IMPULSE

MICROPROCESSOR INTERLOCKING SYSTEM MPC-U

SRPA «Impulse» - the leader of the Ukrainian market of instrumentation and control systems of critical infrastructure facilities

Areas of activity: development, manufacture, supply of railway automation systems; automation and safety systems for NPPs; digital relay protection equipment.

Competences and proposals for railways:

- Microprocessor electrical and traffic control system.
- System of train separation based on digital track circuit and axle counting equipment.
- Locomotive safety system (SLB «ImproTRAIN-250»).
- Rolling stock monitoring equipment: temperature control of axle box units; means for creating hierarchical centralized structures.

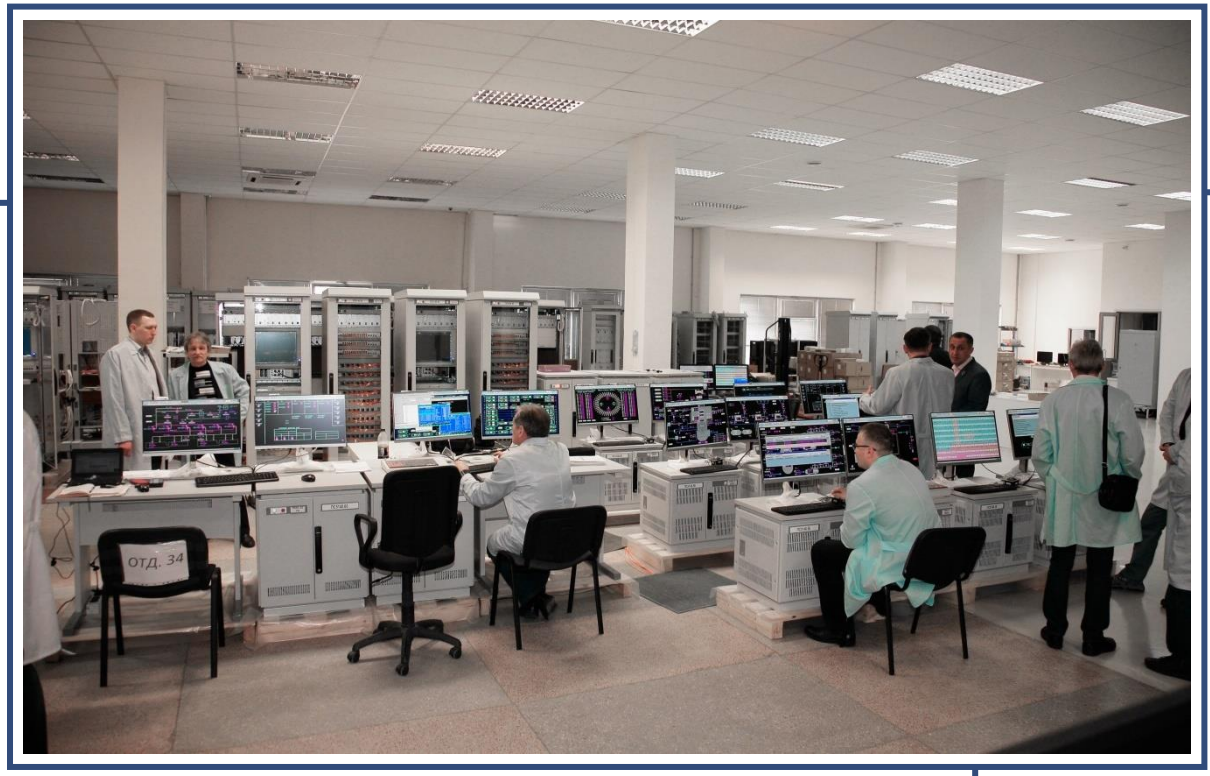
SRPA «Impulse» - the leader of the Ukrainian market of instrumentation and control systems of critical infrastructure facilities

Certified systems in place for compliance requirements:

- quality management system ISO 9001:2015;
- environmental management ISO 14001:2015;
- occupational health and safety management ISO 45001:2018.

In 2022, the company successfully passed a compliance audit Siemens to suppliers (External Sustainability Audit).

Obtained the status of an official supplier of Siemens Mobility.



SRPA «Impulse» - the leader of the Ukrainian market of instrumentation and control systems of critical infrastructure facilities

Gained experience:

- More than 100 systems have been put into operation of railway automation, including in the European Union.
- The railway automation platform developed by SRPA «Impulse» is certified in the EU for SIL4 level (according to CENELEC standards).

CERTIFICATE

Number 9_ОСП/CCS/2307/EN/2024-01/V01

TINSA

Certifying Body	„TINSA" Ltd 3A, Nikolay Haytov St., 1113 Sofia, Bulgaria **A Product Certification Body „NB and DB" No9_ОСП** Accreditation of BDS EN ISO/IEC 17065:2012 and MNB – Assessment scheme 000:RA1044, ver. 2.0, by the order of BAS № А478/08.11.2023
Certificate Holder	**Private Joint Stock Company Severodonetsk Research and Production Association "Impulse"** Verbova st., 17a, Kyiv, 04073, Ukraine
Assessed Product	**Computer based Interlocking System „MPC-U"** **(Modification and Upgrading - No1 and No2)**
Manufacturer	**Private Joint Stock Company Severodonetsk Research and Production Association "Impulse"** Verbova st., 17a, Kyiv, 04073, Ukraine
Legal base	**BDS EN 50126-1:2018, BDS EN 50126-2:2018, BDS EN 50128:2011, BDS EN 50128:2011/A2:2021, BDS EN 50129:2019, BDS EN 50159:2010 и BDS EN 50159:2010/A1:2020**
Result of the Assessment	This Certificate is the result of the application of a documented procedure by the Certifying Body for assessing of the safety integrity level of equipment for modification and upgrading No1 and No2 of the previously certified product "Computer based Interlocking System MPC-U" (see Annex, Clause 5) for compliance with safety integrity level SIL4. From presented evidences on application of the targets, methods and means to ensure safety at the stages of development/ design, manufacture, validation and operation of the equipment for modification and upgrading No1 and No2 of the MPC-U, as well as based on the assessment results presented in the Report SIL_REP_2307_CCS_BG_2024_1, Certifying Body certifies that modification and upgrade objects No. 1 and No. 2 for various independent applications (Generic Product) **„Computer based Interlocking System MPC-U"** fulfils the quantitative and qualitative requirements for safety integrity level **SIL4** in accordance with **BDS EN 50126-1:2018, BDS EN 50126-2:2018, BDS EN 50128:2011, BDS EN 50128:2011/A2:2021, BDS EN 50129:2019, BDS EN 50159:2010 and BDS EN 50159:2010/A1:2020.** Within the first specific application for objects Nos. 7, 9, 10, 11 and 12 (see Annex A, Clause 5), performance tests shall perform and the Certifying Body must be informed about the test results.
Annex	The Annex A of 11 pages is an integral part of this Certificate.
Validity period	**Unlimited.** This certificate is valid for the equipment for modification and upgrading No1 and No2 of the product "Computer based Interlocking System MPC-U", whose production is performed in accordance with the mentioned in the Annex A list of documentation.
Head of the Product Certification Body „NB and DB" „TINSA" Ltd.	**Eng. Borislav Boiadjiev, PhD**
Date and Place of issue:	**25.01.2024, Sofia**

PRODUCT CERTIFICATION BODY TINSA № 9/ОСП „NB and DB"

Currently, projects for railways are being implemented:

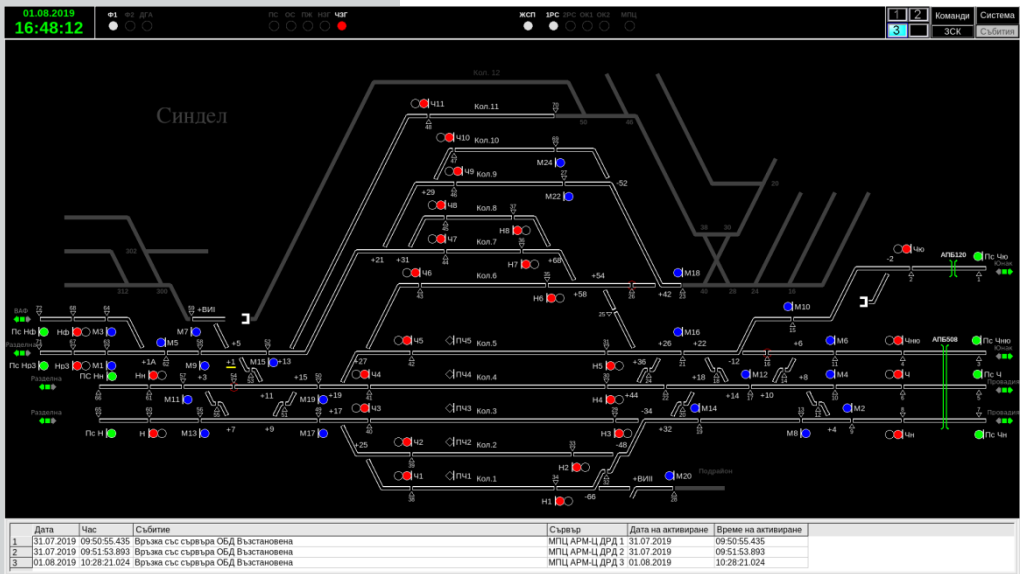
- Equipping the rolling stock of JSC «Lithuanian Railways» sets of ImproTRAIN-250 (186 pcs.).
- Manufacturing and commissioning of microprocessor track circuits (2460 pcs.) for Estonian Railways Ltd under the contract with Siemens.
- Deliveries of 190 sets of hot axle box detection system.

Railway automation systems

Railway automation systems manufactured by SRPA «Impulse» form a modern integrated intelligent system for safe control of train traffic and transportation process.

They fulfill the requirements of the following standards: EN 50121-3-1; EN 50121-4; EN 50126; EN 50128; EN 50129; EN 61373; EN 50155; SOU 45.020 00034045 002; DSTU 4178

MPC-U equipment in the «relay» room of the electrical interlocking post



Microprocessor interlocking system MPC-U

The main system is MPC-U. All traffic control and management functions, route and individual control of trackside equipment are implemented in this system.

The MPC-U platform implements automatic block signaling MAB-U, semi-automatic block signaling MPAB-U, rail circuits MRC-U, axle counting system MSSO-U, and other functions for controlling train traffic and trackside equipment of railway automation. These functions can be applied as stand-alone systems or integrated into the MDC-U.

The safety and reliability of systems based on the MPC-U platform are confirmed by the international certificate of compliance with the highest level of safety completeness SIL4 and a decade of operation on mainline railway lines in Ukraine and Europe.

The optimal solution for modernising the automation of railway stations with adjacent crossings is the application of MPC-U with block signaling functions (MAB-U or MPAB-U).

Since the first implementation in 2012, dozens of projects have been developed and implemented on the MPC-U platform

Microprocessor interlocking system MPC-U

Implementation of MPC-U on railway transportation will allow:

Improve train throughput and safety through the use of digital fault-tolerant control and management technologies

Remotely operate any type of trackside equipment, shunting areas and fleets

Minimise the probability of EC failure through a trialled secure processor structure (2oo3d), redundant object controllers (2oo2d) and diversionary software

Simple to integrate with various electrical centralisation, dispatch centralisation, traffic control and other systems via digital serial and parallel discrete relayless interfaces

Significantly reduce labour and financial expenses of SCB equipment maintenance, switch to condition based maintenance due to deep self-diagnostics of MPC-U and diagnostics of SCB equipment

Microprocessor interlocking system MPC-U

Key features

Possibility to build centralisation systems in accordance with the «1520 area» standards and European standards *of traffic safety and quality assurance*

ERTMS/ETCS compatibility

Unified complex of technical means and unified interfaces for all railway automation systems: digital rail circuits, ALSN, automatic block signaling, semi-automatic block signaling on the basis of axle counting are integrated into MPC-U without additional linkages

Cyber security, in accordance with ISO/IEC 27000 group standards

Distributed structure allows to place the equipment both centrally (in one room) and in the form of distributed fragments by stations and spans (with the equipment placed in standard transportable modules)

The passive cooling system *increases system reliability and minimises the frequency of periodic maintenance*

Guaranteed power supply. Redundant power supply system and echeloned lightning protection

Low «lifecycle» cost

Operational support and service from the manufacturer for the entire system lifecycle

Microprocessor interlocking system MPC-U

Main functions

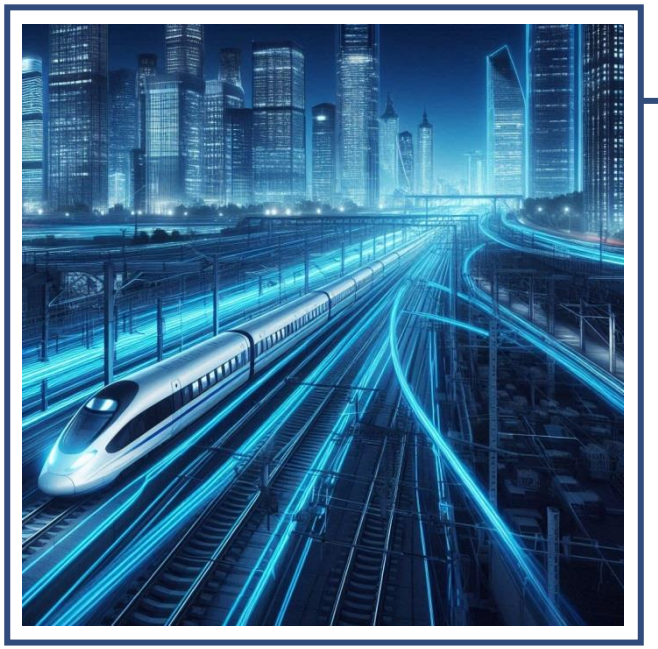
- Control and management of the processes of receiving, departing, passing, overtaking trains, shunting operations at the station
- Ensuring the safe movement of trains along the routes
- Display of reliable information on train position and status of SCB devices to the station duty officer's workstation and electromechanic's workstation
- Control of the power supply system
- Reporting the actions of operating and maintenance personnel, archiving all received information and generating the necessary protocols and reports
- Verify the awareness of the operator's actions when setting responsible control commands

Microprocessor interlocking system MPC-U

MPC-U has a three-level structure

Main functions of the Automated workstation of the station operator:

- Display of information on train situation at the station and crossings, status of trackside equipment..
- Receiving control commands of the station duty operator, with confirmation of actions in the assistant mode of operation.
- Real-time visualisation on the monitors of the automated workstation:
  - gridiron with display of the train situation at the station and span.
  - information on the status of the MPC-U equipment.
- Recording of operator's actions and archiving of all information on the state of trackside equipment and MPC-U equipment.
- Transmission of control commands of the station duty officer to the safe processor.



Human-machine interface level: automated workstations of station operator and signal technician with control and diagnostics server.

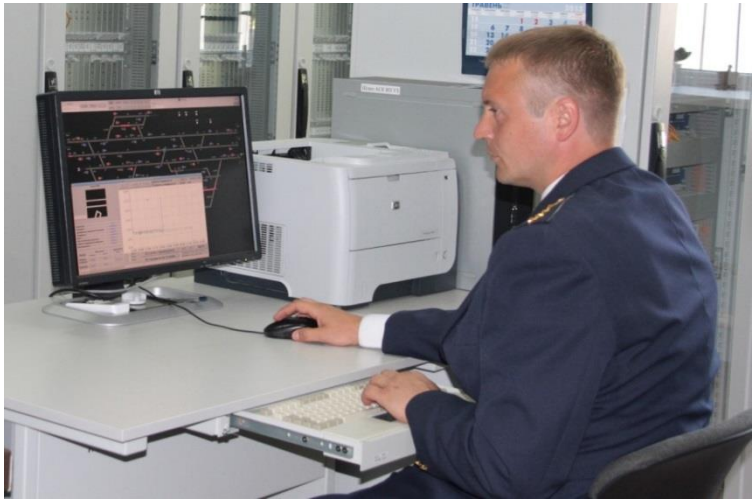
Microprocessor interlocking system MPC-U

The station operator's workstation consists of two workstations that operate independently of each other. The station duty operator can use both of them for work, but to issue control commands it is necessary to activate one of them with a special command, after which the second one will be on "hot" standby..

The main function of signal technician workstation: visualisation of information on the state of MPC-U and trackside equipment with logs and parameter archives.

The gateway provides cyber-secured digital communication between the MPC-U and external systems.

Station operator's workstation (ARM DSP)



Workstation of signal technician (ARM ShN)

Microprocessor interlocking system MPC-U

Logic level of train control and traffic management: fail-safe computer.

The three computing channels use industrial microprocessors with different architectures, control systems and diversified application software.

The fail-safe computer performs all basic interlocking functions, including the processing of logical dependencies and the issuing of control commands to the object controllers:

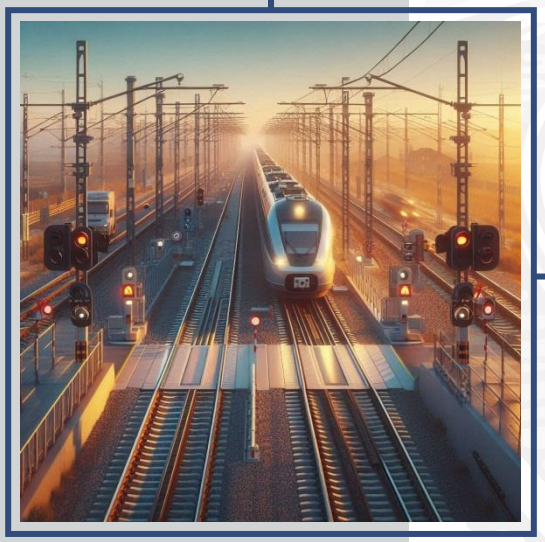
- reception of messages from the object level, data processing using 2oo3d logic (majorisation with diagnostics) and transmission to the upper level;
- reception of control commands from the upper level with majorisation and checking of safety conditions;
- generation and transmission of control commands to the object level (individual/route control, blocking signals, control of traffic signals and point positions, generation of Automatic Locomotive Signaling (ALS) code signals, etc.);
- self-diagnostics of software and hardware;
- reconfiguration (2oo3d → 2oo2d) in case of failure of one of the three channels.

Microprocessor interlocking system MPC-U

Object level: object controllers controlling the trackside equipment via contactless interface. Located centrally in the interlocking unit room or in the immediate vicinity of the controlled trackside equipment (in transportable modules).

Main functions:

- receiving signals about the status of floor equipment;
- generation of control operations (according to the 2oo2d logic) by commands from the logic level (which are processed according to the 2oo3d logic);
- diagnostics of the trackside equipment status.



Microprocessor interlocking system MPC-U

Composition of object controllers

Controller of safe normalisation of signals MBN.
Safe or normal input of 16 / 32 / 64 signals of "dry contact" type (interrogation of the state of contact groups of relays of the first class, as well as detection (decoding) of ALS codes, and other rapidly changing signals).

Safe signal conditioning controller MBF.
Safe generation of 24 V DC voltage signals on 16 outputs for relay control (safe digital signal output)

Discrete signal conditioning controller MFDS.
Control of 48 DC or AC voltage switching channels

Light signal controller MSS.
Control and status monitoring of three / six lamps or LED emitters of traffic signals

Controller of rail circuits power supply MPRC.
Formation of supply of tone rail circuits (TRC) and reception of signals from them, coding, control of occupancy of track sections by rolling stock

Controller of control of rail circuits MKRC.
Receiving signals from TRC, control of track sections occupancy by rolling stock

Digital signal input controller MVDS.
Input of 48 discrete DC or AC voltage signals

Point controller MSt.
Control of one or two DC or AC directional electric actuators with control of point positions

Automatic locomotive signaling controller MALS.
Formation of ALS code signals for 12 channels

MPC-U power supply system

Reliable power supply system and echeloned lightning protection guarantee the operation of MPC-U in difficult weather conditions and in case of power grid disturbances.

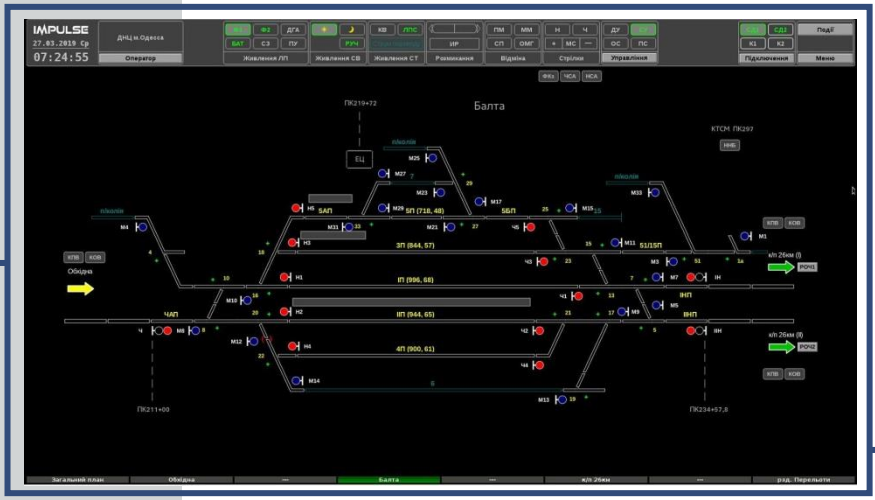
Provided:

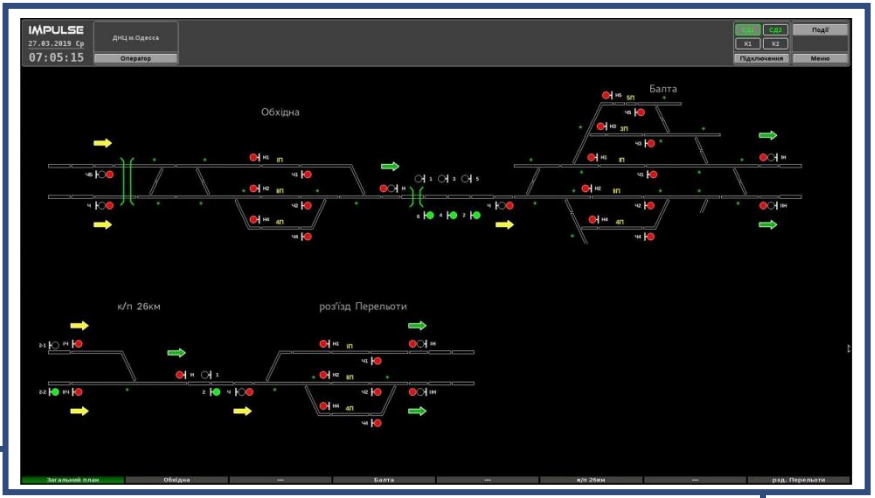
- protection of circuits against overvoltage and high-voltage impulse interference;
- normalisation and galvanic isolation of circuits of different signals;
- control of cable insulation resistance reduction;
- control of the state of in-house equipment.

Functional safety of MPC-U

The functional safety of MPC-U is ensured by:

- three-channel structure of the fail-safe computer, each channel of which uses microprocessors with different architectures and diversified software. A faulty module can be replaced and put into operation without stopping the system and without additional configuration of the replaced module (plug and play);
- internal redundancy of object controllers having two divert channels each and operating under the 2oo2d scheme;
- radial trialled point-to-point fibre optic connection between each channel of the fail-safe computer and each cage of object controllers (failure of any connection does not affect the operation of other connections);
- redundant execution of station operator's workstation;
- safe behaviour in case of failures;
- permanent control and diagnostics of signaling, centralization and blocking (SCB) devices and software and hardware of MPC-U with collection, processing, archiving and displaying of information on workstation of signal technician .

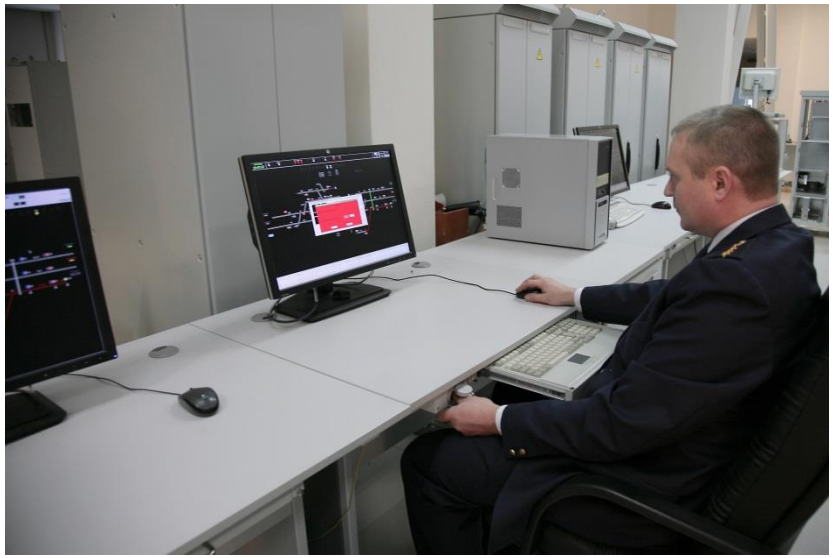




Simple operation of MPC-U

Permanent monitoring, diagnostics and archiving of parameters with prediction of pre-failure states allow preventing malfunctions of component parts and the system as a whole.

Before delivery, MPC-U passes a full-scale functioning test with the assistance of a specialised software and hardware complex, which allows to fully simulate in real time the operation of all SCB devices (including electrical loads) for a particular gridiron of the station. This significantly reduces the time of commissioning and operation of MPC-U



Systems based on the MPC-U platform

On the base of MPC-U platform a range of microprocessor-based railway automation systems is implemented:

- Automatic block signaling MAB-U
- Semi-automatic block signaling MPAB-U
- Rail circuits MRC-U
- Axle counting system MSSO-U, etc.

These systems have the same features, reliability and functional safety (SIL4 level) as MPC-U.

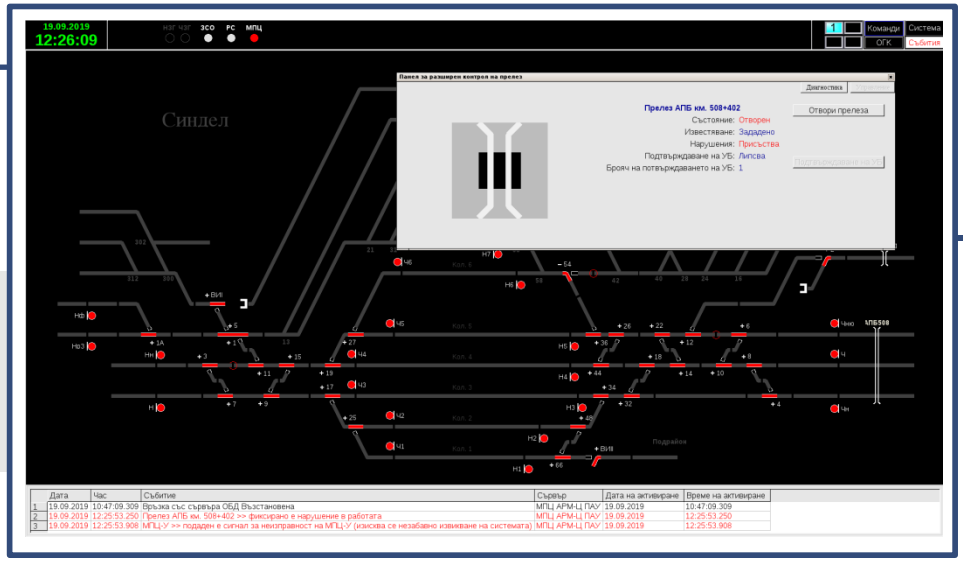
Can be used as stand-alone systems and as functions integrated into MPC-U.

Microprocessor automatic block signaling MAB-U

MAB-U is a system of interval regulation and real-time train traffic safety.

Performs remote control of objects on the span (traffic signals, railway level-crossing, rail circuits, coding of rail circuits, etc.) and interconnection between stations bordering the current span.

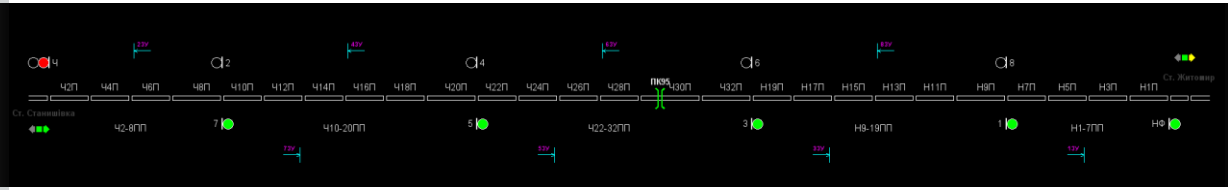
Implemented on the basis of rail circuits or axle counting system



Microprocessor automatic block signaling MAB-U

Main functions

- Control of the integrity of rails and freedom of block sections of the spans.
- Control of the sequence of occupation and vacating of block sections with automatic block signaling in case of violations.
- Control of signals of passing traffic signals.
- Control of crossing and tunnel signaling.
- Coding of rail circuits of block sections by ALS signals.
- Implementation of three-digit or four-digit signaling algorithm (depending on customer's requirements).
- Real-time display of information about train position and status of SCB devices at the span on station operator's and signal technician workstations.



Microprocessor semi-automatic block signaling MPAB-U

MPAB-U is a system for interval regulation and ensuring the safety of train traffic on single-track and multi-track low-traffic railway spans with different types of traction with using the semi-automatic block signaling function.

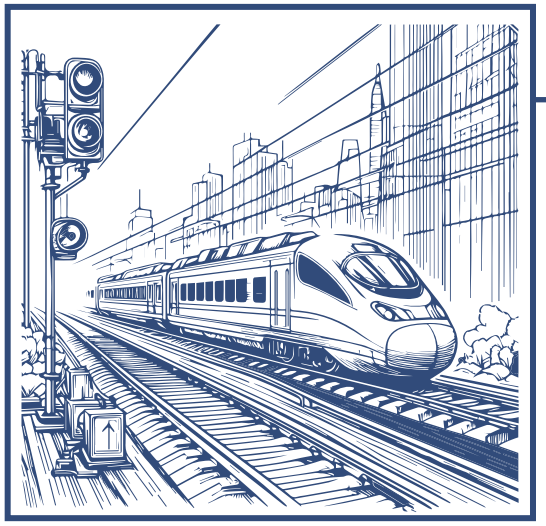
Control of occupancy/unoccupancy of the line is carried out using axle counting equipment. There is an option to organise automatic checkpoints at the span to increase the traffic capacity. MPAB-U has digital and relay contact interfaces for pairing with any type of electrical interlocking.

Microprocessor semi-automatic block signaling MPAB-U

Main functions

- Control of occupancy/unoccupancy of each track of the span.
- Automatic control of full train arrival.
- Sharing information between adjacent stations for implementation of semi-automatic block signaling algorithm.
- Coding of rail circuits of station approach sections by ALS signals.

Microprocessor tone frequency rail circuits MRC-U



MRC-U are intended for:

- control of track sections occupancy and integrity of rail lines;
- formation of ALSN code signals.

Main functions

- Formation of rail circuits power supply (tone frequency signals), measurement of current and voltage levels.
- Formation of ALSN codes.
- Diagnostics and transmission of information on the state of rail circuits equipment to the upper level.
- Protection against external electromagnetic influences (caused by atmospheric phenomena, traction currents of 50 Hz frequency, etc.).
- Self-diagnostics, transition to the protective state when failures are detected.

MRC-U can be used on mainline and industrial railway transport, in subways

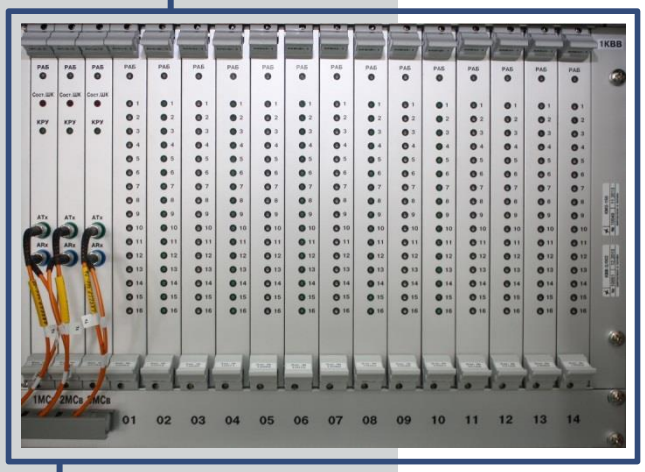
Microprocessor tone frequency rail circuits MRC-U

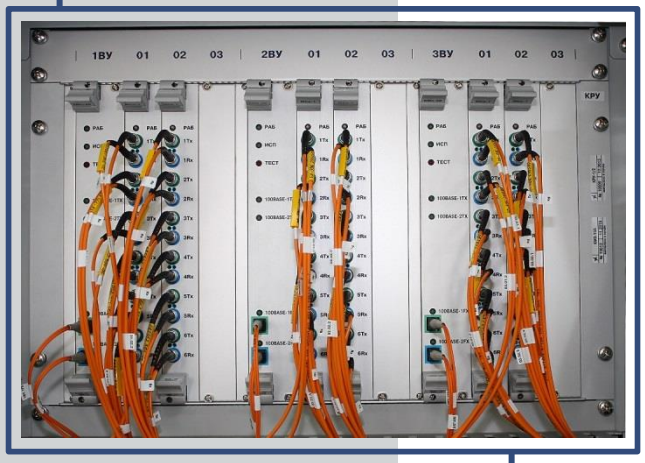
Implementation of MRC-U will allow:

- Exclude all rail circuit coding relays and ALSN or parallel discrete interface equipment.
- Minimize maintenance due to stability of MRC-U parameters under changing external conditions.
- Optimize the process of calculating rail circuits.
- Provide easy interfacing via digital or parallel discrete interfaces with microprocessors, relay centralization and automatic block signaling systems.

- Perform continuous monitoring of cable parameters, including core-to-core and ground faults.
- Provide continuous monitoring of rail circuit parameters, including insulated rail joint convergence, rail integrity and residual voltage at the receiver.
- Minimize the impact of the “human factor” by controlling the tweaking processes.

Microprocessor tone frequency rail circuits MRC-U





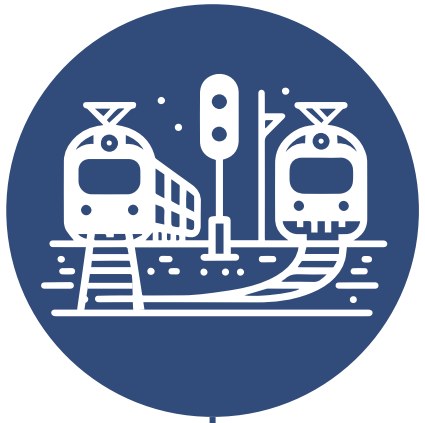
Key features

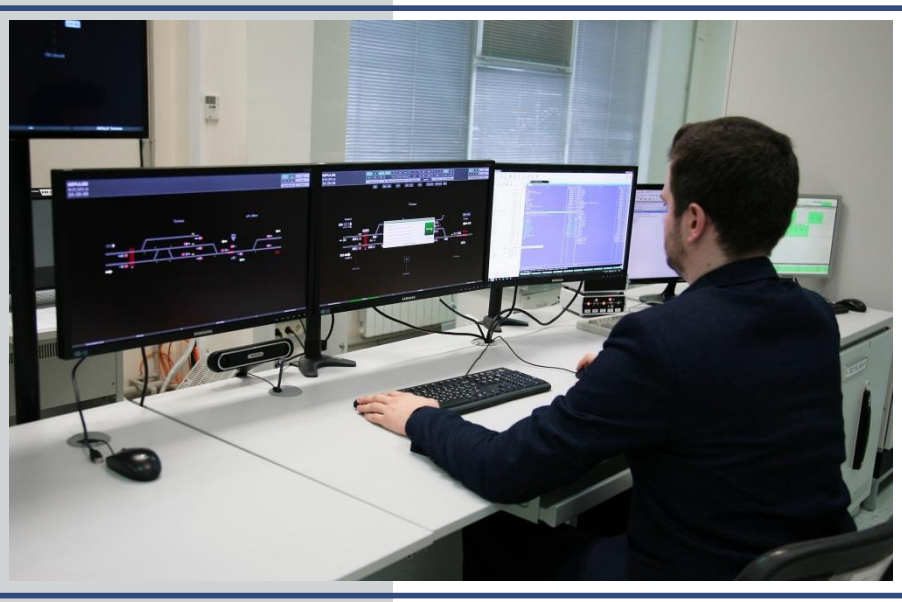
- MRC-U and ALSN signal parameters do not depend on changes in climatic conditions. Adjustment is performed once during commissioning.
- Extended control, measurement, diagnostics of electrical and timing parameters.
- Synchronization of ALSN signal formation within one system (all routes on station or open line).
- Accuracy and stability of generated signals.
- Generator + receiver tone rail circuits + ALSN generator in one module.
- "Hot" redundancy and module replacement without reconfiguration.
- Resistant to traction current harmonics and other electromagnetic interference.
- Operational support and service from the manufacturer for the entire life cycle.

Axle counting system MSSO-U

MSSO-U is applied for determining the vacancy of track sections of any type of complexity and configuration at stations and spans by axle counting method using RSR180 wheel sensors and Frauscher modules.

MSSO-U can be used in systems of various manufacturers in such railway transport segments as: high-speed, mainline and secondary railway lines; subways; industrial railway transport; light rail transport.





Combined with a semi-automatic block signaling system, an automatic checkpoint can be implemented.

Axle counting system MSSO-U

Main functions of MSSO-U (in connection with microprocessor interlocking):

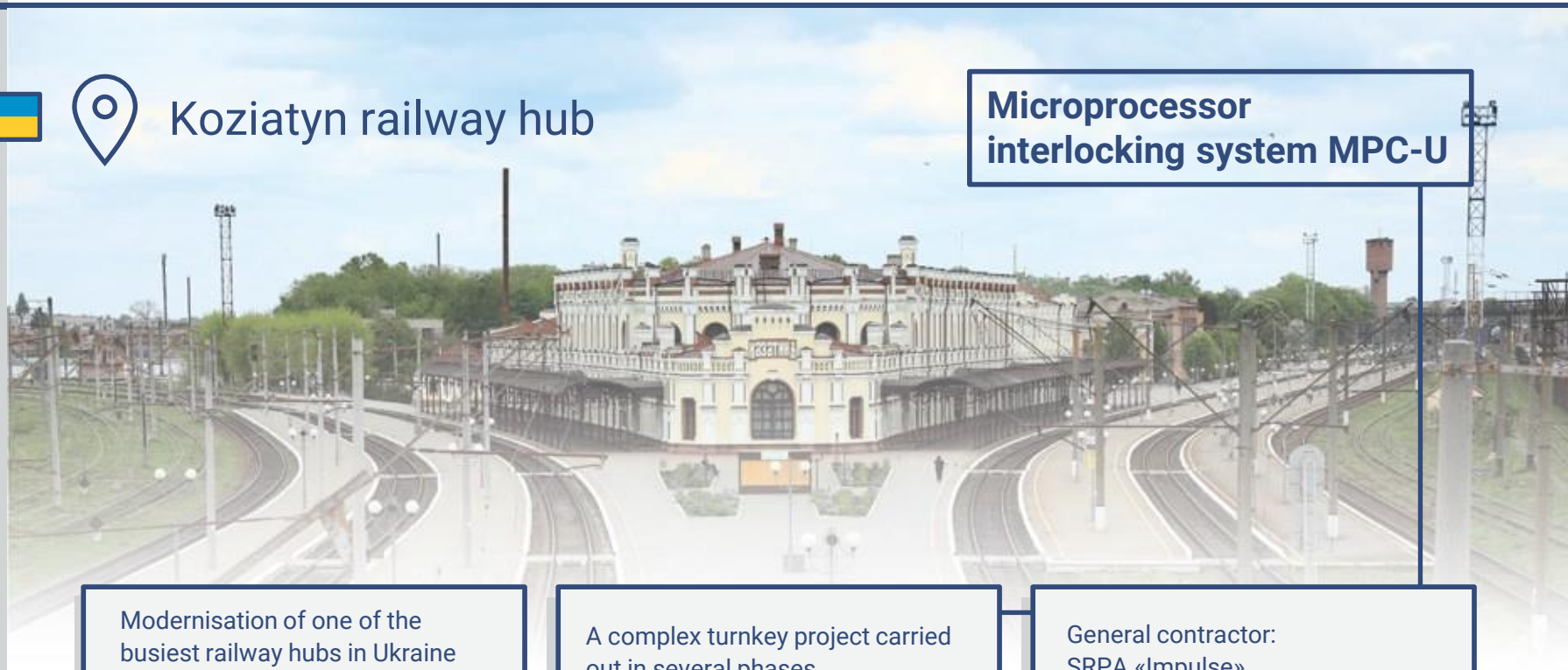
- Determination of track section status:
  - determination of vacancy;
  - resetting of false occupancy of the track section by the responsible command of the station operator;
  - determination of partial passage error (in case of prolonged presence of a wheel in the detector coverage area).

- Control of span vacancy with semi-automatic block signaling:
  - determination of the vacancy of the span;
  - automatic detection of complete rolling stock arrival;
  - coding of approach / departure sections of the adjacent to the station spans with semi-automatic block signaling;
  - display for the station operator and signal technician of information about the traffic state, status of technological objects and devices of MSSO-U.
- Interfacing with relay station systems of electric centralisation.
- Diagnostics of MSSO-U devices.

Examples of Projects Implemented

Koziatyn railway hub

Microprocessor interlocking system MPC-U



Modernisation of one of the busiest railway hubs in Ukraine (2019-2021).

A complex turnkey project carried out in several phases.

General contractor: SRPA «Impulse».

Control of a railway hub part, including:
85 points (EC-3)
44 points (EC-1).

Vacancy monitoring and coding ALSN is provided by **digital rail circuits** integrated into a MPC-U.

Completely contactless control with no relay components.

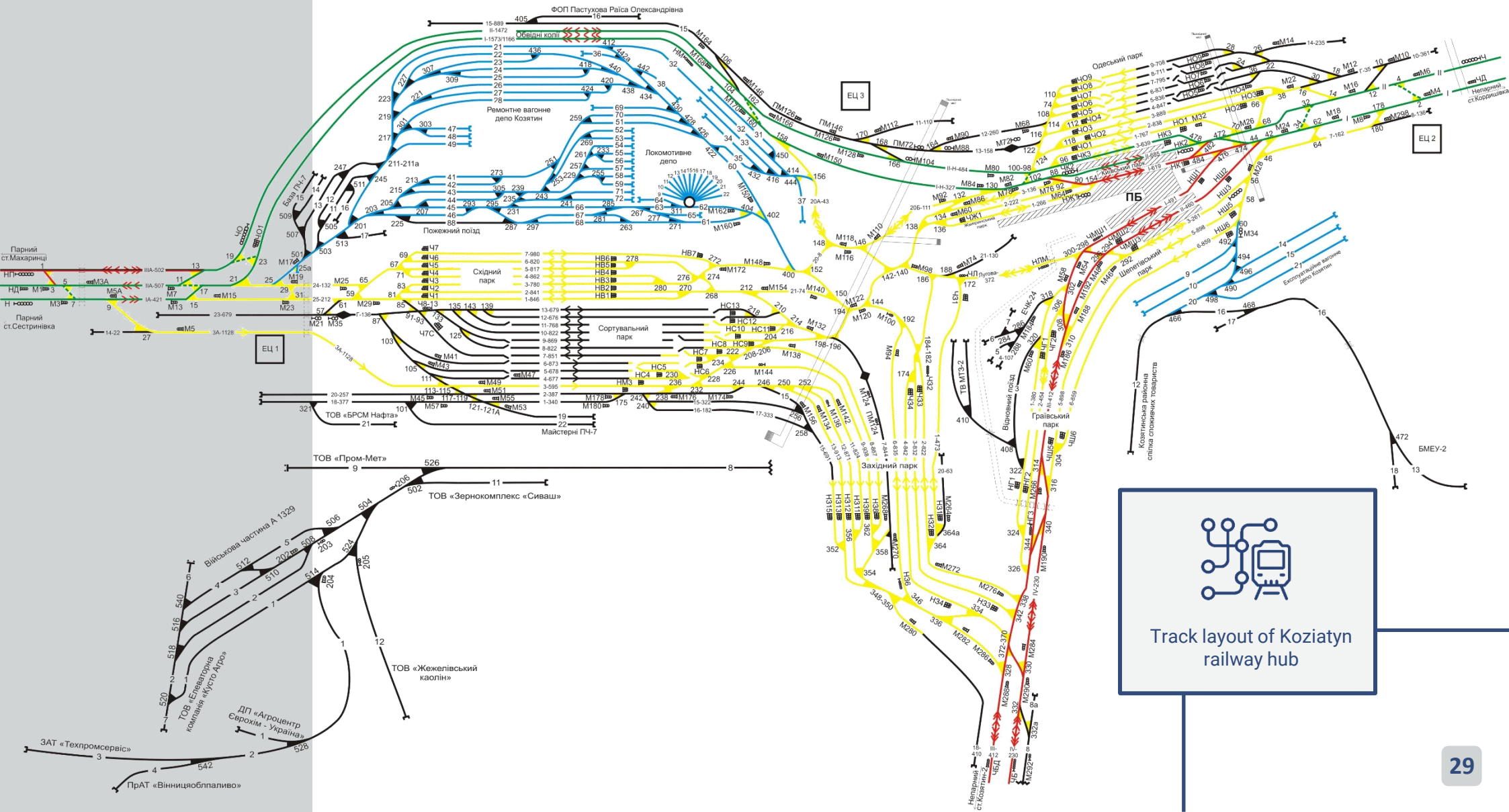
The system of complex automation of the process of disassembling the train of wagons from two low-capacity racks in different shunting areas of the railway hub, integrated into the MPC-U, has been implemented.

Communication with the main elements of the railway infrastructure is provided: level crossing automatics, automatic blocks on the adjacent spans, etc.

Examples of Projects Implemented

Koziatyn railway hub

Microprocessor interlocking system MPC-U

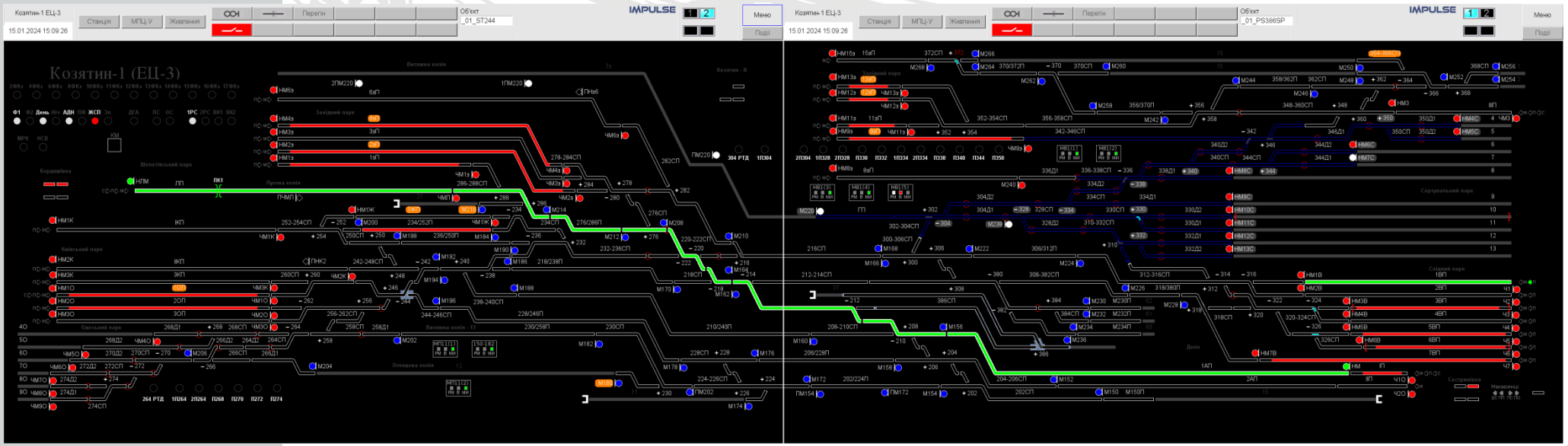


Track layout of Koziatyn railway hub

Examples of Projects Implemented

Railway hub Koziatyn premises of EC-3

Safety controllers and equipment of the object level of microprocessor interlocking system MPC-U



Examples of Projects Implemented

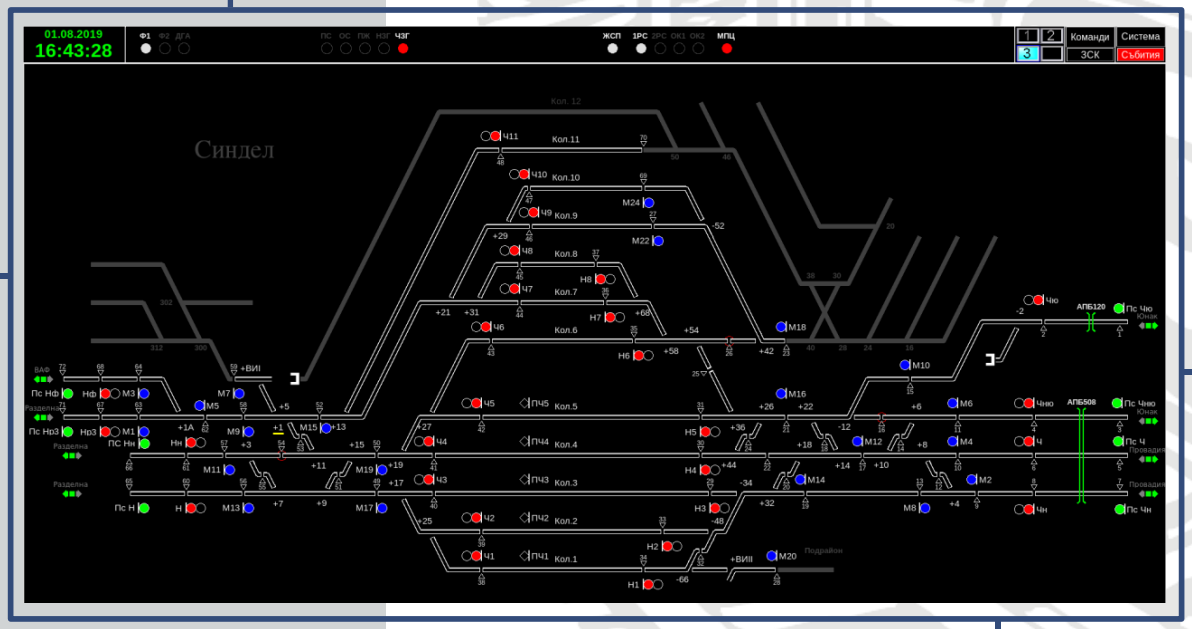
Microprocessor interlocking Sindel station, Bulgaria

Sindel - hub station, **37 switches.**

Integration with the **Frauscher axle counting subsystem** is implemented.

Digital interfaces are provided for **linkage with MDC and ETCS systems.**

The project was successfully completed in 2021.



Projects in Progress

Modernisation of rail circuits of AS Eesti Raudtee

(the project is implemented under a contract with Siemens Mobility)

Vacancy control and continuous ALSN are realised by means of digital rail circuits manufactured by SRPA «Impulse».

Contactless control of field equipment with complete elimination of relay components.

SIEMENS MOBILITY OFFICIAL SUPPLIER STATUS OBTAINED

SIEMENS

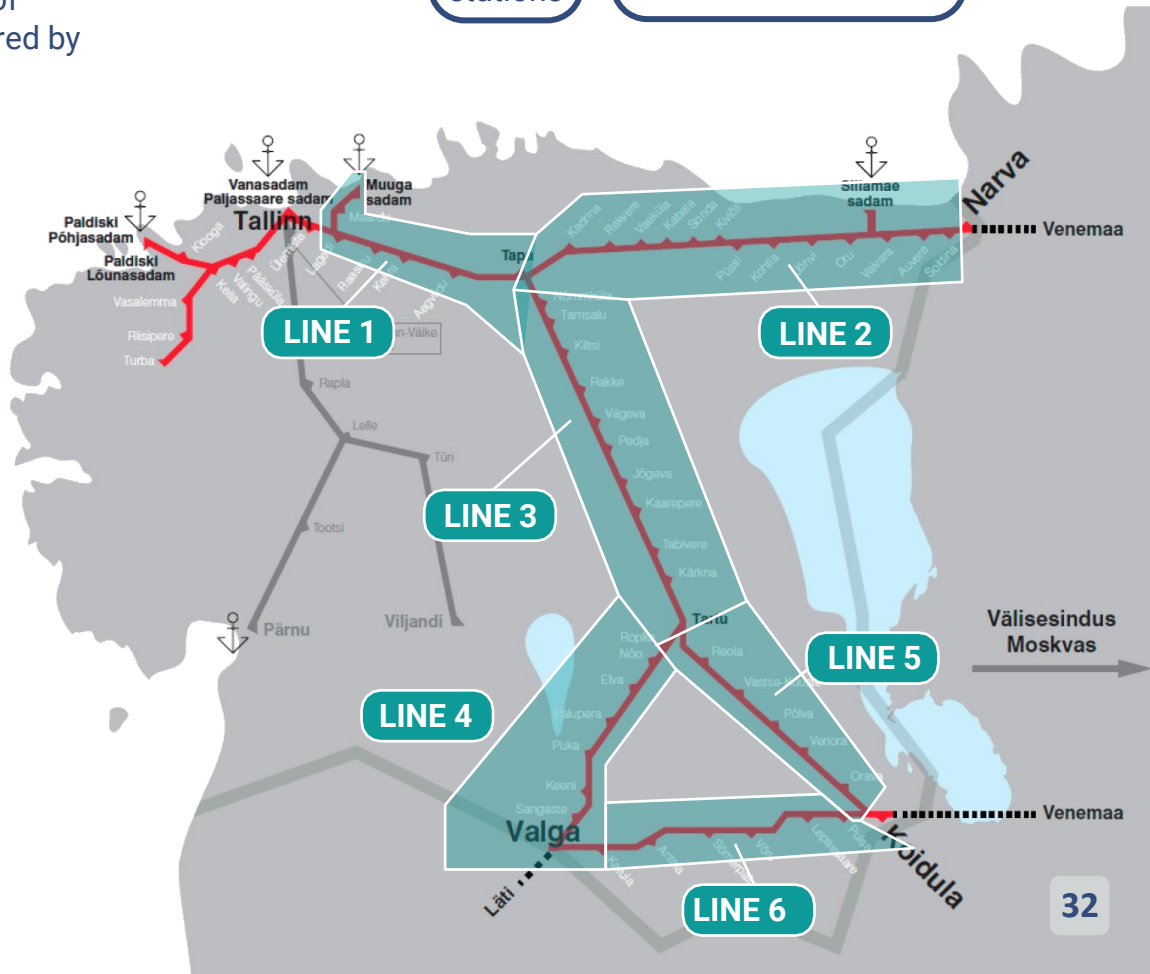
Ingenuity for life

The project covers

90% of Estonian railway infrastructure

56 stations

6 railway lines with automatic block signaling and ALSN



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