



DC SWITCHGEAR

CITY ELECTRIC TRANSPORT ■
RAILWAYS ■ METRO

ABOUT COMPANY

PLUTON is one of the largest manufacturers of electrotechnical equipment in Europe. The company holds key position in electrical industry and has been successfully working for over 25 years, implementing the strategy of intensive growth, development and continuous improvement of products and services quality. More than 70 kinds of various equipment produced by PLUTON are supplied to many countries around the world and are successfully operated in the fields of transport, energy and industry. PLUTON Group of companies has representative offices in 9 countries of the world and continues dynamic development and expansion of its presence geography.

The company confirmed compliance of its management principles with quality management system international standard ISO 9001:2015, Environmental Safety ISO 14001:2015, as well as occupational safety and health OHSAS 18001:2007 requirements.

Due to vast experience and modern technologies we make secure, reliable and efficient energy distribution. We are building future, creating products of up-to-date level in compliance with international standards, innovative technologies that ensure safety and comfort of people.

DC SWITCHGEAR

PLUTON offers the best solutions in the field of energy distribution. We have developed switchgear, which provide reliable power supply and trouble-free control.

We provide a full range of services starting with recommendations on switchgear components optimum choice and design, and up to installation and commissioning of the supplied equipment on operation site.

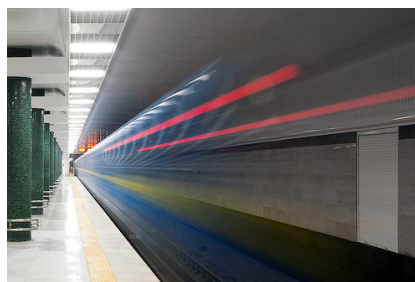
We provide the following after switchgear start-up:

- personnel correct and safe operation and maintenance training;
- warranty maintenance;
- post-warranty maintenance;
- spare parts supply;
- repairs.

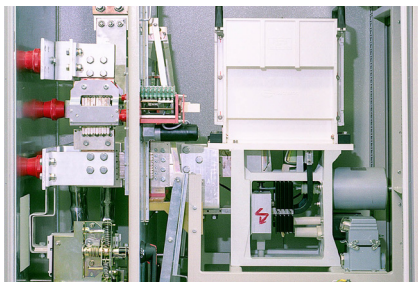


APPLICATION AREA

Voltage class	600 V	750 V	825 V	1500 V	1650 V	3000 V	3300 V
Tram		■	■	■			
Trolleybus	■	■					
Light rail	■	■	■	■			
Metro		■	■	■			
Railway				■	■	■	■



MAIN FEATURES



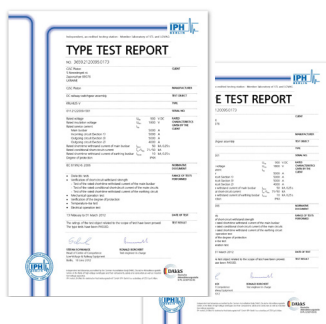
Reliability

Application of components with high switching capacity, high dynamic resistance to short-circuit currents and long mechanical life provides high reliability of equipment.

Compliance with International Standards

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

DC Switchgears meet international standards EN 50123-1:2003 / IEC 61992-1:2014, EN 50123-6:2003+A1:2014 / IEC 61992-6:2014.



Maintenance

- no need in frequent periodic maintenance and periodic repairs;
- convenient inspection due to application of withdrawable trolley with circuit breaker and line disconnector;
- unilateral maintenance provides free access to all components of the cubicle and maintenance safety.

Safety

During switchgear development special attention is paid to safe operation provided by automatics, controls, electrical and mechanical interlockings as well as separating and protective structures logic.

Contact Connections Stabilizing

Power part of switchgear is made using technology of maintenance-free contact connections. There is no need of the contact connections control, periodical readjustment, cleaning during operation. Temperature stabilization of contact connections increases fire safety of switchgear and substation.

Environmental Compatibility

PLUTON uses materials with minimal impact on environment in its production. The materials are safe not only during operation, but also at the end of product life.



Control

- easy switching devices control, trolley rolling in and out control using touch screen;
- quick displaying of switching elements condition, trolley position, current and voltage values, messages history, trends, settings, traction network monitoring system screens;
- control mode selection (manual, remote, program).

Protection, monitoring, diagnostics

Switchgear is equipped with innovative SMTN-3 system, provided for traction network protection against short circuit current and harmful overloads, as well as traction power supply parameters monitoring in real time.

Switchgear can be equipped with line test device and cable monitoring system that allows measuring internal and external cable insulation resistance value in real time and provides emergency prevention in case of insulation characteristics degradation.

DESIGN

Switchgear components are mounted in separate compartments. High and low voltage compartments are separated from each other. The separation ensures operation reliability, equipment servicing and operational safety.

Switchgears are manufactured both for uni- and bilateral maintenance.



1. Automatics and Control Compartment:

- B&R (Austria) 4PPC70 panel controller with visualization function,
- traction network monitoring and protection system SMTN-3,
- mechanisms control modules,
- contactor relay devices.

2. High Speed Circuit Breaker Compartment:

- DC high speed circuit breaker,
- operating busbar two-pole disconnector,
- interlocks operational units,
- line tester (short circuits tester SCT).

3. Power Busbars and Cables Compartment:

- operating and output busbars,
- earthing busbar,
- disconnectors of various purpose (reserve , earthing),
- power cables mounting frame,
- cables control system.

The following is also installed in the compartment depending on the purpose and type of DC switchgear:

- power circuit shunt,
- power circuit current and voltage control components,
- reserve busbar.



Disconnectors Control Compartment

(in DC Switchgears 1500 V, 1650 V, 3000 V and 3300 V):

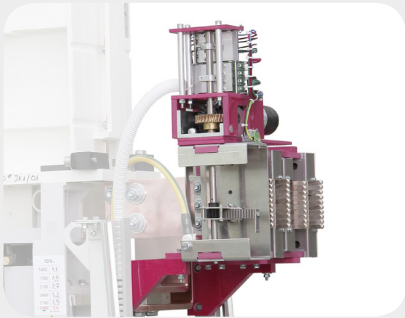
Protection device against remote short-circuits, measuring module SMTN-3 and secondary circuits output terminal is installed in disconnectors control compartment.

COMPONENTS



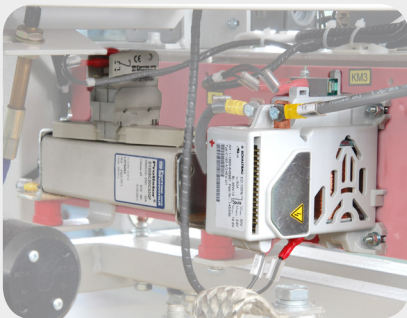
① High Speed Circuit Breaker (Secheron)

- high switching capacity;
- longtime mechanical durability;
- minimum tripping time;
- design providing minimum maintenance.



② Two-pole disconnect

- crimp-type;
- wiping contacts;
- long time without maintenance;
- silent efficient electric drive;
- high electrodynamic resistance.



③ Line Tester (Short Circuits Tester SCT)

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



4 Control, Monitoring and Protection System

- complete automation of cubicle and traction substation control;
- cubicle and traction substation equipment condition monitoring with equipment self-diagnostics function;
- cubicle events logging at traction substation;
- data transfer to the upper control level;
- traction network protection with present day microprocessor system SMTN-3.



5 Cable Control System

- resistance measurement range of external cable insulation 50 - 500 kOm; of internal cable insulation 200 - 2000 kOm;
- operating line power supply;
- 3 pairs of discrete failure signals;
- galvanic isolation with data processing module.



Withdrawable Trolley

Application of withdrawable trolley in DC switchgear structure provides quick inspection and equipment reconditioning in case of damage, ensuring personnel maintenance safety.

High speed circuit breaker, line disconnecter and short-circuit tester (SCT) is mounted on withdrawable trolley.

Withdrawable trolley has three positions: operation, control and maintenance. Withdrawable trolley moves automatically from operation position to control one, and back from control to operation position with the help of an electric drive with low power consumption, without applying any effort by maintenance staff. This ensures safe operation due to electromechanical interlocking system.

COMPONENTS

High Speed Circuit Breaker

High speed circuit breakers manufactured by Secheron (Switzerland) are applied in DC Switchgear.

Circuit breakers of this type have high breaking capacity and dynamic stability to short circuit currents.

Main advantages of high speed circuit breakers:

- mechanical simplicity;
- automatic adjustment of contact tightness;
- long lifetime;
- inspection after 250 protection trippings;
- insulation material wiping under arc;
- stepless regulation of trip setting;
- compliance of all insulation materials with strict International and European environmental standards requirements;
- minimum tripping time;
- no need for often lubrication, adjustment, maintenance for a long time;
- no need for periodic calibration;
- high mechanical resistance - 8x25000 cycles.



High Speed Circuit Breakers Technical Parameters

Name of Parameter	Unit	High speed circuit breaker type							
		UR 26-81 (82)	UR36-81 (82)	UR40-81 (82)	UR60-81 (82)	UR26-64	UR36-64	UR40-64	UR60-64
Type of arc chute	-	81 (82)				64			
Main circuit current	-	Direct							
Rated operating current, cabinet installation	A	2600	3600	4000	6000	2600	3600	4000	6000
Rated voltage of main circuit	V	900 (1800)*				3600			
Setting currents limits	kA	1.4-8.0	2.0-15.0	2.0-15.0	6.0-18.0	1.4-8.0	2.0-15.0	2.0-15.0	6.0-18.0
Breaking capacity in noninductive circuit: - rated - peak	kA	125 (80)* 180 (115)*				40 57			
Mechanical strength without maintenance, cleaning and greasing (non-emergency trippings)	-	8 x 25000							
Special inspection	-	Inspection after 250 overload trippings							
Test voltage 50 Hz, 1 min	kV	15(12)*				15			
Impulse test voltage at voltage increase 1,2/50 μs	kV	20				30			
Voltage of control coil, DC	V	24, 36, 48, 72, 96, 110, 220							

* - The values shown in parentheses are consistent with Secheron's arc chute type 82

Disconnectors

EST, EDT disconnectors manufactured by Elpro (Germany) are applied for electric power circuit switching.

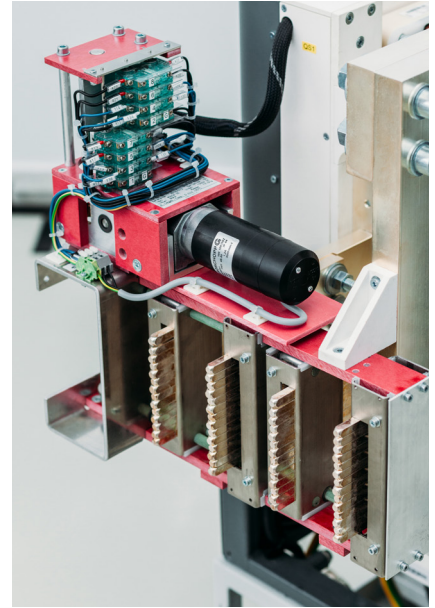
Disconnectors have a unique crimp-type contact system design with double gap and wiping contacts, geared by a small-sized electric drive.

Easy rolling out of trolley with circuit breaker and EDT double-pole disconnector is achieved due to disconnector unique design.

Each pole has two rows of lamellae. They are separated from each other in off-line state, and allow connected busbars entering lamellae gaps smoothly, without mechanical withstand strength.

When activating disconnector electric drive brings lamellae rows together and crimps a busbar with high effort.

EST and EDT disconnectors are classified as maintenance-free components, with the number of cycles before maintenance - 10,000 cycles (or 10 years). Disconnectors have noiseless efficient electric drive, capacity 18 W. Application of electric drives controlled with automation system reduces risk of disconnectors and support insulation damage in case of false staff operation with undue exertion.



Disconnectors Technical Parameters

Name of Parameter	Unit	Disconnector type				
		EST 1000	EDT 2500	EDT 4000	EST 3-10	EDT 3-40
Rated voltage	V	1000	1000	1000	3600	3600
Rated current	A	1000	2500	4000	1000	4000
Short-time current maximum value	kA	80	100		80	100
Mechanical strength (maximum number of switchings)	-	30000	20000		30000	20000
Drive force	N	7	10		7	10
Maintenance intervals	-	10000 cycles (or once per 10 years)				

COMPONENTS

Control, Monitoring and Protection System

Switchgears are equipped with control, monitoring and protection system, which includes:

- 4PPC70 panel controller with visualization function;
- I/O modules series X20;
- traction network monitoring and protection system SMTN-3.

Main System Functions:

- analysis of interlocks and implementation of traction substation control algorithms using microprocessor industrial controllers;
- traction substation events logging for personnel actions and equipment operation analysing;
- protection and recording of all network transient processes due to integrated traction network monitoring and protection system SMTN-3;
- traction substation equipment condition monitoring.

I/O modules series X20

B&R X20 compact I/O modules with a great number of channels significantly reduce time for installation and provide space saving in switchgear.



4PPC70 panel controller



B&R (Austria) 4PPC70 panel controller is applied in switchgear to monitor condition of switching devices, to implement algorithms of control and communication with external devices.

Application of these controllers minimizes the risk of personnel mistakes that can cause emergencies or other negative consequences.

Due to visualization function, the required information is displayed in convenient intuitive form and switching units control is performed via touch.



Traction network monitoring and protection system SMTN

Traction network monitoring and protection system SMTN-3 is applied in switchgear to protect traction network against short circuit currents and unacceptable overloads.

Traction network monitoring and protection system SMTN-3 analyzes occurred emergencies, monitors traction network parameters.

Traction network protection is provided by continuous control and analysis of traction network current and voltage dynamics history with issuing commands to open DC switchgear high speed circuit breaker in case of protection functions set parameters exceed.

Implementation of protections is based on the amplitude-time analysis of protected network.

SMTN-3 is implemented as an electronic modules package:

- **measuring module** with voltage divider is installed in high voltage zone (busbar compartment);
- **processor module** is installed in low voltage zone (control compartment).



Types of electronic protections (ANSI code):

- instantaneous overcurrent (50);
- overcurrent protection (76);
- current rate of rise protection;
- current increment directional protection;
- overvoltage protection (59);
- undervoltage protection (27);
- thermal protection (49);
- breaker failure (BF).

SMTN-3 generates and stores the following records:

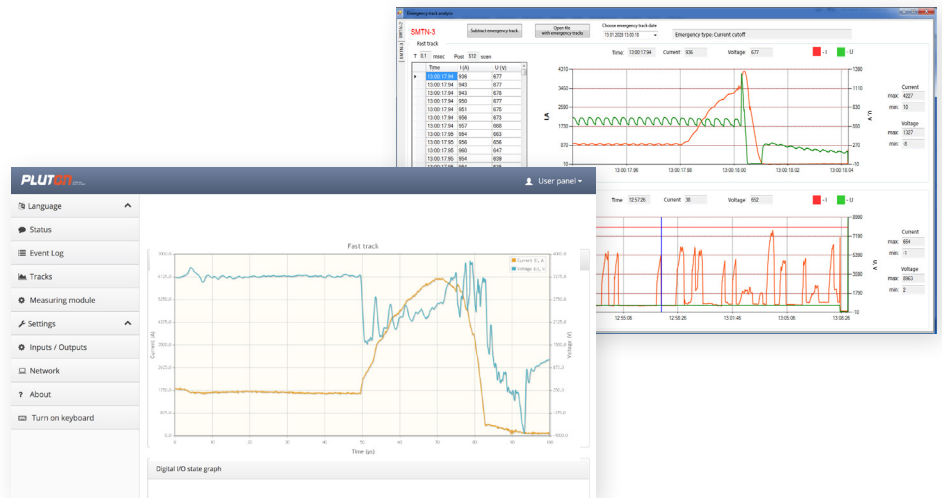
- events log;
- failures log;
- emergency oscillograph records.

Records are stored on nonvolatile solid data storage medium that guarantees data storage in case of devices power supply interruption, and high reliability.

SMTN-3 system provides generation and storage of emergency oscillograph records. Emergency oscillograph record generation is performed when one of protective functions operates.

Two emergency oscillograph records are generated and stored when one of protective functions operates:

- "Fast track" record;
- "Slow track" record.



SMTN-3 system provides the following methods of parameters setting for both the system itself and protection functions parameters:

- local "Human Machine" interface based on LCD touch screen;
- remote "Human Machine" interface based on WEB-technologies;
- remote access to device using ModBus RTU, ModBus TCP/IP protocol, for upper level systems and power management systems, etc.

Line Tester (Short Circuits Tester SCT)

Short circuit tester SCT allows to determine line short circuit / no line short circuit before high speed circuit breaker closing. If line resistance is lower then setting parameter, SCT prohibits closing of high speed circuit breaker.

Cable Control System

Cable control system provides monitoring of cable internal and external insulation resistance, as well as signaling in case of insulation degradation.

Cable control unit is supplied by circuit voltage, therefore is at potential to operating busbar. Galvanic isolation is made of optic wire conductor.

The unit has three contacts pairs - two per each signal:

- voltage availability;
- external insulation resistance reduction lower the setting;
- internal insulation resistance reduction lower the setting.

Voltage galvanic isolation is done by application of relay with insulation voltage minimum 5 kV. The casing is made of fire-resistant insulating material.

MAIN TECHNICAL PARAMETERS

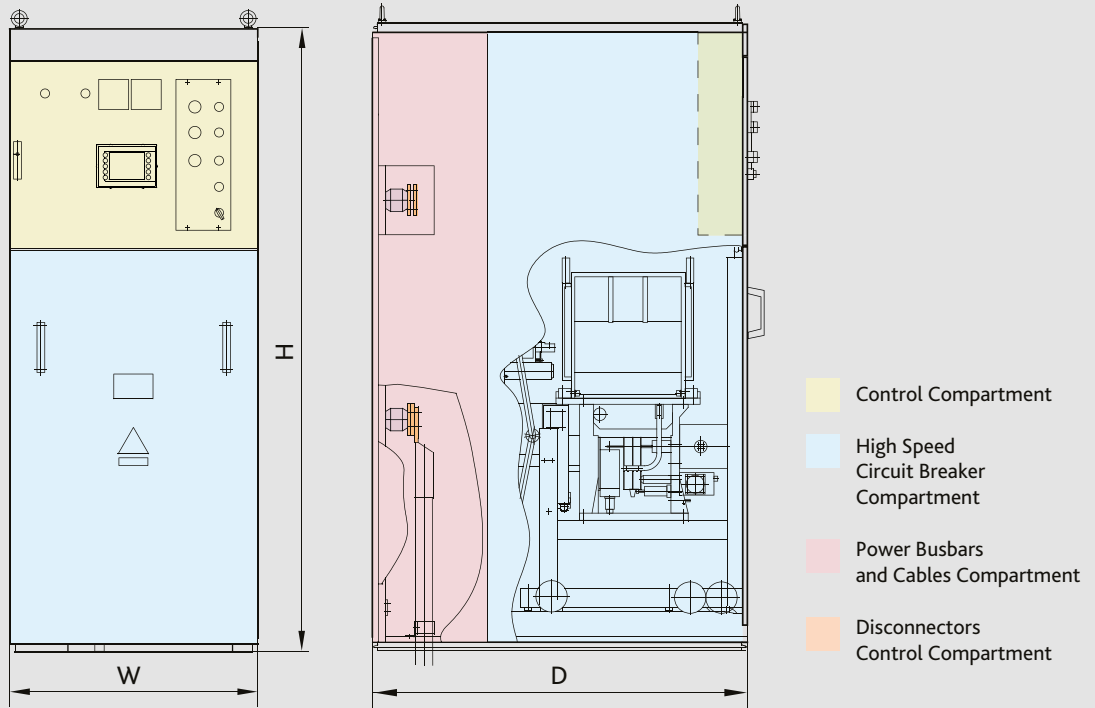
DC Switchgear Technical Parameters

Name of Parameter	Unit	Value		
Rated voltage	V	600, 750, 825	1500, 1650	3000, 3300
Maximum operating voltage	V	1000	2000	4000
Rated insulation voltage	V	3000		4800
Rated current of power network	A	up to 8000*		up to 6000*
Test voltage, 50 Hz, 1 min	kV	5	18.5	
Type of high speed circuit breaker	-	UR 26-81, UR 36-81, UR 40-81, UR 60-81	UR 26-82, UR 36-82, UR 40-82, UR 60-82, UR 80-82	UR 26-64, UR 36-64, UR 40-64, UR 60-64
Electrodynamic resistance	kA	100	80	55
Breaking capacity in noninductive circuit, rated / peak	kA	125/180		40/57
Control	-	microprocessor		
Reverse current protection setting	A	0.05-1 I _{NOM}		
Rated voltage of control circuits	V	110, 220		
Rated voltage of lighting AC circuits	V	220		
Rated voltage of signaling DC circuits	V	24		
Cooling	-	natural air		
Protection degree	-	IP43		
Overall dimensions of cubicles with power circuit rated current up to 4600 A	mm	W 600, 800 H 2000 D 1200	W 1200 H 2200 D 1400	
Overall dimensions of cubicles with power circuit rated current 6000 A	mm	W 600, 800 H 2000 D 1600	W 1200 H 2200 D 1600	

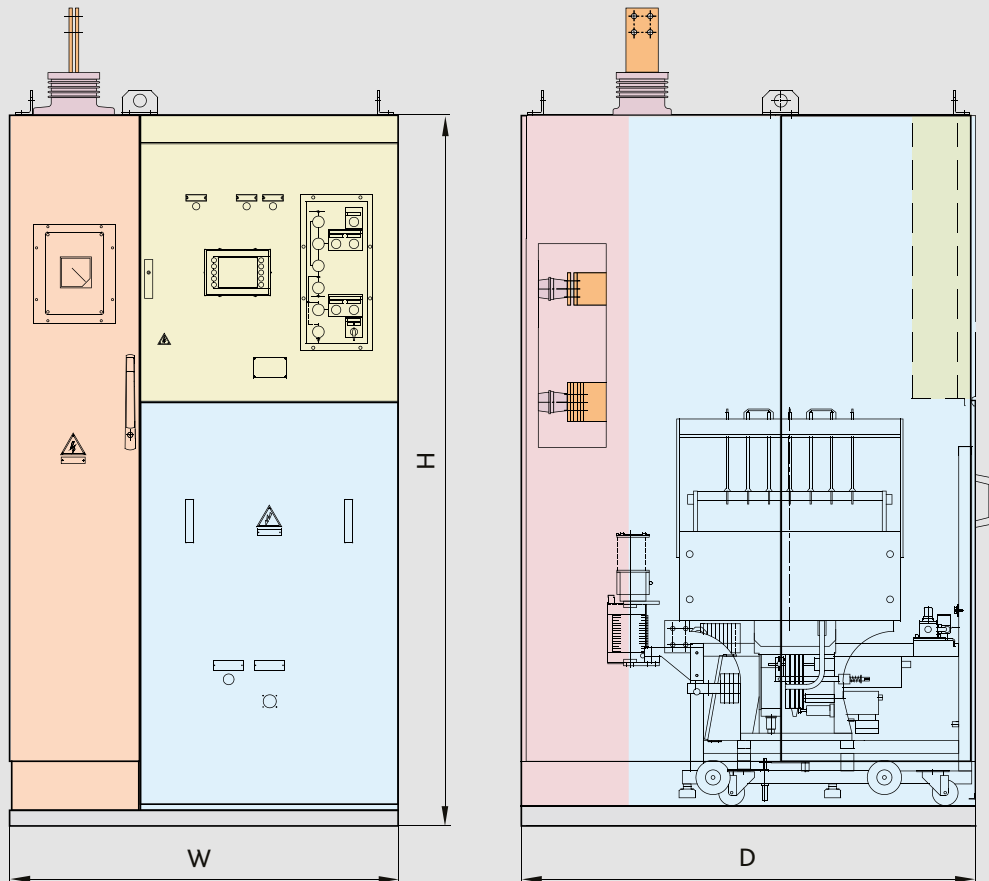
*- manufacturing of DC switchgear with parameters different from those stated above is made by special order

DC Switchgear Overall Dimensions

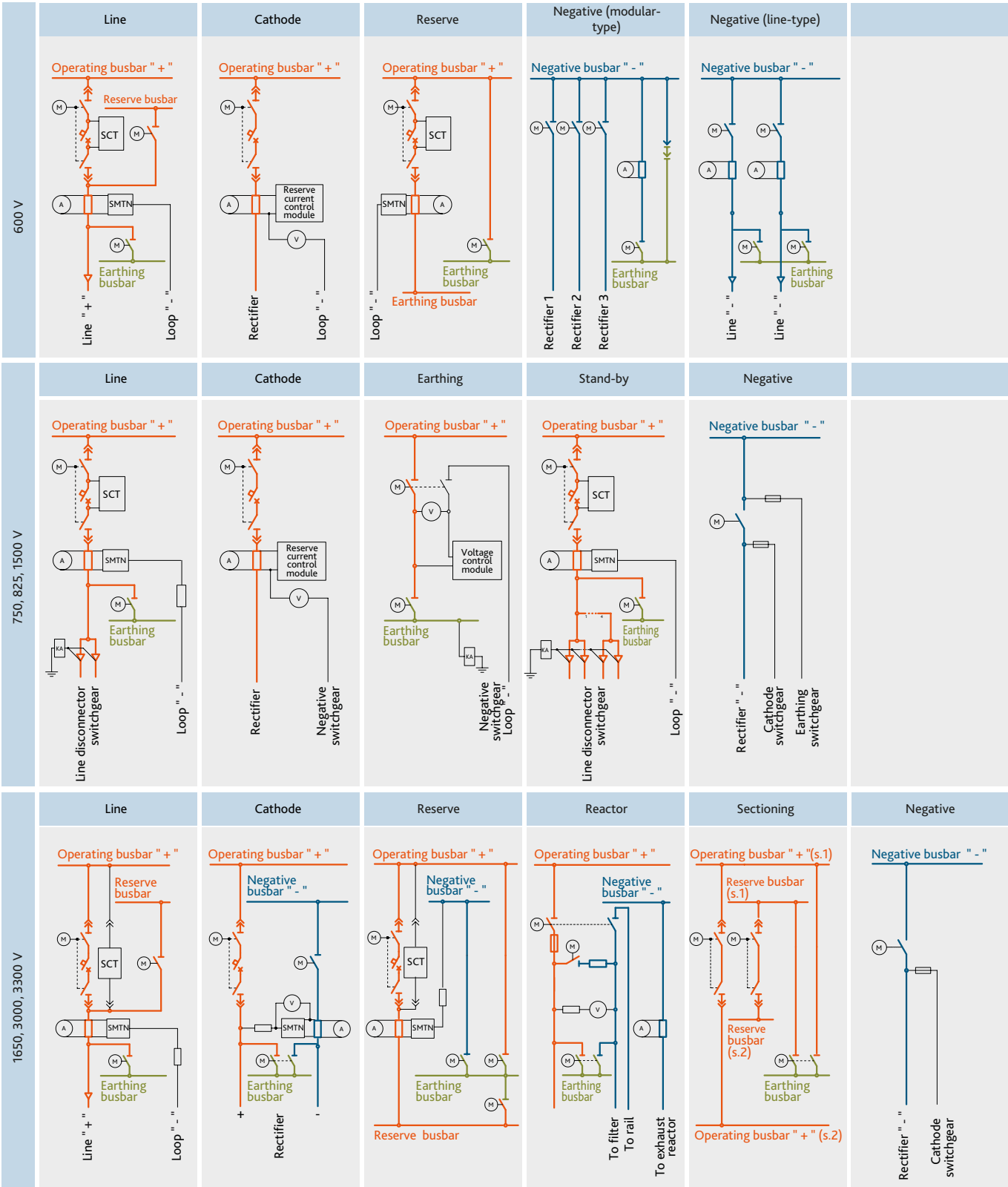
600 ... 825 V



1500 ... 3300 V



SWITCHGEAR SINGLE-LINE DIAGRAMS



Type of cubicle	Designation
Cathode	For traction substation rectifier cathode circuit switching and protection
Line	For the line supply circuits switching and protection
Reserve, Stand-by	For the line supply circuits switching and protection as a backup unit for line switchgear
Sectioning	For busbars sectioning
Earthing	For operating busbar earthing
Reactor	For exhaust reactor and filter device connection to power circuit
Negative	For closing and opening of negative line dead sections

NEGATIVE SWITCHGEAR



▲ Negative Switchgear for metro

Negative Switchgears are provided for operation at traction substations, depot substations for receiving and distribution of electricity, as well as for switching of public electric transport, metro, railways lines power circuits.

Negative Switchgears are applied to close and open feeder negative line dead sections.

The Switchgears are individual metal cabinets of unilateral maintenance. Installation in a row is provided.

Depending on design solutions, switchgears can be manufactured for outdoor installation.

Switchgear design provides:

- high reliability and maintainability;
- easy access for internal inspection;
- convenient access to measuring devices, as well as to components subject to regulation and adjustment;
- no fasteners loosening due to design;
- maintenance with standard tools.



▲ Negative Switchgear for railway

Switching devices manual controls are located on the door.

Disconnectors' manual control is provided with the help of handle.

Negative Switchgears are subdivided in two types: modular-type and line-type.

Modular-type switchgears are provided for rectifying units negative pole connection to negative busbar.

Modular-type switchgears main functional parts:

- disconnectors assembly;
- negative busbar earthing disconnecter;
- microprocessor control system;
- poles insulation control unit.

Negative line-type switchgears are provided for overhead network outgoing feeders connection to substation negative busbar. Line-type switchgears main functional parts:

- line disconnectors;
- earthing disconnectors.



▲ Negative Switchgear for city electric transport

MAIN TECHNICAL PARAMETERS

Negative Switchgear Technical Parameters

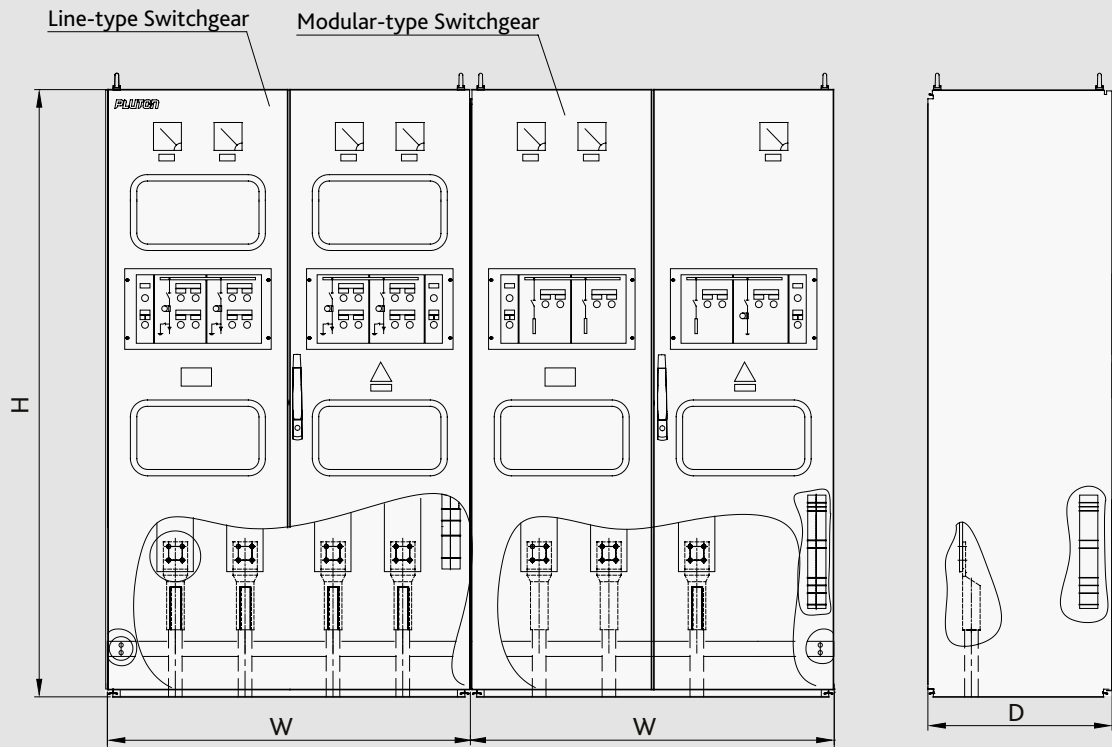
Name of Parameter	Unit	Value				
Rated voltage of power circuit	V	600	750, 825	1500, 1650	3000, 3300	
Negative switchgear type	-	line	modular	-		
Rated current of power circuit	A	1000	2000	up to 8000*		
Electrodynamic resistance	kA	80	100	80	55	
Test voltage	kV	10				
Control	-	microprocessor				
Rated voltage of control circuits	V	110, 220				
Rated voltage of lighting AC circuits	V	220				
Rated voltage of signaling DC circuits	V	24				
Cycling	times per hour	40				
Mechanical strength, minimum	cycles	20000	30000	20000 (30000)**		
Protection degree	-	IP43				
Cooling	-	natural air				
Overall dimensions	mm	City electric transport		Metro, Railway		
		line-type		modular-type	up to 4 kA	up to 8 kA
		1-2 lines	3-4 lines	2-4 units		
		Width	W 600	W 1200	W 600	W 800
		Height	H 2000	H 2000	H 2000, 2200	H 2000
Depth	D 600	D 600	D 600	D 800		

*- manufacturing of negative switchgear with parameters different from those stated above is made by special order

** - the value depends on disconnector type

Negative Switchgear Overall Dimensions

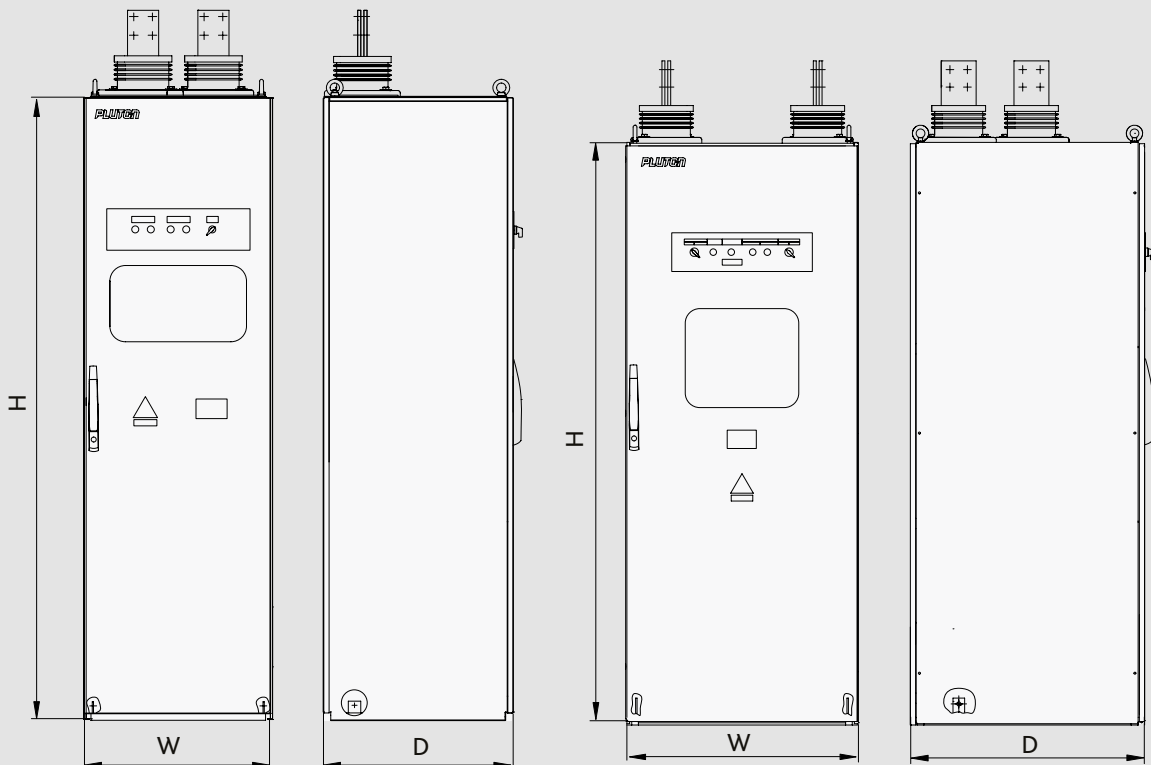
City electric transport



Metro, Railway

up to 4 kA

up to 8 kA



IMPLEMENTED PROJECTS

METRO

Republic of Kazakhstan	Almaty Metro	DC Switchgear 825 V - 79 units
Republic of Belarus	Minsk Metro	DC Switchgear 825 V - 160 units
Republic of Azerbaijan	Baku Metro	DC Switchgear 825 V - 72 units
Ukraine	Kyiv Metro	DC Switchgear 825 V - 132 units
	Kharkiv Metro	DC Switchgear 825 V - 26 units
Russian Federation	Yekaterinburg Metro	DC Switchgear 825 V - 25 units
	Nizhny Novgorod Metro	DC Switchgear 825 V - 12 units
Republik of Uzbekistan	Tashkent Metro	DC Switchgear 825 V - 13 units
Republic of Korea	Busan City Metro	DC Switchgear 1500 V - 2 units
	Dawonsys Company	DC Switchgear 1500 V - 4 units
Republic of Turkey	Izmir Metro	DC Switchgear 750 V - 6 units

CITY ELECTRIC TRANSPORT

Republic of Belarus	Minsk, Grodno, Gomel, Brest, Vitebsk	DC Switchgear 600 V - 158 units
Poland	Lodz	DC Switchgear 660 V - 23 units
	Poznan	DC Switchgear 660 V - 1 unit
Romania	Oradea	DC Switchgear 750 V - 6 units
Ukraine	Kyiv, Odesa, Lviv, Vinnytsia, Kramatorsk, Dnipro, Mykolaiv	DC Switchgear 600 V - 185 units
AR of Crimea	Simpheropol, Kerch	DC Switchgear 600 V - 49 units
Sweden	Stockholm	DC Switchgear 750 V - 33 units DC Switchgear 1500 V - 6 units
Republic of Tajikistan	Dushanbe	DC Switchgear 600 V - 57 units
Russian Federation	Moscow	DC Switchgear 600 V - 14 units
	Naberezhnye Chelny	DC Switchgear 600 V - 12 units

RAILWAYS

Ukraine	Ukrainian Railways (Ukrzaliznytsia)	DC Switchgear 3.3 kV - 2 units
	Southern Mining Company (Kryvyi Rih), departmental railway	DC Switchgear 1.65 kV - 15 units
Russian Federation	Magnitogorsk Iron and Steel Works, industrial railway	DC Switchgear 1.65 kV - 76 units



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