AVL
REACH LIMITED

DC SWITCHGEAR

CITY ELECTRIC TRANSPORT ■
RAILWAYS ■ METRO

BUILDING FUTURE **TOGETHER**!

DC Switchgear

Company “AVL Reach Limited” offers an outstanding solution in the field of energy distribution. We supply switchgears and provide lifetime equipment support enabling reliable power supply and trouble-free control.

We provide a full range of services starting from consultancy regarding switchgear components optimal choice and design, and up to installation and commissioning of the supplied equipment on operational site.

We provide the following post commissioning services:

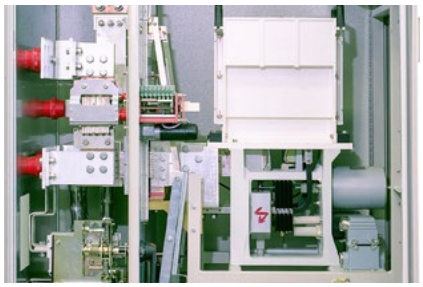
- personnel safe operation and maintenance training;
- warranty maintenance;
- post-warranty maintenance;
- spare parts supply;
- troubleshooting and repairs.

Application Area

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

Serviceability

Retractable trolley allows quick inspection of equipment. Unilateral maintenance provides ease of access to all components of the cubicle and maintenance safety.



Reliability

A skilful selection of components with high switching capacity, high dynamic strength to short-circuit currents and large mechanical resource is a distinguishing feature of AVL Reach switchgears that provides high reliability of equipment.

Compartmentation

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

Safety

Sophisticated electromechanical interlocking and protection system guarantees extraordinary safety level for maintenance staff.

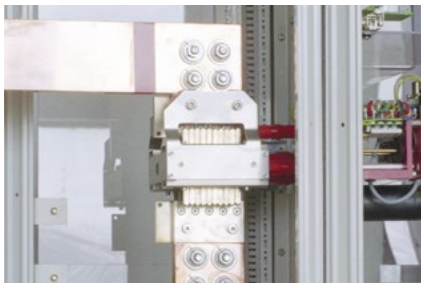
Environmental Compatibility

Materials with minimal impact on environment are applied in DC switchgears. The materials are safe not only during operation, but also at the end of product life.

Compliance with International Standards

DC Switchgears were successfully type-tested for compliance with International Electrotechnical Commission (IEC) standards in IPH Institut (Berlin, Germany) test centre.

DC Switchgears comply with international standards IEC 61992-6:2006 and EN 50123-2:2003.



Contact Connections Stabilising

High-tension part of switchgear manufactured with utilisation of unique maintenance-free contacts technology. There is no need for periodical control, re-adjustment, cleaning of contact joints during switchgear operation. Temperature stabilisation of contact connections increases fire safety rating of switchgear and substation.

DC Switchgear Design

1. Automatics and Control Compartment:

- industrial controller manufactured by Bernecker & Rainer (Austria),
- traction network monitoring and protection system SMTN-2, SMTN-3,
- visualisation power panel PP65,
- control modules,
- contactor relays.

2. High Speed Circuit Breaker Compartment:

- DC high speed circuit breaker,
- operating busbar double-pole disconnector,
- earthing switch,
- line tester (short circuits tester SCT).

3. Power Busbars and Cables Compartment:

- operating and output busbars,
- earthing busbar,
- 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,
- retractable trolley servo drive,
- electromagnetic interlockings actuators,
- reserve busbar.

4. Disconnectors Control Compartment

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

Protection device against remote short-circuits and secondary circuits output terminal is installed in disconnectors control compartment.

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-2, SMTN-3

High Speed Circuit Breaker (Secheron)

- High switching capacity;
- Prolonged mechanical durability;
- Minimal tripping time;
- Low-maintenance design.

Line Tester (Short Circuits Tester SCT)

- Line resistance measurement;
- High speed circuit breaker tripping interlock.

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 from processing module (SMTN-3 system) by means of optic fiber.

Disconnector

- Crimp-type;
- Wiping contacts;
- Long time without maintenance;
- Silent economic electric drive;
- High electrodynamic resistance.

Retractable Trolley

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

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

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

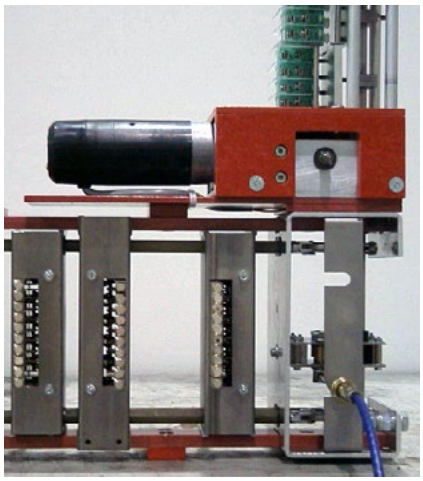
High Speed Circuit Breaker

As a rule **high speed circuit breakers** applied in DC Switchgear are manufactured by **Secheron (Switzerland)**.

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 setting of contact tightness;
- Long lifetime (3000 short circuit currents disconnections before contacts replacement);
- Inspection after 250 protection operations;
- Insulation material wiping under arc;
- Precise regulation of trip setting;
- Compliance of all insulation materials with strict 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.



Disconnector

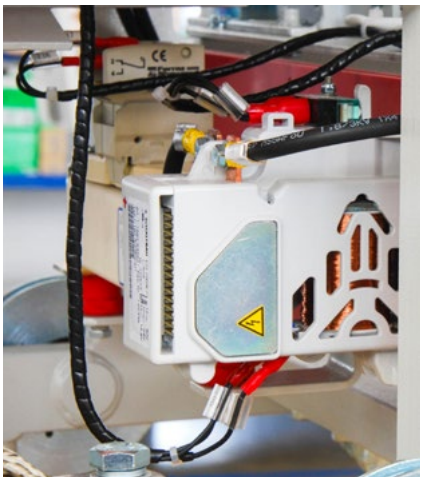
EST, EDT disconnectors manufactured by Elpro (Germany) are applied for electric power circuit switching.

Disconnectors have a unique crimp-type contact system design with double gap and wiping contacts, geared by a small-sized servo drive. Ease of trolley with double-pole EDT disconnector withdrawal is achieved by original design of the disconnector.

Each pole has two rows of fingers that in original (opened) condition are set so that the connected busbars enter the gap between fingers easily without mechanical resistance.

Further, servo drive brings the fingers together to busbar, crimping the busbar with great force.

EST and EDT disconnectors are categorised as maintenance-free components, with the 10,000 maintenance free cycles (or 10 years). Disconnectors have noiseless, efficient, 18W electric drive. Application of electric drives with automation system reduces the risk of disconnector and support insulation damage in case of human error.



Line Tester (Short Circuits Tester SCT)

Short circuit tester SCT allows to determine line resistance immediately before high-speed circuit breaker closing cycle. If line resistance is lower then pre-set value, SCT signals alarm and prohibits closing cycle of high-speed circuit breaker.

Cable Control System

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

Cable control system is fully self-sufficient feeding from network voltage, therefore is at potential to operating busbar. The unit provides high galvanic isolation by the fibre-optic technology.

“Dry contact” signalling carried out by three contacts pairs - two per each signal:

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

“Dry contacts” galvanic isolation is rated for 5 kV galvanic insulation voltage. Encasement is made of fire-resistant insulating material.

Control, Monitoring and Protection System

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

- industrial controller X20,
- visualisation power panel PP65,
- traction network monitoring and protection system SMTN-2 or SMTN-3.

Core System Functions:

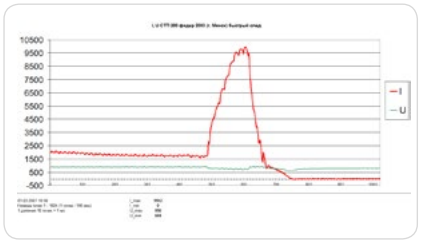
- processing of interlocks positions and implementation of traction substation control algorithms using microprocessor industrial controllers;
- traction substation events logging for personnel actions and equipment operation analysis;
- protection and recording of all network transient processes by integrated traction network monitoring and protection system SMTN-2 or SMTN-3;
- traction substation equipment condition monitoring.

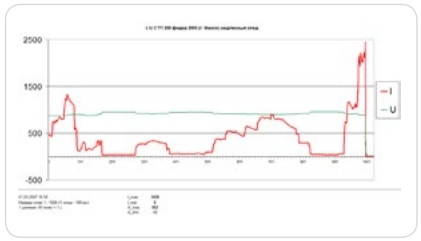
Traction network monitoring and protection system SMTN-2 or SMTN-3 is integrated in switchgear to protect traction network against short circuit currents and unacceptable overloads.

Traction network monitoring and protection system SMTN- 2 or SMTN-3 constantly monitors traction network condition and predict occurrence of emergency situations.

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 all protections is based on amplitude-time analysis of protected device voltage and current values.





SMTN-2 and 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.

Industrial controller X20 manufactured by Bernecker & Rainer (Austria) is applied in switchgear to monitor condition of switching devices, to implement algorithms of control and communication with external devices. Application of comprehensive programmable logic controllers completely eliminates the risk of human error, which can lead to a critical situation.

Types of electronic protections (ANSI code):

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

Visualisation power panel PP65 produced by Bernecker & Rainer (Austria) is applied for visualisation and control of switchgear components. Visualisation power panel makes it easy and convenient to display the needed information and to control switching devices from touchscreen.

DC Switchgear Technical Parameters

Name of Parameter		600 V, 750 V, 825 V	1500 V, 1650 V, 3000 V, 3300 V
Rated voltage	V	600, 750, 825	1500, 1650, 3000, 3300
Maximum operating voltage	V	1000	4000
Rated insulation voltage	V	3000	4800
Rated current of power network	A	up to 6000*	up to 6000*
Test voltage	kV	15	
Type of high speed circuit breaker		UR 26-81, UR 36-81, UR 40-81, UR 60-81	UR 26-64, UR 36-64, UR 40-64, UR 60-64
Electrodynamic resistance	kA	80	64
Rated breaking capacity	kA/ ms	125/100	40/31.5
Control		microprocessor	
Reverse current protection setting	A	from 0.05-1 I_{NOM}	
Rated voltage of control circuits	V	110, 220	
Rated voltage of lighting DC circuits	V	24	
Rated voltage of signaling DC circuits	V	24	
Cooling		natural convection	
Protection degree		IP43	

* DC switchgear can be optionally designed with parameters altered from stated above.

High Speed Circuit Breakers Technical Parameters

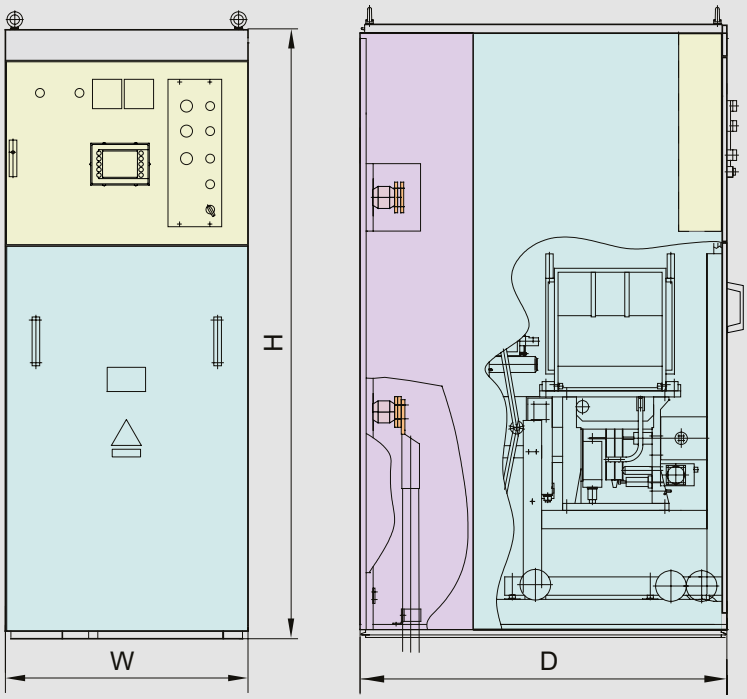
Name of Parameter		UR26-81	UR36-81	UR40-81	UR60-81	UR26-64	UR36-64	UR40-64	UR60-64
Main circuit current		Direct							
Rated operating current in the cabinet	A	2600	3600	4000	6000	2600	3600	4000	6000
Rated voltage of main circuit	V	900				3600			
Setting currents limits	kA	1.4-8.0	2.0-15.0	2.0-15.0	6.0-18.0	1.4-8.0	2.0-15.0	2.0-15.0	6.0-18.0
Short circuit current rated breaking capacity	kA/ ms	125/100				40/31.5			
Mechanical strength without maintenance, cleaning and greasing (non-emergency trippings)		8 x 25000							
Special inspection		Inspection after 250 overload trippings							
Test voltage	kV	15							
DC auxiliaries voltage	V	24, 36, 48, 72, 96, 110, 220							

Disconnectors Technical Parameters

Name of Parameter		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 trippings)		30000	20000		30000	20000
Drive force	N	7	10		7	10
Maintenance intervals		10000 cycles (or once per 10 years)				

DC Switchgear Overall Dimensions

600 V, 750 V, 825 V



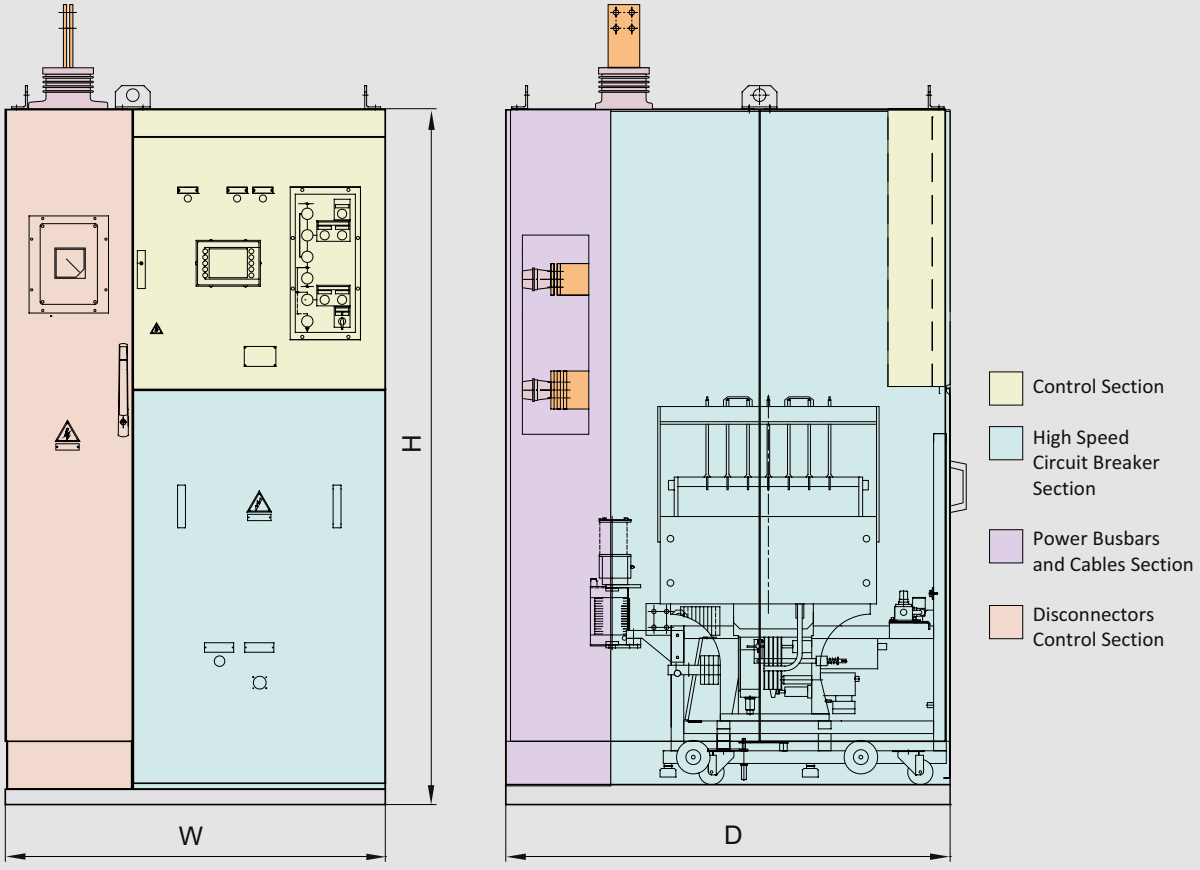
Overall dimensions of cubicles with main circuit rated current up to 4600 A

	W, mm	H, mm	D, mm
600 V	800	2000	1200
750 V			
825 V			
1500 V	1200	2200	1400
1650 V			
3000 V			
3300 V			

Overall dimensions of cubicles with main circuit rated current up to 6000 A

	W, mm	H, mm	D, mm
600 V	800	2000	1600
750 V			
825 V			
1500 V	1200	2200	1600
1650 V			
3000 V			
3300 V			

1500 V, 1650 V, 3000 V, 3300 V



Negative Switchgear

▲Negative Switchgear for city electric transport

Negative Switchgears are used in city transport and underground traction substations for isolation of negative busbar.

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

Switchgear design provides:

- high reliability and maintainability;
- easy access for internal inspection;
- convenient access to measuring devices, as well as to components;
- maintenance with standard tools.

Switching devices local control buttons are located on the door.

Disconnectors can be manually operated by the hand-held actuator, which is located inside switchgear compartment.

Negative Switchgear for city electric transport (tram, trolleybus)

"Negative" Switchgears are provided for operation in city electric transport (tramway, trolleybus) and rolling stock power supply system.

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

Modular-type switchgears are provided for rectifiers negative busbars connection to main negative busbar.

Modular-type switchgears main functional parts:

- disconnectors assembly;
- negative busbar earthing disconnector;
- 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 Subway

Negative Switchgear for Subway

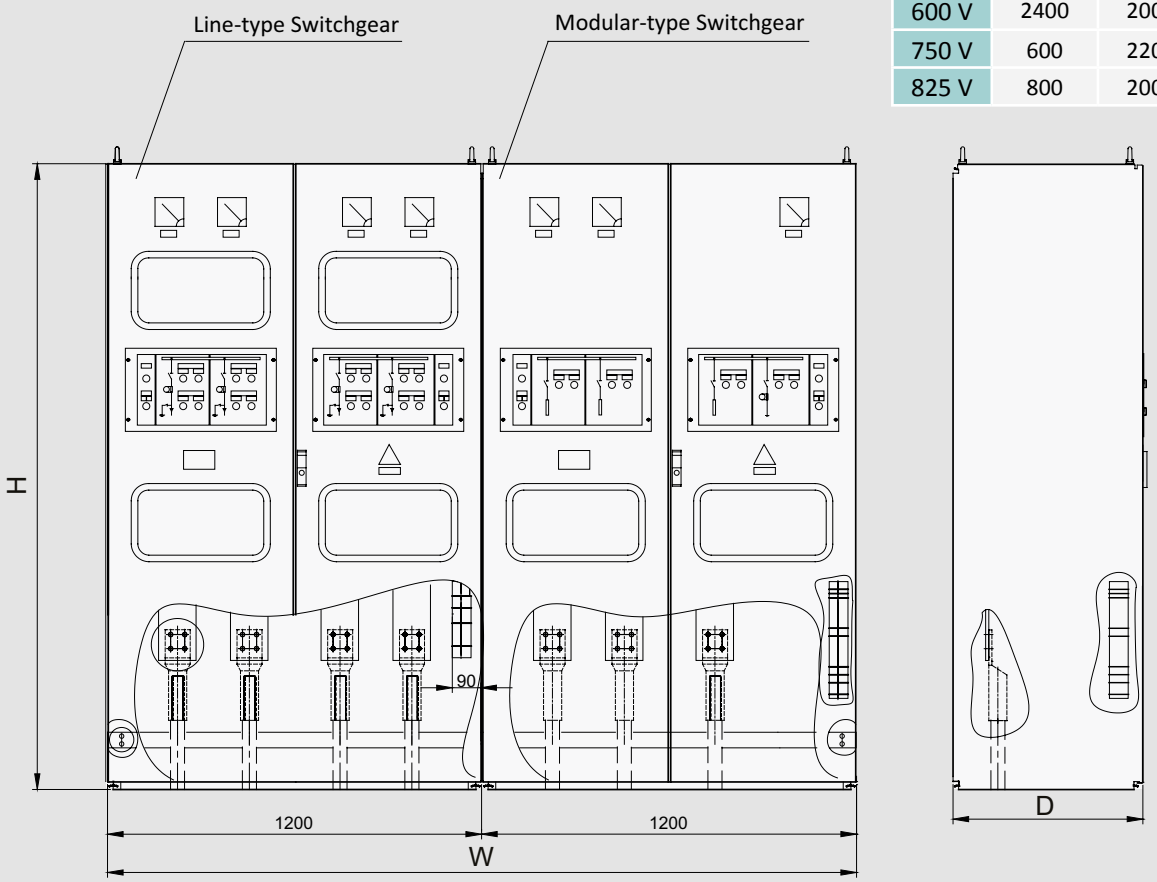
"Negative" Subway Switchgears are designed for operation at depot traction substations for receiving, distribution and protection of 750 V and 825 V power circuits.

Negative Switchgears are used to close and open feeder negative line of end sections on subway traction substation side of 750 V, 825 V.

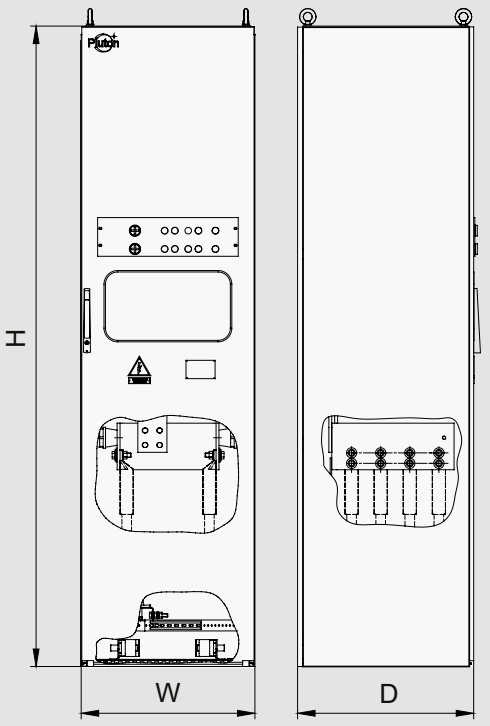
Negative Switchgear Overall Dimensions

	W, mm	H, mm	D, mm
600 V	2400	2000	600
750 V	600	2200	600
825 V	800	2000	800

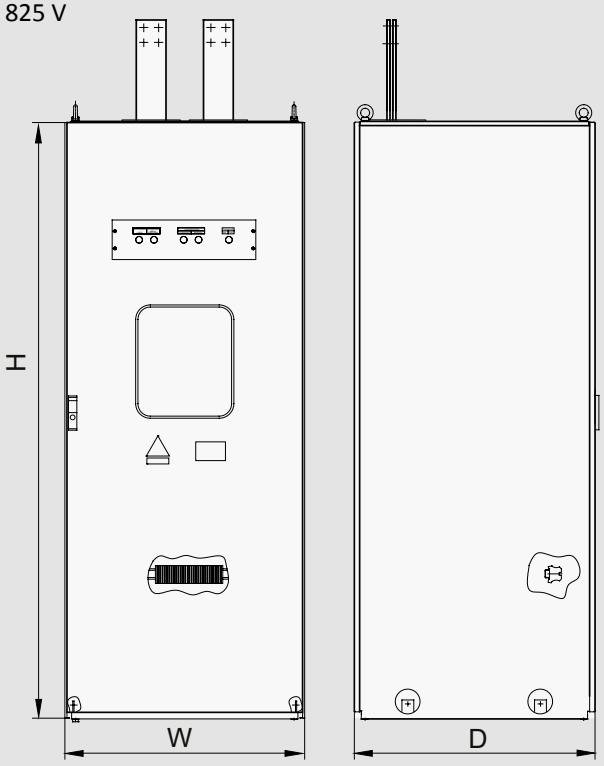
600 V



750 V



825 V



Negative Switchgear Technical Data

Name of Parameter		600 V		750 V, 825 V
Negative switchgear type		line	modular	-
Rated voltage of power circuit	V	600		750, 825
Rated current of power circuit	A	1000	2000	4000
Electrodynamic resistance	kA	80	100	100
Test voltage	kA	10		
Control		microprocessor		microprocessor, relay
Rated voltage of control circuits	V	110, 220		
Rated voltage of lighting DC circuits	V	24		
Rated voltage of signaling DC circuits	V	24		
Cycling	per hour	40		
Mechanical strength, minimum	cycles	20000	30000	30000
Protection degree		IP43		
Cooling		natural convection		

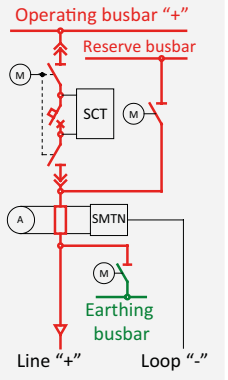
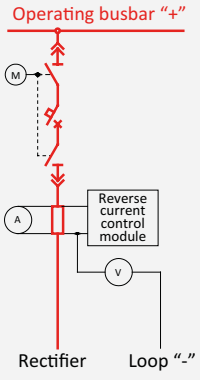
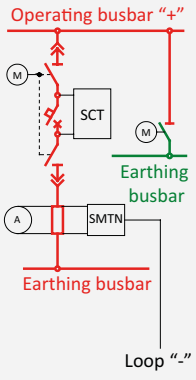
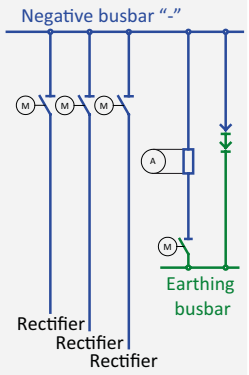
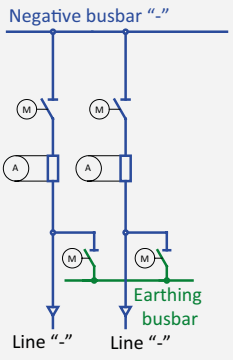
Switchgear can be optionally designed with parameters altered from stated above.

Types of DC Switchgear

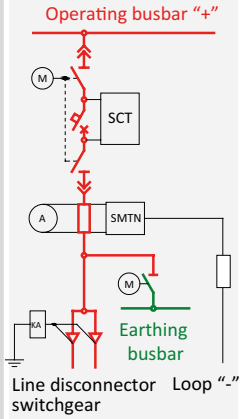
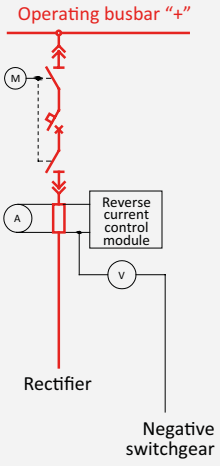
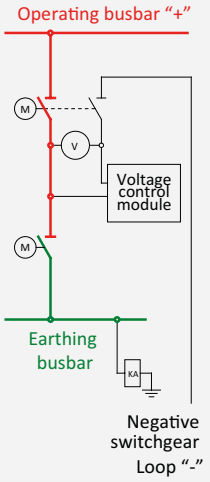
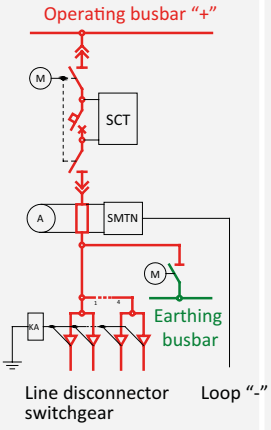
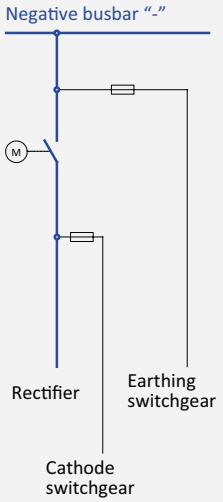
Type of cubicle	Designation
Cathode	For traction substation rectifier cathode circuit switching and protection
Line	For the line supply circuits switching and protection
Reserve, Stand-by	For the line supply circuits switching and protection as a backup unit for line switchgear
Sectioning	For busbars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

Switchgear Single-line Diagrams

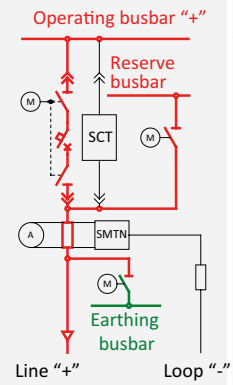
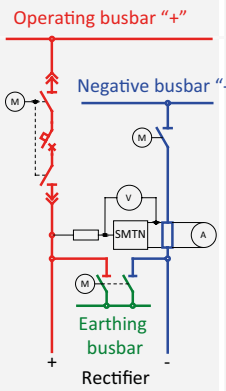
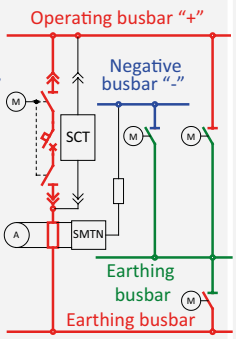
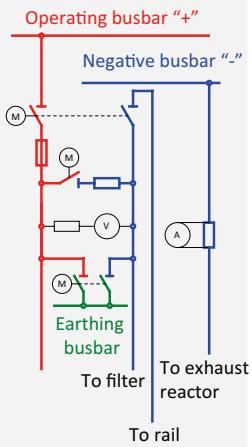
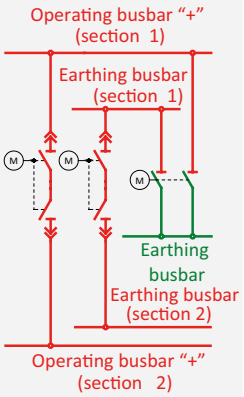
600 V

Line	Cathode	Reserve	Negative (modular-type)	Negative (line-type)
				

750 V, 825 V, 1500 V

Line	Cathode	Earthing	Stand-by	Negative
				

1650 V, 3000 V, 3300 V

Line	Cathode	Reserve	Reactor	Sectioning
				

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