



Product Brochure

Gas-insulated Switchgear ELK-04 Modular System up to 170 kV, 4000 A, 63 kA

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Innovation by Tradition



ELK-04 in 1½ circuit breaker arrangement

Decades of experience create the basis for a mature technology

ABB is one of the technology leaders in the range of gas-insulated switchgear. Nobody has more hands-on experience, gathered in thousands of applications, in all climates, operating conditions.

The ABB portfolio for gas-insulated high voltage switchgear comprises several modular designed model ranges for voltage ratings from 52 kV up to 1100 kV.

More than 14000 installed bays in almost 2500 substations in over 70 countries demonstrate their value every day. This extensive substation operational experience under a wide variety of conditions and requirements forms the basis for the development and production of our gas-insulated switchgear.

ELK-04 meets the most demanding quality requirements. Owing to factory pre-manufactured and pre-tested components, transport, assembly and commissioning are simple and fast. As a matter of course all functional modules were type-

tested according to IEC-Standard (IEC 62271-203). High availability with reduced operating and maintenance costs guarantee excellent substation productivity. In this way, ELK-04 represents the lowest cost over the entire life cycle of the substation.

ABB has more than 40 years of experience in the development, production, engineering and project handling in the gas-insulated switchgear business. That means more than 40 years of customer fulfillment and long-term management of customer benefits.

ABB is a pioneer of GIS-technology, with unequalled know-how and unrivaled system competence.

Building Block System

ELK-04 – a model of success since 1992

The ABB portfolio for gas-insulated switchgear has seen continuous upgrades and improvements since the end of the sixties. Market and customer requirements are met by innovative solutions.

For instance, the ELK-04 gas-insulated switchgear was developed in such a manner that a complete bay fits within one standard industrial shipping container. At the time of its market launch in 1992, ELK-04 was designed for a rated current of 3150 A, a rated short circuit current of 40 kA and a rated voltage of 170 kV. Depending on the requirements, today it is possible to assemble switchyards with higher or lower rated values at optimized costs from a well-devised modular system.

A differentiation with respect to the required layout design is basically possible with the standardized flange diameter. For a rated voltage up to 145 kV and a rated normal current of 2500 A, modules with small flange diameters can be used. For ratings above these values modules with a larger flange diameter are necessary.

Perfect modules result in powerful systems

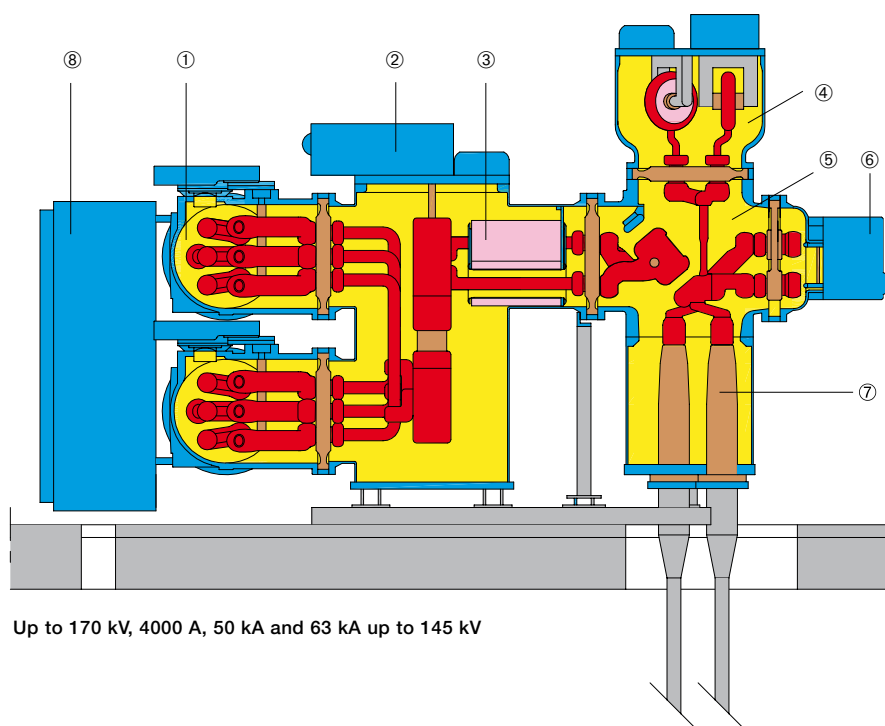
The system of gas-insulated switchgear is composed by functional modules consisting of different primary and secondary technology. Each functional module fulfils the task in an optimal way in conjunction with other functional modules.

We see our challenge in the continuous improvement of all functional modules and in the enhancement of the operational reliability, realized by appropriate constructions, fail safe system architectures, careful testing and strict methodological quality assurance.

A unique optimized building block system fulfils almost all requirements in high voltage technology.

The essential modules of the ELK-04 building block system:

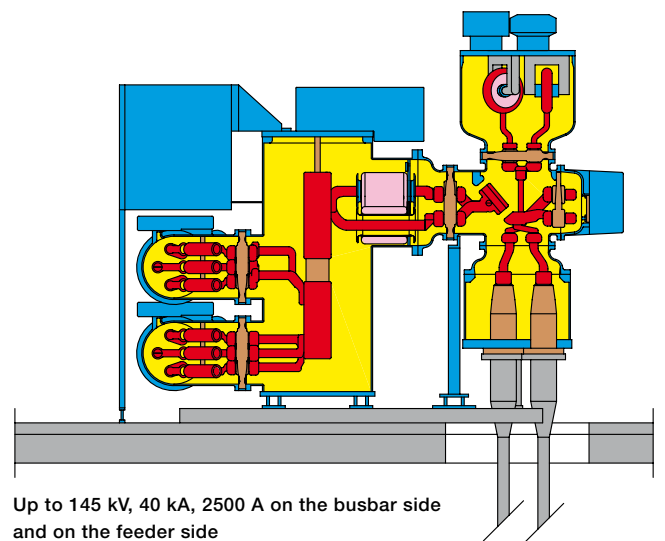
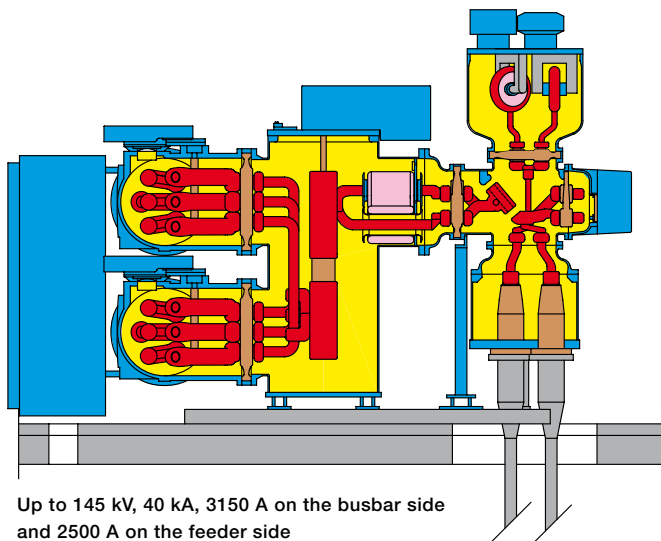
- ① Busbar with disconnecter and earthing switch
- ② Circuit breaker
- ③ Current transformer
- ④ Voltage transformer
- ⑤ Feeder disconnecter and earthing switch
- ⑥ Make-proof earthing switch
- ⑦ Cable end unit
- ⑧ Local control cabinet



- Active parts under high voltage
- Enclosure
- SF₆-Gas
- Insulation material
- Mechanical parts, structures
- Low voltage parts



ELK-04 in double busbar arrangement



Circuit Breaker

Core of every switchgear – the circuit breaker

Circuit breakers are the most important modules of switchgear. Their wide flexibility significantly influences the scope of a space saving design of the complete substations.

Basically, ELK-04 circuit breakers are equipped with self blast interrupters, with one interrupter unit per pole. They require minimum maintenance and only a low amount of switching energy.

Depending on customer requirement a multiplicity of circuit breaker enclosures with large and small flange dimensions are available. Hereby, the substation's layout determines the number of the flanges.

Current transformers can be integrated into all flange designs by adjusting the length of the support plate.

The hydromechanical spring operating mechanism of HMB type is common for all circuit breaker variants. Due to the space saving and modular design, variants with single and triple pole operation are available. The energy storage in modular arranged spring disk columns allows different switching duty cycles without recharging.

ELK-04 circuit breakers are flexible and require low maintenance. They can be adapted perfectly to the requirements of the substation layout.

1,2 Manufacturing of interrupters | 3 Assembly of circuit breakers



Innovative and safe circuit breaker technology requiring minimum space

The interrupting units deployed in the 40, 50 and 63 kA circuit breakers are standardized and multi-type-tested components. They show only minor differences and they are not only used for ELK-04 gas-insulated switchgear. Those interrupting units are applied in other products of the ABB high voltage switchgear portfolio as well (e.g. conventional air-insulated circuit breaker modules).

All interrupting units are characterized by the consistent separation of the continuous current contacts and the auxiliary contacts for the arc extinction. Long-life auxiliary contacts for arc extinction and the low wear of the continuous current contacts results in low inspection and maintenance effort. In most cases, inspection and maintenance are even unnecessary.

In contrast to the common puffer interrupting unit, the self blast interrupting unit is equipped with a two-stage blast volume. The partial volumes are separated from each other by means of a freely movable non-return flap. In the compression volume, the SF₆-gas is compressed during the switch off movement. The gas suppresses switching arcs in the range of the operating currents in the same manner as known from the conventional puffer interrupting unit. Compression volume and contact geometry are optimized with regard to low overvoltage and soft extinction behavior.

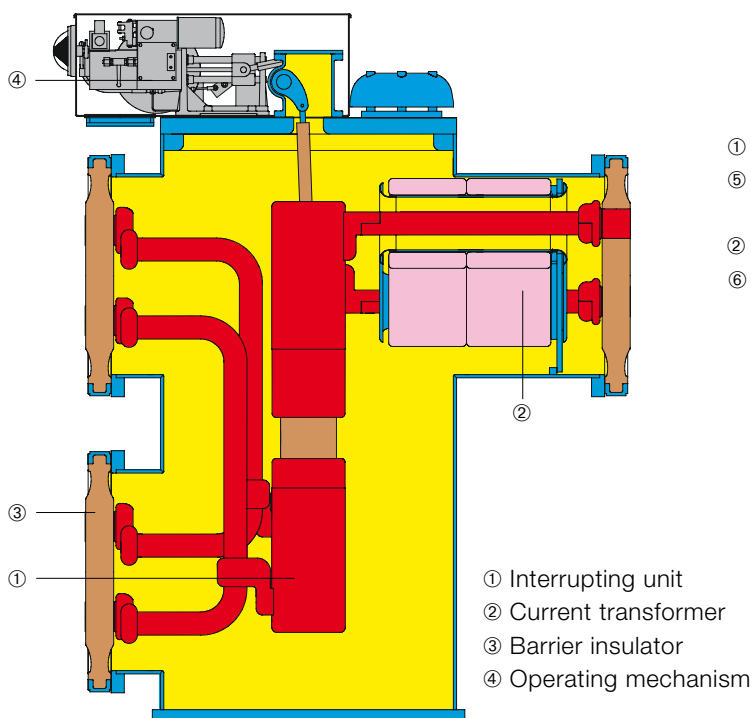
In contrast, for short circuit currents the energy of the high-amp arc heats up the quenching gas and increases its pressure in the heating up volume. The pressure guarantees the arc extinction of short circuits up to the rated short circuit current. The compression power to interrupt the short circuit currents does not need to be supplied by the breaker operating mechanism. Consequently, the operating mechanism needs only to be dimensioned for the switching of normal operating currents.

In case a hydromechanical spring operating mechanism is applied, due to the easily adaptable operating characteristics the occurring reaction forces are almost negligible. This counts for the entire system, consisting of interrupter unit, mechanical linkage and operating mechanism.

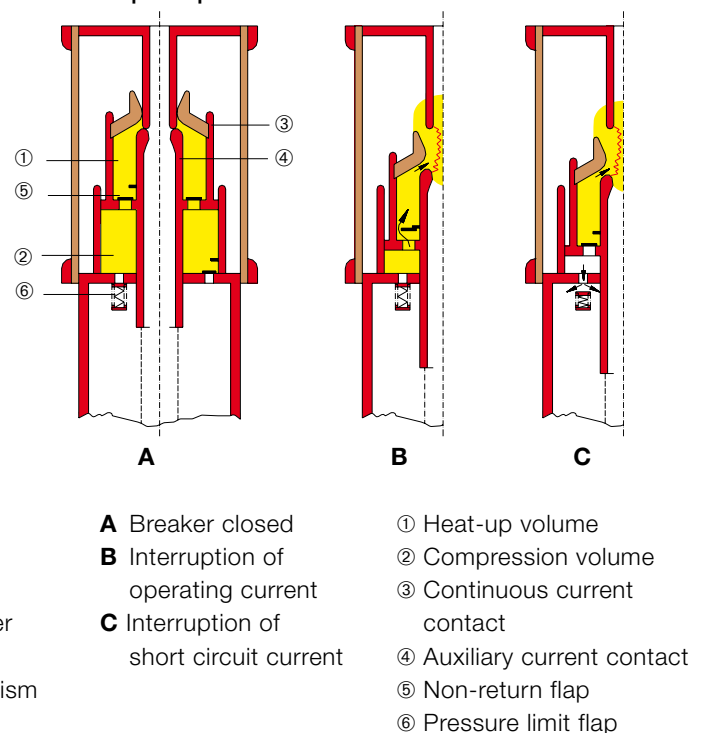
The circuit breaker can therefore be designed quite simple and reliable.

Interrupting unit based on the self blast principle and hydromechanical spring operating mechanism for a reactionless, reliable switching with soft extinction behavior.

Circuit breaker



Self blast principle



Circuit Breaker Operating Mechanism

Wear-free force transmission

The hydromechanical spring operating mechanism of the circuit breaker combines optimally the wear-free force transmission of a hydraulic system with the robustness of a mechanical spring operating mechanism. Hydromechanical spring operating mechanism are not only used for the complete ABB portfolio of gas-insulated switchgear in the range of 52-1100 kV. Due to the easy and fast adaptation, they are successfully applied in more than 100 different applications worldwide. The excellent features of this operating mechanism family are reliability, long-term stability and temperature insensitivity.

All hydromechanical spring operating mechanisms are characterized by a quasi co-sinusoidal course of motion. This is realized by an integrated adaptable end-of-stroke damper. Thus, mechanical reaction forces are only moderate.

Depending on the rated short circuit of the ELK-04 gas-insulated switchgear either an operating mechanism of type HMB-1 or HMB-2 is applied. In addition, with the operating mechanism HMB-1s and HMB-2s types a mechanically independent single pole operation with high operating time consistency can be realized. Due to the energy storage in a disk spring column the duty cycle is not limited to the duty cycle of O-0.3s-CO as required in standards.

Modularity, a key feature for circuit breaker operating mechanisms too

The operating mechanism for triple pole operation comprises several functional modules:

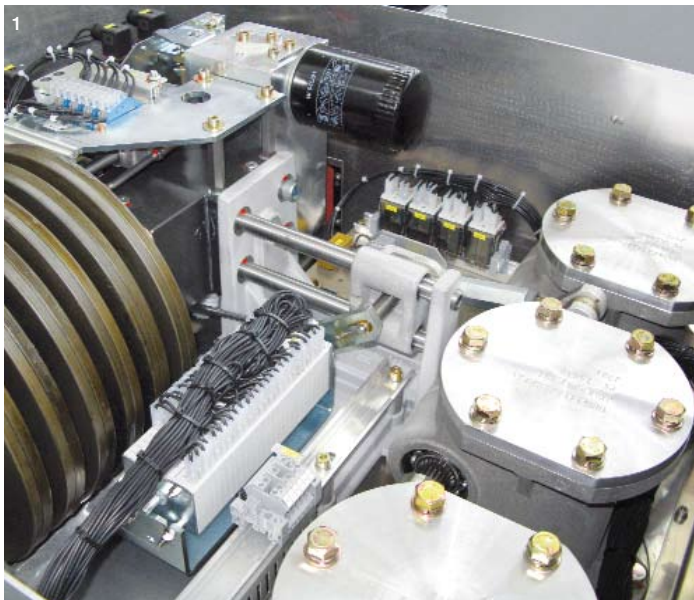
- Recharging module
- Storage module with disk spring assembly
- Working module with piston and integrated end-position damping
- Monitoring module with spring limit switch
- Control module with open-close pilot valves

The version for single-pole actuation consists of three working and control modules.

Tripping and transmission of energy is based on proven and tested components from mechanics of fluids (changeover valves, hydraulic pump with non-return valve).

More than 65000 operating mechanisms delivered are successfully in operation, proven and with high-performance, requiring minimum space.

1 Circuit breaker operating mechanism of type HMB-1 | 2 Pilot valves for HMB-2 circuit breaker operating mechanism



A Operating mechanism in position “OPEN” position, springs not charged

HMB operating mechanisms combine the advantages of classical hydraulic operating mechanisms (wear-free force transmission) and purely spring operating mechanisms (energy storage in metal springs). But in contrast to classical hydraulic operating mechanisms a hydromechanical spring operating mechanism does not need any external piping at all.

The advantage of the multiple stacked disk spring column ① results in a high energy density requiring minimum space. This is the case for switching ON as well as for switching OFF. The load position of the disk spring column is continuously monitored by a control link ② (spring travel switch). A compensation of slight internal pressure losses is achieved by incidental recharging of the hydraulic pump ③. This guarantees a permanent self supervision of the operating mechanism, even in the case of long idle times.

B Operating mechanism in “OPEN” position, springs charged

The operating piston ④ follows the differential piston principle. It guarantees the force-fit retention force of the operating piston. The same principle is applied for the changeover valve of the control module ⑤ with closing and opening magnet.

Activation of the hydraulic pump charges the disk spring column with oil under high pressure. Hereby the volume below the operating piston ⑥ serves as high pressure reservoir. Simultaneously the high pressure is working on the piston rod of the operating piston and the valve rod of the control module. When the spring column is fully charged, the motor current is interrupted with the help of a micro switch. Due to the differential principle of the operating piston, the changeover valve and consequently the operating mechanism are securely held in “OPEN” position.

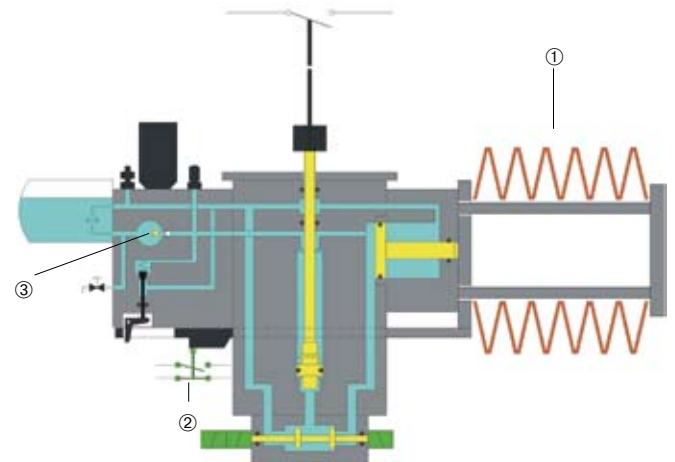
C Operating mechanism in “CLOSED” position, springs charged

Activation of the closing magnet results in a fast movement of the changeover valve. Thus, the area beneath the piston rod is connected with the high pressure reservoir. Now, system pressure is applied to both sides of the piston. Note that the area beneath the operating piston rod is greater than the opposite area. Therefore, the operating piston moves into CLOSED-direction. As long as the high pressure is applied on the area beneath the piston rod the operating piston remains in CLOSED-position. Before the operating piston reaches its end position the integrated hydraulic damper uniformly slows down the movement.

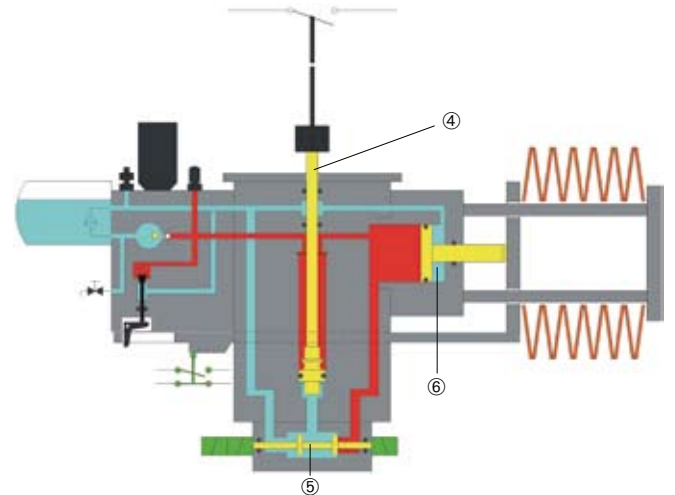
When the OPENING magnet is actuated, the changeover valve switches over to its original position. Now the area beneath the operating piston rod is loaded with low pressure. The piston rod is again securely held in position “OPEN”.

Simplified hydraulic scheme of the HMB-1 at different operating states

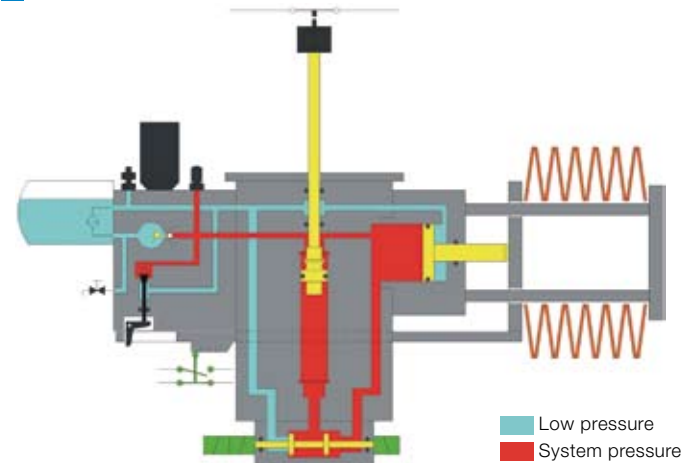
A



B



C



Disconnecter and Earthing Switch

Integrated technology

Two different types of enclosures are available to integrate the combined disconnector and earthing switch into the building block system. On the busbar side an enclosure with 3 flanges is usually applied. On the feeder side the enclosure typically contains 4 flanges. Both types are made up of the same elements under high voltage.

For maximum safety, both the disconnector and the earthing switch are equipped with separate control units.

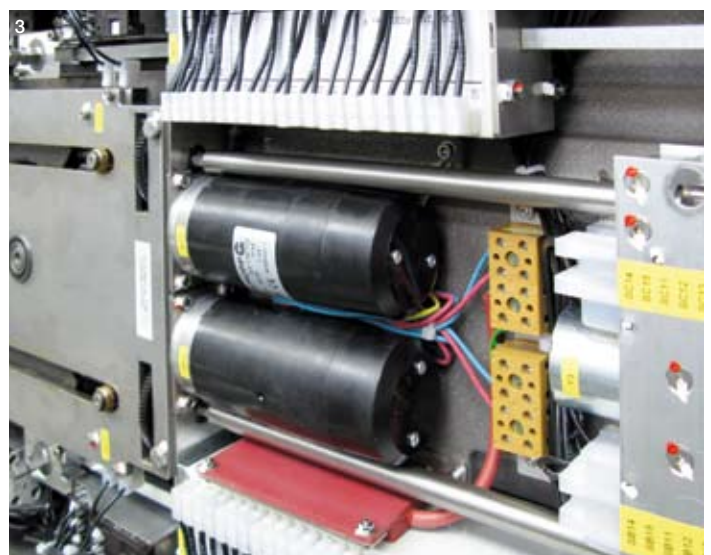
Thus, inadvertent mechanical or electrical operation is prevented.

Busbar disconnector and earthing switch module

The busbar module of the combined disconnector and earthing switch contains the busbar conductors and in addition thereto a transversal arranged three position switch. This guarantees that the circuit breaker can safely be disconnected and earthed.

To provide for a safe coupling between the individual bays, this disconnector and earthing switch is equipped with a flexible transverse assembly element. Plug-in contacts in the transverse assembly element connect the busbar conductors. Hence, alternations in length caused by temperature fluctuations are compensated. Mechanical strains on the insulators due to different heat up of the individual conductors and the enclosures are thus completely avoided.

1 Busbar conductors | 2 Disconnecter and earthing switch (feeder side) | 3 Open view of operating mechanism



Feeder disconnecter and earthing switch module

The feeder sided disconnecter and earthing switch module allows the connection of a voltage transformer. The electrical connection can be made either ahead of or behind the insulating distance. This means, the voltage can be measured either on the station or line side. The connecting flange of the voltage transformer also serves as a test flange for the high voltage test of the substation or the cable.

In general this module is combined with a voltage transformer, a make-safe earthing switch and a cable end unit or a gas-insulated line. In addition a module with isolated earthing contacts is available.

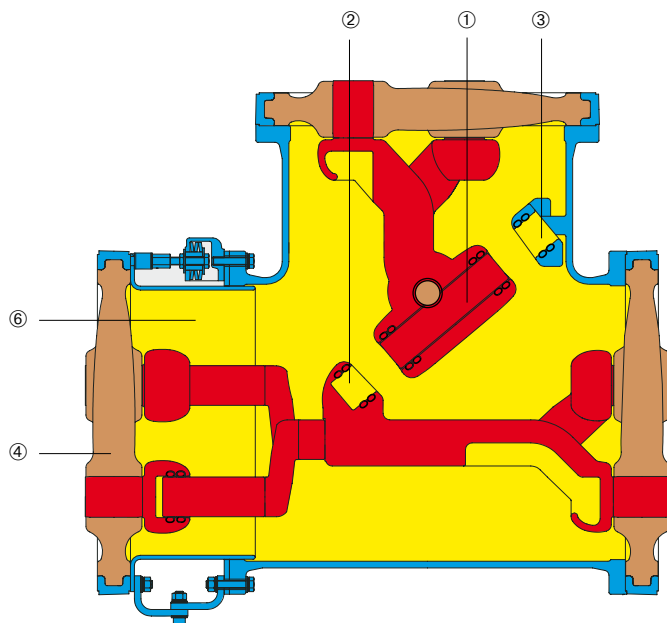
The standardized operating mechanism of the disconnecter and earthing switch module contains all components needed to ensure safe mechanical movement as well as interlocking.

Position indicators and auxiliary switches are positively connected to the operating mechanism. Their contacts switch over directly before the main contacts reach their end position. By that, a real image of the main contact position is always assured. By means of a crank handle, manual operation of the disconnecter and earthing switch is possible as well.

There is no need to open the operating mechanism to perform an interlocking and a mechanical operation.

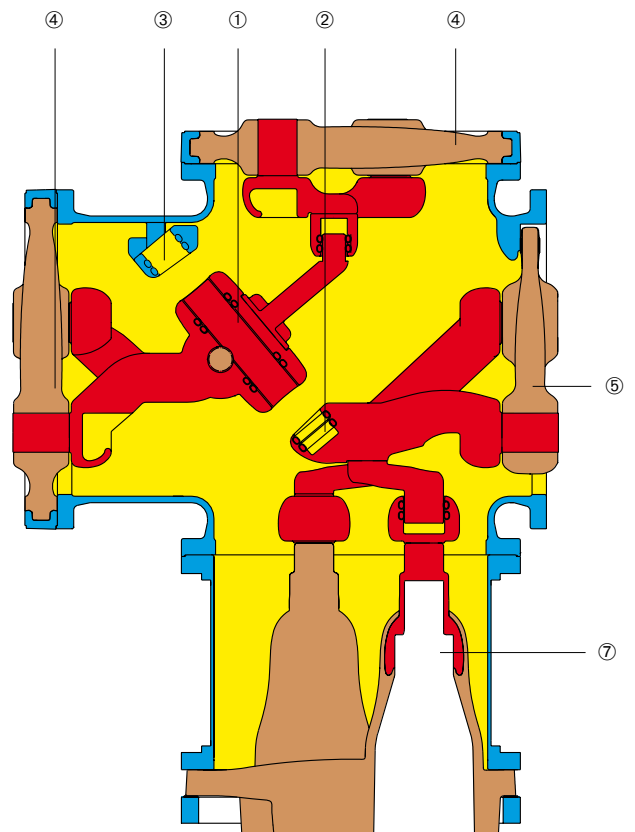
Integrated, proven and tested technology for the disconnecter and earthing switch and their operating mechanism.

Busbar disconnecter and earthing switch Standardized operating mechanisms



- ① Three position switch
- ② Disconnecter contact
- ③ Earthing contact
- ④ Barrier insulator
- ⑤ Support insulator
- ⑥ Transverse assembly element
- ⑦ IEC dry type cable connection

Feeder disconnecter and earthing switch



Make-Proof Earthing Switch



Mechanical routine test of the make-proof earthing switch

Maximum security by full short circuit current withstand capability

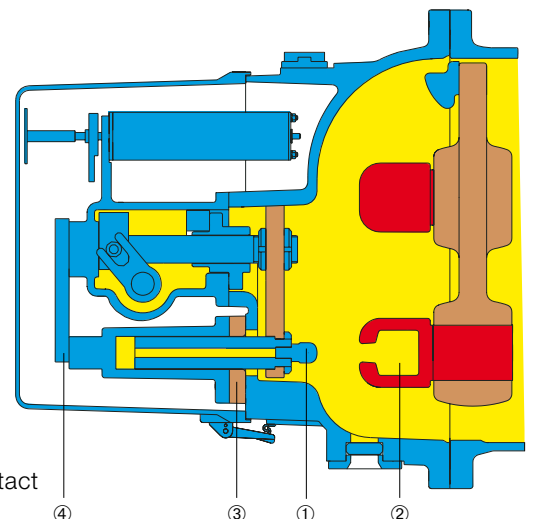
The make-proof earthing switch can safely switch against full short circuit current. This module can be placed on the feeder side or on the busbar side. It drastically reduces the effects of incorrect switching operation. The make-proof earthing switch is equipped with a spring operating mechanism to ensure very fast switching. The operating mechanism is loaded by an electrical motor and contains all required components for a safe mechanical movement as well as electrical interlocking.

Position indicators and auxiliary switches are positively connected to the operating mechanism in the same manner as for the disconnecter and earthing switch module. In that way, an accurate indication of the main contact position is always assured. Manual operation of the make-proof earthing switch is possible via a crank handle as well.

The closed make-proof earthing switch can be isolated from the operational earthed enclosure during an inspection. It is therefore possible to create an electrical connection from outside the housing of the earthing switch via the movable contact pins (which are insulated from each other) to the main circuit. This facilitates the adjustment and check of the

protective relays, cable checks and location of cable defects considerably. During operation, the insulation is short-circuited.

Make-proof earthing switch



- ① Contact pin
- ② Female contact
- ③ Insulation
- ④ Earthing connection

Cable End Unit, Gas-to-Air Bushings



1 Plug-in dry type cable connection | 2 SF₆-Gas-to-air bushing to connect overhead lines

Cable end unit

Although cables of virtually any type can be connected to the gas insulated switchgear via the cable end unit, XLPE and fluid filled cables are most commonly deployed.

All cable end units conform to IEC 62271-209. This guarantees compatibility with all cable manufacturers. Additionally, custom cable end units can be developed for special cables if necessary.

The main elements of the plug-in cable connections are the plug-in sockets made of epoxy resin and the cable connectors with the pre-manufactured stress-cones made of silicone rubber. An advantage is present in the consistent separation of the switchgear installation from the cable installation.

For other types of fluid filled cables, a cable end unit with longer cable insulators can be selected. Optionally all cable end units can be equipped with a high voltage detection system and/or a barrier insulator to separate the gas compartment from the remaining part of the bay. Note a separation of the gas compartment makes only sense in case of a fluid filled cable end unit.

SF₆-gas-to-air bushing

The gas-to-air bushing allows the transition from the encapsulated substation to overhead lines or to transformers.

Composite material bushings are preferably applied. They are characterized by a fiber-reinforced supporting bus duct, made of epoxy resin with vulcanized shields, realized by silicone rubber. These bushings are fail-safe, explosion-proof and easy to handle. Due to the hydrophobic insulation material they show an excellent pollution layer characteristic. Upon customer request, classical bushings with porcelain insulation can also be provided.

Optimum grid integration of the switchgear due to a wide range of cable end units and gas-to-air bushings.

Current and Voltage Transformers

Inductive instrument transformers for metering and protection

For measurement and protection purposes inductive, single-phase current and voltage transformers are used, sometimes also three phase modern current and voltage sensors.

In general voltage transformers are located in a single enclosure, separated from the residual part of the bay with a barrier insulator. The current transformer is normally integrated in the circuit breaker. Alternatively, a solution in a separate enclosure can be selected. The primary sided insulation is provided by SF₆-gas for both, current and voltage transformers. The terminals of the secondary windings are interfaced to the substation via a terminal box consisting of a multiple bushing disk and terminal blocks.

Inductive current transformers

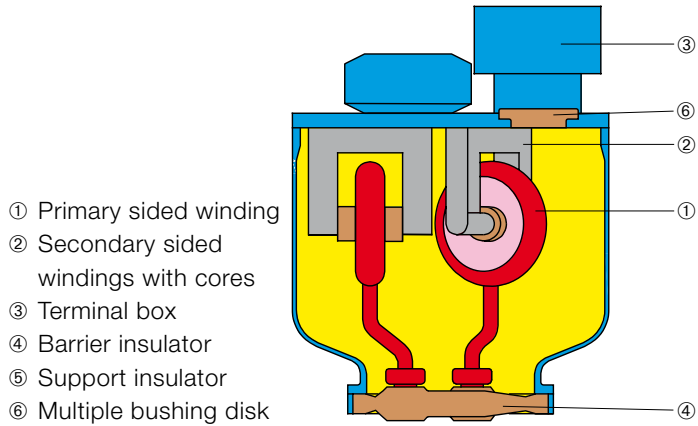
The current transformer is designed as a low voltage transformer. The available transformation ratios, apparent output power, accuracy classes, etc. of the transformers correspond to the normal requirements of modern protection and measurement technology.

Current transformers are of toroidal core type. Depending on the protection concept they can be arranged in front of or behind the circuit breaker's interrupting unit. Usually current transformers are integrated into the flanges of the circuit breaker enclosure. Depending on the apparent output power different separate enclosures with large and small flange connections are available as well.

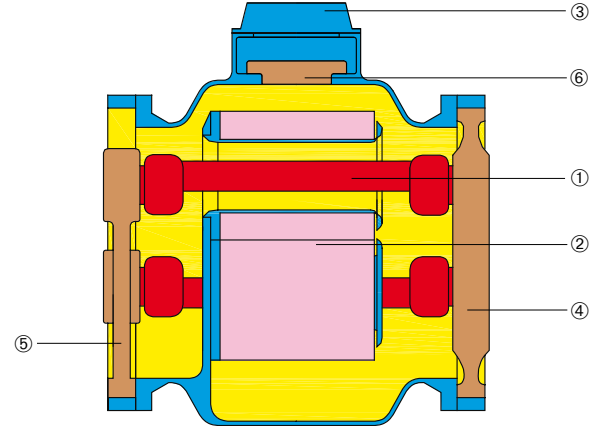
Assembly of integrated current transformer



Voltage transformer



Separate current transformer



Inductive voltage transformer

Besides the standardized versions, the voltage transformer portfolio contains variants with ferro-resonance damping as well as voltage transformers with an integrated isolation device. In the latter case a motor operated isolation device and a manually operated isolation device are available. Voltage transformers with integrated isolation devices are usually applied, when a cable test with a high DC voltage on the feeder side is performed and the voltage transformer was connected to the feeder sided cable.

On the secondary side of the voltage transformer, measurement windings and an open delta winding for earth fault detection can be provided.

The voltage transformer contains side by side windings. The layers loaded with high voltage are insulated from each other by a plastic film. The intermediate spaces are impregnated in a special process with SF₆-gas.

Reliable and long lasting inductive current and voltage transformers – for maximum safety and for high measurement accuracy.

1 Manually operated isolation device | 2 Typical voltage transformer with terminal box and rupture disk



Completion Modules

Completion modules to reach a perfect modularity

In addition to the essential functional modules a complete configuration of a substation may require different completion modules. These are mainly:

- Adapters
- Bus ducts and angle pieces
- T- und cross pieces
- Transformer direct connections
- Surge arrester

These modules are equipped with a support or barrier insulator. Plug-in and tulip contacts serve to connect the conductors.

Adapters

Adapters are required to extend phased-out products that ABB ever produced in the voltage range of 52 up to 170 kV. Besides pure three phase adapters, single phase to three phase adapters are available as well.

In addition, adapters to connect flanges with large and small diameter are at hand.

Bus ducts

Bus duct pieces are mainly used in case of a connection to a gas-to-air bushing or a SF₆-insulated connections to a power transformer. For that purpose, bus ducts with a total length of 6 m at 170 kV, 3150 A and 63 kA are available.

T- and cross pieces

T- and cross pieces are basically required in case of a current tee junction. The enclosures are identical with those used for the disconnecter and earthing switch.

Transformer direct connections

With transformer direct connections a power transformer can be connected directly to the switchgear via SF₆-insulation. A connection with a SF₆-gas-to-air bushing is not required any longer. Depending on the type and size of the power transformer, three phase and three phase/single phase types of transformer direct connections are available.

ELK-04 in ring bus arrangement



Surge arresters

Surge arresters are used to protect the switchgear itself, connected cables and down-stream overvoltage sensitive components like power transformers. They consist of stacked ZnO-discs resistors and show an extremely non-linear voltage-current characteristic. Surge arresters are available with different voltage protection levels and line discharge classes (LD3 und LD4).

Gas insulated surge arresters are mounted in a typical bus duct. They can be interfaced to the switchgear with a standard barrier insulator.

Gas compartment system

For the circuit breaker SF₆-gas serves as a quenching and insulating medium. For all other compartments SF₆-gas is required as insulation medium. The gas compartments are partitioned by barrier insulators. In each module the gas density is monitored by temperature compensated pressure relays (density relays).

All gas compartments are equipped with a non-return valve. Accordingly, maintenance, taking gas samples or refilling of SF₆-gas can be performed without any problems.

For reasons of occupational safety and environment protection, ABB does neither offer nor deliver any external gas piping, neither for permanent nor for temporary use.

Completion modules assure an almost unlimited flexibility in switchgear configuration.

1 Three phase power transformer direct connection | 2 Temperature compensated gas pressure relay with scale



Control and Monitoring

Conventional local control cabinet

All auxiliary electrical components for control, signalization, interlocking etc. are located in separate on-site control cabinets. The main functions of the local control cabinet are:

- Local operation and visualization of the switching status by control buttons and position indicators
- Protection of operators and the switchgear by realization of interlocking functions
- Acquisition and visualization of operational measurement values (voltage, current)
- Visualization and handling of alarms, warnings and operation counters.

On the front panel of the control cabinet the single line diagram of the switchgear with embedded position indicators and related control buttons are displayed. Key switches are in place for overriding the interlocking of switching devices, or for switching over from local to remote control.

The high voltage switching devices are connected to the control cabinet by control cables with coded heavy duty connectors. These connections are assembled and tested in the factory. Inside the control cabinet all signals to the station control centre are fixed on terminal blocks. The connection is realized by control cables. Alternatively the control cabinets can be connected by a digital communication protocol.

ELK-04 in double bus bar arrangement with integrated local control cabinets



Digital control and protection

Several digital control and protection devices are available that can be configured according to the desired control and protection philosophy. In case of digital control technology, the single line diagram with position indicators and control buttons is replaced by a digital human-machine interface.

Digital control devices provide the same functions as conventional control technology. Furthermore a lot of versatile, additional control and protection functions can be implemented:

- Synchro-check
- Auto re-closing
- Operating frequency supervision
- Fault recorder
- Backup protection

Connection to station control

Communication between bay devices and the device on station level uses solely the new standardized communication protocol IEC 61850. Other proprietary communication protocols (e.g. LON) or IEC 60870/5-103, Modbus or Profibus are available as well.

Conventional and digital control and protection for high availability of the switchgear.

1 Human-machine interface of digital control device | 2 Local control cabinets with digital control and protection



Control and Supervision

Digital monitoring systems

Either the conventional or the digital control technology is completed by digital monitoring systems. These systems operate as an add-on to the existing control technology and do not interact with the switchgear protection.

That means a malfunction of the monitoring system has no influence on the control or protection function of the switchgear. Monitoring systems increase the already very high reliability of gas-insulated switchgear furthermore.

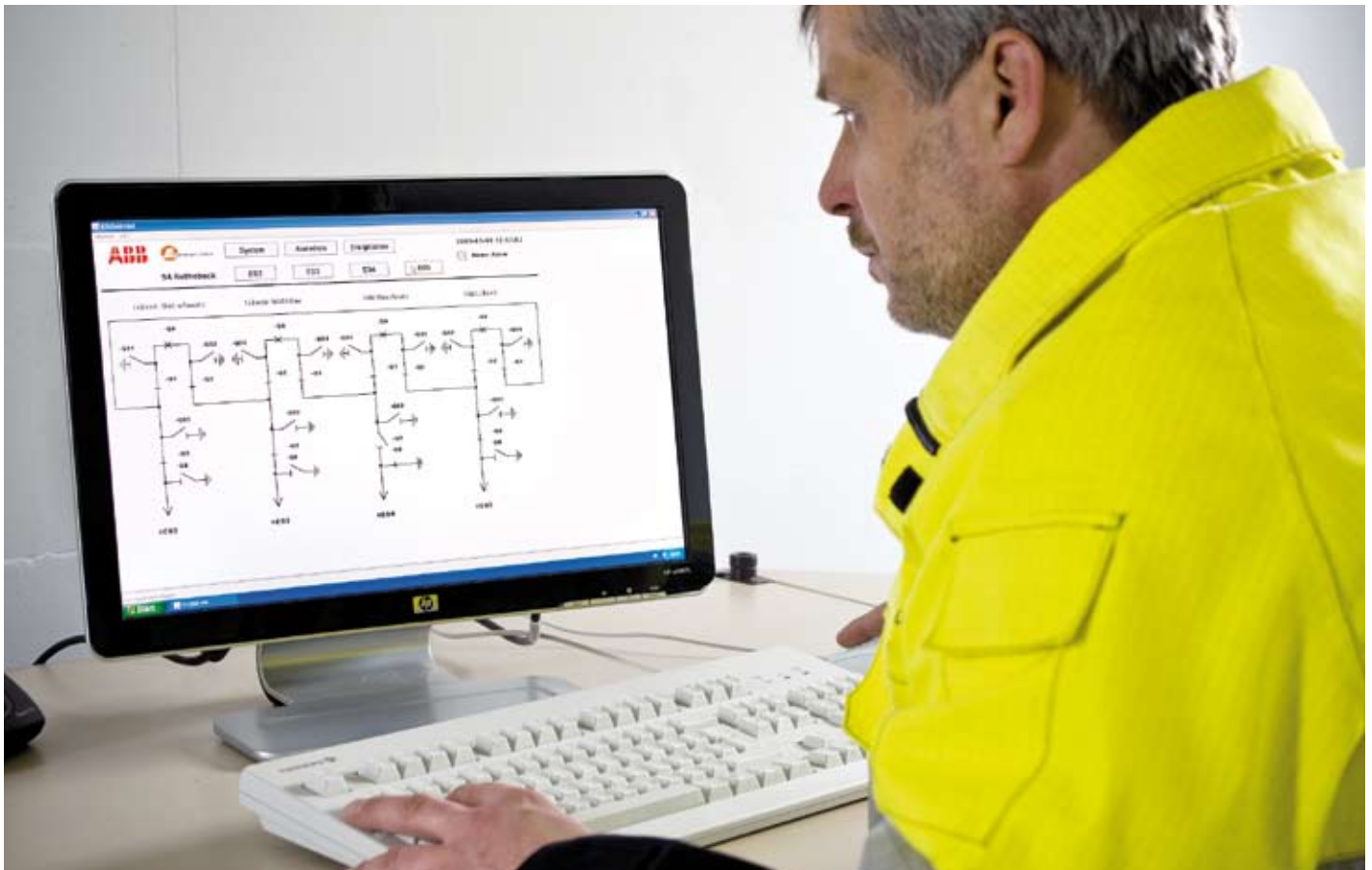
Monitoring systems improve the overall availability by continuous supervision of all vital functions of the switchgear. This ensures an early detection of critical situations and scheduling of countermeasures into non-critical times.

Monitoring systems are advantageous especially for important keypoint substations or in substations where no or only reduced service personnel is available. Currently available monitoring functions are:

- High voltage detection system, applicable e. g. for interlocking of an earthing switch against an energized incoming cable
- Arc detection for fast protection of the switchgear or identification of affected gas compartments
- Partial discharge measurement for preventive investigation of isolation defects
- Circuit breaker supervision including monitoring of mechanical and electric functions of the breaker and contact wear estimation
- Circuit breaker operating mechanism supervision
- Monitoring of all gas compartments with discrete limits and trend analysis

All available monitoring systems are designed as modular components in the same manner as for the primary components. They can be tailor-made.

Substation control with digital control



In the figures on the right some screenshots clarify the navigation through the user software. The pictures show a possible sequence after a service request triggered by operation count.

A Station view

Starting at station overview a red colored button indicates a pending service request in bay E01.

B Bay view

In the underlying hierarchy level, the bay view, the circuit breaker is marked as affected component. At the bottom of the screen all supervision events are listed.

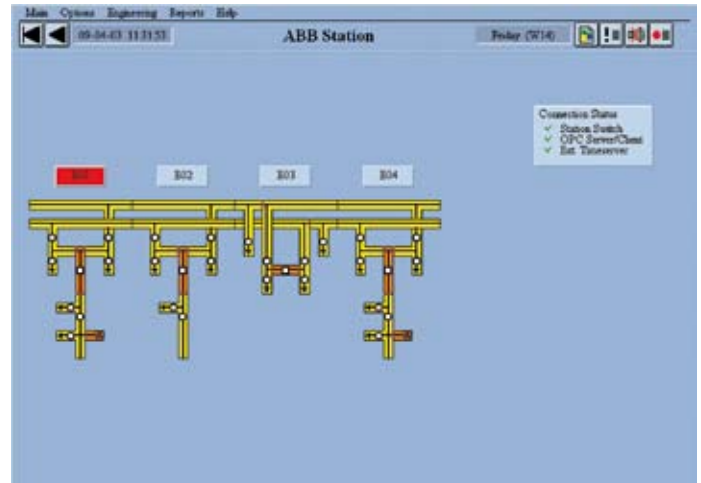
C Detail view

From the bay view one gets to the detail view which displays all current data of the circuit breaker as operation count, the timing behavior of the circuit breaker and contact wear estimation. In the shown example the operation count has reached 9231 and reported since the circuit breaker should be overhauled after 10000 operations.

Further views allow visualization of the data in a time related diagram to allow better investigation. Naturally all acquired data are reported and archived and can be exported to run a more detailed analysis.

Example navigation after service request when reaching approx. 10000 operations

A



B



C



Combination of Modules

Optimized building block system, leaves almost nothing to be desired

Since the market launch in the year 1992 the gas-insulated switchgear of type ELK-04 was consistently further developed, resulting in a highly standardized building block system. This building block system is characterized by the fact that a wide variety of technical requirements can be met with a limited number of modules. This counts for the primary components e. g. the interrupting units in the circuit breaker modules and their operating mechanisms. It guarantees an optimum layout of the complete switchgear with respect to different rated voltages 72.5/123/145/170 kV, rated different short circuit currents 40/50/63 kA as well as for different rated normal currents of 2500/3150/4000 A.

The standardized module portfolio assures an easy and cost-efficient extension of old gas insulated switchgear. Moreover, it is conveniently suited for replacement of conventional air-insulated switchgear by gas-insulated switchgear.

No other switchgear manufacturer has such a complete range of modules available for rated voltages from 52 up to 170 kV.

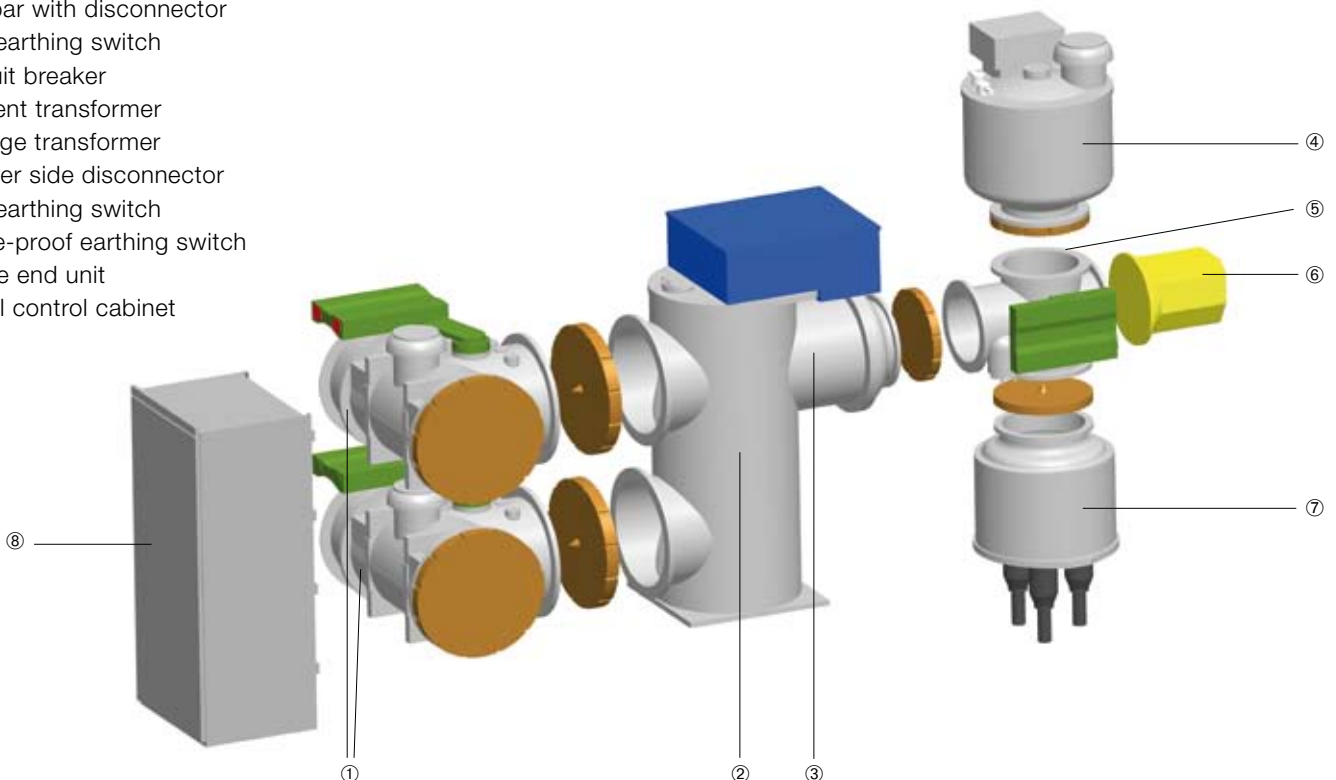
Gas-insulated switchgear of type ELK-04 is suited for indoor and outdoor application. It is always the right choice, when reduced space availability is an important selection criterion. Consequently, supply of electrical energy in cities, urban centers and industrial complexes is assured by the ELK-04. Due to the full encapsulated parts under high voltage, gas-insulated switchgear is perfectly suited at places where harsh environmental conditions are prevalent.

Because of the modular design, all normal substation layouts can be realized in an optimal way. Depending on priority, different requirements like building dimensions, subsequent substation extensions, security of energy supply, clear arrangement of substation layout, accessibility, protection concept etc. can be considered.

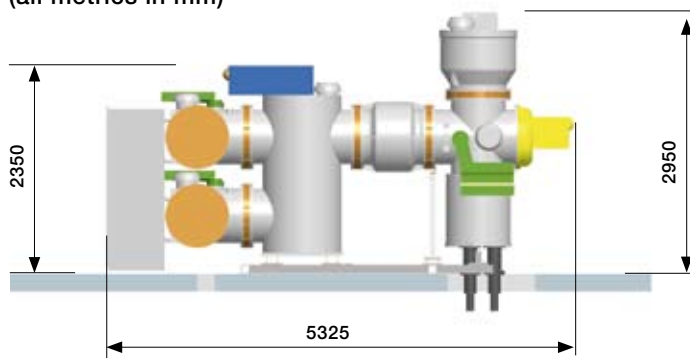
The following examples demonstrate the flexibility of the system and should motivate conception and planning of new substations.

Combination of modules for a double busbar bay with integrated local control cabinet

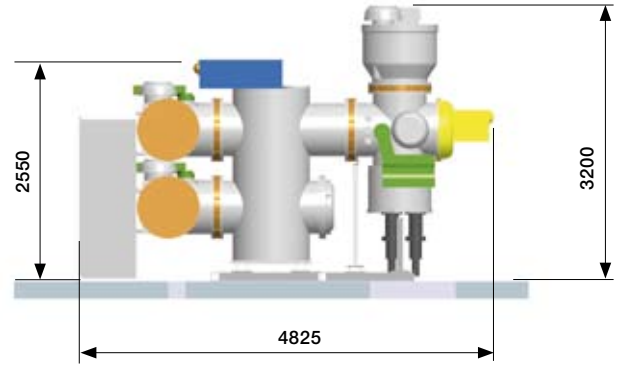
- ① Busbar with disconnectors and earthing switch
- ② Circuit breaker
- ③ Current transformer
- ④ Voltage transformer
- ⑤ Feeder side disconnectors and earthing switch
- ⑥ Make-proof earthing switch
- ⑦ Cable end unit
- ⑧ Local control cabinet



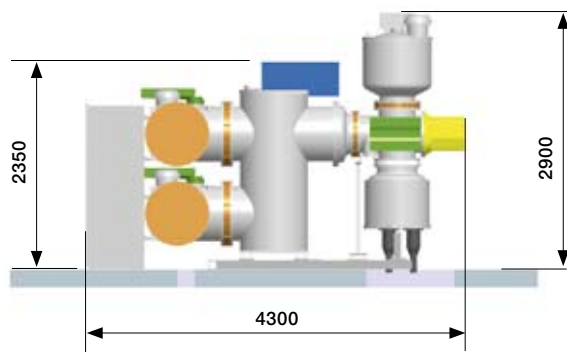
Combination of modules for an optimal customization of the switchgear exemplary shown for different rated values (all metrics in mm)



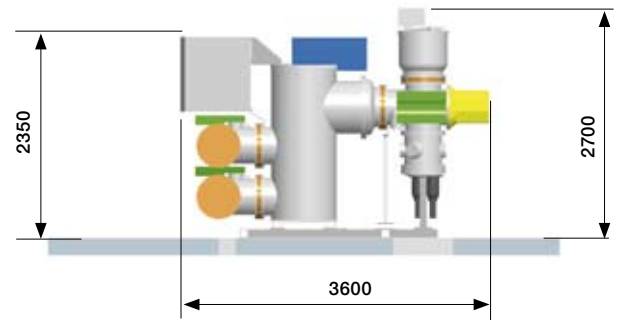
170 kV, 50 kA, 4000 A



145 kV, 63 kA, 3150 A

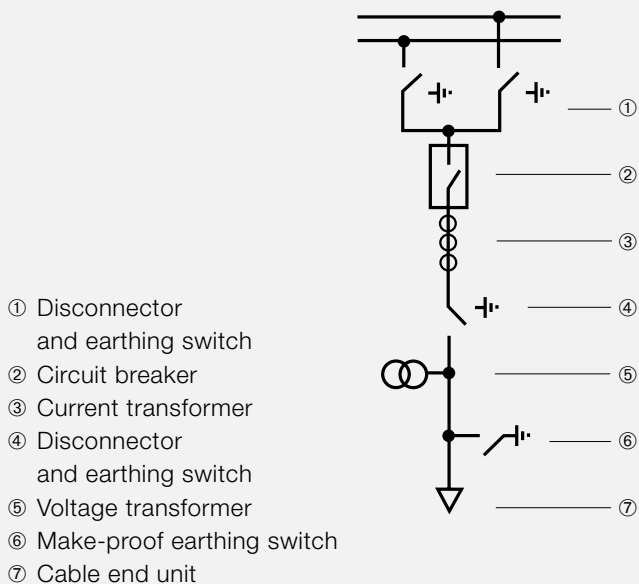


145 kV, 40 kA, 3150 A



145 kV, 40 kA, 2500 A

Single line of a double busbar bay



The unique combination variety evolved from decades of ABB experience and imposed by market requirements results in a consistently further development and a continuously improvement of the ELK-04.

Execution Examples

Double busbar arrangement

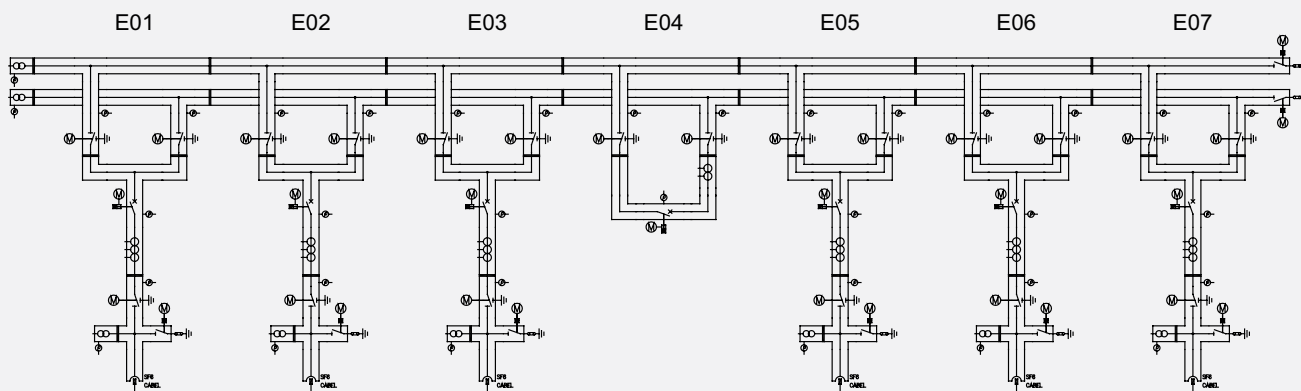
This arrangement is most common for important key point substations, power plant feed-in etc.

If both busbars are operated with the same priority – instead of the operating method with main and reserve busbars – the principle of busbar separation can be applied to reduce the short circuit current. Both busbars and their feeders are part of separate sub-grids. If required, individual feeders can be allocated to the other sub-grid. This concept relieves

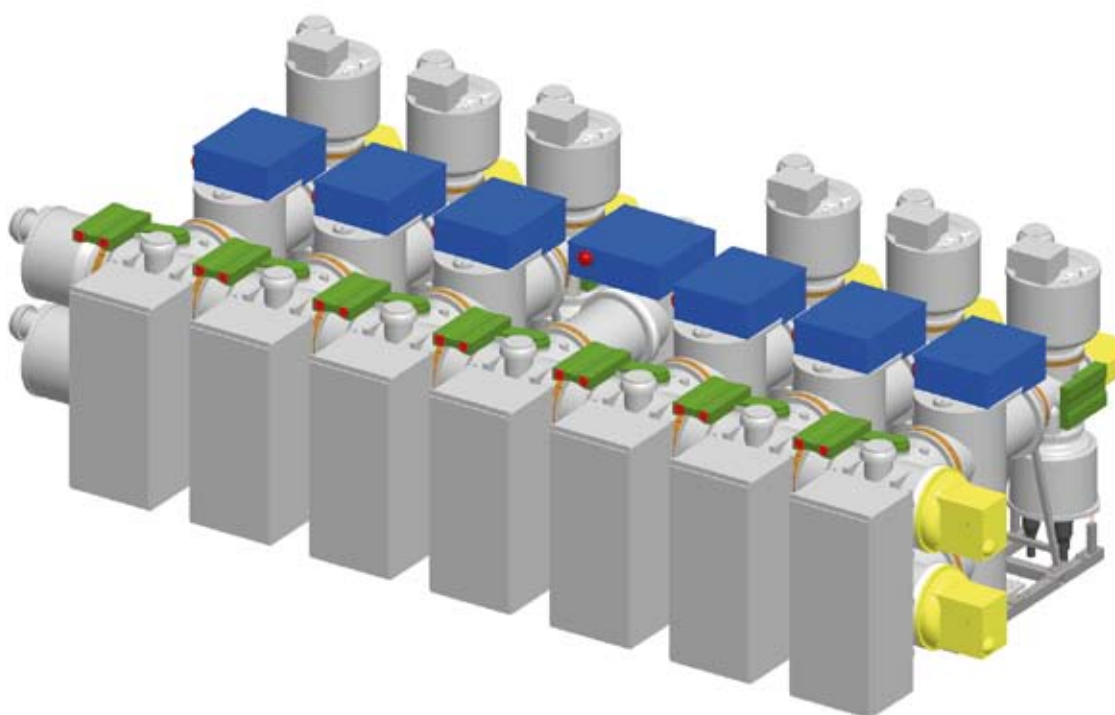
the substation equipment as result of reduced short circuit withstand capability and longer maintenance intervals. In addition, it guarantees greater safety of energy supply.

Especially the different coupling variants show a wide range of applications: Two examples are the simple bus coupling or the combined sectionalizing and bus coupling with six or eight disconnecter switches. Double disconnecter switches allow even subsequent high voltage tests after station extensions or maintenance during partially normal operation.

Gas scheme and single line for double busbar arrangement



Isometric projection for double busbar arrangement with integrated local control cabinets

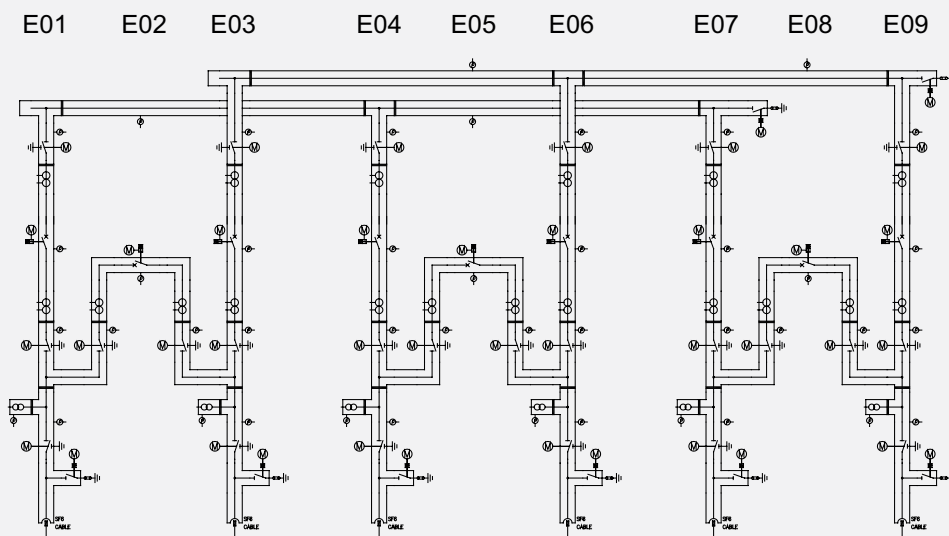


1½-circuit breaker arrangement

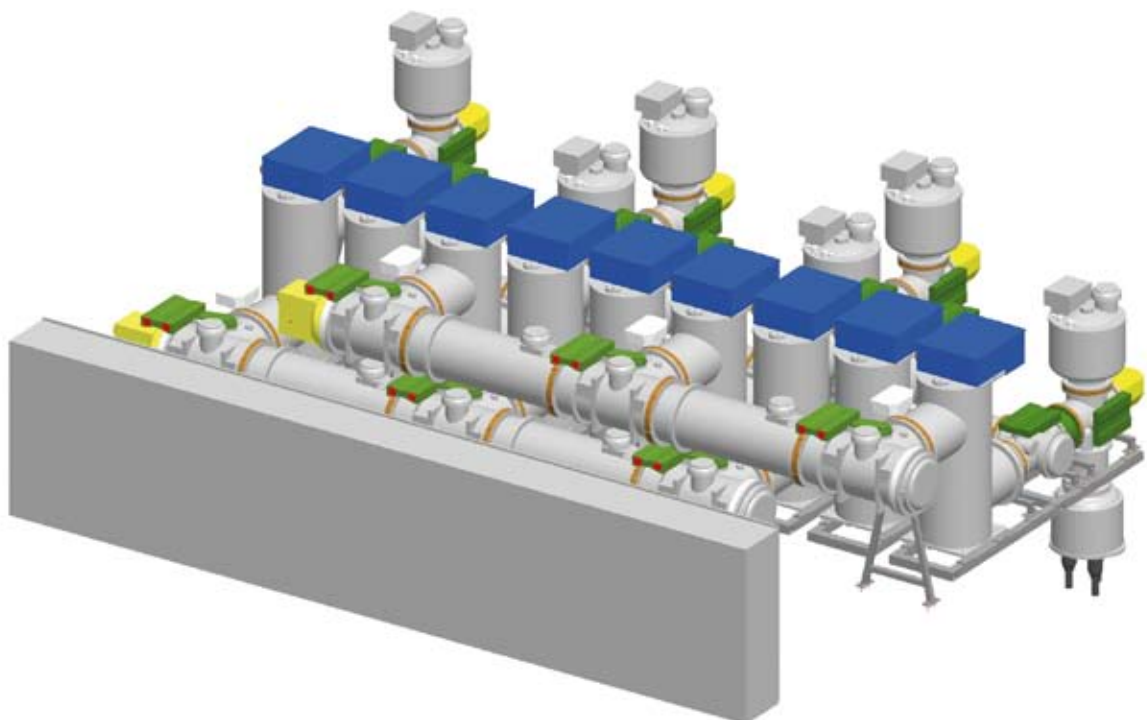
The 1½-breaker arrangement is a traditional circuitry. In this case especially the non-availability of the circuit breaker during maintenance is taken into consideration.

Such grids or substations are usually operated in such a way that all switches are closed. Each feeder is then fed from two sides, so that even a faulty busbar can be switched off without any outage.

Gas scheme and single line for 1½-circuit breaker arrangement



Isometric projection of a 1½-circuit breaker arrangement with separated local control cabinets

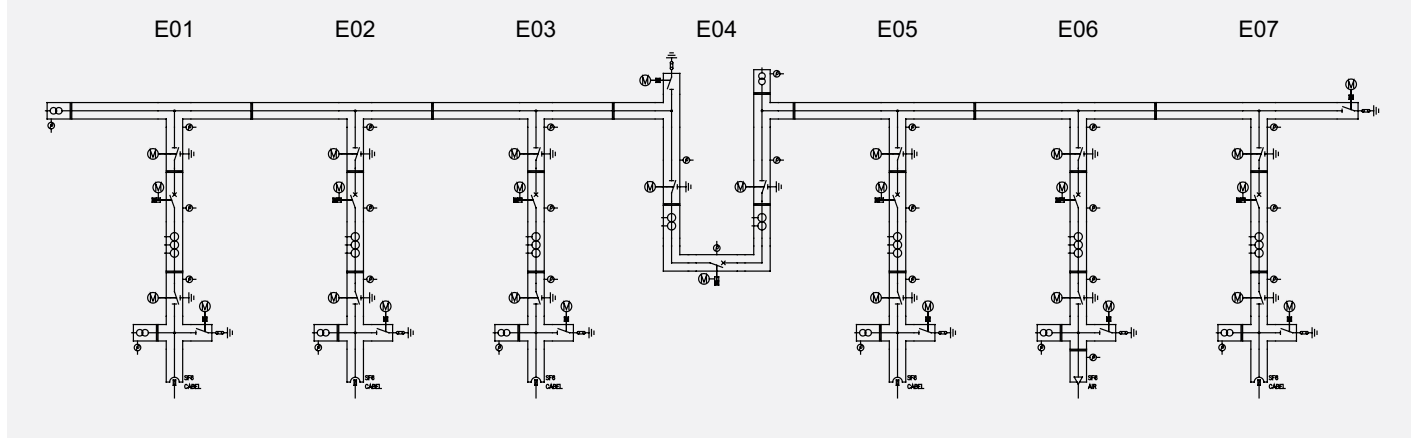


Execution Examples

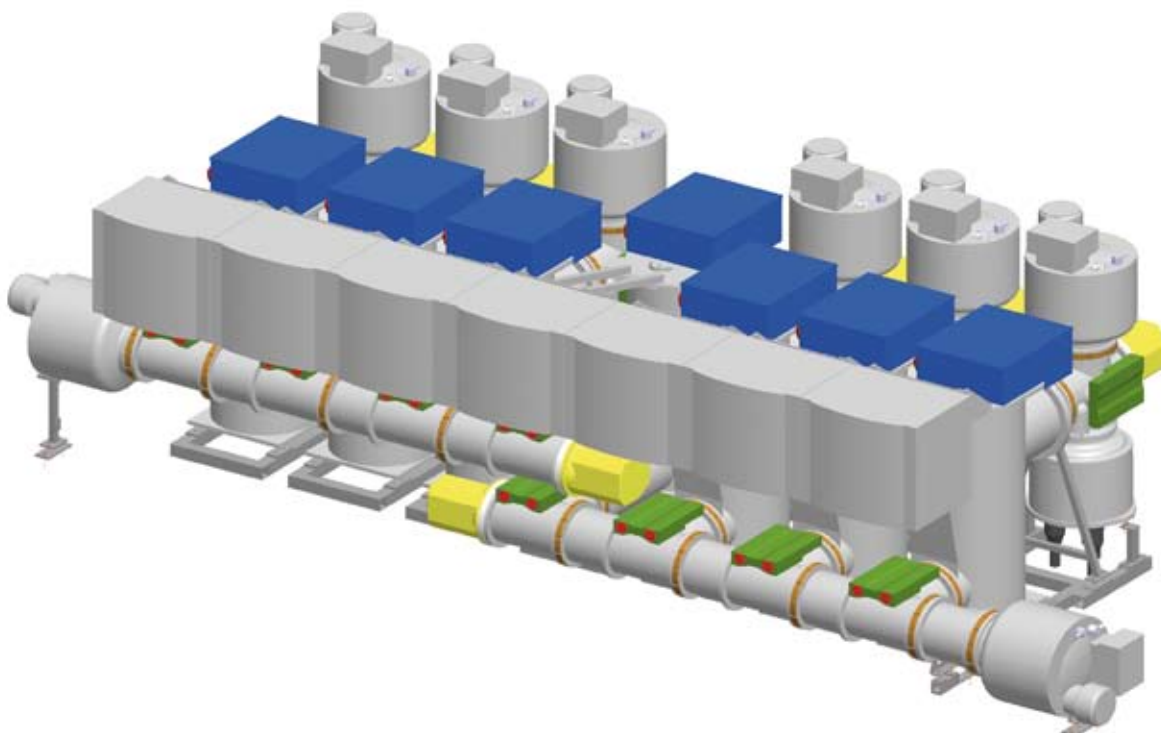
Single busbar arrangement

The layout of a substation with single busbar arrangement is similar to that of a double busbar one's. Either the lower or upper busbar is not applicable. A single busbar arrangement can later be upgraded to a double busbar arrangement, when appropriate connection flanges are provided on the circuit breakers already on the initial version. Smaller substations or single-feed stations are frequently designed with single busbar arrangement.

Gas scheme and single line for single busbar arrangement



Isometric projection of a single busbar arrangement with integrated local control cabinets



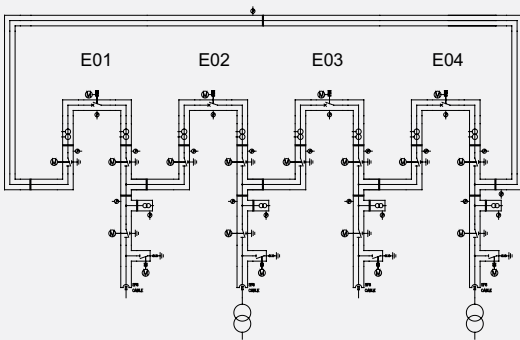
Ring busbar arrangement

Similar to the 1½-breaker arrangement, even in case of circuit breaker maintenance the ring busbar arrangement allows an uninterrupted operation of all cable and line feeders. With this circuit, the number of circuit breakers and the cable as well as line feeders is equal. Consequently, in general this kind of arrangement is more inexpensive compared to a version based on 1½-breaker per feeder.

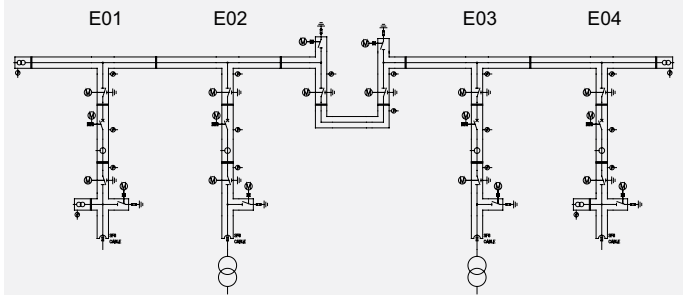
H-busbar arrangement

The H-busbar arrangement is often used to supply industrial enterprises or smaller regions. With respect to supply reliability two feeding lines and two step-down transformers are optimal. The station can be operated as a double-feed station, with closed cross connection as a ring substation as well. If a subsequent extension of the substation is under consideration, a layout with single busbar and section coupling is selected. Later, this substation can be upgraded to double busbar arrangement and bus coupling. When further extensions are not planned, the compact version without busbar is selected.

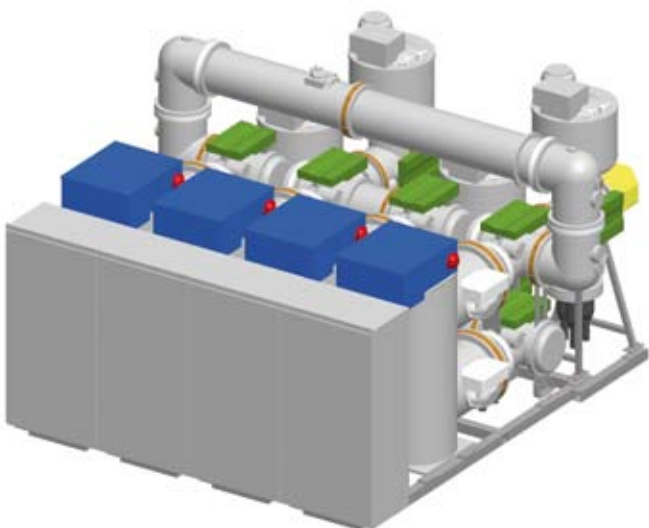
Gas scheme and single line for ring busbar arrangement



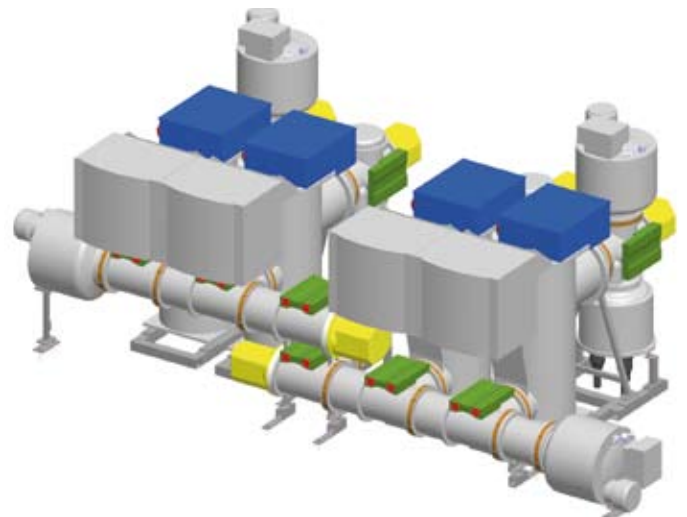
Gas scheme and single line for H-busbar arrangement



Isometric projection of a ring busbar arrangement with integrated local control cabinets



Isometric projection of an H-busbar arrangement with integrated local control cabinets



Value Added, Innovation, Quality

Complete process chain from R & D up to substation commissioning and beyond

Over the entire life cycle highest availability and profitability characterizes ABB gas-insulated switchgear. For the current gas-insulated switchgear portfolio and a rated voltage from 52 kV up to 170 kV the experience of more than 4 decades is reflected.

The know-how, the creativity and the engagement of our specialists lead to innovative products again and again and an all-time system competence for our customers.

The unique value added in relation with a consequent, all-over quality management over the complete process chain guarantees a high standard of our products. Input from actual research activities, latest state-of-the-art production technique and application relevant evaluations lead to further developments, improvements and optimization of all our components and modules.

1 Final inspection area of switchgear bays in the factory | 2 Assembly of a bay | 3 Fully automated electroplating of conductor parts



Engineering, Project Handling, Service

Engineering and project handling

Our experts collaborate with our customers, from the first meeting up to the scheduled commissioning of a substation and beyond.

This comprises a comprehensive study of all requirements at site, power system planning, planning and configuration of the substation with primary technology, protection and control technology, production, assembly and test in the factory, transport of the pre-manufactured modules, installation at site, filling of gas compartments, commissioning and handing over at site as well as substation specific training of staff. Our project handling is well defined and optimized by many projects. By that, our customers gain more confidence, time and a not inconsiderable cost benefit. They achieve a faster amortization of their investment.

Service

As one of the leading manufacturers of gas-insulated switchgear, ABB has a worldwide service organization with a very well trained and fast reacting team.

ABB personnel at site support our customers in retrofit of old substations with new technology, easy extension of old substations with new modules, replacement of single modules or components or other kind of service activities.

By that, for our customers worldwide an excellent investment protection results.

Smooth, fast project handling and service at site – for maximum customer benefit.

Teamwork together with our customer



Summary, Technical Data

The gas-insulated switchgear of type ELK-04 represents the ideal solution for a reliable and environmentally friendly energy supply up to a rated voltage of 170 kV, a rated normal current up to 4000 A and a rated short circuit current up to 63 kA. The space saving, modular design and the high reliability guarantee an energy efficient usage not only in areas of high population density and at all other places, where a high energy demand is requested. Moreover, already by now ELK-04 is an inherent part of regenerative energy sources like offshore wind farms or hydropower stations.

Since the market launch in the year 1992 the gas-insulated switchgear of type ELK-04 provides worldwide a valuable contribution to a reliable energy supply. ELK-04 meets a wide variety of technical requirements with a limited number of volume optimized modules. This applies for all primary technology components (parts under high voltage) as well

as for all secondary technology components. Transport, installation and commissioning can be arranged easily and fast due to the pre-manufactured and pre-tested components and modules.

High availability with reduced operating and maintenance costs guarantees excellent substation productivity.

ELK-04, a future-proof decision.

ELK-04 in 1½-circuit breaker arrangement, outdoor installation in front of a conventional air-insulated switchgear



Rated Values according to IEC

Operating voltage	kV	72,5	123/126	145	170
Operating frequency	Hz	50/60	50/60	50/60	50/60
Lightning impulse withstand voltage against earth	kV	325	550	650	750
across isolating distance	kV	375	630	750	860
Power frequency withstand voltage against earth	kV	140	230	275	325
across isolating distance	kV	160	265	315	375
Normal current	A	1250–4000			
Peak withstand current	kA	80–164			80–130
Short circuit breaking current	kA	31.5–63			31.5–50
Minimum insulating gas pressure at 20 °C	kPa	520/600			
Minimum quenching gas pressure at 20 °C	kPa	600/630			
Permissible ambient temperature	°C	-30/+40			
Encapsulation	three-phase				
Location of installation	indoor/outdoor				
Dimensions	m	1.0 x 3.6 x 2.7 – 1.2 x 5.3 x 3.2 (for double busbar bay with integrated local control cabinet and voltage transformer)			
Weight	kg	2400–3800 (for double busbar bay)			
Circuit breaker operating mechanism	hydromechanical, with energy storage in spring				

The above data should not be understood as limiting values. Further data upon request.

Contact us

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