

The EZB 750 V DC is air-insulated cabinet switchgear manufactured and delivered by Elektrizace železnic Praha a.s. (Railway Electrification Prague Inc.).

This equipment has been designed for traction rectifier substations supplying city public transportation systems with traction supply system 750 V (600 V) DC. The switchgear is a functional unit designed for positive pole distribution in traction supply system. It consists of single modules being mechanically and electrically interconnected. Each switchgear unit is invariably composed of two modules; by varying configuration of units, or (more precisely) single modules, individual functional units are formed, for example: traction feeder, main bus-bar coupler, and rectifier.

The traction feeder unit the switchgear consists of the EZB-DUR module, i.e. the module with a rapid circuit breaker, and of the EZB-STC module, where the elementary electric equipment is formed by the 750 V DC main (auxiliary) positive terminal bus-bar, disconnectors, load switch, current and voltage measuring device.

EZB-DUR Module + chariot

The EZB-DUR module fulfills a function of a traction feeder of contact line. The module cabinet is made as a welded self-supporting structure consisting of metal profiles with following overall dimensions: 600 mm (width) × 1 050 mm (depth) × 2 000 mm (height).

A chariot containing a rapid circuit-breaker is placed in the EZB-DUR module bottom part. Interior surfaces of cabinet walls are covered with GFRP (glass-fiber reinforced plastic) having a self-extinguishing feature, which protects the cabinet structure against electric and thermal effects of arcs resulting from the rapid circuit-breaker opening operation. The cabinet back wall (forming a junction to the EZB-STC module) contains holes, movement shall cover these holes, when the chariot slides out of the cabinet, so that after pulling out the chariot, the cabinet is safely separated from the power supply system. Chariot movements are partly provided using a servo-drive: to the end push-in position and releasing the chariot from this position to allow pulling it out. The remaining part of pulling out and pushing in movements of the chariot are to be carried out manually. In the emergency mode, for example, in case of loss of operating voltage, the chariot containing a rapid circuit-breaker can be pulled out manually (using a crank) after opening the small door in the front panel of chariot. The chariot is locked in its push-in end position by a self-locking worm-gear unit, which is a part of the servo-drive. The chariot can contain, in addition to a rapid circuit-breaker, a sensor to measure the voltage and current, instruments to check the contact line isolation (EDL) (electromagnetic contactor, resistor, fuse, and current sensor), contact heads to connect the positive pole power circuit, negative pole heads to measure the voltage, and heads to connect the chariot exposed conductive parts to protective earthing.

The chariot containing a rapid circuit-breaker has three functional modes:

- operating mode, when the rapid circuit-breaker is prepared to be switched on, or is on;
- testing mode, when the 750 V power circuit is opened, but the rapid circuit-breaker can perform closing operations, because operating circuits remain connected;

- inspection mode, when the rapid circuit-breaker can be repaired and measured, operating circuits are disconnected and the chariot is pulled out of the switchgear.

In the top front part of the module is placed LV compartment for auxiliary circuits and control & command circuits, which is placed in a separated space outside the main power circuit. The LV compartment includes a programmable logic controller (PLC), direct-current protection, and connecting and joining parts of auxiliary circuits. A touch display fulfilling an operating and visualization function for one unit of the switchgear (EZB-DUR + EZB-STC) is attached to the cabinet door. The measurement and control system integrated into individual units of the switchgear allows operating and controlling it locally, and in connection with the traction rectifier substation local control system, it allows remote and central controlling.

Measurement and Protection

In the positive pole switchgear, there is measured the voltage value on the output of each rapid circuit-breaker, current going from the traction feeder module to the contact line, and then is possible to measure current which is going through individual outgoing-feeder cables. These values are subsequently displayed on the touch panel and in the remote and central control system. To check the contact line isolation (EDL), the electrical resistance is measured based on outgoing-feeder voltage and outgoing-feeder current going via the EDL circuit (limiting resistance, fuse, contactor, current sensor). Based on such electric resistance, the system identifies, whether the contact line measured is in short circuit or is in operating condition.

In the EZB-DUR module LV compartment is installed a digital direct-current protection, which protects the contact line. This digital protection provides protective functions such as overcurrent, short-circuit current, di/dt, undervoltage, and overvoltage protections. In addition, the EZB 750 V DC switchgear can be equipped with a protection against any outgoing-feeder cables insulation damages and earth fault protection.

EZB-STC Module

The EZB-STC module is built as a self-supporting welded metal structure having following overall dimensions: 600 mm (width) 650 mm (depth) × 2 000 mm (height). It is to be fixed to the back part of the EZB-DUR module by bolts. Operators can access the module back part using the door. This door has a safety glass window enabling to check positions of disconnectors visually. The door is equipped with a door end position switch, which shuts down the traction feeder module, when the door is opened. The module includes strip conductors of the main (auxiliary) bus-bar, instruments such as a motor-operated load switch, auxiliary bus-bar disconnector, manually operated disconnectors of single outgoing-feeder cables, outgoing-feeder earthing switch, sensor measuring the output current generally, sensors measuring the output currents of single cables, sensor measuring the output voltage, instruments monitoring the outgoing-feeder cables condition, earth fault protection, and surge voltage protectors (SVP).

EZB-USM Module

To the EZB 750 V DC switchgear, the EZB-USM cubicle-type twelve-pulse (six-pulse) diode rectifier can be connected. The self-cooled rectifier nominal output current is 1 200 A

(max. 3 000 A) by default. The rectifier cabinet has following dimensions: 1 000 mm (width), 1 050 mm (depth), and 2 000 mm (height). Diode rectifier has standard protections and touch panel with diagnostic placed on cabinet.

EZB-SIA Module

The EZB-SIA module is built as a self-supporting welded structure having following overall dimensions: 1 000 mm (width) × 650 mm (depth) × 2 000 mm (height). It is to be fixed to the EZB-USM module back part. This EZB-SIA module is used to distribute positive and negative poles of the EZB-USM rectifier via a single-pole or two-pole motor-driven disconnecter. Thereafter, the positive pole distribution system is leading via the main bus-

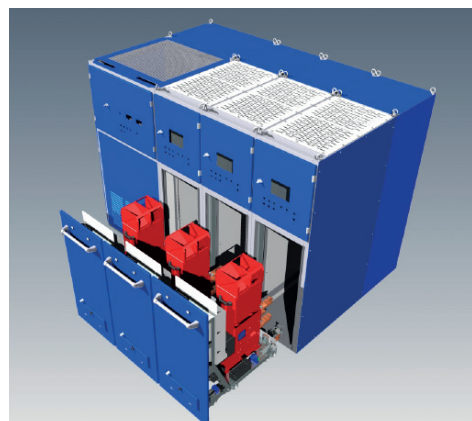
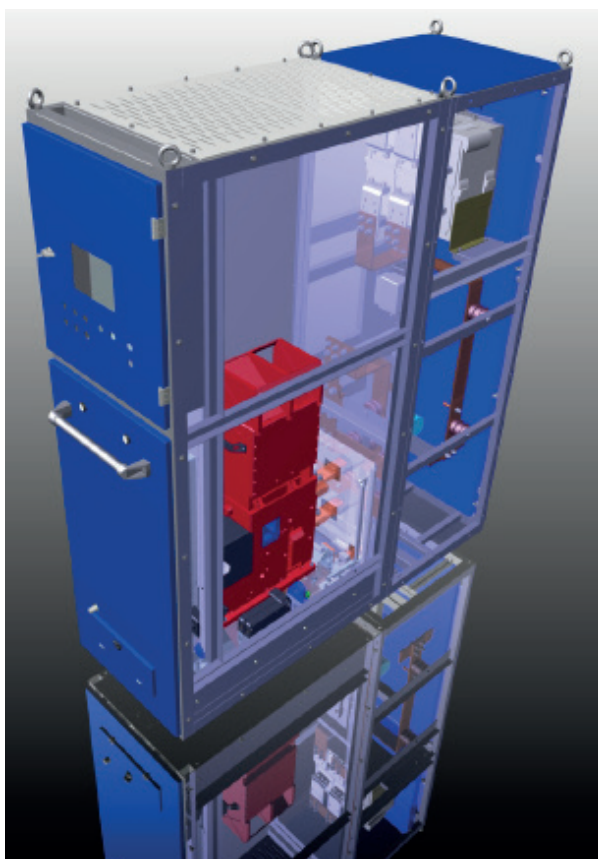
-bar to EZB-STC modules to the contact heads, where the DUR chariot containing the rapid circuit-breaker is connected (see: EZB-DUR module + chariot). The negative pole is led to a jumper flag to connect return cables. For application in environment where is required protection of switchgear exposed metalwork parts by double insulation is available version of all switchgear modules with insulation sheathing made of polyester panels. These panels must have minimal protection IP2X. All functional parameters of switchgear are similar with implementation which is made of standard stainless steel casing.

Conclusion

- all and any modules with type instrumentation have been tested in an authorized testing laboratory according to relevant standards,
- the EZB 750 V DC switchgear have been installed in traction rectifier substations of tram lines in Angers, Montpellier, Lyon (France), Rabat (Morocco), Rotterdam (Netherlands), Liberec, Praha, Ostrava (Czech Republic),
- the switchgear is supplied to a construction site as a compact unit consisting of single modules so that overall connection and installation works are not time-consuming at all,
- enclosures of each unit as well as all switchgear meet, at least, requirements of IP 20 according to EN 50123-6 ed.2,
- dimensions of EZB-STC, EZB-SIA back modules may vary depending on instrumentation types used,
- when designing the structure and manufacturing the EZB 750 V DC cubicle-type switchgear, especially provisions of following standards were fully satisfied: ČSN EN 50123-6 ed.2, ČSN EN 50328, EN 50163 ed.2, ČSN 34 1500 ed.2, ČSN 33 2000-4-41 ed.3.

TABLE OF SINGLE MODULE ELEMENTARY PARAMETERS

Parameters	EZB-DUR Module	EZB-DUR + Chariot	EZB-STC Module	EZB-SIA Module	EZB-USM Module
Nominal voltage [V]	750 V DC	750 V DC	750 V DC	750 V DC	750 V DC
Nominal auxiliary voltages	48, 110 V DC, 230 V AC	48, 110 V DC, 230 V AC	48, 110 V DC, 230 V AC	48, 110 V DC, 230 V AC	48, 110 V DC, 230 V AC
Nominal current of main bus-bars and main circuits [A]	up to 6 000	-	up to 6 000	up to 6 000	up to 3 000
Nominal current of auxiliary bus-bar [A]	up to 3 000	-	up to 3 000	-	
Nominal current of circuit-breaker [A]	-	up to 3 600	-	-	-
Nominal current of disconnecter [A]	-	-	up to 4000	up to 4 500	-
Nominal short-time withstand current [A]	20 000	20 000	20 000	20 000	20 000
Nominal ground fault current [A]	16 000	16 000	16 000	16 000	16 000
Degree of protection by enclosure	IP40/00	-	IP40/00	IP40/00	IP20/00
Weight [kg]	210	180	160-240	190	350
Operating temperature [°C]	-5 to +40	-5 to +40	-5 to +40	-5 to +40	5 to +40
Dimensions: w × d × h [mm]	600 x 1 050 x 2 000	580 x 952 x 1 244	600 x 650 x 2 000	1 000 x 650 x 2 000	1 000 x 1 050 x 2 000



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