

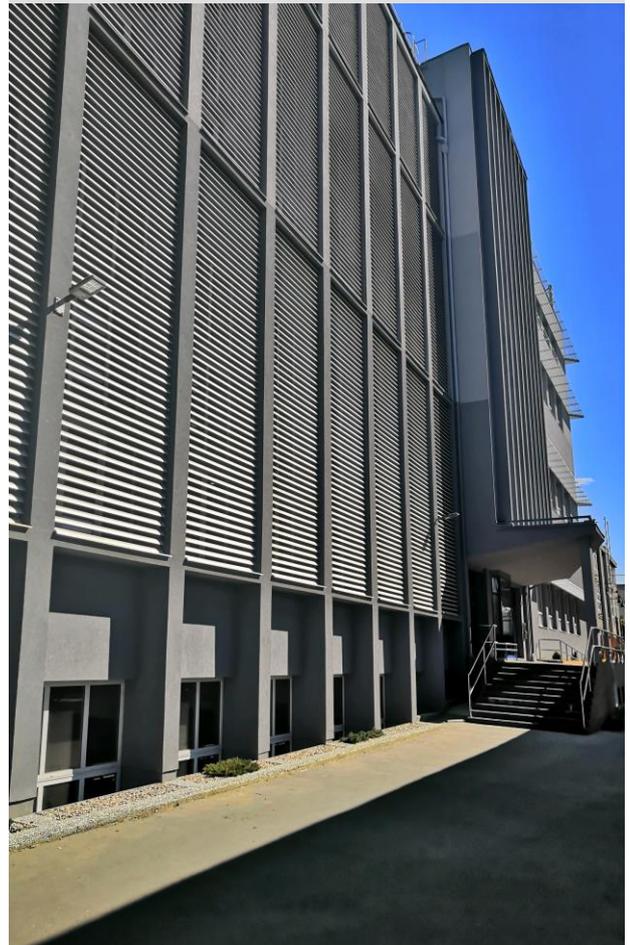


ELEKTROTECHNIKA

# Substations for DC and AC tractions

**ELEKTROTECHNIKA**, a.s. was established in 1999.

ELEKTROTECHNIKA, a.s. is operating on domestic and foreign markets in the segments of electrotechnical equipment, especially semiconductor applications with focus to equipment and services with a high added value rate. This all involves promoting internal Research & Development, design, production, testing, and taking care of the customers requiring particular approach at their needs. Focusing to special and unit production creates a competitive advantage over large and strong multinationals in those areas where the customers search for specific and optimal made-to-measure design enabling minimizing the investment costs and especially the expenses of reconstructions and up-grading the existing equipment. Customer approach involves also enhancing further supplementary services – especially advisory services (for example feasibility studies or energetic audits before starting tenders), further on, bids of financing mainly quick-capital-return projects, as well as providing fast and effective service and inspections. Since its foundation ELEKTROTECHNIKA, a.s. has acquired a range of significant references nearly throughout the entire scope of its operation both at home and on the foreign markets.



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## Diode substations for public transport

ELEKTROTECHNIKA, a.s. presents up-to-date substations for city public traffic with variable solution for tram and trolleybus networks and undergrounds. All of the manufactured types of substations (stationary, container, mobile) are suitable for both local and remote control (using a modem or radio transmission).

### Outer side of substation

The input part of the diode substation is a high voltage switchgear unit that can be of a classic vault or up-to-date box version made by the firms HOLEC, SCHNEIDER or ABB as required by the customer. The space separation of the input part of the high voltage switchgear with supplies of the power supply company from the substation technology part is commonplace.

The high voltage switchgear unit supplies traction transformers modified for traction

operation and with usable outputs ranging from 400kVA, 630kVA, 800kVA, 1100kVA, 1650kVA, 2000kVA and 2500kVA. As for technology, the transformer can be dry, vacuumimpregnated or with resin-filled winding. The input voltage can be up to 35kV, the output voltage corresponds with DC rating of the substation (660V and 825V). As for technology, the transformer can be dry, vacuumimpregnated or with resin-filled winding.



Traction transformer 1100 kVA, 22/0.65 kVA in vault of trolley bus substation

## Technological substation unit

The substation unit consists of three basic switchgears on the DC side. The first of them is positive (plus) DC switchgear including boxes of **traction converters, outlet feeders, or longitudinal coupling**. The longitudinal coupling box can be used advantageously when a new substation shall be built and put into operation in two phases or when an old substation shall be restored during operation.

The second basic switchgear is a negative (minus) DC switchgear including boxes of **negative cables** and supplemented by a **longitudinal coupling** if required. If required by the substation keeper, this switchgear can be also supplemented by supply boxes that

serve for cable connection of the negative switchgear with traction converters. Through an installed with traction converters. Through an installed disconnecter, these boxes enable to disconnect traction converter outputs from the negative cable boxes. Nowadays when telescopic converters are used they become groundless. To ensure functions of the above two DC switchgears, the substation is equipped with its own consumption switchgear including one or two **boxes with its own consumption transformers, its own consumption AC distribution box and its own consumption DC distribution box** with accumulators and chargers .



Traction converter

## Traction converters 660 and 825 V DC

Traction converters are offered in **six pulse** and **twelve pulse** connection, standardly in telescopic version. For restoration cases or if required by the customer, we can deliver also classic box non-telescopic converters. Cheaper frame converters are suitable to be installed into a traction transformer vault. All of the converters are in the load class V according to SN EN 50 328. Boxes of telescopic converters designed to be assembled in a switchgear with outlet charger fields meet SN EN 50123-6 for DC converters.

The converter output voltage = substation voltage is given by 10% higher in comparison with traction network value (600 or 750VDC).



*Telescopic 12pulse converter 1500 A / 825 V*

### The non-telescopic converter version

The converters can be in box or frame versions and they are usually modified constructionally as specifically required by the customer, e.g. cables can be connected from above or from below. These converters are delivered in three-phase bridge connection and according to rectifier current with one to three parallel elements equipped with a quick safety. The diodes are cooled by coolers designed specially for non-telescopic traction converters.

The standard equipment includes an overvoltage protection that compensates magnetizing current of the traction transformer, two-stage diode temperature signalling and indication of diode and overvoltage protections.

### Telescopic converter version

Diode monoblock consists of six (6-pulse converter) or twelve (12-pulse converter) of high-parameter elements, **cooled by heat pipes** with natural cooling. The diode monoblock is equipped with sensors for two-stage contact temperature signalling. The cooling air is sucked from the front of the trolley. The box height is used for necessary air thermocirculation. If required by the customer, the converter can be equipped also with a continual temperature measurement system with an isolation converter. The whole unit is placed in the bottom part of the box on a telescopic, easily accessible trolley that includes also a **reactive energy compensation circuit** of a traction transformer and limitation of commutation and turning off over-voltages. Auxiliary circuits of the converter are placed in the instrument panel behind the upper box door. There is a control automatic panel placed on the door that is connected to the commutation line of the converter technology.

The converter control includes also **instructions for a high voltage switch** of the traction transformer. Telescopic 12pulse converter 1500 A / 825 V current-carrying cap. The position of contact heads of the power connection with the trolley box enables you to maintain them easily.

The trolleys with diode monoblocks cooled with heat pipes have much **lower weight** in comparison with converters consisting of separate blocks. These separate blocks consist of a pastille diode and a classic two-part cooler used for double-sided cooling. If required by the customer, we are able to deliver the **telescopic part of the traction converter with the diode block** in both 6-pulse and 12-pulse version, **modified for a box of another manufacturer** of converter technology. There was a partnership established with the firm ŽS Brno, a.s., for which the whole power group of 6-pulse and 12-pulse trolleys is built up in version of their DC converter assembly.

Version of converter	Telescopic converter				Non-telescopic converter	
current-carrying cap	800 A	1500 A	2250 A	3000 A	1500 A	2250 A

## OUTLET FEEDERS

The charger box is designed to offer all required functions. It enables easy access to the individual parts of the unit and overview of the running operations. The power connection is given through continuous main and additional bus bars from the left and from the right. The cable outputs pass through the box bottom.



*telescopic converter 12p 1500A / 825 V*

The main component of the charger box is a rapid circuit breaker with the nominal current 2600A or 3600A made by the firm SÉCHERON or MEP Postřelmov as required by the customer. The rapid circuit breaker is placed on the telescopic part – trolley that is mechanically and electronically interchangeable with trolleys of other chargers of the substation. The auxiliary circuits of the rapid circuit breaker, including the control automatic unit, are placed on the frame of the trolley under the rapid circuit breaker. The power distribution is placed in the box rear. There is a motor controlled (manual if need) disconnecter in the middle part to connect to the auxiliary bus bar and there are 4 manual controlled cable disconnecters max. with current measurement in the bottom part that can be controlled either from the box front after taking out the trolley without any access to the box rear, or from the box rear after opening the lower door. The auxiliary circuits of the chargers offer voltage-free control of the motor disconnecter of the auxiliary bus bar or of the charger in case of a failure of the control automatic unit. To detect a status of the supplied section (if there is a short circuit or not) before turning on the rapid circuit breaker, use the line resistance measurement current UZM-7.



*DC distributor (Zlín, Czech Republic)*

## The programmable automatic unit TRACDYN

The charger operation including several types of overcurrent protections is concentrated in the programmable automatic unit TRACDYN. The individual overcurrent protection and evaluation of failure statuses enable optimum adjusting of the chargers to various loading types. The most important are:

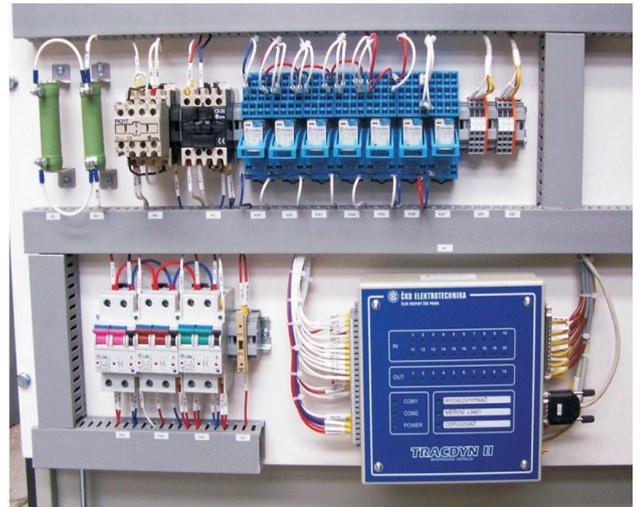
- a) static overcurrent trigger – with the possibility to preset two separate values ( $I_{max1}$ ,  $I_{max2}$ )
- b) rate of rise ( $di/dt$ ) – reacting when the preset rate-of-current-rise value is exceeded.

Activation chooses protection and alignment parameters gives possibility practise direct from control panel corresponding feeder or remotely. Impressing relevant protection is indicate remotely and locally, on display of automat control panel TRACDYN. In case demand can be display and running of cut-off current with possibility its another graphical process. Except of main characteristics is possible show number of overcurrent cut off, limited repasi cut-out key and as specific outfit provide control running power individual feeders for given period. Control conception make possibly for paralel feeders cooperation, too. Standard functions of the charger include also automatic turning on of the rapid circuit breaker in case of an auxiliary voltage failure or due to over current protection. Currently the new-generation **control automatic unit TRACDYN II** is developed for substation applications with a graphic control panel.



## MONITORING AND CONTROL

The communication line of the control automatic units and logic and analogue signals from the whole substation are concentrated in the remote control box, which includes also a control automatic unit or computer of small substations to transfer all signals and instructions to the control station. The remote control box includes necessarily a ground protection circuit. As for bigger substations, this box consists of a remote control box including only an industrial computer with an externally connected display.



The following modes of monitoring and control of the substation unit are possible:

- a) Local – from the cubicle consoles with possible complete programming of the feeders protections;
- b) Central – from a PC, using the program **TRACONAX**, via communication device **TRACDYN C** to an individual controllers
- c) Remote
  - via a galvanically separated relay interface with transmission of all basic states and control of basic functions and change of the basic overcurrent protection of the feeder  $I_{max1}$ ,  $I_{max2}$  (this type enables connection of any supervising system without knowledges of communication protocols);
  - via a computer interface of TRACDYN C over a link, enabling detailed monitoring of states including possibility of program changes in protections of the feeder according to the current state of the traction line fed.



*Cubicle of remote control (DMX)  
and cubicle of remote transfer with industry PC  
and radio signal*

## Substations for DC tractions

**ELEKTROTECHNIKA, a.s.** is a succeder of the traditional branch of technological devices for substations. These devices have worked always reliably and to full satisfaction of our customers. For diode substations, we standardly deliver traction transformers, traction converters – rectifiers with over-voltage protections, air smoothing chokes. Further, we are able to deliver also a metal-clad box DC switchgear with telescopic trolleys of feeder rapid circuit breakers.



Traction transformer in outdoor cubicle version  
38T-23SF-184/83 5,3MVA - substation Opočinek

## Input transformer

The HV switchgear supplies dry traction transformers adapted for traction operation with the range of usable outputs from 2200 to 5300kVA. The input voltage can be up to 35kV (with connecting taps  $2 \times \pm 2,5\%$ ); the output corresponds to the required nominal DC substation voltage, i.e.  $2 \times 2500\text{V}$ . The transformers are standardly equipped with temperature probes connecting fans through a temperature regulator.

## Frame diode converters of 3kVDC traction

We offer the diode converters in classic open frame version or in box version with a telescopic part to mount into a metal-clad box DC switchgear assembly. The basic type of the frame version is the verified 6-pulse converter 18-UKTB-3M-00833 with the nominal current 800A and consisting of 12 diodes (2 in series).

For 12-pulse connection, we deliver two frames differing in its equipment - 01 and 02. The converter construction in two versions enables you to interconnect the converters easily for 12-pulse connection of converters being side by side or back to back. The converters are equipped with RC members to limit commutation over-voltages, an over-voltage AC input protection and circuits to identify and signal a diode breakdown on the auxiliary panel. The basic version 01 has an over-voltage diverter installed from the DC side and an auxiliary loading resistance to limit max. voltage during off-load operation. The basic equipment of the converter can be supplemented by circuits of a 2-stage signalling of contact diode temperatures – warnings and breakdowns. The input and output modules to identify diode breakdowns and signal temperatures are interconnected using optical cables to separate HV and LV circuits safely and in accordance with requirements of SN EN 50 328 for traction converters with a higher value of the test insulating voltage. The converters are made of self-extinguishing materials to meet requirements of the new standard for fire resistance.



Traction transformer in IP00 version

## Cubicle diode converters of 3kV DC traction

The metal-clad 12-pulse converter **1500A in the loading class V** is designed for needs of metal-clad box DC switchgears consisting of a compact assembly of traction converters, feeder outlets and possibly also of longitudinal connections. This converter with a telescopic part is designed in cooperation with the firm EŽ Praha, a.s. The converter has the type identification **28 UKTB-2x3M-01533**. It has **EZB-U** identification in the construction version of switchgears by the firm EŽ Praha, a.s. The 12-pulse converter is made of two boxes, each of them has a mutually interchangeable telescopic part. The telescopic part (trolley) includes except the diode 6-pulse bridge block (with two diodes in series cooled by heat pipes) also circuits to identify diode breakdowns for every pairs individually and circuits of 2-stage diode temperature signalling. The trolley construction is based on a solution verified in service and used in substations for city public traffic and is supplemented with an electric actuator to handle in the converter box.



Two view on trolley cubicle converter – there are from back side - up good visible condensers of diode block and down contact head

The converter boxes contain space-separated HV and LV circuits. Power circuits of the box -passes for AC and DC connection, over-voltage protection and a motor-controlled disconnecter of output cables of the traction voltage – are accessible from the box rear. (The plus pole disconnecter is in one of the boxes and the minus pole disconnecter in the other one). Both of the boxes have a common over-voltage diverter on the converter output and a loading resistance to limit max. voltage for off-load passing. When the trolley is out, contact power connection knives are automatically covered in the box.

The box front includes auxiliary voltage, control, signalling and measurement circuits. The local and remote control of the box is provided by a programmable automatic unit with a touch panel that is common for both of the boxes. The automatic unit measures the DC current and voltage, evaluates over-current values, diode temperature values of both diode blocks, temperature values of the corresponding traction transformer, identifies diode breakdowns, control the input HV switch and signals failures of the input over-voltage converter protections.

## Frame diode converters of 1,5kV DC traction

For the DC 1500V traction network, we deliver frame converters. In comparison with the converters for the DC 3000V traction network, they are equipped with HV fuses for each of the diodes and it is possible to place a 12-pulse converter including two diode bridges on one frame when one diode in series and one diode parallelly are used. These converters can be protected to limit communicating and switching over-voltage, overvoltage diverter on DC side, over-voltage resistance to limit max. voltage for load-off passing operation, or two-stage diode temperature signalling.

An example is the converter **26 UKTB-2x3M-01516 with the nominal current 1500A in the loading class V.** delivered to restore the substation Malšice. These protections are not installed on the converter frame because separate frames are used with over-voltage protections of UZP-101 type.

All converters are designed for the loading class V and new producing converters be up to standard norm SN 50 328 in term of insulating assay and fire resistance.



### Overview of manufactured types of traction converters

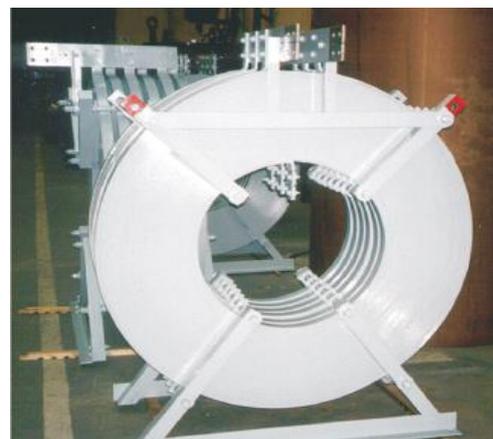
Type of converter	Voltage system	Current-carrying cap	Connec-tion	Over voltage protection	Signaling of diody breakdown diode	Over voltage diverter	Version
<b>5 UKTB-3M-00733</b>	3 kV	750 A 1500 A	6p 12p	external UZP-101	elektronická	ne	1 frame 2 frames
<b>18 UKTB-3M-00833</b>	3 kV	800 A 1600 A	6p 12p	YES	elektronická	ano	1 frame 2 frames
<b>26 UKTB-2x3M-01516</b>	1,5 kV	1500 A	12p	external	od pojistek	ano	1 frame
<b>28 UKTB-2x3M-01533</b>	3 kV	1500 A	12p	YES	elektronická	ano	2 cubicles
<b>29 UKTB-3M-002216</b>	1,5 kV	2200 A	6p	YES	od pojistek	ano	1 frame

### Air chokes

Our deliveries of traction converters or DC switchgears usually include chokes to rectify the ripple and limit the rate of rise of the short-circuit current during transition events in the connected traction circuits behind diode converters. These are air disc internal chokes of TLV series for the loading class V. Standard types are as follows:

- TLV 139/45 4mH 1100A
- TLV 168/53 4mH 1750A

Chokes of different parameters can be made if agreed.



## Converter 3000 V DC for traction applications

The converter is designed to convert (traction network parameters) 3000 to a three-phase voltage with the parameters  $3 \times 400 \text{ V}$ , 50 Hz. Equipment is used on the railways to supply signaling and communications equipment, as well as to heat switches, and both functions can be implemented with a single transmitter (transformer (inverter) (converter).



Use of this converter allows excluding of diesel generator, which is used for this purpose. The converter consists of an input transducer that lowers the overhead line voltage by about 1 kV and three-phase inverter (on power transistors IGBT), output harmonic filter that ensures quality of output voltage at the required rate for electricity consumers. An integral part of the transducer is the input and output contactors and Surge arrester in the output. The converter has a control panel with microprocessor controller with alphanumeric display and controlled signaling elements. The remote has an interface allowing remote control and communication over serial lines.

TECHNICAL PARAMETERS	
<b>INPUT PARAMETERS</b>	
Nominal input voltage	3 000 V DC
Tolerance of input voltage in the steady state	+ 20 %, -33%
Allowable momentary (short) deviation (variation)	+ 30%, 33%
Nominal input current (amperage)	45 A
<b>OUTPUT PARAMETERS</b>	
Nominal output voltage	3X400 V AC
Admission to the output voltage	+10 %
Distortion (deformation) of the output voltage	8%
Nominal output power	120 kVA
Nominal output frequency	50Hz
Nominal output current (amperage)	170 A
Allowable asymmetry of burden (load)	- 15% of the most loaded phase
An auxiliary supply voltage (to start)	1 x 230 V, 50Hz, 200W
Cooling	air
Degree of protection (enclosure)	IP 00

**REFERENCES – TRANSFORMER STATIONS FOR RAILWAY TRANSPORTATION**

CUSTOMER	COUNTRY	PARAMETRS		YEAR	SKORE OF DELIVERY	AMOUNT
		VOLTAGE	CURRENT			
<b>VIAMONT /TM Běchovice</b>	Czech Republic	3000 V		2014/2015	Ferry TMR	2
<b>TMR Valašské Meziříčí</b>	Czech Republic	3300 V	1600 A	2014	Traction frame 12-pulse converter and chokes	4
<b>TMR Ústí u Vsetína</b>	Czech Republic	3300 V	1500 A	2014	Traction frame 12-pulse converter and chokes	4
<b>TMR Kerhanice</b>	Czech Republic	3300 V	1500A	2014	retractable part of EZB-U rectifier	9
<b>MR ČD Studénka</b>	Czech Republic	3300 V	1500 A	2013	Retractable part of EZB-U rectifier	6
<b>MR ČD Pečky</b>	Czech Republic	3300 V	1500 A	2013	rectifier reconstruction	3
<b>ČMŽO Přerov</b>	Czech Republic	3 kV DC 25 kV AC 12kV AC	2 MVA	2012	voltage sources for railway testing department	1
<b>Pars nova, a.s.</b>	Czech Republic	3 kV DC 25 kV AC 12kV AC	1 MVA	2011	substation to power trolley and test habitats	1
<b>Velim Testing Center</b>	Czech Republic	3300 V	2000 A	2009	modernizace TNS	1

**REFERENCES – SUBSTATIONS FOR PUBLIC TRANSPORT**

CUSTOMER	COUNTRY	PARAMETRS		YEAR	SKORE OF DELIVERY	AMOUNT
		VOLTAGE	CURRENT			
<b>Skanska Norge</b>	Norway	750 V	1500 V	2019	Trolleybus portable substation in concrete container	1
<b>Power Service Int.</b>	Slovakia	660 /825V	2000 A	2015	complet tram substation	1
<b>APTA / Alexandrie</b>	Egypt	600 V	3000 A	2014	complet tram substation	1
<b>Public Transport – Klárov</b>	Czech Republic	660 / 750 V	3000 A	2014	the pull-out part of the 6-pulse converter	3
<b>Prague Public Transport – Sécheron</b>	Czech Republic	880 V	9000 A	2013	traction rectifiers for substations Motol	11
<b>Public Transport Veolia Teplice</b>	Czech Republic	660 V	2250 A	2012	trolleybus traction substation	2
<b>Prague Public Transport – Sécheron</b>	Czech Republic	880 V	9000 A	2012	traction rectifiers for substations Motol	2
<b>Prague Public Transport – Sécheron</b>	Czech Republic	880 V	9000 A	2011	traction rectifiers for substations Vyšehrad metro stations	2
<b>Prague Public Transport – Hostivař substation</b>	Czech Republic	660 V	1100 A	2010	tram traction substation	1
<b>Prague Public Transport – Radlice substation</b>	Czech Republic	660 V	1100 A	2008	tram traction substation	2
<b>Hradec Králové Public Transport Company</b>	Czech Republic	660 V	1100 A	2008	trolleybus traction substation	1

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