

BASIC FEATURES OF NEW 145 kV METAL- ENCLOSED, SF₆ GAS INSULATED SWITCHGEAR



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1) GENERAL

Gas insulated metal enclosed switchgear of type K8D.6-N 123 /145 KV is made as a three-pole enclosed switchgear with aluminium-alloy encapsulation in different configurations using standard modules.

Main part of the switchgear bay K8D.6-N is vertically placed circuit-breaker with integrated current transformer and it carries all other bay components.

Typical switchgear cable bay is assembled, tested and delivered to site as complete transport unit with SF₆ pre-filling at 0.15 MPa.

A typical line feeder bay of K8D.6-N with double-busbar system and single cable termination compartment is shown in Fig. 1.

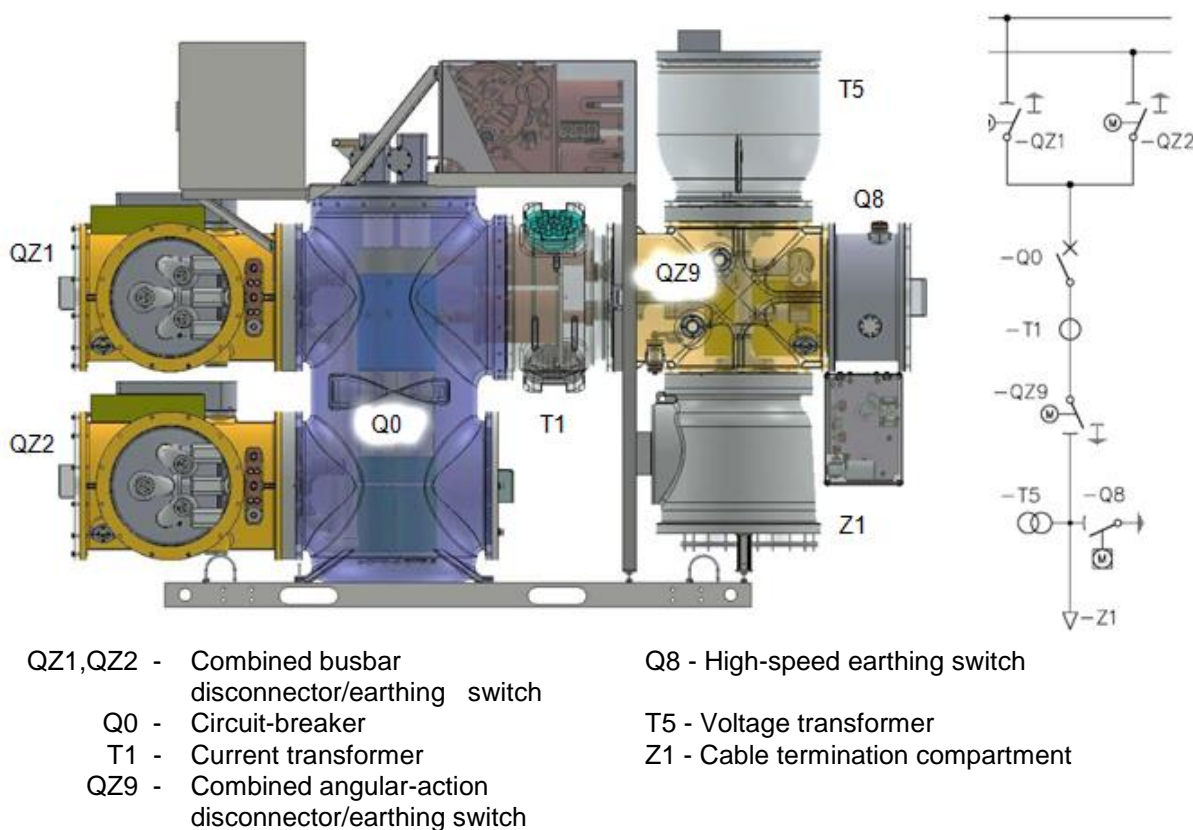



Fig.1 Cross-section through a typical K8D.6-N cable bay and a single-line diagram

Each switchgear unit consists of several gas-filled sections, the actual arrangement depends on operational requirements. Various modules of the switchgear are separated by gastight and arc-proof bushing plates. In this way, a fault will affect only a very limited part of the switchgear unit. Each gas-filled section is fitted with a rupture diaphragm to prevent the pressure build up to an unduly high level. A moisture-absorption filter is installed in each section, its size matched to the particular capacity. The gas monitoring system is realized through the density monitors.

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2) TECHNICAL DATA

Table 1 General technical data

Rated voltage	kV	123	145
Rated power frequency withstand voltage (1 min)	kV		
- to earth and between phases		230	275
- across isolating distance		265	315
Rated lightning impulse withstand voltage (1.2/50µs)	kV		
- to earth and between phases		550	650
- across insulating distance		630	750
Rated frequency	Hz	50	
Rated current	A		
- feeder		to 3150	
- busbar		to 3150	
Rated short-time withstand current	kA	40	
Rated peak withstand current	kA	104	
Rated duration of short-circuit	s	3	
Rated control voltage	V DC	110/125/220	
Rated motor voltage	V DC, V AC	110/220	
Nominal filling gas pressure at 20°C in:	MPa	0.75	
- circuit breaker compartment			
- other than circuit breaker compartment		0.6	
Alarm gas pressure:	MPa	0.67	
- circuit breaker compartment			
- other than circuit breaker compartment		0.56	
Minimum operating gas pressure at 20 °C:	MPa	0.65	
- circuit breaker compartment			
- other than circuit breaker compartment		0.54	
Ambient temperature	°C	-5 ... +40	
Bay width	mm	800	
Dimensions	mm	4150 x 2950 x 800	
Mass	kg	4530	
Standards		IEC 62271-1, IEC 62271-203, IEC 62271-100, IEC 62271-102 IEC 62271-209	


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Table 2 Technical data of circuit breaker

Rated short circuit breaking current	kA	40
Rated making current	kA	104
Rated operating sequence		O-0.3s-CO-3min-CO
Rated opening time	ms	25±5
Rated closing time	ms	55±5
Rated breaking time	ms	≤50
First pole to clear factor	-	1.5
Electrical and mechanical endurance class		E2, C2, M2
Rated capacitive breaking current:	A	
- rated line charging breaking current		50
- rated cable charging breaking current		160
Operating mechanism		motor charged spring MOP-3-180
Charging time	s	15
Rated motor voltage	V DC	230
Rated motor current	A	8.5
Motor starting current	A	<15
Rated motor power	W	1420
Rated motor speed	°/min	8500
Rated motor torque	Ncm	160
Rated power of coil	W	400
Dimensions (with operating mechanism)	mm	1615x2950x800
Mass of gas	kg	53
Mass (with operating mechanism)	kg	2010


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Table 3 Technical data of disconnector/earthing switch

Rated opening time	s	2
Rated closing time	s	2
Mechanical endurance class		M1
Motor operating time	s	< 2
Operating mechanism		motor NPS-20-KC
Rated motor voltage	V DC	230
Rated motor current	A	1.98
Motor starting current	A	<5
Rated motor power	W	260
Rated motor speed	°/min	8506
Rated motor torque	Ncm	29
Rated bus transfer switching current	A	1600
Rated bus transfer switching voltage	V	10
Dimensions (with operating mechanism)	mm	1160x900x800
Mass of gas	kg	20
Mass (with operating mechanism)	kg	515

Table 4 Technical data of high speed earthing switch

Rated short-circuit making current	kA	104
Total opening time	s	≤8
Rated opening time	ms	55±5
Closing time	s	≤8
Rated closing time	ms	65±5
Electrical and mechanical endurance class		E1, M1
Operating mechanism		motor charged spring MOP-1-30
Rated motor voltage	V DC	230
Rated motor current	A	1.98
Motor starting current	A	<5
Rated motor power	W	260
Rated motor speed	°/min	8506
Rated motor torque	Ncm	29
Charging time	s	≤8
Rated induced current (electromagnetic coupling)	A	80
Rated induced voltage (electromagnetic coupling)	kV	2
Rated induced current (electrostatic coupling)	A	2
Rated induced voltage (electrostatic coupling)	kV	6
Dimensions (with operating mechanism)	mm	470x1260x800
Mass (with operating mechanism)	kg	245

3) COMPONENTS OF SWITCHGEAR

3.1) Circuit breaker unit

SF₆-insulated, metal-enclosed circuit-breaker unit of type K8D.6-N is shown in Fig 2 and cross section through the circuit-breaker unit in Fig 4.



Fig. 2 Circuit-breaker unit

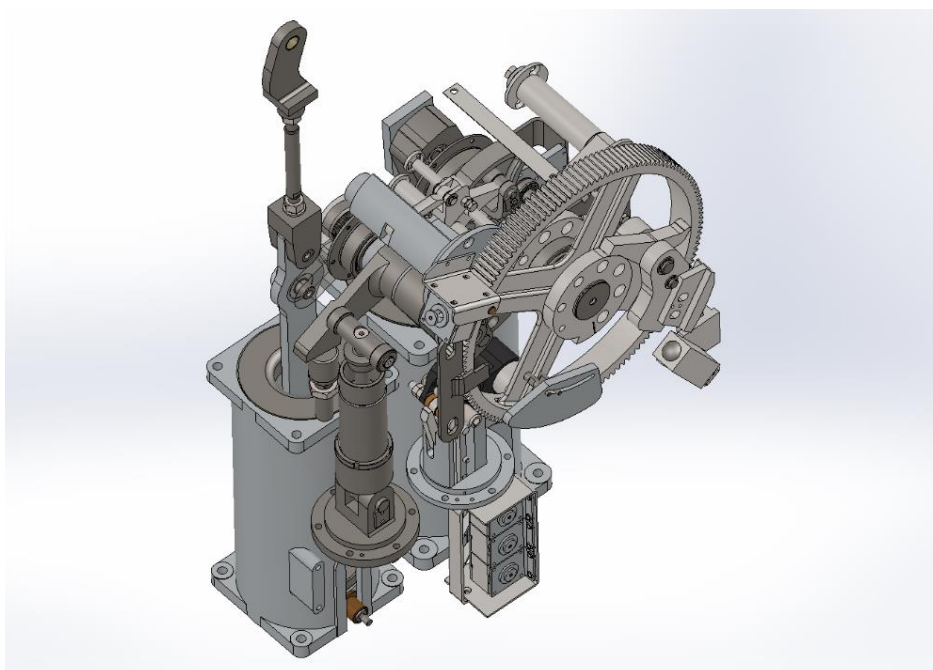


Fig. 3 Motor charged spring operating mechanism

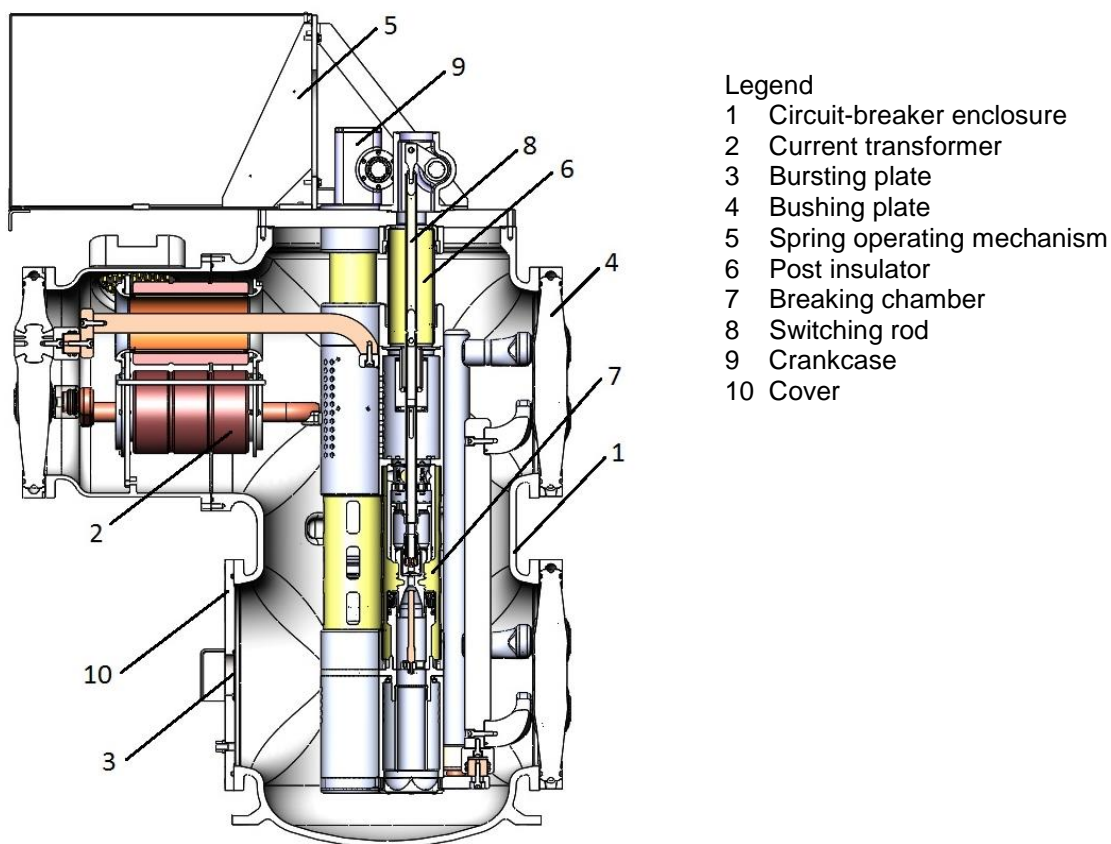


Fig 4. Cross section through the circuit-breaker unit

It is three-pole encapsulated where three breaking chambers are actuated by common spring operating mechanism shown in Fig. 3.

The filter element screwed to cover removes from the SF₆ both moisture and the gaseous decomposition products which arise during operation. In the cover there is also a bursting plate, which is protected with a cap from the outside. This weak breaking spot protects the circuit breaker against excessive high increase of gas pressure.

The breaking chamber of the circuit-breaker is a combination of auto-puffer and self-blast type. For small current interruption, gas flow is produced by piston in a compression chamber. For high current interruption, high pressure in expansion chamber is produced mainly by the ablation of nozzle material due to the electric arc and partially by heating the SF₆ gas.

3.2) Combined disconnector with earthing switch

Combined busbar disconnector with earthing switch (Fig. 6) is three-pole encapsulated and designed as three-position device with common drive shaft. This ensures that the functions of isolating and earthing are mechanically blocked. Typical closing and opening time of disconnector and earthing switch is about 1 s.

3.2.1) Combined busbar disconnecter with earthing switch

The combined busbar disconnecter with earthing switch is shown in Fig. 5. The conductors are made of aluminum. Bus conductors are held by gas-tight bushing plates. The cover is fitted with a filter, a rupture diaphragm and a service connection. Motor drive mechanism controls the disconnecter and earthing switch. Disconnector can be equipped with standard contacts as well as bus transfer contacts for the commutation of load current from one bus system to another (IEC 62271-102 Annex B).

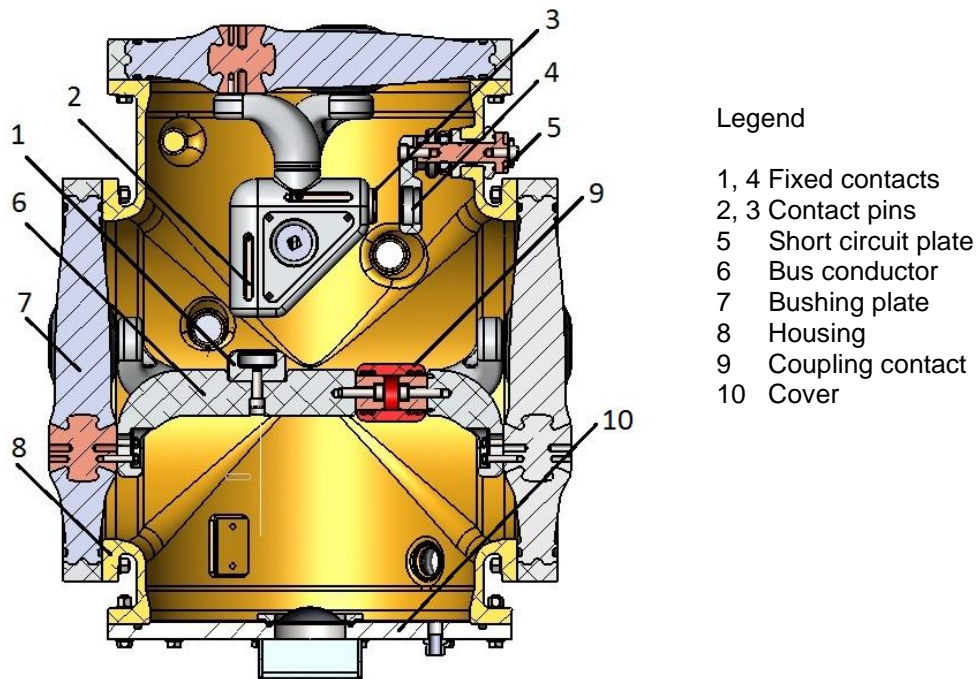
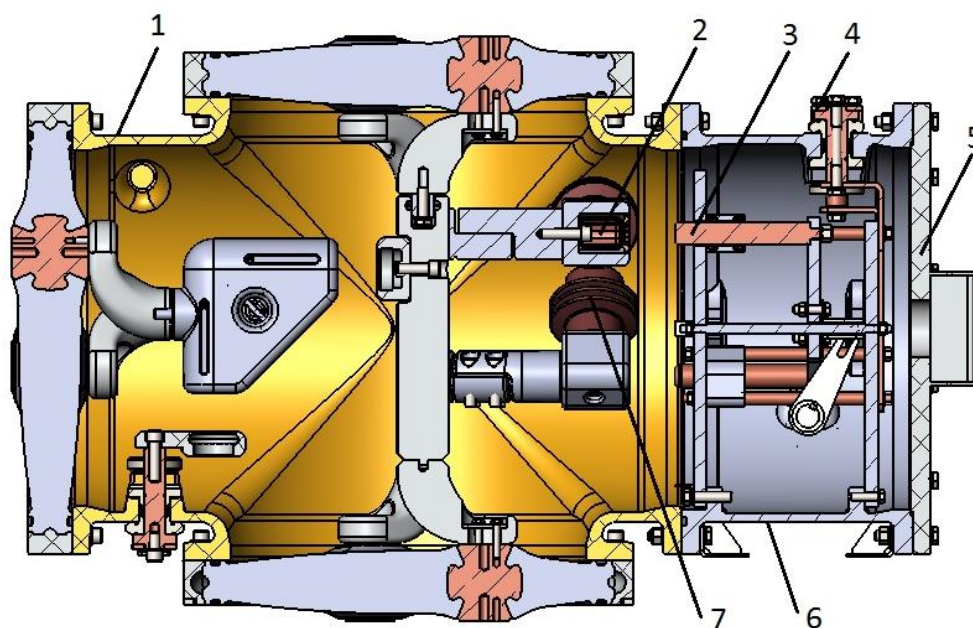


Fig. 5 Combined busbar disconnecter/earthing switch

3.2.2) Combined angular-action disconnecter with earthing switch

The combined angular-action disconnecter with earthing switch (Fig. 6) can be installed at various points of a bay and may serve as an outgoing disconnecter and earthing switch, for example. In the case when it is used as an outgoing disconnecter and earthing switch, within the same housing, fixed contacts of high-speed earthing switch are located.



Legend:

- 1 Angular-action disconnect/earthing switch housing
- 2 Fixed contact of HSES
- 3 Contact pin of HSES
- 4 Short-circuit plate
- 5 Cover
- 6 HSES housing
- 7 Post insulator

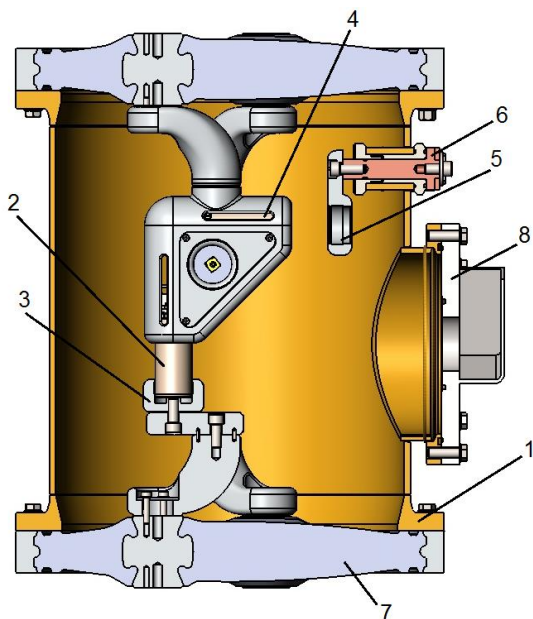
Fig. 6 Combined angular-action disconnect/earthing switch and high-speed earthing switch

3.2.3) High-speed earthing switch

Contact pins of high-speed earthing switch are located in the separate housing but share the same gas space with angular-action disconnect/earthing switch. All three contact pins are linked together and are operated jointly. Spring motor mechanism actuates a contact pins via a drive shaft and lever. Current transfer between the contact pins and the earthed current carrying rods is achieved by the spring type contacts. High speed earthing switch has its own spring motor drive that enables fast closing and opening times. For the short circuit making test the drive was provided with latching device and a trigger to ensure stable closing times. Motor charging time is about 8 s. High-speed earthing switch has making capacity of 104 kA and the possibility of switching inductively and capacitively induced currents according to IEC standard 62271-102.

3.2.4) Combined linear-action disconnect with earthing switch

The linear-action isolators can be installed in the busbars as sectionalizers and in the feeder circuit as outgoing isolators. Depending on the intended duty, bushing plates which are gastight or pervious to gas can be fitted. The cover can be fitted with a filter, a rupture diaphragm and a service connection. These items can be provided singly or in any desired arrangement.



Legend:

1. Housing
2. Contact pins of disconnector
3. Fixed contact of disconnector
4. Contact pin of ES
5. Fixed contact of ES
6. Short-circuit plate
7. Bushing plate
8. Cover

Fig. 7 Combined linear-action disconnector with earthing switch

3.3) Current transformer

Inductive current transformer is three-pole encapsulated and is usually an integral part of the circuit-breaker. If it is needed, a current transformer can be made as a separate module.

Inductive bar-type current transformers are used in the switchgear installation. The conductor which is run straight through the module assumes the function of the primary winding. Inductive current transformers (CT) step the operating current down to values which are suitable for measuring instruments and protective devices connected.

3.4) Voltage transformer

Inductive voltage transformer is three-pole encapsulated, designed as a separate module. It can be developed and integrated with a manually operated disconnector, which serves to separate the voltage transformer from the rest of the bay during the high-voltage tests.

3.5) Cable termination compartment

Cable termination has three-pole shielded housing and is a structural element of the bay for the connection of high-voltage cable. Is made in accordance with the norm: IEC 62271 – 209.

4) TYPE TESTING

The switchgear is manufactured and tested according to IEC standards:

IEC 62271-1	High-voltage switchgear and controlgear – Part 1: Common specifications
IEC 62271-100	High-voltage switchgear and controlgear – Part 100: Alternating current circuit-breakers
IEC 62271-102	High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches
IEC 62271-203	High-voltage switchgear and controlgear – Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV
IEC 62271-209	High-voltage switchgear and controlgear – Part 203: Cable connections for gas-insulated metal-enclosed switchgear for rated voltages above 52 kV

