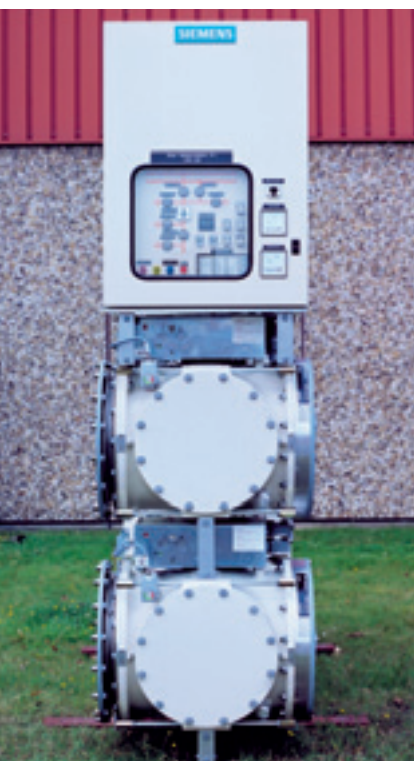


Benefitting from Experience



8DN8 switchgear for
rated voltages up to
145 kV



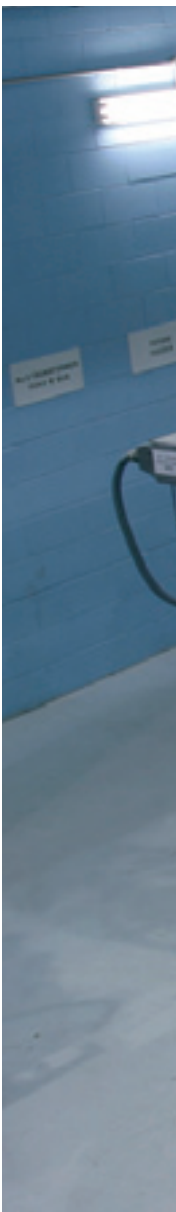
The operator panel
of the processor bus
bay control system is
integrated in the
operating front of
the bay

Our 8D type range of gas-insulated switchgear represents a highly successful product concept. Since its introduction back in 1968, Siemens has installed more than 17,000 bays worldwide. More than 230,000 bay-years of operation have since been recorded. Intensive research work and continuous further development of the prototypes has ultimately led to today's generation of gas-insulated metal-enclosed switchgear.

This switchgear is notable in particular for:

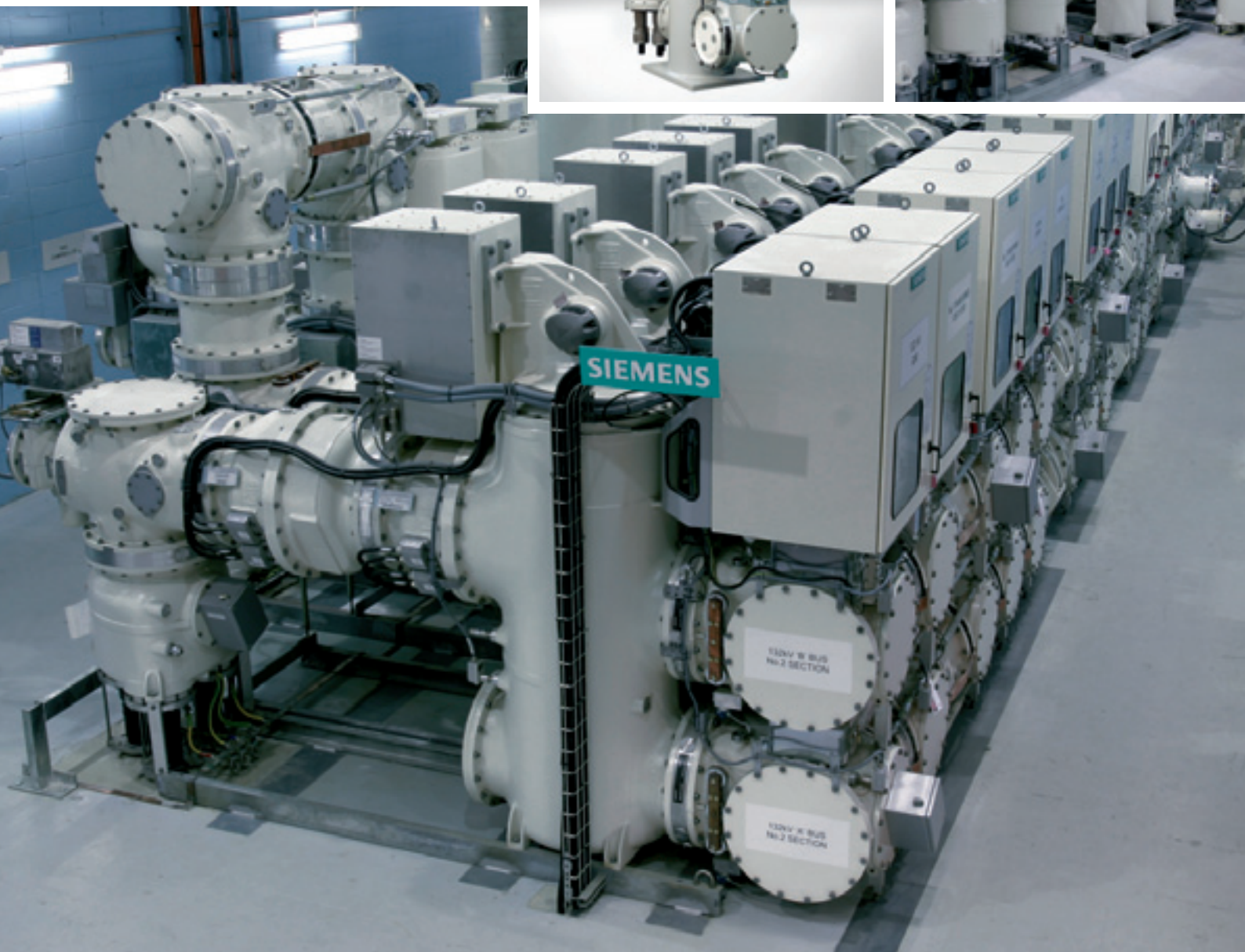
- Economic efficiency
- High reliability
- Safe encapsulation
- High degree of gastightness
- Long service life
- Low life cycle and maintenance costs
- Good accessibility and ergonomics
- High availability
- Safe operation even under extreme environmental conditions.

All requirements nowadays specified for modern and advanced switchgear in terms of performance and reliability are met by our type 8DN8 switchgear for rated voltages of up to 145 kV. This switchgear design represents one of the most compact solutions available in this voltage range. Its space-saving design and its low weight contribute to making this switchgear extremely economical. Since the levels of noise and field emission (EMC) are extremely low, it is possible to integrate this switchgear even in sensitive environments, residential quarters, and city centers. With these characteristics, our type 8DN8 switchgear meets all requirements for environmentally compatible high-voltage switchgear.



8DN8 switchgear for rated voltages up to 72.5 kV

Both plug-in type and conventional cable-sealing ends can be used in conjunction with type 8DN8 switchgear



Flexible Due to Modular Design



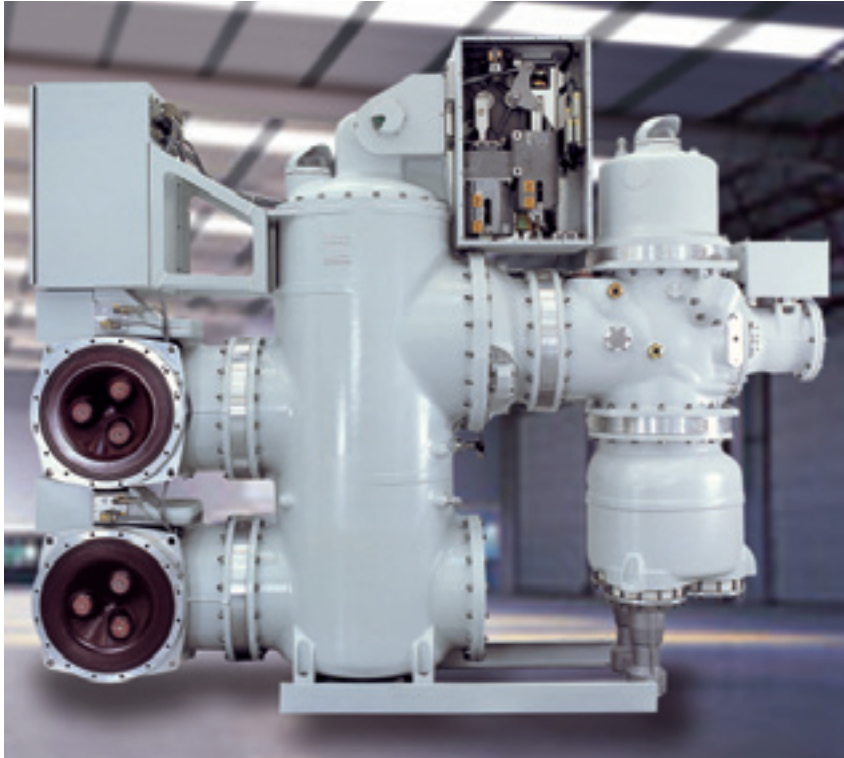
A fundamental feature of our gas-insulated switchgear is the high degree of versatility provided by its modular system. Depending on their respective functions, the components are housed either individually and/or combined in compressed gastight enclosures. With a remarkably small number of active and passive modules, all customary circuit variants are possible. Sulphur hexafluoride (SF_6) is used as the insulating and arc-quenching medium.

Three-phase enclosures are used for type 8DN8 switchgear in order to achieve extremely low component dimensions. This concept allows a very compact design with reduced space requirement. Aluminum is used for the enclosure. This assures freedom from corrosion and results in low weight of the equipment. The use of modern construction methods and casting techniques allows optimizing the enclosure's dielectric and mechanical characteristics. The low bay weight ensures minimal floor loading and eliminates the need for complex foundations.

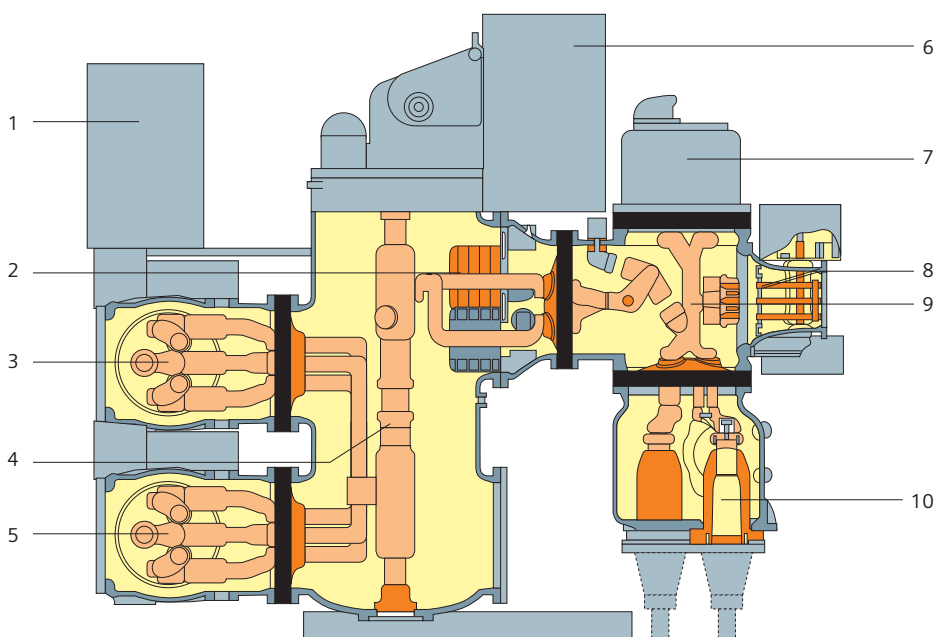
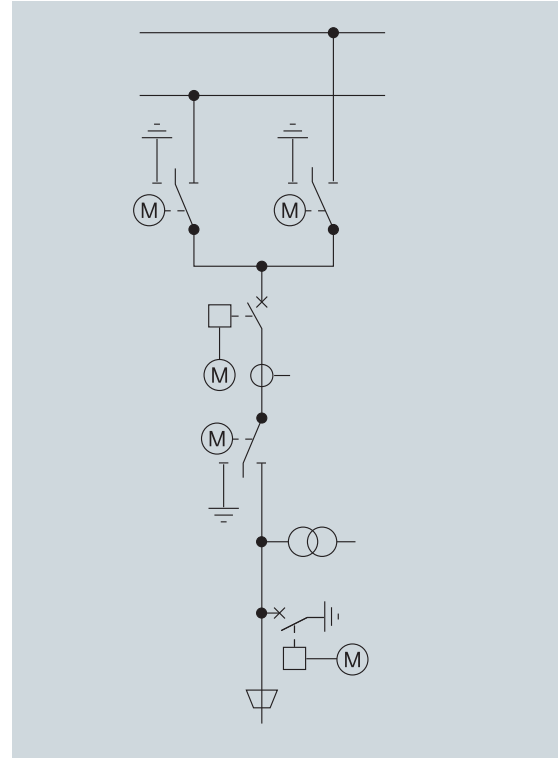
All the modules are connected to one another by means of flanges. The gastightness of the flange connections is assured by proven O-ring seals.

Temperature-related changes in the length of the enclosure and installation tolerances are compensated by bellows-type expansion joints. To that end, the conductors are linked by coupling contacts. Where necessary, the joints are accessible via manway openings. Gastight bushings allow subdivision of the bay into a number of separate gas compartments. Each gas compartment is provided with its own gas monitoring equipment, a rupture diaphragm, and filter material. The static filters in the gas compartments absorb moisture and decomposition products.

The rupture diaphragms prevent build-up of an impermissible high pressure in the enclosure. A gas diverter nozzle on the rupture diaphragm ensures that the gas is expelled in a defined direction in the event of bursting, thus ensuring that the operating personnel is not endangered.

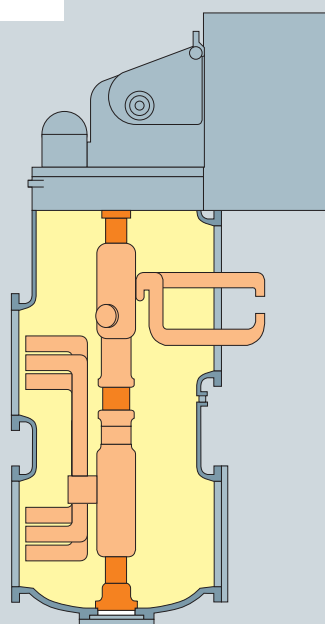
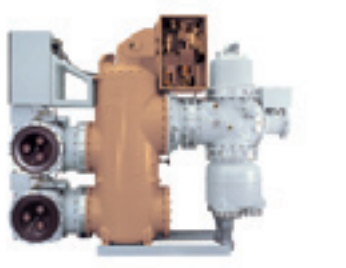


Three-phase enclosure allows compact design



Gas-tight bushing
 Gas permeable bushing

1. Integrated local control cubicle
2. Current transformer
3. Busbar II with disconnector and earthing switch
4. Interrupter unit of the circuit breaker
5. Busbar I with disconnector and earthing switch
6. Spring-stored energy mechanism with circuit breaker control unit
7. Voltage transformer
8. High-speed earthing switch
9. Outgoing feeder module with disconnector and earthing switch
10. Cable sealing end



Circuit breaker module

Circuit breaker module

The central element of the gas-insulated switchgear is the three-pole circuit breaker module enclosure comprising the following two main components:

- Interrupter unit
- Operating mechanism

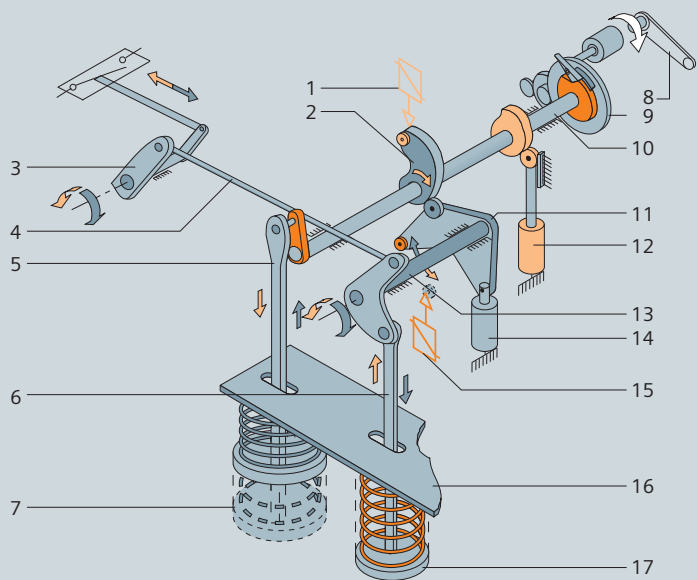
The design of the interrupter unit and of the operating mechanism is based on proven and in most cases identical designs, which have often been applied for outdoor switchgear installations.

Operating mechanism

The spring-stored energy operating mechanism provides the force for opening and closing the circuit breaker. It is installed in a compact corrosion free aluminum housing. The closing spring and the opening spring are arranged so as to ensure good visibility in the operating mechanism block. The entire operating mechanism unit is completely isolated from the SF₆ gas compartments. Antifriction bearings and a maintenance free charging mechanism ensure decades of reliable operation.

Proven design principles of Siemens circuit breakers are used, such as vibration-isolated latches and load free decoupling of the charging mechanism. The operating mechanism offers the following advantages:

- Defined switching position which is securely maintained even if the auxiliary power supply fails
- Tripping is possible irrespective of the status of the closing spring
- High number of mechanical operations
- Low number of mechanical parts
- Compact design.



- | | |
|---|---------------------------------|
| 1. "On" release | 9. Charging mechanism |
| 2. Cam disc | 10. Charging shaft |
| 3. Corner gears | 11. Roller lever |
| 4. Drive linkage | 12. "On" damper |
| 5. Connecting rod of the closing spring | 13. Breaker actuating shaft |
| 6. Connecting rod of the opening spring | 14. "Off" damper |
| 7. Closing spring | 15. "Off" release |
| 8. Manual charging crank | 16. Operating mechanism housing |
| | 17. Opening spring |

Arc-quenching principle

Interrupter unit

The interrupter unit used in the circuit breaker for arc-quenching operates on the self-compression principle. Owing to the low amount of drive energy required, the mechanical forces involved are minimal. This has a positive effect on the stressing of both the circuit breaker and the enclosure.

The current path

In the case of a self-compression circuit breaker, the current path is formed by the contact support (1), the base (6), and the moving contact cylinder (5). In the closed condition, the operating current flows through the main contact (3). An arcing contact (4) is connected in parallel to the main contact.

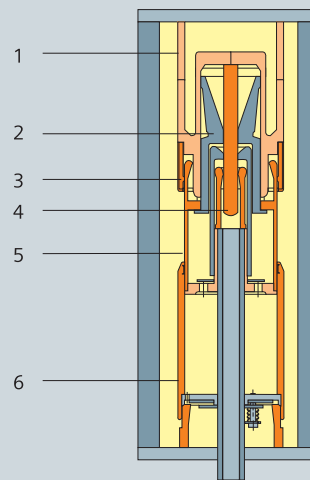
Interruption of operating current

During the breaking operation, the main contact (3) opens first and the current commutates on the arcing contact (4), which is still closed. This avoids erosion of the main contact. As the breaking operation progresses, an arc develops between the contacts (4). Simultaneously, the contact cylinder (5) moves into the base (6) and compresses the remaining arc-quenching gas. The compressed arc-quenching gas flows through the contact cylinder (5) into the contact gap and extinguishes the arc.

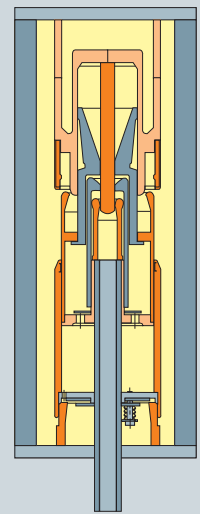
Interruption of fault current

If the short circuit current is high, the arc-quenching gas at the arcing contact is heated considerably by the arc's energy. This leads to a pressure rise in the contact cylinder. Consequently, the energy required for producing the arc-quenching pressure does not have to be supplied by the operating mechanism. As the switching operation progresses, the fixed arcing contact releases the outflow from the nozzle (2). The gas now flows out of the contact cylinder and through the nozzle, thus extinguishing the arc.

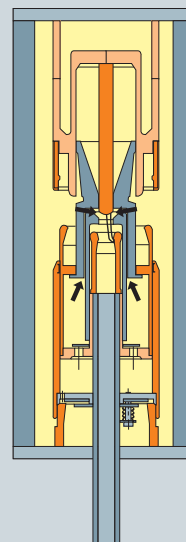
1. Contact support
2. Nozzle
3. Main contact
4. Arcing contact
5. Contact cylinder
6. Base



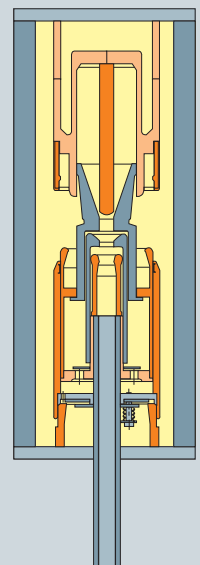
Breaker in
"On" position



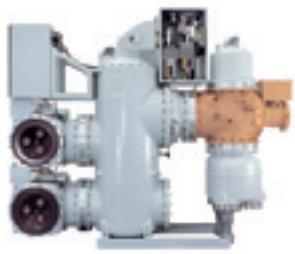
Breaking:
Main contact
open



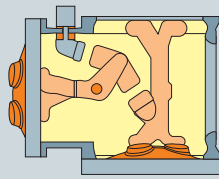
Breaking: Arcing
contact open



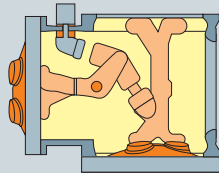
Breaker in
"Off" position



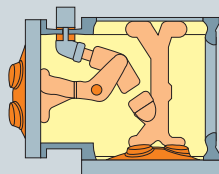
Schematic diagram



Neutral position



Disconnecter closed



Earthing switch closed

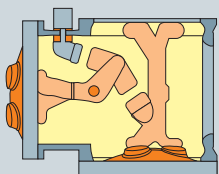
Three-position switching device

The functions of a disconnecter and an earthing switch are combined in a three-position switching device.

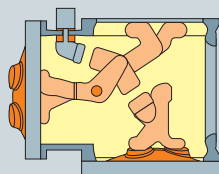
The moving contact either closes the isolating gap or connects the high-voltage conductor to the fixed contact of the earthing switch. Integral mutual interlocking of the two functions is achieved as a result of this design, thus obviating the need for providing corresponding electrical interlocking within the switchgear bay. An insulated connection to the fixed contact of the earthing switch is provided outside the enclosure for test purposes. In the third, neutral position, neither the disconnecter contact nor the earthing switch contact is closed. The three poles of a bay are mutually coupled and all the three poles are operated at once by a motor. Force is transmitted into the enclosure via gastight rotating shaft glands. The check-back contacts and the on/off indicators are mechanically robust and are connected directly to the operating shaft. Emergency operation by hand is possible. The enclosure can be provided with inspection windows, in the case of which the "On" and "Off" position of all three phases is visible.

Outgoing feeder module

The outgoing feeder module connects the basic bay with various termination modules (for cable termination, overhead line termination, and transformer termination). It contains a three-position switching device, which combines the functions of an outgoing feeder disconnecter and of a bay-side earthing switch (work-in-progress type). Installation of a high-speed earthing switch and of a voltage transformer is also possible where required. The high-voltage site testing equipment is generally connected to this module.



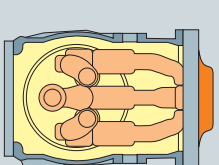
Outgoing feeder module: Voltage transformer downstream of the disconnector



Outgoing feeder module: Voltage transformer upstream of the disconnector

Busbar module

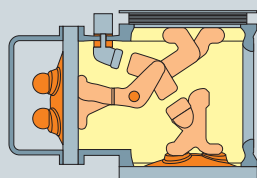
Connections between the bays are effected by means of busbars. The busbars of each bay are enclosed. Adjacent busbar modules are coupled by means of expansion joints. The module contains a three-position switching device, which combines the functions of a busbar disconnecter and of a bay-side earthing switch (work-in-progress type).



Busbar module

Bus sectionalizers

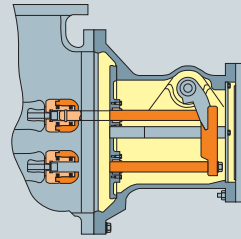
Bus sectionalizers are used for isolating the busbar sections of a substation. They are integrated in the busbar in the same manner as a busbar module. The module contains a three-position switching device, which combines the functions of a bus sectionalizer and of an earthing switch (work-in-progress type).



Bus sectionalizer

High-speed earthing switch

The high-speed earthing switch used is of the so-called "pin-type". In this type of switch, the earthing pin at earth potential is pushed into the tulip-shaped fixed contact. The earthing switch is equipped with a spring-operated mechanism, charged by an electric motor.



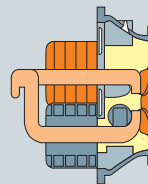
High-speed earthing switch

Instrument transformers

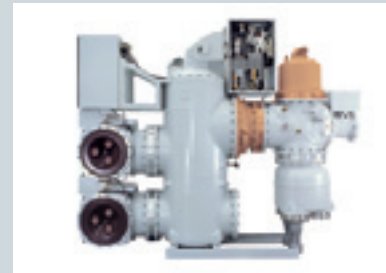
Both current and voltage transformers are used for measuring and protection purposes. They are supplied in a number of variants – ranging from conventional instrument transformers to advanced current and voltage sensors.

Current transformer

As a general rule, power-optimized induction type current transformers are used. The current transformer can, however, be located at any point within the bay or substation. The high-voltage conductor, supported by gastight bushings, forms the primary winding. The cores with the secondary windings are designed in line with the requirements in terms of class precision and rating. Changeover to a different transformation ratio is possible by means of secondary-side connections of the current transformer, which are led out of the enclosure through gastight bushings and are made available at terminals in the integrated local control cubicle.

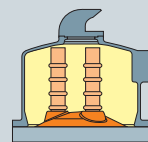


Current transformer

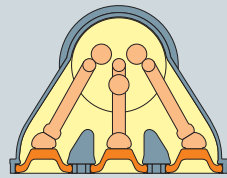


Voltage transformer

The voltage transformer shown operates on the principle of a voltage divider. Usually, however, induction type voltage transformers are used. The voltage transformers can be installed either upstream or downstream of the outgoing feeder disconnector or at the busbar. The secondary-side connections are led out of the enclosure through a gastight bushing plate and brought into contact with terminals in the integrated local control cubicle.



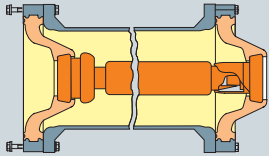
Non-conventional voltage transformer



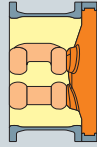
Splitting module

Splitting modules, single-pole/three-pole

The splitting modules are used for connecting three-pole plant components to single-pole components. As a rule, they form the connection between the outgoing feeder module and various termination modules (for overhead line termination, transformer termination).



Single-pole extension module



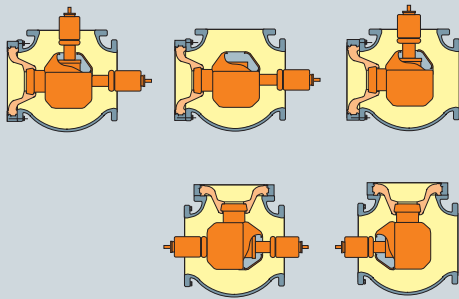
Three-pole extension module

Connection modules

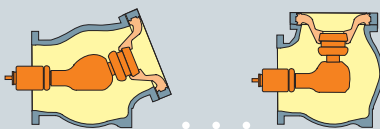
These modules are used to make the required joints within a bay and for pipework penetrations. Both single-pole and three-pole enclosed connection modules are available. The following connection modules can be used, depending on the circuit and the spatial layout of the bay:

T-module

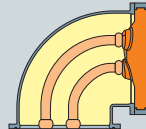
T-modules are used as branch-off points or for attaching a surge arrester. They are available in various designs; however, their basic form is always the same.



Design variants of single-pole T-modules



Design variants of single-pole angular modules



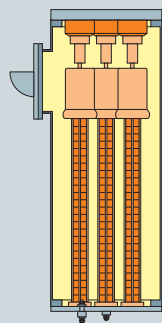
Three-pole 90° angular module

Angular module

Angular modules are used for splitting the conductors in outgoing leads. They are available in designs with angles of 30°, 45°, 60°, and 90°.

Surge arrester

If required, enclosed surge arresters can be connected directly. They serve to limit the over-voltages that may occur. Their active part consists of metal-oxide resistors with strongly non-linear current/voltage characteristics. The arrester is generally flange-jointed to the switchgear via a gastight bushing. The tank of the arrester module incorporates a manway opening, through which the internal conductor can be accessed for inspection purposes. There are connections for gas monitoring and arrester control devices on the underside.



Surge arrester

Termination modules

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

- Overhead line
- Transformer or reactor coil
- Cable.

They form the transition between the SF₆ gas insulation within the enclosure and other insulating media.

Cable termination

This three-pole module links the metal-enclosed gas-insulated switchgear with a high-voltage cable. All customary types of high-voltage cables can be connected. The primary conductor connection between the cable sealing end and the switchgear can be removed in the neighboring outgoing feeder module to perform a high-voltage withstand test. Both conventional type cable sealing ends and plug-in types can be used.

Outdoor termination

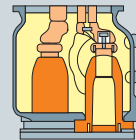
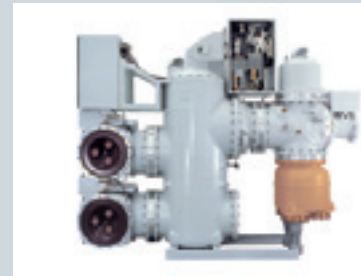
The single-pole outdoor termination module forms the transition from the gas-insulated switchgear to air-insulated components or overhead lines. This termination is a combination of a single-pole connection module and an outdoor/SF₆ bushing. Length, shielding form, and creepage distance of the outdoor/SF₆ bushing are determined in line with insulation coordination, minimum clearance, and degree of pollution. The outdoor termination module is suitable for air-insulated connections between GIS and:

- Overhead lines
- Outdoor bushings of outdoor transformers or reactor coils
- Outdoor sealing ends of high-voltage cables.

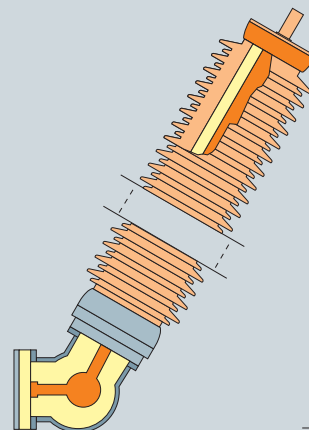
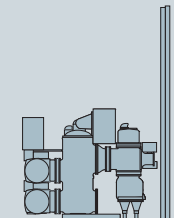
The splitting of the connection points for the three phases with the necessary clearance in air for conductor insulation is taken into account in the design of the switchgear.

Transformer termination

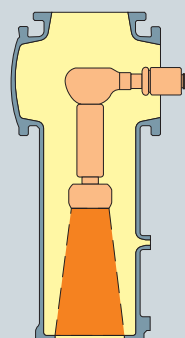
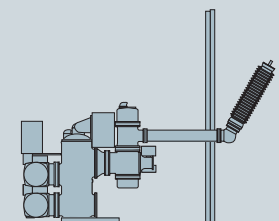
Similar to the outdoor termination module, the single-pole transformer termination module is connected to the three-phase encapsulated basic bay via a combination of connection modules. It effects the transition from the gas insulation directly to the bushing of oil-insulated transformers or reactor coils. The transformer bushing must be oiltight and resistant to gas pressure. Temperature-related movements and non-uniform settling of the switchgear and transformer foundations are absorbed by expansion joints.



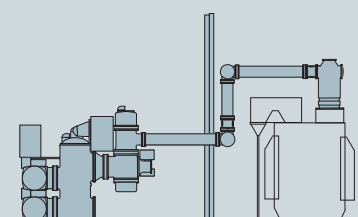
Example: Cable termination (plug-in type)



Outdoor termination



Transformer termination



Control and Monitoring – Consistent and Flexible Control and Protection

Proven switchgear control

All the elements required for control and monitoring are accommodated in a decentralized arrangement in the high-voltage switching devices. The switching device control systems are factory-tested and the switchgear is usually supplied with bay-internal cabling all the way to the integrated local control cubicle. This minimizes the time required for commissioning and reduces the possibilities of error. By default, the control and monitoring system is implemented with electromechanical components. Alternatively, digital intelligent control and protection systems including comprehensive diagnostics and monitoring functions are available. More detailed information on condition of the substation state permits condition-based maintenance. This consequently reduces life cycle costs even further.

Gas monitoring

Each bay is divided into functionally distinct gas compartments (circuit breaker, disconnecter, voltage transformer, etc.). The gas compartments are constantly observed by means of density monitors with integrated indicators; any deviations are indicated as soon as they arrive at the defined response threshold. The optionally available monitoring system includes sensors that allow remote monitoring and trend forecasts for each gas compartment.

Flexible and reliable protection in bay and substation control

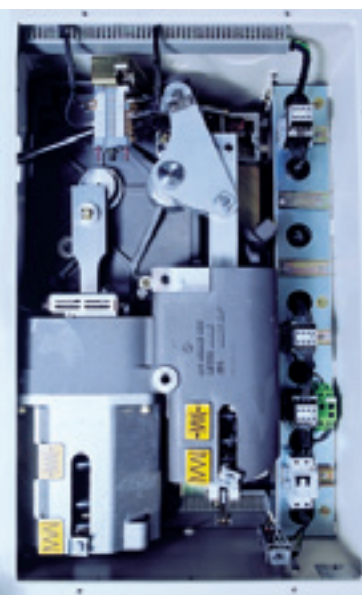
Control and feeder protection are generally accommodated in the local control cubicle, which is itself integrated in the operating panel of the switchgear bay. This substantially reduces the amount of time and space required for commissioning. Alternatively, a version of the local control cubicle for installation separate from the switchgear is available. Thus, different requirements with respect to the arrangement of the control and protection components are easy to meet. The cabling between the separately installed local control cubicle and the high-voltage switching devices is effected via coded plugs, which minimizes both the effort involved and the risk of cabling errors.

Of course we can supply high-voltage switchgear with any customary bay and substation control equipment upon request. We provide uniform systems to meet your individual requirements.

Neutral interfaces in the switchgear control allow interfacing

- conventional control systems with contactor interlocking and control panel
- digital control and protection comprising user-friendly bay controllers and substation automation with PC operator station (HMI)
- intelligent, uniformly networked digital control and protection systems with supplementary monitoring and telediagnostics functions.

Given the wide range of Siemens control and protection equipment, we can provide customized concepts with everything from a single source.



Spring-stored energy
operating mechanism



Integrated local control cubicle

Transport, Installation, Commissioning, Maintenance

Transport

To ensure optimal transport and on-site installation, our switchgear assemblies are shipped in the largest possible units that are still easy to handle. It is thus possible to dispatch up to three completely assembled and tested switchgear bays, prefilled with SF₆ gas, as a single transport unit. In transport units containing switching devices, all operating mechanism attachments are preset at the factory prior to shipment. The jointing points of the transport units are protected against corrosion and sealed with transport covers. All items are packed according to means, duration, and route of transport, as well as in line with the nature and duration of storage. Shipments within Europe are normally effected by road. Switchgear supplied to countries outside Europe is enclosed in sealed packing suitable for transport overseas and for a combined duration of transport and storage of up to 12 months. In special cases, the sealed packing can be designed for an even longer period.

Installation and erection

The delivery of complete factory-assembled bays significantly reduces the effort required for installation on site. All it takes is simple devices to take the transport unit to its location of installation and align it for assembly with the other bays. A mounting frame facilitates movement and rapid alignment of the bays. Only few anchorings and additional steel supports are required for securing the switchgear to the foundation. Depending on the bay design, only the bay termination needs to be assembled. On the secondary side, only bay-to-bay cabling and interfacing to the substation control and protection are required.

Uncomplicated work procedures, detailed installation instructions, and the use of relatively few special tools allow easy and rapid installation of the switchgear by your own personnel under the guidance of an experienced supervisor from Siemens. Our training facilities are at your disposal.

Commissioning

Upon completion of the assembly work, all switching devices and all electrical circuits for control and monitoring are tested to ensure their proper function in both mechanical and electrical terms. Flange joints made on site are tested for gas leaks. All other flange joints are factory-tested. All tests are performed in conformity with IEC. The results are documented in reports.

Operation and maintenance

Our gas-insulated switchgear is designed and manufactured so as to achieve an optimal balance of design, materials used, and maintenance required. The hermetically sealed enclosures and automatic monitoring ensure minimal switchgear maintenance: The assemblies are practically maintenance free under normal operating conditions. We recommend that the first major inspection be carried out after 25 years.



High-voltage test on site



Factory-assembled panel

Quality Assurance

A consistent quality management system supported by our employees makes sure that we produce high quality gas-insulated 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 process-oriented and 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. From that point on, they have been considered independent.

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 ensure that the system is effective and up-to-date at all times and that appropriate measures are taken to continuously improve it. The reviews and audits are based on the consistent documentation of all processes relevant to quality and the environment. The quality of our switchgear consequently 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.

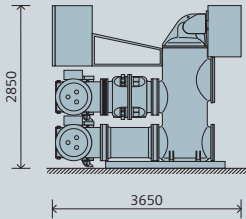
Comprehensive manufacturing inspections and routine testing of individual components, sub-assemblies, and modules all ensure reliable operation of the overall product. Mechanical routine and high-voltage tests of the complete bay or complete shipping units verify that the manufactured quality complies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



Typical Bay Arrangements

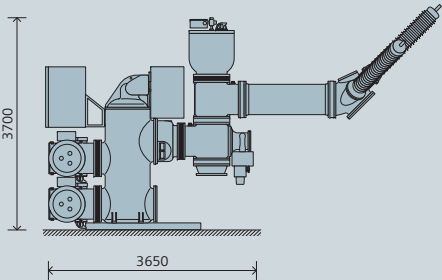
All the standard circuit configurations can be realized using our type 8DN8 switchgear.

Coupling bay



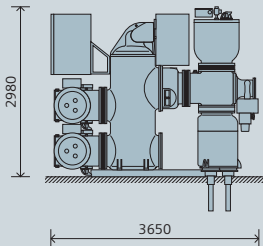
Bay weight approx. 2.8 t

Overhead line bay



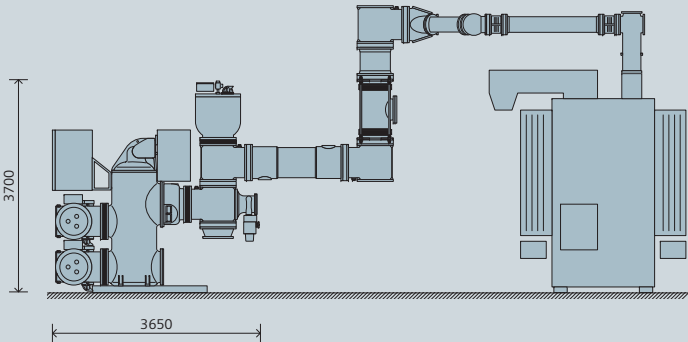
Bay weight approx. 3.1 t

H-configuration



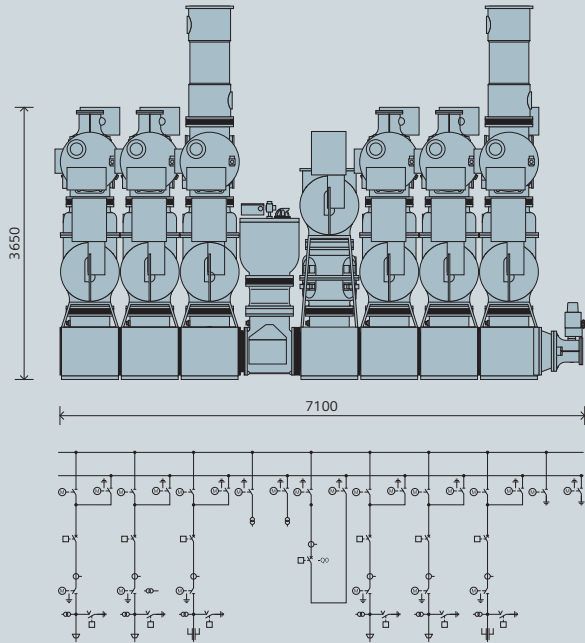
Bay weight approx. 3 t

Direct connection to the transformer

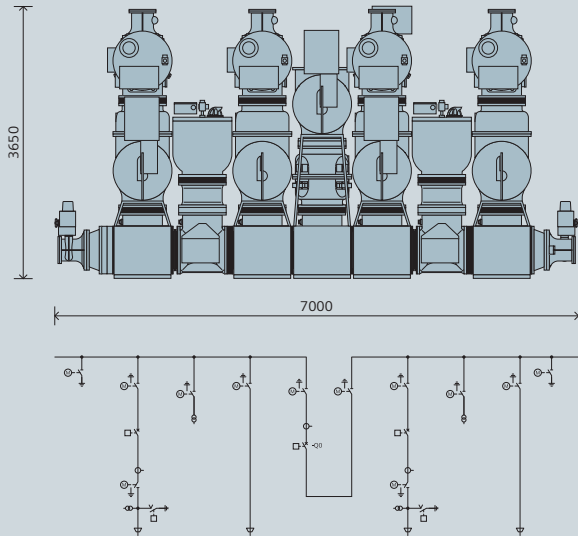


Bay weight approx. 3.1 t

Typical asset arrangement with double busbar



Typical asset arrangement with H-configuration



Technical Data

Switchgear type	8DN8
Rated voltage	72.5/145 kV
Rated frequency	50/60 Hz
Rated power frequency withstand voltage (1 min)	140/275 kV
Rated lightning impulse withstand voltage (1.2/50 µs)	325/650 kV
Rated normal current busbar	2500/3150 A
Rated normal current feeder	2500/3150 A
Rated short breaking current	31.5/40 kA
Rated peak withstand current	85/108 kA
Rated short-time withstand current	31.5/40 kA
Leakage rate per year and gas compartment	≤ 0.5 %
Bay width	650/800/1200 mm
Height, depth	see typical bay arrangements
Driving mechanism of circuit breaker	stored-energy spring
Rated operating sequence	O-0.3 s-CO-3 min-CO CO-15 s-CO
Rated supply voltage	60 to 250 V DC
Expected lifetime	> 50 years
Ambient temperature range	−30/−25 °C up to +40 °C
Standards	IEC/IEEE

Other values on request

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