

**HIS – Highly Integrated Switchgear
up to 145 kV, 40 kA, 3150 A
Type 8DN8**

Answers for energy.

SIEMENS



HIS – Highly Integrated Switchgear – Solves Space Problems



You needn't have any space worries with HIS, the gas-insulated switchgear for indoor and outdoor use, because HIS requires less than half the space of a comparable air-insulated switchgear.

The 8DN8-type HIS is a compact switchgear solution for a rated voltage of up to 145 kV, used mainly for cost-efficient renewal or expansion of air-insulated outdoor and indoor substations, particularly if the operator wants to carry out modifications while the switchgear is in service. New construction projects, high site prices and increasingly complex approval procedures mean that space requirement is the prime factor in costing. With the HIS solution, the circuit-breakers, disconnectors, earthing switches and instrument transformers are accommodated in compressed gas-tight enclosures, which makes the switchgear extremely compact.

Thus, you can meet the growing demands on your switchgear within the scope of the existing site.



HIS – Highly Integrated Switchgear – is the Cost-Effective Alternative



Cost-effective and versatile

With HIS, it is possible to implement all commonly-used substation configurations by using compact, standardized modules. Thus, for example, one air-insulated (conventional) bay can be replaced by two HIS bays – with space to spare! Low operating costs, minimal maintenance requirements and a long service-life of the system additionally help to reduce life-cycle costs. With the units preassembled and tested at the factory the switchgear is easily set up. In addition, HIS will readily fit your existing control and protection concept – whether it is conventional, digital or process-bus based. This allows flexibly and cost-effectively integrating HIS in your substation.

Low investment cost

State-of-the-art CAE and IT tools for order and execution management in combination with highly efficient manufacturing processes make for short planning and delivery times.

The switchgear is delivered to the site in preassembled units that have already been tested. This significantly reduces the time between award of the contract and handover of the complete switchgear to the client. In addition, HIS requires only half the ground area of air-insulated switchgear. Due to the small, compact bay structure, only a few foundations are necessary. Civil works activities are reduced to a minimum, so that even in mountainous, rocky terrain, construction presents no problems. Expansion of existing outdoor switchgear, to a large extent, is possible during operation. Isolating subsections of the equipment for short periods of time is all it takes for this purpose. This minimizes switchgear outage time. This way, you can keep investment costs down and ensure speedy commissioning.



You can rely on our switchgear even in the most hostile environment

Installation of our switchgear presents no problems, even in rocky, mountainous regions

Safe, reliable operation

The enclosed design protects operating personnel from contact with live parts. Integrated disconnectors and earthing switches on the busbar and outgoing feeder sides permit riskfree isolation and earthing of switchgear sections. Outgoing feeder earthing switches can also be supplied in the make-proof high-speed version. This avoids release of conductor connections to establish isolating sections and the use of mobile earth rods. Rupture diaphragms with defined directions of discharge prevent unacceptably high pressure rises in the enclosures. Bay construction on a single level makes for a straightforward switchgear layout. In addition to operator safety, the HIS solution provides excellent protection against vandalism. Thus, you can ensure maximum safety for your personnel and your switchgear as well as reliable operation.

Environmentally compatible

The environment also benefits from your HIS. The oil-free operating mechanism and the highly effective sealing of the enclosure prevent environmental pollution. The long service-life of HIS and its reduced space requirement additionally conserve resources. You are thus investing in an environmentally-friendly solution.

Robust and low maintenance

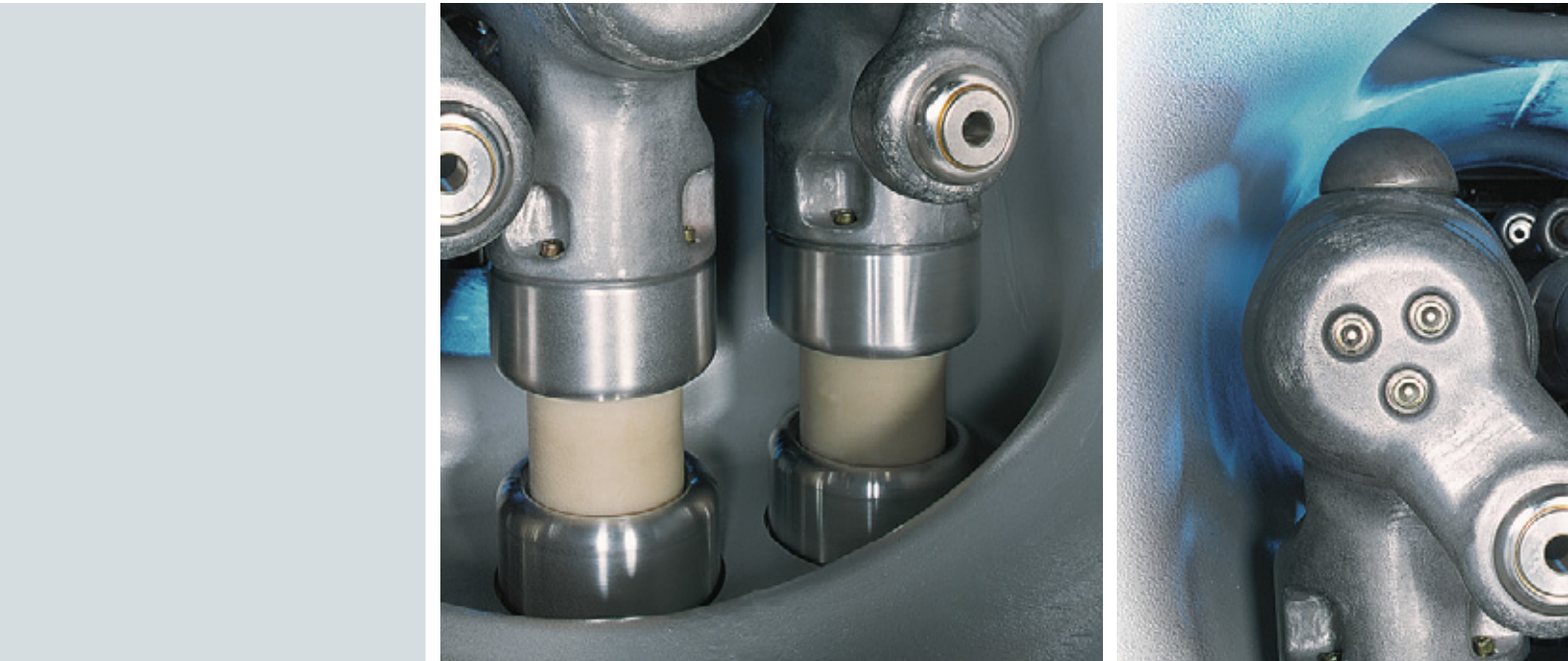
The high quality of the switchgear is a result of comprehensive quality management. The enclosures are corrosion-resistant aluminum castings and the motor-operated mechanisms are self-lubricating. The switchgear has no contact systems or operating linkages exposed to air, so that it is protected from external influences, even under corrosive environmental conditions. It is also aseismic and impervious to wind. This means that you can rely on your switchgear at all times – at an extremely low operating cost.

The creative solution

Based on GIS technology, HIS offers a creative solution for your switching functions as it is:

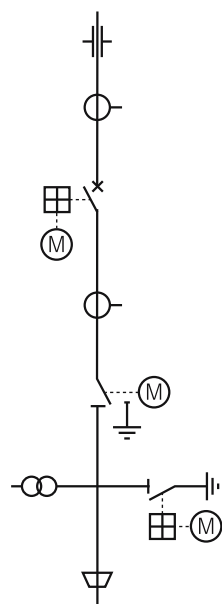
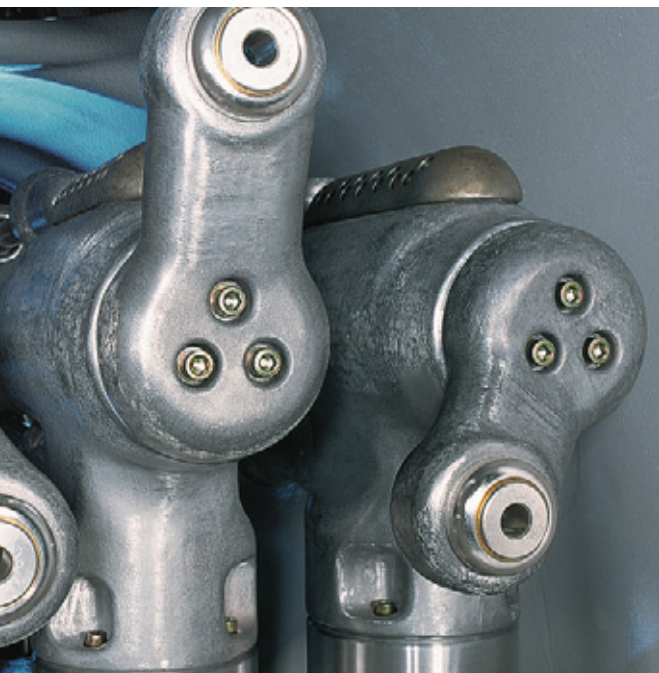
- Compact
- Low-cost and
- Modular for indoor as well as outdoor application

Compact by virtue of innovative technology

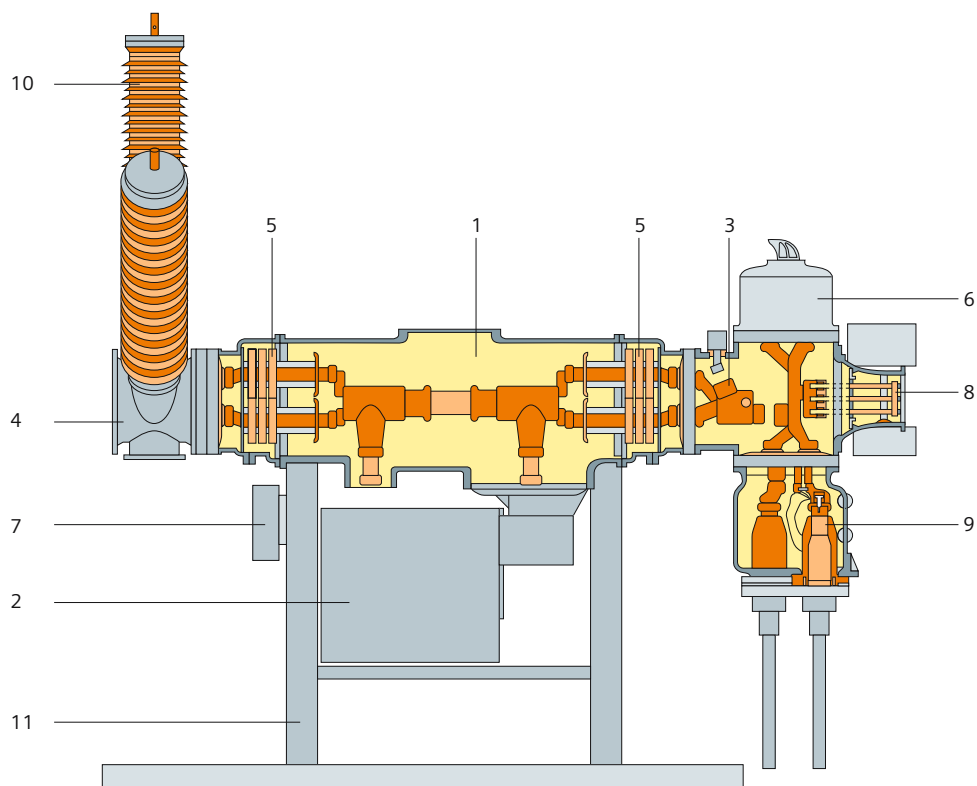


HIS switchgear is three-phase encapsulated in order to achieve an extremely compact module size. The switchgear is clearly laid out on a single level. Aluminum is used as enclosure material. As a result, the switchgear is free from corrosion and exceptionally lightweight. State-of-the-art design methods and casting techniques permit optimum dielectric and mechanical construction of the enclosures. Sulfur hexafluoride (SF_6) is used as the insulating and arc-quenching gas. All modules are attached to one another by flanges. The gas-tightness of the flange joints is ensured by the Siemens O-ring sealing principle, proven over years of service. Gas-tight bushings permit sub-

division of the bay into several distinct gas compartments. Each gas compartment is fitted with its own gas monitor, rupture diaphragm and filter material. Static filters absorb moisture and decomposition products. In the improbable event of a fault, bursting plates prevent unacceptably high pressure buildup in the enclosures. When they activate, diverter nozzles ensure defined direction of discharge of the gas. The outdoor-proof enclosures and operating mechanisms are fitted with space heaters. Screws and nuts are corrosion-proof.



In/out feeder



- 1 Circuit-breaker interrupter unit
- 2 Stored-energy spring mechanism (single pole or common drive) with circuit-breaker control unit
- 3 Outgoing feeder module with disconnecting and earthing switch
- 4 Splitting module
- 5 Current transformer
- 6 Voltage transformer
- 7 Transformer terminal box
- 8 High-speed earthing switch
- 9 Cable sealing end
- 10 SF₆/air bushing
- 11 Supporting structure

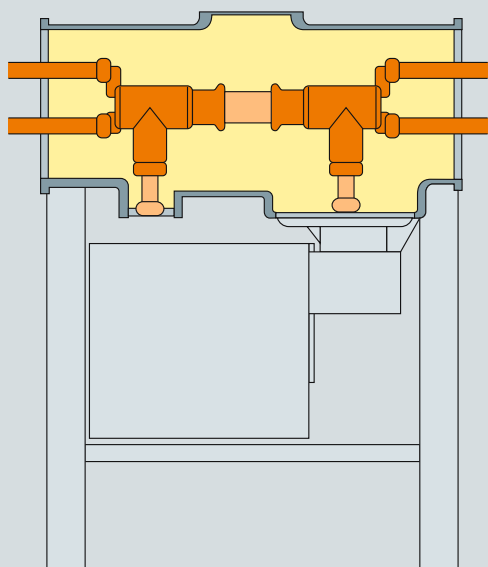


Circuit-breaker Module

The center-piece of the HIS switchgear is the three-phase encapsulated circuit-breaker module with its two elements:

- Stored-energy spring mechanism (single pole or common drive)
- Interrupter unit

For air-insulated switchgear (AIS) and gas-insulated switchgear (GIS), the same interrupter units and operating mechanism are used. The use of this platform concept in a wide range of applications has provided us with decades of comprehensive experience.



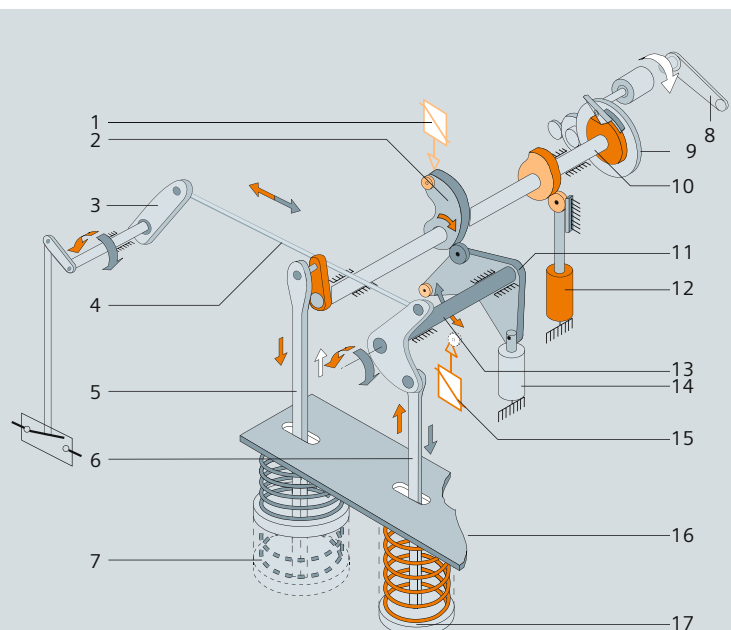
Circuit-breaker module with interrupter unit



Common drive



Single pole drive



- | | |
|-------------------------------------|----------------------------|
| 1 Trip coil CLOSE | 9 Charging gear |
| 2 Cam plate | 10 Charging shaft |
| 3 Corner gear | 11 Roller lever |
| 4 Connecting rod | 12 Damper (for closing) |
| 5 Connecting rod for closing spring | 13 Operating shaft |
| 6 Connecting rod for opening spring | 14 Damper (for opening) |
| 7 Closing spring | 15 Trip coil OPEN |
| 8 Emergency hand crank | 16 Drive mechanism housing |
| | 17 Opening spring |

Stored-energy spring mechanism

State-of-the-art production techniques allow using compact housing. Since the closing and opening springs are housed in the operating mechanism, the structure is compact and sturdy.

This design results in a small number of moving parts. The use of roller bearings and the maintenance-free spring mechanism are a prerequisite for decades of reliable operation. Proven design principles, such as vibration-isolated latches and load-free isolation of the charging mechanism, are retained.

The advantages of the stored-energy spring mechanism:

- One principle for rated voltages from 72.5 up to 550 kV
- High reliability due to low operating energy
- Simple principle of operation
- Switching state controllable at all times
- Low-maintenance, economical with a long service life
- Low environmental impact

Arc-quenching principle

Interrupter unit

The interrupter unit used for arc-quenching in the circuit-breaker operates on the self-compression principle. By virtue of the low operating energy required, very low mechanical forces occur. This results in a favorable effect on the mechanical loading of the circuit-breaker itself, on the enclosure and on the foundation design. The same interrupter unit is used for single pole and common drive.

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 parallel to the main contact.

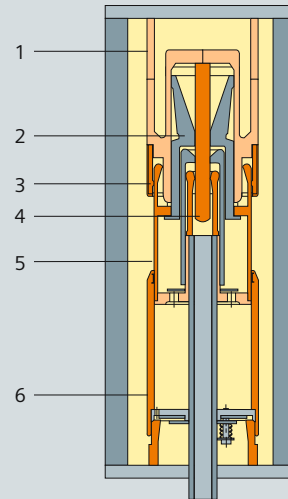
Interruption of operating current

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). The contact cylinder (5) moves simultaneously 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.

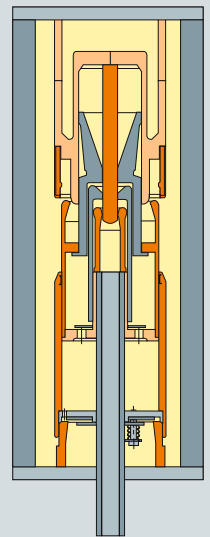
Interruption of fault current

If the short-circuit current is high, the arc-quenching gas at the arcing contact is heated up considerably by the energy of the arc. 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.

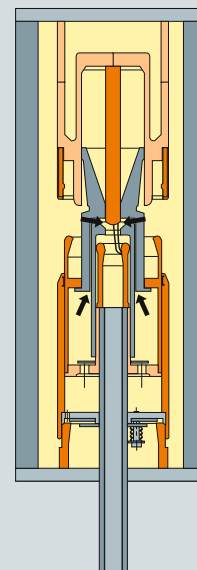
- 1 Contact carrier
- 2 Nozzle
- 3 Main contact
- 4 Arcing contact
- 5 Contact cylinder
- 6 Base



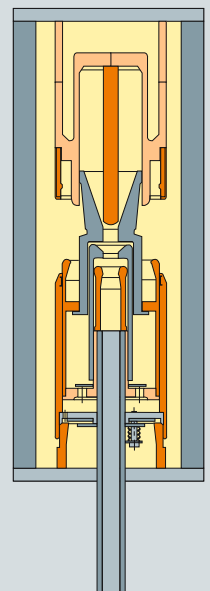
Breaker in
"On" position



Breaking:
Main contact opened

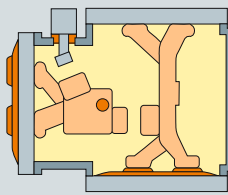


Breaking:
Arcing contact opened

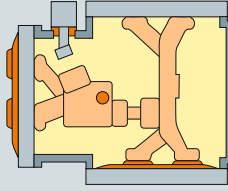


Breaker in
"Off" position

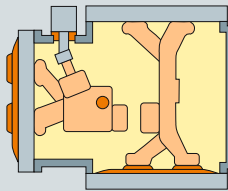
Diagrammatic view of three-position unit



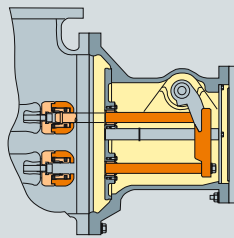
Neutral position



Disconnecter closed



Earthing switch closed



High-speed earthing switch

Disconnecting and Earthing Switches

The functions of disconnecting and earthing switches are combined in a three-position unit. The moving contact either closes the isolating gap or connects the high-voltage conductor to the fixed contact of the earthing switch. This design ensures natural mechanical interlocking of the two functions in relation to one another, which subsequently no longer need to be taken into account in the electrical interlocking of the bay. The fixed contact of the earthing switch is brought out of the enclosure for test purposes. In a third neutral position, neither the disconnecter nor the earthing switch contact is closed. The three poles of a bay are mechanically inter-connected; thus, all three poles are operated jointly with a single motor-operated mechanism. Power transmission inside the enclosure is effected by means of compressed gas-tight, rotary insulating shafts. Alarm switches and contact position indicators are mechanically reliable and are attached directly to the operating shaft. Manual emergency operation is possible.

High-speed Earthing Switch

The high-speed earthing switch is a moving-contact earthing switch. With this switch, the moving contacts at earth potential slide into the tulip-shaped fixed contacts. The earthing switch is fitted with a stored-energy spring mechanism which is charged by means of an electric motor.

Instrument Transformers

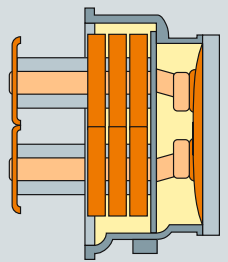
Current and voltage transformers are employed for the purpose of measurement and protection. They are supplied in numerous variants – from conventional transformers, right up to state-of-the-art current and voltage sensors.

Current transformer

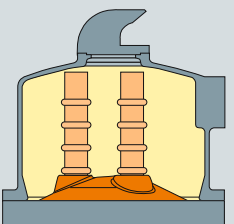
Generally, optimized-performance inductive current transformers are used. The current transformer can be integrated anywhere in the bay and substation construction. The high-voltage conductor forms the primary winding. The cores with secondary windings are designed in accordance with accuracy class rating and performance requirements. Tap-changing to the different transformation ratios is made possible by secondary connections of current transformers. The latter are brought out of the enclosure via a gas-tight bushing plate and are electrically accessible in the transformer terminal box underneath the circuit-breaker.

Voltage transformer

Both inductive and optimized-performance voltage transformers are employed. Voltage transformers can be arranged on either side of the outgoing feeder disconnecter. The secondary connections are brought out of the enclosure via a gas-tight bushing plate and are electrically accessible in the transformer terminal box underneath the circuit-breaker.



Optimized-performance current transformer



Example of optimized-performance voltage transformer

Termination Modules

Termination modules link the HIS bays to the equipment by means of the following:

- Overhead line
- Transformer or reactor
- Cable

Thus, they form the transition from the SF₆ gas insulation inside the enclosure to other insulating media.

Cable termination

This three-phase encapsulated module links the metal-enclosed HIS switchgear to a high-voltage cable.

In the cable termination module, it is readily possible to connect all common types of high-voltage cables. It is possible to employ both conventional and plug-in cable sealing ends.

SF₆/air termination

The transition from the HIS switchgear to air-insulated switchgear modules or overhead lines is accomplished by the single-phase SF₆/air bushing termination. It can take the form of a composite or porcelain insulator. This connection is a combination of single-phase connecting modules and SF₆/air bushings. Overall length, shield shape and creepage path will be designed according to insulation coordination, minimum clearance and degree of pollution. The SF₆/air termination is suitable for air-insulated connections of HIS to:

- Overhead lines
- Transformer or reactor bushings
- High-voltage cables sealing ends

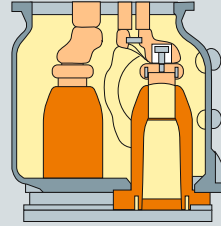
The spread of the three phases' connections to achieve the air clearance required for insulating the conductors against one another is 45°.

Transformer tube-termination

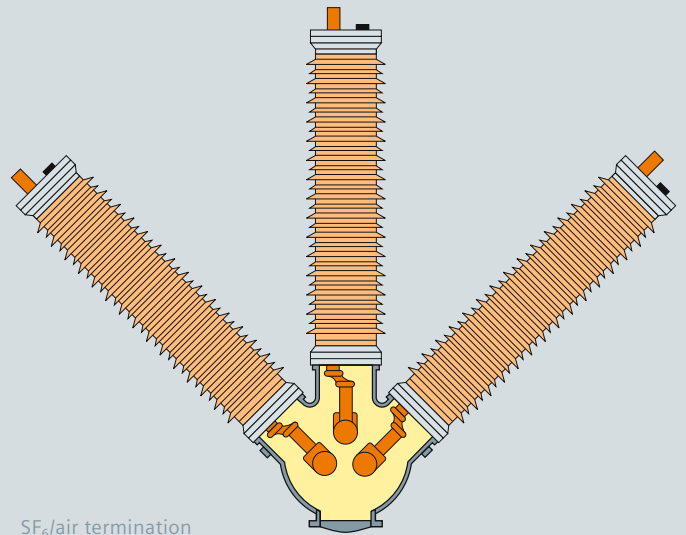
Just like the SF₆/air termination, the single-phase transformer termination module is connected to the three-phase encapsulated basic bay by means of a combination of link modules. It facilitates the transition from the gas insulation directly to the bushing of oil-insulated transformers or reactors. For this purpose, the transformer bushing must be designed to be oil and pressure-tight. Temperature-related movement and different settling of the switchgear and transformer foundations are corrected with expansion joints.

Extension module

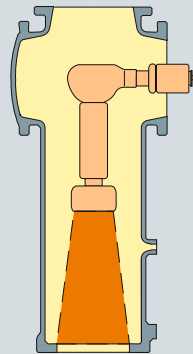
The links necessary within a bay are established by means of extension modules.



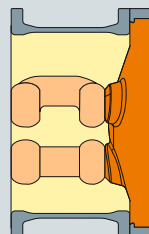
Example of cable termination (plug-in type)



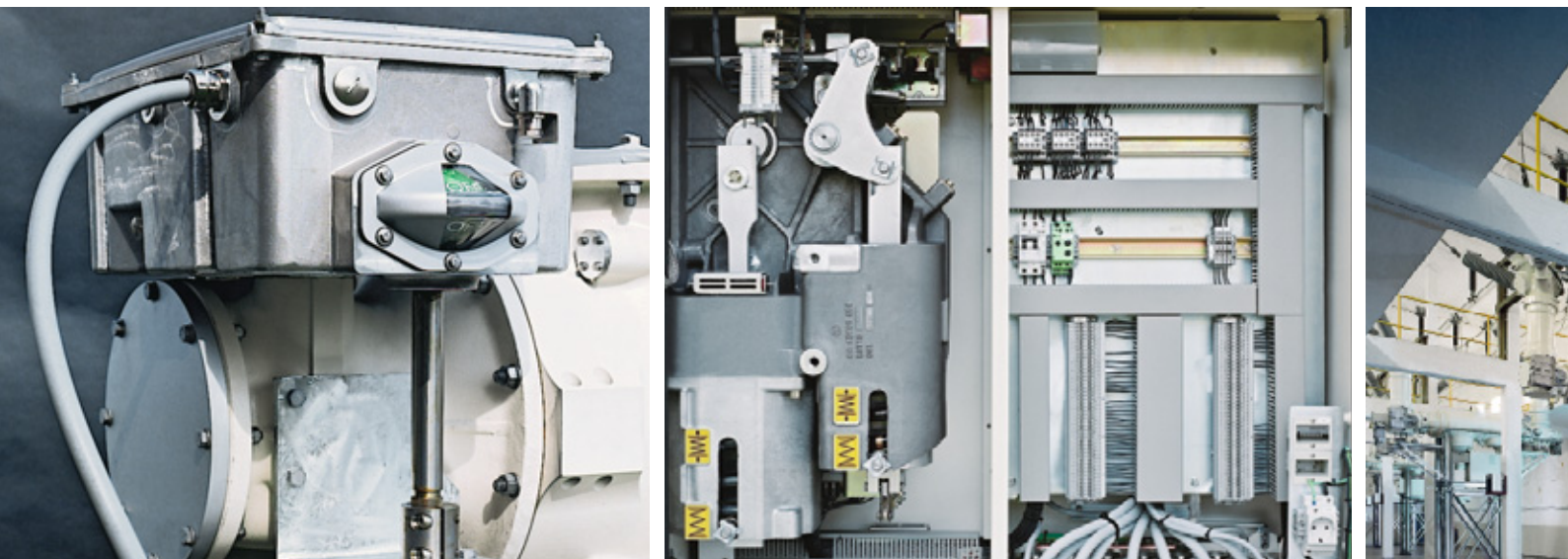
SF₆/air termination



Transformer tube-termination



Extension module



Operating mechanism of the circuit-breaker

Control and Monitoring – Reliable and Flexible Control and Protection System

Proven switchgear control

Robust electrical components are used to control and monitor circuit-breakers as well as other switchgear components. All elements necessary for the control and monitoring of circuit-breaker, disconnecting and earthing switches are incorporated in the respective control unit.

The operating mechanisms are pre-tested at the factory to reduce commissioning time to a minimum and to avoid any failures on-site.

Gas monitoring

Gas-tight insulating partitions subdivide each switchgear bay into separate gas compartments (e.g. circuit-breakers with current transformer, disconnecting switches, voltage transformers, surge arresters and termination modules).

The gas compartments are constantly monitored by density monitors providing alarm and blocking signals via contacts.

Reliable and flexible control and protection system

Local control is easily accessible in the separately mounted control cubicle. As an option, the feeder protection can also be included in the same cubicle. The local control cubicle is normally placed nearby the switchgear, but installations in a separate control room are also customary. Screened control cables are used for the connections between the local control cubicle and the high-voltage equipment. Coded plug connectors are used to cut the costs of installation and minimize the risk of cabling failures. 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 and protection systems with user-friendly bay controllers and substation 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 a wide range of customized concepts from a single source.



Renovation of air-insulated indoor switchgear



Loading onto truck

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. Restrictions on transport dimensions usually do not allow transporting a whole bay in one unit. The means of transport, routes and on-site handling are taken into consideration in the process.

All shipping units are mechanically and dielectrically tested before delivery. 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 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.

Installation and erection

The delivery of the bays in just a few, easy-to-handle transport units reduces the time and effort needed for on-site installation. The control unit of the circuit-breaker is pre-assembled on the supporting frame at the factory. 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.

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 especially those fitted on site. Commissioning work on the primary section ends with the high-voltage test to verify that all installation work, including the work done inside the enclosure, has been done correctly. All tests are performed in accordance with IEC standards and the results are documented in the final test reports.

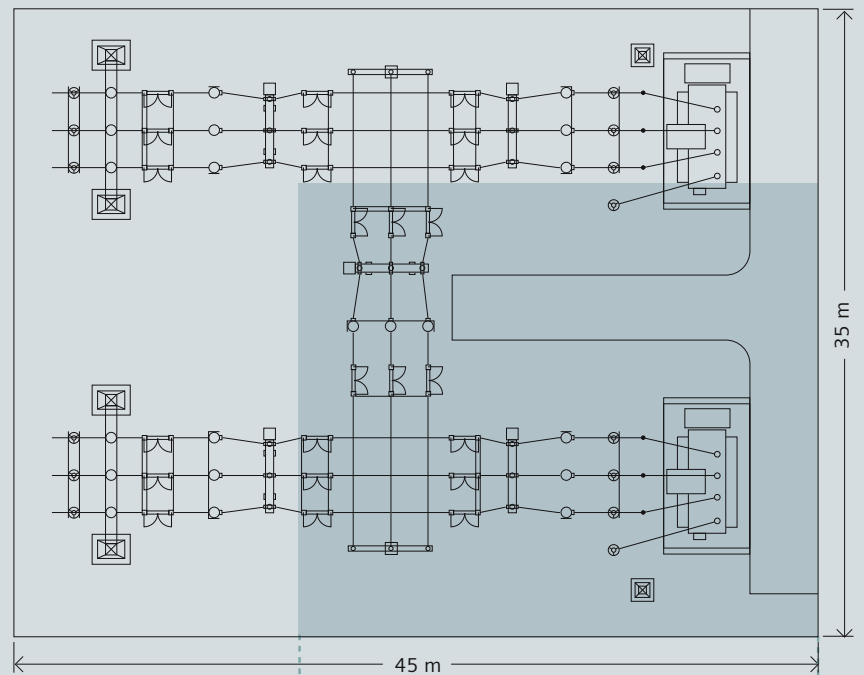
Maintenance

Our HIS switchgear installations are designed and manufactured to provide an optimum balance in design, manufacturing, operation and maintenance. Due to the tightly-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. A major inspection is not recommended before 25 years of operation.

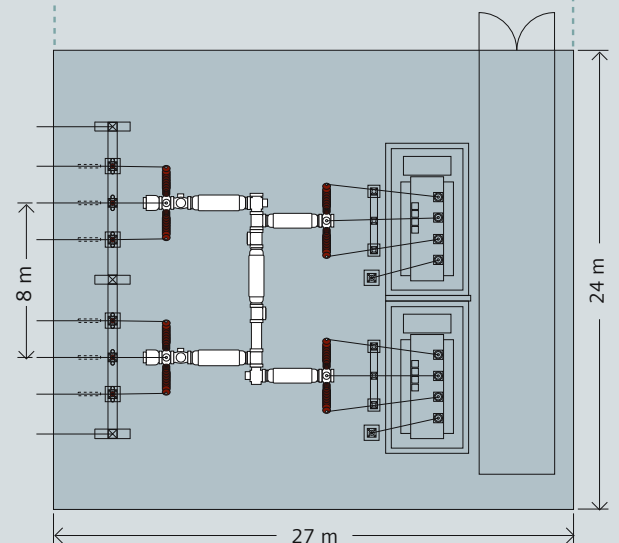
Examples of switchgear configurations



H-arrangement



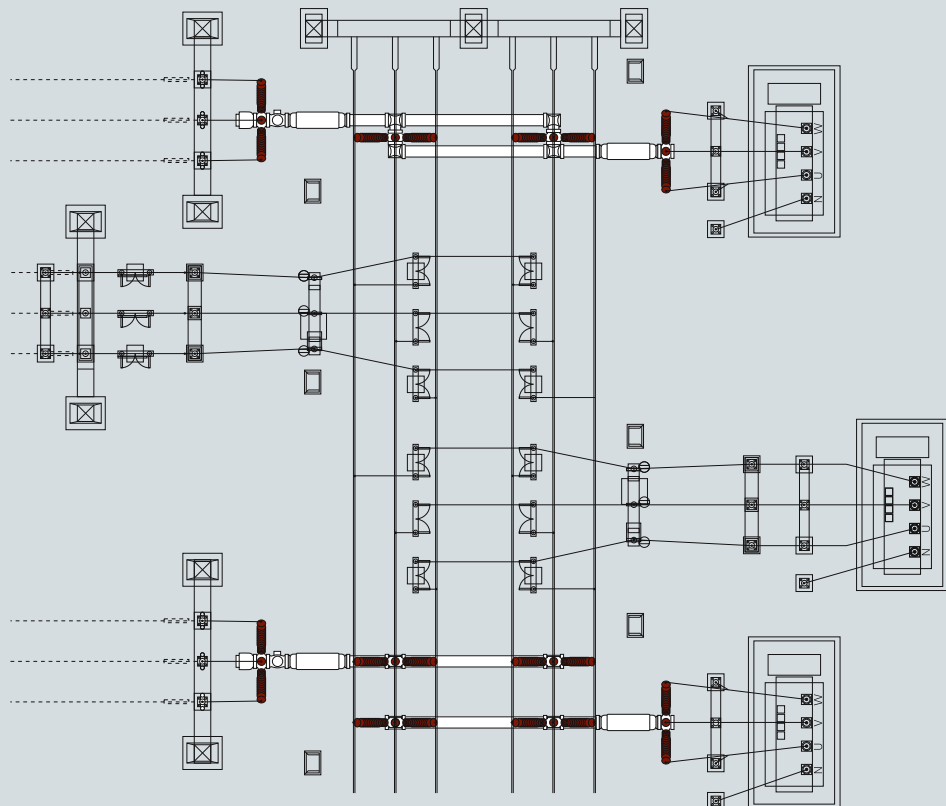
Previously:
Air-insulated switchgear unit;
Space requirement:
approx. 1600 m²



Subsequently:
HIS – Highly Integrated
Switchgear;
Space requirement:
approx. 650 m²

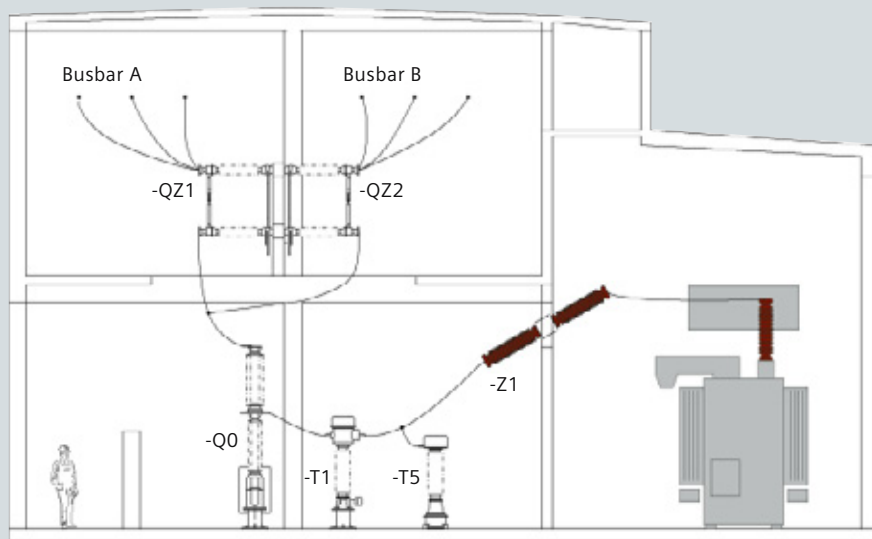


Extension, air-insulated outdoor switchgear, in-line-arrangement

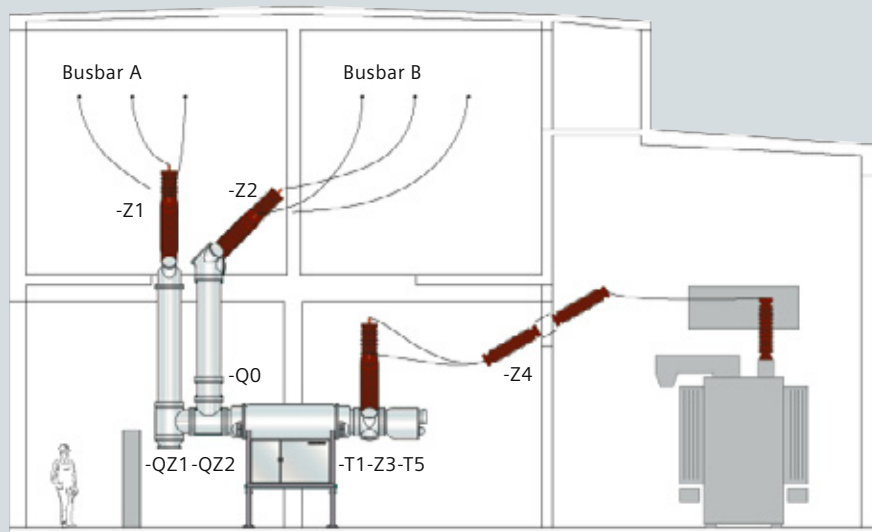




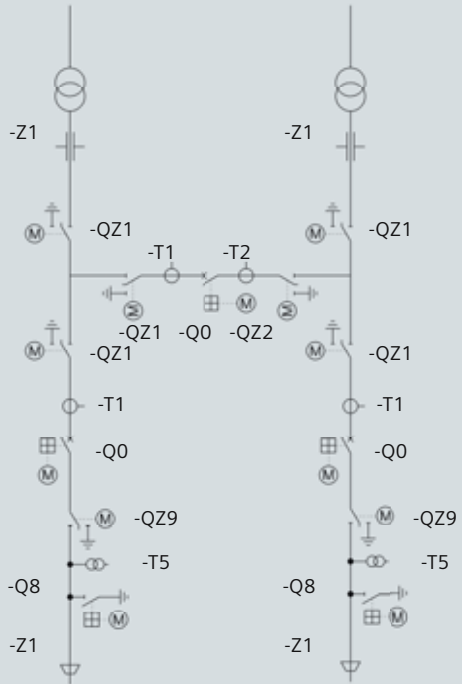
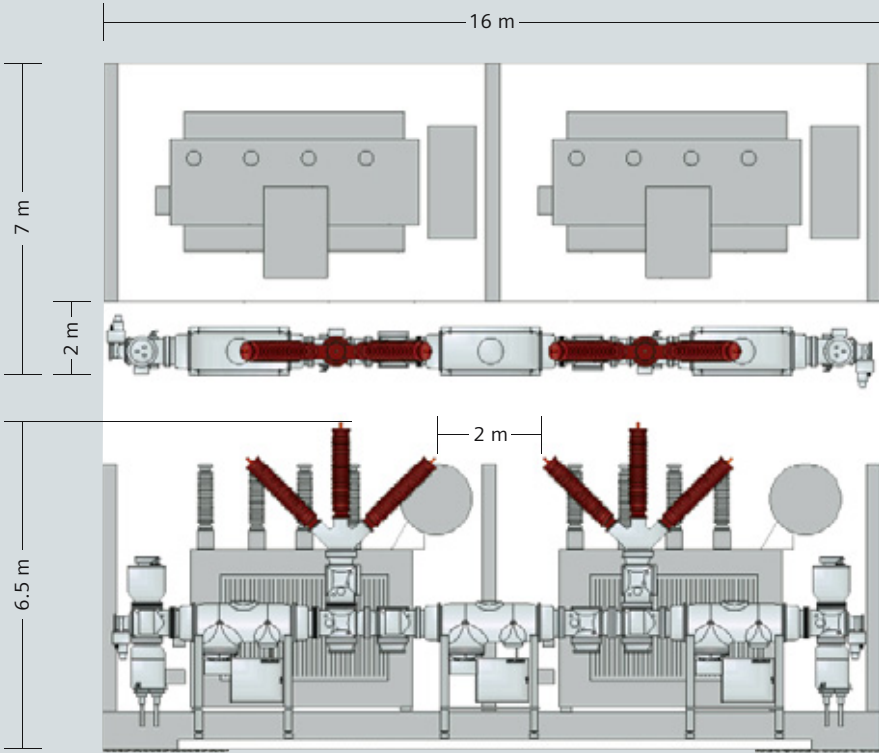
Renovation of air-insulated indoor switchgear, double busbar arrangement



Previously:
Air-insulated indoor Switchgear



Subsequently:
HIS – Highly Integrated Switchgear



Quality Assurance

Factory testing



A consistent quality management system supported by our employees makes sure that we produce high-quality gas-insulated switchgears. 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' lifecycles, 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. 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.

Technical Data

Switchgear Type	8DN8
Rated voltage	145 kV
Rated frequency	50/60 Hz
Rated power frequency withstand voltage (1 min)	275 kV
Rated lightning impulse withstand voltage (1.2/50 μ s)	650 kV
Rated normal current busbar	3150 A
Rated normal current feeder	3150 A
Rated short-breaking current	40 kA
Rated peak withstand current	108 kA
Rated short-time withstand current	40 kA
Leakage rate per year and gas compartment	≤ 0.5 %
Height, depth	see typical bay arrangements
Driving mechanism of circuit-breaker (single pole or common drive)	stored-energy spring
Rated operating sequence	O-0.3 s-CO-3 min-CO CO-15 s-CO
Rated supply voltage	60–250 V DC
Expected lifetime	> 50 years
Ambient temperature range	–30 °C to +55 °C
Standards	IEC/IEEE

For further Information

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