SIEMENS

Gas-insulated switchgear up to 550 kV, 63 kA, 5000 A Type 8DQ1

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Answers for energy.

Leading worldwide due to innovative technology

Our switchgear ensures extraordinarily high availability at a low operating cost

The Siemens gas-insulated switchgear (GIS) is an extremely successful product concept. Since its introduction back in 1968, Siemens has installed more than 28,000 indoor and outdoor switchgear bays worldwide, and well over 300,000 bay-years of operation have been recorded.

Since 1974 we have supplied gas-insulated substations for voltage levels of up to 420 kV. A permanent process of improvement has led to today's 8DQ1, suitable for a voltage range of up to 550 kV.

Intense research and continuous further development of the first system types have led to today's generation of gas-insulated, metal-encapsulated switchgear – a world leader in terms of

- Economic efficiency
- High reliability
- Safe encapsulation
- High degree of gastightness
- Long service life
- Low maintenance costs
- Easy access and ergonomic design
- High availability
- Reliable operation even under extreme environmental conditions

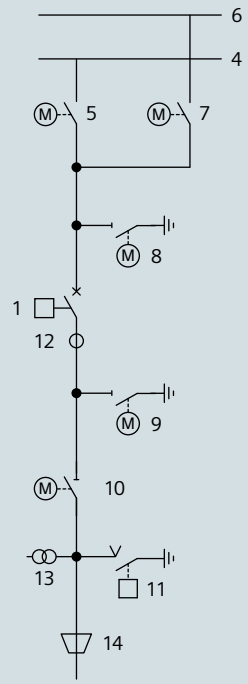
Our current 8DQ1 switchgear, which is designed for rated voltages of up to 550 kV, meets all requirements for modern, next-generation switchgear in terms of performance and reliability.

Flexibility thanks to modular design

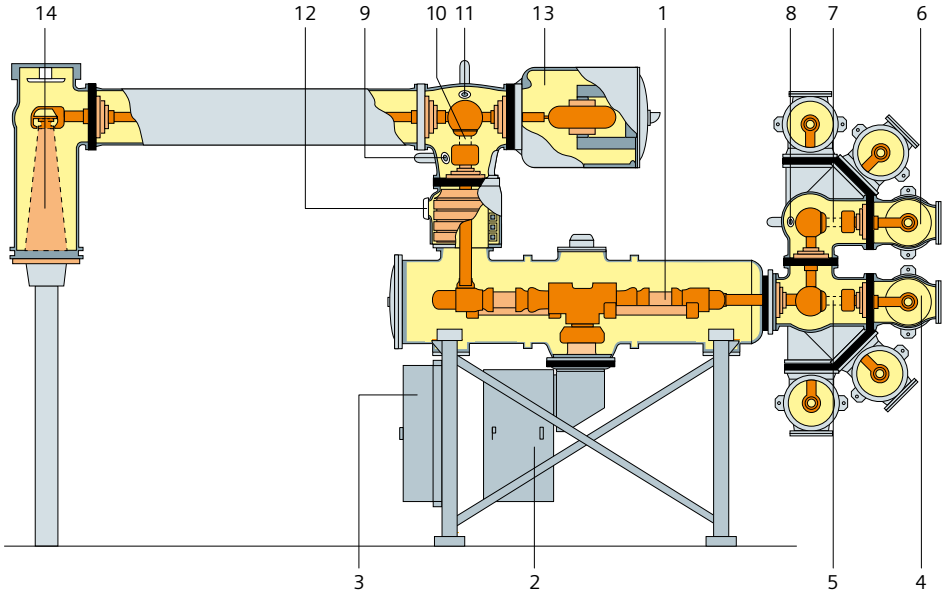
A fundamental feature of our gas-insulated switchgear is the high degree of flexibility provided by a modular system. The components are arranged in pressure-resistant gastight enclosures according to their functions. All customary bus schemes can be implemented with only a small number of active and passive modules.

The switchgear type 8DQ1 up to 550 kV is of single-phase, metal-enclosed design which minimizes dielectric and dynamic loading. The encapsulation material is corrosion-resistant aluminum. The O-ring seals – a proven construction principle since 1968 – guarantee gastightness.

Coupling contacts capable of absorbing temperature-related changes in length link the conductors. The insulating and arc-quenching medium is sulfur hexafluoride (SF_6). The extremely tight casing prevents environmental pollution. Any moisture or decomposition products are absorbed by static filters in the gas compartments, which are attached to the inside of the covers of the access openings. Rupture diaphragms prevent excessive pressure in the enclosure. Diverter nozzles on the rupture diaphragms ensure that the gas is expelled in a defined direction in the event of bursting, which prevents danger to the operating personnel.

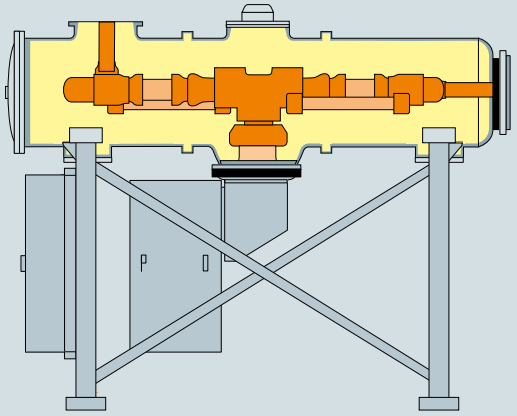


With only a few modules, all typical switching configurations can be implemented



Typical double busbar feeder

1. Circuit-breaker interrupter unit
2. Stored-energy spring mechanism
3. Circuit-breaker control unit
4. Busbar I
5. Busbar disconnector I
6. Busbar II
7. Busbar disconnector II
8. Work-in-progress earthing switch
9. Work-in-progress earthing switch
10. Outgoing-feeder disconnector
11. Make-proof earthing switch (high-speed)
12. Current transformer
13. Voltage transformer
14. Cable sealing end



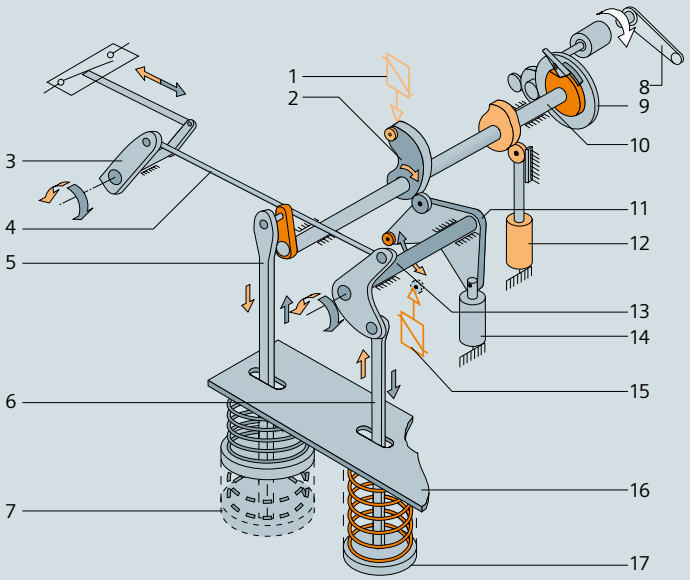
Circuit-breaker module

Circuit-breaker module

The central element of a switchgear bay within the gas-insulated switchgear is the single-phase encapsulated circuit breaker. The circuit breaker is designed for single-pole automatic reclosure. It consists of two main components:

- Interrupter unit
- Stored-energy spring mechanism

The design of the interrupter unit and the spring mechanism is based on time-tested identical constructions widely used in air-insulated as well as gas-insulated switching technology for many years. This design, decades of experience, and high quality guarantee the surpassing reliability of our switchgear.



1. Closing release
2. Cam plate
3. Coupling linkage
4. Operating rod
5. Closing spring connecting rod
6. Opening spring connecting rod
7. Closing spring
8. Hand-wound mechanism
9. Charging mechanism
10. Charging shaft
11. Roller lever
12. Closing damper
13. Operating shaft
14. Opening damper
15. Opening release
16. Mechanism housing
17. Opening spring

Stored-energy spring mechanism

The stored-energy spring mechanism provides the force required to operate the circuit breaker. It has a compact, corrosion-free aluminum housing. Both the opening and the closing spring are visibly arranged within the drive unit. The complete drive unit is strictly separated from the SF_6 compartment. Roller bearings and the maintenance-free spring mechanism ensure decades of reliable operation. Proven technology, such as vibration-isolated latches and load-free isolation of the charging mechanism, improve the reliability of the mechanism.

The advantages of the stored-energy spring mechanism:

- Identical construction principle for rated voltages from 72.5 to 550 kV
- Low operating energy
- Simple principle of operation
- Switching state controllable at all times
- Low maintenance, economical with a long service life

Interrupter unit

The interrupter unit used in the circuit breaker for arc-quenching operates according to the dynamic self-compression principle. This principle requires only little operating energy, which keeps the mechanical stresses on the circuit breaker and its housing as well as the foundation loads to a minimum.

Current path

In the closed position, the operating current flows through the contact finger (2) and the contact cylinder (10). The arcing contacts (1, 7) are plugged in in parallel to the main contacts.

Interruption of operating currents

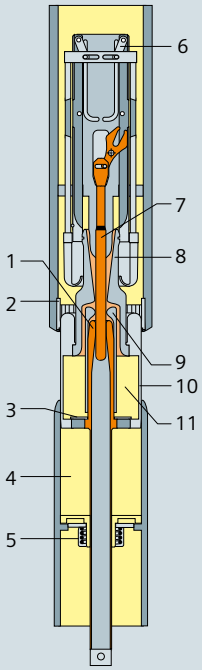
During the breaking operation, the contact finger (2) with the contact cylinder (10) opens and the current commutates to the arcing contacts (1, 7), which are still closed. This avoids erosion of the main contacts. As the breaking operation continues, an arc forms between the contacts (1) and (7). At the same time, the contact cylinder (10) compresses the SF_6 gas located in the compression volume (4). The compressed arc-quenching gas flows through the heating volume (11) into the contact gap and extinguishes the arc.

Interruption of fault currents

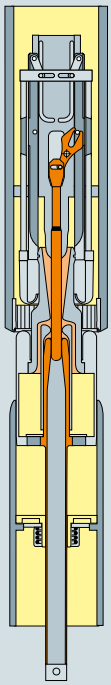
In the case of large short-circuit currents, the gas between the arcing contacts (1) and (7) is heated by the arc energy. Thus, the pressure in the heating volume (11) increases. When the current passes through zero, the gas flows back from the heating volume (11) through the nozzle (9) and quenches the arc. The valve (3) of the contact cylinder (10) prevents the high-pressure gas from entering the compression volume (4). Thus, the operating mechanism does not have to supply the arc-quenching energy.

Arc-quenching principle

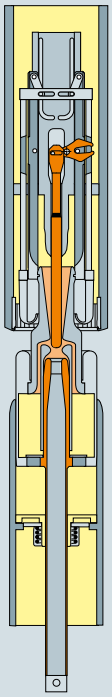
1. Moving arcing contact
2. Main contact
3. Check valve
4. Compression volume
5. Check valve
6. Steering gear
7. Moving arcing rod
8. Insulating nozzle
9. Auxiliary nozzle
10. Contact cylinder
11. Heating volume



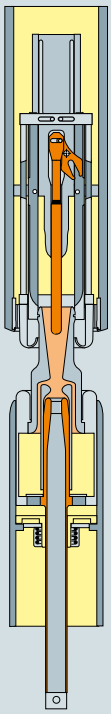
Breaker in »On« position



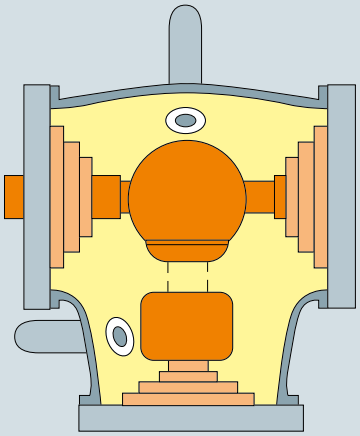
Breaking: main contact opened



Breaking: arcing contact opened



Breaker in »Off« position

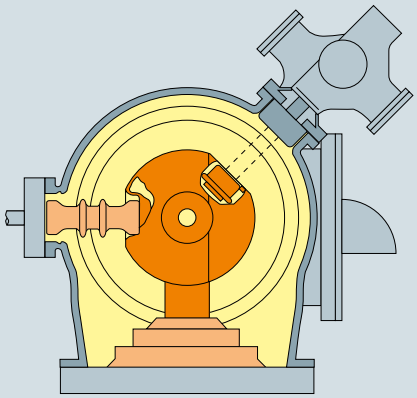


Disconnecting switch

Disconnecting switches

In the open position, disconnecting switches assure a dielectrically safe gap between system parts at different potentials, for example the busbar disconnector isolates the feeders from the busbar. Cast-resin bushings keep the contact system in place, and the pressurized gas serves as the high-voltage insulating medium between live parts and the metal housing.

The conductor terminals vary for different types of adjacent modules. Up to two earthing switches can be installed simultaneously. The disconnecting switches can be built as separate gas compartments with their own monitoring or be combined with surrounding modules.



Pin-type earthing switch

Earthing switches

Earthing switches (work-in-progress earthing switches or busbar earthing switches, for example) are used for properly connecting de-energized live parts of the high-voltage system to the grounding system. On the outgoing side of the feeders, a make-proof version (high-speed) is frequently used to dissipate inductive and capacitive currents from parallel cables or overhead lines or to reduce the risk to the GIS system in case of faulty connections. In the insulated design they are also used for measuring purposes and for testing protection relays.

In the switchgear type 8DQ1 up to 550 kV, the earthing switches are of a pin-type design. Depending on the switchgear design, they are either incorporated in a common housing with the disconnection switches or installed in a separate housing. With the pin-type earthing switch, the earthing pin at earth potential is pushed into the matching contact. Make-proof earthing switches are equipped with a stored-energy spring mechanism. The spring, which stores the required switching energy, can be recharged either with a motor or manually in an emergency.

Common features of disconnecting and earthing switches

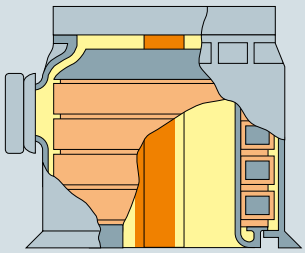
- The three poles of a bay are coupled mechanically
- All three poles are commonly operated by one motor drive
- Alarm switches and ON/OFF indicators are friction-locked and directly connected to the drive shaft
- Identical motor drives are used for disconnecting and earthing switches
- Manual emergency operation is integrated
- Enclosures can be fitted with inspection windows for visual monitoring of the switching position on request

Instrument transformers

Both current and voltage transformers are used for measuring and protection purposes.

Current transformer

The current transformers are of the single-phase inductive type with one or more cores and preferably located on the outgoing side of the circuit breaker. They can, however, be located at any point within the bay or substation. The high-voltage conductor forms the primary winding. The cores with the secondary windings are located on a grounded electrode and are designed to comply with the requirements in terms of accuracy, class, and power rating. Different ratios can be achieved via taps in the secondary winding accessible in a terminal box. The pressurized SF_6 gas between the high-voltage conductor and electrode serves as the primary insulation. The cores are completely metal-enclosed which makes for very high reliability in terms of electromagnetic compatibility (EMC).



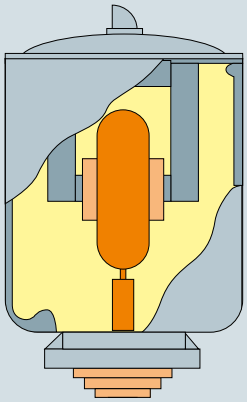
Current transformer

Voltage transformer/RC-voltage divider

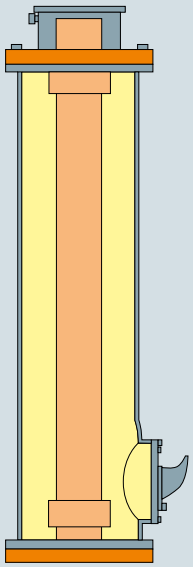
Each single-phase inductive voltage transformer is encapsulated in its own housing and thus forms a separate gastight module. Each voltage transformer consists of the following main components:

- The primary winding
- One or more secondary windings (forming one coil)
- An iron core

The pressurized gas inside the enclosure in combination with the film insulation provides insulation against high voltage. The high-voltage connection to the switchgear is established via the primary conductor, which is supported by a gastight bushing. The secondary connections are routed via a gastight bushing plate to the terminal box.



Conventional voltage transformer

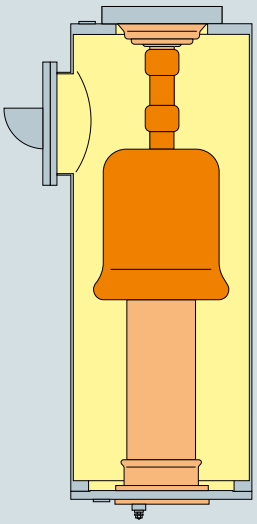


RC voltage divider

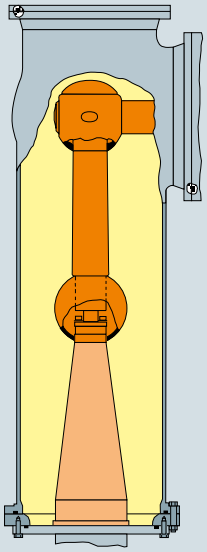
Resistive-capacitive voltage dividers (RCVD) consist of oil-impregnated capacitive elements with parallel mounted resistors in hermetically sealed glass fiber reinforced plastic tubes (GRP). The RCVD has a common gas compartment with the neighboring gas compartment. It is also available in another version with a separate gas compartment. The secondary connection can either be designed as single or as double unit (redundant version). The RCVD has a smaller size and weight in comparison to inductive voltage transformers. It is a ferroresonance-free technology with no saturable cores. The RCVD maps high voltage in linear form over a wide frequency range from DC up to 20 kHz and has an excellent transient characteristic. The power output is low but sufficient for the demands of modern protection and energy counting systems (e.g. SIPROTEC 5).

Surge arrester

If desired, encapsulated surge arresters can be connected directly. Their purpose is to limit any overvoltages. Their active parts consist of metal-oxide resistors with a strongly non-linear current/voltage characteristic. The arrester is generally flange-jointed to the switchgear via a gastight bushing that is included with the delivery. An inspection hole in the arrester housing allows opening the internal conductor when inspecting the switchgear. The connections for gas monitoring, arrester testing, and a surge counter are at the bottom.



Surge arrester



Transformer tubetermination

Termination modules

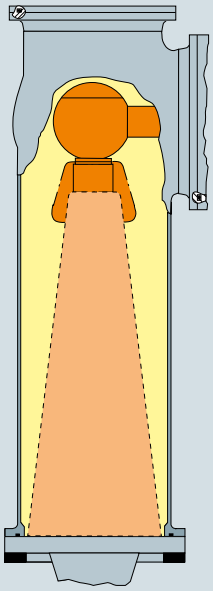
The termination modules connect the bays of the gas-insulated switchgear to the following items of equipment:

- Transformer or reactor
- Cables
- Overhead lines

They form the transition from the SF_6 gas insulation to other insulating media.

Transformer termination

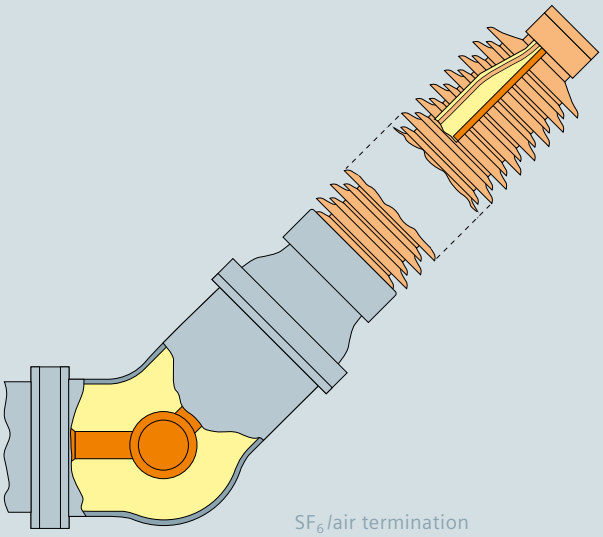
The transformer termination module enables a direct SF_6/oil tube connection from the GIS to an oil-insulated transformer or reactor. For this purpose, the transformer bushing must be oil-tight, gastight, and pressure-resistant. Temperature-related movements of the switchgear and the transformer as well as the settling of foundations are absorbed by expansion joints in the tube connection. (Acc. to IEC 61639/IEC 62271-211)



Cable termination

Cable termination

This module acts as a link between the metal-enclosed gas-insulated switchgear and the high-voltage cable. All types of high-voltage cables complying with IEC 62271-209 can be connected. The inspection hole also provides the connecting flange for the high-voltage cable testing set. During high-voltage cable testing, the primary conductor between the cable sealing end and the switchgear can be removed.



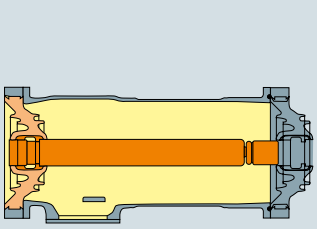
SF_6/air termination

SF_6/air termination

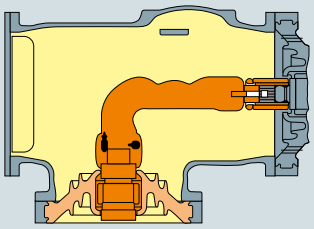
The SF_6/air termination module enables the connecting of the gas-insulated switchgear to air-insulated components or overhead lines by means of a bushing, which is available either as a porcelain or a composite insulator. This termination is a combination of an angle-type module and an SF_6 bushing. The length, shed form, and creepage distance of the outdoor/SF_6 bushing can be adapted to various requirements with regard to insulation coordination, minimum clearance, or degree of pollution.

Extension and angle-type modules

These modules are used for connections within a bay and for conduit lead-outs. Their shape and number depends on the circuit and the layout of the bay.



Extension module



Angular module

Busbar module

The switchgear type 8DQ1 up to 550 kV has a single-phase encapsulated passive busbar, i.e. without integrated switching devices. Busbar disconnecting switches, sectionalizers, and earthing switches are housed in separate gas compartments. Depending on the configuration, extensions and maintenance work are easily effected with the switchgear in operation. The busbar modules of adjacent bays are connected with expansion joints which absorb constructional tolerances and temperature-related movements in both longitudinal and transverse directions to the busbar. Axially guided sliding contacts between the conductors compensate temperature-related changes in conductor length. A sectionalizer is easily fitted to increase the availability of the system.

Busbar module

Control and monitoring – a reliable and flexible control and protection system

Control cubicle with circuit-breaker operating mechanism

Proven switchgear control

Robust electrical components are used to control and monitor the circuit breaker as well as other switchgear components. All elements necessary for the control and monitoring of the circuit breaker and the disconnecting and earthing switches are incorporated locally in the respective high-voltage devices. All device controls are tested at the factory. This cuts commissioning time to a minimum and avoids failures on-site.

Gas monitoring

Gastight insulating partitions subdivide each switchgear bay into functionally separate gas compartments (e.g., circuit breakers with current transformers, disconnecting switches, voltage transformers, surge arresters, and termination modules). Density monitors with red/green indication constantly monitor the gas compartments and provide alarm and blocking signals via contacts.

Reliable and flexible control and protection system

The control unit is housed in the local control cubicle, which provides for easy access.

As an option, the feeder protection can also be included in the same cubicle. The local control cubicle is usually located opposite the switchgear. Shielded cables and coded plugs are used for the cabling between the local control cubicle and the high-voltage switching devices, which minimizes both installation cost and the risk of cabling errors. On request, we can supply our high-voltage switchgear with any of the commonly available digital control and protection systems.

Standard interfaces in the local control allow the connection of

- Conventional control systems with protective interlocking and control panels
- Digital control systems with user-friendly bay controllers and station automation with PC workstations (HMI)
- Intelligent, fully networked digital control and protection systems with additional monitoring and remote diagnostic functions

Thanks to the extensive range of Siemens control and protection systems, we can offer you customized concepts from a single source.

Transport, installation, commissioning, maintenance

Transport

To facilitate easy transport and on-site installation, our switchgear assemblies are split into optimized shipping units with emphasis on ease of handling. Standard switchgear bays are usually shipped as one transport. All shipping units are mechanically and dielectrically tested before dispatch. In the case of modules which contain switching devices, all operating-mechanism attachments are preset at the factory prior to shipment. All flanges, where the modules are to be joined to other equipment, are protected against corrosion and sealed with transport covers.

All goods are packed according to means, duration, and route of transport as well as in line with conditions and duration of storage. Shipments within Europe are normally done by road. Switchgears supplied to overseas countries are sealed in suitable shipping units with seaworthy packing, taking into account any temporary storage that may be necessary.

On-site installation

The fact that the switchgear is split into a few, easy-to-handle shipping units reduces the time and effort required for installation on site. Detailed installation instructions and the use of relatively few special tools allow easy and rapid installation of the switchgear. It can even be effected by your own personnel under the supervision of an experienced supervisor from Siemens. Our training facilities are at your disposal if required.

Commissioning

After completion of the assembly work on-site, all switching devices and electrical circuits for controlling and monitoring are tested to ensure proper electrical and mechanical function of the whole system. All flanges are double-checked for tightness. Commissioning work on the primary section ends with the high-voltage test on-site to verify that all installation work has been carried out correctly. All tests are performed in accordance with IEC standards and the results are documented in the final test reports.

Maintenance

Our gas-insulated switchgear installations are designed and manufactured to provide an optimum balance in design, materials used, and maintenance measures. Thanks to the hermetically sealed enclosure, a minimum of maintenance is needed and the GIS system can even be regarded as maintenance-free under normal operating conditions. Subject to environmental conditions, visual inspections are recommended. A visual inspection is carried out bay by bay without any need for outages or the opening of gas compartments. The first major inspection is not due until after 25 years.

Quality assurance

A consistent quality management system supported by our employees makes sure that we produce high-quality gasinsulated switchgear. The system was certified in 1983 in accordance with CSA Z299 and again in 1989 according to DIN EN ISO 9001. The quality management system is subject to continuous improvement. Certification according to DIN EN ISO 9001:2000 was passed with flying colors in 2003. As early as 1994, the environmental protection system according to DIN EN ISO 14001 was implemented as an addition to the existing quality management system and successfully certified. One of the fundamental milestones in developing testing competence was the certification of the test labs according to ISO/IEC 17025 (previously EN 45001) in 1992 and the accreditation as an independent PEHLA test lab.

The quality management and environmental protection systems cover every single process in our products' life cycles, from marketing to after-sales service.

Regular management reviews and internal audits of all processes based on the consistent documentation of all processes relevant to quality and environmental protection ensure that the system is efficient and up-to-date at all times and that appropriate measures are taken to continuously improve it. Consequently, the quality of our switchgear meets even the highest requirements.

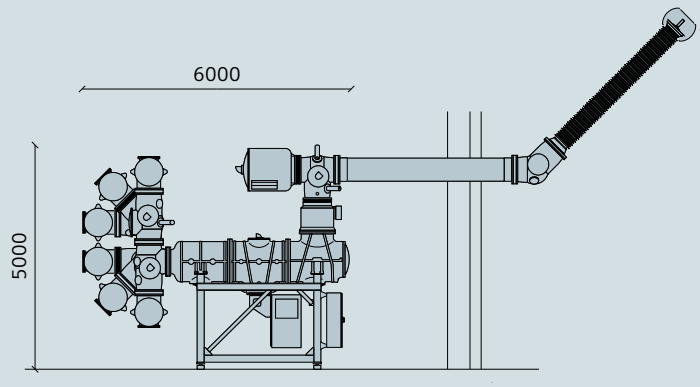
In addition to consistent quality management and environmental protection, the special »clean« areas set up in the production workshops are an important contribution towards the high quality of our gas-insulated switchgear.

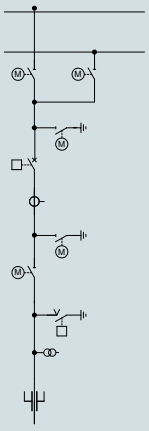
Comprehensive manufacturing inspections and routine testing of individual components, sub-assemblies, and complete modules all play an important part in ensuring reliable operation of the overall product. Mechanical routine and high-voltage tests of the complete bay or complete shipping units verify that the manufactured quality complies with the standards. Suitable packing provides for the switchgear's safe arrival at its destination.

Switchgear bay examples

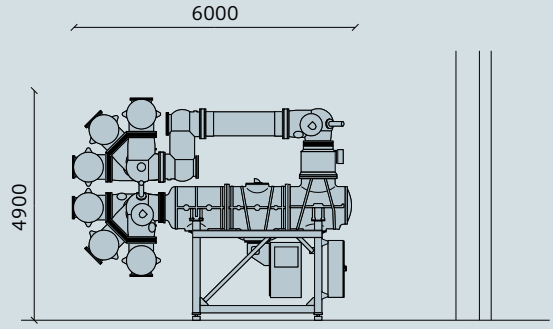
The modular system not only allows all customary circuit arrangements but also individual solutions for specific building dimensions, system extensions, and much more.

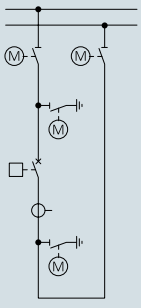
Double busbar arrangement



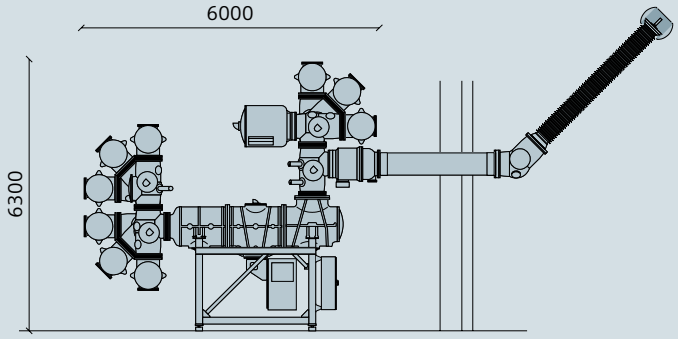


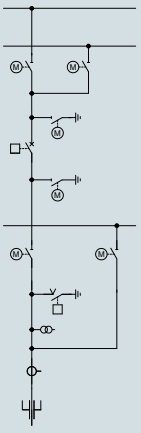
Bus coupling arrangement



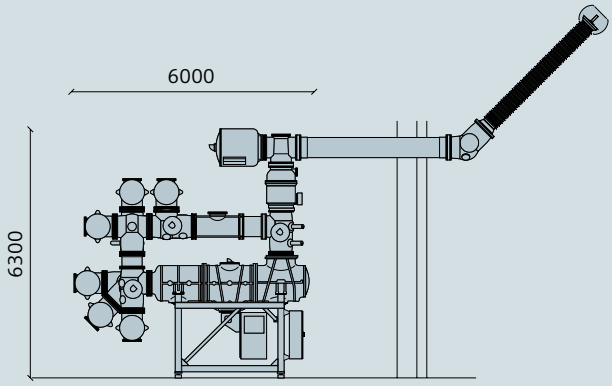


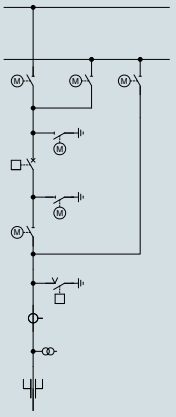
Double busbar arrangement with transfer bus



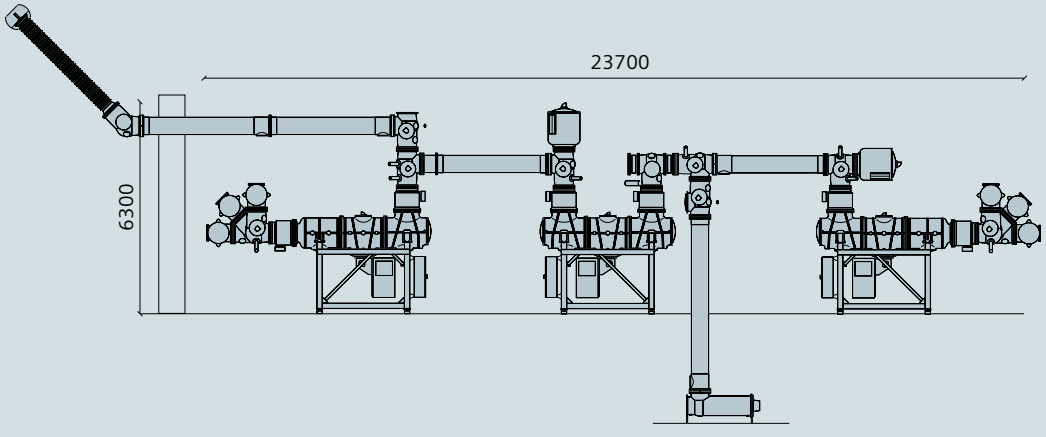


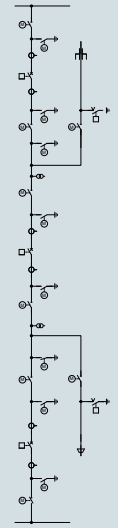
Double busbar arrangement with bypass





1½ circuit-breaker arrangement





Technical data

Switchgear type		8DQ1
Rated voltage	up to	550 kV
Rated frequency		50 / 60 Hz
Rated short-duration power-frequency withstand voltage (1 min)	up to	740 kV
Rated lightning impulse withstand voltage (1.2 / 50 µs)	up to	1,550 kV
Rated switching impulse withstand voltage (250 / 2,500 µs)	up to	1,175 kV
Rated normal current busbar	up to	5,000 A
Rated normal current feeder	up to	5,000 A
Rated short-circuit breaking current (< 2 cycles)	up to	63 kA
Rated peak withstand current	up to	170 kA
Rated short-time withstand current (up to 3 s)	up to	63 kA
Leakage rate per year and gas compartment (type-tested)		< 0.1 %
Driving mechanism of circuit breaker		stored-energy spring
Rated operating sequence		O-0.3 s-CO-3 min-CO CO-15 s-CO
Bay width		3,600 mm
Bay height, depth (depending on bay arrangement)		4,800 mm x 10,000 mm
Bay weight (depending on bay arrangement)		21 t
Ambient temperature range		-25 °C up to +55 °C
Installation		indoor
First major inspection		> 25 years
Expected lifetime		> 50 years
Standards		IEC / IEEE / GOST

Other values on request

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