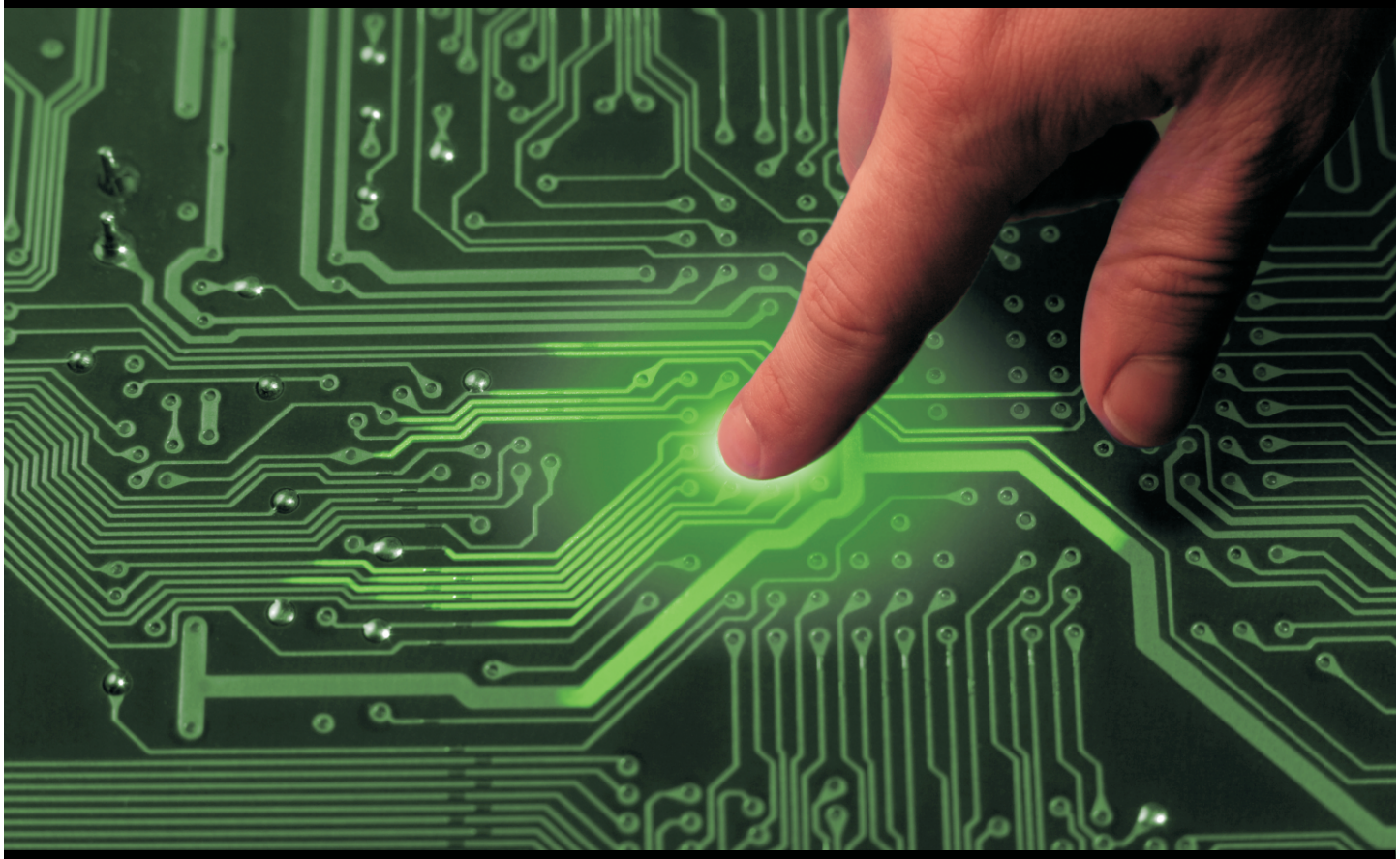
Automation for experts



The traction automation system CZAT 6

ELESTER-PKP

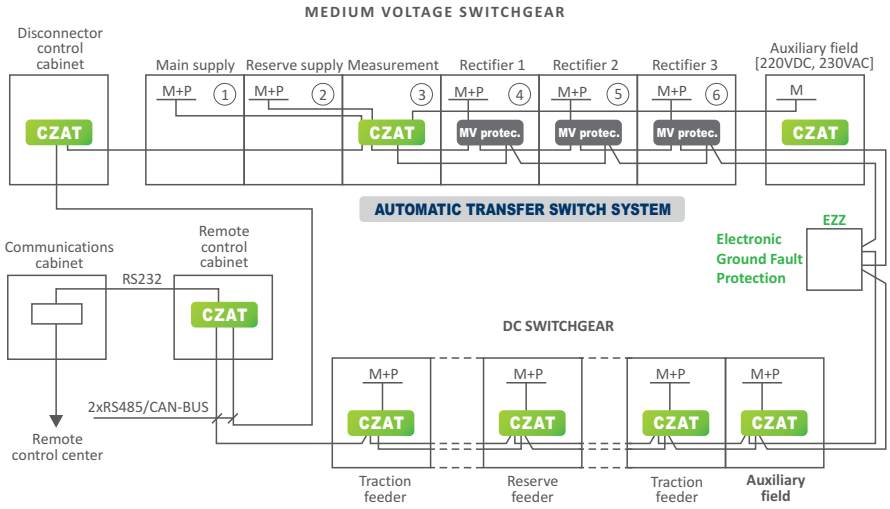
SAT-CZAT

The traction automation system for traction substations

Traction substation „Rondo Kaponiera" in Poznan, Poland (MPK Poznań)

SAT-CZAT is a system for monitoring and measuring electronic automation and safety devices. It is also responsible for local and remote control of systems and devices located on a traction substation. In particular, it is applied in direct current switching stations, medium voltage switching stations, and auxiliary switching stations.

Simplified diagram of a traction substation



The system is based on a distributed automation structure. Individual devices are connected to each other via a parallel CAN bus and using the PPM2 transmission protocol. A convenient solution is the use of a CZAT controller in almost all elements of the distributed system (except for RSN safety devices). The controllers in each switching station differ only with regard to the applied software. This solution allows for optimization of costs arising from equipment maintenance and possible expansion of the system.

UPK-CZAT dependency systems for high-speed circuit breakers

The UPK system is an efficient dependency system for high-speed circuit breakers. This solution ensures safe automatic operation between traction substations and between substations and sectioning cabins, dually powering a common section of a traction network.

As a result of inclusion of sectioning cabins to the UPK-CZAT dependency system, it is possible to control the high-speed circuit breaker of the sectional cabin from neighbouring traction substations. If a nearby traction substation is included in the remote control system, it is possible to control the circuit breaker of the cabin and the traction disconnectors located at the cabin from the control centre (the remote control centre). The UPK-CZAT automation unit replaces the field of automation of the sectioning cabin disconnector. The system's devices are microprocessor controllers from the CZAT family.

The system is based on CZAT type controllers placed in:

- *Traction feeder fields*
- *Reserve breaker fields*
- *Rectifier unit fields*
- *Sectional breaker fields*
- *Gamma filter fields*
- *Rectifier unit fields*
- *Medium voltage switching stations*
- *Auxiliary switching stations*

The system's configuration can be expanded to include such elements as:

- *a control cabinet for medium-voltage line isolating (cut-off) switches,*
- *a remote control cabinet,*
- *electronic ground-fault protection (EZZ),*
- *burglar and fire alarm systems,*
- *monitoring of authorised entrance to the facility,*
- *automatic control of heating, ventilation and air conditioning,*
- *dependency systems for high-speed circuit breakers (UPK-CZAT),*
- *local control terminal,*
- *facility monitoring system,*
- *smoothing device field (e.g. a gamma filter).*

CZAT automation functions in the traction or backup feeder field

- Testing the line before it is switched on.
- Automatic transfer switch (ATS).
- Substation-cabin (for railway stations) or substation-substation dependencies.
- Voltage and current measurements of the feeder.
- Measurement of uneven load on feeder cables in twin cable feeders.
- Protections: undervoltage, overvoltage, I>T, short-circuit I>, di/dt to detect distant short circuits (steep).
- Local and remote control.
- A blocking option (after a failed line test, from protection of the line test resistor, after immediate ejection).
- Energy measurements.
- Recording of currents and voltages.
- Recording of events.
- Counter of events (generating statistics).
- Local and remote warning signalling in the event of faults, detection of defects and loss of auxiliary voltages.
- Control by means of bypass breakers.
- Local reserve breaker.

CZAT automation functions in the rectifier unit field

- Automatic control of the operation of units (according to schedule or load).
- Current-time protection I>t.
- Current and voltage measurements of the rectifier unit on the 660V, 3 kV side.
- Remote and local control of the unit disconnector and DC current breaker (if the station is connected to a remote control system).
- Cooperation with safety devices of other companies.
- Recording of events and a counter of events.
- Local and remote warning signalling in the event of faults, detection of defects and loss of auxiliary voltages.

CZAT automation functions in the medium voltage switching station

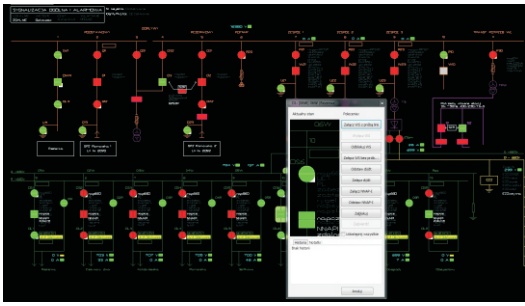
- Automatic transfer switch (ATS).
- Local and remote control.
- Recording of events.
- Local and remote warning signalling in the event of faults, detection of defects and loss of auxiliary voltages.

CZAT automation functions in the auxiliary field

- Monitoring of operation of the rectifier station’s heating and ventilation system.
- Emergency shutdown of the rectifier station.
- Cooperation with the fire and burglar protection installations.
- Measurements of the station’s total current on the 660V, 3 kV DC side.
- Measurements of voltage on 660V, 3 kV DC busbars.
- Local and remote control.
- Reactive power compensation.
- Recording of events.
- Automatic transfer switch.
- Local and remote warning signalling in the event of faults, detection of defects and loss of auxiliary voltages.
- Central signalling for 110kV station.

CZAT automation functions in the gamma filter field

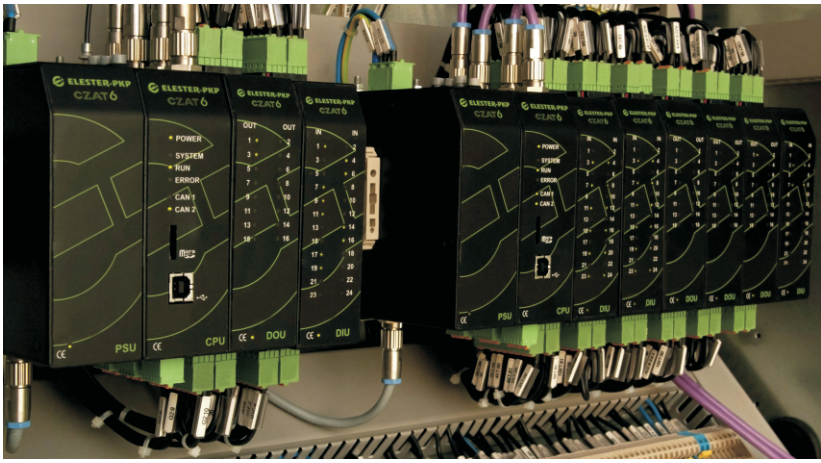
- Local and remote control and filter automation.
- Contact with the user via a touch screen.
- Measurement of voltage and RMS effective current value.
- Monitoring of high-voltage fuse.
- Monitoring of presence of auxiliary voltages.
- Temperature and thermal protection measurement.
- Protections: 16-step overcurrent, undervoltage, overvoltage.
- Handling of over-pressure protections for capacitors.
- Cooperation with undervoltage, ground-fault and TCK protection.



Imaging on a substation terminal

The CZAT 6 plant controllers system

Distributed automation in the traction substation



CZAT 6 in the backup feeder field

Microprocessor controllers of the CZAT family have been produced by the company Elester-PKP for over 20 years. We are currently presenting you the sixth generation of CZAT controllers, which is the result of work aimed at continuous improvement of our solutions. Each successive generation of controller is based on ever more advanced technology in order to optimize its operation and reduce its dimensions. The latest system of CZAT 6 controllers remains compatible with its predecessors, thanks to which full support has been preserved for devices already installed in facilities.

Purpose of the system

CZAT microprocessor controllers are used to build monitoring and control systems for devices in railway and tramcar power facilities. The CZAT 6 system in traction substations may be applied in direct current switching stations, medium voltage switching stations and auxiliary switching stations. The system configuration can also be expanded to include:

- control cabinets with isolating (cut-off) switches on the traction network,
- control cabinets for medium-voltage line isolating (cut-off) switches,
- remote control cabinets,
- electronic ground-fault protection (EZZ),
- burglar and fire alarm systems,
- monitoring of authorised entrance to the facility,
- automatic control of heating, ventilation and air conditioning,
- dependency systems for high-speed circuit breakers (UPK-CZAT)
- local control terminal,
- facility monitoring system,
- smoothing device field (e.g. a gamma filter).

System architecture

CZAT 6 controllers are modular in build. The basic unit consists of a central processing unit (CPU), a power supply module (PSU) and at least one slave input/output module (DOU, DIU, DIOU). This is the optimum solution, because it allows one to adjust the system to specific needs, its further expansion and execution of modernization work in stages. The basic unit can optionally also be equipped with an operator's LCD touch screen panel (CZAT Synoptic), supporting local control of particular devices (e.g. a single field).

The mechanical design

Devices from the CZAT 6 family are placed in a metal housing, providing high resistance to electromagnetic interference. The modules are designed to be mounted on a TS35 mounting rail. The communication bus is located on a DIN TS35/15 rail, thanks to which it is enough to connect the module to the bus to result in it being powered and connected to the central unit. This is a convenient solution, because it reduces the number of unnecessary cables and reduces the installation time of the devices.

CZAT 6 CPU (Central Processing Unit)

The central unit is responsible for processing information from the attached modules, controlling their operation, diagnostics and communication with the master remote control system. For quick connection between individual unit modules, a bus is used, located in a TS35 mounting rail in the RS485 standard. Cooperation between successive CPUs is ensured by a CANBUS (Controller Area Network bus). The CPU module is equipped with an (RJ45) Ethernet connector, two (2) RS232/422/485 type communication ports and an RS232 port. For convenience, these ports are made in the form of detachable spring connectors, thanks to which there is no need for additional clamping tools. The controller has two fibre optic inputs and two outputs, allowing for direct connection of two HVM modules. These may be measuring or counter modules. Fibre optic interfaces cooperate with plastic fibre optics. The CZAT 6 controller also has two binary outputs (directly from the CPU), allowing for very rapid control of any device (e.g. tripping of a safety device).

CZAT 6 in the traction feeder field

Controller configuration changes can be made locally via a USB port or the CZAT Synoptic operator panel. Remote control is provided by Ethernet network (engineering channel), CANBUS or the master display and remote control system. Reading and saving of files does not require an interruption of the application currently being performed by the controller. In order to facilitate access during local operation with the controller (e.g. collecting of files from the event recorder) both the microSD card slot and USB port are located at the front of the housing.

Software

A big advantage of CZAT 6 controllers is the flexibility of their programming. One can easily expand the system to include new devices or use existing devices in other configurations. Ease of programming also allows one to increase the functionality of devices, matching the software layer to individual user's needs. The creation of user applications is carried out using the LOGIKA PLUS program, working on a PC platform. The controller's internal memory is used to store user and configuration applications, test programs, and other data (e.g. event recorder files). The use of a removable MicroSD memory card allows one to store and transfer data between devices. File system access is possible locally through a USB port or remotely by means of the CANBUS bus or the Ethernet. Reading and saving of files does not require an interruption of current operation of the controller.

CZAT 6 DIU (Digital Input Unit)

The DIU module contains 24 isolated digital inputs. Information is entered into the system by means of this module. The CZAT 6 DIU module's operation involves processing the voltage quoted at the module's input into a digital value which is then sent in the RS485 standard to the CPU central unit. It is equipped with an AC/DC optocoupler input for voltage up to 230V RMS. The most common input information are the statuses of switches (disconnectors, isolating switches, circuit breakers), the arming status of switches, various types of electric locks, status of the relays used to control auxiliary voltages in the system, and the contact surfaces of on/off buttons.

CZAT 6 DOU (Digital Output Unit)

The DOU module is a 16 digital outputs module by means of which external devices are controlled. The appropriately defined software of the CPU central unit interprets input data and sends commands via an RS485 interface to the appropriate output modules. CZAT 6 DOU is most often used to turn on/off switches with electric drives, implement electric locks, switch on alarms, and control heating and ventilation devices.

CZAT 6 DIOU (Digital Input Output Unit)

This is a mixed module, containing 8 isolated digital inputs and 8 relay outputs. Using the digital inputs, information is entered into the controller, while the outputs allow one to control external devices. The CZAT 6 DIOU module comes in versions with an input voltage of 24V or 230V. The module contains 8 x 2 AC/DC optocoupler inputs with common potential, 2 independent outputs with normally open and normally closed contacts and 6 independent outputs with normally closed contacts.

Basic design of CZAT 6 DIOU can be used in any system where there is a need for digital inputs and outputs. In practice, it is mainly used in small, in terms of number, controlled devices (such as dependency systems for high-speed circuit breakers, remote control cabinets or non-traction automation control systems).
The module is additionally equipped with an RS232 communication port, allowing for independent operation of the element without the need to add a CPU controller. This solution is used in line breaker control systems for non-traction purposes.

CZAT 6 PSU (Power supply unit)

This is a PSU module designed to power CZAT 6 system components with 12V DC, 3A. In addition, the task of this unit is to control the correct supply of voltage, which enables the controller to react early to a possible voltage failure. The module is powered by a 230V AC voltage and must be connected to a three-wire (earthed) network. The device is protected at its input by an overvoltage protection and interference filter. The CZAT 6 PSU design is based on a pulse inverter, ensuring an efficiency of 93%. The solution used is characterized by a favourable (above average) power to volume ratio. The power supply unit ensures galvanic isolation from the mains and also features protection against short circuit and overload.

The PSU module can also be used independently as a universal power supply unit in industrial conditions.

CZAT Synoptic operator panel

CZAT Synoptic is an LCD touch screen which presents data in a text or graphic form. This terminal operates directly with the controller and uses information contained in its records. This allows not only monitoring of device operation, but also their control and modification of their settings.

Compared to standard signalling systems, a graphic terminal provides more convenient and faster operation of devices. The panel is a configurable module, so it is possible to graphically present any objects, diagrams or processes. For the needs of traction facilities, these are visualization of the status of disconnectors or circuit breakers. In addition, this module plays back audio messages and emits audible alarm signals. Configuration files are prepared using SynoCAD software. The panel is operated using an LCD 7" touch screen and 10 function keys. The display reacts to the intensity of light in the room, so that the screen's backlight is automatically adjusted.

The operator's terminal is located in a robust metal housing and designed to be installed in the door of the control cabinet. The device communicates with the controller via an RS485 (4-pin type TRIAD) bus. It is equipped with two CANBUS connectors, an Ethernet connector, a USB port, an RS232 interface and an SD/MMC memory card slot.

CZAT 6 units

- *CZAT 6 CPU - central processing unit*
- *CZAT 6 PS - power supply unit*
- *CZAT 6 DIU - digital Input unit*
- *CZAT 6 DOU - digital output unit*
- *CZAT 6 DIOU - digital input - output unit*
- *CZAT Synoptic - operator panel LCD*

CZAT Synoptic

EZZ

Electronic ground-fault protection

Electronic ground-fault protection is designed to protect the direct current electric traction power systems with both poles isolated from the earth. The EZZ provides an earth-fault breaking capacity at a level much lower than that guaranteed by basic station overcurrent protection. The device is manufactured in a 3300V version, tailored to railway needs and a voltage of 660V for a tramcar version.

The use of EZZ on traction substations ensures:

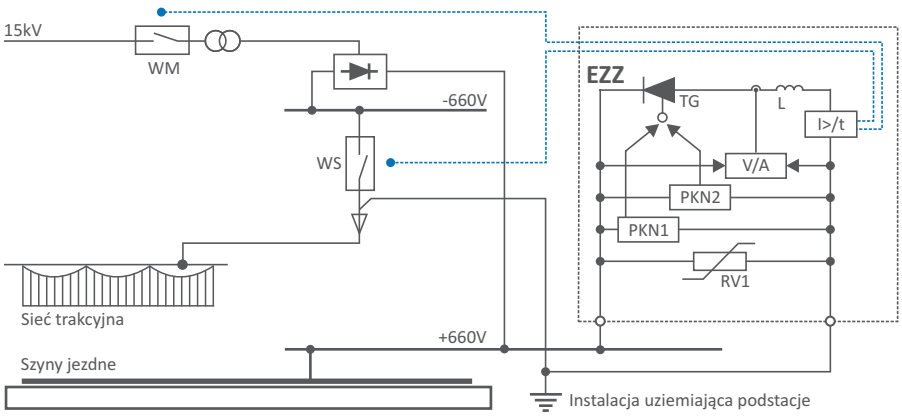
- disconnection of earth shorting faults in substations,
- disconnection of earth shorting faults in traction feeder cables without disruption of the substation's operation,
- disconnection of a substation in the event of a break in return cables,
- protection against electric shock,
- monitoring the status of the network and return cables through the control of earth shorting voltage and current,
- ability to reduce stray currents through the monitoring and signalling of earth shorting of the minus rail.

›› *There is also a special execution of the EZZ protection, dedicated to the protection of traction substations with a power supply of 110kV.*

In the event of a voltage in excess of the safety extra-low voltage appearing on the housings of devices, the thyristor short-circuiting device is tripped connecting the bus-connected pole with the station's earthing system. This protection operates independently, regardless of the presence of auxiliary voltages.

The EZZ is of a two-piece construction consisting of a thyristor short-circuiting device and a control cabinet. The thyristor short-circuiting device is connected to the minus rail and the earthing of the station. Together with commutation circuits, an overcurrent relay and a terminal strip, it is mounted in the lower chamber of the housing. The upper chamber of the cabinet contains the control unit and a signalling and control panel. The device is equipped with internal optical signalling circuits and external signalling - designed to connect signallers or automatic control circuits.

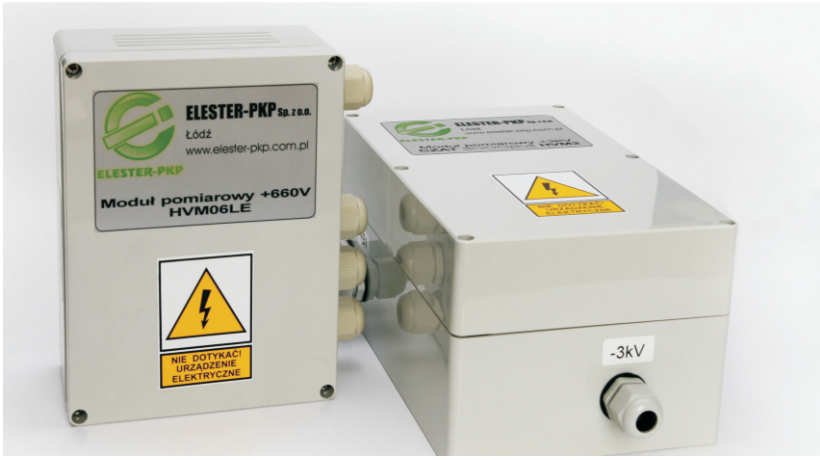
Simplified block diagram of the EEZ transducer



WM – power breaker, WS – high-speed circuit breaker, TG – main thyristor block, L – steep coil, RV1 – varistor, V/A – measuring block, PKN1,2 – voltage control package, I>/t – overcurrent sensor with time delay circuits.

HVM
High Voltage Measurement Unit

This device is available in the rail and tram execution



The HVM is designed to take measurements of voltage and DC current, necessary to implement the protections of the automation field. The main application of this module is to take measurements in the traction feeder fields, backup circuit breakers or rectifier units. Current measurement is carried out using the voltage drop obtained on the external bypass. Depending on the version, the bypass may be located in the plus or minus rail. Two bypasses can be connected to the transducer, providing the possibility of taking measurements of uneven currents propagation for twin-cable feeders. The device is manufactured in versions with a power of 3300V, tailored to railway needs and a tramcar version with a voltage of 660V.

The HVM transducer performs the following functions:

- measurement of voltage and DC current in tram and railway traction networks,
- measuring any inequality of load on cables for twin-cable feeders,
- measuring the power taken up and returned on the basis of the measured voltage and current,
- recording of voltage and current from the traction network,
- cooperation with the field automation (CZAT controllers), allowing implementation of traction protections.

Thanks to the measuring system being powered directly from the measured voltage, the problem of providing adequate insulation has been solved. The required level of safety is achieved through the use of a fibre optic bus, using this for the needs of the protection functions and reserving for the automation of a given field (connection with the CZAT 6 controller).

A dedicated measurement transducer for the gamma filter field

The HVM3F high voltage transducer has been prepared and adapted to the gamma filter field. It performs measurements of voltage and the effective value of current with a deformed course. Measurement of RMS current drawn through the filter, enables a multi-step overcurrent protection of I>T, reacting to the real psofometric load on capacitors. This protection protects the gamma filter against overload which can occur in case of an excessive current load on a substation, interference in the operation of diode rectifiers or the converters on vehicles.

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