Gas-insulated Switchgear Type ELK-3
GIS for maximum performance, 420 kV
ABB switchgear systems offer maximum flexibility
Than we draw on experience to meet the needs of tomorrow

ABB’s SF₆ gas-insulated switchgear technology has been proving its worth, day in and day out, for years. In applications all over the world. It owes its leading international position to a string of significant advantages: system security, reliable performance, economical use and an extremely long service life, even under the toughest conditions.

Apart from its many classical qualities, the ELK-3 series boasts several very advanced features. With compact architecture and fewer components, for example, it requires less space, less SF₆-gas and less material than previous systems. Its use simplifies operations and cuts costs from the moment you start using it. And goes on doing so. ABB’s GIS systems are designed for future upgrading because both main circuits and control & protection are totally modular. Which means you can expand and adapt them when you need to. Simply and efficiently. We call it systematized flexibility.

Ideally suited for voltages up to 420 kV, the modular ELK-3 system combines innovation with tried-and-tested qualities: the features that have given ABB GIS systems their international reputation.

Safety
The combined disconnector/earthing switch guarantees maximum operational safety.

Reliability
All live parts are enclosed and effectively protect the insulation system against negative external influences. The amount of moving parts and number of drives are reduced to a minimum.

Availability
A sophisticated partitioning divides the system into separate, gas-tight gas compartments, which will limit the impact on other modules to a minimum and therefore ensures a 100% service continuity during maintenance and repair work. World-wide service organization, together with a mature spare parts concept, assures shortest downtime for maintenance and repair.

Long-life cycle periods
Top-quality materials and workmanship guarantee maximum life-time with a minimum of service and maintenance.

Compactness
The ELK-3 modular system is so well designed that it requires much less space, which shows especially in cities and metropolitan areas its advantages.

Flexibility
The system’s modular architecture permits individual solutions that can be adapted to changing needs at any time.

Economy
Use of aluminium enclosures reduces the weight of the system, cutting the cost of foundations, load-bearing components and reduction of variants.

Efficiency
Prefabrication of subassemblies and stringent quality control at our own factory simplify final installation and commissioning.

Environmentally friendly
Significant reduction in number of flanges and seals, as well as a small compact design lead to a low environmental impact.
World-wide success
GIS ELK-3

Austria
2 substations
15 bays

Azerbaijan
1 substation
7 bays

Bahrain
1 substation
12 bays

Czech Republic
1 substation
7 bays

Denmark
2 substations
19 bays

Finland
2 substations
14 bays

Germany
11 substations
47 bays

Hong Kong
1 substation
24 bays

Hungary
4 substations
9 bays

India
6 substations
46 bays

Iraq
3 substations
30 bays

Ireland
1 substation
1 bay

Italy
5 substations
66 bays

Kuwait
7 substations
167 bays

Libya
1 substation
8 bays

Mexico
4 substations
6 bays

Netherlands
4 substations
10 bays

Nigeria
1 substation
7 bays

Norway
5 substations
32 bays

Qatar
4 substations
77 bays

Russia
4 substations
38 bays

Saudi Arabia
30 substations
382 bays

Singapore
2 substations
32 bays

South Africa
3 substations
27 bays

Spain
2 substations
12 bays

Sweden
1 substation
7 bays

Switzerland
13 substations
78 bays

Taiwan
3 substations
32 bays

Ukraine
1 substation
5 bays

United Arab Emirates
3 substations
33 bays

United Kingdom
13 substations
71 bays

US
4 substations
11 bays
Continuous improvements from the early stage till now
GIS ELK-3

In the early stage of gas-insulated switchgear (GIS) in this voltage level, ABB introduced one of the world's first 500 kV GIS Type ELK-3 in 1976. The low centre of gravity using a horizontal double-breaker puffer circuit-breaker, optimal characteristics in seismic areas could be achieved. Meanwhile the circuit-breaker with one to four interrupting chambers is implemented in different applications up to 1100 kV and 80 kA. Over the years, ABB was continuously faced with changing market demands and further steps in technology. Together with continuous requests in more compact products due to increasing costs for land in megacities.

Thus, ABB is continuously improving their products, applying newest perceptions in GIS technology and service experiences. Together with adaptations of the product to the increasing demands of latest IEC standards, the most compact GIS with horizontal arrangement of the circuit-breaker could be created for voltage range up to 420 kV and short-circuit ratings up to 63 kA. Changing standards and further market development towards higher competitiveness result in a standardisation process to minimize complex installation variants. Any different switching variants can be simply and transparently realised from tried and tested standard modules.

During the latest improvements of ABB’s ELK-3, a great deal of emphasis was placed on excellent accessibility of all items of equipment requiring operator attention in spite of the compact design and space-saving arrangement. The installation can therefore be readily accommodated in smaller buildings.

A Product Certificate for the entire product ELK-3 signed by independent authority assures: Conformity of all type-tests with standards, conformity with the design and construction, conformity of routine testing and conformity of all internal manufacturing processes according the certified quality management system.
ELK-3 as single busbar switchgear
The ELK-3 switchgear system from ABB
Clear-cut advantages and outstanding qualities

From ABB’s decades of experience a highly standardized modular system was developed, which is characterized by the fact that a wide variety of technical requirements can be met with a small number of modules.

Greater performance with fewer components, this counts for both, the primary equipment and control & protection. That makes ABB’s ELK-3 so revolutionary: Since it requires less space, it drastically cuts your construction costs and saves your operating costs at the same time.

Maximum system security with a minimum of maintenance is another quality feature of the environment-friendly ELK-3 system. And because it is modular, it can be extended or adapted at any time to meet your present and future requirements.

**High-performance circuit-breakers**
Enhanced performance and lower maintenance – that is the simple principle behind ABB’s high-voltage circuit-breakers. Designed for maximum efficiency with quality in mind.

**Save disconnectors and earthing switches**
Even the disconnectors and earthing switches prove ABB’s pioneering technology in terms of construction and design as well as system safety.

**Reliable current and voltage transformers**
The current and voltage transformers are as efficient as they are economical, and leave nothing to be desired in terms of service life. This is also true for the latest generation of NCITs (non-conventional instrument transformers).

**Versatile connecting elements**
ABB’s product range also features a collection of connecting elements in various shapes and sizes which enable our substations to be adapted to virtually any customers requirement.

**Innovative control & protection technology**
ABB’s forward-looking control & protection technology is fully integrated and completely open, which makes it more adaptable and simplifies operation.
1 Circuit-breaker | 2 Disconnectors and earthing switches | 3 Current and voltage transformers | 4 Connecting elements | 5 Control & protection
ABB high-voltage circuit-breaker
For solid, improved performance and less maintenance

The circuit-breaker
Over the years, the circuit-breaker, using SF₆-gas for insulation and arc-quenching purposes, has been continuously developed and improved. Extensive operating experiences, as well as ongoing research and development activities are the cornerstone to meet the future market requirements.

Features
– Reliable making and breaking capacity for heavy load and short-circuit currents
– Easy access to active parts for inspection and overhaul
– Low noise level
– Separate contact system for continuous current and current interruption
– High dielectric withstand in open and closed position
– Single-phase auto-reclosing
– Compact spring operating mechanism
– Continuous self-supervision of energy transmission system
– Type tested according latest IEC and ANSI standards
– Maintenance-free design

Breaker Design
Each circuit-breaker type ELK-3 comprises three single-phase metal-enclosed breaker poles. According to the technical requirements a circuit-breaker with one or two interrupting units is employed. Each pole consists of the operating mechanism, the interrupter column with one or two interrupting chambers and the enclosure with the basic support structure.

When a two-chamber circuit-breaker is employed, the chambers are mechanically connected in series to guarantee simultaneous interruption. Also one grading capacitor for each chamber assures an equalised voltage distribution across the interrupting chambers (example of a circuit-breaker with two chambers see page 4).

In case of an overhaul, the interrupter column can easily be removed from the enclosure.

The circuit-breaker is a single-pressure type and works on the latest arc-quenching technology. During an interruption, a compression piston in the each chamber generates the SF₆-gas pressure required to extinguish the arc between the contacts.
Circuit-breaker operating mechanism

Each pole of the circuit-breaker is equipped with a spring operating mechanism. The mechanism combines the non-wearing properties of a hydraulic system with the robustness of mechanical spring operating mechanisms. Spring operating mechanisms are used for ABB’s entire GIS portfolio, from 72.5 kV to 1’100 kV and for various other applications in AIS, PASS and DTB. ABB has supplied more than 65’000 spring operating mechanisms of this type.

The components of the operating mechanism
- Charging system
- Energy storage with disk spring stack
- Three independent actuator pistons and control valves
- Auxiliary switches and position indicators

A hydraulic energy control system is integrated within a compact, sealed block that does not require any external piping. All components are easily accessible for maintenance and repair.

Charging
A pump moves oil from the low-pressure oil reservoir to the high-pressure side of the energy storage piston and compresses the disk spring stack. A micro switch stops the pump when the disk spring stack is fully charged.

Close operation
A magnetically operated change-over valve initiates the close operation and connects the high pressure side of the energy-storage piston to the actuator piston. Both sides of the actuator piston are connected to the high-pressure reservoir. Due to the different areas of both surfaces of the actuator piston, the circuit-breaker closes and is retained in a closed position.

Open operation
The trip coil operates the change over valve and connects the actuator piston to the low pressure reservoir. The circuit-breaker opens and is retained in an open position by the pressure difference.
The disconnector/earthing switch
The disconnector/earthing switch combines two functions – a disconnector and a maintenance earthing switch – in one common enclosure, sharing one common operating mechanism.

The disconnector/earthing switch is based on a modular design. It has identical active parts for all variants and incorporates an insulating gap for the disconnector and one for the earthing switch. Variable arrangement of the active parts allows up to eight different configurations. This ensures the highest degree of flexibility with the lowest number of different parts.

The operating mechanism is of modular design. The modular design enables rapid replacement of complete modules, thus ensuring greater service friendliness and excellent access for maintenance and repair.

Features
- Reliable SF₆-gas insulation across the isolation distance
- Reliable switching capacity for small capacitive currents and bus-transfer currents
- High capacity for carrying rated and short-circuit currents
- Space-saving combination of disconnector and earthing switch
- Mechanical interlocking between disconnector and earthing switch
- Insulated earth connection allows measurements without opening gas compartment
- Manual operation by hand crank possible
- Reliable 3-pole operating mechanism
- One drive only for both functions
- Location of drive unit outside SF₆-gas compartment
- Separated mechanically coupled position indicator for each function
- Viewing port for checking position and condition of contacts
- Fully type-tested for conformity to latest IEC and ANSI standards

The fast-acting earthing switch
The fast-acting earthing switch is used to earth insulated sections of the installation to protect personnel during overhaul and assembly work. But it is also employed for earthing capacitance (cables, transmission lines, etc.). The earthing switch can be mounted at any position by using a linear connection element, thus ensuring the greatest flexibility in switchgear layout.

The controlled “Open”-operation results from a slow linear contact motion directly driven by an electric motor, which is located in one of the outer phases and connects the other phases by rotating shafts. This enables optimal switching movement during contact opening.

The fast “Close”-operation is spring-actuated. After a closing command, the electric motor and the rotating shafts will compress the spring of a phase. After reaching the required state of charge, they are automatically released until the next closing command is activated.

Features
- Reliable earthing of main circuit
- High short-circuit current carrying capacity in closed position
- High short-circuit current making capability
- Insulated operating mechanism
- Capable of switching induced capacitive and inductive currents
- Fast linear contact motion by spring-loaded drive for “Close”-operation
- Manual operation by hand crank possible
- Location of drive unit outside the SF₆-gas
- Position indicator mechanically coupled to the moving contact
- Viewing ports for checking position and condition of contacts
- Safety elements such as padlocks can be provided
- Fully type-tested for conformity to latest IEC and ANSI standards
Disconnector/earthing switch

Fast-acting earthing switch

disconnector/earthing switch

disconnector only

Earthing switch only

Disconnector/earthing switch

Fast-acting earthing switch
Voltage and current transformers
Maximum safety, practicality and high reliability

The voltage transformer
Used for system protection or revenue metering, ABB’s powerful transformers offer years of trouble-free service. Even for heavy-duty applications. They are based on the electromagnetic transformer principle, where primary and secondary windings are galvanically separated from one another. The single-pole inductive voltage transformers are connected to the switchgear with a standardised connecting flange and a partition insulator. The primary winding is wound on top of the core and the secondary windings. The latter are connected to the terminals in the external terminal box through a gas-tight multiple bushing.

Features
– Utilisation of SF₆-gas as insulating medium, together with plastic foil in the windings
– High secondary output and accuracy
– Ratio and number of secondary windings according to actual GIS plant requirements
– Effective damping of very fast transients, transmitted to the secondary side
– Rectangular type core of low loss magnetic sheets
– No ferroresonance possible in absence of circuit-breaker grading capacitors
– Horizontal or vertical mounting possible
– Separate gas volume with density monitoring
– Over-pressure relief device provided
– Secondary fuses on request
– Maintenance-free

The current transformer
The ring core current transformers concentrically enclose the primary conductor. The core support is provided by the pressure-proof enclosure, which is insulated from the basic flange to prevent the return current from passing through the cores.

Features
– Simple ring-core type windings integrated in the main current path
– SF₆-gas as main insulation according to ABB’s well-proved GIS technique
– Secondary windings on ring-cores, located inside of the SF₆-gas compartment and mechanically protected
– Efficient damping of the very fast transients transmitted to the secondary side
– Any accuracy class defined by international standards is possible
– Maintenance-free

The non-conventional instrument transformer (NCIT)
NCITs replace the conventional voltage and current transformers. The NCIT uses two redundant Rogowski Coils to measure the current value. The primary voltage is measured by a capacitive voltage divider composed of two cylindrical electrodes, the conductor and the enclosure. The measured values are digitally processed by the “Secondary Converters” and sent to the “Merging Unit”. From there the data is routed through a standardized, optical connection to the protection, measurement and control devices.

Features
– High bandwidth, high accuracy and linearity, high reliability
– SF₆ insulated unit with excellent long term stability and long service life
– No saturation or ferroresonance effects
– Standardised digital interfaces according to IEC 61850-9-2
– Configurable voltage and current ratings (for protection, control and measurement applications and energy metering)
– Integrated self supervision
– Maintenance-free

Current/voltage sensor
Terminals and connecting elements
ELK-3 — a system with unique adaptability

The connecting elements
Switching systems need to be as varied as the purposes for which they are intended. That is why ABB supplies connecting elements in all shapes and sizes: cross-shaped and T-elements, as well as simple straight sections, are the links that join up individual GIS components.

Compensators of various types allow for heat expansion, vibrations during operation and tolerances in the lengths of specific components. Moreover, lateral dismantling units guarantee hassle-free assembly and dismantling.

The terminal connections
ABB’s GIS range includes the connecting elements for peripherals such as the SF₆-air bushings, the enclosures for the cable terminations and the enclosures for the transformer terminals.

The transformer termination
The transformer connection enables transformers to be connected directly to the switchgear using bellows.

Features
- Effective compensation of vibrations
- Connection between the SF₆ switchgear and the transformer
- Isolation of the SF₆ switchgear from the transformer for testing possible
- Interface according IEC 61639
- Maintenance-free

Transformer connection
The cable termination
Cable connections, which are part of the cable manufacturer’s scope of supply, consist typically of an epoxy resin barrier insulator and can be either of dry type or of fluid-filled type.

Features
– Interface according IEC 62271-209
– The GIS and the high-voltage cable can be galvanically separated and the high-voltage tests be carried out independently
– Removable link easily accessible
– Flange available to attach a test bushing
– Easy mounting of the cable at any rotation angle
– Maintenance-free

The SF₆-air bushing
The SF₆-air bushings are available in two different versions: with classical porcelain insulators or in the standard version, with fibre-reinforced resin insulators with silicon sheds.

Features
– High creepage current resistivity
– Self-cleaning silicon sheds
– Single pressure SF₆-gas insulation
– Explosion and vandal-proof
– Resistivity against sandstorms
– All fitting positions possible
– Low weight
– Maintenance-free
ABB's proven local control concept
Operational benefits based on experience and innovation

The local control cubicle
The local control cubicle (LCC) includes all required functions for control and supervision of a GIS bay and provides safe access to the secondary circuits. The portfolio of local control solutions contains a modern and a conventional control concept.

The modern concept is based on ABB’s intelligent bay control unit REC670 for remote and local control. Optionally a bay control mimic can be provided for emergency control of the complete bay. The modern solution is rich in functionality and can simply be integrated in a substation automation system according to IEC 61850.

The conventional local control solution is based on contactor logic in combination with a bay control mimic for local control. A hardwired parallel interface provides the data for the remote control system.

The local control is usually installed opposite the circuit-breaker drives.

A wide range of functionality assures safe and reliable operation of the substation:

Basic functions
- Save local control of all motorized equipment
- Operation mode selectable by key switch (local/remote/emergency/off as well as normal operation or interlock bypass)
- Interface for remote control and protection, either hardwired or optionally through IEC 61850 station bus
- Feeder and station interlocking, depending on the position of all high-voltage apparatus as well as the various blocking conditions
- Command inhibition (eg, crank-handle insertion)
- Circuit-breaker supervision, including gas density, position indication, operation counters, pole discrepancy and monitoring of the operating mechanism
- Gas density supervision of the entire switchgear
- Measurement visualization and alarm indication

Function possibilities of modern local control cubicles
While all basic control functions including synchrocheck are usually integrated in the modern control solution. A wide range of additional functions can be configured if requested:
- Remote communication to station automation system, eg, through IEC 61850
- Horizontal communication between control and/or protection IEDs; applying IEC 61850 GOOSE messages
- Auto-reclosure as well as back-up or main protection functions can be integrated in the IED
- Optional integration of dedicated protection or monitoring devices inside the LCC
Local control cubicles
The GIS from ABB
Uniquely variable, invariably unique

Innovative, intelligent and flexible, creative, economical and ecologically safe: these are the outstanding features of the successful ELK-3. As it is well thought-out as it is mature, it can be used for virtually any application.

All ABB GIS comply with or exceed the latest international standards (IEC/ANSI) and have been type tested in independent laboratories. Our certified design and manufacturing processes guarantees the highest quality of our products.

Site testing according to IEC/ANSI standards and ABB quality assurance procedures include leakage checks on flanges, instrument transformer tests, control and monitoring functions, resistance measurements and a high-voltage test. Site installation can be carried out by ABB, but also by personnel from your own company under the guidance of a certified ABB supervisor. ABB University offers training courses for every aspect of GIS installation, operation and maintenance.

ABB’s metal-enclosed gas-insulated switchgear requires minimal maintenance in service. In normal operational conditions, more than 25 years fault-free operation is assured with periodic visual checks, after which time a first full inspection is recommended. ABB Service provides competent 24/7 worldwide support in case of failures.
Double busbar bay with cable connections

Section of a 1½-breaker arrangement
Main technical data
GIS ELK-3

GIS ELK-3 double busbar bay

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>1 chamber</th>
<th>2 chambers</th>
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</thead>
<tbody>
<tr>
<td>a</td>
<td>min. 4715</td>
<td>min. 4985</td>
</tr>
<tr>
<td>b</td>
<td>6521</td>
<td>7295</td>
</tr>
<tr>
<td>c</td>
<td>3811</td>
<td>4081</td>
</tr>
<tr>
<td>d</td>
<td>min. 2160</td>
<td>min. 2700</td>
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### Main data

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage (kV)</td>
<td>420</td>
</tr>
<tr>
<td>Power-frequency withstand voltage, 1 min. (kV)</td>
<td>650</td>
</tr>
<tr>
<td>Power-frequency withstand voltage, 1 min. across open contacts (kV)</td>
<td>815</td>
</tr>
<tr>
<td>Lightning impulse withstand voltage (kV)</td>
<td>1425</td>
</tr>
<tr>
<td>Lightning impulse withstand voltage across open contacts (kV)</td>
<td>1425 + 240</td>
</tr>
<tr>
<td>Switching impulse withstand voltage (kV)</td>
<td>1050</td>
</tr>
<tr>
<td>Rated frequency (Hz)</td>
<td>50/60</td>
</tr>
<tr>
<td>Rated continuous current (A)</td>
<td>4000/5000</td>
</tr>
<tr>
<td>Rated short-time withstand current (kA)</td>
<td>63</td>
</tr>
<tr>
<td>Rated withstand impulse current (kA)</td>
<td>170</td>
</tr>
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### Disconnector & earthing switch

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacitive current switching capability (mA)</td>
<td>500</td>
</tr>
<tr>
<td>Bus transfer current switching capability (A/V)</td>
<td>1600/20</td>
</tr>
<tr>
<td>Opening/closing time (s)</td>
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</table>

### Fast-acting earthing switch

<table>
<thead>
<tr>
<th>Property</th>
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</thead>
<tbody>
<tr>
<td>Making capacity (kA)</td>
<td>63</td>
</tr>
<tr>
<td>Inductive currents (kV)</td>
<td>10</td>
</tr>
<tr>
<td>Current (A)</td>
<td>160</td>
</tr>
<tr>
<td>Capacitive currents (kV)</td>
<td>20</td>
</tr>
<tr>
<td>Current (A)</td>
<td>18</td>
</tr>
<tr>
<td>Motor running time (s)</td>
<td>&lt; 6</td>
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### Voltage transformer

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated output (VA)</td>
<td>300</td>
</tr>
<tr>
<td>Rated accuracy class (%)</td>
<td>0.5</td>
</tr>
<tr>
<td>Rated thermal power (VA)</td>
<td>2000</td>
</tr>
<tr>
<td>Rated voltage factor (1.9/8 h)</td>
<td></td>
</tr>
<tr>
<td>Number of secondary windings</td>
<td>2</td>
</tr>
</tbody>
</table>

### Current transformer

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cores for metering</td>
<td></td>
</tr>
<tr>
<td>Cores for protection (transient performance optional)</td>
<td></td>
</tr>
</tbody>
</table>

### SF₆-air bushing

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous bending load (N)</td>
<td>2500</td>
</tr>
<tr>
<td>Test bending load (N)</td>
<td>5000</td>
</tr>
<tr>
<td>Creepage distance (mm/kV)</td>
<td>20, 25, 31</td>
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</table>
ABB’s ELK solutions offer
Improved performance, more practically - at a fraction of cost

Switching systems require an exceptionally high degree of safety

Indoor switching systems are designed to minimize space to claim

Protected installations especially when exposed to particular dirty, polluted or corrosive environments (e.g. coastline locations, deserts or industrial zones)

Extension of conventional outdoor substations with limited space
In underground switching systems for hydro-electric and pump-storage power stations

Upgrading the voltage level of existing conventional substations without the need for more space

Hybrid solutions combining dead tank and live tank components to reduce dimensions