainguard 200 Bi differs from Trainguard 100 Bi in that the hardware for GSM-R data communication is integrated (boards and GSM-R antenna) and a software update causes all components to achieve ETCS Level 2 compatibility in addition.

Trainguard 200 Bi + STM
In standard practice, national signaling and safety systems are connected in ETCS via an STM (Specific Transmission Module). Trainguard 200 Bi is made STM-capable by adding the PROFIBUS STM interface.

<table>
<thead>
<tr>
<th>Main features</th>
<th>Trainguard Basic Indusi Classic</th>
<th>Trainguard Basic Indusi Standard</th>
<th>Trainguard Basic Indusi Semi-STM</th>
<th>Trainguard 100 Bi</th>
<th>Trainguard 200 Bi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indusi / PZB 90 functionality</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Indusi magnets / receiving unit</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>TCC-based central unit</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>MV8</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Odometer pulse generators</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>JRU-based data storage</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>DMI-based control and display</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>PZB STM functionality</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Balise antennas / receiving unit</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>ETCS Level 1 functionality</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>GSM-R antennas / receiving units</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>ETCS Level 2 functionality</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
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Trainguard Eurobalise S21 and S22
For track-to-train communications
Ensuring mobility is one of the big challenges in our society. To ensure our mobility in future, we need networked transportation and information systems. And we will only meet these mobility requirements through efficient coordination and perfect meshing of all modes of transportation. This is why Siemens – with its “Complete mobility” approach – is offering integrated transportation and logistics solutions for safe, cost-effective and environmentally friendly passenger and freight services.

Trainguard is the Siemens solution for the standardized European ETCS automatic train control system which is gradually replacing the different national train protection and train control systems. Standardized interfaces between track and train ensure interoperability across national borders. Siemens in its role as one of the ETCS pioneers offers Trainguard 100 and Trainguard 200 as advanced ETCS systems and components. One important component of the Trainguard product family are the Trainguard Eurobalises S21 and S22 which have already proven themselves in more than 10,000 applications.

Range of applications
Siemens Eurobalises are used to transmit data for locating and train control purposes to the vehicle at any point along the track. They are used in mainline and mass transit applications all over the world. Due to their small dimensions and weight, the Trainguard Eurobalises S21 and S22 are easy to install. They are weather-proof and maintenance-free. Existing outdoor equipment can be easily extended by implementing Trainguard Eurobalises.

Interoperability
The Eurobalises made by Siemens allow trouble-free interoperation with components from various manufacturers. They have been developed, tested and certified on the basis of the European Union’s TSI (Technical Specification for Interoperability).

Optimal operating conditions
The Trainguard Eurobalise S21 is a reduced-size balise with a height of only 4 cm. The Trainguard Eurobalise S22 is also a reduced-size balise with a height of 5.5 cm. It meets all requirements of a Class A balise. Thanks to proven foam embedding technology and compact design, in-track application presents no problems.

The Trainguard Eurobalises S21 and S22 are available in two variants each which can be applied universally. Each time a train passes, the fixed-data balise containing a permanently stored telegram transmits the same data to the balise antenna aboard the vehicle. The other Eurobalise S21 variant, the S21 transparent-data balise, transmits variable data according to the signal aspect. This balise variant is controlled by a lineside electronic unit (LEU) which is connected via a permanently attached cable without plug.

Benefits of the Eurobalise S21

<table>
<thead>
<tr>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>cost-effective</td>
</tr>
<tr>
<td>compact</td>
</tr>
<tr>
<td>highly reliable data transmission up to 500 km/h</td>
</tr>
<tr>
<td>contactless programming</td>
</tr>
</tbody>
</table>
Principle of operation
The Trainguard Eurobalises use a standardized transmission protocol. The transmission method is based on inductive coupling and data transmission with frequency shift keying and has been used successfully for years by Siemens for train control purposes.

When a train passes, the balise/loop antenna aboard the vehicle activates the Eurobalise by emitting a low-power signal. The Eurobalise uses this power to transmit its information to the balise/loop antenna. In this course, it transmits the data required for train control to the vehicle intermittently. This information is used by the EVC (on-board computer) for train supervision purposes and serves as a basis for the data displayed on the DMI (driver-machine interface) in the driver’s cab. Depending on the application, fixed-data or transparent-data balises of type S21 or S22 are deployed.

Programming
The Eurobalises are programmed contactlessly across an air gap by means of a handheld computer and a test and programming unit. Using this unit, line operators can read out and change the balise programming conveniently at any time.

The Trainguard Euroloop S21, a member of the Trainguard 100 family, is a continuous option complementing the Trainguard Eurobalise S21 which permits semi-continuous data transfer to the vehicle. In both cases, the same balise/loop antenna aboard the train is used.

The Trainguard Euroloop S21, an up to 1,000 meter-long leaky feeder, is laid at the base of the rail web between the distant and main signals. The advantage of the data transfer is that the latest information is sent to the vehicle continuously (infill), not which merely via a defined point. With minimal modification to the vehicles, the Trainguard Euroloop S21 allows higher train speeds in the relevant sections with a continuing high level of safety.
S21 and S22 fixed-data balise
As a fixed-data balise, the Eurobalise sends a line data telegram to the vehicle. This telegram contains operating information and provides details of the position of the vehicle on the line (reference point). In the fixed-data balise, the line data telegram is stored permanently. This data can be altered by the user at any time, if required.

S21 and S22 transparent-data balise
All 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 appropriate telegram is passed on to the transparent-data balise which in turn transmits it to the vehicle.
Trainguard Eurobalise S21 and S22

Technical data

<table>
<thead>
<tr>
<th>Specification</th>
<th>S21 fixed-data balise</th>
<th>S21 transparent-data balise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed range</td>
<td>0 to 500 kph (310 mph)</td>
<td></td>
</tr>
<tr>
<td>Power transmission frequency</td>
<td>27.095 MHz</td>
<td></td>
</tr>
<tr>
<td>Data transmission frequency</td>
<td>4.234 MHz</td>
<td></td>
</tr>
<tr>
<td>Data transmission rate</td>
<td>565 kbit/s</td>
<td></td>
</tr>
<tr>
<td>Type of modulation</td>
<td>Frequency shift keying (FSK)</td>
<td></td>
</tr>
<tr>
<td>Telegram length</td>
<td>341 bits or 1,023 bits (selectable)</td>
<td></td>
</tr>
<tr>
<td>Usable data length</td>
<td>210 bits or 830 bits (selectable)</td>
<td></td>
</tr>
<tr>
<td>Programming</td>
<td>contactless via an air gap by means of a test and programming unit</td>
<td></td>
</tr>
<tr>
<td>Operating distance</td>
<td>up to 5,000 m</td>
<td></td>
</tr>
<tr>
<td>LEU S21–Eurobalise</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(MTBF as per SN 29500)</td>
<td>S21 fixed-data balise &gt; 800 years</td>
<td>S21 transparent-data balise &gt; 160 years</td>
</tr>
<tr>
<td>Dimensions (L x W x H)</td>
<td>S21 balise 480 x 260 x 40 mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S22 balise 480 x 260 x 55 mm</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>4 kg without cable (Trainguard fixed-data balise S22), 10 kg with 9.6 m cable (Trainguard transparent-data balise S22)</td>
<td></td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>–40 °C to +55 °C (without direct exposure to the sun)</td>
<td></td>
</tr>
<tr>
<td>IP rating</td>
<td>IP67</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>Reduced size balise</td>
<td></td>
</tr>
<tr>
<td>Trainguard Eurobalise S21 Debris Class</td>
<td>Installation condition according to Class B</td>
<td></td>
</tr>
<tr>
<td>Trainguard Eurobalise S22 Debris Class</td>
<td>Installation condition according to Class A</td>
<td></td>
</tr>
<tr>
<td>Conformity</td>
<td>UNISIG SUBSET-036 FFFIS for Eurobalise</td>
<td></td>
</tr>
<tr>
<td></td>
<td>UNISIG SUBSET-085 Test Specification for Eurobalise FFFIS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>UNISIG SUBSET-091 Safety Requirements for the Technical Interoperability of ETCS at Levels 1 &amp; 2</td>
<td></td>
</tr>
</tbody>
</table>
Trainguard® is a registered trademark of Siemens AG.

The information in this document contains general descriptions of the technical options available. The required features should therefore be specified in each individual case at the time of closing the contract. For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action and integrate each component into a holistic, state-of-the-art security concept. Third-party products that may be in use should also be considered.
With the Trainguard Eurobalise S21 and S21, infra-structure data in preformatted telegrams (including position reference, temporary speed restriction sections, gradient profiles, etc.) or signal aspects, in combination with the Trainguard Eurobalise S21 lineside electronic unit, are transmitted to the train wherever required along the track.

More than 150,000 Trainguard Eurobalise S21 and S21 systems are used in mainline railways, mass transit and light rail transport. The same balise types are used for different applications. The system has a modular structure and is equipped with standardized interfaces in accordance with UNISIG. A Trainguard Eurobalise is compatible with existing ATP systems (KVB, EBICAB and RSDD).

When a train passes, the vehicle antenna activates the Trainguard Eurobalise S21 by emitting a low-power signal. The balise uses this power to transmit its information. It is received by an interrogator onboard the train and transmitted to the on-board computer via the data bus.

Benefits

Compliance with all relevant European standards
- UNISIG SUBSET-036 V2.4.1
- UNISIG SUBSET-085 V2.2.2
- UNISIG SUBSET-091 V2.5.0
- UNISIG SUBSET-036 V2.4.1 and V3.0.0
- UNISIG SUBSET-085 V2.2.2 and V3.0.0
- UNISIG SUBSET-091 V2.5.0 and V3.2.0

Reuse of existing outdoor equipment

Easy extension thanks to a modular structure

High-reliability data transmission

Programming across an air gap

Maintenance-free

High level of availability

Low purchase and life-cycle costs
The Trainguard Eurobalise S21 and S22 from Siemens are available in two variants each:

- As a fixed-data balise, it transmits track information in a fixed, pre-programmed telegram to the train. This telegram provides information on the position of the train on the line. The telegram data can be changed at any time.

- Transparent-data balises are connected via point-to-point cables to a Trainguard LEU S21 lineside electronic unit installed at the trackside. All the signal codes corresponding to the possible signal aspects and their associated telegrams are stored in this Trainguard LEU S21. In accordance with the signal aspect, the appropriate telegram is passed on to the relevant transparent-data balise and transmitted from there to the train. When doing so, the transparent-data balise checks the quality of the data signals received from the Trainguard LEU S21 and, in the event of an error, transmits a default telegram stored in the non-volatile memory of the balise.

According to Subset 036
- a Trainguard Eurobalise S21 is a Class B balise and
- a Trainguard Eurobalise S22 is a Class A balise

**References (examples)**
Australia, Austria, Belgium, China, Germany, Greece, Italy, Luxembourg, Mexico, Netherlands, New Zealand, Poland, Saudi Arabia, Spain, Sweden, Switzerland, Tunisia, Turkey, etc.

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**Technical data**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed range</td>
<td>0 to 500 km/h</td>
</tr>
<tr>
<td>Power transmission frequency</td>
<td>27.095 MHz</td>
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<tr>
<td>Data transmission frequency</td>
<td>4.234 MHz</td>
</tr>
<tr>
<td>Data transmission rate</td>
<td>565 kbits/s</td>
</tr>
<tr>
<td>Type of modulation</td>
<td>frequency shift keying</td>
</tr>
<tr>
<td>Overall telegram length</td>
<td>1,023 bits or 341 bits (selectable)</td>
</tr>
<tr>
<td>Usable data length</td>
<td>830 bits or 210 bits (selectable)</td>
</tr>
<tr>
<td>Programming of balise</td>
<td>contactless across an air gap</td>
</tr>
<tr>
<td>Distance LEU–balise</td>
<td>max. 5,000 m</td>
</tr>
</tbody>
</table>

**Type**
- Trainguard Eurobalise S21 debris class
- Trainguard Eurobalise S22 debris class

**Reduced size balise**
- Installation conditions according to Class B
- Installation conditions according to Class A

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Trainguard® is a registered trademark of Siemens AG.
Trainguard Euroloop S21 F
For optimum performance with ETCS Level 1
Trainguard Euroloop S21 F – increased safety and performance for ETCS Level 1

Ensuring mobility is one of the big challenges in our society. To ensure our mobility in future, we need networked transportation and information systems. And we will only meet these mobility requirements through efficient coordination and perfect meshing of all modes of transportation. This is why Siemens – with its “Complete mobility” approach – is offering integrated transportation and logistics solutions for safe, cost-effective and environment-friendly passenger and freight services.

Trainguard is the Siemens solution for the standardized European ETCS automatic train control system which is gradually replacing the different national train protection and train control systems. Standardized interfaces between track and train ensure interoperability across national borders.

Siemens in its role as one of the ETCS pioneers offers Trainguard 100 and Trainguard 200 as advanced ETCS systems and components. For lines with ETCS Level 1, the Trainguard Euroloop S21, as a supplement to the Trainguard Eurobalise S21, offers the option of changing to a less restrictive signal aspect (infill), thus enabling shorter headways.

The Trainguard Euroloop S21 is the continuous option complementing intermittent transmission by Eurobalises. Semi-continuous communication between train and track decisively upgrades ETCS Level 1 lines with a surprisingly cost-effective solution.

Benefits and features

**Performance**

Thanks to semi-continuous transmission, a movement authority can be transmitted directly and even to a stationary vehicle. In this way, even with ETCS Level 1, cab signaling is updated continuously and line efficiency is increased notably.

**Safety**

No release speed is required for the departure hindrance function. This ensures safety when no overlaps are available.

**No additional effort for data configuration**

Thanks to its identical telegram structure, the Trainguard LEU S21 is capable of controlling both Eurobalises and Euroloops. Additional data configuration is thus not required. The on-board antenna receives telegrams from the Eurobalise and Euroloop in the same way.

**Tried-and tested technology**

The system has been in operation since 1999. Several hundred units have already been installed.
Robust design
The cable is laid at the base of the rail web and so protected against external conditions.

High level of availability
Its high level of availability has already been demonstrated in service.

Cost-effectiveness
Simple configuration, easy installation of the cable at the base of the rail and maintenance-free operation are major advantages as compared to other infill solutions.

Principle of operation
The Trainguard Euroloop S21 F extends the contact range of an Eurobalise to up to 800 m. Telegram structure and coding are identical.

A coaxial leaky feeder laid in the inner or outer rail web base transmits the ETCS telegram to the train. The information programmed in a balise group announces a Euroloop transmission to the on-board computer.

The ETCS telegrams of the lineside electronic unit (LEU) are modulated in the Euroloop modem (ELM S21 F) onto the carrier signal in accordance with the spread spectrum code (loop key).

This spreads out the transmit signal over a frequency range of 9 to 18 MHz. Thanks to the spread spectrum coding, the signal is optimally protected against interference.

The loop cable termination prevents undesirable reflections at the end of the cable. The train-mounted balise/loop antenna receives the Euroloop signal and passes it to the loop receiver.

Programming and diagnostics
Programming is not required as the telegram data stored in the LEU is transmitted transparently. Only the configured spread spectrum code needs to be set at the loop-key module. The modem status and possible cable connection faults are indicated via LEDs on the front panel. A relay contact is used to indicate a group alarm.

Installation
Contrary to what the term “loop” suggests, the leaky feeder is a single cable fixed at the base of the rail by means of proven clamps. Like a wheel detector, the robust cable termination is attached to the rail web using two bolts. The compact Euroloop modem is installed either next to the LEU in a signal cabinet or in a trackside connection box. A four-wire cable is used to supply power and telegram data to the modem.

The transmit signal is routed via a flexible coaxial cable (jumper cable) to the leaky feeder. All connections are of the plug-in type and protected against damage and environmental conditions by flexible tubing.
**Trainguard Euroloop S21 F**

### Technical data

**Trackside equipment**

*LKA S21 (loop cable termination)*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input resistance</td>
<td>47 Ω ±15 % (up to 50 MHz DC)</td>
</tr>
<tr>
<td>Input power</td>
<td>max. 25 W (mounted on rail)</td>
</tr>
<tr>
<td>Insulation</td>
<td>2 kV AC (50 Hz, 60 s)</td>
</tr>
<tr>
<td>Reliability</td>
<td>&gt; 25 years (MTBF as per SN 29500, 60 °)</td>
</tr>
<tr>
<td>Dimensions (L x W x H)</td>
<td>310 x 40 x 40 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>3.6 kg</td>
</tr>
<tr>
<td>IP rating</td>
<td>IP67</td>
</tr>
</tbody>
</table>

**Leaky feeder**

<table>
<thead>
<tr>
<th>Typ</th>
<th>FILORADIO radiating coaxial cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal conductor diameter</td>
<td>4.05 mm</td>
</tr>
<tr>
<td>Outer diameter</td>
<td>15.4 mm</td>
</tr>
<tr>
<td>Impedance</td>
<td>50 ±2 Q</td>
</tr>
<tr>
<td>Attenuation</td>
<td>10 MHz 1.3 dB /100 m</td>
</tr>
<tr>
<td></td>
<td>30 MHz 2.8 dB /100 m</td>
</tr>
<tr>
<td></td>
<td>80 MHz 6.3 dB /100 m</td>
</tr>
<tr>
<td></td>
<td>160 MHz 11.3 dB /100 m</td>
</tr>
<tr>
<td>Resistance of internal conductor</td>
<td>2.1 Ω/km</td>
</tr>
<tr>
<td>Resistance of external conductor</td>
<td>7.1 Ω/km</td>
</tr>
<tr>
<td>Capacitance</td>
<td>81 pF/m</td>
</tr>
<tr>
<td>Weight</td>
<td>0.19 kg/m RoHS-compliant in line with IEC 60754-1</td>
</tr>
</tbody>
</table>
### Technical data

#### Trainguard Euroloop Subsystem

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data rate</td>
<td>9,567 bits/s</td>
</tr>
<tr>
<td>Transmit frequency</td>
<td>9 to 18 MHz</td>
</tr>
<tr>
<td>Field strength</td>
<td>at center of track 32 to 67 dBµA/m</td>
</tr>
<tr>
<td>Spread spectrum code</td>
<td>472 bits (15 key codes)</td>
</tr>
<tr>
<td>Modem activation</td>
<td>27.095 MHz (balise / loop antenna)</td>
</tr>
<tr>
<td>ETCS specifications</td>
<td>UNISIG SUBSET-044 FFFIS for Euroloop</td>
</tr>
<tr>
<td>Distance LEU S21–ELM S21 F</td>
<td>max. 2500 m (cable impedance: 120 Ω)</td>
</tr>
</tbody>
</table>

#### Trackside equipment

<table>
<thead>
<tr>
<th>ELM S21 F (Euroloop modem)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>85 to 264 V_m (50 / 60 Hz)</td>
</tr>
<tr>
<td></td>
<td>150 to 264 V_m (50 / 16.7 Hz)</td>
</tr>
<tr>
<td></td>
<td>120 to 340 V DC</td>
</tr>
<tr>
<td>Input power</td>
<td>&lt; 50 W (stand-by: &lt; 10 W)</td>
</tr>
<tr>
<td>HF output power</td>
<td>+44 dBm (26 W) at 50 Ω</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>−40 °C to +70 °C</td>
</tr>
<tr>
<td>Reliability</td>
<td>&gt; 48 years</td>
</tr>
<tr>
<td></td>
<td>(MTBF as per SN 29500, 40 °C)</td>
</tr>
<tr>
<td>Dimensions (L x W x H)</td>
<td>220 x 226 x 133 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>3 kg</td>
</tr>
<tr>
<td>IP rating</td>
<td>IP20</td>
</tr>
</tbody>
</table>
Trainguard® is a registered trademark of Siemens AG.

The information in this document contains general descriptions of the technical options available. The required features should therefore be specified in each individual case at the time of closing the contract. For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action and integrate each component into a holistic, state-of-the-art security concept. Third-party products that may be in use should also be considered.
The Trainguard Euroloop S21 F is a continuous (up to 800 m) supplement to the Trainguard Eurobalise S21. It is used for automatic changeover to a less restrictive signal aspect or departure hindrance at a stop signal.

A coaxial leaky cable laid in the inner or outer base of the rail transmits the ETCS telegram to the train. Information programmed in a balise group announces a Euroloop transmission to the on-board computer. The ETCS telegrams of the lineside electronic unit (LEU) are modulated onto the carrier signal in accordance with the selected spread spectrum code (loop key) in the Euroloop modem (ELM S21 F).

Semi-continuous transmission enables a movement authority to be directly transmitted to a vehicle (also to stationary vehicles). In this way, continuous cab signaling is implemented at ETCS Level 1.

Benefits

<p>| Compliance with all relevant European standards |
| Highly reliable data transmission |
| Higher performance thanks to optimal usage of existing infrastructure |
| Energy savings thanks to efficient train control |
| No maintenance required |
| High levels of safety and availability |
| Low purchase and life-cycle costs |</p>
<table>
<thead>
<tr>
<th>Technical data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ELM S21 F (Euroloop modem)</strong></td>
<td></td>
</tr>
<tr>
<td>Power supply</td>
<td>85 V&lt;sub&gt;min&lt;/sub&gt; to 264 V&lt;sub&gt;max&lt;/sub&gt; AC (50/60 Hz) 150 V&lt;sub&gt;min&lt;/sub&gt; to 264 V&lt;sub&gt;max&lt;/sub&gt; AC (16.7 Hz) 120 V to 340 V DC</td>
</tr>
<tr>
<td>Input power</td>
<td>&lt; 50 W (standby: &lt; 10 W)</td>
</tr>
<tr>
<td>HF output power</td>
<td>+44 dBm (26 W) at 50 Ω</td>
</tr>
<tr>
<td>Ambient temperature range</td>
<td>−40 °C to +70 °C</td>
</tr>
<tr>
<td>Reliability (MTBF as per SN 29500)</td>
<td>48 years (40 °C)</td>
</tr>
<tr>
<td>Dimensions (l x w x h)</td>
<td>220 x 226 x 133 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>3 kg</td>
</tr>
<tr>
<td><strong>IP rating</strong></td>
<td>IP20</td>
</tr>
<tr>
<td><strong>Leaky cable</strong></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>FILORADIO radiating coaxial cable</td>
</tr>
<tr>
<td>Internal conductor diameter</td>
<td>4.05 mm</td>
</tr>
<tr>
<td>Outer diameter</td>
<td>15.4 mm</td>
</tr>
<tr>
<td>Impedance</td>
<td>50 ±2 Ω</td>
</tr>
<tr>
<td>Attenuation</td>
<td>10 MHz 1.3 dB /100 m 30 MHz 2.8 dB /100 m 80 MHz 6.3 dB /100 m 160 MHz 11.3 dB /100 m</td>
</tr>
<tr>
<td>Resistance of internal conductor</td>
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<tr>
<td>Resistance of external conductor</td>
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<tr>
<td>Weight</td>
<td>0.19 kg/m RoHS-compliant in line with IEC 60754-1</td>
</tr>
<tr>
<td><strong>Euroloop subsystem</strong></td>
<td></td>
</tr>
<tr>
<td>Data transmission rate</td>
<td>9.567 bits/s</td>
</tr>
<tr>
<td>Transmitting frequency</td>
<td>9 MHz to 18 MHz</td>
</tr>
<tr>
<td>Field strength</td>
<td>32 to 67 dBμA/m in center of track</td>
</tr>
<tr>
<td>Spread spectrum code</td>
<td>472 Bits (15 key codes)</td>
</tr>
<tr>
<td>Modem activation</td>
<td>27.095 MHz (balise/loop antenna)</td>
</tr>
<tr>
<td>ETCS specification</td>
<td>UNISIG SUBSET-044 FFFIS for Euroloop</td>
</tr>
<tr>
<td>Distance LEU S21–ELM S21 F</td>
<td>max. 2,500 m (cable impedance: 120 Ω)</td>
</tr>
<tr>
<td><strong>LKA S21 (loop cable termination)</strong></td>
<td></td>
</tr>
<tr>
<td>Input resistance</td>
<td>47 Ω ± 15 % (DC up to 50 MHz)</td>
</tr>
<tr>
<td>Input power</td>
<td>max. 25 W (rail-mounted)</td>
</tr>
<tr>
<td>Isolation</td>
<td>2 kV AC (50 Hz, 60 s)</td>
</tr>
<tr>
<td>Reliability (MTBF as per SN 29500)</td>
<td>25 years (60 °C)</td>
</tr>
<tr>
<td>Dimensions (l x w x h)</td>
<td>310 x 40 x 40 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>3.6 kg</td>
</tr>
<tr>
<td><strong>IP rating</strong></td>
<td>IP67</td>
</tr>
</tbody>
</table>

**Technical options**

- **Power supply**
  - 85 V<sub>min</sub> to 264 V<sub>max</sub> AC (50/60 Hz)
  - 150 V<sub>min</sub> to 264 V<sub>max</sub> AC (16.7 Hz)
  - 120 V to 340 V DC
- **Input power**
  - < 50 W (standby: < 10 W)
- **HF output power**
  - +44 dBm (26 W) at 50 Ω
- **Ambient temperature range**
  - −40 °C to +70 °C
- **Reliability (MTBF as per SN 29500)**
  - 48 years (40 °C)
- **Dimensions (l x w x h)**
  - 220 x 226 x 133 mm
- **Weight**
  - 3 kg
- **IP rating**
  - IP20

**Euroloop subsystem**

- **Data transmission rate**
  - 9.567 bits/s
- **Transmitting frequency**
  - 9 MHz to 18 MHz
- **Field strength**
  - 32 to 67 dBμA/m in center of track
- **Spread spectrum code**
  - 472 Bits (15 key codes)
- **Modem activation**
  - 27.095 MHz (balise/loop antenna)
- **ETCS specification**
  - UNISIG SUBSET-044 FFFIS for Euroloop
- **Distance LEU S21–ELM S21 F**
  - max. 2,500 m (cable impedance: 120 Ω)

**LKA S21 (loop cable termination)**

- **Input resistance**
  - 47 Ω ± 15 % (DC up to 50 MHz)
- **Input power**
  - max. 25 W (rail-mounted)
- **Isolation**
  - 2 kV AC (50 Hz, 60 s)
- **Reliability (MTBF as per SN 29500)**
  - 25 years (60 °C)
- **Dimensions (l x w x h)**
  - 310 x 40 x 40 mm
- **Weight**
  - 3.6 kg
- **IP rating**
  - IP67

**Notes**

- The information in this document contains general descriptions of the technical options available. The required features should therefore be specified in each individual case at the time of closing the contract. For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action and integrate each component into a holistic, state-of-the-art security concept. Third-party products that may be in use should also be considered.
Trainguard LEU S21
Central trackside equipment component
Ensuring mobility is one of the big challenges in our society. To ensure our mobility in future, we need networked transportation and information systems. And we will only meet these mobility requirements through efficient coordination and perfect meshing of all modes of transportation. This is why Siemens – with its “Complete mobility” approach – is offering integrated transportation and logistics solutions for safe, cost-effective and environment-friendly passenger and freight services.

**Trainguard LEU S21 – cross-border safety with ETCS Level 1**

Trainguard is the Siemens solution for the standardized European ETCS automatic train control system which is gradually replacing the different national train protection and train control systems.

The Trainguard LEU S21 (lineside electronic unit) is the link between the existing fixed trackside signals and the in-track ETCS components Trainguard Eurobalise S21 and Trainguard Euroloop S21 F. In more than 1,000 applications in various countries, the Trainguard LEU S21 has demonstrated its extreme reliability.

**Principle of operation**

A transmission point equipped for ETCS normally comprises a fixed-data balise and a variable-data balise. The telegrams are transmitted intermittently using Eurobalises, but continuous transmission by means of Euroloops is also possible at certain locations. The aspect shown by a signal is extracted by the Trainguard LEU S21, the associated telegram selected and a serial data stream transmitted continuously to the variable-data balise(s) or Euroloop modem via a standardized interface. When a vehicle equipped with ETCS passes, the ETCS telegram is sent and evaluated by the EVC (European vital computer). All the configuration data, signal codes and telegrams belonging to a signal are stored in the Trainguard LEU S21. When the LEU detects an invalid signal aspect, a fault telegram is output.

**Programming and diagnostics**

The core element for Trainguard LEU S21 programming and diagnostics is a handheld computer. The data created during configuration is transferred via the handheld computer and safely stored in the Trainguard LEU S21 memory. Moreover, the displays on the Trainguard LEU S21 as well as the handheld computer offer convenient support for diagnostics.

**Installation**

The entire wiring and all connectors for external connections are integrated into a mounting rack and accessible from the front. The Trainguard LEU S21 is generally accommodated in the signal cabinet of the signal being equipped. It is connected directly to the cable feeder from the interlocking to the signal or the lamp circuit.
Benefits and features of the Trainguard LEU S21

Compact design
Installation is possible in practically all off-the-shelf cabinets which are accessible from the front. This enables easy component replacement and guarantees low modification costs.

Safe current pick-off
A low-impedance transformer can be looped into existing signal circuits without affecting the control distance. Lamp tapping using a current transformer is in conformance with SIL 4.

Absence of interaction
Easily proven thanks to the properties of the isolating current transformer. The Trainguard LEU S21 has already been approved for various signaling systems.

Cascadability
A modular Trainguard LEU S21 with signal interface supplies the signal aspect to up to three simplified cascaded LEUs. Hence, a maximum of eight outputs is available for balises/loops.

Patented programming procedure
The patented programming procedure ensures data transmission between the handheld computer and the Trainguard LEU S21 in conformance with SIL 4.

Three-level diagnostic concept
General diagnostics without tools is possible at two levels:
• LEDs (operating state)
• 7-segment display (cause of fault)

Detailed diagnostics using a handheld computer allows data recording in the case of temporary faults.

High level of availability
The Trainguard LEU S21 disables outputs for Eurobalises/Euroloops in the event of faults and enables them as soon as the fault has been remedied. Monitoring functions ensure smooth operation, thus increasing availability of trackside equipment considerably and minimizing the number of maintenance staff deployed.

Maintenance-free operation
The Trainguard LEU S21 is maintenance-free – no periodic checking is required.

1 Trainguard LEU S21
2 S21 fixed-data balise
3 S21 variable-data balise
4 Trainguard Euroloop S21 F (optional)
5 Balise/loop antenna
6 Receive-and-forward unit
7 European vital computer (EVC, on-board computer)
8 DMI (driver-machine interface)
9 Odometer pulse generator
10 Radar
### Trainguard LEU S21

#### Technical data

**Current inputs**
- **Number of inputs**: up to 16 inputs configurable
- **Input range**: 30 mA to 4 A (15 to 440 Hz)
- **Flashing detectors**: up to four inputs configurable

**Voltage inputs**
- **Number of inputs**: up to eight inputs configurable
- **Input range**: AC 0 V<sub>min</sub> bis 181 V<sub>max</sub> (15 Hz bis 66 Hz); DC 0 bis 181 V
- **Flashing detectors**: 2 inputs configurable

**Power supply**
- **Input ranges**: AC 88 V<sub>min</sub> bis 264 V<sub>max</sub> (15 Hz bis 90 Hz); DC 34 V bis 177 V

**Telegram generator/outputs**
- **Outputs**: 2 S21 variable-data balises
  - 2 Trainguard Euroloops of type S21 F or combination
- **Extension**: up to eight outputs using cascaded Trainguard LEU S21
- **Interface signal ‘C’**: as per UNISIG SUBSET-036 FFFIS for Trainguard Eurobalise
- **Interface signal ‘CL’**: as per UNISIG SUBSET-044 FFFIS for Trainguard Euroloop
- **Number of telegrams**: 1,023 (2 x) telegrams per output
- **Telegram length**: 341 or 1,023 (2x) bits (selectable)
Trainguard LEU S21

**Technical data**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability</td>
<td>&gt; 31.7 years</td>
</tr>
<tr>
<td>(MTBF as per SN 29500)</td>
<td></td>
</tr>
<tr>
<td>Dimensions (L x W x H)</td>
<td>185 x 190 x 286 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>3.8 kg</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>–40 °C to +70 °C</td>
</tr>
<tr>
<td>IP rating</td>
<td>IP20 (installation in housing with rating of at least IP 54)</td>
</tr>
</tbody>
</table>

1. Trainguard LEU S21 for bus connection
2. Trainguard LEU S21 with handheld computer
3. Trainguard LEU S21 with ELM S21 F Euroloop modem in signal cabinet
4. Trainguard LEU S21 for signal connection
Trainguard® is a registered trademark of Siemens AG.

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The Trainguard LEU S21 (Lineside Electronic Unit) forms the link between the existing fixed signals and the ETCS (European Train Control System) components in the track, the Eurobalises and Euroloops.

The telegrams are transmitted intermittently by means of Trainguard Eurobalises and, if required, semicontinuously by the Trainguard Euroloop. 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 Euroloop modem. If a train fitted with ETCS equipment traverses the transparent balise(s) or Euroloop, the telegram is transmitted to the train and evaluated by the European Vital Computer (EVC, on-board computer).

Thanks to an identical telegram structure, the Trainguard LEU S21 can control both Eurobalises and Euroloops; additional data configuration is thus not necessary. A conventional balise/loop antenna is sufficient on the train.

Benefits

<table>
<thead>
<tr>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliance with all relevant European standards</td>
</tr>
<tr>
<td>Modular design</td>
</tr>
<tr>
<td>Accommodation in concrete equipment houses, switchgear cabinets or relay rooms</td>
</tr>
<tr>
<td>High-reliability data transmission</td>
</tr>
<tr>
<td>No maintenance required</td>
</tr>
<tr>
<td>High level of availability</td>
</tr>
<tr>
<td>Low purchase and life-cycle costs</td>
</tr>
<tr>
<td>Low power consumption</td>
</tr>
</tbody>
</table>
## Technical data – Trainguard LEU S21

<table>
<thead>
<tr>
<th><strong>Current inputs</strong></th>
<th><strong>Voltage inputs</strong></th>
<th><strong>Power supply</strong></th>
<th><strong>Telegram generator/outputs</strong></th>
<th><strong>Reliability (MTBF as per SN 29500)</strong></th>
<th><strong>Dimensions (l x w x h)</strong></th>
<th><strong>Weight</strong></th>
<th><strong>Ambient temperature range</strong></th>
<th><strong>IP rating</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of inputs</strong></td>
<td><strong>Input range</strong></td>
<td><strong>Input range</strong></td>
<td><strong>Input ranges</strong></td>
<td><strong>AC 88 V&lt;sub&gt;rms&lt;/sub&gt; to 264 V&lt;sub&gt;rms&lt;/sub&gt; (15 Hz to 90 Hz); DC 34 V to 177 V</strong></td>
<td><strong>185 x 190 x 286 mm</strong></td>
<td><strong>3.8 kg</strong></td>
<td><strong>−40 °C to +70 °C</strong></td>
<td><strong>IP20 (installation in housing with min. IP54)</strong></td>
</tr>
<tr>
<td>up to 16 inputs configurable</td>
<td><strong>30 mA to 4 A (15 Hz to 440 Hz)</strong></td>
<td><strong>AC 0 V&lt;sub&gt;rms&lt;/sub&gt; to 181 V&lt;sub&gt;rms&lt;/sub&gt; (15 Hz to 66 Hz); DC 0 to 181 V</strong></td>
<td><strong>up to 8 inputs configurable</strong></td>
<td><strong>&gt; 31.7 years</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Flashing detectors</strong></td>
<td><strong>Flashing detectors</strong></td>
<td><strong>Input ranges</strong></td>
<td><strong>Outputs</strong></td>
<td><strong>2 transparent balises, 2 Euroloops or combined</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>configurable at up to 4 inputs</td>
<td>configurable at up to 2 inputs</td>
<td>88 V&lt;sub&gt;rms&lt;/sub&gt; to 264 V&lt;sub&gt;rms&lt;/sub&gt; (15 Hz to 90 Hz); DC 34 V to 177 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Interface signal C** as per UNISIG SUBSET-036 FFFIS for Eurobalise

**Interface signal CL** as per UNISIG SUBSET-044 FFFIS for Euroloop

**Number of telegrams/Telegram length** 1023 telegrams per output, 341 bits or 1023 bits (selectable)

**Dimensions (l x w x h)** 185 x 190 x 286 mm

**Weight** 3.8 kg

**Ambient temperature range** −40 °C to +70 °C

**IP rating** IP20 (installation in housing with min. IP54)

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HTS 9077/212

The information in this document contains general descriptions of the technical options available. The required features should therefore be specified in each individual case at the time of closing the contract. For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action and integrate each component into a holistic, state-of-the-art security concept. Third-party products that may be in use should also be considered.
The use of ETCS components such as the Trainguard LEU MT lineside electronic unit enables an ETCS system to be installed for the infrastructure operator which can be integrated into the existing infrastructure both simply and free from any interaction and which complies with the requirements of the Technical Specification for Interoperability (TSI).

The Trainguard LEU MT from Siemens, which has been developed for mass-transit applications, solves one of the challenges encountered in equipping a line with ETCS Level 1: the connection to the existing infrastructure. Existing (national) train control systems can thus be extended by ETCS Level 1 or ETCS Level 1 LS (European Train Control System Level 1 Limited Supervision) both cost-effectively and interoperably.

A Trainguard LEU MT consists of a TESA and a PROSIG board. It is the interface between a signal and the associated balises installed between the rails (transparent-data and fixed-data balises), evaluates signal aspects and generates the telegram for the respective transparent-data balise.

A Trainguard LEU MT can be installed in both an outdoor and an indoor cabinet.

<table>
<thead>
<tr>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliance with European standards</td>
</tr>
<tr>
<td>Simplification of signal-interlocking configuration</td>
</tr>
<tr>
<td>Reduction of the scope of equipment along the track</td>
</tr>
<tr>
<td>Migration to ETCS functionality</td>
</tr>
<tr>
<td>Further usage of existing outdoor equipment</td>
</tr>
<tr>
<td>Reusability after alterations</td>
</tr>
<tr>
<td>Low life-cycle costs</td>
</tr>
<tr>
<td>Simple evidence of absence of any interaction</td>
</tr>
</tbody>
</table>
The information in this document contains general descriptions of the technical options available. The required features should therefore be specified in each individual case at the time of closing the contract. For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action and integrate each component into a holistic, state-of-the-art security concept. Third-party products that may be in use should also be considered.

A Trainguard LEU MT can be used to control both a main signal balise in the vicinity of the signal and an advanced infill balise. The infill balise can be used to change an already existing proceed aspect for the vehicle to a less restrictive state.

The modular design of a Trainguard LEU MT means that customer-specific adjustments can be made for the purpose of replacing further existing systems and making the line ETCS-compliant.

References
- Guangzhou L5
- Beijing L10
- Nanjing
- Istanbul

---

<table>
<thead>
<tr>
<th>Technical data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of telegrams</td>
<td>10 telegrams per output</td>
</tr>
<tr>
<td>Number of outputs</td>
<td>Trainguard Eurobalise S21: 2 units</td>
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<tr>
<td>Power consumption</td>
<td>&lt; 2,000 mW</td>
</tr>
<tr>
<td>Control distance</td>
<td>&lt; 3,000 m</td>
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</table>

Trainguard® is a registered trademark of Siemens AG.
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
The PZB 90 system operated in Germany uses track magnets which are directly connected to the different signaling systems via a standard interface.

This interface is described in German Railways' Guideline 819.1310. Usually, there is only one in the interlocking. Since the PZB system (track and vehicle magnets) has to be maintained until the railway operator’s rolling stock has been completely converted, the PZB function must not be influenced.

The control information of the national Indusi train protection system is read into the Trainguard MiniLEU S15 and provided again via a contact multiplier to control the relevant magnets. A pointer which selects the ETCS data telegram stored for each balise output is generated from this information. The telegram is then sent to the Trainguard Eurobalise S21.

When traversed, the Eurobalise is activated by the train-mounted antenna’s magnetic coupling and then sends the telegram which is received again by the train-mounted antenna and evaluated by the on-board computer.

Technical data

<table>
<thead>
<tr>
<th>Number of telegrams</th>
<th>10 telegrams per output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of outputs</td>
<td>3 Trainguard Eurobalises S21</td>
</tr>
<tr>
<td>Power consumption</td>
<td>&lt; 2000 mW</td>
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</tbody>
</table>

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The Trainguard MiniLEU S11 was designed for rail customers wanting to retrofit their existing systems with ETCS in a quick, cost-effective and environmentally-friendly way. Whether it is to increase safety or interoperability: in combination with the new ETCS Mode Level 1 Limited Supervision mode, customers can now implement a roll-out without reduction in performance or extensive changes to operating rules and regulations.

**ETCS installation – quick and straightforward**

The MiniLEU S11 was developed to enable blanket ETCS installation within the shortest of timescales and with minimal effort. To achieve this, we reduced the amount of effort involved – from programming and configuration, installation through to commissioning – to a minimum.

**Minimal lifecycle costs**

Lifecycle costs were reduced to a minimum through the following measures:

- No need for preventive maintenance thanks to automatic notification of faults or a low-battery level.
- Extremely high MTBF (mean time between failures) reduces intervention effort that would otherwise be required in the event of a failure.
- Status indicators on the front panel of each board allow a diagnosis to be established without equipment. Necessary steps can be taken and implemented within the shortest of timescales.
- Thanks to fixed programming and configuration, no re-programming is required if boards are changed.
- A battery service life of 10 years or more can be expected based on the low energy consumption.

Installed ETCS systems guarantee interoperability across borders, lines and vehicles.
The MiniLEU system comprising an electronics unit, solar-powered MiniLEU S11 and Eurobalise S11.

Referenzen

SBB Ltd
- About 2,000 MiniLEU S11 installed and in operational use by September 2014
- About 5,000 MiniLEU S11 installed by the end of 2017

Approval

Operational use in Switzerland

Technical Data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>MiniLEU S11 weight</td>
<td>6.8 kg (incl. housing)</td>
</tr>
<tr>
<td>Dimensions</td>
<td>300 x 300 x 300 mm</td>
</tr>
<tr>
<td>Average power consumption</td>
<td>30 mW</td>
</tr>
<tr>
<td>Number of balise interfaces</td>
<td>2</td>
</tr>
<tr>
<td>Maximum distance: MiniLEU S11 to balise</td>
<td>300 m</td>
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Environmental conditions

<table>
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<tr>
<th>Parameter</th>
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<tr>
<td>Operating temperature range</td>
<td>−40 °C to +70 °C</td>
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<tr>
<td>Ventilation</td>
<td>Not required</td>
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<tr>
<td>Storage categories</td>
<td>1K2, 1Z2, 1B1, 1C2, 1S2, 1M2</td>
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<tr>
<td>Storage temperature</td>
<td>−25 °C to +70 °C</td>
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<tr>
<td>Protection class</td>
<td>IP54 in the housing</td>
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<tr>
<td>Air humidity</td>
<td>According to EN 50125-3, Climate Category T1</td>
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<tr>
<td>Vibrations</td>
<td>According to EN50125-3, use 1–3m next to trackside</td>
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<tr>
<td>Fouling degree</td>
<td>4C3, 4B1, 4S3 (applies externally to the housing)</td>
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<td>EMC</td>
<td>EN 50121-4, EN 61000-6-2, EN 61000-6-4</td>
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<tr>
<td>Insulation coordination</td>
<td>EN 50124-1</td>
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<tr>
<td>Service life</td>
<td>25 years</td>
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Trainguard – references
For ETCS Level 1 and Level 2 lineside and on-board equipment
<table>
<thead>
<tr>
<th>Rail operator</th>
<th>Project/line</th>
<th>System</th>
<th>Equipment</th>
<th>Commissioning date</th>
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<tbody>
<tr>
<td>Hellenic Railways Organization (OSE), Athens, Greece</td>
<td>SKA–Kiato 110 km, 160 km/h</td>
<td>Trainguard 100</td>
<td>600 Eurobalises S21, 200 LEUs S21</td>
<td>2005</td>
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<tr>
<td>Administrador de Infraestructuras Ferroviarias (ADIF), Madrid, Spain</td>
<td>La Sagra–Toledo 26 km, 350 km/h</td>
<td>Trainguard 200, Trainguard 100 as fall-back level</td>
<td>106 Eurobalises S21, 5 EVCs</td>
<td>2005</td>
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<tr>
<td>Infrabel Brussels, Belgium</td>
<td>Lütich–Aachen, Line L3 30 km, 300 km/h</td>
<td>Trainguard 100 as fall-back level</td>
<td>250 Eurobalises S21, 35 LEUs S21</td>
<td>2006</td>
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<tr>
<td>Société Nationale des Chemins de Fer Belges (NMBS/ SNCB), Brussels, Belgium</td>
<td>Antwerp–HSL Zuid, Line L4, 40 km, 300 km/h</td>
<td>Trainguard 100</td>
<td>250 Eurobalises S21, 35 LEUs S21</td>
<td>2006</td>
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<tr>
<td>HSL Zuid Projectorganisatie Utrecht, Netherlands</td>
<td>Amsterdam–Rotterdam 100 km, 300 km/h</td>
<td>Trainguard 200 on-board units, Trainguard 100 as fall-back level</td>
<td>750 Eurobalises S21, Integration of 2 Radio Block Center, 15 LEUs S21, 3 EVCs</td>
<td>2007</td>
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<tr>
<td>Saudi Railways Organization (SRO) Saudi Arabia</td>
<td>Dammam–Riyadh 449 km</td>
<td>Trainguard 100</td>
<td>465 Eurobalises S21, 165 LEUs S21, 15 EVCs</td>
<td>2007</td>
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<tr>
<td>Ministry of Railways (MOR) Beijing, China</td>
<td>JJ-DPL Line, Beijing–Tianjin 120 km</td>
<td>Trainguard 100 and CTCS</td>
<td>40 EVCs, 1,124 Eurobalises S21, 85 LEUs S21, 154 MSTTs</td>
<td>2008</td>
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<tr>
<td>Red Nacional de los Ferrocarriles Espanoles (RENFE), Madrid, Spain</td>
<td>On-board equipment</td>
<td>Trainguard 100, Trainguard 200</td>
<td>12 EVCs Level 1, 60 EVCs Level 2</td>
<td>2009–2010</td>
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<tr>
<td>Infrabel Brussels, Belgium</td>
<td>4,000 signals for Belgium</td>
<td>Trainguard 100</td>
<td>12,000 Eurobalises S21, 4,000 LEUs S21</td>
<td>2010</td>
</tr>
<tr>
<td>Železnice Slovenskej Republiky (ŽSR), Bratislava, Slovakia</td>
<td>Sváty Jur–Nové Mesto nad Váhom 89 km, 160 km/h</td>
<td>Trainguard 100</td>
<td>836 Eurobalises S21, 290 MSTTs</td>
<td>2010</td>
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<tr>
<td>Société Nationale des Chemins de Fer Belges (NMBS/ SNCB), Brussels, Belgium</td>
<td>On-board equipment</td>
<td>Trainguard 100, TBL1+</td>
<td>305 on-board units for RER Brussels regional trains (Siemens’ Desiro Mainline)</td>
<td>2010–2016</td>
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<tr>
<td>Türkiye Cumhuriyeti Devlet Demiryollari (TCDD), Turkey</td>
<td>Ankara–Konya high-speed line</td>
<td>Trainguard Futur</td>
<td>Trainguard Futur 2500 ETCS Level 2 lineside equipment, Trainguard Futur 3000 ETCS Level 2 on-board equipment</td>
<td>2011(Phase 1)</td>
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<tr>
<td>Office National des Chemins de Fer (ONCF), Rabat, Morocco</td>
<td>On-board equipment</td>
<td>Trainguard 100</td>
<td>97 EVCs, 135 Eurobalises S21</td>
<td>2011–2012</td>
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<tr>
<td>Österreichische Bundesbahnen (ÖBB), Vienna, Austria</td>
<td>ETCS Level 2 in Corridor E Vienna–Bréclav Line (Nordbahn)</td>
<td>Trainguard 200 RBC</td>
<td>1,250 Eurobalises S21, interface to 11 interlockings</td>
<td>2011–2013</td>
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<td>MRCE Netherlands</td>
<td>On-board equipment</td>
<td>Trainguard 200</td>
<td>30 locomotives</td>
<td>2012</td>
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<tr>
<td>Metro Kolkata KMRCL, India</td>
<td>On-board equipment</td>
<td>Trainguard 100</td>
<td>70 metro trains</td>
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<td>Kiwi Rail</td>
<td>Auckland Metropolitan Network</td>
<td>Trainguard Futur</td>
<td>Trainguard Futur for ETCS Level 1</td>
<td>2012–2015</td>
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<td>Administrador de Infraestructuras Ferroviarias (ADIF), Madrid, Spain</td>
<td>Madrid–Valencia–Albacete high-speed line</td>
<td>Trainguard Futur</td>
<td>Signaling, interlockings, 42 on-board units ETCS Level 1 track circuits, Trainguard Futur 1300, Trainguard Futur 2500, CTC</td>
<td>2013</td>
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<tr>
<td>Schweizerische Bundesbahnen (SBB), Berne, Switzerland</td>
<td>On-board equipment</td>
<td>Trainguard 200</td>
<td>Retrofitting of 365 vehicles</td>
<td>2013–2015</td>
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<td>Bahnbetreiber</td>
<td>Anlage/Strecke</td>
<td>System</td>
<td>Ausrüstung</td>
<td>Inbetriebnahme</td>
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<tr>
<td>DB Schenker</td>
<td>On-board equipment</td>
<td>Trainguard 200</td>
<td>72 Bombardier TRAXX BR185 vehicles</td>
<td>2013–2017</td>
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<td>Stadler Pankow GmbH, Hungary</td>
<td>6 GySEV trains, 42 MÁV trains</td>
<td>Trainguard Basic,</td>
<td>6 on-board units, 42 on-board units</td>
<td>2014</td>
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<td>Saudi Railways Organisation (SRO),</td>
<td>Makkah–Madinah high-speed line, Haramain project</td>
<td>Trainguard Futur</td>
<td>Trainguard Futur 2500 ETCS Level 2 lineside equipment, Trainguard Futur 3000 ETCS Level 2 on-board equipment</td>
<td>2014</td>
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<td>Saudi Arabia</td>
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<td>Stadler GmbH, Poland</td>
<td>20 LKA Łódź regional trains, 20 PKP IC intercity trains</td>
<td>Trainguard 200</td>
<td>20 on-board units, 40 on-board units</td>
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<td>Schweizerische Bundesbahnen (SBB),</td>
<td>3000 km line with more than 11,000 signals and ETCS</td>
<td>Trainguard 100</td>
<td>Trainguard Mini LEU S11, Trainguard LEU S21 MS at approx. 2,000 Signale, Euroloops</td>
<td>2014–2017</td>
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<td>Berne, Switzerland</td>
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<tr>
<td>Deutsche Bahn AG (DB AG), Germany</td>
<td>VDE 8 ETCS Level 2 project, Erfurt–Halle/Leipzig</td>
<td>Trainguard 200</td>
<td>13 Simis D electronic interlockings, GSM-R</td>
<td>2015</td>
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<td>Deutsche Bahn AG (DB AG), Germany</td>
<td>ETCS on-board equipment</td>
<td>Trainguard 200</td>
<td>260 ETCS on-board units</td>
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<td>KTZh, Kazakhstan</td>
<td>Nikeltau–Kandyagash</td>
<td>Trainguard Futur</td>
<td>Trainguard Futur 2500, ETCS Level 2 lineside equipment</td>
<td>2015</td>
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<td>Cordoba–Malaga high-speed line</td>
<td>Trainguard Futur</td>
<td>Trainguard Futur 1300, Trainguard Futur 2500, Trainguard Futur 3000</td>
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<td>Ferroviarias (ADIF), Madrid, Spain</td>
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<td>Administrador de Infraestructuras</td>
<td>Antequera–Granada high-speed line</td>
<td>Trainguard Futur</td>
<td>Trainguard Futur 2500 (Level 2), Trainguard Futur 3000 (on-board equipment), Clearguard FS3000 jointless track circuits</td>
<td>2015</td>
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<td>Ferroviarias (ADIF), Madrid, Spain</td>
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<td>Türkiye Cumhuriyeti Devlet Demiryollari (TCDD), Turkey</td>
<td>Bandirma–Menemen high-speed line</td>
<td>Trainguard Futur</td>
<td>Trainguard Futur ERTMS for Level 1 and Level 2</td>
<td>2015</td>
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<td>Adelaide Metropolitan Passenger</td>
<td>Metro line</td>
<td>Trainguard 100</td>
<td>Trainguard Futur equipment</td>
<td>2015 (awarded in 2013)</td>
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<td>Rail Network (AMPRN), Australia</td>
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<td>Cross London Trains (XLT), United Kingdom</td>
<td>Thameslink</td>
<td>Trainguard 200</td>
<td>Trainguard 200 ETCS Level 2 on-board equipment for 119 Desiro city trains</td>
<td>2015–2017</td>
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<td>Türkiye Cumhuriyeti Devlet Demiryollari (TCDD), Turkey</td>
<td>On-board equipment</td>
<td>Trainguard 200</td>
<td>7 Velaro trains</td>
<td>2015–2017</td>
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<tr>
<td>Société Nationale des Transports</td>
<td>Boughezoul–M’Sila, 9 stations, Tissenssil–Bougezoul,</td>
<td>Trainguard 100,</td>
<td>Simis W, ETCS Level 1,</td>
<td>2016</td>
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<tr>
<td>Ferroviaires (SNTF), Algiers, Algeria</td>
<td>7 stations, Strecke Senia–Arzew, 43 km 6 stations, Mécheria–EL Bayadh,</td>
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<td>Simis W, ETCS Level 1,</td>
<td>2016</td>
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<td>Strecke Senia–Arzew, 43 km 4 stations, Mécheria–EL Bayadh, 5 stations, Djelfa–Laghouat, 6 stations</td>
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<td>Simis W, ETCS Level 1,</td>
<td>2017</td>
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<td>VR Track, Finland</td>
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<td>Trainguard 100</td>
<td>80 Vectron locomotives</td>
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<td>Schweizerische Bundesbahnen (SBB),</td>
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<td>Trainguard 200 RBC</td>
<td>Trainguard 200 RBC</td>
<td>2017</td>
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<td>Berne, Switzerland</td>
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<td>Beni Mancour–Bejaia</td>
<td>Trainguard 100</td>
<td>Trainguard 100 ETCS Level 1</td>
<td>2018</td>
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<td>Ferroviaires (SNTF), Algiers, Algeria</td>
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</tr>
</tbody>
</table>
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