
PLUTON
TURN ON THE FUTURE

# TRACTION SUBSTATIONS

## FOR CITY ELECTRIC TRANSPORT

# ABOUT COMPANY

# PLUTON GROUP OF COMPANIES

# PLUTON GROUP OF COMPANIES. MAIN OFFICE

LLC Pluton IC
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# GENERAL INFORMATION

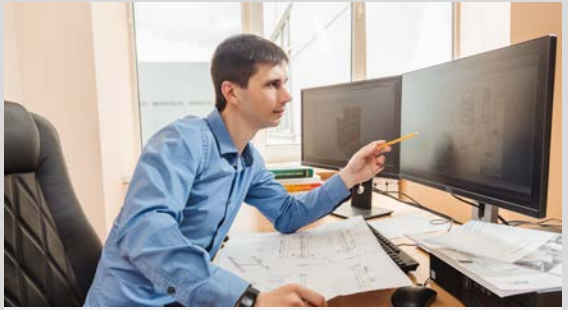
**Location of Mother Company LLC Pluton IC**

4-B Lukasha M. st.,
Lviv, 79026 Ukraine


**8 representative offices**
around the globe

**30 years of experience**
in electrical equipment manufacturing

**515 implemented projects**
in 99 cities
of the world



**Number of employees**

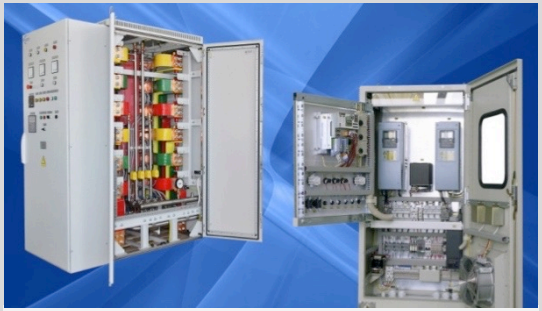
- in Ukraine – more than 320 persons;
- other countries – more than 100 persons.

**Share of exports**

- over 80 %.

# SCOPE OF ACTIVITIES

**Turn-key substations** for power industry, metro, city electric transport, railway



**Electric equipment packages**
for different mechanisms and systems

**Automatic control systems**
of technological processes at iron and steel works, power and mining enterprises, transport

# HISTORY

1970 1980 1990 2000 2010 2020

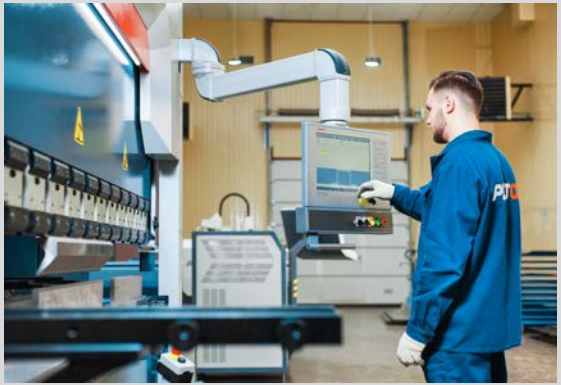
## 1970

**All-Union Production Association "Preobrazovatel"** — leading manufacturer of electrical industry

## 1992

**PLUTON** — leading manufacturer of equipment for traction substations of public electric transport, metro and railway

# PRODUCTION AREA

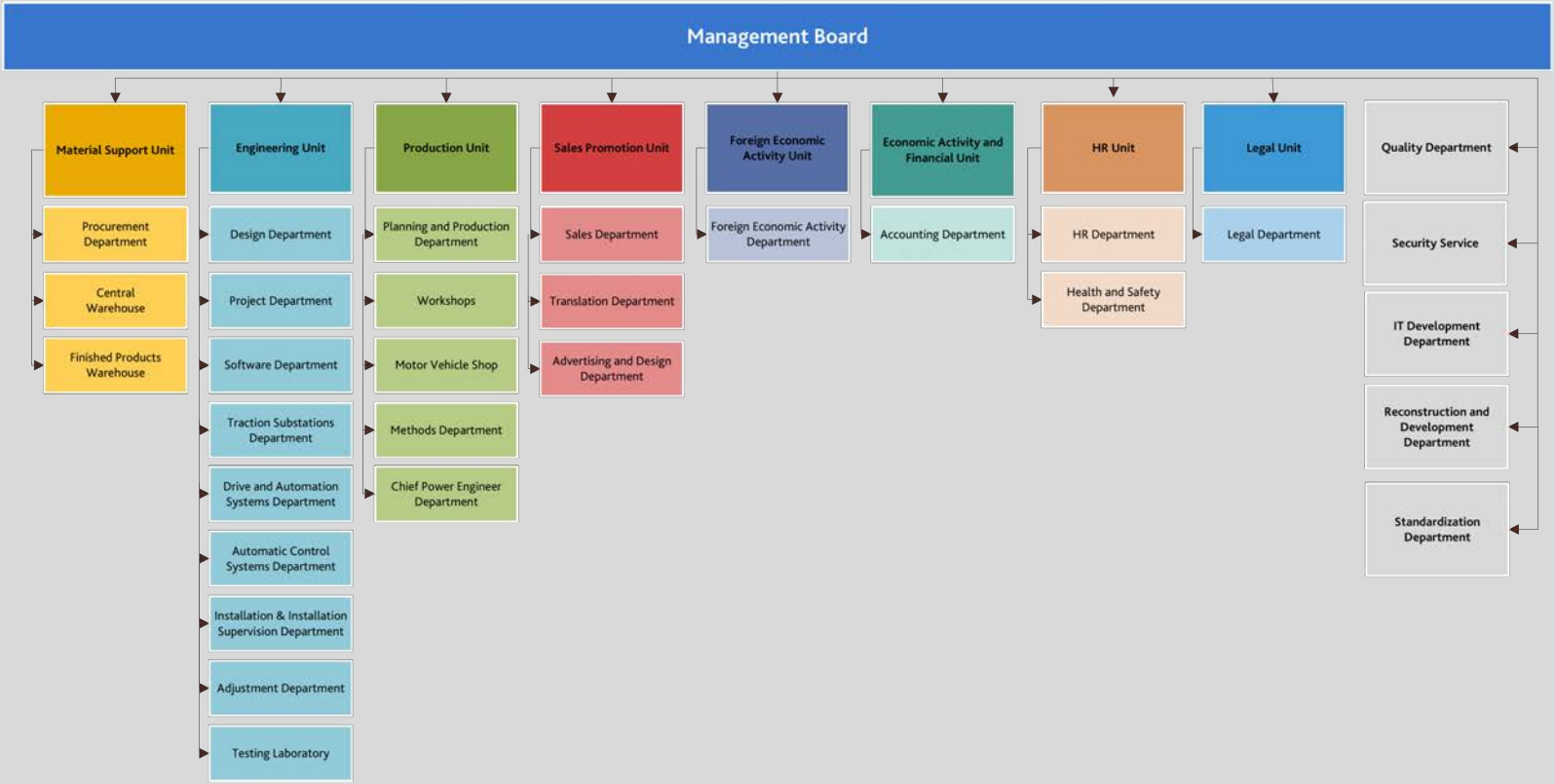


# PRODUCTION AREA



# PRODUCTION AREA
## (PLUTON POLSKA, WARSAW)


# ORGANIZATION CHART



# CONFORMITY CERTIFICATES


Quality Management System


Environmental Quality System


Occupational Health and Safety Management System

# TURN-KEY TRACTION SUBSTATIONS

# TRACTION SUBSTATIONS. EQUIPMENT

**Medium voltage switchgear 6 kV... 40.5 kV**

**rectifier units:**

- rectifiers;
- transformers

**DC Switchgear 600 V, 750 V, 1500 V**

**Auxiliary equipment:**

- control current cabinets;
- auxiliary cabinets;
- input equipment.

**SCADA System:**

- lower level including duty operator's automated workplace;
- power operator's upper level control system (SCADA).

**Modular traction substations**

# MEDIUM VOLTAGE SWITCHGEAR 6 (10) KV

## Main advantages


### Benefits of X10 Evolution medium voltage switchgear:

- **internal arc resistance** (IAC classification - AFLR), verified by type tests for localization in an accredited test center;
- **gas exhaust duct** with pressure relief valve for each compartment (except relay protection compartment);
- **protection** against operating personnel mistakes due to built-in mechanical and electromagnetic interlocks;
- ensuring an increased level of operational **safety**;
- **digital relay protection**;
- medium voltage switchgear complies with **IEC 62271-1 and IEC 62271-200** standards requirements.

# MEDIUM VOLTAGE SWITCHGEAR 6 (10) KV

## Main advantages

**Benefits of X10 Evolution medium voltage switchgear:**

- withdrawable elements with electric drive option;
- due to compact size of the switchgear, they can be placed in a substation with minimum of space, contributing to a more efficient use of area.

# MEDIUM VOLTAGE SWITCHGEAR 6 (10) KV

## Main components


### EasyPact EXE circuit breaker

- rated current: 630 A, 1250 A, 1600 A, 2000 A, 2500 A;
- rated breaking current: 25 kA-31,5 kA;
- mechanical life: 10,000 operations;
- new withdrawable trolley with the circuit breaker motorized draw-in and –out option;
- secure interlocking system;
- possibility of the circuit breaker remote draw-in/-out;
- reliable vacuum chambers, drive mechanism and withdrawable trolley.

# MEDIUM VOLTAGE SWITCHGEAR 6 (10) KV

## Main components


### EasyPact EXE circuit breaker

An important benefit of EasyPact EXE vacuum circuit breakers is their compactness and relative lightweight. They occupy less space and weight than standard circuit breakers, making them easy to install and maintain.

EasyPact EXE vacuum circuit breakers offer long service life and minimal maintenance requirements, reducing total cost of mastering them.

# RECTIFIERS

## for city electric transport and metro

Rectifiers are produced both with “zero” and “bridge” 6- and 12-pulse rectification circuits.

Rectifier arm can be made with “diode-diode” or “diode-fuse” structure.

Rectified current 800 A, 1000 A, 1250 A, 1600 A, 2000 A, 2500 A, 3000 A, 4000 A, 5000 A, 8000 A.

Rectifiers are equipped with oil and dry transformers (Resibloc®).

# RECTIFIERS
## Advantages

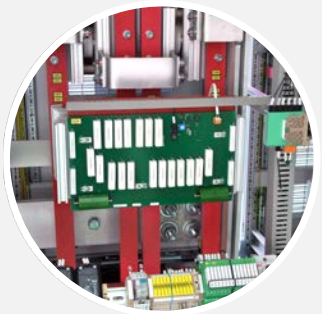
- forced **current division** in parallel branches;
- **two diodes connected in series** provides longer service life due to decrease of cyclic-repeated loads, double reserve in class;
- diodes **diagnostics** in four parameters;
- diodes heating **temperature supervisi**on;
- **protection** against overvoltage;
- support of **IEC 61850** protocol;
- **WEB interface**;
- **events protocol**.

# RECTIFIERS
## Main components

### Diodes

Pill diodes class 25 manufactured by VISHAY.

For better reliability, longer service life, each rectifier arm has 2 diodes connected in series.



### Galvanic isolation boards

Protection against internal switching surge voltage.

Information acquisition on diode condition and temperature for the analysis of diodes condition by diagnostics system.

### Protection panels

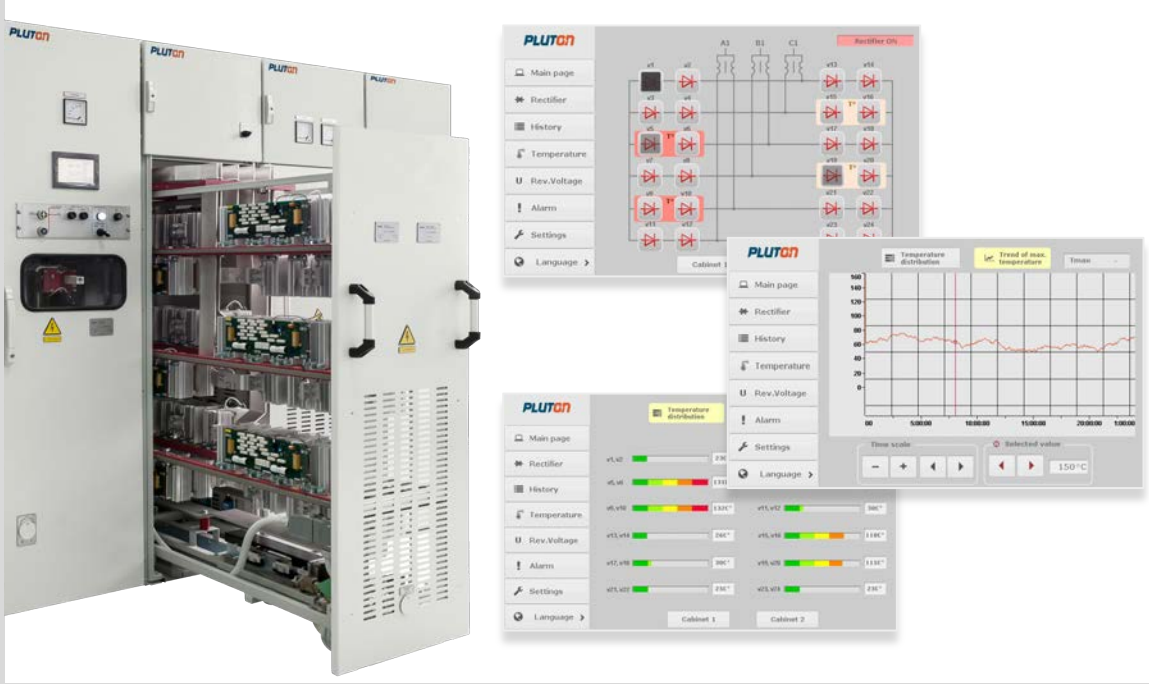
Protection of power semiconductors against external switching surge.

# RECTIFIERS
## Main components


### Protection, diagnostics and control system:

- built on the basis of **industrial controller SOTA®** manufactured by PLUTON;
- support of IEC 61850 protocol for power systems;
- monitoring of each diode parameters in dynamic mode;
- event logging;
- visualization of temperature distribution, reverse voltage distribution;
- protection of rectifier and transformer;
- communication with SCADA system.

# RECTIFIERS
## Main components




**The following information is displayed on visualization panel of SOTA® controller:**

- rectifier single-line diagram;
- events log;
- diodes temperature;
- diodes temperature variation diagram;
- reverse voltage distribution between two diodes in series;
- signals:

  - transformer overheating;
  - doors condition;
  - rectifier overheating;
  - diode parameters derating;
  - diode breakdown;
  - diode fault.

# RECTIFIERS

## Withdrawable rectifiers

PLUTON offers withdrawable rectifiers.

Advantages of withdrawable rectifiers:

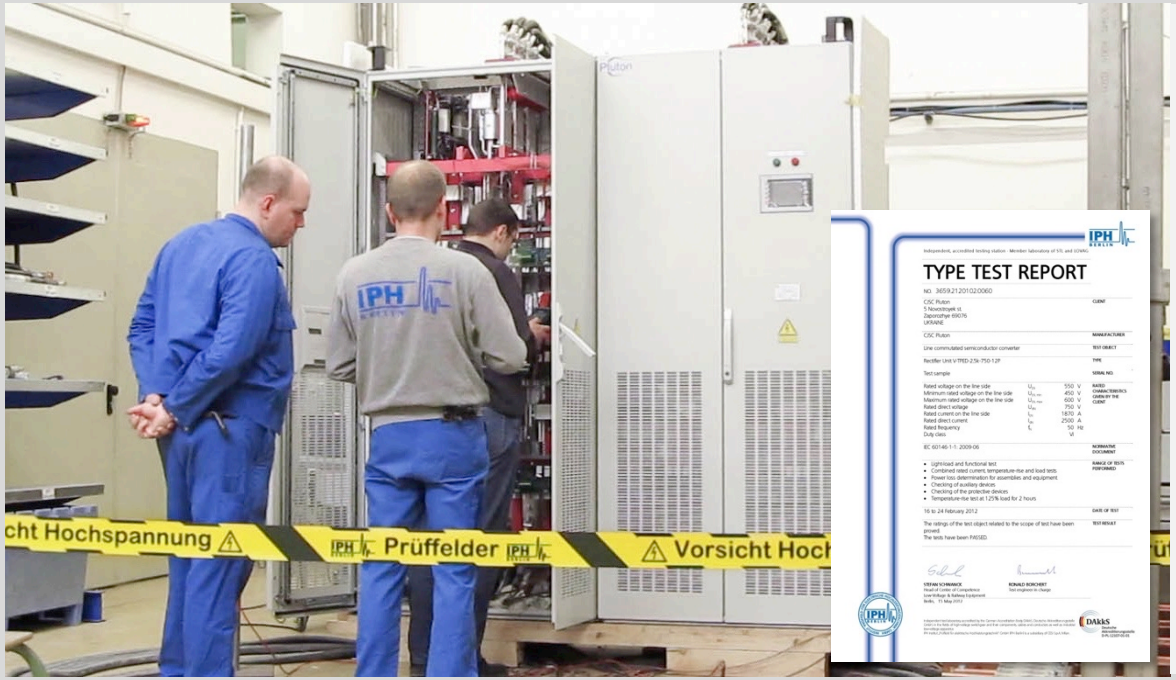
- easy access to components for convenient maintenance;
- compact design;
- operating safety;
- increased concentration of power per unit volume of rectifier.

# RECTIFIERS

## Withdrawable rectifiers

# RECTIFIERS

## IEC, EN conformity tests






TYPE TEST REPORT

NO. 3659.2120102.0060

Rectifiers manufactured by PLUTON were successfully type-tested for the **conformity to the International standards (IEC) and the European standards (EN)** in test center IPH Institut (Berlin, Germany).

# TRANSFORMERS
## Advantages

- **reliable operation** under conditions of high pollution density, high humidity, low temperature;
- **dynamic stability** of the winding – 650-750 N/mm$^2$;
- all the materials are flame-resistant and do not sustain combustion process;
- **vibration-absorbing units;**
- windings and core **temperature supervision**;
- **"cold" start** with maximum load;
- **minimum** technical maintenance;
- **increased resistance** to overvoltage and short-circuit currents.


Resibloc® transformer

# DC SWITCHGEARS

DC switchgears include components from world-leading manufacturers with high switching capacity, high dynamic resistance to short-circuit currents, and sufficient mechanical durability.

# DC SWITCHGEARS
## Advantages

- **smaller** overall dimensions;
- application of **maintenance-free** components;
- **high reliability**;
- **convenient** maintenance and personnel **safety;**
- **microprocessor monitoring and traction network protection system**;
- **high level of automation** that excludes human factor;
- **long service life** (30 years);
- **protection** against dust and humidity (protection level IP43).

# DC SWITCHGEARS
## Main components

**DC high speed circuit breaker (Sécheron, Switzerland):**

- design providing minimum maintenance;
- high switching capacity;
- minimum tripping time;
- уменьшенное перенапряжение во время отключения.

# DC SWITCHGEARS
## Main components

**DC high speed circuit breaker (Sécheron, Switzerland):**

- automatic setting of contact tightness;
- long lifetime;
- insulation material wiping under arc;
- stepless regulation of trip setting;
- high mechanical resistance — 8x25000 cycles.

# DC SWITCHGEARS
## Main components


AFB ARC-FREE CIRCUIT BREAKER



AFB40 AFB25

**AFB® arc-free ultra high-speed DC circuit breaker (PLUTON):**

- arc-free commutation principle, high wear resistance, the lowest maintenance;
- ultra high speed of short circuit currents interruption;
- safety and environmental friendliness, no damaging effect of arc.

# DC SWITCHGEARS
## Main components

### Service busbar double-pole disconnector:

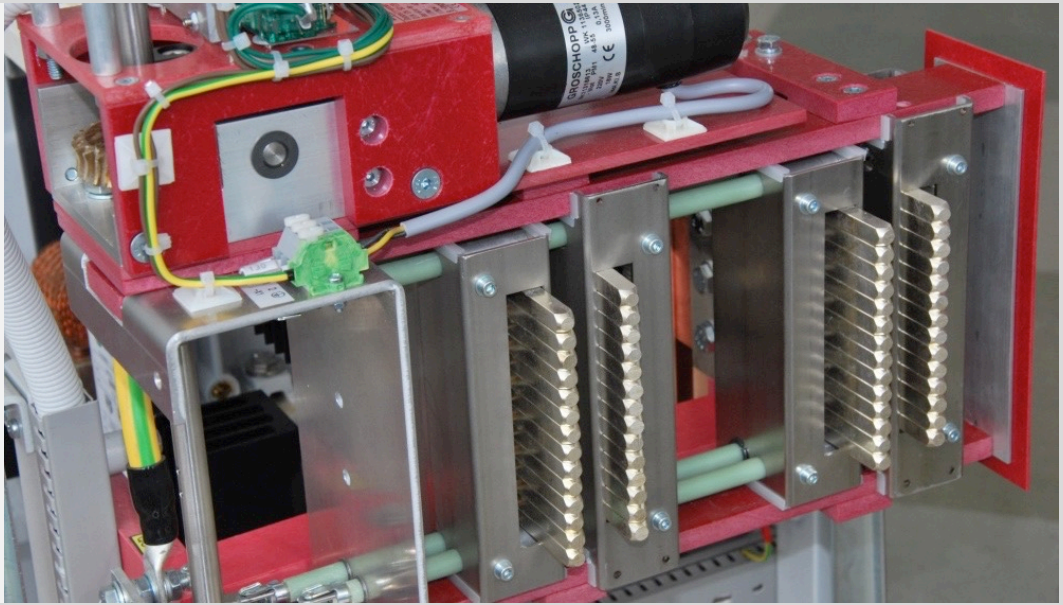
- wiping contacts;
- long time without maintenance (once every 10 years);
- silent economic electric drive (18 W);
- high electrodynamic resistance;
- high mechanical resistance (30 000 cycles);
- allows to install trolley into service position without mechanical effort.

# DC SWITCHGEARS
## Main components

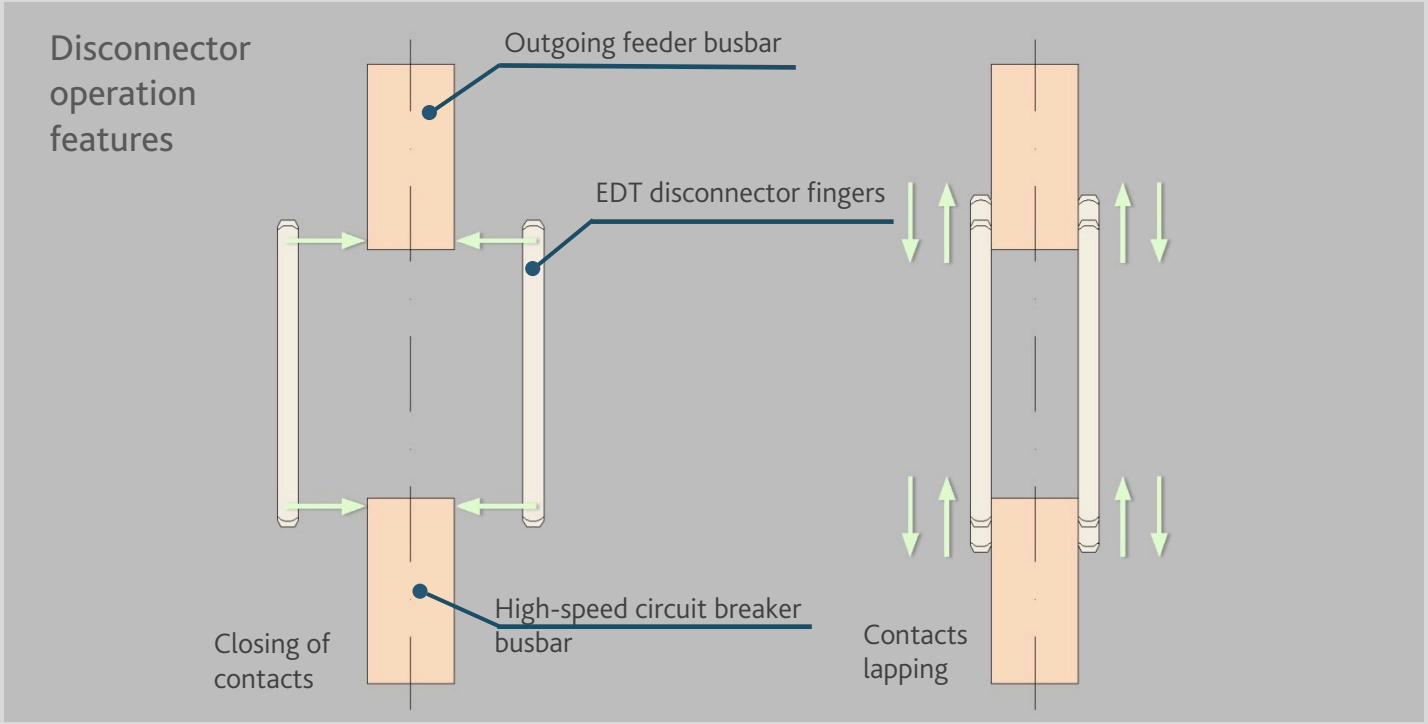
### Service busbar double-pole disconnector

Disconnectors have unique design of contact system. The contacts move during operation and crimp the busbar.

Disconnectors require lowest maintenance, once every 10 years.

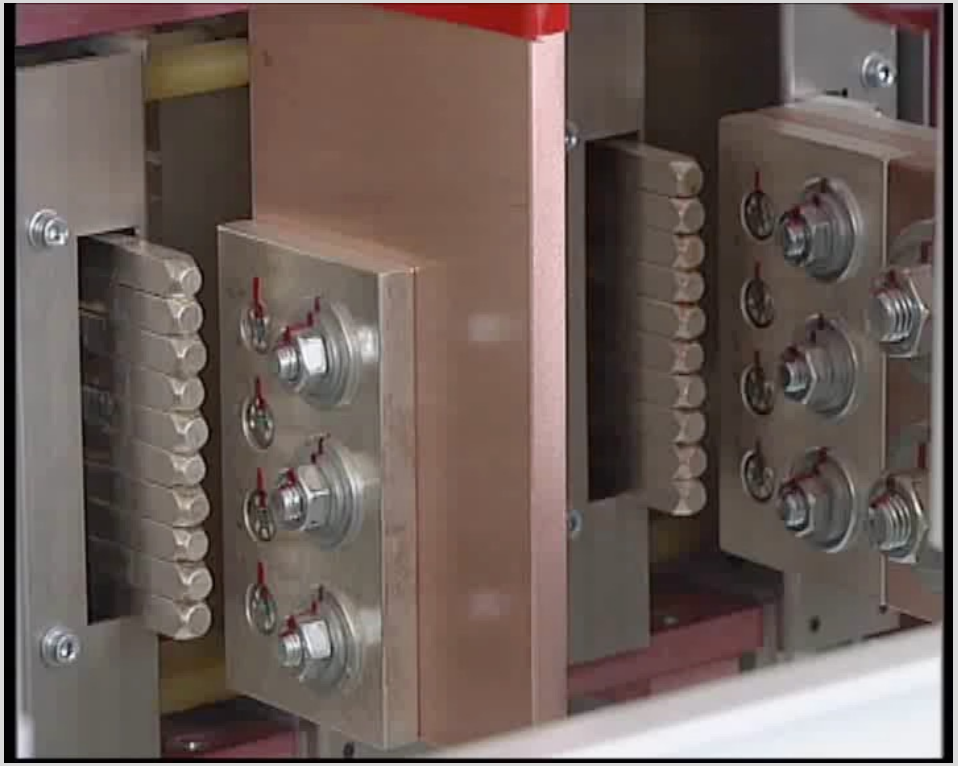


# DC SWITCHGEARS
## Main components



# DC SWITCHGEARS

## Main components



# DC SWITCHGEARS

# DC SWITCHGEARS

# DC SWITCHGEARS

## Main components

### Cable control system:

- resistance measurement range of external cable insulation — 50-500 kOhm, of internal cable insulation — 200-2000 kOhm;
- operating line power supply;
- 3 pairs of discrete failure signals;
- galvanic isolation from processing module (SMTN-3 system) by means of optic fiber.

# DC SWITCHGEARS

## Main components

### Line tester (short circuits tester SCT):

- line resistance measurement;
- high speed circuit breaker tripping interlock.

# DC SWITCHGEARS
## Main components

**SOTA® system** is a combined microprocessor-based relay protection device. This solution combines relay protection and PLC systems into a single modular system for performing a wide range of tasks.

Modular architecture of SOTA® system, combined with modern surface mount technology, ensures high reliability, high processing power, and fast response.

SOTA® provides high precision measurement of electrical values and time intervals to improve performance of processing operations and response of protection functions.

# SOTA®
## Main functions


Traction network parameters monitoring


Emergency processes waveforms recording


Data collection for further analysis


Traction network protection against short-circuit current and overloads


Events logging


System remote control


Cubicle operation control (PLC)


Daily trends storage


Communications protocols support

# SOTA®
## Protection functions

SOTA® provides the following protections:

| | |
|---|---|
| **Io** | instantaneous overcurrent (ANSI 50) |
| **Imax** | time overcurrent protection (ANSI 76) |
| **di/dt** | current rate of rise protection |
| **ΔI** | current increment directional protection |
| **I(t)** | time/current protection (ANSI 49) |

| | |
|---|---|
| **Umin** | undervoltage protection(ANSI 27) |
| **Umax** | overvoltage protection (ANSI 59) |
| **BF** | breaker failure |
| **DDL** | DDL protection |
| **R-prot.** | impedance protection |

# SOTA®
## Control functions

- displaying the required information on visualization panel with liquid crystal graphic display;
- switching units control in convenient intuitive form;
- PLC operation algorithms programming using IEC 61131-3 standard languages (ST, IL, LD, FBD, SFC).

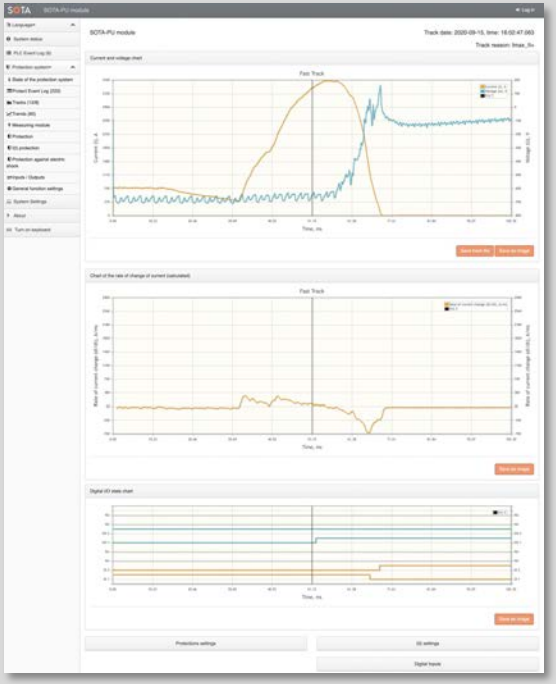

Visualization panel

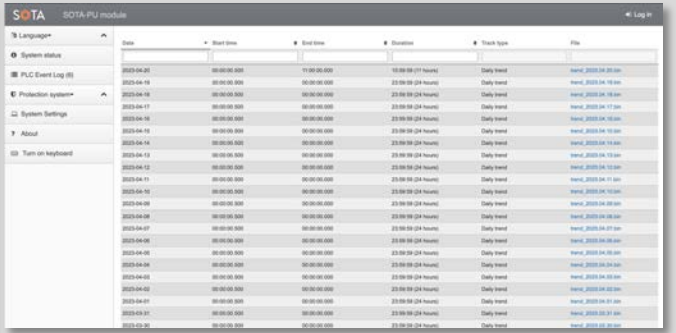
SOTA® processing module

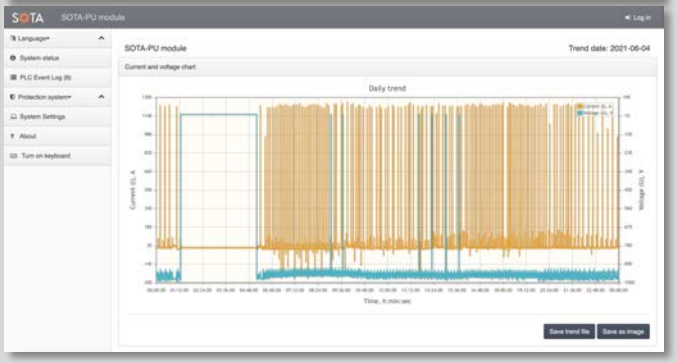
# SOTA®
## Measuring and recording functions

SOTA® generates and stores the following records:

- events log;
  failures log;
- emergency oscillograph records (Fast track, Slow track);
- daily trends







# SOTA®
## Measuring and recording functions

Emergency records can be:

- viewed using **Web-interface**,
- read by upper level system via **Ethernet interface**,
- saved on external **USB disc** for later analysis using PC.

# SOTA®
## Data storage functions

SOTA® stores emergency processes data for further analysis:

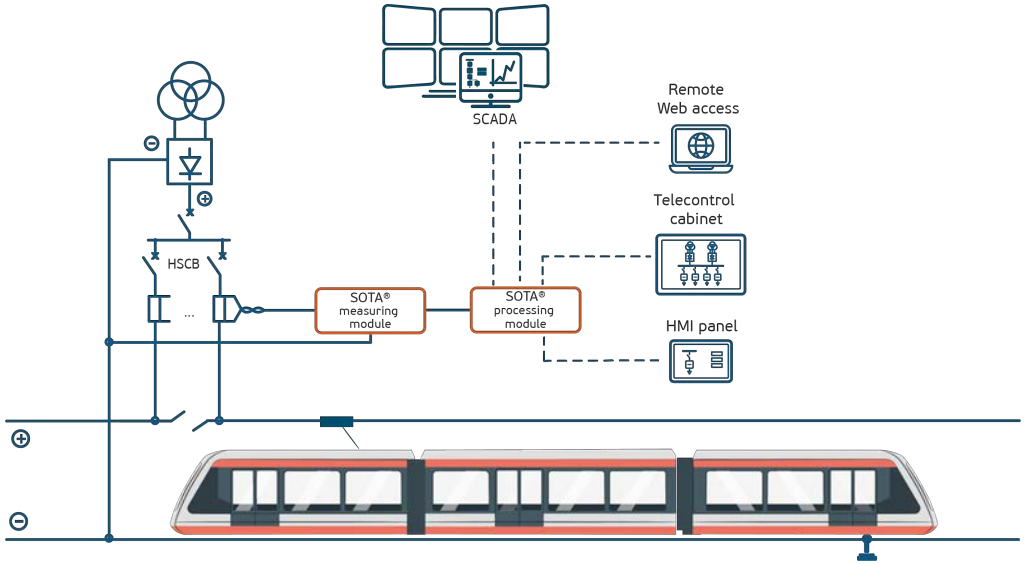
**up to 200 emergency records**
(Fast track, Slow track)

**up to 200 days**
in events log

**up to 60 days**
daily trends

# SOTA®
## Communication functions

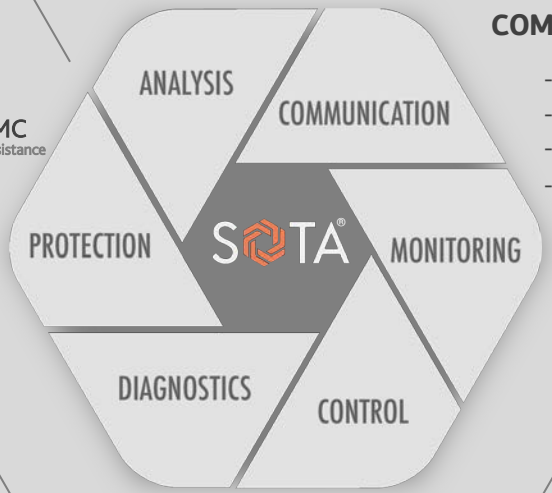
- reading of traction network actual electrical parameters by the upper level system from SOTA® (or their independent transfer when using IEC 61850 protocol);
- two-way data transfer between SOTA® and ACS, PC via standard communication channels.



# SOTA®
## Advantages

### COMPLIANCE WITH INTERNATIONAL STANDARDS

- IEC 60068-2-1, -2, -6, -14, -27, -30, -31, -78
- IEC 60255-21-1, -2, -32
- IEC 61131-1,2
- IEC 60255-26 EMC mechanical and climatic resistance



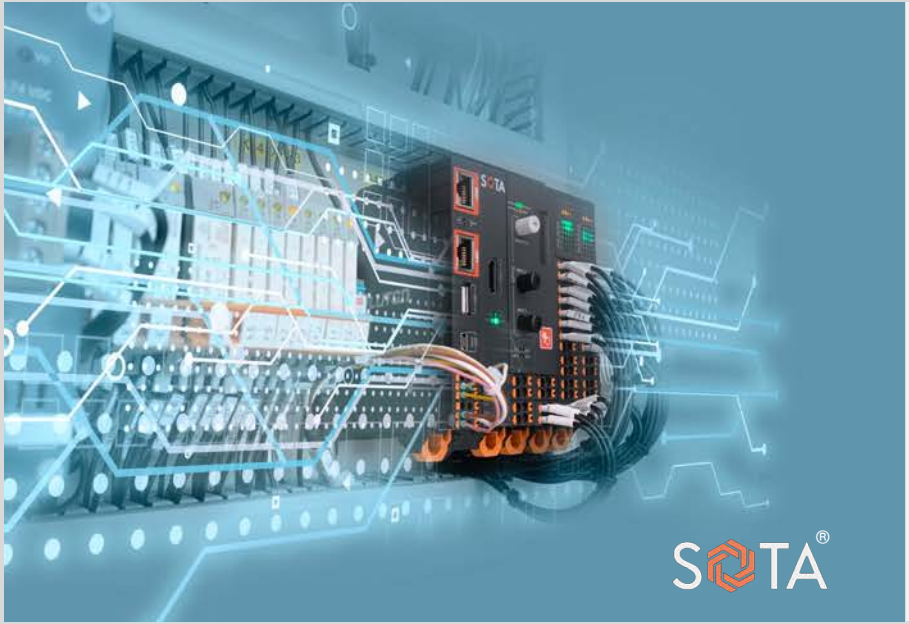

### COMMUNICATION PROTOCOLS SUPPORT

- IEC 61850
- IEC 60870-5-101
- IEC 60870-5-103
- IEC 60870-5-104
- Modbus
- DNP 3.0
- CANopen
- SNTP client

### PLC PROGRAMMING LANGUAGES SUPPORT

- IEC 61131-3

# SOTA®
## IEC 61850

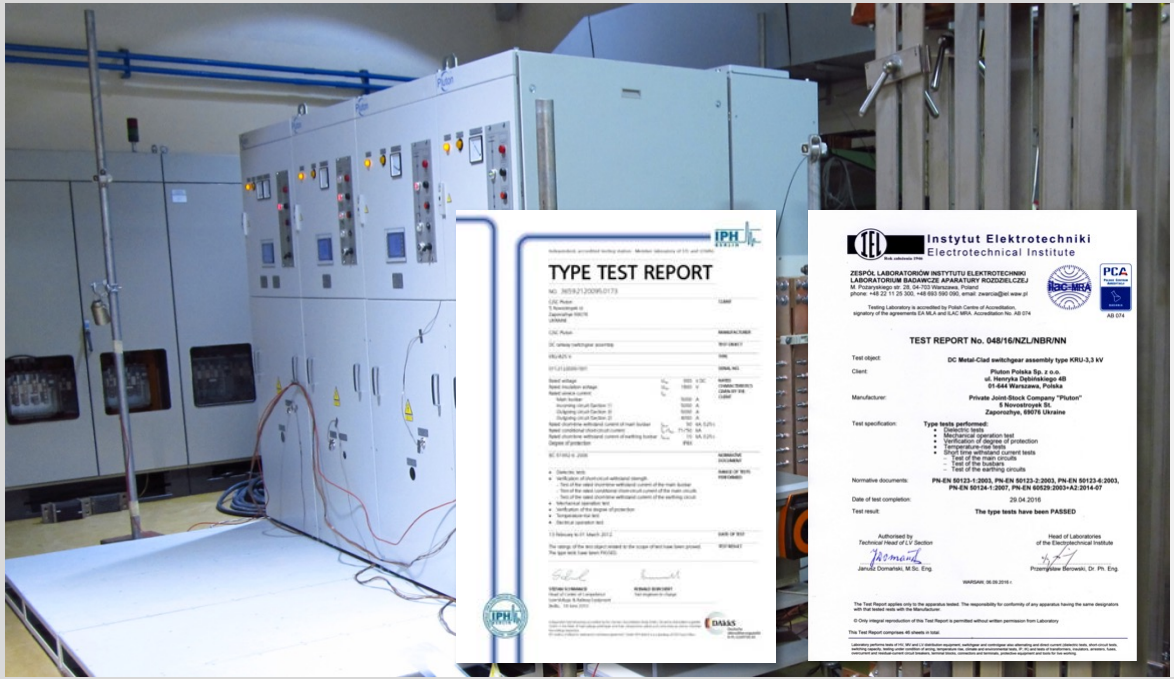



**IEC 61850** is a universally applicable international standard that allows to arrange unrelated solutions produced by different manufacturers of relay protection equipment and data transfer systems that are applied at the substations.

IEC 61850 provides:

- signal transfer reliability increase;
- compatibility and interchangeability of equipment in case of substation expansion (modernization);
- application of IEC 61850 standard opens up opportunities for future transition from traditional to digital substation, i.e. to a qualitatively new level of power facilities automation and control.

# DC SWITCHGEARS
## IEC, EN conformity tests




DC switchgears manufactured by PLUTON were successfully type-tested for **compliance with International Electrotechnical Commission (IEC) standards** and **European standards (EN)** in such test centers as IPH Institut (Berlin, Germany) and IEL (Warsaw, Poland) including internal arc testing.

# NEGATIVE BUSBAR SWITCHGEAR

## Advantages

- high **reliability and repairability**;
- **easy access** to measuring instruments, and also to the components subject to regulation, adjustment and internal inspection;
- **integration** into common automatic system of traction substation control and communication with upper control level.

# AUXILIARIES EQUIPMENT

Auxiliary set consists of:

- auxiliary cabinet;
- input equipment;
- control current cabinet.

Set of auxiliary cabinets **links up ideally** with other equipment that we supply for public electric transport traction substations.

Equipment includes relay-switching units from **world-leading manufacturers**.

# AUXILIARIES EQUIPMENT
## Advantages

- **high reliability;**
- **smaller** dimensions and weight;
- **convenient maintenance** and less time for maintenance and trouble-shooting;
- **lower fire possibility**;
- **personnel protection** against electrical shock;
- **integration** into common automatic system of traction substation control system and communication with upper control level.

# INNOVATIONS

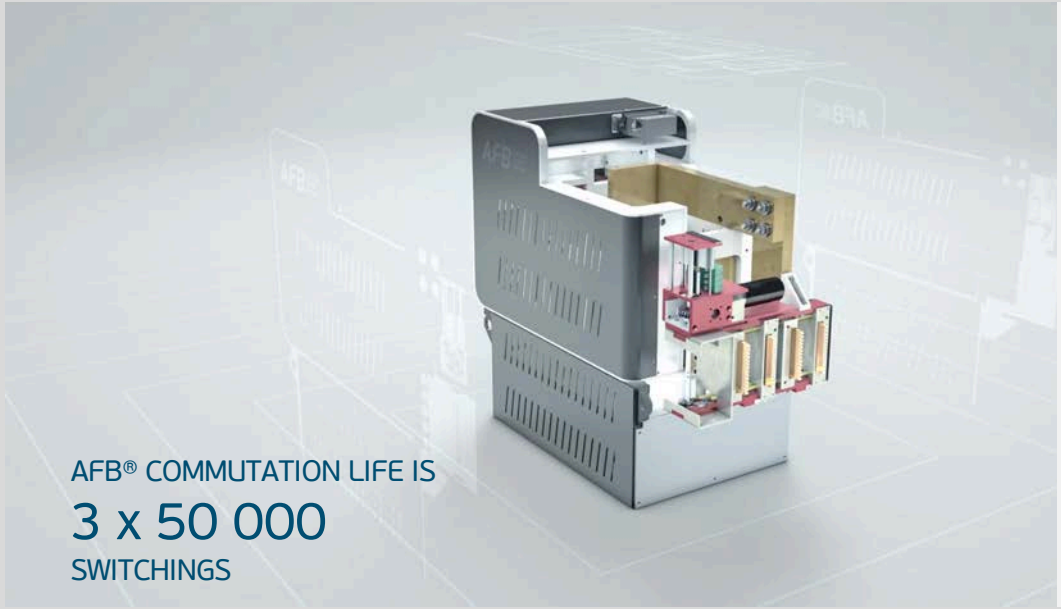
## DC switchgear with arc-free circuit breaker

AFB ARC-FREE CIRCUIT BREAKER


Arc-free ultra high-speed
DC circuit breaker

# INNOVATIONS

## DC switchgear with arc-free circuit breaker



AFB® COMMUTATION LIFE IS

**3 x 50 000**

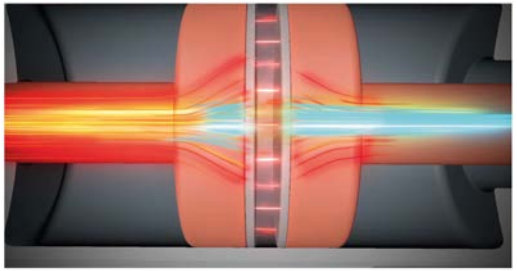
SWITCHINGS

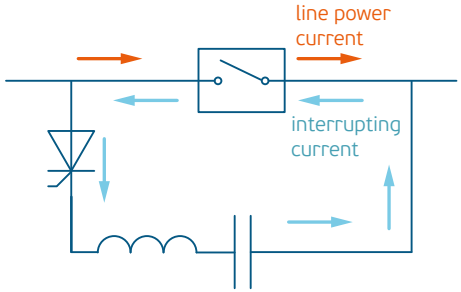
### Lowest maintenance:

- **number of emergency** current interruptions is **much greater** in comparison with circuit breaker with standard switching and arc interruption;
- no arc interruption contacts, and as a result, no need for their periodic **replacement**;
- no main contacts **wear**;
- no need of contacts **inspection** after emergency currents interruption with unlimited number of trippings.

# INNOVATIONS

## DC switchgear with arc-free circuit breaker






### Operating principle

The main innovation of AFB® circuit breaker is operation of main contact in vacuum. Pre-charged high-voltage capacitor generates current to interrupt short-circuit current in antiphase to the main circuit current. The contact opens in vacuum interrupter, when currents algebraic sum is zero.

Thus, the main contact opens with a current value close to zero.

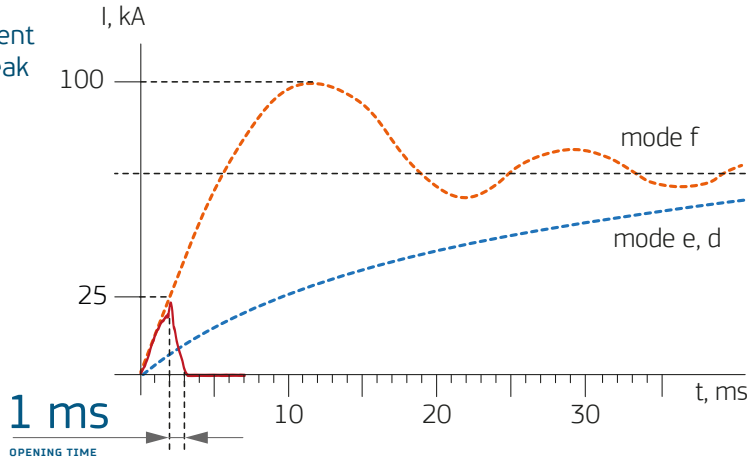
# INNOVATIONS

## DC switchgear with arc-free circuit breaker

**<25 kA**

short circuit current limitation with peak calculated value

**100 kA**



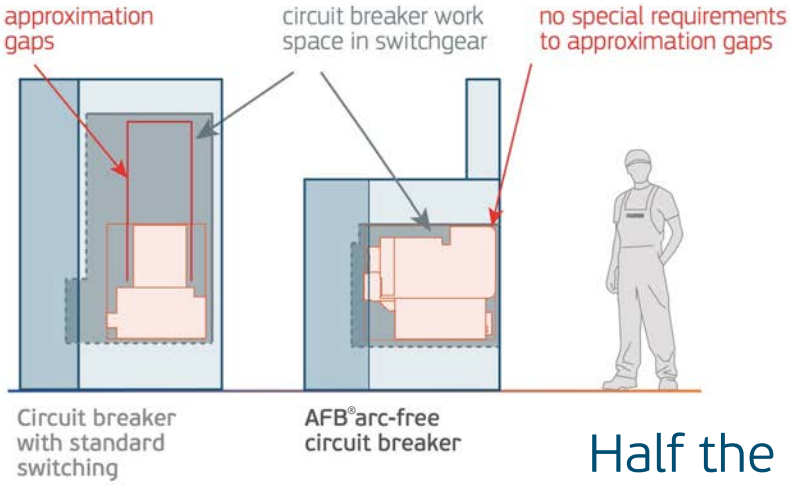

AFB® provides high-speed power contact opening and circuit breaker di/dt tripping before short-circuit setting reaching.

Opening time is **<1 ms**, with minimum level of overloads ejected into contact network (max. 2 kV).

AFB® circuit breaker provides secure low current interruption, and as a result, circuit breaker contacts damage prevention.

# INNOVATIONS

## DC switchgear with arc-free circuit breaker




**Half the size**
of work space

### Compact design

In contrast to standard contact circuit breaker, which requires additional work space for plasma ejection in its operation, AFB® circuit breaker applies principle of power circuit interruption in vacuum, thereby leading to reduction of switchgear work space.

# INNOVATIONS

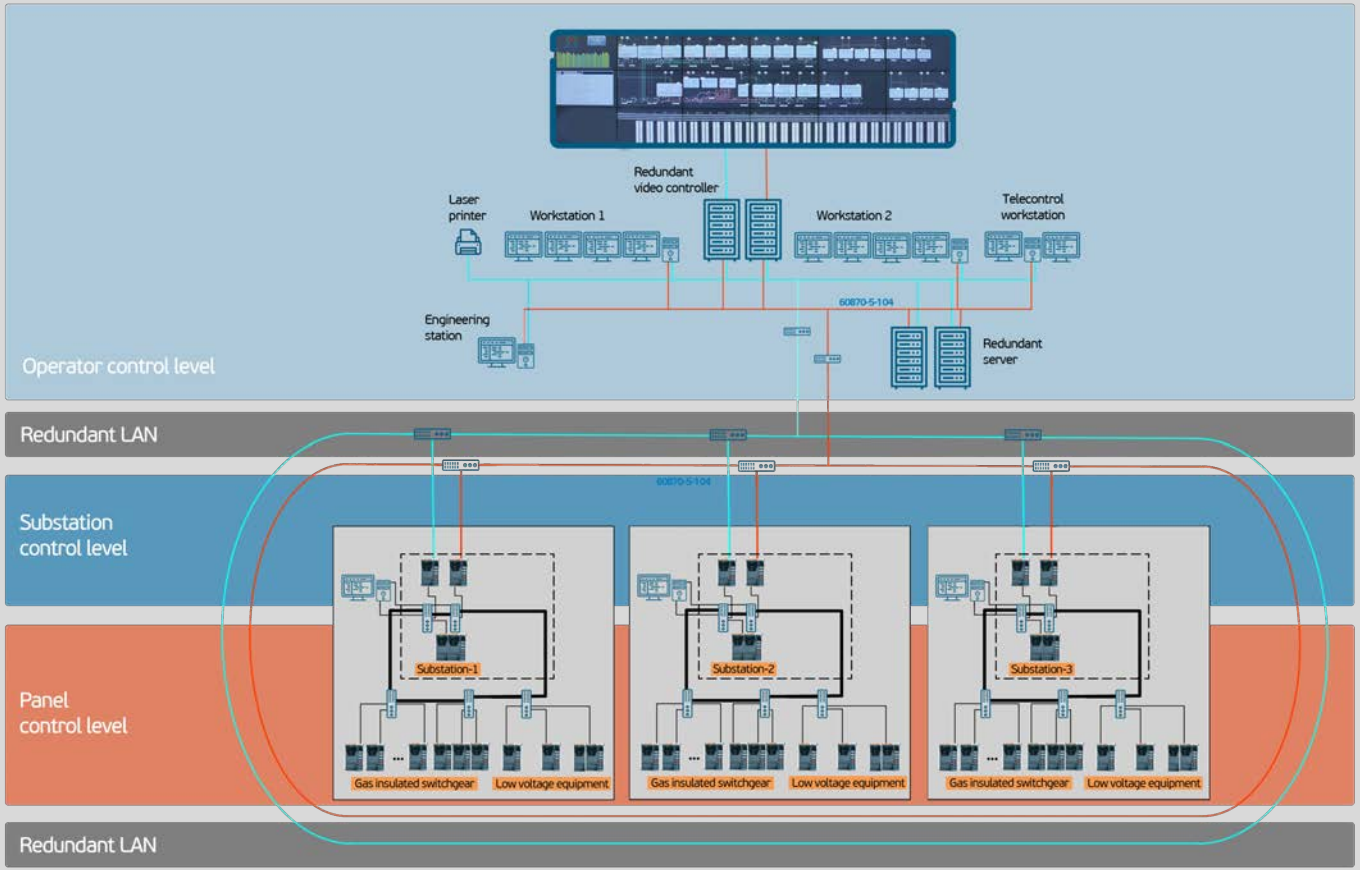
## DC switchgear with arc-free circuit breaker


### Operational and environmental safety:

- no arc plasma emission upon interruption;
- no combustion products and their deposits on circuit breaker components and switchgear units;
- no arc plasma overpressure in switchgear during switching;
- fire risk reduction.

# SCADA SYSTEM

SCADA System
has **three-level structure:**



# SCADA SYSTEM

1st level. Panel control

Traction substation equipment (switchgear, rectifiers, auxiliary equipment, etc.) is controlled **at the first level.**

The first level of control is implemented on the basis of modern industrial controllers built into the equipment.

Controllers **monitor and control** equipment, as well as perform **protection functions.**

# SCADA SYSTEM

2nd level. Substation control

**Second level** provides general substation control.

Substation control level provides:

- **supervision** of current mode and status of the main circuit of the substation from the automatic workplace of operation personnel;
- **control** of switching units in normal and emergency modes;
- **registration** of emergency messages;
- **events logging**;
- **display** of current status of traction substation equipment, operation of hardware and software, etc. on mimic diagrams of the monitor.

# SCADA SYSTEM

3rd level. Operator control

**The third level** of control combines dispersed traction substations into a **single system**, which provides **remote control and monitoring** using software and hardware of **operations control center**.

Modern backup servers are applied for collecting and processing of data from substation controllers. Power operators **workstations**, as well as **video wall** displaying the state of all substations electrical equipment is provided for substations operational control.

# SCADA SYSTEM

# MODULAR TRACTION SUBSTATIONS


Modular traction substation is an **integrated solution** for reliable power supply of electric transport catenary.

Modular traction substation can be used as **transportable or fixed** electric power distribution point.

Modular traction substation is designed for operation **in automatic mode** being an unattended installation.

# MODULAR TRACTION SUBSTATIONS
## Advantages

- **minimum of construction works** on installation site;
- **high readiness** for commissioning;
- **rapid mounting** (simple connection of primary and secondary circuits);
- **possibility to configure** different circuits;
- antiburglar **protection** and disassembling;
- **easy access** to equipment;
- **mobility** and possibility to move to the new operation place.

# MODULAR TRACTION SUBSTATIONS

Modular traction substation is a functionally finished product with organization of power and secondary circuits connections.

Modular traction substation can be of single-, double- or triple-unit type.

Manufacturing of modular traction substation for a more number of units is possible on case of necessity.

Modules are mechanically unrelated, and are installed in accordance with the design solution.

# MODULAR TRACTION SUBSTATIONS

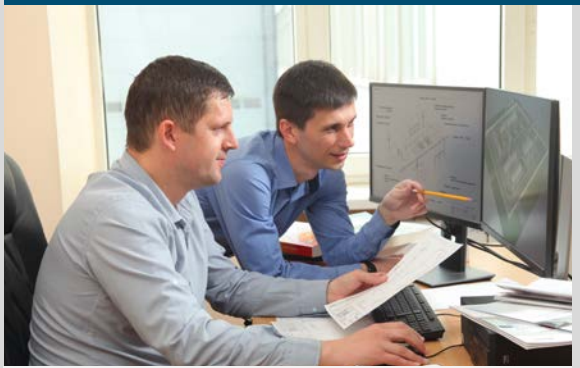
Reliable power supply is provided by modern traction equipment system, **automatically** controlled by SCADA system.

Modular traction substation is equipped with:

- operating and emergency lighting system;
- heating, ventilation, air conditioning system;
- intruder alarm;
- fire extinguishing system.

# CUSTOMER CARE

## PACKAGED APPROACH TO THE PROJECTS OF ANY COMPLEXITY



### DESIGN WORKS

- project audit;
- recommendations for equipment selection;
- engineering surveys;
- development of design documentation;
- field supervision.

### PRODUCTION AND ENGINEERING

- manufacturing;
- delivery to the site
- full-scale tests;
- installation and commissioning;
- start-up.


### AFTER-SALES SERVICE

- training of the Customer's personnel;
- providing operational support;
- warranty and after-sales service.

# IMPLEMENTED PROJECTS

# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

**Sweden,**
**Stockholm**

Supply of equipment for **10** traction substations (Högberga, Baggeby, Käppala, Ropsten, Aga, Sickla, Arninge, Konsthallen, Vallentuna, Lindholmen):

- rectifier - 10 units
- DC switchgear 750 V - 33 units
  including DC switchgear with
  AFB circuit breaker - 3 units
- DC switchgear 1500 V - 18 units
- high-speed circuit breaker test device - 9 units
- service equipment - 4 sets




# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

### Republic of Poland, Lodz

Turn-key project. Supply of Telefoniczna substation.
Current turn-key project: Reconstruction of Wacława and Zapolska traction substations.

- MV switchgear 17,5 kV - 3 sets
- DC switchgear 660 V (RU-600, RU-660RV, RU-660PSH) - 52 units
- rectifier - 12 units
- transformer - 12 units
- auxiliaries equipment - 6 units
- AC switchgear 0.4 kV - 1 set
- SCADA system - 3 sets

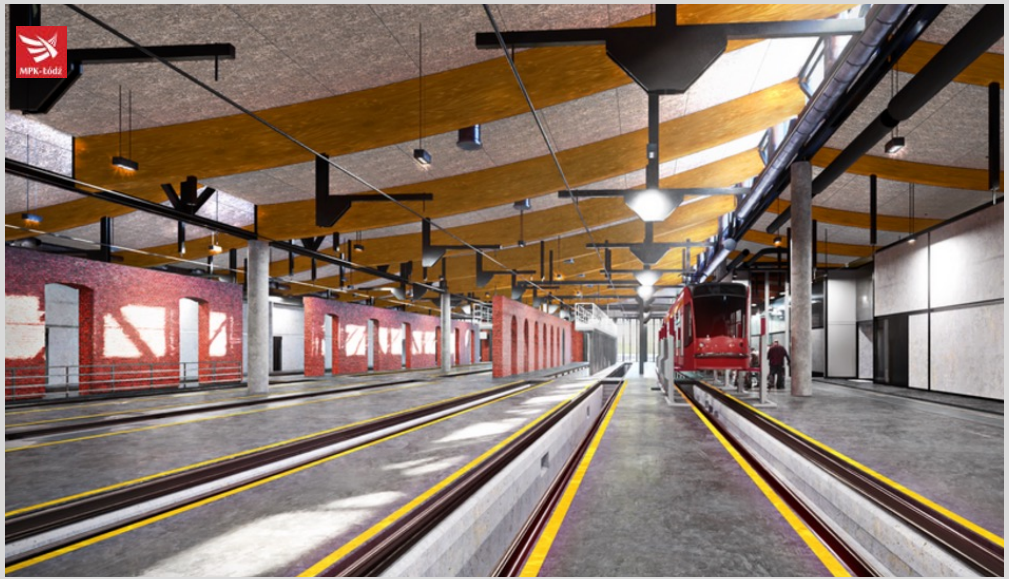


# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

### Republic of Poland, Lodz

Current turn-key project: Chocianowice depot reconstruction.

- DC switchgear 660 V - 3 units
- rectifier - 3 units
- transformer - 3 units
- equipment for retrofit of Switchgears 600 V - 12 sets
- equipment for retrofit of auxiliaries - 1 set
- MV relay protection and automation - 3 units
- MV cubicles, transformers, MV relay protection and automation upgrade package - 12 sets
- disconnectors control cabinets - 1 unit
- busbars connection cubicle - 1 unit



# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

### Republic of Poland,
### Lodz

Turnkey project: modernized automated operations control system for Lodz central operations control center and connection of 32 tram substations.

- reconstruction project;
- development of HMI design;
- equipment supply: power cabinet, server cabinet, 4x3 video wall, workstations;
- development of SCADA software;
- installation and commissioning.


# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

**Republic of Poland,**
**Zgierz, Konstantynów Łodzki**

Turn-key project.
Supply of Łąkowa two-unit modular traction substation.
Current turnkey project:
Supply of Przygraniczna two-unit modular traction substation.

- module - 4 units
- MV switchgear 17,5 kV - 2 sets
- rectifier - 4 units
- transformer - 4 units
- DC Switchgear 660 V with AFB circuit breaker - 16 units
- DC Switchgear 660 V (RU-660RV, RU-660PSH) - 6 units
- auxiliaries equipment - 6 sets
- SCADA system - 2 sets



# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

**Republic of Poland,**
**Poznan**

Trial operation of DC switchgear at Bóżnicza substation:

- DC switchgear 660 V - 1 unit

# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

**Romania,**
**Oradea**

Turn-key project:
Supply of Cicero two-unit modular traction substation.

- module - 2 units
- switchgear SM6 20 kV - 1 set
- rectifier - 2 units
- transformer - 2 units
- DC switchgear 750 V - 6 units
- auxiliaries equipment - 1 set
- telecontrol equipment - 1 set
- contact network overvoltage protection unit OVLD - 1 unit
- protection unit DEPEC - 1 unit


# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

**Romania,**
**Medias, Vaslui**

Supply of 2 single-unit modular turn-key traction substations (Medias).
Supply of two-unit modular traction substation (Vaslui).

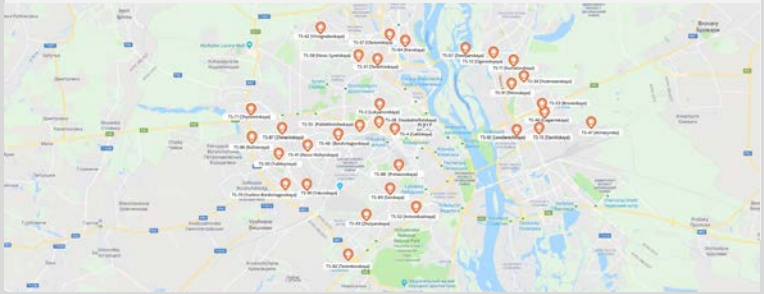
- module - 4 units
- MV switchgear SM6 20 kV - 2 sets
- rectifier - 4 units
- transformer - 4 units
- DC switchgear 750 V (RU-750, RU-750RV, RU-750OSH) - 21 units
- auxiliary transformer - 3 units
- auxiliaries equipment - 7 units
- protection unit DEPEC - 3 units

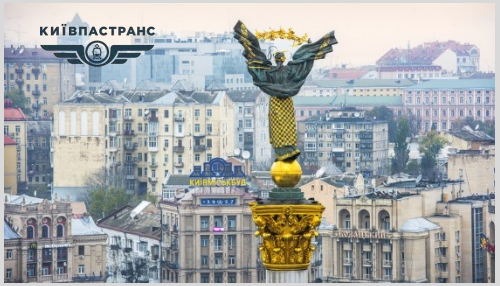

# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

**Ukraine,**
**Kyiv**

Supply of equipment for traction substations:

- NEX Switchgear 10 kV - 2 sets
- rectifier - 118 units
- transformer - 4 units
- DC Switchgear 600 V - 120 units
- auxiliaries equipment - 59 units
- telecontrol equipment - 3 sets






# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

**Ukraine,**
**Kyiv**

Supply of single-unit Lybidska modular turn-key traction substation.
Supply of two-unit Almatynska modular turn-key traction substation.
Supply of single-unit Pushcha-Vodytsia modular traction substation.
Supply of two-unit Podilska modular turn-key traction substation.

- module - 6 units
- NEX Switchgear 10 kV - 2 sets
- X10 Evolution Switchgear 10 kV - 2 sets
- rectifier - 6 units
- transformer - 6 units
- DC Switchgear 600 V with AFB® circuit breaker - 28 units
- DC Switchgear 600 V (RU-RV, RU-PSH, RU-OSH) - 9 units
- auxiliaries equipment - 4 sets
- telecontrol equipment - 4 sets

# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

**Ukraine,**
**Kramatorsk**

Supply of three-unit modular turn-key traction substation:

- module - 3 units
- NEX switchgear 6 kV - 1 set
- rectifier - 3 units
- transformer - 3 units
- DC switchgear 600 V - 12 units
- auxiliaries equipment - 1 set
- SCADA system - 1 set

# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

**Ukraine,**
**Lviv**

Modernization of operator's control center and **19** traction substations:

- switchgear 6 kV - 85 units
- equipment for retrofit of existing Switchgears 6 kV - 79 sets
- DC Switchgear 600 V - 40 units
- equipment for retrofit of existing Switchgears 600 V - 130 sets
- auxiliaries equipment - 72 units
- SCADA system - 42 sets

Turn-key project: design, dismantling, installation of Automated system for electric power consumption accounting (ASEPCA), Security alarm system (SAS) and Fire alarm system (FAS), supply of equipment, civil works, installation works, commissioning, training.


# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

**Ukraine,**
**Lviv**

Supply of three-unit modular turn-key traction substation:

- module - 3 units
- NEX switchgear 6 kV - 1 set
- transformer - 3 units
- rectifier - 3 units
- DC switchgear 600 V - 12 units
- auxiliaries equipment - 1 set
- telecontrol equipment - 1 set


# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

**Ukraine,**
**Kryvyi Rih**

Supply of equipment for **7** substations of fast tram line.

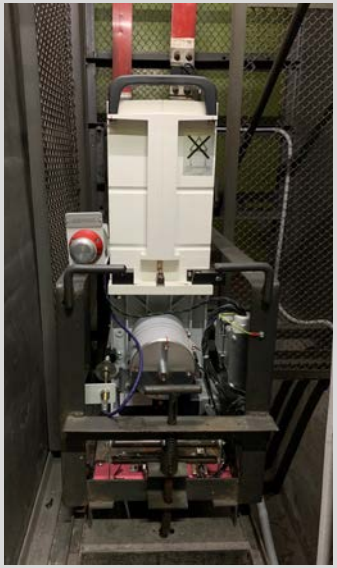
Technical modernization of power distribution center 6 kV and DC cubicles of traction substation №4, including design, supply of equipment, installation and commissioning supervision. Application of DC switchgears with AFB circuit breaker.

# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

**Ukraine,**
**Kremenchuk**

Supply of equipment for traction substation:

- MV switchgear 10 kV modernization package - 3 units
- DC switchgear 600 V modernization package - 9 sets

# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

**Ukraine,**
**Vinnytsia**

Supply of two-unit modular turn-key traction substation:

- module - 2 units
- NEX switchgear 10 kV - 1 set
- rectifier - 2 units
- transformer - 2 units
- DC Switchgear 600 V - 8 units
- auxiliaries equipment - 1 set
- telecontrol equipment - 1 set

Retrofit of 2 DC cubicles 600 V with replacement of high-speed circuit breaker.

Renovation of traction substation №19:

- rectifier - 1 units
- switchgear 600 V - 5 units
- auxiliaries equipment - 1 set

# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

### Ukraine, Mykolaiv
Supply of two-unit modular traction substation:
- module - 2 units
- NEX switchgear 6 kV - 1 set
- rectifier - 2 units
- transformer - 2 units
- DC switchgear 600 V - 7 units
- auxiliaries equipment - 1 set
- telecontrol equipment - 1 set

### Ukraine, Dnipro
Supply of equipment for TS-26, TS-15, TS-17, TS-19 traction substations:
- transformer - 1 unit
- rectifier - 7 units
- DC switchgear 600 V - 22 units

### Ukraine, Sumy
Supply of single-unit modular traction substation.

# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

**Ukraine,**
**Ivano-Frankivsk**

Building of the new traction substation (TSS-15) with a capacity of 2x1600 kVA and Mazepy street – Pivdenny Blvd. – Pivnichnyy Blvd. trolleybus line (Communal Enterprise "Electroavtotrans").

Supply of two-unit modular turn-key traction substation:

- module - 2 units
- NEX switchgear 10 kV - 2 sets
- Rectifier - 2 units
- Transformer - 2 units
- DC switchgear 600 V - 7 units
- auxiliaries equipment - 2 sets
- telecontrol equipment - 1 set

# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

### Autonomous Republic of the Crimea

Modernization of **7** turn-key traction substations for Crimean Trolleybus.

Supply **2** turn-key traction substations for Kerch city electric transport.

- rectifier - 3 units
- transformer - 3 units
- DC switchgear 600 V - 49 units
- auxiliaries equipment - 20 units
- cable protection cabinet - 1 unit

# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

**Republic of Moldova,**
**Beltsy**

Modernization of **4** turn-key traction substations:

- rectifier - 12 units
- equipment for retrofit of existing Switchgears 600 V - 33 sets



# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

**Republic of Latvia,**
**Riga**

Supply of equipment for traction substations:

- rectifier - 33 units
- transformer - 8 units

# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

### Germany

**City electric transport in Berlin, Hamburg, Dresden, Chemnitz, Dusseldorf, Karlsruhe, Leipzig, Erfurt, Bochum, Gelsenkirchen, Cottbus, Wuppertal, Krefeld, Hanover, Frankfurt an der Oder, Kassel, Magdeburg**

Supply of MWA measuring modules and KUB cable insulation control modules as part of SGBA control and protection system (manufactured by ELPRO) for DC switchgear of traction substations:

- MWA module - 297 units
- KUB module - 42 units

# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

### Switzerland

### City electric transport in Winterthur and Bern

Supply of MWA measuring modules and KUB cable insulation control modules as part of SGBA control and protection system (manufactured by ELPRO) for DC switchgear of traction substations:

- MWA Module - 34 units
- KUB Module - 8 units

# IMPLEMENTED PROJECTS
## CITY ELECTRIC TRANSPORT

**Republic of Tajikistan,**
**Dushanbe**

Turn-key reconstruction of **8** trolleybus electric traction substations for TS-2, TS-3, TS-4, TS-5, TS-6, TS-7, TS-8, TS-10:

- switchgear 6 kV, 10 kV - 8 sets
- converter transformer - 28 units
- rectifier - 28 units
- DC switchgear 600 V - 88 units
- cables combined protection cabinet - 8 units
- equipment for substation power supply - 24 units
- telecontrol equipment - 8 units
- SCADA system - 1 set




# INNOTRANS 2022 (BERLIN, GERMANY)

# TRAKO 2023 (GDANSK, POLAND)