Gas-insulated switchgear ELK-04 C, 145 kV
Modular and reliable
ABB is a leader in power and automation technologies that enable utility and industry customers to improve their performance while lowering environmental impact. The ABB Group of companies operates in around 100 countries and employs about 145,000 people.

ABB offers a wide range of high-voltage products up to 1200 kV that help enhance the reliability, efficiency and quality of power in transmission and distribution grids, power plants and industries while enhancing eco-efficiency. The wide product range is complemented by a comprehensive service offering.

ABB is the global leader in high-voltage GIS (gas-insulated switchgear) technology with more than 25,000 bays installed around the world. In 2009, ABB commissioned a GIS rated to handle more than one million volts (1200 kV), with a transmission capability of 6900 megawatts, reaching new heights in terms of global voltage levels.

We pioneered high-voltage GIS in the mid-1960s and with the introduction of the new 145 kV we complete the innovative switchgear portfolio comprising a uniform design and operation philosophy. We continue to drive technology and innovation within the full range of advanced GIS for voltages from 52 kV to 1200 kV.
Table of contents

ABB and 50 years of GIS innovation .......................................................... 2

The ELK-04 C, 145 kV .......................................................... 4
Applications .................................................................................. 4
Benefits ..................................................................................... 4
Modular, compact design ................................................................. 4
Simple and reliable .................................................................. 4
Convenient operation and serviceability ......................................... 4
Low environmental impact ............................................................. 4
Advanced features for smart grid enabled GIS substations ............. 4
Technology .................................................................................. 5
GIS from ABB ............................................................................. 5

ABB’s high-voltage circuit-breaker .................................................. 6
The circuit-breaker ...................................................................... 6
The circuit-breaker operating mechanism ...................................... 7

ABB’s disconnectors and earthing switches .................................. 8
The disconnector ...................................................................... 8
The earthing switch .................................................................. 9

ABB’s voltage and current transformers ....................................... 10
The voltage transformer ............................................................. 10
The current transformer ............................................................ 11

ABB’s terminals and connecting elements .................................... 12
The connecting elements ............................................................ 12
Surge arresters ........................................................................ 12
The terminal connections ........................................................... 13
Transformer connections ............................................................ 13
Cable terminations .................................................................. 13
SF₆-air bushings ....................................................................... 13

ABB’s local control cubicle .......................................................... 14
The local control cubicle (LCC) .................................................... 14
Advanced features for smart substations ..................................... 14

ABB’s commitment to total quality control ................................. 16
Enhancing eco-efficiency over the life cycle ................................. 17
The life cycle phases ................................................................ 17
Manufacturing phase ................................................................ 17
Use phase .................................................................................. 17
End of life phase ....................................................................... 17

Technical data .............................................................................. 18
ABB holds a distinguished record of innovations in GIS technology and our latest ELK-04 series for 145 kV is designed to reduce complexity and life cycle costs.

Applications

In a power system, switchgear is used to control, protect and isolate electrical equipment thereby enhancing the reliability of electrical supply. With GIS technology, key components including contacts and conductors are protected with insulating gas making this a preferred solution where space is a constraint such as in mega cities or in harsh environmental conditions.

Benefits

**Modular, compact design**

Small, lean three-phase enclosure with single-phase insulators results in a small footprint and excellent accessibility. A small number of modules and a set of standardized connection elements allow an optimal realization of different GIS layouts.

ELK-04 C uses a horizontal circuit-breaker and vertical current transformers. Consequently, the bay requires always the same footprint regardless of the current transformer configuration. Planning is simplified and the civil works can commence earlier.

**Simple and reliable**

ELK-04 C reduces complexity by a number of distinct features: conductors and switches of the three phases are arranged in line and use less complex and fewer parts. A simple and robust mechanical linkage replaces electrical wiring to drives in the bay. The drives for disconnector and earthing switches are located at the front panel and have identical user interface for manual operation and mechanical interlocking. Current transformers are located outside the gas compartments without the need for a gas-tight feed to the secondary terminals.

**Convenient operation and serviceability**

The integrated local control cubicle as well as the drive cubicle is located at the front of the switchgear. Easy access is granted for manual operation of all equipment.

Gas density information can be displayed on the integrated local control cubicle using combined density sensors/monitors. All instrument transformers are wired to the integrated local control cubicle.

A service catwalk between the integrated local control cubicle and the bay gives convenient access to viewports and gas filling points.
The ELK-04 C is designed to enhance eco-efficiency. Optimized, lean enclosures and single phase insulators reduce weight and the use of SF₆ insulating gas up to 60 percent compared to its predecessor resulting in an outstanding environmental performance.

To ensure an interoperable and future-proof substation, the ELK-04 C, 145 kV has been designed to incorporate the core values of the IEC 61850 standard. The standard defines strict rules for realizing interoperability between functions and devices used for protection, monitoring, control and automation in substations.

GIS from ABB are built on 50 years of pioneering research and development and experience delivering over 25,000 switchgear bays in over 100 countries. Our switchgears are crafted using standardized and modular components that enable the construction of common layouts and bus schemes.
ABB’s high-voltage circuit-breaker
Reliable, well proven technology

The circuit-breaker

The horizontal circuit-breaker module provides optimal performance and low maintenance. ELK-04 C circuit-breakers are equipped with Auto-puffer™ interrupters, i.e. self-blast interrupters with one unit per pole. They require minimum maintenance and only a low amount of operational energy. The optimized and compact layout minimizes the volume of SF₆ insulating gas by 70 percent compared to its predecessor. The circuit-breaker fits to all layouts and is used in other ABB GIS applications as well as for live tank and dead tank circuit-breakers.

Circuit-breaker drive cubicle

Circuit-breaker with operating mechanism
To open or close the circuit-breaker, a spring operating mechanism is used. The closing latch generates the energy required to close the circuit-breaker and will charge the opening latch. The mechanical energy required for opening is therefore always stored in the opening latch, when the circuit-breaker is closed. Immediately after the closing a motor automatically reloads the closing latch again. After the closing latch is charged, the circuit-breaker is always ready to perform an opening operation or a complete auto-reclosing (O – 0.3 s – CO).

The entire drive is outside the SF₆ gas compartment. The torsion springs produce less vibration than conventional compression springs and the robust loading motor ensures that the closing latch is charged in less than 15 seconds. The closing spring can be charged by means of a hand crank if the auxiliary power supply or control circuit fails.
ABB’s disconnectors and earthing switches
Convenient operation and serviceability

The disconnector

The disconnectors provide a safe insulating gap to isolate sections with different potential, for example busbar disconnectors, which isolate the circuit-breaker from the busbar.

The operating mechanism of the disconnector and earthing switch is mounted in the drive cubicle at the front of the bay and contains all the components needed for operation and is wired to the integrated local control cubicle next to it. Position indicators and hand-crank access are features conveniently located in the drive cabinet and are easy accessible.
Earthing switches connect isolated sections of the switchgear to the earth potential during maintenance and assembly work.

Feeder terminals are often equipped with fast-acting (or make-proof) earthing switches. These devices are able to earth induced currents on overhead lines, discharge capacitances such as cables, and provide safety when the opposite end of a line is not properly de-energized. The fast-acting earthing switch includes a spring operated mechanism, which is either charged by a motor or by a hand crank.

Similar to disconnectors, the operating mechanism of the maintenance earthing switch is located in the drive cubicle at the front of the bay. Hand-crank access, position indicators and mechanical interlocking, are features conveniently located in the drive cubicle and are easy accessible from the operator’s corridor. The operating mechanism of the fast-acting earthing switch is located at the equipment itself and controlled via the control cubicle.
ABB’s voltage and current transformers
Highly reliable metering, control and protection functions

The voltage transformer

Our maintenance-free voltage and current transformers provide highly reliable metering, control and protection functions. Used for system protection, our powerful transformers offer years of trouble-free service even for heavy-duty applications.

The three-pole inductive voltage transformers are connected to the switchgear with a standardized connecting flange and a partition insulator. The primary winding is coiled on top of the core and the secondary windings.
The single-pole inductive current transformers are attached to the same housing where the maintenance earthing switch is located. They are located outside the gas compartment eliminating the need for a gas-tight feed to the secondary terminals. The current transformer can be placed on the feeder side and on the busbar side and may contain multiple cores for metering and protection. Current transformer parameters such as burden, ratio and accuracy class are set to meet specific project requirements. Multi-ratio transformers provide different ratios selectable by taps.
ABB’s terminals and connecting elements
Maximum flexibility

The connecting elements

We have versatile terminal and connecting elements that enable the switchgear to be customized to fit your project requirements. We offer connecting elements in various shapes and sizes including phase rotation modules, different angular modules and straight sections.

The busbar module of ELK-04 C covers a universal expansion joint to absorb heat expansion and vibrations during operation. During site installation, the expansion element ensures that neighboring bays can be connected easily.

Surge arresters

Surge arresters are fully-enclosed metal components that limit switching and lightning over voltages. For stable and reliable operations, the ELK-04 C is equipped with gapless gas-insulated metal-oxide surge arresters. Ratings and discharge classes are tailored to your project specific requirements.
We offer a complete range of connecting elements for peripherals, such as SF₆-air bushings, enclosures for cable terminations and direct transformer connections.

Our standardized transformer connections link power transformers directly to the switchgear via SF₆ insulated bus ducts. Vibrations, thermal expansion of the transformer and switchgear, as well as movements resulting from the settling of foundations, are compensated by bellows and expansion joints. A removable high-voltage conductor link isolates the transformer for testing.

Our supply can include cable connections of the plug-in type with dry-type or fluid-filled terminations. The interfaces are conform to IEC standards. A removable link disconnects and isolates the GIS from the cable during high-voltage test for convenience and ease of operations.

Our lightweight SF₆-air bushings are available in two variants – in the standard version, with composite insulators and silicon sheds or with classical porcelain insulators. Creepage distance, length, and shape depend on the project-specific environmental requirements. We provide SF₆-air bushings that are maintenance-free with self-cleaning silicon sheds.
ABB’s local control cubicle
Reduced commissioning and installation time

The local control cubicle (LCC)

The local control cubicle (LCC) includes all required functions for the control and supervision of the GIS bay. The LCC is usually integrated with the bay and located on top of the drive cubicle. As an integral part of the ELK-04 C, the LCC is wired, factory-tested and shipped together with the bay as one transport unit. This reduces installation and commissioning time to a minimum and eliminates errors during site installation. Connections from the LCC’s prepared terminal blocks to dedicated protection cubicles, control systems, power supply and inter-bay wiring are the only installation work done on site.

Our LCC’s can either be of the Smart Grid Enabled type or the conventional type with Mimic, position indicators and the associated control switches. Our advanced Relion® family of protection and control-IEDs as well as the conventional Mimic solution ensures the safe and economical operation of the switchgear.

Advanced features for smart substations

Our broad range of control and protection systems includes IEC 61850 compliant products that provide open, future-proof and flexible system architecture. Our advanced local control cubicles enable monitoring and remote diagnostic functions ensuring high availability and fast access to precise information from anywhere in the system, speeding up responses and reducing outage time. Depending on the project requirements, we can also deliver standalone LCC’s with all customary control and protection devices.
The switchgear can be equipped with a Modular Switchgear Monitoring device (MSM). This add-on monitors SF₆ density, calculates and supervises leakage rates and gas level limits. It fits all kinds of switchgear layouts. The MSM operates independently of control and protection devices. The system status can be conveniently accessed and displayed at any time through a range of displays, e.g., an LCD display in the local control cubicle, via IEC 61850-8-1 over SCADA or remotely through a web browser.
Our products are type tested according to different standards
- IEC
- ANSI/IEEE

The ELK-04 C is factory assembled and fully tested as one bay with the local control cubicle in a manufacturing facility using an advanced flow production system that adheres to ABB internal quality and manufacturing excellence procedures. All bays are produced and tested in controlled conditions under the strict supervision of ABB’s engineers and GIS experts.

ABB believes that innovation is a key to ABB’s competitive advantage and it has consistently invested in research and development to become a market leader. The ELK-04 C is based on pioneering GIS technology since the 1960s and installation in around 100 countries. It complies with or exceeds the latest international standards (IEC/ANSI) and has been type tested in independent laboratories.

We are committed to giving you products of the highest quality that is why we strive to produce only products that comply with or exceed the latest international standards (IEC/ANSI). In addition, our products have been type tested in independent laboratories. Our certified design and manufacturing processes guarantee the highest quality of our products.

Our GIS bays are fully assembled and tested in the factory with standardized, automated and reliable procedures. After routine testing, shipping units are packed in accordance with the freight carrier’s requirements, the duration of transportation, the dispatch route and site storage requirements.

Pre-tested, wired and SF₆ pre-filled bays reduce the on-site installation work and gas handling significantly. Bays are coupled using standard tools. Site testing according to IEC/ANSI standards and ABB quality assurance procedures include leakage checks on flanges, instrument transformer, control and monitoring functions, resistance measurements and a high-voltage test. Site installation can be carried out by ABB or by personnel from your own company under the guidance of a certified ABB supervisor. ABB offers training courses for every aspect of GIS installation, operation and maintenance.

ABB’s metal-enclosed gas-insulated switchgear requires minimal maintenance in service. Under normal operational conditions, more than 50 years smooth operation is assured with periodic visual checks. ABB Service provides competent 24/7 worldwide support in case of failures.
Enhancing eco-efficiency over the life cycle
Low environmental impact

For ABB, sustainability is about balancing economic success, environmental stewardship and social progress to benefit all our stakeholders.

Sustainability considerations cover how we design and manufacture products, what we offer customers, how we engage suppliers, how we assess risks and opportunities, and how we behave in the communities where we operate and towards one another, while striving to ensure the health, safety and security of our employees, contractors and others affected by our activities. In line with our business practices, we publish environmental product declarations for each product we manufacture.

The life cycle of the ELK-04 C is separated into three phases: manufacture, use and disposal. The manufacture scenario includes materials used, transport of components and SF₆ gas leakage rates. The usage scenario includes transport of products to customers as well as SF₆ gas leakage rates and energy losses assuming a 50-year life time. The disposal phase refers to SF₆ gas leakage rates and the energy for making recycled metals reusable.

- Continuous improvement in product design resulted in a more compact housing that uses less aluminum and other metals
- Low thermal losses due to innovative designs and material choices
- Full bay shipment due to compact design reduces the environmental impact of transportation
- ABB’s factory is ISO 14001 certified for environment best practices and we also conduct regular environment audits at our suppliers’ facilities

- Online monitoring for preventive maintenance
- The low operating energies used by ABB’s modern interrupters combined with the efficient mechanical spring drives result in lower auxiliary power supply consumption
- Type tested for 0.1 percent SF₆ gas leakage rate per year
- Minimized SF₆ gas leakage rates due to well proven sealing system

- Use of material which is easy to recycle or dispose
- Improved maintenance processes that avoid the accidental release of gases and oil
- Improved recycling and disposal through clear declarations adjusted to different global boundary conditions
Technical data
ELK-04 C, 145 kV
**ELK-04 C, 145 kV**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>145 kV</td>
</tr>
<tr>
<td>Rated short-duration power-frequency withstand voltage</td>
<td>275 kV</td>
</tr>
<tr>
<td>Rated short-duration power-frequency withstand voltage across isolating distance</td>
<td>315 kV</td>
</tr>
<tr>
<td>Rated lightning impulse withstand voltage</td>
<td>650 kV</td>
</tr>
<tr>
<td>Rated lightning impulse withstand voltage across isolating distance</td>
<td>750 kV</td>
</tr>
<tr>
<td>Rated frequency</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Rated normal current</td>
<td>3150 A</td>
</tr>
<tr>
<td>Rated short-time withstand current</td>
<td>40 kA</td>
</tr>
<tr>
<td>Rated duration of short-circuit</td>
<td>3 s</td>
</tr>
<tr>
<td>Rated peak withstand current</td>
<td>108 kA</td>
</tr>
<tr>
<td>Installation</td>
<td>Indoor/outdoor</td>
</tr>
<tr>
<td>Rated filling pressure / minimum functional pressure (abs. at 20 °C)</td>
<td>0.68/0.60 MPa</td>
</tr>
</tbody>
</table>

**Circuit-breaker**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated short-circuit breaking current, 50/60 Hz</td>
<td>40 kA</td>
</tr>
<tr>
<td>Rated short-circuit making current, peak value</td>
<td>108 kA</td>
</tr>
<tr>
<td>First pole-to-clear factor</td>
<td>1.3/1.5</td>
</tr>
<tr>
<td>Drive type</td>
<td>Spring</td>
</tr>
<tr>
<td>Rated opening time</td>
<td>26 ... 35 ms</td>
</tr>
<tr>
<td>Rated closing time</td>
<td>45 ... 55 ms</td>
</tr>
<tr>
<td>Reclosing time</td>
<td>≤ 300 ms</td>
</tr>
<tr>
<td>Rated operating sequence</td>
<td>O - 0.3s - CO - 3min - CO</td>
</tr>
<tr>
<td>Number of mechanical operations</td>
<td>Class M2</td>
</tr>
<tr>
<td>Rated capacitive switching currents</td>
<td>Class C2</td>
</tr>
</tbody>
</table>

**Disconnector and earthing switch**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacitive current switching capability</td>
<td>500 mA</td>
</tr>
<tr>
<td>Rated bus-transfer current / rated bus-transfer voltage</td>
<td>1600/30 A/V</td>
</tr>
</tbody>
</table>

**Fast-acting earthing switch**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated short-circuit making current</td>
<td>108 kA</td>
</tr>
<tr>
<td>Rated induced voltage (electromagnetic coupling)</td>
<td>6 kV</td>
</tr>
<tr>
<td>Rated induced current (electromagnetic coupling)</td>
<td>100 A</td>
</tr>
<tr>
<td>Rated induced voltage (electrostatic coupling)</td>
<td>6 kV</td>
</tr>
<tr>
<td>Rated induced current (electrostatic coupling)</td>
<td>5 A</td>
</tr>
<tr>
<td>Classification for electrical endurance</td>
<td>Class E1</td>
</tr>
</tbody>
</table>