TRAMWAY SIGNALING SYSTEMS

Elektroline

INTRODUCTION

Elektroline has established itself as one of the industry leaders in light rail signaling. Its signaling solutions are renowned for safety, flexibility, low-maintenance requirements, and competitive costs.

Elektroline signaling systems represent a modern technology for the tramway and light rail networks of the 21st century.

Safety, reliability and user friendliness has, is, and will be a priority for all our products.

Flexible Customized Solutions

By listening to our clients, we learned our products and solutions must be as unique as our customers. By having the in-house Design, Product Development, Manufacturing, Installation and Logistics departments, we are able to flexibly react to customers' demands.

Integrated Solutions

Elektroline products are designed as modular sub-systems that can be put together to create a single signaling solution or can be integrated through a step-by-step implementation.

Furthermore, the scalability of the components enables a full integration into the non-Elektroline system(s).

Quality and Knowledge

In addition to the step-by-step integration, Elektroline products are simply operational through our remote connectivity interface and equipment. This allows customers to easily control and monitor the entire network online from a single device.

Safety

When it comes to development and manufacturing of products for public transport service, safety cannot be compromised. Elektroline signaling products therefore meet or exceed the industry safety standards. Elektroline is an ISO 9001-certified company and the signaling products are developed according to Railway Industry CENELEC Standards. The safety compliance is subsequently assessed and confirmed by an Independent Safety Assessor (ISA). Elektroline products such as track circuits, point machines and other safety-relevant equipment reach the SIL2 or SIL3 rate.

CONTENTS

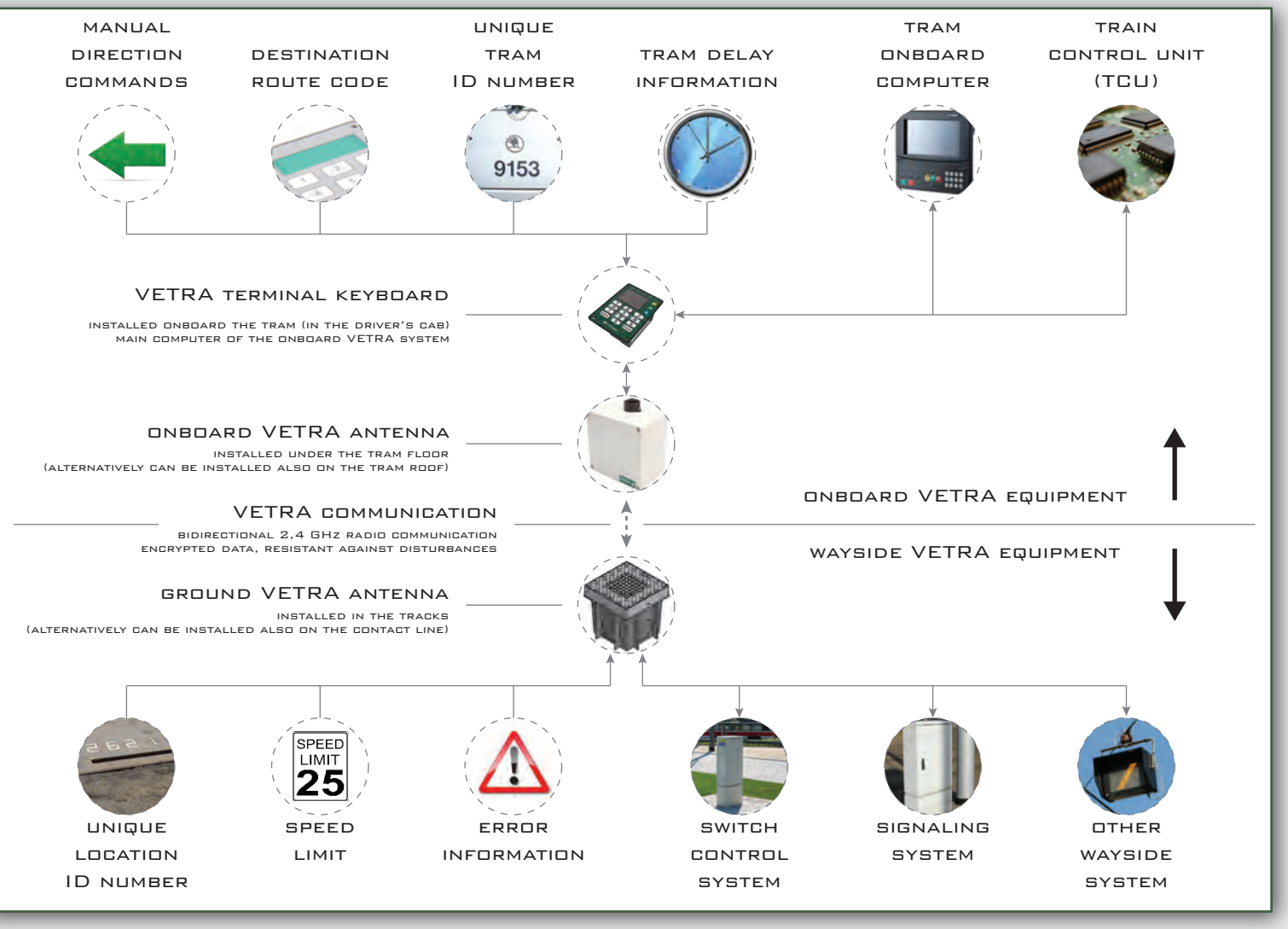
TRAM-TO-WAYSIDE COMMUNICATION VETRA

Highlights

- » **Radio-based**
- » **Easy-to-Install**
- » **Transmit Up/Transmit Down**
- » **No installation Restrictions**
- » **Automatic Routing**
- » **Flexible & Versatile**

The VETRA Tram-to-Wayside Communication (TWC) is a bi-directional radio-based system operating at 2.4 GHz frequency through the compact-size transponders installed on the trams and in the tracks. The high-speed communication enables a rapid data exchange at speeds up to 100km/h. It is therefore an ideal solution for both the tramway as well as the light rail applications. What makes the VETRA even more unique is its capability of transmitting the data upwards or downwards. Fact, the wayside transponders don't have to be installed only in the tracks but can be placed in the catenary infrastructure, is extremely important at locations where the ground works are restricted or forbidden.

When installed in the tracks, thanks to the transponders' compact size,



VETRA can be installed in the track circuit areas or in any steel reinforcements unlike traditional loop-based communication systems. The ground VETRA antenna can be even installed in the area of a resonant track circuit or in an area with a steel reinforcement in the concrete which is a big advantage compared to the low-frequency inductive vehicle-communication systems.

Simply speaking, the VETRA's flexible application offers a large advantage over traditional systems and is the industry leader in modern tramway/LRT networks.

Ground VETRA transponder installed in track

Applications

VETRA is a true flexible solution. Its versatility goes beyond the route request function. The extended capabilities include:

- Automated Depot Tram Control
- Tram Traffic Priority
- Automatic Vehicle Localization System
- Passenger Information System (PIS)
- Speed Limit

On-board Interface

The VETRA on-board system has been designed to offer maximum compatibility with the tramway on-board computers of various manufacturers. The interface is provided by the Vehicle Terminal Keyboard VTK15. It is an easy-to-install device used for the communication, data upload/download (itineraries, route codes, vehicle status, failure logs, etc.) and the route requests when a manual push-button commanding is selected. The VTK15 enables communication with the on-board computer via Ethernet, RS-485 and/or logical inputs/outputs.

Onboard VETRA terminal keyboard

Wayside Interface

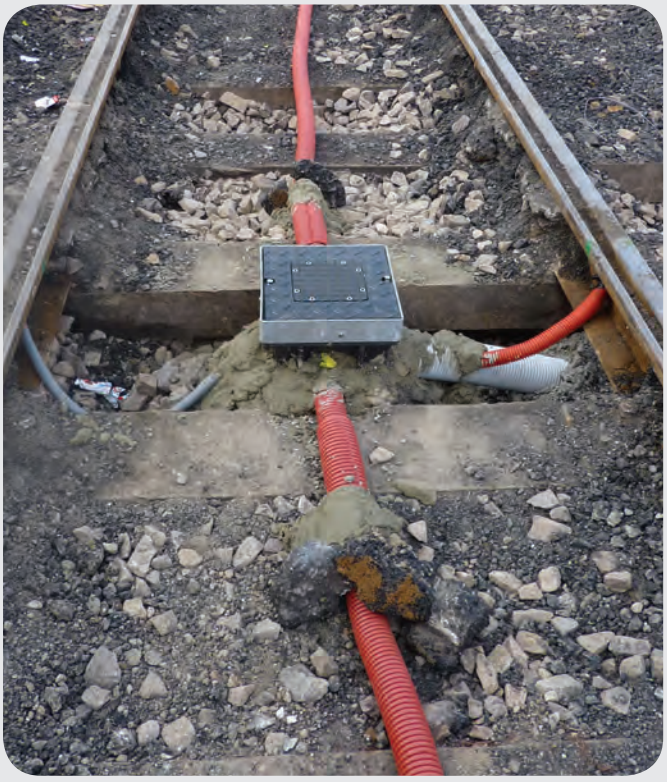
By choosing VETRA, the customers do not have to replace their existing signaling infrastructure. VETRA can be easily integrated into the system they operate. The 3rd-party wayside systems can interact with the VETRA via a standardized interface called STC (Smart Traffic Controller). The STC is a sleek compact-size yet powerful device that can be installed either inside your signaling controller or as a stand-alone controller with its own housing and power supply. The STC is a gateway to the VETRA system.

TRACK CIRCUITS

Highlights

- **Fail-safe Detection**
- **Combined Detection Method**
- **Maintenance-free**
- **Harsh Conditions Resistance**
- **Automatic fine-tuning**
- **SIL3**

The Blocking Resonant Circuits (BRC) represent a safety-crucial component of modern signaling systems. The track circuits are widely used as one of the most reliable methods to detect a presence of a tramway. They are used to safely block a point machine and prevent it from an accidental switch during a tram maneuver through the switch point.



Connecting a track circuit in the tracks

Fail-safe Detection

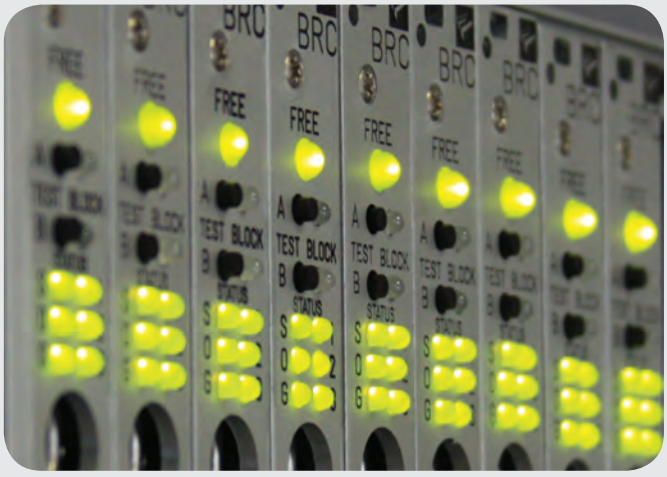
Elektroline track circuit is an SIL2/SIL3-assessed reliable and fail-safe detection device. They primarily detect a presence of tramways but are able to distinguish rail vehicles from cars, trucks, buses, etc. If installed properly following Elektroline's recommendations the track circuit system will work for years without the need to be maintained or replaced.

Principle of Detection

Elektroline track circuits are based on a hybrid detection principle combining the short circuit (shunt) detection (caused by the tramway's axles) and the metal mass detection. The hybrid detection principle guarantees the tramways are detected no matter the environmental conditions (tree leaves, sand, mud, snow, ice, etc.). The system remains immune to accidental detections from the road vehicles. However, if desired, it can be programmed to detect road vehicles as well.

Flexible System

The track circuits can be delivered either as a part of Elektroline's complex integrated solution or as a component that will be integrated into a non-Elektroline system.



Track circuit electronic units BRC

Another facet of its variability is its ability to read-and-react to weather conditions. The track circuit continuously evaluates its environment and accordingly adjusts its settings.

The Digital User Interface

Highlights

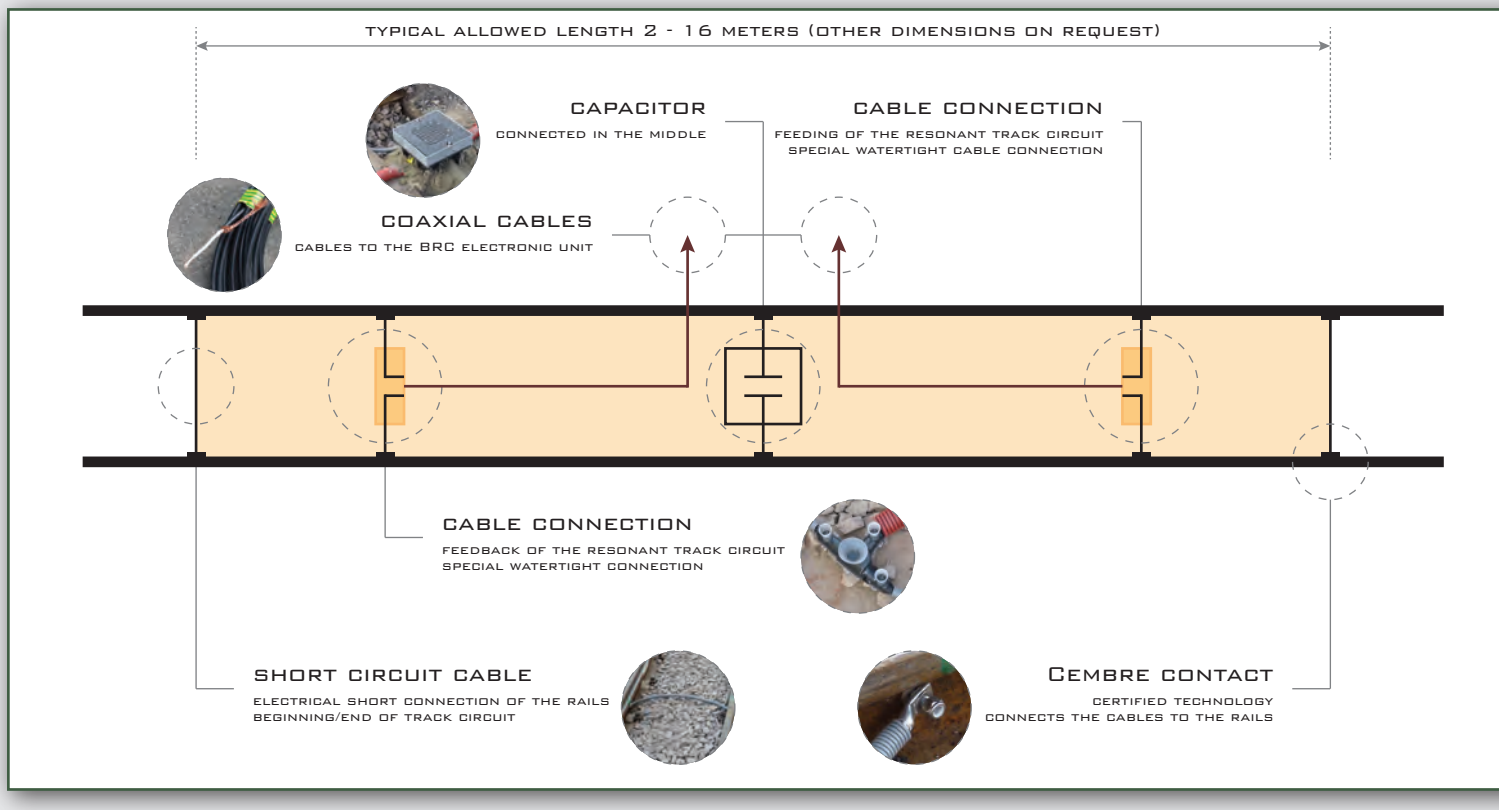
- Easy-to-use
- User-guiding
- Cross-platform
- Light-weight

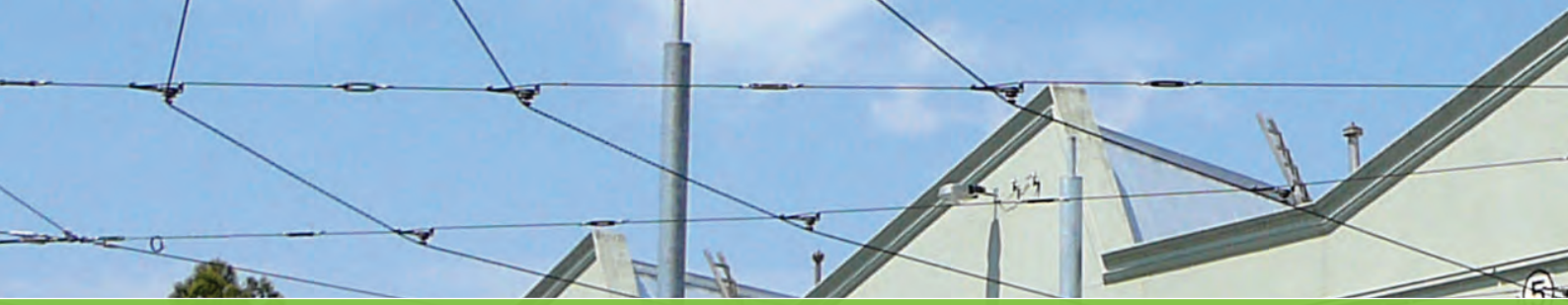
In order to make the work with the BRC easy, Elektroline introduces a revolutionary brand-new user interface BRClab. It is a cross-platform software application for tablets, laptops and/or computers running OS Windows, Mac, Linux and/or Android.

The BRClab is a smart interface for the measuring and configuring of various parameters. Likewise, the track circuit's brain – the BRC unit - automatically evaluates the parameters of the track circuit and suggests the optimal settings for its use.

This allows new track circuits to be easily installed as users can automatically set the parameters and measure detection changes right on their computers.

Automatic configuration of the track circuit





TRAM SWITCH CONTROL (TSC)

Highlights

» **Fully Automatic**
» **AC/DC**
» **Remote Access & Monitoring**
» **Data Logs**
» **Points Heating (optional)**
» **SIL3**

The TSC is a smart all-in-one solution for a switch point control enabling route requests in 3 different modes:

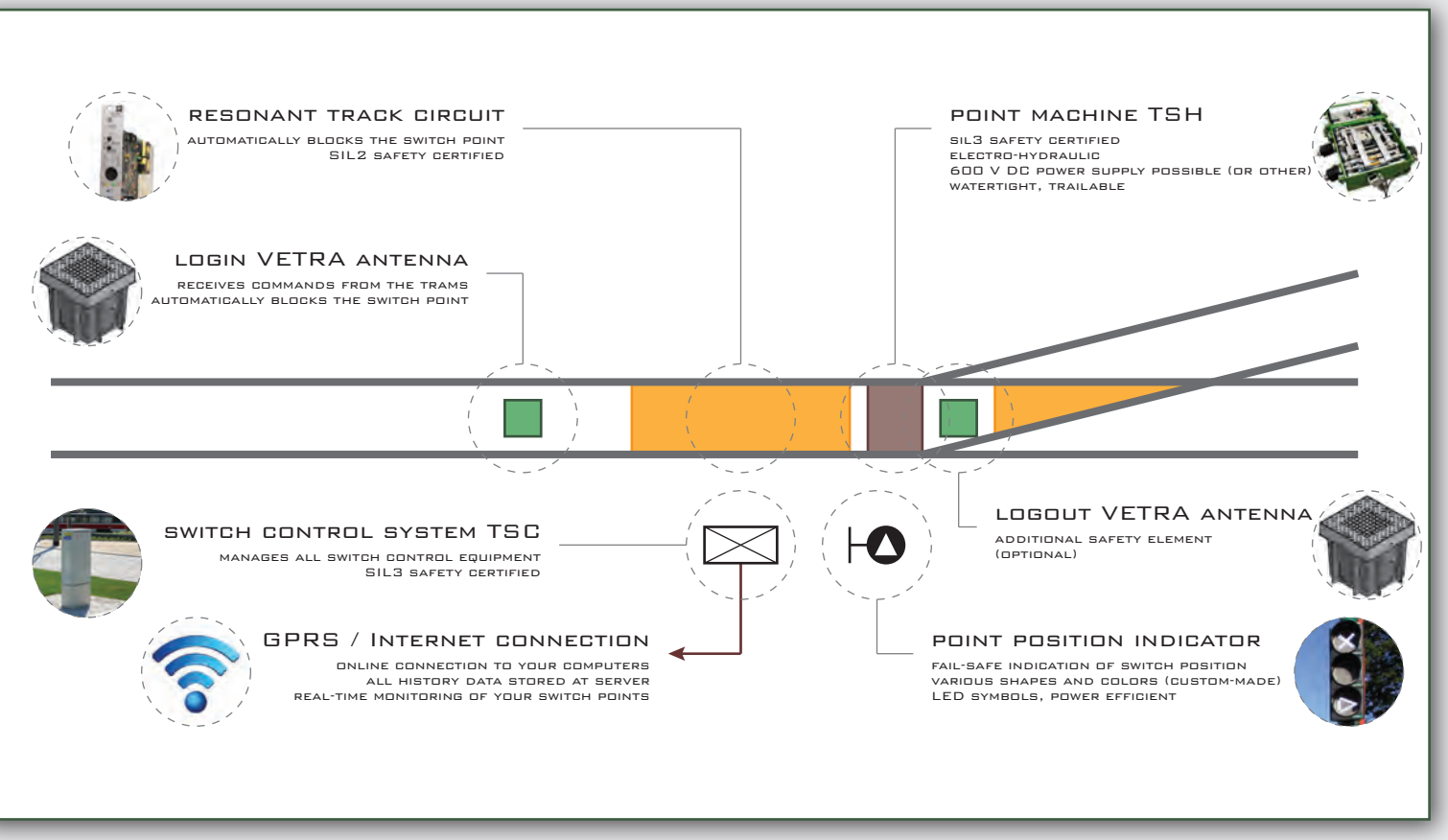
1. **Automatic**: route codes transmitted by the TWC (VETRA, VECOM, AWA, etc.)
2. **Directional**: requests transmitted by the pantograph contact device
3. **Directional**: push-button operation by a tram driver transmitted via TWC

Power Supply

Various power supplies available. The TSC can be powered either with 120V AC, 230V AC or 650-700V DC.

Points Heating

As a true all-in-one controller, not only is the TSC capable of the switch point control but it also enables the points heating. With the intelligent built-in heating module, the TSC can control up to 4 heating elements (in standard configuration). It monitors the environment and temperature and turns the heating ON/OFF accordingly. The heating can be, however, controlled remotely from an OCC.



Remote Monitoring and Memory

With the Elektroline's Elesys software tool, the customers can either monitor the real-time operation of the switch points all across the city or can download and analyze the history logs. The TSC can be accessed either remotely via an urban network (metallic, fiber-optics), GSM or in the field via LAN.

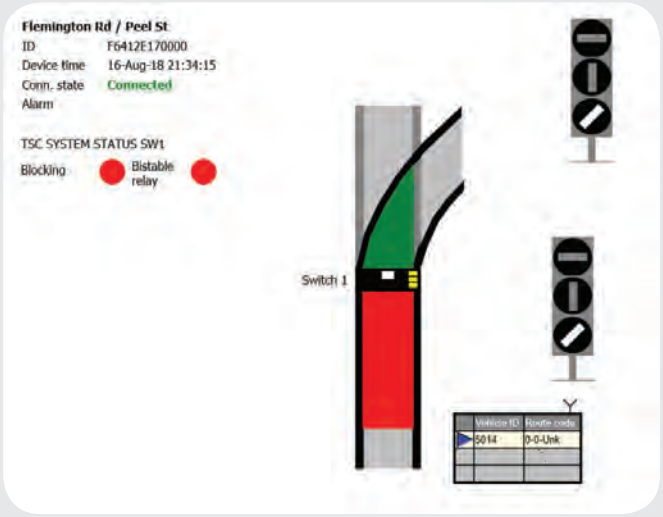
All critical system data are stored permanently in the system's flash memory. If desired, the data can be backed-up to Elektroline's servers.

SIL3

The safety-related components of the TSC are assessed up to SIL3. It allows the TSC to be installed and operated at switch points with utmost safety requirements.

Other Interfaces

The TSC enables interfaces through any form of communication. Customers can use the standardized interfaces or can define their own.



Elektroline Elesys software

SIGNALING SYSTEMS & INTERLOCKING

Highlights

- » **Scalable & Versatile**
- » **Automatic**
- » **Safe**
- » **Robust & Flexible**
- » **Remote Access & Monitoring**
- » **Inter-connectivity**

Elektroline's full-scale Signaling System & Interlocking enable a rapid yet safe tramway/LRT operation at locations such as intersections, terminal stations, level crossings and temporary day-time parking zones. The interlocking combines particular sub-systems such as resonant track circuits, TWC, point setting, and point heating and creates a robust yet flexible signaling solution.

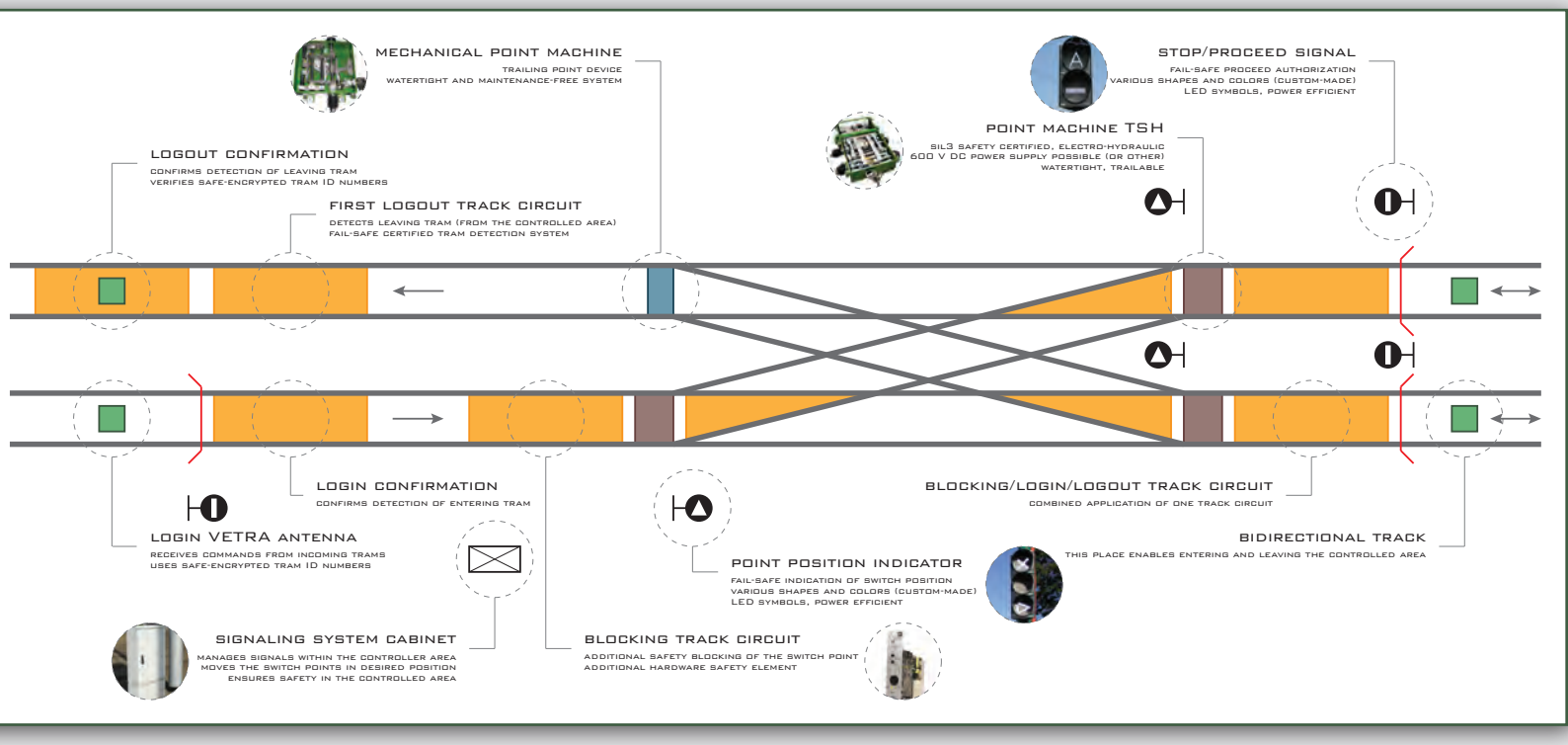
Scalability & Versatility

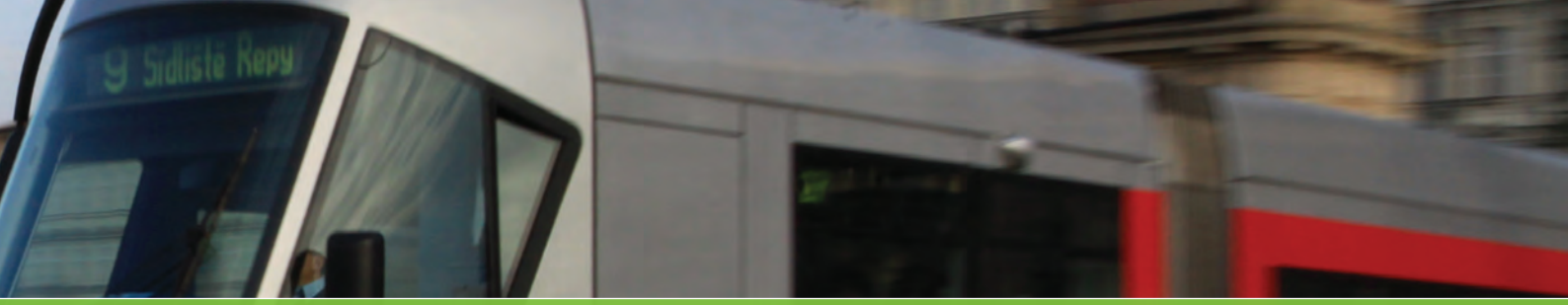
By bringing together the hardware and software, and by using the cutting-edge industrial PLCs, we are enabled to build a true signaling LEGO-like solution and adapt to any customers' needs.

Unlike the signaling sub-systems capable of providing only limited functionalities, the interlocking provides operational control and organization of entire zones such as management of compatible/incompatible route requests, collision prevention, tram travel priority, signalization of STOP/PROCEED orders, etc.

Operability

A real-time visualization software for line dispatchers can be supplied together with the interlocking system. It further improves the functionality and safety of the system and is especially useful for new tramway networks and/or networks without existing Operational Control Centers (OCC).





The design, program and performance of the system is custom-made in order to meet customers' different operational needs.

Safety

Such a robust and complex system must guarantee the highest level of safety. Elektroline interlocking guarantees the operational safety at the level 3 (SIL3).

Connectivity

The interlocking system is highly flexible when it comes to connectivity. It can be inter-connected with other (non)-Elektroline systems and/or OCC via SCADA, metallic/fiber-optic networks, GSM or locally via LAN.

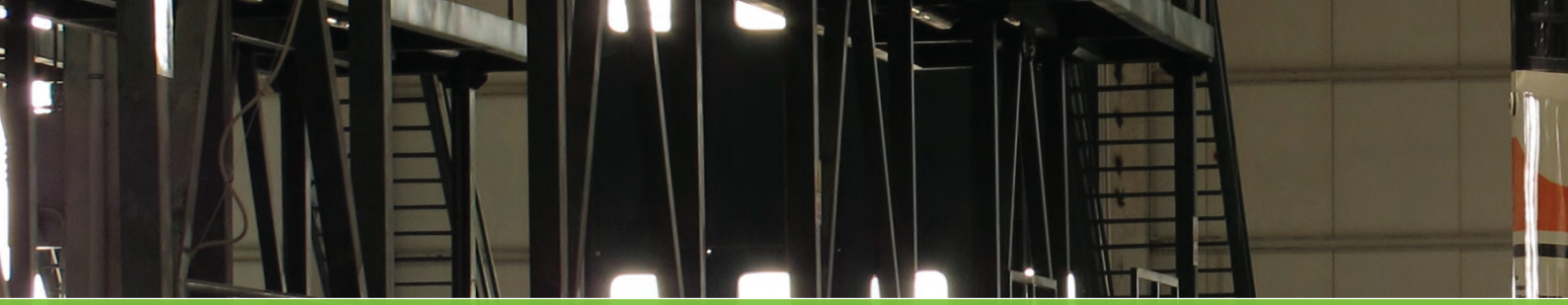
The customers can use the standardized interfaces or can define their own.

Remote Access & Monitoring

The remote access, history logs downloads and monitoring are features automatically coming with the interlocking system.

Elektroline signaling system in Athens, Greece

Custom-made LED signals



ELEKTROLINE YARD AUTOMATION SYSTEM

Highlights

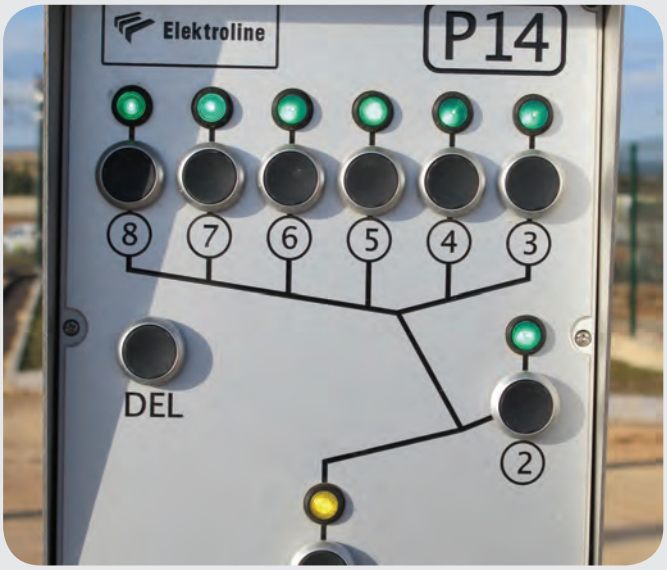
- **Scalable**
- **Fast**
- **Automatic**
- **Fail-safe**
- **User-friendly**

Elektroline Yard Automation System EYAS offers a complete solution for the safe and reliable operation of modern train depots.

By using EYAS, trams can enter and exit the depot in a fraction of the time compared to traditional solutions. This is thanks to the intelligent system of automatic tram routes ensuring all switches move automatically.

Safety

Operational safety is ensured by the SIL2/SIL3-assessed track circuits. The control system is equipped with hardware safety circuits, preventing the accidental movement of switch points. This could potentially occur when there is a tram present in the switch point area.

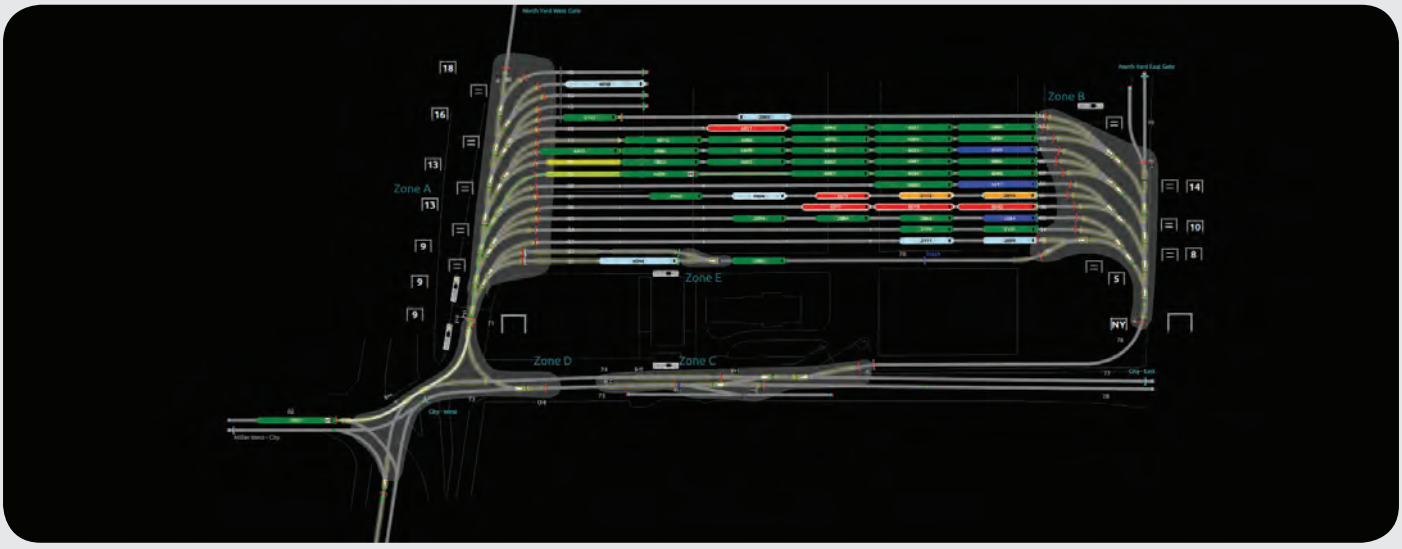


Semi-automatic depot control system

Real-time Visualization

Tram operations in the depot are available in real-time on visualization screens providing information about position and direction. Even the movements of trams within the depots are visible on the screen in real-time.

Moreover, all data from the system are stored and can be accessed and analyzed 24/7 using Elektroline software.



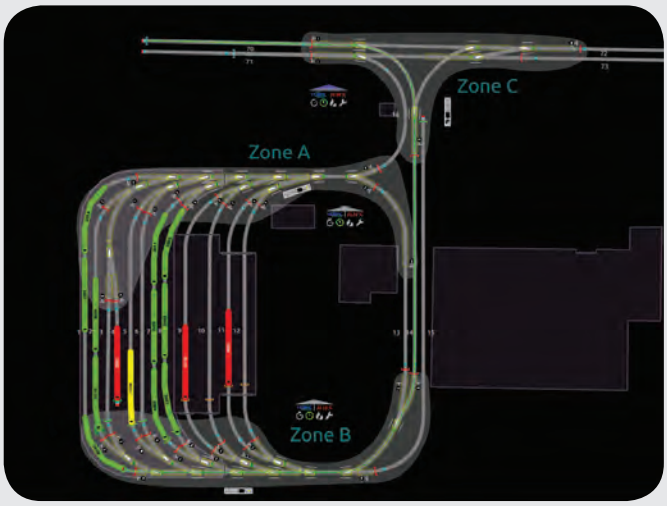
Elektroline supplies custom-built depot systems from the design to the implementation

Automatic Parking Plan

All movements of the tram depot control system can be pre-programmed through the visualization screen to maximize efficiency.

For example, the depot dispatcher can create a parking plan before trams even begin to arrive. When a tram enters the depot, the system can use a pre-defined parking plan to route the tram automatically.

Elektroline's VETRA system is used to detect and select trams entering the depot, which ensures the smooth function of the automatic system.



Custom-made depot visualization screen

Customized Function

Our depot control systems are custom-made top down according to customers' requirements. It allows us to provide a wide range of solutions for a safe and efficient operation of tram depots.

Furthermore, EYAS can be easily interfaced with other systems present in the depot (automatic doors opening, overhead contact lines, etc.) These systems can even be integrated in the visualization software enabling their status to be visualized.

Fully-automatic depot control system (Prague)

Complete system including Elektroline point machines

TRAM PRIORITY SYSTEMS

Highlights

- » **reliable** tram detection system
- » **maintenance-free** contact-less solution
- » **very easy installation**, modular system
- » suitable for tram **speed up to 100 km/h**
- » RS485 data communication **saves a lot of cables** (only one cable to each side from the junction is needed)

Elektroline's tram priority system helps you speed up your tram system and avoid delays, consequently providing services to more customers. This is done through our tram to wayside communication system VETRA.

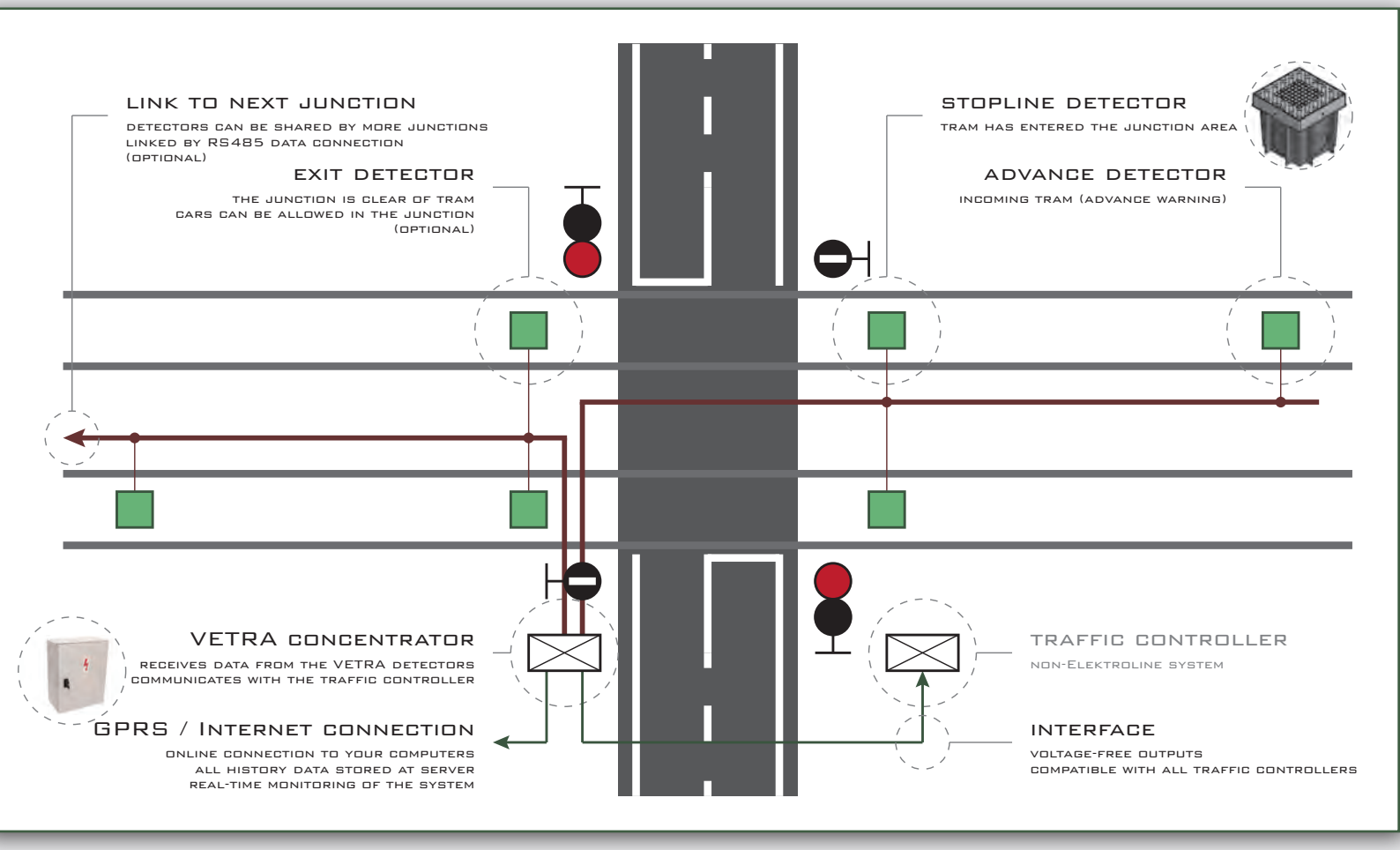
Outstanding Reliability

Like previously stated, this is done through our tram to wayside communication system VETRA, which provides information about the location, speed, and direction of trams in real time. When a tram approaching a junction is detected, the traffic control has sufficient time to clear and prepare the junction as well as prioritize the tram.

The VETRA detection system can consistently detect trams traveling up to 100 km/h.

Maintenance-free System

Troubleshooting the system is straightforward and simple, due to the VETRA system's reliable and low level of maintenance. When issues do arise however, they can be



Elektroline tram priority system (United Kingdom)

solved using the small touch screen of the priority system. This interface monitors proper function of tram detection points.

Flexible and Modular System

With Elektroline's tram priority system, you can find an integrated solution for any type of junction. The system is equipped sophisticated configuration software, allowing users to provide the exact information to traffic controllers, even in complicated situations.

Tram Localization System

The tram localization system can be used as part of network-wide tram localization system. Users can send data of detected trams to a centralized system which can thereby provide this information to any third-party.

This solution enables the use of one system for a variety of uses and enables the potential implementation of a real time passenger information system.

Tramway Level Crossings

TThe technology of the tram priority system can additionally be used to build a complete system of level crossings. These systems guarantee the complete safety of a tramway level crossing using warning lights for road vehicles and pedestrians as well as traffic barriers.

Tram detection system control electronics

PASSENGER INFORMATION SYSTEM

Elektroline VETRA system can be very easily used for implementing a real-time passenger information system within your tramway network.

The VETRA system provides very accurate information about position of all trams within the network (automatic vehicle localization system). All positioning information is gathered by a central server. The central server can therefore calculate estimated time to arrival for all trams at all tram stops. This information is provided by the central server to the tram stops and visualized on information panels installed on the chosen tram stops.

Flexible Visualization

Elektroline uses special type of LCD panels with excellent visibility designed for outside installation. The LCD panels can display all information about approaching trams, additional traffic information, but also other customized information like weather forecast, news, or even commercials.

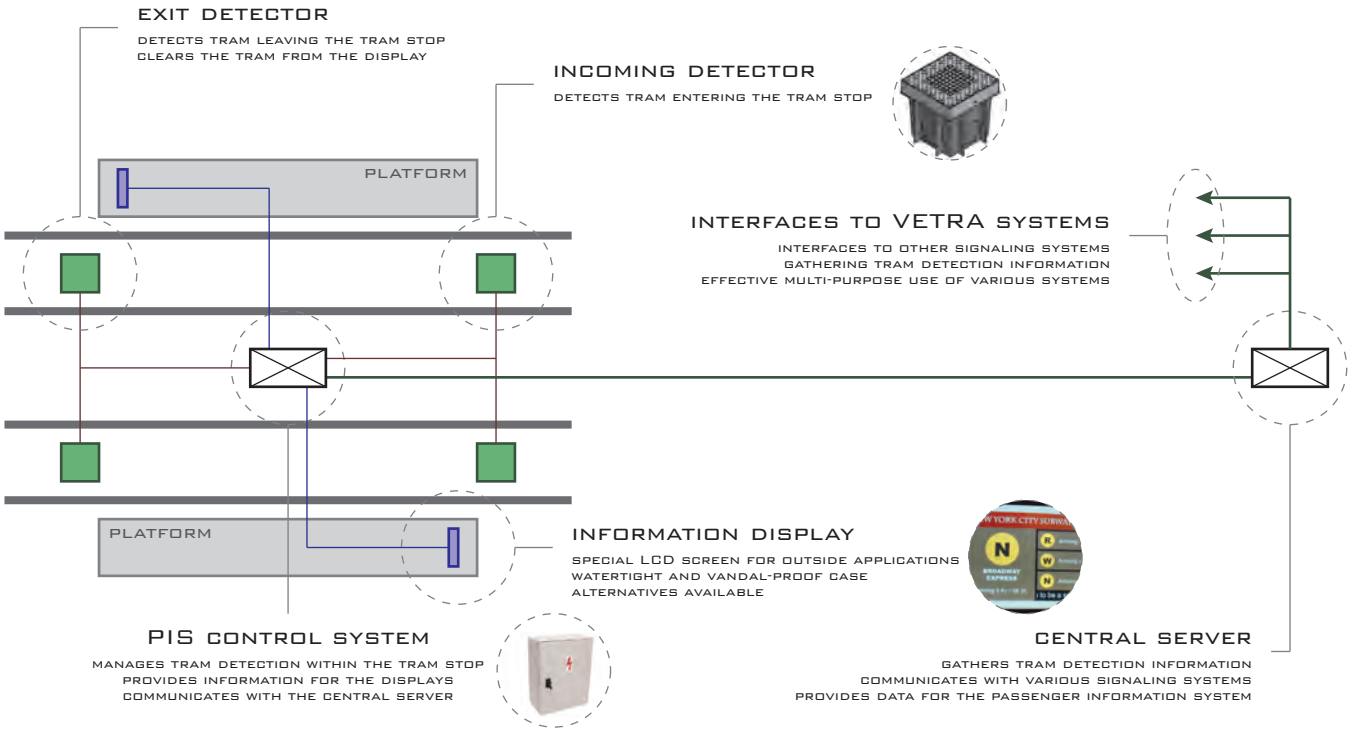
It is a good idea to let the information system earn some extra money for you by providing attractive space for commercials.

Elektroline information screens can display static or dynamic text, any type of graphics and even visualizations or video to the passengers waiting at the tram stops.

Effective Tram Localization

One of the biggest benefits of the Elektroline passenger information system is the possibility to use other existing systems within the tramway network as part of the passenger information system.

In your tram network, do you have automatically controlled switch points? And what about junctions equipped with tram priority system? All these systems can provide valuable tram detection information to you. It is an excellent idea to connect all these systems to the passenger information system and use the already existing systems for something extra.



One-track Signaling System

The last signaling system we would like to offer you is a safety signaling system for one-track operation which can be very conveniently combined with Elektroline automatic switch control systems TSC.

The system is based on combination of resonant track circuits and Elektroline tram-to-wayside communication system VETRA.

The system automatically detects incoming trams and ensures that a conflicting movement of two trams going against each other never occurs.

The system is equipped with history memory log which permanently saves all data from the operation and enables even remote diagnostics via internet connection.

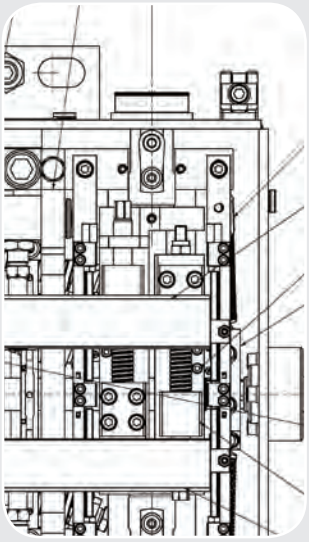
Custom-made stop/proceed signals are permanently monitored by the signaling system. The system is immediately blocked in case of failure of any critical component.

Custom-made Signaling Systems

We can never put all different modifications and combinations of the signaling system in one document. If you have not found here what you are looking for, we are always happy to consult a custom-made solution with you and to design the system according to your requirements.

We have our own team of software and hardware engineers with many experiences from tramway networks all over the World always available for you and your queries.

In Elektroline, we understand that our work is not finished by installing the system. We are always here for you to help you with any requests you may have. We provide both online support as well as maintenance support on place or expert training of your maintenance workers. After all, it is our best reward when you are satisfied with your new Elektroline signaling system.



Design

Expert design of special signaling system applications together with ongoing high-tech development processes

Delivery

High quality and ecological friendly manufacturing processes with focus on continuous education of people

Installation

Professional installation even in demanding conditions done by Elektroline experts with World-wide experiences

Support

Outstanding after-sale support for all situations guarantees immediate professional help anywhere at any time

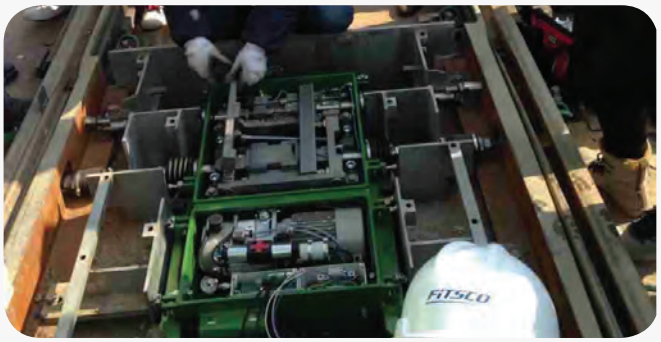
CHOSEN REFERENCE PROJECTS

Australia, Melbourne - Preston

- full - automatic depot control system (EYAS), incl. depot signaling system
- tram priority system
- switch point control system
- VETRA tram-to-wayside communication system
- BRC unit - track circuit LRT detection

China: Wuhan, Suzhou, Shenyang, Quingdao, Beijing, Donghu

- BRC unit - track circuit LRT detection
- VETRA tram-to-wayside communication system
- electro-hydraulic point machines



- BRC unit - track circuit, LTR detection
- point machines (electro-hydraulic and mechanical)

Belgium, Brussels

- full - automatic depot control system (EYAS), incl. depot signaling system
- tram priority system
- switch point control system
- VETRA tram-to-wayside communication system
- BRC unit - track circuit LRT detection

Poland: Poznan, Lódź, Olzstyn, Katowice, Gdańsk, Czestochowa, Bydgoszcz

CHOSEN REFERENCE PROJECTS

United Kingdom, Blackpool

- switch point control systems
- VETRA tram-to-wayside communication system
- tram priority system
- depot signaling system
- point machines (electro-hydraulic and mechanical)

Belgium, Gent

- tram priority system
- switch point control system
- signaling system
- BRC unit track circuit, LRT detection

- switch point control systems
- fully-automatic depot control system
- PRIPAT tram-to-wayside communication system
- automatic switch heating
- point machines
- nonstop 24/7 maintenance

Czech Republic, Prague

- semi-automatic depot control system
- automatic washing management system
- custom-made real-time visualization
- including fail-safe track circuits BRC

Netherlands, Amsterdam

Elektroline

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