



SIEMENS

HIS – Highly Integrated Switchgear up to 550 kV, 63 kA, 5000 A Type 8DQ1

[siemens.com/energy](https://www.siemens.com/energy)

Answers for energy.

HIS – Highly Integrated Switchgear – solves space problems



No more losing sleep over space restrictions: HIS, the gas-insulated switchgear for indoor and outdoor use requires less than half the space of comparable air-insulated switchgear.

The 8DQ1-type HIS is a compact switchgear solution for rated voltages of up to 550 kV. It is 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 make space prime factor in costing. With the HIS solution, the circuit-breakers, instrument transformers, disconnecting and earthing switches are accommodated in pressure-gas-tight enclosures with a minimum of five independent gas compartments, 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 with 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 the award of the contract and handing over the complete switchgear to the client. In addition, HIS requires only half the floor space of air-insulated switchgear. Due to the small, compact bay structure, only few foundations are necessary. Civil works activities are reduced to a minimum, so that even in mountainous, rocky terrain, construction presents no problems. To a large extent, the work required for expanding existing outdoor switchgear can be performed during operation. Isolating subsections of the equipment for short periods of time is all it takes. This minimizes switchgear outage time, which, in turn, helps keep investment costs down and ensure speedy commissioning.

Safe, reliable operation

The enclosed design protects operating personnel from contact with live parts. Integrated disconnecting and earthing switches on the busbar and outgoing feeder sides permit risk-free isolation and earthing of switchgear sections. All operations are remote controlled. Outgoing feeder earthing switches can also be supplied in the make-proof high-speed version. This avoids releasing conductor connections to establish isolating sections as well as the use of mobile earth rods. Rupture diaphragms with defined discharge directions 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 requirements additionally conserve resources. This means that you are protecting the environment for the future.

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, which protects it 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



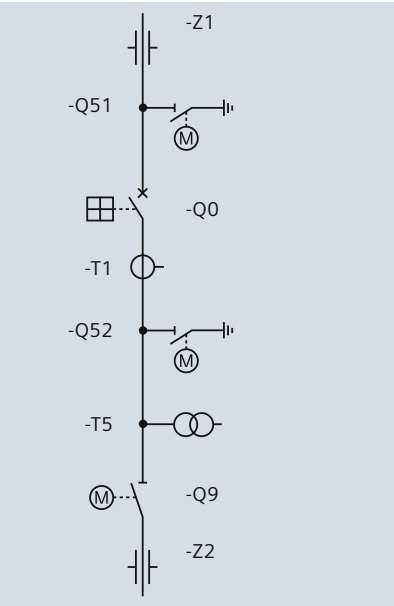
Flexibility thanks to modular design



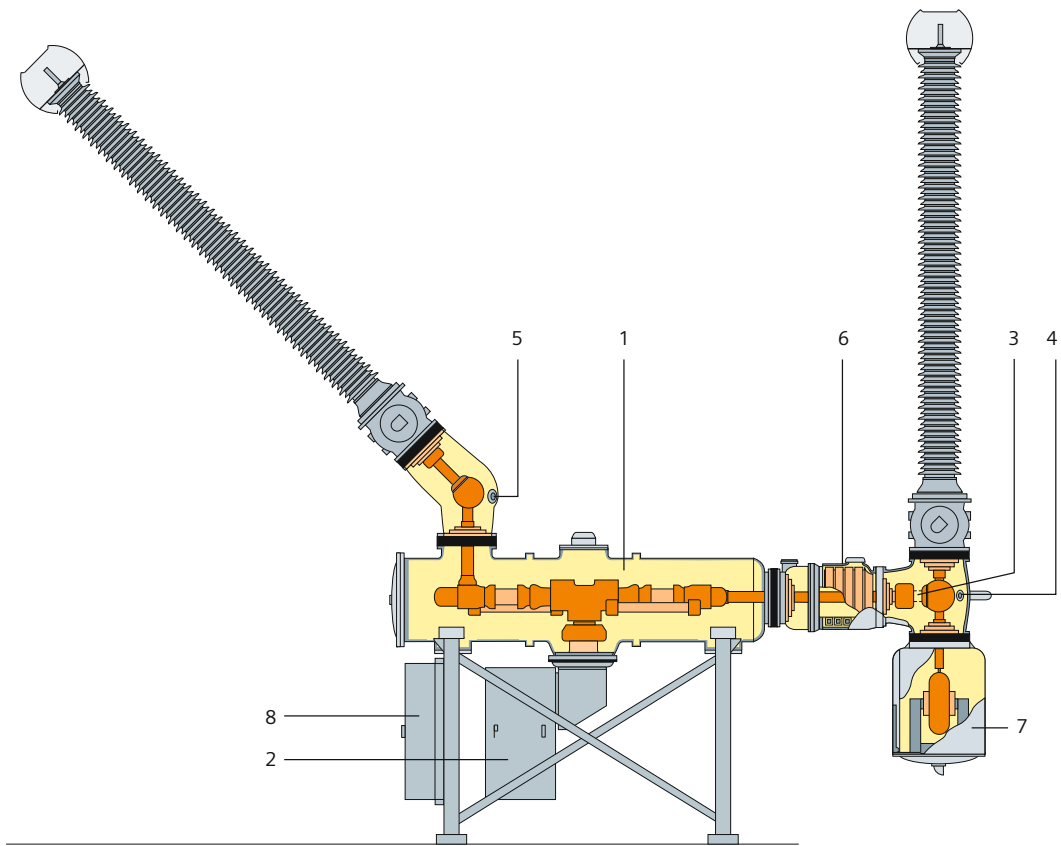
HIS switchgear is single-phase encapsulated in order to keep dielectric and dynamic stresses to a minimum. The switchgear is clearly laid out on a single level. Its enclosure is made of aluminum. As a result, the switchgear is corrosion-proof and exceptionally lightweight.

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 with flanges. The gas-tightness of the flange joints is ensured by the Siemens O-ring

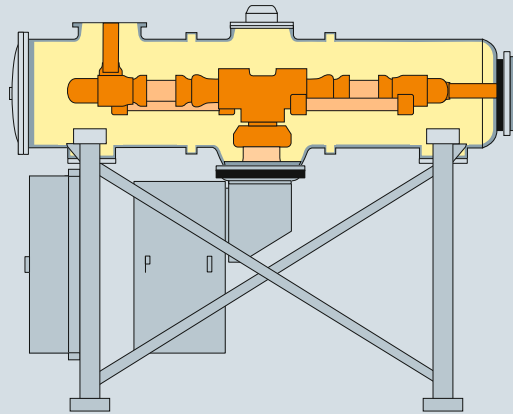
sealing principle, proven over decades of service. Gas-tight bushings permit subdividing the bay into several distinct gas compartments. Each gas compartment is fitted with its own gas monitor, rupture disks and filter material. Static filters absorb moisture and decomposition products. In the improbable event of a fault, rupture disks prevent unacceptably high pressure buildup in the enclosures. When activated, diverter nozzles ensure discharge of the gas in a defined direction. The outdoor-proof enclosures and operating mechanisms are fitted with space heaters. Screws and nuts are corrosion-proof.



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



- 1 Circuit-breaker interrupter unit
- 2 Stored-energy spring mechanism
- 3 Outgoing feeder module with disconnecting switch
- 4 Earthing switch
- 5 Earthing switch
- 6 Current transformer
- 7 Voltage transformer
- 8 Circuit-breaker control unit



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

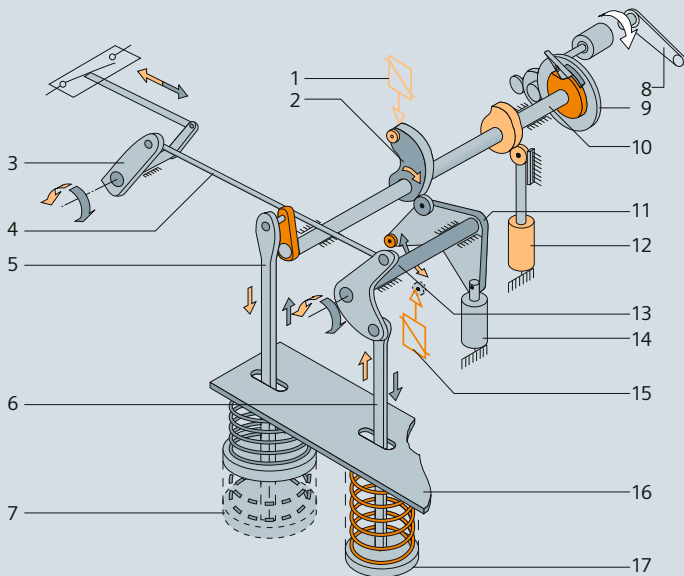
The design of the interrupter unit and the spring mechanism is based on time-tested identical constructions widely used in air-insulated as well as gas-insulated switching technology for many years. This design, decades of experience, and high quality guarantee the surpassing reliability of our switchgear.

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 SF₆ 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



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

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

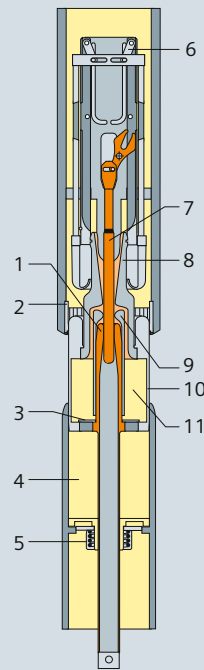
During the breaking operation, the contact finger (2) with the contact cylinder (10) opens and the current commutates to the arcing contacts (1, 7), which are still closed. This avoids erosion of the main contacts. As the breaking operation continues, an arc forms between the contacts (1) and (7). At 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

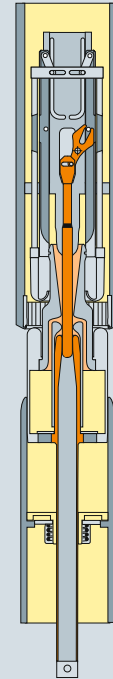
In the case of large short-circuit currents, the gas between the arcing contacts (1) and (7) is heated by the arc energy. Thus, the pressure in the heating volume (11) increases. When the current passes through zero, the gas flows back from the heating volume (11) through the nozzle (9) and quenches 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

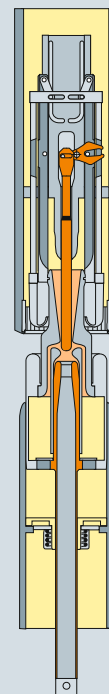
- | | |
|--------------------------|----------------------|
| 1. Moving arcing contact | 7. Moving arcing rod |
| 2. Main contact | 8. Insulating nozzle |
| 3. Check valve | 9. Auxiliary nozzle |
| 4. Compression volume | 10. Contact cylinder |
| 5. Check valve | 11. Heating volume |
| 6. Steering gear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



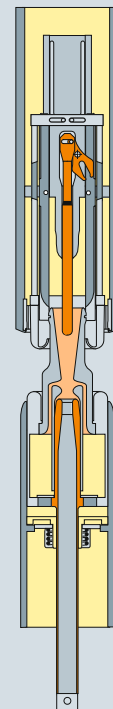
Breaker in
»On« position



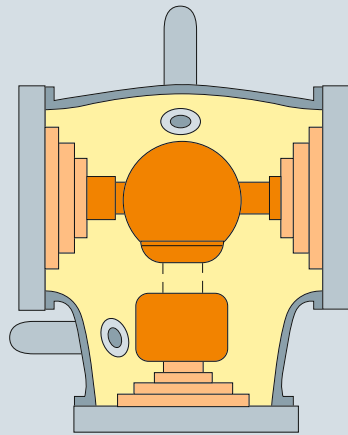
Breaking:
main contact opened



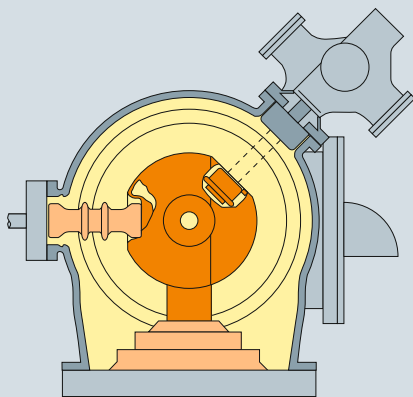
Breaking:
arcing contact opened



Breaker in
»Off« position



Disconnecting switch



Pin-type earthing switch

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

Disconnecting switches

In the open position, disconnecting switches assure a dielectrically safe gap between system parts at different potentials, for example the busbar disconnecter 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.

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.

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 SF₆ 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).

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.

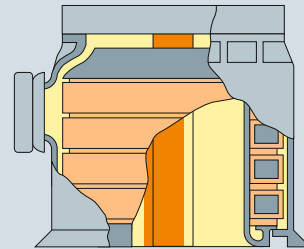
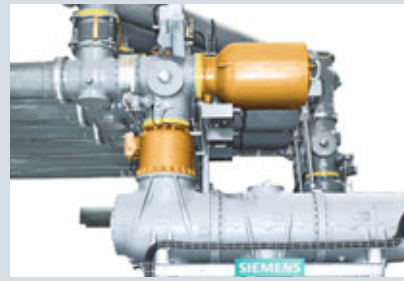
Resistive-capacitive voltage dividers (RCVD) consist of oil-impregnated capacitive elements with parallel mounted resistors in hermetically sealed glass fiber reinforced plastic tubes (GRP). The RCVD has a common gas compartment with the neighboring gas compartment. It is also available in another version 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

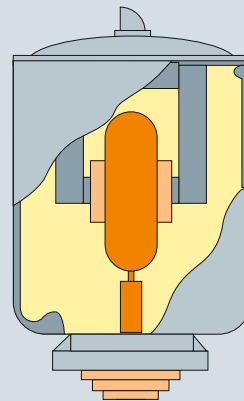
If desired, encapsulated surge arresters can be connected directly. Their purpose is to limit any overvoltages.

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.

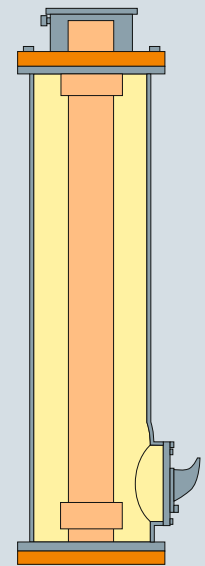
An inspection hole in the arrester housing allows opening the internal conductor when inspecting the switchgear. The connections for gas monitoring, arrester testing, and a surge counter are at the bottom.



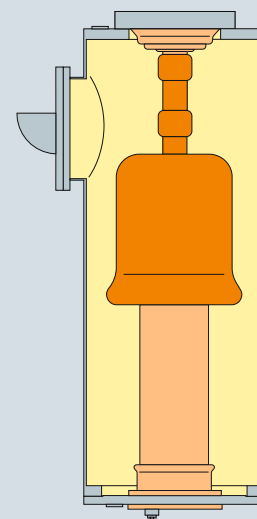
Current transformer



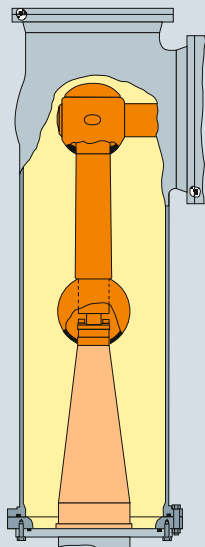
Conventional voltage transformer



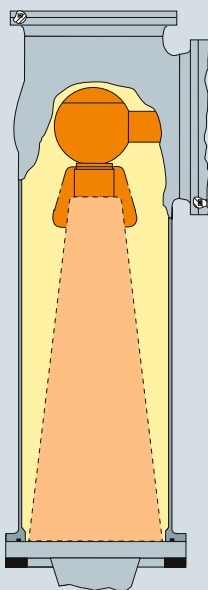
RC voltage divider



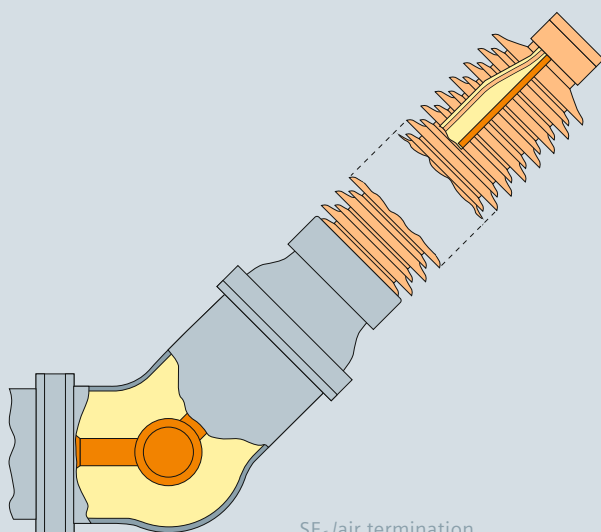
Surge arrester



Transformer tubetermination



Cable termination



SF₆/air termination

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 SF₆ gas insulation to other insulating media.

Transformer termination

The transformer termination module enables a direct SF₆/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

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.

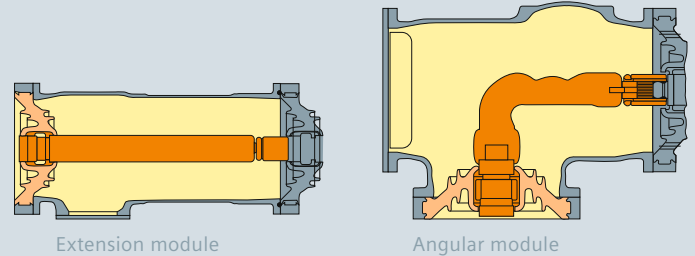
SF₆/air termination

The SF₆/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 SF₆ bushing. The length, shed form, and creepage distance of the outdoor/SF₆ 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.

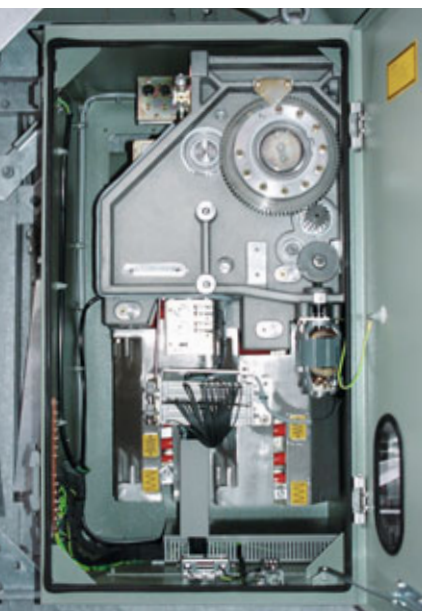


Busbar module

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.



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 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 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.

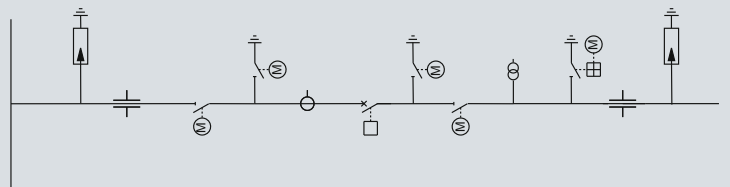
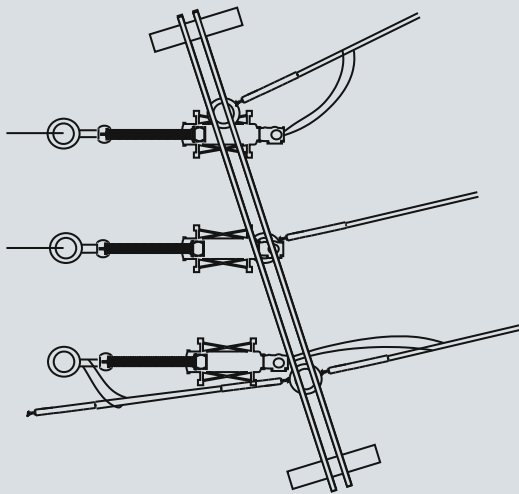
Regular management reviews and internal audits of all processes based on the consistent documentation of all processes relevant to quality and environmental protection ensure that the system is efficient and up-to-date at all times and that appropriate measures are taken to continuously improve it. Consequently,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

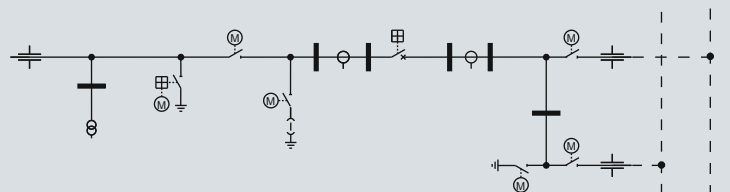
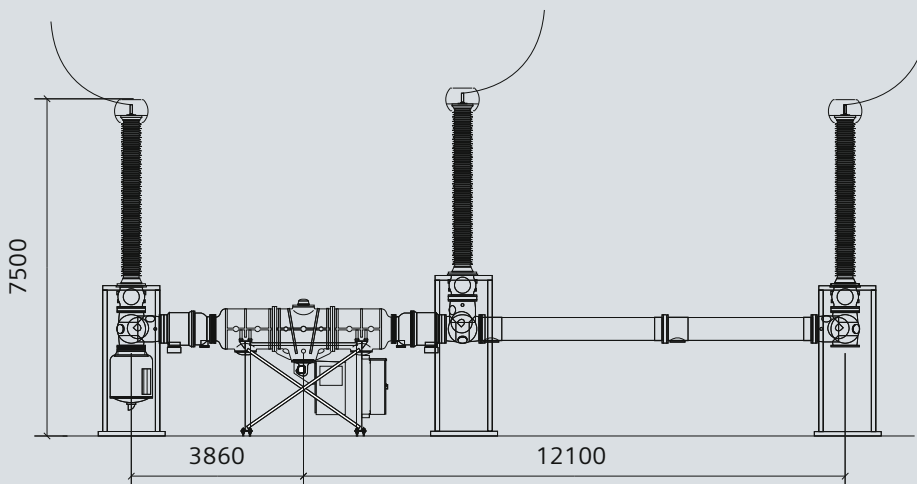
Comprehensive manufacturing inspections and routine testing of individual components, sub-assemblies, and complete modules all play an important part in ensuring reliable operation of the overall product. Mechanical routine and high-voltage tests of the complete bay or complete shipping units verify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

Switchgear bay examples

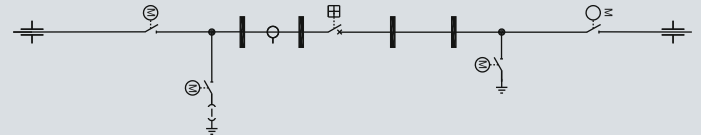
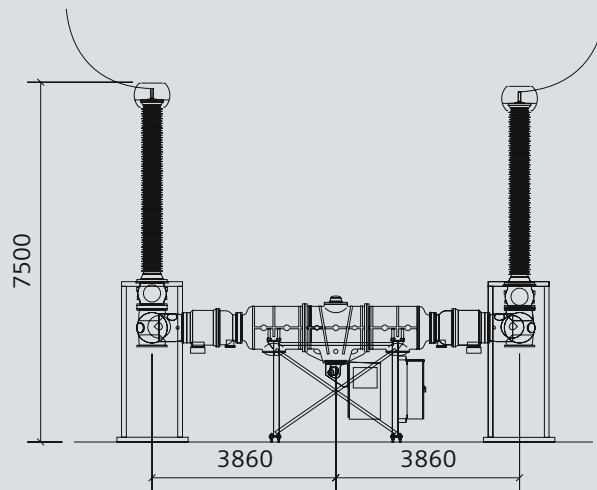
In/out arrangement



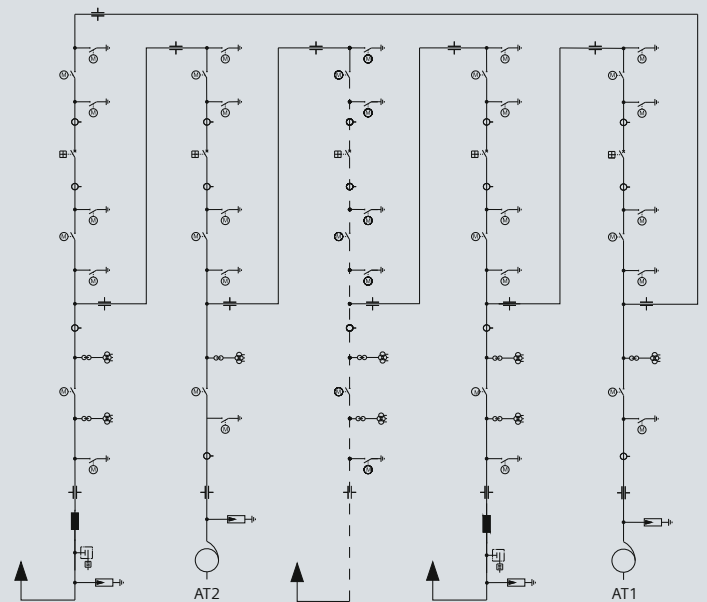
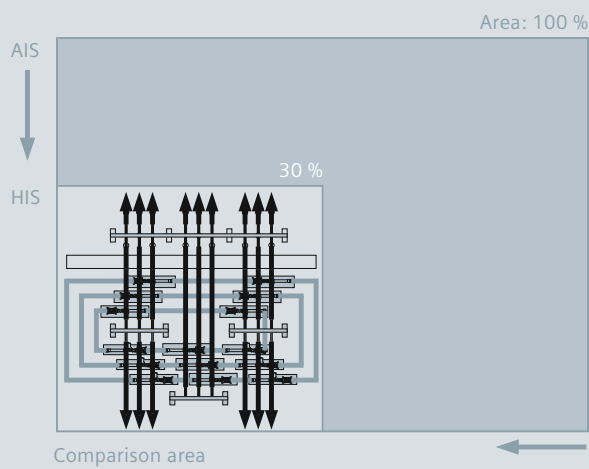
Double busbar arrangement



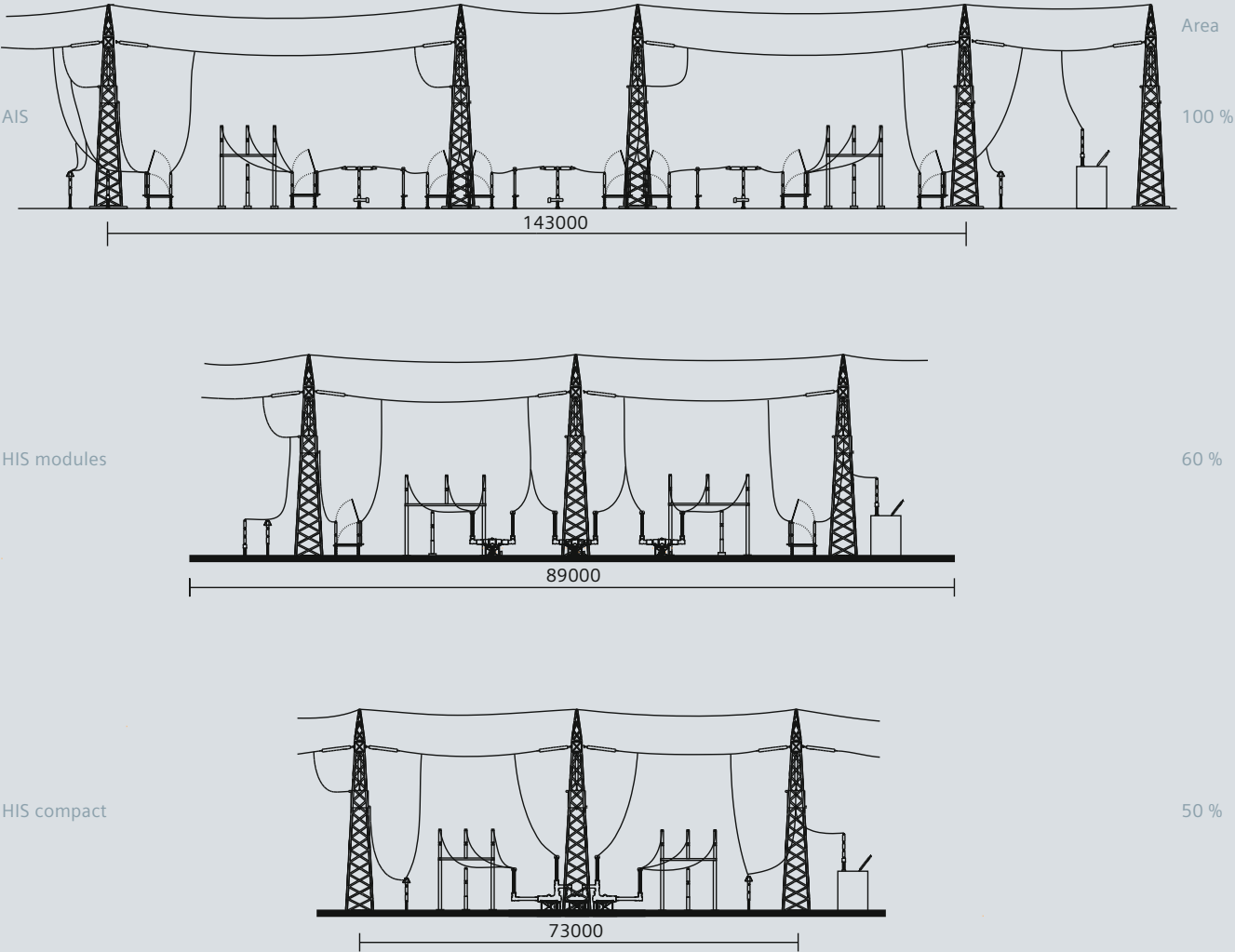
Bus coupler arrangement



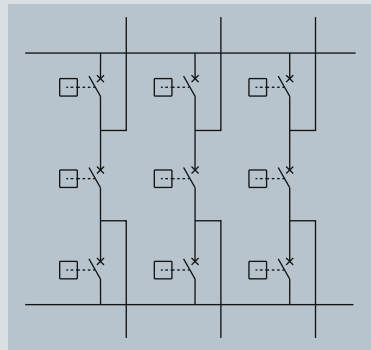
Comparison AIS – HIS: Ring busbar arrangement



Comparison AIS – HIS: Diameter 1 1/2 CB arrangement

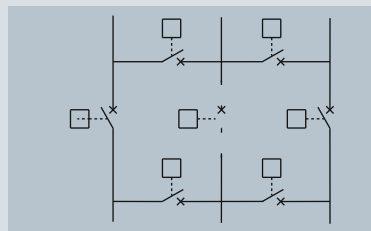


Comparison 1 1/2 CB arrangement – Ring arrangement



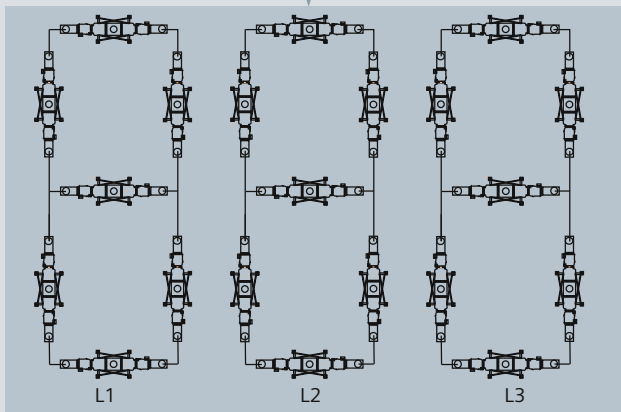
AIS 1 1/2 CB arrangement (9 CB):

- High redundancy
- High reliability
- High availability
- Low failure costs

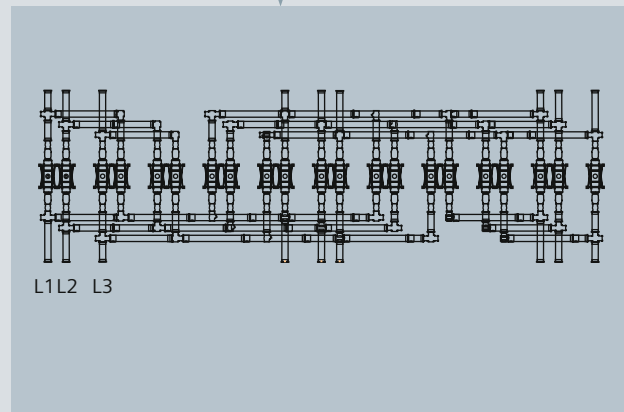


HIS ring arrangement (6+1 CB):

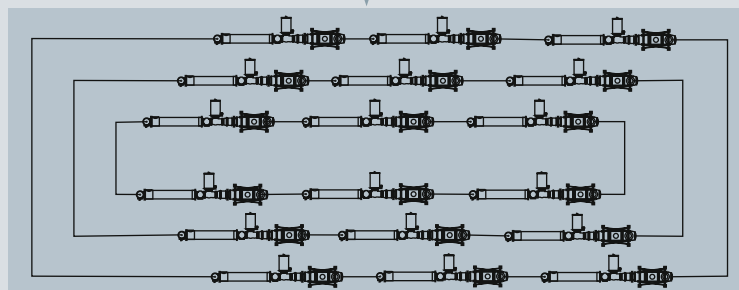
- Low redundancy
- Higher reliability
- Higher availability
- Lower failure costs



HIS modules – segregated phases



HIS compact



HIS modules (6 CB)

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 μ s)	up to	1,550 kV
Rated switching impulse withstand voltage (250 / 2,500 μ s)	up to	1,175 kV
Rated normal current	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 height, depth (depending on bay arrangement)	7,500 mm x 7,500 mm	
Bay weight (depending on bay arrangement)	22,5 t	
Ambient temperature range	-30 °C up to +55 °C	
Installation	outdoor	
First major inspection	> 25 years	
Expected lifetime	> 50 years	
Standards	IEC / IEEE / GOST	

Other values on request

Published by and copyright © 2014:
Siemens AG
Energy Sector
Freyeslebenstrasse 1
91058 Erlangen, Germany

For more information, please contact
our Customer Support Center.
Phone: +49 180 524 70 00
Fax: +49 180 524 24 71
(Charges depending on provider)
E-mail: support.energy@siemens.com

High-voltage products
Order No.: E50001-G630-A248-X-4A00
Printed in Germany
Dispo 30002, SIMC-0000-44416
TH 263-140078 473946 WS 09142.

Printed on elementary chlorine-free
bleached paper.

All rights reserved.
Trademarks mentioned in this document
are the property of Siemens AG, its affiliates,
or their respective owners.

Subject to change without prior notice.
The information in this document contains
general descriptions of the technical options
available, which may not apply in all cases.
The required technical options should therefore
be specified in the contract.