Medium voltage products

UniGear ZS1 - CSA
Medium voltage, arc-resistant, air insulated switchgear
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UniGear ZS1 Description

- UniGear ZS1 is the ABB mainline global switchgear
- More than 300,000 panels produced and installed in more than 100 countries
- UniGear ZS1 CSA version switchgear is available at 4.76 kV, 4000 A, 50 kA and 15 kV, 4000 A, 50 kA as well as 27.6k V, 2500 A, 25 kA.
- Each UniGear ZS1 panel consists of a single unit which can be equipped with a circuit-breaker or isolating switch, as well as with all the accessories available for conventional switchgear units
• Approved to be used for special applications such as seismic and type tested for IEC and CSA standards
• The switchgear is available with front access for installation or maintenance, all the operations are carried out from the front

Characteristics of UniGear ZS1 CSA version

Range
- ...4.76 kV, ...4000 A, ...50 kA, ...60 kV BIL
- ...15.0 kV, ...4000 A, ...50 kA, ...95 kV BIL
- ...27.6 kV, ...2500 A, ...25 kA (or 31.5 kA), ...125 kV BIL
- CSA C22.2 No. 31 certified
- Highly customizable

Safety
- Metal-Clad construction
- Arc resistant with internal arc classification IAC AFLR for 1 sec
- Gas exhaust evacuation
- Equipped with safety interlocks
- Closed door circuit breaker racking
- Dedicated low voltage compartment

Flexibility
- Wide range of applications
- Withdrawable vacuum and SF6 circuit-breaker
- Front and rear access configurations
- Compact design
- Service entrance and metering

Quality
- High quality ABB design and manufacturing
- Very large worldwide installed base
- ISO certified

Design includes
- Protection and control
- Fully withdrawable VT’s with shutters
- Grounding switch with viewing window
- IR windows
- Grounding studs
- Arc Flash Pressure Sensors
- REA (arc flash relay)

Applications

Utilities and Power Plants
- Power generation stations
- Substations
- Main and auxiliary switchgear

Industry
- Pulp and Paper
- Cement
- Textiles
- Food
- Automotive
- Quarrying
- Petrochemical
- Oil and gas
- Metallurgy
- Rolling mills
- Mines

Transport
- Airports
- Ports
- Railways
- Underground transport

Infrastructure
- Shopping malls
- Hospitals
- Large infrastructure and civil works
UniGear ZS1

Description

UniGear ZS1 is medium voltage switchgear with a metal enclosure, suitable for indoor installations. Metal partitions segregate the compartments from each other and the live parts are air-insulated. Since the switchgear is highly modular type, this make simple selection of components required by any application.

Optionally, the functional units of the switchgear are guaranteed arc resistant in accordance with the IEC 62271-200 Standards, appendix AA, class A accessibility, criteria 1 to 5.

All the installation, operation and maintenance operations can be carried out from the front of the unit. The switchgear and the earthing switches are operated from the front with the door closed. Switchgear can also be offered with front access only configuration.

Apparatus

The following apparatus are available for the CSA version of UniGear ZS1:

- withdrawable vacuum circuit-breakers with mechanical and electromagnetic actuator
- withdrawable gas circuit-breakers
- withdrawable potential transformers
- fixed version of switch-disconnectors
- fixed version of isolating switches.

This makes it possible to offer a single switchgear-user interface, with the same operational and maintenance procedures.

The switchgear can be fitted with instrument transformers for current and voltage measurement and protection and any type of protection and control unit.

Normal operation conditions

The rated characteristics of the switchgear are guaranteed under the following ambient conditions:

- minimum ambient temperature: –5 °C
- maximum ambient temperature: +40 °C

For different temperature ranges, please contact your ABB sales representative.

- Ambient humidity:
  - maximum 24 h average of relative humidity 95% RH
  - maximum 24 h average of water vapour pressure 2.2 kPa
  - maximum monthly average of relative humidity 90% RH
  - maximum monthly average of water vapour pressure 1.8 kPa

- The normal operational altitude is up to 1,000 m above sea level. For higher altitude applications, please contact your ABB sales representative.

- Presence of normal, non-corrosive and uncontaminated atmosphere.
Standards

The switchgear and main apparatus contained in it comply with the following Standards:

- CSA C22.2.No 31-14.
- IEC 62271-1 for general purposes.
- IEC 62271-2 for the earthing switch.
- IEC 62271-100 for the circuit-breakers.
- IEC 60071-2 for the insulation coordination.
- IEC 60529 for degree of protections.

Colour of the external surfaces

RAL7035 - light grey (front doors and side sheets).
Other colours available on request.

Degrees of protection

The degrees of protection of the switchgear conform with IEC 60529 Standards.

UniGear ZS1 switchgear is normally supplied with the following standard degrees of protection:

- IP4X for the enclosure
- IP2X for the partition between compartments.

On request, the external housing can be supplied with a higher degree of protection; in this case please contact your ABB sales representative.

The electrical characteristics of the switchboard can vary for ambient conditions other than those described in the previous section and also if a higher degree of protection is used.

CSA electrical characteristics of UniGear ZS1 - Single Busbar System

<table>
<thead>
<tr>
<th>Panel version</th>
<th>UniGear ZS1 - 5 kV</th>
<th>UniGear ZS1 - 15 kV</th>
<th>UniGear ZS1 - 27.6 kV</th>
<th>UniGear ZS1 - 27.6 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of construction - Internal Arc Classification acc. to IEC</td>
<td>IAC AFLR</td>
<td>IAC AFLR</td>
<td>IAC AFLR</td>
<td>IAC AFLR</td>
</tr>
<tr>
<td>Rated maximum voltage [kV]</td>
<td>4.76</td>
<td>15.0</td>
<td>27.6</td>
<td>27.6</td>
</tr>
<tr>
<td>Rated insulation voltage [kV]</td>
<td>4.76</td>
<td>15.0</td>
<td>27.6</td>
<td>27.6</td>
</tr>
<tr>
<td>Rated power frequency withstand voltage [kV x 1 min]</td>
<td>19</td>
<td>36</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Rated lightning impulse withstand voltage (BIL) [kV]</td>
<td>60</td>
<td>95</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>Rated frequency [Hz]</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Rated main busbar current (40 °C) [A]</td>
<td>... 4000</td>
<td>... 4000</td>
<td>... 2500</td>
<td>... 1200</td>
</tr>
<tr>
<td>Rated feeder current (40 °C) [A]</td>
<td>... 4000</td>
<td>... 4000</td>
<td>... 2400</td>
<td>... 1200</td>
</tr>
<tr>
<td>Rated short-time current [kA x 3 s]</td>
<td>... 50</td>
<td>... 50</td>
<td>... 25</td>
<td>... 25</td>
</tr>
<tr>
<td>Arc resistant withstand current (IEC 62271-200) [kA x 1 s]</td>
<td>... 50</td>
<td>... 50</td>
<td>... 25</td>
<td>... 25</td>
</tr>
</tbody>
</table>

Tested according to CSA

Overall dimensions of the basic cubicle

| H [mm] | 2200 ... 2900 ** | 2325 ... 2875 ** | 2325 ... 2875 ** |
| W [mm] | 650 / 800 / 1000 *** | 800 / 1000 *** | 800 / 1000 / 1500 *** |
| D [mm] | 1340 / 1390 *** | 1560 / 1700 / 1800 *** | 2163 *** |

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*) Complying with Hydro-Quebec F22-01 Electricity Metering for Medium and High-Voltage Installations and E 21-12 Red Book

**) With installed exhaust gas duct

*** Depending on rating of nominal current, short-circuit current or design

****) Rating with forced cooling. Natural cooling up to 2100 A

*****) Rating with forced cooling. Natural cooling up to 3000 A
UniGear ZS1 is designed and tested in accordance with CSA C22.2 No 31-14 as a Metal-Clad switchgear containing switching and other associated equipment, as circuit breakers, disconnectors, instrument transformers, sensors, buses, connections that are located in separate grounded metal compartments.

Interlock-controlled accessible compartment
The front of UniGear ZS1 is classified interlock-controlled because the access of the compartments containing high-voltage parts, intended to be opened for normal operation and/or normal maintenance, is controlled by the integral design of the switchgear.

Tool-based accessible compartment
The rear of the UniGear ZS1 is classified tool-based because it is possible to open the compartment containing high-voltage parts, that may be opened, but not for normal operation and maintenance, only using a tool. Special procedures are required.

Internal arc classification – IAC AFLR (IEC)
UniGear ZS1 switchgear is classified IAC AFLR. When the switchgear is specified and installed, some fundamental points must be taken into consideration:
- Level of the fault current (up to 50 kA).
- Duration of the fault (0.1...1s).
- Escape routes for the hot and toxic gases produced by combustion of materials.
- Dimensions of the room, with special attention to the height.

Please consult your ABB representatives for detailed information.

Partition Metallic - PM
With regard to the type of partitions or shutters between live parts and an open compartment:
- Class PM (Partition made of Metal).
UniGear ZS1 is defined with PM partition class having the segregation between compartments made of metallic sheets/shutters.

Loss of service continuity
UniGear ZS1 is classified as LSC-2B because the busbar, circuit-breaker and cable compartments are physically and electrically segregated. This is the category that defines the possibility of accessing the circuit-breaker compartment with the busbars and cables energized. In case of using the fixed isolating switch and in service switchgear, the panel is defined LSC 1 because the cable and apparatus compartments are not physically segregated.

- LSC-1: The whole switchgear shall be put out of service for opening a main circuit compartment for normal operation and/or normal maintenance or for gaining access to any switchgear components.
- LSC-2B: The whole switchgear with the exception that the main busbars and the functional units adjacent to the one under maintenance shall be put out of service for opening a main circuit compartment for normal operation and/or normal maintenance or for gaining access to any switchgear components. The cable compartment is segregated and can remain energized.
Compartments
Each switchgear unit consists of three power compartments: circuit-breaker [A], busbars [B] and cables [C]; please refer to page 11.
Each unit is fitted with a low voltage compartment [D], where all the auxiliary instruments are housed.
Arc-resistant switchgear is normally provided with a duct [E] for evacuation of the gases produced by an arc; different types of gas ducts are available.
All the compartments are accessible from the front and maintenance operations can correctly carried out with the switchgear installed up against a wall, unless rear access is required under specific conditions.
The compartments are segregated from each other by metallic partitions.

Main busbars
The busbar compartment contains the main busbar system connected to the upper isolating contacts of the circuit-breaker by means of branch connections.
The main busbars are made of electrolytic copper.
For ratings up to 2500 A, the busbars are flat bars; while for currents between 3150 A and 4000 A, a special D-shape busbar is used.
The busbars are covered with insulating material.
There is a single busbar compartment along the entire length of the switchgear divided into compartments by bushings. For 40/50 kA these bushings are a standard feature.

Cable connections
The cable compartment contains the branch system for connection of the power cables to the lower contacts of the circuit-breaker.
The feeder connections are made of electrolytic copper and they are flat busbars for the whole range of currents.
They are covered with insulating material.

Grounding switch
Cable compartment can be fitted with an grounding switch for cable grounding.
The same device can also be used to ground the busbar system (measurements and bus-tie units).
It can also be installed directly on the main busbar system in a dedicated compartment (busbar applications).
The grounding switch has short-circuit making capacity.
Control of the grounding switch is from the front of the switchgear with manual operation, and optionally, can also be motor operated.
The position of the grounding switch can be seen from the front of the switchgear by means of a mechanical coupled indicator. Additionally, the enclosure is provided with a viewing window on the rear cover in order to visually check the grounding switch position.

Grounding busbar
The grounding busbar is made of electrolytic copper and it runs longitudinally throughout the switchgear, thereby guaranteeing maximum personnel and installation safety.

Insulating bushings and shutters
The insulating bushings in the circuit-breaker compartment contain the contacts for connection of the circuit-breaker with the busbar compartment and cable compartment respectively.
The insulating bushings are of single- or three-pole type and are made of epoxy resin or thermoplastic. The shutters are metallic and are activated automatically during movement of the circuit-breaker from the racked-out position to the operation position and vice versa.

Cables
Single and three-core cables up to a maximum of twelve per phase can be used depending on the rated voltage, the unit dimensions and the cable cross section.
The switchgear can be back to wall installed as the cables are easily accessible from the front.
Gas exhaust duct

The gas exhaust duct is positioned above the switchgear and runs along its whole length. Each power compartment is fitted with a flap on its top surface. The pressure generated by the fault makes it open, allowing the gas to pass into the duct. Evacuation from the room of the hot gases and incandescent particles produced by the internal arc must normally be carried out. The UniGear ZS1 switchgear can be fitted with a complete range of solutions to satisfy all requirements, either in the case where evacuation is possible directly at the end of the switchgear, or when solutions from the front or rear are requested. Some installations, such as marine applications, do not allow evacuation of the gases to the outside of the room and therefore a dedicated solution has been developed to guarantee personnel safety and conformity with the Standards, such as longitudinal evacuation chimneys. Please contact your ABB sales representative for more information.

Busbar applications

UniGear ZS1 5 kV or 15 kV can optionally be fitted with an accessory busbar application:
- Voltage transformers for busbar measurements
- Busbar system earthing switch.
- Top entry duct or cables to make interconnections between different sections of switchgear

Unit compartments

A  Circuit-breaker compartment
B  Busbar compartment
C  Cable compartment
D  Low voltage compartment
E  Gas duct channel

UniGear ZS1 single level section view
UniGear ZS1
Fully type-tested

The UniGear ZS1 switchgear has undergone all the tests required by the CSA Standards. Each switchgear unit is subjected to routine tests in the factory before delivery. These tests are also intended to provide a functional check of the switchgear based on the specific characteristics of each installation.

CSA type tests
- Short-time and peak withstand current
- Temperature rise
- Dielectric test

CSA routine factory tests
- Visual inspection and check
- Mechanical sequence operations
- Cabling check
- Electrical sequence operations
- Power frequency withstand voltage
- Measurement of the resistance of the main circuits
- Secondary insulation test
- Corona-extinction test

Description of tests

- **Short-time and peak withstand current**
  The test shows that the main power and the grounding circuits resist the stresses caused by the passage of the short-circuit current without any damage. It should also be noted that both the grounding system of the withdrawable circuit-breaker and the grounding busbar of the switchgear are subjected to the test. The mechanical and electrical properties of the main busbar system and of the top and bottom branch connections remain unchanged even in the case of a short-circuit.

- **Temperature rise**
  The temperature rise test is carried out at the rated current value of the switchgear unit and shows that the temperature does not become excessive in any part of the switchgear unit. During the test, both the switchgear and the circuit-breaker it may be fitted with are checked.

- **Dielectric test**
  These tests verify that the switchgear has sufficient capability to withstand the lightning impulse and the power frequency voltage. The power frequency withstand voltage test is carried out as a type test, but it is also a routine test on every switchgear unit manufactured. Corona-extinction test proves the insulation is in good condition, the maximum allowable value is below 100pC per assembled switchboard.
• Circuit-breaker making and breaking capacity
The circuit-breaker is subjected to the rated current and short-circuit current breaking tests. Furthermore, it is also subjected to the opening and closing of capacitive and inductive loads, capacitor banks and/or cable lines.

• Grounding switch making capacity
The grounding switch of the UniGear ZS1 switchgear can be closed under short-circuit. Although, the grounding switch is normally interlocked to avoid being operated on circuits which are still live. However, should this happen for any one of several reasons, personnel safety would be fully safeguarded.

• Mechanical operations
The mechanical endurance tests on all the operating parts ensures the reliability of the apparatus. General experience in the electro-technical sector shows that mechanical faults are one of the most common causes of a fault in an installation. The circuit-breaker is tested by carrying out a high number of operations - higher than those which are normally carried out by installations in the filed. Furthermore, the switchgear components are part of a quality control program and samples are regularly taken from the production lines and subjected to mechanical life tests to verify that the quality is identical to that of the components subjected to the type tests.

UniGear ZS1
Description of tests
When developing modern medium voltage switchgear, personnel safety must necessarily take priority. This is why the UniGear ZS1 switchgear has been designed and tested to withstand an internal arc due to a short-circuit current of the same current level as the maximum short-time withstand level.

The tests show that the metal housing of UniGear ZS1 switchgear is able to protect personnel near the switchgear in the case of a fault which evolves as far as striking an internal arc.

An internal arc is a highly unlikely fault, although it can theoretically be caused by various factors, such as:

- Insulation defects due to quality deterioration of the components. The reasons can be adverse environmental conditions and a highly polluted atmosphere.
- Overvoltages of atmospheric origin or generated by the operation of a component.
- Inadequate training of the personnel in charge of the installation.
- Breakage or tampering of the safety interlocks.
- Overheating of the contact area, due to the presence of corrosive agents or when the connections are not sufficiently tightened.
- Entry of small animals into the switchgear (i.e. through cable entrance).
- Material left behind inside the switchgear during maintenance activities.

The characteristics of the UniGear ZS1 switchgear notably reduce the incidence of these causes for faults, but some of them may not be eliminated completely.

The energy produced by the internal arc causes the following phenomena:

- Increase in the internal pressure.
- Increase in temperature.
- Visual and acoustic effects.
- Mechanical stresses on the switchgear structure.
- Melting, decomposition and evaporation of materials.

Unless suitably protected, these phenomena have very serious consequences for the personnel, such as wounds (due to the shock wave, flying parts and the doors opening) and burns (due to emission of hot gases). The internal arc test verifies that the compartment doors remain closed and that no components are ejected from the switchgear even when subjected to very high pressures, and that no flames or incandescent gases penetrate, thereby ensuring safety of the personnel near the switchgear.

The test also ensure that no holes are produced in external accessible parts of the housing, and finally, that all the connections to the ground circuit remain intact, hence guaranteeing the safety of personnel who may access the switchgear after the fault.

The IEC 62271-200 Standard describes the methods to be used for carrying out the test and the criteria which the switchgear must conform to.

The UniGear ZS1 switchgear fully conforms to all the five criteria indicated by the IEC standards.

The IAC classification is proved by the test according to the following designations:

- General: classification IAC (Internal Arc Classified)
- Accessibility: A, B or C (switchgear accessible to authorized personnel only (A), to all (B), not accessible due to installation (C))
- F, L, R: access from the front (F – Front), from the sides (L – Lateral) and from the rear (R – rear).
- Test values: test current in kiloamperes (kA), and duration in seconds (s). UniGear ZS1 meets IAC A-FLR for full short circuit rating for a duration up to 1 second.

The parameters of each specific plant mean that evacuation of the hot gases and incandescent particles must be checked very carefully in order to ensure and maintain personnel safety.

Fault limiting systems

The structure of the UniGear ZS1 switchgear offers complete passive type protection against the effects of a fault due to an internal arc for a time of 1 second up to 25 kA.

ABB has also developed excellent active protection systems which allow very important objectives to be achieved:

- Detection and extinction of the fault, normally in less than 100 ms, which improves network stability.
- Limitation of damage on the apparatus.
- Limitation of outage time for the switchgear unit.

For active protection against an internal arc, devices consisting of various types of sensors can be installed in the various compartments, which detect the immediate outburst of the fault and carry out selective tripping of the circuit-breakers.

The fault limiting systems are based on sensors which use the pressure or light generated by the arc fault as trigger for fault disconnection.
ITH
The ITH sensors consist of micro-switches positioned on the top of the switchgear near the gas exhaust flaps of the three power compartments (busbars, circuit-breaker and cables). The shock wave makes the flaps open and operate the micro-switches connected to the shunt opening release of the circuit-breaker.
Total tripping time is 75 ms (15 ms ITH + 60 ms circuit-breaker).

TVOC
This system consists of an electronic monitoring device located in the low voltage compartment which is connected to optic sensors. These are distributed in the power compartments and are connected to the device by means of optic fibres. When a certain pre-set light level is exceeded, the device opens the circuit-breakers.
To prevent the system from intervening due to light occasionally generated by external phenomena (flash of a camera, reflections of external lights, etc.), current transformers can also be connected to the monitoring device.
The protection module only sends the opening command to the circuit-breaker if it receives the light and short-circuit current signal simultaneously.
Total tripping time is 62 ms (2 ms TVOC + 60 ms circuit-breaker).

REA
This system offers the same functionality as TVOC. The REA system consists of the main unit (REA 101) and optional extension units (REA 103, 105, 107) which make it possible to create customized solutions with selective tripping. For more information, please see the dedicated chapter at page 35.
Total tripping time is 62,5 ms (2,5 ms REA + 60 ms circuit-breaker).

UFES (ultra fast earthing switch)
The UFES is an innovative design of an extremely fast-acting earthing switch, grounding all 3 phases within <4 ms after detection of an internal arc fault.
For more information please see the dedicated chapter at page 26.

Arc protection in IED
The REF615, RET615, REM615 and REF610 IEDs (Intelligent Electronic Device) can optionally be fitted with a fast and selective arc flash protection. It offers a two-to three-channel arc-fault protection system for arc flash supervision of the circuit breaker, cable and busbar compartment of switchgear panels.
Total tripping time is 72 ms (12 ms IED + 60 ms circuit-breaker).
UniGear ZS1 switchgear is fitted with all the interlocks and accessories needed to guarantee the highest level of safety and reliability for both installation and personnel.

Interlocks
The safety mechanical interlocks are standard ones [1-5], please see the dedicated table at page 17. They are set out by the IEC standards and are therefore necessary to guarantee the correct operation sequence. ABB safety interlocks guarantees the highest level of reliability, even in the case of an accidental error, and enables highest operator safety system of interlocks.

Keys
The use of key interlocks is very important in realising the interlocking logics between panels of the same switchgear, or of other medium, low and high voltage switchgear. The logics are realised by means of distributors or by ringing the keys. The apparatus truck [6] can be locked in the racked-out position and the relevant lock key can only be removed with the apparatus in this position. The grounding switch closing [7] and opening [8] operations can be locked by means of keys, key logic is explained in the table at page 17. These locks can also be applied to the earthing switch of busbar applications. The circuit-breaker racking-in/out operations [9] and grounding switch opening/closing [10] can be prevented by means of key locks, which prevent insertion of the relevant operating levers. The key lock can also be applied to the grounding switch of busbar applications. The keys can always be removed.

Padlocks
The circuit-breaker [12] and cables [13] compartment doors can be locked in the closed position by means of padlocks. These can be applied to both door closing versions –with central handle (standard) or screws (optional). The operations for apparatus racking-in/out [14] and grounding switch opening/closing [15] can be prevented by applying the padlocks to the insertion slots of the relevant operating levers. The padlock can also be applied to the grounding switch of busbar applications. The metallic segregation shutters [16] between circuit-breaker, busbars and cables compartments can be locked by means of two independent padlocks in both the open and closed positions. Padlocks from 4 to 8 mm diameter can be accommodated.

Locking magnets
The locking magnets enable automatic interlocking logics without human intervention. The circuit-breaker racking-in/out [17] and the grounding switch closing/opening [18] operations can be interlocked. This magnet can also be applied to the grounding switch of busbar applications. The magnets operate with active logics and therefore the lack of auxiliary voltage leaves the interlocking system active in safety condition.

Additional mechanical keys
The switchgear can be equipped with an additional mechanical keys that further increase safety while operating the switchgear. A special set of keys are developed for the service switchgear enabling safe operation of the disconnectors while the circuit breaker is securely disconnected from the main.
### Standard safety interlocks (mandatory)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Condition to be met</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 A</td>
<td>Apparatus racking-in/out</td>
<td>Apparatus in open position</td>
</tr>
<tr>
<td>1 B</td>
<td>Apparatus closing</td>
<td>Defined truck position</td>
</tr>
<tr>
<td>2 A</td>
<td>Apparatus racking-in</td>
<td>Apparatus multi-contact plug plugged</td>
</tr>
<tr>
<td>2 B</td>
<td>Apparatus multi-contact plug unplugging</td>
<td>Truck in test position</td>
</tr>
<tr>
<td>3 A</td>
<td>Grounding switch closing</td>
<td>Truck in test position</td>
</tr>
<tr>
<td>3 B</td>
<td>Apparatus racking-in</td>
<td>Grounding switch in open position</td>
</tr>
<tr>
<td>4 A</td>
<td>Apparatus compartment door opening</td>
<td>Truck in test position</td>
</tr>
<tr>
<td>4 B</td>
<td>Apparatus racking-in</td>
<td>Apparatus compartment door closed</td>
</tr>
<tr>
<td>5 A</td>
<td>Feeder compartment door opening</td>
<td>Grounding switch in ON position</td>
</tr>
<tr>
<td>5 B</td>
<td>Grounding switch opening</td>
<td>Cable compartment door closed</td>
</tr>
</tbody>
</table>

Note: Apparatus are circuit-breakers and contactors.

### Keys (on request)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Condition to be met</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Apparatus racking-in lock</td>
<td>Can only be removed with the truck in the racked-out position</td>
</tr>
<tr>
<td>7</td>
<td>Grounding switch closing lock</td>
<td>Can only be removed with the truck in the racked-out position</td>
</tr>
<tr>
<td>8</td>
<td>Grounding switch opening lock</td>
<td>Can only be removed with the truck in the racked-out position</td>
</tr>
<tr>
<td>9</td>
<td>Insertion of the apparatus racking-in/out crank lever</td>
<td>Can always be removed</td>
</tr>
<tr>
<td>10</td>
<td>Insertion of the grounding switch operating lever</td>
<td>Can always be removed</td>
</tr>
<tr>
<td>11</td>
<td>Operation of the NAL isolating switch</td>
<td>The Tie CB (service switchgear) shall be removed or disconnected in test position</td>
</tr>
</tbody>
</table>

### Padlocks

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Condition to be met</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Apparatus compartment door opening</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Cable compartment door opening</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Insertion of the apparatus racking-in/out crank lever</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Insertion of the grounding switch operating lever</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Shutters opening or closing</td>
<td>It is necessary to use padlocks with 5-8 mm hasp diameter</td>
</tr>
</tbody>
</table>

### Locking magnets (on request)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Condition to be met</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Apparatus racking-in/out</td>
<td>Magnet energized</td>
</tr>
<tr>
<td>18</td>
<td>Grounding switch ON/OFF</td>
<td>Magnet energized</td>
</tr>
</tbody>
</table>

### Accessory devices

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Condition to be met</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>Shutters fail-safe</td>
<td>The device locks the shutters in the closed position when the apparatus is removed from the compartment. The operator cannot open the shutters manually. The shutters can only be operated by the apparatus truck or the service trucks (please see the dedicated chapter at page 22).</td>
</tr>
<tr>
<td>20</td>
<td>Apparatus-switchgear unit compatibility matrix</td>
<td>The apparatus multi-contact plug and relative switchgear unit socket are equipped with a mechanical matrix, that disables apparatus racking-in into a switchgear unit with an inappropriate rated current.</td>
</tr>
<tr>
<td>21</td>
<td>Circuit-breaker mechanical operating mechanism</td>
<td>The apparatus compartment is equipped with a mechanical device, that enables circuit-breaker closing and/or opening directly by means of the front operating mechanism pushbuttons, keeping the door closed. The controls can be operated with the circuit-breakers in the operation and racked-out position.</td>
</tr>
</tbody>
</table>
UniGear ZS1
Vacuum circuit-breaker

UniGear ZS1 switchgear can be fitted with the widest range of apparatus available on the market today and of these the vacuum circuit-breaker now occupies a position of prime importance in all sectors of primary distribution. Vacuum circuit-breakers cover the whole range of switchgear parameters and therefore the whole range of applications.

Many years of experience gained in developing and using vacuum interrupters is today reflected in the range of ABB circuit-breakers, which stand out for their exceptional electrical and mechanical characteristics, extremely long life, low maintenance, compactness and the use of highly innovative construction techniques. ABB develops and produces a complete range of interrupters for use in circuit-breakers and contactors and for all medium voltage applications.

VD4 circuit-breaker
The VD4 medium voltage circuit-breaker interrupters use vacuum to extinguish the electric arc and as the insulating medium. Thanks to the unequalled properties of vacuum and the breaking technique used, current interruption takes place without arc chopping and without overvoltages. Restoration of the dielectric properties following interruption is extremely rapid. The VD4 circuit-breakers are used for protection of cables, overhead lines, motors and transformers. For generator and capacitor applications, contact ABB.

Standards
IEC 62271-100 for the circuit-breaker.

Poles
The VD4 medium voltage circuit-breakers use vacuum interrupters embedded in poles. Embedding the interrupter in the pole makes the circuit-breaker particularly sturdy and protects the interrupter itself against shocks, deposits of dust and humidity. The vacuum interrupter houses the contacts and provides the interruption chamber. ABB circuit-breakers use the most advanced vacuum-breaking techniques: with radial magnetic flow for circuit-breakers with medium-low ratings and with axial magnetic flow for those with high breaking capacity. Both techniques guarantee even distribution of the arc roots over the whole surface of the contacts, allowing optimum performance at all current values.

The structure of a vacuum interrupter is relatively simple. The housing is made up of a ceramic insulator closed at the ends by stainless steel covers. The contacts are made of pure copper and sintered chrome and are welded to the copper terminals. A metallic bellows allows movement of the moving contact-terminal group, at the same time guaranteeing that the vacuum is maintained in the interrupter. The interrupter components are welded in an environment under a very strong vacuum to guarantee a vacuum of less than \(10^{-5}\) Pa in the interrupter.

This means that the interrupter does not any ionisable material. In any case, on detachment of the contacts, an electric arc is generated which only consists of the melted and vaporised material of the contact. A metallic shield is integrated inside the interrupter to capture the metallic vapours given off during interruption, as well as for controlling the electric field. The particular shape of the contacts generates a magnetic field which forces the arc to rotate and to involve a much wider surface than that of a fixed contact arc.
Apart from limiting the thermal stress on the contacts, this makes contact erosion negligible and, above all, allows the interruption process to be controlled even with very high short-circuit currents.

The electric arc remains supported by the external energy until the current passes through its natural zero. The ABB vacuum interrupters are zero current interrupters and are free of any re-striking phenomena.

The rapid reduction of the current density and fast condensation of the metallic vapours, that happens at the instant that the current passes through zero, allow the maximum dielectric strength between the interrupter contacts to be re-established within a few milliseconds. Supervision of the vacuum level is not necessary as the circuit-breaker poles are sealed-for-life and do not require any maintenance.

Operating mechanism

The VD4 circuit-breaker is fitted with a mechanical stored energy type operating mechanism.

The trip free mechanism allows opening and closing operations independent of the operator.

The operating mechanism spring system can be recharged either manually or by means of a geared motor. The apparatus can be opened and closed by means of the pushbuttons on the front of the operating mechanism or by means of electric releases (shunt closing, shunt opening and undervoltage). The circuit-breakers are always fitted with an anti-pumping device to eliminate the possibility of simultaneous opening and closing commands, closing commands with springs discharged or with the main contacts not yet in their run-end position.

Truck

The poles and operating mechanism are fixed onto a metal support and handling truck.

The truck is provided with a wheel system which makes the operations for racking the apparatus into and out of the switchgear unit possible with the door closed. The truck allows efficient grounding of the circuit-breaker by means of a sliding contact touching the guide rail and directly connected to the frame main grounding bus bar.

The vacuum circuit-breaker truck can be optionally motor-operated. The racking-out and racking-in operations can be carried out by means of electrical controls, either locally by the operator or by a remote system.

Apparatus-operator interface

The front part of the circuit-breaker provides the user interface. It features the following equipment:

- ON pushbutton.
- OFF pushbutton.
- Operation counter.
- Indicator of the circuit-breaker open and closed state.
- Indicator of the charged or discharged state of the operating mechanism springs.
- Manual charging device for the operating mechanism springs.
- Override selector of the undervoltage release (optional).

VM1 circuit-breaker

The conventional mechanical stored energy type of operating mechanism used on the VD4 circuit-breakers can be replaced with an operating mechanism with magnetic actuator, creating the VM1 series of circuit-breakers available for UniGear ZS1 5 kV and 15 kV.

All the characteristics of the circuit-breakers described in this chapter remain unchanged except for the operating mechanism.

The operating mechanism is based on a greatly reduced number of components:

- Actuator with permanent magnets. The heart of the operating mechanism consists of the magnetic actuator which carries out the closing and opening operations, and keeps the main contacts in their positions taken up after the operation. The magnet transmits the operating mechanism to the interrupters by means of a single transmission lever.
- Electronic control device. All the functions (trip, operation, energy charging and watchdog) are carried out by the integrated electronic controller. The circuit-breaker is fitted with a multivoltage direct and alternating current feeder.
- Capacitors. The energy required to switch the operating mechanism is provided by an incorporated capacitor bank. The stored energy guarantees the complete O-C-O reclosing sequence.
- Position sensors. The position of the circuit-breaker contacts is detected by means of electronic proximity sensors.

Standards

IEC 62271-100 for the circuit-breaker.
UniGear ZS1 switchgear can also be fitted with SF6 gas circuit-breakers.
The ABB vacuum and gas series of circuit-breakers are mechanically interchangeable and the same switchgear unit can therefore take either type of apparatus. Only ABB can offer apparatus representing both techniques for the whole range of applications, voltage levels (12-17.5 kV), rated current (630...4000 A) and breaking capacity (16...50 kA).
This makes it possible to specify the optimum solution for the installation characteristics and the feeders to be switched and protected.
ABB’s long practical experience shows that the two types of circuit-breakers are equally valid and complementary.

HD4 circuit-breaker
The HD4 medium voltage circuit-breakers use sulphurhexafluoride gas (SF6) to extinguish the electric arc and as the insulating medium.
Thanks to the excellent properties of SF6 gas, interruption of the currents takes place without arc chopping and overvoltages. There is no restriking phenomenon after interruption and the dielectric properties following interruption are recovered extremely rapidly.
Gas circuit-breakers are available for all electric power distribution applications. They are particularly recommended for use on capacitor banks, motors, transformers insulated in oil and in installations where components which are particularly sensitive to dielectric and dynamic stresses are installed (for example, old cables or transformers).

Poles
The HD4 circuit-breaker poles use the autopuffer breaking system, combining the compression and self-blast techniques in a single solution.
The autopuffer system is the most innovative technique in the field of gas circuit-breakers and originates from high voltage apparatus.
Operating mechanism

The HD4 circuit-breaker is fitted with a mechanical stored energy operating mechanism. This is trip free and therefore allows opening and closing operations independent of the operator.

The operating mechanism spring system can be recharged either manually or by means of a geared motor. The operating mechanism is of the same type for the whole series and has a standardised range of accessories and spare parts.

All the accessory components can easily be replaced by means of plug-socket connectors.

Opening and the closing of the apparatus can be carried out by pushbuttons on the front of the operating mechanism or by electric releases (shunt closing, shunt opening and undervoltage).

The circuit-breakers are always fitted with an anti-pumping device to eliminate the possibility of simultaneous opening and closing commands, closing commands with springs discharged or with the main contacts not yet in their run-end position.

Truck

The poles and operating mechanism are fixed onto a metal support and handling truck.

The truck is provided with a wheel system which makes the operations for racking the apparatus out of and into the switchgear unit possible with the door closed.

The truck allows effective earthing of the circuit-breaker by means of the metallic structure of the switchgear unit.

Apparatus-operator interface

The front panel of the circuit-breaker provides the user interface. It features the following equipment:

- ON pushbutton.
- OFF pushbutton.
- operation counter
- indicator of the circuit-breaker open and closed state
- indicator of the charged and discharged state of the operating mechanism springs
- manual charging device for the operating mechanism springs
- override selector of the undervoltage release (optional)
- LED gas pressure indicator (optional)

HD4-HXA circuit-breaker for high unidirectional components

The range of HD4 circuit-breakers is extended by the HD4-HXA version.

This series of circuit-breakers maintains all the features described in this chapter, but is notable for its ability to switch loads with strong unidirectional components.

For breaking capacities of 40 kA or lower, HD4-HXA circuit-breakers are able to switch loads with unidirectional components IDC = 100%, up to service voltage 13.8 kV; at 50 kA the unidirectional component percentage IDC is reduced to 50%.

They can be used in all installations affected by strong unidirectional components, but their natural field of application is found in switching and protecting transformers of the auxiliary circuits in power generating stations.

Standards

IEC 62271-100 for the circuit-breaker.
IEC 60376 for the SF6 gas.
The UniGear panels can be fitted with ABB NAL type Isolating switches for the service switchgear type. The NAL isolating switches are medium voltage air-insulated apparatus consisting of a fixed support to which the post insulators are applied (top and bottom), the system of contacts (fixed and moving) and latching pliers (of the insulating bars).

NAL-NALF isolating switch

The isolating switch is fitted with two systems of moving blade contacts, the main one (through which the load current passes with the switch in the closed position) and the arc-breaking one (through which the current passes during the opening and closing operations). This solution means the main contacts are not stressed and therefore keeps the electrical characteristics of the apparatus unchanged. During isolating switch opening, air is compressed by the pistons contained in the top insulator cylinders. At the moment of opening and separation of the contacts, a blast of compressed air is emitted through special nozzles, so the arc is cooled and deionised.
UniGear ZS1 panel with fixed isolating switch is classified LSC1 because the cable and apparatus compartments are not physically segregated. Each switchgear panel is fitted with an auxiliary compartment, where the instruments and auxiliary cabling are housed. All the switchgear panels are accessible from the front and maintenance and service operations can therefore be carried out even when the switchgear is wall-mounted.

Standards
- CSA C22.2 No. 193 High Voltage Full-Load Interrupter Switches

### Electrical characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated maximum voltage</td>
<td>27.6 kV</td>
</tr>
<tr>
<td>Rated insulation voltage</td>
<td>27.6 kV</td>
</tr>
<tr>
<td>Rated power frequency withstand voltage</td>
<td>27.6 kV 1 min 60</td>
</tr>
<tr>
<td>Rated lightning impulse withstand voltage</td>
<td>125 kV</td>
</tr>
<tr>
<td>Rated frequency</td>
<td>60 Hz</td>
</tr>
</tbody>
</table>
The UniGear ZS1 range is equipped with all the service trucks needed for service maintenance activities. The trucks are divided into four different types:

- Grounding without making capacity
- Grounding with making capacity
- Cable test
- Isolation

Grounding truck without making capacity
These trucks carry out the same function as the grounding switches without making capacity. They therefore have no capacity to ground live circuits in fault conditions. They are used to ensure an additional fixed ground, as is required by certain installation service and maintenance procedures, as a further safety guarantee for personnel. The use of these trucks require the removal of the apparatus (circuit-breaker) from the switchgear and its replacement with the truck.

The switchgear panels preset for use of the grounding trucks must be provided with a key lock which, when activated, prevents their racking-in. This truck is available in two versions:

- Grounding of the main busbar system.
- Grounding of the power cables.

The grounding truck of the main busbars, during the racking-in phase, only lifts the top shutter and earths the contacts connected to the top branch connections (and therefore to the main busbar system) by means of the switchgear structure.

Grounding truck with making capacity
These trucks carry out the same function as the grounding switches with making capacity. They consist of circuit-breakers provided with top (grounding of the main busbars) or bottom (earthing of the power cables) terminals only. The contacts without terminals are short-circuited by means of a copper bar and connected to ground by means of the apparatus truck. They keep all the characteristics of the circuit-breakers, such as full making and breaking capacity on live circuits under fault conditions.

They are used to ensure extremely effective grounding on circuits stressed by a fault. They allow opening and closing operations to be carried out rapidly with electric remote control.

The use of these trucks require the removal of the apparatus (circuit-breaker) from the switchgear and its replacement with the truck. The switchgear panels preset for use of the grounding trucks must be provided with a key lock which, when activated, prevents their being racked-in.
This truck is available in two versions:

• Grounding of the main busbar system.
• Grounding of the power cables.

The grounding truck of the main busbars, during the racking-in phase, only lifts the top shutter and presets the contacts connected to the top branch connections (and therefore to the main busbar system) for closing to ground by means of operating mechanism.

The grounding truck of the power cables, during the racking-in phase, only activates the bottom shutter and presets the contacts connected to the bottom branch connections (and therefore to the power cables) for closing to earth by means of operating mechanism.

These trucks can also be used in the bus-tie unit. In this case, they ground one of the two sides of the main busbar system.

**Power cable test truck**

These trucks allow the insulation tests on the power cables to be carried out without accessing the feeder compartment or disconnecting the cables from the switchgear.

The use of these trucks require the removal of the apparatus (circuit-breaker) from the switchgear and its replacement with the truck.
The UFES (Ultra Fast Earthing Switch) is an innovative design of an extremely fast-acting earthing switch, grounding all 3 phases within less than 4 ms after detection of an internal arc fault.

The extremely short operating time of the primary switching element, in conjunction with rapid and reliable detection of fault current and light, ensures that an internal arc fault is extinguished nearly immediately after its formation. Thermal and mechanical damage inside of the protected switchgear system are thus effectively prevented.

The UFES is available to fulfill a variety of applications in the UniGear ZS1 switchgear:
- Busbar installation with top-housing box (UniGear ZS1 5 kV and 15 kV)
- Cable compartment installation (UniGear ZS1 5 kV, 15 kV, 27.6 kV)

Unbeatable advantages in case of an arc fault event
- Drastic reduction of repair costs: no damages on the switchgear equipment to be expected. No exchange of the faulty panel.
- Greatly increased system availability: after inspection and elimination of the fault reason the switchgear can be taken into service again within shortest possible time.
- Greatly increased operator safety for human mal-operation under maintenance conditions.

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### Electrical maximum characteristics in UniGear ZS1

<table>
<thead>
<tr>
<th></th>
<th>IEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated insulation voltage (rms) (1)</td>
<td>kV 12</td>
</tr>
<tr>
<td>Rated power frequency withstand voltage (rms)</td>
<td>kV 28</td>
</tr>
<tr>
<td>Rated lightning impulse withstand voltage (peak)</td>
<td>kV 75</td>
</tr>
<tr>
<td>Rated frequency</td>
<td>Hz 50/60</td>
</tr>
<tr>
<td>Rated short-time withstand current (rms) (1)</td>
<td>kA 50</td>
</tr>
<tr>
<td>Rated short-circuit making current</td>
<td>kA 125</td>
</tr>
<tr>
<td>Rated duration of short-circuit</td>
<td>s 3</td>
</tr>
</tbody>
</table>

(1) GB/DL version is available with higher request in dielectric characteristics (42 kV) and short-time withstand current (4 s).
UniGear ZS1
Instrument transformers

Block type current transformers
The block type current transformers are epoxy resin insulated and used to supply the measurement devices and protection instruments. These transformers can have a wound core or a bushing bar with one or more cores, with performance and accuracy classes suitable for the installation requirements. They conform to the CAN/CSA-C61869-1. Their dimensions are in accordance with the DIN 42600 Narrow Type Standard, in the Medium and Long Size versions up to 2500 A.
The current transformers can also be provided with a capacitive socket for connection to voltage signalling devices. The current transformers are normally fitted on the load side of the apparatus compartment for measurement of the phase currents of the switchgear unit. Fitting on the supply side of the apparatus compartment is also possible (busbar applications) for measuring the busbar currents or for achieving particular protection schemes. The ABB range of current transformers is designated TPU.

Ring core current transformers
The toroidal transformers are of the epoxy resin insulated type and are used to supply measurement and protection devices. These transformers can feature either a closed or openable core. They can be used both for measuring phase currents or for detecting the earth fault current. They conform to the CAN/CSA-C61869-1.

TPU 2500 A
KOKS 3150 A
UniGear ZS1
Instrument transformers

Voltage transformers
The voltage transformers are of the epoxy resin insulated type and are used to supply measurement and protection devices. They are available for installation on removable and withdrawable trucks. They conform with the CAN/CSA-C61869-2 Standards. Their dimensions are in accordance with the DIN 42600 Narrow type Standard. These transformers can have one pole, with performance and precision classes suited to the functional requirements of the instruments connected to them. When they are installed on removable or withdrawable trucks they are fitted with medium voltage protection fuses. The withdrawable trucks also allow replacement of the fuses with the switchgear in service. Truck racking-out with the door closed automatically operates closure of a metallic segregation shutter between the live parts of the switchgear and the instrument compartment. The ABB range of voltage transformers is designated TJP.
Sensors based on advanced measurement principles have been developed as successors to conventional instrument transformers in order to achieve significant reduction in dimensions, increase of safety and to provide greater rating standardization with a wider functionality range. The sensor technology has been used in ABB since the beginning of the 1990s and there are more than 120 000 sensors installed and operating to date.

Conventional instrument transformers with magnetic cores are based on well-known principles that have been utilized with all their advantages as well as limitations for more than 120 years. However the connected equipment (protection relays) has significantly changed during the last 20 years. New protection relays place different requirements on primary measurement equipment (instrument transformers) compared to classic electromechanical relays. These new requirements also open up the opportunity for the utilization of advanced measurement principles that offer a wide range of additional benefits. Sensors open up a way for current and voltage signals needed for the protection and monitoring of medium voltage power systems. These advantages can be fully used in connection with modern protection relays.

**Sensor characteristics**

ABB current and voltage sensors are designed without the use of a ferromagnetic core. The current sensor is based on the principle of Rogowski coil, voltage sensor uses the principle of resistive voltage divider. Sensor technology brings several important benefits for the user and the application. The main benefit is that the behavior of the sensor is not influenced by magnetizing curve which results in a highly accurate and linear response across a wide dynamic range of measured quantities. The linear and highly accurate characteristic curve of the sensor across its full operating range enables several metering and protection classes to be combined in one particular winding.

**Energy savings solution**

The sensor technology means no transfer of power from the primary to the secondary side, which means negligible power losses. Therefore, the sensors exhibit extremely low energy consumption the value of which is just a fraction of what is converted into heat in a conventional instrument transformer. This fact contributes to significant energy savings during the system’s entire operating life, supporting world-wide efforts to reduce energy consumption.

**Easy switchgear integration solution**

Since the sensor elements are particularly small and the same elements are used for both measurement and protection, the current and voltage sensors can easily be integrated in the switchgear. These facts enable the sensors to be designed in a highly optimal way, which contributes to a high level of switchgear simplification.

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**Performance comparison between conventional current transformer and current sensor**

<table>
<thead>
<tr>
<th>Secondary output</th>
<th>Saturation level</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 A</td>
<td>10 A</td>
</tr>
<tr>
<td>100 A</td>
<td>100 A</td>
</tr>
<tr>
<td>1 000 A</td>
<td>1 000 A</td>
</tr>
<tr>
<td>10 000 A</td>
<td>10 000 A</td>
</tr>
</tbody>
</table>

**ABB sensor**

- ABB sensor

**Standard CT**

- Standard CT
Indoor current sensors
Current measurement in KECA sensors is based on the Rogowski coil principle.

**KECA 80 C104 / KECA 80 C165**

For dynamic current measurement (protection purposes) the ABB sensors KECA 80 C104, and KECA 80 C165, fulfill requirements of protection class 5P up to an impressive value reaching the rated short-time thermal current \( I_{th} \) (31.5 kA or 50 kA).

With KECA 80 C104 and KECA 80 C165 sensors, measuring class 0.5 is reached for continuous current measurement in the extended accuracy range from 5 % of the rated primary current \( I_{pr} \) not only up to 120 % of \( I_{pr} \) (as being common for conventional current transformers), but even up to the rated continuous thermal current \( I_{cth} \) (1 250 A or 4 000 A).

That provides the possibility to designate the corresponding accuracy class as 5P400 and 5P630, proving excellent linearity and accuracy measurements.

**Technical parameters**
- Continuous thermal current: 1 250 / 4 000 A
- Rated primary current: 80 A / 150 mV @ 50 Hz
- Rated primary current: 80 A / 180 mV @ 60 Hz
- Accuracy class: 0.5 / 5P400; 0.5 / 5P630

**KECA 80 C184 / KECA 80 C216**

For dynamic current measurement (protection purposes) the ABB sensors KECA 80 C184, and KECA 80 C216, fulfill requirements of protection class 5P up to an impressive value reaching the rated short-time thermal current \( I_{th} \) (31.5 kA).

With KECA 80 C184 and KECA 80 C216 sensors, measuring class 0.5 is reached for continuous current measurement in the extended accuracy range from 5 % of the rated primary current \( I_{pr} \) not only up to 120% of \( I_{pr} \) (as being common for conventional current transformers), but even up to the rated continuous thermal current \( I_{cth} \) (1 250 A or 3 150 A).

That provides the possibility to designate the corresponding accuracy class as 5P400, proving excellent linearity and accuracy measurements.

**Technical parameters**
- Continuous thermal current: 1 250 / 3 150 A
- Rated primary current: 80 A / 150 mV @ 50 Hz
- Rated primary current: 80 A / 180 mV @ 60 Hz
- Accuracy class: 0.5 / 5P400
UniGear ZS1
Current and voltage sensors

Indoor voltage sensors
Voltage measurement in the KEVA sensor is based on the resistive divider principle.

KEVA 17.5 B20
KEVA B sensor can be used in all applications up to the voltage level 17.5 kV.
The sensor fulfills requirements of accuracy class 0.5 for measurement purposes and accuracy class 3P for protection purposes.

Technical parameters
■ Rated primary voltage 15/√3 kV
■ Rated power frequency withstand voltage 38 (42) kV
■ Rated lightning impulse withstand voltage 95 kV
■ Transformation ratio 10 000:1
■ Accuracy class 0.5 / 3P

KEVA 24 B20
KEVA B sensor can be used in all applications up to the voltage level 27.6 kV.
The sensor fulfills requirements of accuracy class 0.5 for measurement purposes and accuracy class 3P for protection purposes.

Technical parameters
■ Rated primary voltage 22/√3 kV
■ Rated power frequency withstand voltage 50 kV
■ Rated lightning impulse withstand voltage 125 kV
■ Transformation ratio 10 000:1
■ Accuracy class 0.5/3P
ABB's power protection philosophy

Having delivered protection relays to more than 100 countries, ABB fully understands the need for diverse protection philosophies that meet local legislation, safety requirements and engineering practice. Therefore, ABB has developed a power protection philosophy that not only serves the specific needs and requirements of diverse power systems, but also creates confidence and peace of mind for both the power system owners and users.

The main purpose of a protection relay system is to recognize any abnormal power system condition(s), or abnormally operating system component(s). Based on the information gathered, the protection system will initiate corrective actions that return the system to its normal operating state. This provides a safe environment for all.

Protection relays are activated when something abnormal has happened in the power system; they do not prevent network faults from arising. Selecting the right protection functions and methods improves the performance and the reliability of the protection system, thus minimizing the effects of network faults and preventing the disturbance from spreading to the healthy parts of the network.
Advantages of a complete protection system

Close attention must be paid to operating speed, sensitivity, selectivity and reliability of the protection system. There is a strong correlation between the operating speed of the protection system and the damage and danger caused by a network fault. Substation automation provides remote control and monitoring capabilities, which speed up the location of faults and the restoration of the power supply. Fast operation of the protection relays also minimizes post-fault load peaks. Together with voltage dips, post-fault load peaks increase the risk of the disturbance spreading to healthy parts of the network. The sensitivity of the protection must be adequate to detect relatively high resistance earth faults and short-circuits in the most distant parts of the network. Reliable selectivity is essential to limit the loss of power supply to as small a part of the network as possible, and to allow the faulted part of the network to be reliably located. Corrective actions can then be directed to the faulty part of the network, so that the power supply can be restored as quickly as possible.

The protection system must have a high degree of reliability. This also means that if, for example, the circuit breaker (CB) fails to operate, the back-up protection will clear the fault. Substation automation (SA) puts the operator in complete control of the substation. In addition, SA improves the power quality of the transmission and distribution network under normal operation, but especially in a disturbance situation and during substation maintenance activities. An SA or SCADA brings the full benefits of digital technology into protection and control of the networks. The protection relays are easily set-up and parameterized through easy and safe access from the operator’s workplace.

Example of ABB power system using Relion protection relays, Station Automation COM600 and MicroSCADA Pro/System 800xA
Relion® protection and control relays
The Relion® product family offers the widest range of products for the protection, control, measurement and supervision of power systems for IEC and ANSI applications – from generation and interconnected transmission grids over primary distribution to secondary distribution kiosks.

The Relion protection relays are deeply rooted in ABB’s vast experience of developing successful protection and control relays. These relays have been developed during many years and are built on the experience gathered from wide ranging application and functionality requirements of ABB’s customers globally.

To ensure interoperable and future-proof solutions, Relion products have been designed to implement the core values of the IEC 61850 standard. The genuine implementation of the IEC 61850 substation modelling and communication standard covers both vertical and horizontal information exchange between protection relays and external systems. The protection and control IED manager PCM600 provides versatile functionality throughout the life cycle of all Relion protection and control relays. PCM600 is IEC 61850 compliant, which ensures smooth engineering of the relays and enables information exchange with other IEC 61850 compliant tools.

With these products, you benefit from ABB’s leading-edge technology, global application knowledge and experienced support network. The Relion technology is leading the way and setting the future trends in the field of protection and control systems.
Relion 610 series
The Relion 610 series provides dedicated protection for utility distribution and industrial applications. The 610 series protection relays offer protection and supervision of the medium-voltage power systems in a compact design. The 610 series is popular for its easy parametrization, thus short time-to-operation.

Relion 615 series
The Relion 615 series protection relays can be defined as a compact and versatile solution for power distribution in utility and industrial applications. The 615 series provides standard configurations, which allows you to easily adapt and set-up your applications, still allowing you to adapt the configuration according to application-specific needs. The 615 series combines compactness and powerful features in one smart package.

Relion 620 series
The Relion 620 series protection relays increase flexibility in demanding utility and industrial applications for power distribution. They are delivered with example configurations to ease adaptation into your specific applications. The series offers customization possibilities, which supports higher levels of standardization in the applications. The 620 series extends the hardware possibilities further compared to the 615 series.

Relion 630 series
The pre-configured Relion 630 series protection relays feature flexible and scalable functionality to adapt to different needs in power distribution networks and industrial applications. The 630 series protection relays contain pre-configured application configurations, which can be freely tailored to meet specific requirements for distribution applications.

Relion 650 series
The Relion 650 series offers ease of use from ready-to-use solutions. The 650 series protection relays provide optimum ‘off-the-shelf’ solutions. These relays are equipped and configured with complete protection functionality and default parameters to meet the needs of a wide range of applications within generation, transmission and sub-transmission.

Relion 670 series
The Relion 670 series protection and control relays provide versatile functionality, as well as maximum flexibility and performance to meet the highest requirements of any application in generation, transmission and sub-transmission protection systems. The 670 series relays are available as pre-configured and fully customized relays.

Relion Interactive Selection Guide
The Relion Interactive Selection Guide (ISG) helps you select the protection relay type that is the most suitable for your application. It also provides links to relevant documentation online. The Relion ISG is available at: http://abb.relionisg.com
Feeder protection
Feeder protection, or more exactly protection for overhead lines and cables, is the most used type of protection in power systems. The protection has to ensure that the power grid continues to supply energy. In the event of a fault, it has to be prevented from spreading to healthy parts of the network. The relays also have to minimize the damage to the cables and other connected equipment, as well as ensure safety for operating personnel.

ABB has a large number of feeder protection relays. There are several multifunctional protection relays for different application ranges. Among the protection relays there are some used for general feeder protection (protection against overcurrent) and as back-up protection. There are also more specialized relays, for example, for line differential protection.

The selected protection scheme has to fulfill the application specific requirements regarding sensitivity, selectivity and operating speed. The protection requirements are mainly determined by the physical structure of the network. In most cases the requirements, listed above, can be fulfilled with non-directional/directional over-current protection functions. In power networks with a more complex structure, more advanced protection functions, such as, distance protection or line differential protection, may have to be introduced.

The purpose of the over and undervoltage protection system is to monitor the network's voltage level. If the voltage level deviates from the target value by more than the permitted margin for a specific time period, the voltage protection system limits the duration of the abnormal condition and the stresses caused to the power system or its components.

To prevent major outages due to frequency disturbances, substations are usually equipped with underfrequency protection relays, which in turn, control various load-shedding schemes.

A specific area for applying line differential protection is emerging with feeder applications requiring an absolutely selective unit protection system. The zone-of-protection for a line differential protection system is the feeder section, defined by the location between the current measurement devices (current transformers or Rogowski coils). In certain cases there can be a power transformer within the protection zone. Unit protection guarantees exact and fast isolation of the fault and allows continued operation of the unaffected part of the power network.

These are just a few examples of the major protection functions for feeders. More details can be found in the technical documentation available online for ABB’s protection and control devices.

Product offering
The recommended products for feeder protection are part of ABB’s Relion® product family. The Relion product family offers the widest range of products for the protection, control, measurement and supervision of power systems for IEC and ANSI applications.

Relion 615 series
The Relion 615 series offers a compact and versatile solution for power distribution in utility and industrial applications. The protection relays are delivered with a standard configuration for easier and faster relay engineering and shorter time-to-operation.
The Relion 620 series offers flexibility and performance for demanding power distribution in utility and industrial applications. The series offers wider application coverage in one product compared to the 615 series, which enables wider standardization of the product type in your application. The 620 series protection relays are delivered with an example configuration, which helps adaptation to user specific requirements.

For more information, please refer to the following documentation:
– Line Differential Protection and Control RED615 Product Guide
– Feeder Protection and Control REF615 Product Guide
– Feeder Protection and Control REF620 Product Guide
– Feeder Protection and Control REF630 Product Guide

The Relion Interactive Selection Guide (ISG) helps you select the protection relay type that is the most suitable for your application. It also provides links to relevant documentation online. The Relion ISG is available at: http://abb.relionisg.com

The Relion 630 series protection relays feature flexible and scalable functionality to adapt to different needs in power distribution networks and industrial applications. The relays contain pre-configured application configurations, which can be tailored to meet the specific requirements for also the most demanding distribution applications.
Transformer protection
The power transformer is an important component and one of the most valuable discrete units in power distribution networks. High availability of the power transformer is of particular importance for preventing disturbances in the power distribution system.

Although high-quality power transformers are very reliable, insulation breakdown faults occasionally occur. These faults appear as short circuits and/or earth faults. They tend to cause severe damage to the windings and transformer core. The damage is proportional to the fault clearing time, so the power transformer must be disconnected as quickly as possible.

For repair, the power transformer has to be transported to a workshop, which is a very time-consuming process. The operation of a power network, where the power transformer is out of service, is always cumbersome. Therefore, a power transformer fault often constitutes a more severe power system fault than a line fault, which usually can be rectified rather quickly. It is extremely important that fast and reliable protection relays are used to detect transformer faults and initiate tripping.

The size, voltage level and importance of the power transformer determine the extent and choice of monitoring and protection devices to be used to limit the damage, when a fault occurs. Compared to the total cost of the power transformer and the costs caused by a power transformer fault, the cost of the protection system is negligible.

Product offering
The recommended products for transformer protection are part of ABB’s Relion® product family. The Relion product family offers the widest range of products for the protection, control, measurement and supervision of power systems for IEC and ANSI applications.

Relion 615 series
The Relion 615 series offers a compact and versatile solution for power distribution in utility and industrial applications. The series covers two winding transformer application and automatic voltage regulator function in separate product types. Each protection relay is delivered with a standard configuration for easier and faster relay engineering and shorter time-to-operation.
Relion 620 series
The Relion 620 series offers flexibility and performance for demanding power distribution in utility and industrial applications. The series offers wider application coverage, including transformer application and automatic voltage regulator, in one product. Compared to the 615 series, it enables wider standardization of the product type in the application. The 620 series relays are delivered with an example configuration, which can be pre-adapted to user specific requirements.

Relion 630 series
The Relion 630 series protection relays feature flexible and scalable functionality to adapt to different needs in power distribution networks and industrial applications. The relays contain pre-configured application configurations, which can be tailored to meet the specific requirements for also the most demanding distribution applications. In one easily scalable hardware solution, it includes extensive transformer protection and automatic voltage regulator functions.

For more information, please refer to the following documentation:
- Transformer Protection and Control RET615 Product Guide
- Voltage Protection and Control REU615 Product Guide
- Transformer Protection and Control RET620 Product Guide
- Transformer Protection and Control RET630 Product Guide

Relion Interactive Selection Guide
The Relion Interactive Selection Guide (ISG) helps you select the protection relay type that is the most suitable for your application. It also provides links to relevant documentation online. The Relion ISG is available at: http://abb.relionisg.com
Motor protection
Motor protection is generally expected to provide overcurrent, unbalance, earth-fault and short-circuit protection of the motor. However, the fundamental issue for motors is thermal protection, as overheating is the worst threat.

Motors need to be protected not only against electrical faults, but also against any improper usage. ABB’s solutions focus on advanced thermal protection that prevents improper use. Overload conditions of short duration mainly occur during start-up. Improper use of running motors does not necessarily damage the equipment, but shortens its life span. Therefore, a reliable and versatile motor protection system not only protects the motor - it also prolongs its life cycle, which contributes to improving the return of investment of your motor drive.

Product offering
The recommended products for motor protection are part of ABB’s Relion® product family. The Relion product family offers the widest range of products for the protection, control, measurement and supervision of power systems for IEC and ANSI applications.

Relion 615 series
The Relion 615 series offers a compact and versatile solution for power distribution in utility and industrial applications. The series is a suitable choice for protection and control of asynchronous motors. Each protection relay is delivered with standard configuration, for easier and faster relay engineering and shorter time-to-operation.

Relion 620 series
The Relion 620 series offers flexibility and performance for demanding power distribution in utility and industrial applications. Compared to the 615 series, the 620 series offers wider application coverage in one product, which enables wider standardization of the product type in your application. The protection relay is delivered with an example configuration, which can be pre-adapted to your specific requirements.

Relion 630 series
The Relion 630 series protection relays feature flexible and scalable functionality to adapt to different needs in power distribution networks and industrial applications. The relays contain pre-configured application configurations, which can be tailored to meet specific requirements for also the most demanding distribution applications. In one easily scalable hardware solution, it includes extensive motor protection including differential protection function.
For more information, please refer to the following documentation:
– Motor Protection and Control REM615 Product Guide
– Motor Protection and Control REM620 Product Guide
– Motor Protection and Control REM630 Product Guide

**Relion Interactive Selection Guide**
The Relion Interactive Selection Guide (ISG) helps you select the protection relay type that is the most suitable for your application. It also provides links to relevant documentation online. The Relion ISG is available at: http://abb.relionisg.com
Generator protection
Generators or generating units constitute one of the most crucial parts in a power system, making it essential to use a proper protection scheme. A generator has more failure modes than any other component in the power system. It is very important that the protection system detects all faults, and that it does so quickly, as they may cause injury to personnel and damage to the equipment.

It is common practice that earth faults, short circuits and other severe faults must be detected by two independent protection devices. The fault must be cleared, even if one switching device fails to operate. The generator protection system must also provide adequate backup protection for the adjacent components.

A synchronous machine is a complex device, which can operate as a generator or as a motor. The armature/stator winding is arranged in three symmetrical phase belts in slots in the stator surface. The magnetic field intensity can be controlled via the DC-current in the rotor/field winding.

The protection of synchronous generators involves the consideration of more possible faults and abnormal conditions than the protection of any other power system component. We have to consider stator faults, rotor faults, abnormal operating conditions and faults in the connected power grid.

Today there are many and varying power station configurations. This makes the use of a uniform and standardized generator protection system very challenging. Besides the varying power station configuration, the following factors influence the design of the generator protection system:
- generator circuit-breaker or not
- earthing of the generator neutral
- location of the voltage transformers
- location of the current transformers

A rotating machine provides a classic application for differential protection. The generator differential protection gives a fast and absolutely selective detection of generator stator short circuits.

Product offering
The recommended products for generator protection are part of ABB’s Relion® product family. The Relion product family offers the widest range of products for the protection, control, measurement and supervision of power systems for IEC and ANSI applications.

Relion 630 series
The Relion 630 series protection relays feature flexible and scalable functionality to adapt to different needs in power distribution networks and industrial applications. The relays contain pre-configured application configurations, which can be tailored to meet specific requirements for also the most demanding distribution applications. In one easily scalable hardware solution, it includes extensive protection for generator and generator-transformer units used in various power plants.

For more information, please refer to the following documentation:
- Generator Protection and Control REG630 Product Guide
- Relion Interactive Selection Guide

The Relion Interactive Selection Guide (ISG) helps you select the protection relay type that is the most suitable for your application. It also provides links to relevant documentation online. The Relion ISG is available at: http://abb.relionisg.com
Voltage protection

Overvoltage in a network occurs either due to the transient surges in the network or due to prolonged power frequency overvoltages. The overvoltage function can be applied to power network elements, such as generators, transformers, motors, busbar and power lines, to protect the system from excessive voltages that could damage the insulation and cause insulation breakdown.

Undervoltage and low voltage conditions are caused by abnormal operation or a fault in the power system. The undervoltage protection function is used to disconnect from the network devices, for example electric motors, which are damaged when subjected to service under low voltage conditions.

Additionally synchro-check function duration mode checks that the voltages on both sides of the circuit breaker are perfectly synchronized. It is used to perform a controlled reconnection of two systems, which are divided after islanding. It is also used to perform a controlled reconnection of the system after reclosing.

The frequency protection function uses positive phase-sequence voltage to measure the frequency reliably and accurately. The system frequency stability is one of the main principles in distribution and transmission network maintenance. To protect all frequency-sensitive electrical apparatus in the network, operation above/below the allowed bandwidth for a safe operation should be prevented. To guarantee network frequency stability you need to apply underfrequency, overfrequency or load-shedding schemes.

Another important and common way of regulating the voltage in the power network is using a voltage regulator on the power transformer.

Product offering

The recommended products for voltage protection are part of ABB’s Relion® product family. The Relion product family offers the widest range of products for the protection, control, measurement and supervision of power systems for IEC and ANSI applications.

Relion 615 series

The Relion 615 series offers a compact and versatile solution for power distribution in utility and industrial applications. The series is a suitable choice for protection and control of voltage based protection. REU615 standard configuration A is the ideal choice for voltage and frequency based protection, including synchro-check and load-shedding functionality. REU615 standard configuration B offers a dedicated relay with an automatic voltage regulator function for power transformers with on-load tap changer. Each protection relay is delivered with standard configuration, for easier and faster relay engineering and shorter time-to-operation.

Voltage Protection and Control REU615
Relion 620 series
The Relion 620 series offers flexibility and performance for demanding power distribution in utility and industrial applications. Compared to the 615 series, RET620 offers wider application coverage in one product, including voltage and frequency based protection with automatic voltage regulator function. The relays are delivered with an example configuration, which can be pre-adapted to user specific requirements.

Relion 630 series
The Relion 630 series protection relays feature flexible and scalable functionality to adapt to different needs in power distribution networks and industrial applications. The relays contain pre-configured application configurations, which can be tailored to meet specific requirements for also the most demanding distribution applications. In one easily scalable hardware solution, you gain load-shedding with automatic voltage regulator functions.

For more information, please refer to the following documentation:
– Voltage Protection and Control REU615 Product Guide
– Transformer Protection and Control RET620 Product Guide
– Transformer Protection and Control RET630 Product Guide

Relion Interactive Selection Guide
The Relion Interactive Selection Guide (ISG) helps you select the protection relay type that is the most suitable for your application. It also provides links to relevant documentation online. The Relion ISG is available at: http://abb.relionisg.com
Capacitor bank protection

Capacitors form an essential part of the network and must be properly protected against overloads, overcurrents or other distortion during their connection to the network.

Capacitor banks are used for reactive power compensation in utility substations and industrial power systems. Most of the loads connected to the distribution feeders have the power factor on the inductive side, for example, motors and arc furnaces. This reactive current component does not contribute the conversion into useful power, but it stresses the network components, introducing additional voltage drops and heat losses. The most favorable approach is to compensate the reactive current as close to the consumption as possible. The compensation can be done locally, at the place where it is needed, for example, at the factory or facility. It can also be done remotely by, for example, a utility organization.

Extra charges are always applied when excess level of reactive load is taken from the network. Therefore, the utilities have to evaluate the reactive power balance within their distribution network and do the necessary compensation at the most suitable location.

Product offering

The recommended products for capacitor bank protection are part of ABB’s Relion® product family. The Relion product family offers the widest range of products for the protection, control, measurement and supervision of power systems for IEC and ANSI applications.

Relion 615 series

The Relion 615 series offers a compact and versatile solution for power distribution in utility and industrial applications. The series is a suitable choice for protection and control of capacitor banks. Additionally, it can be applied to harmonic filter protection. Each protection relay is delivered with a standard configuration, for easier and faster relay engineering and shorter time-to-operation.

For more information, please refer to the following documentation:

– Capacitor Bank Protection and Control REV615 Product Guide

Relion Interactive Selection Guide

The Relion Interactive Selection Guide (ISG) helps you select the protection relay type that is the most suitable for your application. It also provides links to relevant documentation online. The Relion ISG is available at: http://abb.relionisg.com
Arc fault protection

An electric arc short-circuit in a switchgear installation is normally caused by a foreign object entering the cubicle or by component failure. The arc causes an explosion-like heat and pressure effect, usually causing vast damage to the switchgear and in the worst-case scenario also injury to the operating personnel.

An adequate arc protection system protects your substation against arc faults via minimizing the burning time of the arc, thus preventing excessive heat and damage. It minimizes material damage and allows power distribution to be smoothly and safely restored. The system can also bring cost benefits even before an arc fault occurs. As older switchgear is more prone to arc faults, an arc protection system will effectively extend the life of your switchgear enhancing the return on your investment.

Sources of arcing may be insulation faults, mal-operating devices, defective bus or cable joints, overvoltage, corrosion, pollution, moisture, ferro-resonance (instrument transformers) and even ageing due to electrical stress. Most of these arc fault sources could be prevented by sufficient maintenance. However, regardless of precautions taken, human errors can lead to arc faults.

Time is critical when it comes to detecting and minimizing the effects of an electric arc. An arc fault lasting 500 ms may cause severe damage to the installation. If the burning time of the arc is less than 100 ms the damage is often limited, but if the arc is extinguished in less than 35 ms its effect is almost unnoticeable.

Generally applied protection relays are not fast enough to ensure safe fault clearance times at arc faults. The operation time of the overcurrent relay controlling the incoming circuit breaker may, for instance, have been delayed to hundreds of milliseconds for selectivity reasons. This delay can be avoided by installing an arc protection system. The total fault clearance time can be reduced to a maximum of 2.5 ms plus the circuit breaker's contact travel time. Further, when a cable compartment fault occurs, auto-reclosing can be eliminated by employing arc fault protection.

The REA system is a fast and flexible arc fault protection system for air-insulated low voltage and medium-voltage switchgear.
Product offering
The recommended products for arc fault protection is the arc fault protection system REA 101 with its extension units REA 103, REA 105 and REA 107 and protection and control relays from ABB’s Relion® product family.

REA system
The REA system is a fast and flexible arc fault protection system for switchgears. This type of fast and selective arc fault protection system is a natural constituent of modern switchgear panels, and a safety and security investment for older switchgear panels, to protect human lives and prevent or reduce material damage. The REA system can be described as the fastest operating arc fault protection system in ABB’s product portfolio, with trip command time in less than 2.5 ms.

Relion 615 series and 620 series
The Relion® product family offers integrated arc fault protection in its widest range of products for the protection, control, measurement and supervision of power systems for IEC and ANSI applications.

The Relion 615 and 620 series offer integrated three channel arc fault protection – to protect human lives and prevent or reduce material damage of protected switchgear – for power distribution in utility and industrial applications. The arc fault protection function operates with high-speed outputs with operation times down to 4 ms.

For more information, please refer to the following documentation:
- Arc Fault Protection REA 101 main module Product Guide
- Arc Fault Protection REA 103 extension module Product Guide
- Arc Fault Protection REA 105 extension module Product Guide
- Arc Fault Protection REA 107 extension module Product Guide
- Feeder Protection and Control REF615 Product Guide
- Motor Protection and Control REM615 Product Guide
- Transformer Protection and Control RET615 Product Guide
- Voltage Protection and Control REU615 Product Guide
- Capacitor Bank Protection and Control REV615 Product Guide
- Feeder Protection and Control REF620 Product Guide
- Motor protection and control REM620 Product Guide
- Transformer Protection and Control RET620 Product Guide

Relion Interactive Selection Guide
The Relion Interactive Selection Guide (ISG) helps you select the protection relay type that is the most suitable for your application. It also provides links to relevant documentation online. The Relion ISG is available at: http://abb.relionisg.com

An A redundant and selective arc fault protection system, with a single-busbar, two section switchgear, which is fed from two power transformers. Each Relion 615 series protection relay with integrated arc fault protection is supervising compartments of the metal-enclosed switchgear panels. The selectivity of tripping between the 615 series protection relays is achieved via utilizing IEC 61850 GOOSE communication. The REA 101 main unit is used as the redundant arc protection system for the switchgear bus sections.
Station automation

ABB’s protection and control relays are an integral part of substation automation systems. The substation automation system, together with the protection relays, lay the foundation for all the higher-level remote functions, such as advanced power system management and the monitoring of the condition of the equipment, when it is in service. Station-level systems are easy to use and to adapt to customer-specific requirements.

Increased competition is driving many power providers to focus on system productivity, with the aim to reduce costs and increase customer satisfaction. To reach this goal, an upgrade of an aging infrastructure is usually involved. Updating to substation automation offers the opportunity to reduce operational and maintenance costs, increase plant productivity with the help of enhanced schemes, as well as condition monitoring for the apparatus (e.g., circuit breakers, power transformers).

Product offering

COM600, is an all-in-one communication gateway, automation platform and user interface solution for utility and industrial distribution substations.

The COM600 hardware platform is based on ruggedized mechanics, with no moving parts subject to wear and tear. Thus, the compact and robust design is well adapted for harsh environments. The Station Automation COM600 offers web server functionality, providing a human machine interface (HMI) for local substation monitoring and control. Secure communication enables the access of the substation HMI over the Internet or LAN/WAN for any authorized user with a standard PC and a web browser.

The Station Automation COM600 also provides gateway functions for mapping data and signals between substation and higher-level systems such as SCADA and DCS. COM600 gathers data from protection relays and process devices using different communication protocols. The supported protocols can be combined freely in one station computer, limited only by the number of hardware interfaces and the license. COM600 uses web technology to display data to different users in a user-friendly manner. The optional slave protocols enable the transfer of information to a network control centre (NCC) or distributed control system (DCS).

COM600 benefits from the potential of the IEC 61850 standard by using the IEC 61850-6 substation configuration language (SCL) and IEC 61850-7 communication modeling, regardless of the protocol used. As the IEC 61850 data modeling is used for all communication protocols, the gateway cross-reference is done in the same way regardless of the protocol, for example IEC 61850-8-1 or DNP3.

All primary single-line diagram (SLD) devices are displayed on one screen. The SLD recognizes different voltage levels and different busbar systems, such as single busbar, double busbar and duplex systems. The four-mode busbar coloring visualizes the busbar status and you can configure the coloring of the busbar to your own preferences. The single line diagram can be configured to include an indication for the local/remote selection switch. Alarm symbols and generic symbols can be placed in the SLD to give an even better overview of the status. In addition, generic control buttons can be added to control objects.

COM600 is designed for smooth system integration and interoperability based on pre-configured solutions utilizing connectivity packages for ABB’s protection relays.

For more information, please refer to the following documentation:
– Station Automation Controller COM600 Product Guide
UniGear ZS1
Distribution automation

Example of utility application

Example of industrial application
Remote I/O concept
ABB’s remote I/O concept introduces a new way of extending the I/O capabilities of protection relays. The concept is aimed at increasing the hardware functionality of the protection relays, while still maintaining the relay’s compact design. This way remote I/O can be used, when it is needed. The information between the remote I/O units and the main protection relay is exchanged over the latest communication standard IEC 61850. This enables easy integration into the systems and is in line with the latest standards.

The remote I/O concept also benefits from installing the I/O units as close as possible to the place where the signals need to be digitalized, thus limiting extensive wiring within the switchgear, substation or plant. Digitalization of the signals allows users to use information wherever needed, without need of installing additional auxiliary relays or terminals. IEC 61850 enables signals supervision, thus faster recognition of any errors and proactive operation, if these conditions happen during a critical process.

Product offering
The remote I/O unit RIO600 is designed to expand the digital and analog I/O of ABB’s Relion® series protection relays and to provide I/O for the station automation device COM600 using the IEC 61850 communication.

RIO600 is designed using a modular architecture where the amount and type of I/O ports can be added through modules. The RIO600 modules can be stacked on a standard DIN rail to achieve the required configuration.

RIO600 is built on an industrial hardware platform, which provides the same reliability, performance and real-time functionality as ABB’s protection relays, withstanding extreme temperatures, electromagnetic interference and stringent industry standards.

RIO600 provides an additional I/O within the switchgear itself by using the Ethernet-based IEC 61850 horizontal GOOSE communication. The signals can be transmitted within the switchgear and to the automation systems. Similarly, signals from the automation systems can be executed through RIO600 connected to numerical protection relays.

For more information, please refer to the following documentation:
– Remote I/O unit RIO600 Product Guide
# Selection table for protection relays

The Relion Interactive Selection Guide (ISG) is available online. Go to: http://abb.relionisg.com

In the table:
- x = function supported
- o = function available as option

## Standard
- ANSI
- IEC

## Application
- Arc fault protection application
- Busbar application
- Back-up application
- Capacitor bank application
- Feeder application
- Generator
- Motor application
- Power management/load-shedding application
- Transformer application

## Functionality
- Autorecloser
- Circuit breaker controllability
- Condition monitoring
- Current-based protection
- Distance protection
- Fault locator
- Generator differential protection
- LCD display with Single Line Diagram (SLD)
- Line differential protection (with in-zone transformer support)
- Load-shedding
- Motor differential protection
- On load tap changer control
- Power quality
- Self-powered protection relay
- Synchro-check
- Transformer differential protection
- Voltage based protection
- Withdrawable release mechanism

## Hardware
- Analog inputs (CTs/VTs)
- Analog inputs (sensor channels/CTs)
- Binary inputs/outputs
- RTD/mA inputs
- mA outputs

## Communication protocols
- DNP 3.0
- IEC 60870-5-103
- IEC 61850
- Modbus
- Profibus

## Communication media
- Ethernet (RJ45)
- Ethernet (LC)
- Ethernet redundant solutions (HSR/PRP/RSTP)
- Serial (RS 232/485, ST conn.)

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<thead>
<tr>
<th>Function</th>
<th>REF610</th>
<th>REM610</th>
<th>REL610</th>
<th>REF615 IEC</th>
<th>REM615 IEC</th>
<th>REL615 IEC</th>
<th>RET615 IEC</th>
<th>REU615 IEC</th>
<th>Ref615 ANSI</th>
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**Note:** The table above provides a selection guide for various protection relay models, indicating which functions are supported or available as options across different models.
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|       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| 18/13 | 14/13 | 32/18 | 20/14 | 16/17 | 32/18 | 14/13 | 16/17 | 50/45 | 50/45 | 50/45 | 50/45 | 50/45 | 50/45 | 50/45 | 50/45 | 50/45 | 50/45 | 50/45 |
| 6/2   | 2/1   | 6/2   | 12/4  | 8/3   | 14/5  | 2/1   | 8     | 8     | 8     | 8     | 8     | 8     | 8     | 8     | 8     | 8     | 8     | 8     |
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Power management systems

Power management systems (PMS) are essential for a safe, efficient and reliable operation of a power system within an electrical network. The PMS functionality includes load-shedding generator control, power sharing, network synchronization and power restoration. PMS solutions protect and optimize the stability of industrial systems against disturbances by ensuring power sharing between generators, when the industrial power system is islanded from the grid. These solutions also ensure that the generators meet the required power demand, when the network is grid-connected.

PMS solutions are suitable for industrial power networks:
- With captive power generation, islanded or grid-connected
- With substantial and critical loads
- With unstable grid connectivity
- Without grid connectivity

The PMS functionality suite is applicable to various industrial segments, for example, oil and gas, marine, pulp and paper, metals, minerals and building automation.

Load-shedding is required, when the electrical load demand exceeds the capacity of the available power sources, subsequent to the loss of power sources or network dis-integration. The load-shedding system has to ensure availability of electrical power to all essential and, most importantly, critical loads in the plant. This is achieved by switching off the nonessential loads in case of a lack of power in the electrical network or in parts of it (subnetwork or island).

The load-shedding functionality can also be deployed in industrial power networks with sole dependency on the utility networks. The lack of electrical power can be caused by a loss of generation capacity or power grid connectivity or the tie line feeding power to the plant.

Based on the shortfall of available power in the power network, the load-shedding action initiated by the system ensures that only identified loads are shed, the system is stable after load-shedding, and the impact on the associated plant operation is minimal. The system allows flexibility to select or deselect the load feeders to be load-shed at any point in time during plant operation.

The load-shedding function must be accurate and selective. It is important that it operates only when necessary.

Load-shedding principles

There are two load-shedding system principles: (1) reactive load-shedding (reacts on measurement) and (2) active load-shedding (reacts on cause).

Reactive load-shedding is most commonly used in utility networks in primary distribution substations. Reactive load-shedding reacts based on measuring the system frequency and/or voltage. The system as such can contain several triggering levels for these values. Each triggering level corresponds to one of the load-shedding priority classes or steps, for example, activation of the first triggering level, which sheds the loads belonging to priority class 1. Typically
two or three priority classes or steps are used. Restoration of the shed feeders can take place manually or automatically, in a pre-programmed scenario. Selectivity against protection functions has to be secured, for example, the load-shedding system has to have a change to operate before the protection system is initiated.

Active load-shedding is mostly used in industrial distribution networks. Active load-shedding reacts based on measuring power, current values on supply and load feeders (key feeders included). The load-shedding system knows the present loading situation and calculates shedding priorities for different network scenarios, such as tripping or overloading of a generator or a network power source. Knowing the individual loads of feeders, only the necessary amount of load (feeders) will be shed. The reactive load-shedding system can work as a back-up for active load-shedding.

Product offering

ABB's Relion® protection relays are characterized by functional scalability and flexible configurability. These relays are equipped with enough levels of voltage or frequency based functions and free configurability and can perform reactive load-shedding.

One of the examples for active load-shedding devices is PML630. PML630 is a power management relay that provides a comprehensive load-shedding solution for the power network in an industrial plant. It protects the plant against blackouts and power source outages due to system disturbances. This relay is a member of ABB's Relion product family and a part of its 630 series characterized by their functional scalability and flexible configurability.

PML630 complies to IEC 61850 and offers seamless connectivity with Relion family protection relays, RIO600 I/O units and COM600 to realize the load-shedding functionality. The protection relays use GOOSE and MMS communication profiles for I/O data exchange with other Relion family protection relays and COM600.

PML630 provides system level protection to small or medium-sized industrial systems from the system disturbances. PML630 supports different modes of load-shedding functions:

- Fast load-shedding (active load-shedding)
- Slow (overload or maximum demand violation-based) load-shedding (active load-shedding)
- Manual load-shedding (reactive load-shedding)
- Underfrequency load-shedding as a backup to fast and slow load-shedding (reactive load-shedding)

A network power deficit occurs when a power source such as a generator or a grid transformer trips. There could also be a power shortage, when a network becomes isolated due to trip of a bus coupler or a bus tie breaker. All load-shedding functions can be active concurrently.

For more information, please refer to the following documentation:

- Voltage Protection and Control REU615 Product Guide
- Feeder Protection and Control REF620 Product Guide
- Transformer Protection and Control RET620 Product Guide
- Load-shedding controller PML630 Product Guide
- Relion Interactive Selection Guide

The Relion Interactive Selection Guide (ISG) helps you select the protection relay type that is the most suitable for your application. It also provides links to relevant documentation online. The Relion ISG is available at: http://abb.relionisg.com
Automatic transfer systems are used to ensure maximum service continuity, supplying the power users uninterruptedly.

All this is possible using various systems based on different kinds of techniques. The most common of these are outlined below, with the relevant average transfer times:

- Delayed: 1500 ms
- Depending on the residual voltage: 400 - 1200 ms
- Synchronized automatic transfer system: 200 - 500 ms
- High speed transfer device: 100 ms
- High speed transfer system: 30 ms

The first two systems are the simplest and can also be achieved with conventional logics and instruments. They guarantee average transfer times and can therefore be used in installations where voltage gaps are not particularly critical.

The other three systems: (1) synchronized automatic transfer system, (2) high speed transfer device and (3) high speed transfer system require microprocessor-based apparatus with high technology content. They guarantee fast transfer times. They are used in plants where the process is particularly critical, in which slow transfers would cause serious malfunction or interruption of the process itself.

ABB offers all types of transfer systems, from the simplest to the most complex.

Synchronized automatic transfer system (ATS)

Protection relays from Relion® product family can be used in medium-voltage switchgear to manage automatic and manual transfer between different incoming feeders. The time needed for automatic transfer carried out by means of the Relion family protection relays is between 200 to 300 ms (including the circuit breaker operating times). The time can vary within the range indicated in relation to the complexity of the software transfer logics.

Switchgear equipped with Relion protection relays, suitably configured, are complete and efficient systems able to manage transfer between one power supply system and an alternative one, or to reconfigure the network, passing from double radial distribution to a simple system, in a fully automatic way.

It is also possible to carry out the same operation manually from a remote control station, or from the front of the switchgear under user supervision. Manual transfer means making the passage parallel, by means of the synchronism control function (synchro-check) implemented from the protection relay, the power supply lines are closed simultaneously with synchronisation of the voltage vectors to then return to being disconnected when the transfer has taken place. The applications described do not require additional instruments.
SUE 3000 - High speed transfer device / High speed transfer system

Voltage decrease or complete supply interruptions represent the most crucial and critical problems for the quality of energy supply today. The SUE 3000 High Speed Transfer Device guarantees an optimal safeguarding of energy supply. The device ensures, in combination with the existing circuit breakers, the continued power supply and protects the subsidiary process from expensive stoppage time. Further, the operation of the installation is considerably simplified through the possibility of manually-initiated transfers for targeted clearings.

To achieve the fastest possible transfer time of 30 ms the High Speed Transfer System has to be used. This system is a combination of the SUE 3000 device, special trigger devices and very fast magnetic circuit breakers.

Application areas
The SUE 3000 High Speed Transfer Device can be used wherever a disturbance of the electrical supply would lead to a breakdown in production, which would have a significant impact on the operating costs.

Possible areas of utilization include:
1. Auxiliary installations serving power stations
2. Environmental technology installations
3. Voltage supply to continuous industrial processes

To realize permanent availability, the load is supplied from at least two synchronized feeders, which are independent from one another and equipped with a SUE 3000 device.

SUE 3000 takes on the task of ensuring uninterrupted continuous operation of the connected devices in case of a power supply breakdown. The device takes different physical factors into account and executes the quickest possible transfer to a different feeder, which is kept on stand-by.

Corresponding to its multifaceted areas of application, the SUE 3000 is set up for different switchgear arrangements.

Permanent network comparisons
An exceptionally important characteristic, that clearly distinguishes SUE 3000 from competing concepts, is that synchronicity criteria are continuously available, as they are computed online. This is the reason that, in case of an initiation, the appropriate transfer mode is already determined and can be immediately initiated. This means that the probability of a fast transfer is considerably enhanced. Systems which wait for the instant of initiation to start the determination of the network status are not capable to perform a fast transfer with minimum interruption time.

Transfer modes and times
Four different transfer modes are available in detail: (1) fast transfer, (2) transfer at the 1st phase coincidence, (3) residual voltage transfer and (4) time-operated transfer. When a fault occurs, fast transfer is the optimal transfer mode for ensuring that only a minimum interruption of the voltage supply occurs. With fast transfer mode, the total transfer time, counting from a fault in the main feeder until the standby feeder is cut in, is less than 100 ms.

For more information, please refer to the following documentation:
– High Speed Transfer Device SUE 3000 Product Description
UniGear Digital represents advanced switchgear solution addressing important requirements of the future:

- Flexibility
- Increased process efficiency
- Lower cost of operation
- Maximized integration
- Reliability and safety

Thanks to UniGear Digital you do not need to face many of the practical challenges in today’s more complex applications, and you have less worries in your electrical network.

UniGear Digital makes it easy to focus on applications and create reliable, efficient electrical network due to use of well-proven components: current and voltage sensors, protection and control relays with IEC 61850 digital communication.

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**UniGear Digital is...**

**Safe and reliable**
- Increases equipment reliability
- Increases safety level in your substation
- Extended communication supervision functionality is available

**Intelligent and ready for the future**
- Provides flexibility towards varying load flows
- Provides flexibility during switchgear operation
- Offers possibility of late customizations and changes

**Simple and efficient**
- Minimizes lifetime costs during switchgear operation
- Saves space in your switchgear room by reducing switchgear footprint
- Offers 30 % quicker delivery time from order to switchgear operation *

**Lower environmental impact**
- Lowers energy consumption up to 250 MWh ** which represents saving of 13 000 EUR
- Saves up 150 tons of CO₂ **, that is equal to emissions produced by mid-size European car driven for 1 250 000 km

* compared to a conventional UniGear ZS1
** compared to typical substation with 14 switchgear panels of UniGear ZS1 type over 30 years of operation
Protection relay with IEC 61850

Current sensor

Voltage sensor

UniGear ZS1 Digital

Single-line diagram of typical units

IF - Incoming/outgoing feeder

OFM - Outgoing with BB measurement

BT - Bus-tie

R - Riser
UniGear ZS1
Typical units

Single-line diagram of typical units

**Key to components**
- **Standard components**
- **Optional configurations**
Single-line diagram of typical Service switchgear units for 27.6 kV only

Complying with Hydro-Quebec F22-01 Electricity Metering for Medium and High-Voltage Installations and E 21-12 Red Book
Medium-Voltage Electrical Service

Single supply-side isolating switch - Bottom power cables

Single supply-side isolating switch - Top power cables
UniGear ZS1
Typical units

Single-line diagram of typical Service switchgear units for 27.6 kV only
Complying with Hydro-Quebec F22-01 Electricity Metering for Medium and High-Voltage Installations and E 21-12 Red Book
Medium-Voltage Electrical Service

Double supply-side isolating switch - Bottom power cables

Double supply-side isolating switch - Top power cables
Single-line diagram of typical Service switchgear units for 27.6 kV only

Complying with Hydro-Quebec F22-01 Electricity Metering for Medium and High-Voltage Installations and E 21-12 Red Book
Medium-Voltage Electrical Service

Double supply-side isolating switch with circuit breaker - Bottom power cables

Double supply-side isolating switch with circuit breaker - Top power cables
UniGear ZS1
Typical units

Graphical symbols

- Circuit-breaker
- Isolating switch
- Ground
- Voltage transformers
- Current transformers
- Cable entry
- Busbar entry
UniGear ZS1 - Single Busbar System

Technical data

### Units: ... 5 - 15 kV - ... 31.5 kA

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| IF | Incoming/outgoing |
| BT | Bus-tie |
| R | Riser |
| RM | Riser with measurements |
| M | Measurements |
| IFD | Direct incoming/outgoing |
| IFDM | Direct incoming/outgoing with measurement |

### Units: ... 5 - 15 kV - 40 / 50 kA

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| IF | Incoming/outgoing |
| BT | Bus-tie |
| R | Riser |
| RM | Riser with measurements |
| M | Measurements |
| IFD | Direct incoming/outgoing |
| IFDM | Direct incoming/outgoing with measurement |

### Units: ... 27.6 kV - ... 25 kA

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<td>Depth (mm)</td>
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<td>Rated current (A)</td>
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<td>2000</td>
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| IF | Incoming/outgoing |
| BT | Bus-tie |
| R | Riser |
| RM | Riser with measurements |
| M | Measurements |
| IFD | Direct incoming/outgoing |
| IFDM | Direct incoming/outgoing with measurement |

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(1) The height of the unit is a function of the height of the low voltage compartment, available in the 705 and 1100 mm versions.
(2) Gas duct with outlet. Gas duct with top chimneys = 2875 mm.
Contact us

Your sales contact: www.abb.com/contacts
More product information: www.abb.com/productguide

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