Substations for DC and AC tractions
ČKD ELEKTROTECHNIKA, a.s. was established in 1999. Currently it is integrated into a new thriving “ČKD GROUP” focusing its technological and production capacity to the traditional segments of ČKD operation in electric and general engineering.

ČKD ELEKTROTECHNIKA, a.s. is operating on domestic and foreign markets in the segments of electro-technical 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 ČKD 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. Interlinking with other members of ČKD GROUP brought about the enlargement of the corporate activities scope.

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Certification

The joint stock company ČKD ELEKTROTECHNIKA has implemented the integrated system of management. The company is certified for the Quality Management system according to EN ISO 9001:2009, Environment Management according to ČSN EN ISO 14001:2005 and Safety and Health protection at work management according to OH SAS 18001:2008.

In compliance with the above given certificates, the level of management is continuously perfected with focus to the product and service quality and to the effectiveness of realization processes.
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, vacuum-impregnated 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, vacuum-impregnated or with resin-filled winding.
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 disconnector, 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 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 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.

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.

<table>
<thead>
<tr>
<th>Version of converter</th>
<th>Telescopic converter</th>
<th>Non-telescopic converter</th>
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</thead>
<tbody>
<tr>
<td>current-carrying cap</td>
<td>800 A 1500 A 2250 A 3000 A</td>
<td>1500 A 2250 A</td>
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</table>
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.

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 Postf elmov 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) disconnector in the middle part to connect to the auxiliary bus bar and there are 4 manual controlled cable disconnectors 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 disconnector 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.
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 (Imax1, Imax2)

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.

The programmable automatic unit TRACDYN
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 /$I_{\text{max}1, I_{\text{max}2}}$/ (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
ČKD ELEKTROTECHNIKA, JSČ is a successor 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.

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-UHT-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 LW 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.

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 2x ±2.5%); the output corresponds to the required nominal DC substation voltage, i.e. 2x 2500V.

The transformers are standardly equipped with temperature probes connecting fans through a temperature regulator.
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.

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 disconnector of output cables of the traction voltage - are accessible from the box rear**. (The plus pole disconnector is in one of the boxes and the minus pole disconnector 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, over-voltage diverter on DC side, over-voltage resistance to limit max. voltage for load-off passing operation, or two-stage diode temperature signalling.

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.

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.

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 × 400 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.

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<td>Tolerance of input voltage in the steady state</td>
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<td>Allowable momentary (short) deviation (variation)</td>
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<td>Nominal input current (amperage)</td>
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<td><strong>Output parameters</strong></td>
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<tr>
<td>Nominal output voltage</td>
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<tr>
<td>Admission to the output voltage</td>
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<td>Distortion (deformation) of the output voltage</td>
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<tr>
<td>Nominal output power</td>
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<tr>
<td>Nominal output frequency</td>
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<tr>
<td>Nominal output current (amperage)</td>
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<tr>
<td>Allowable asymmetry of burden (load)</td>
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<tr>
<td>An auxiliary supply voltage (to start)</td>
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<td>Cooling</td>
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<td>Degree of protection (enclosure)</td>
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