
DISTRIBUTION SOLUTIONS

ZS8.4

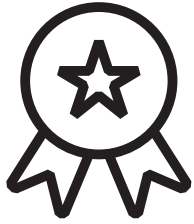
Medium-voltage air-insulated
switchgear



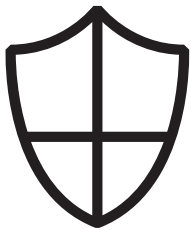
ZS8.4 combines mature, well-established switchgear technology with modern manufacturing processes to deliver the optimum cost-effective solution.

Today there is an installed base of more than 20 000 ZS8.4 panels in Central Europe, Asia and the Gulf States, with the majority found in Germany.

Benefits



Well-established switchgear technology with more than 20 000 panels produced and installed



Maximum flexibility and highest safety level for people and equipment



Cost-effective solution

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ZS8.4

Description

Customers throughout Europe rely on ABB's ZS8.4 family of air-insulated switchgear to provide the ideal, flexible solution for virtually any application.

Today there is an installed base of more than 20.000 ZS8.4-panels in Central Europe, Asia and the Gulf States, with the majority found in Germany.

ZS8.4 combines mature, well-established switchgear technology with modern manufacturing processes to deliver the optimum cost-effective solution. ABB's ongoing product development process has resulted in the addition of a contactor panel as well as panels with expanded automatic protection against accidental contact.

ABB's ZS8.4 range is designed to provide maximum flexibility and the highest possible safety for circuit-breaker systems or switch-disconnector installations, using either conventional instrument transformers or modern sensor technology. Developed to meet the specific needs of medium voltage switchgear users in every respect, ZS8.4 delivers perfect power distribution.

ABB provides utility, industrial and commercial customers with safe, reliable and smart technologies for the distribution of electricity. This extensive global offering includes distribution automation products, switching, limiting, measuring and sensing devices, switchgear, modular substation packages and related services.

ABB offers innovative and fully-integrated compact medium voltage switchgear concepts that enable customers operating in today's increasingly competitive demanding markets to receive the maximum return on investment in their vital network assets.

ZS8.4 is available up to 24 kV. The 17.5 kV and 24 kV switchgear are built up by two power compartments, while the 12 kV version is available with two or three compartments - see chapter IEC Classification for more details.

ZS8.4 switchgear can be equipped with vacuum circuit-breakers and switch-disconnectors, as well as with conventional instrument transformers and with sensors. Available panel variants includes incoming, outgoing, metering, bus tie and bus riser. ZS8.4 offers very compact dimensions, especially depthwise.

ZS8.4 is type tested according to IEC 62271-200 and also according to the new IEC 62271-202 standard.

ZS8.4 is medium voltage switchgear with a metal enclosure, suitable for indoor installations. The partitions between the switchgear compartments are available with either:

- Metallic partitions between adjacent compartments (PM)
- Insulated partitions between adjacent compartments (PI)

Since the switchgear is highly modular type, this make simple selection of components required by any application.

The functional units of the switchgear are guaranteed arc proof 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. The switchgear can be back to wall installed.

Apparatus

The range of apparatus available for ZS8.4 includes:

- Withdrawable vacuum circuit-breakers with mechanical
- Withdrawable vacuum contactors with fuses
- Fixed version of switch-disconnectors

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 or sensors 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:

- IEC 62271-1 for general purposes
- IEC 62271-200 for the switchgear
- IEC 62271-102 for the earthing switch
- IEC 62271-100 for the circuit-breakers
- IEC 60071-2 for the insulation coordination
- IEC 62271-106 for the contactors
- IEC 60265-1 for the switch-disconnectors
- IEC 60529 for degree of protections

Colour of the external surfaces

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

Degrees of protection

The degrees of protection of the switchgear conform with IEC 60529 Standards. ZS8.4 switchgear is normally supplied with the following standard degrees of protection:

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

The electrical characteristics of the switchboard can vary for ambient conditions other than those described in the previous section.

ZS8.4

Description

Switchgear		ZS8.4 12 kV	ZS8.4 17.5 kV	ZS8.4 24 kV
Width	[mm]	650	650	800
Depth (LSC type PI)	[mm]	1 000	1 000	1 200
Depth (LSC type PM)	[mm]	1 200	1 200	1 200
Rated voltage	[kV]	12	17.5	24
Rated power frequency withstand voltage	[kV / 1 min]	28	38	50
Rated lightning impulse withstand voltage	[kV]	75	95	125
Rated frequency	[Hz]	50 / 60	50 / 60	50 / 60
Rated main busbar current (40°C)	[A]	630 / 1 250	630 / 1 250	630 / 1 250
Rated feeder current (40°C) Circuit-breaker panel	[A]	630 / 1 250	630 / 1 250	630 / 1 250
Rated feeder current (40°C) Switch-disconnector panel	[A]	630 ¹⁾	630 ¹⁾	630 ²⁾
Rated feeder current (40°C) Contactor panel	[A]	220 ^{3) 5)}	-	-
Rated peak withstand current	[kA]	...63	... 63 ⁶⁾	... 63 ⁸⁾
Rated short-time current	[kA / 3 s]	16 / 20 / 25	16 / 20 / 25 ⁷⁾	16 / 20 / 25 ⁷⁾
Arc proof withstand current (IEC 62271-200) ⁹⁾	[kA / 1 s]	16 / 20 / 25	16 / 20 / 25 ⁷⁾	16 / 20 / 25 ⁷⁾
Rated load breaking current of the switch-disconnector	[A]	...630	...630	...630
Rated short-circuit making current of the switch-disconnector	[kA]	...63	...50	...40 ⁸⁾
Rated short-circuit breaking current of the circuit-breaker	[kA]	...25	...25	...25
Rated short-circuit making current of the circuit-breaker	[kA]	...63	...63	...63
Rated operating sequence		O - 0.3 s - CO - 15 s - CO	O - 0.3 s - CO - 15 s - CO	O - 0.3 s - CO - 15 s - CO
Total break time	[ms]	50 ... 75	50 ... 75	50 ... 75
Operating time	[ms]	60 ... 80	60 ... 80	60 ... 80
Internal arc classification - gas exhaust into switchgear room		AFL	AFL	AFL
Internal arc classification - gas evacuation out of swg. room		AFLR	AFLR	AFLR
Tested according to		IEC	IEC	IEC
Height of cable connection	[mm]	341 - 582 ⁴⁾	341 - 582 ⁴⁾	341 - 767

¹⁾ 1 000 A available on request

²⁾ 800 A available on request

³⁾ Rated current at max. fuse size 400 A (SIBA) 6 kV

⁴⁾ Cable connection height depends on panel type

⁵⁾ Max. service voltage 7.2 kV

⁶⁾ 17.5 kV switch-disconnector panel up to 50 kA

⁷⁾ 17.5 kV switch-disconnector panel only 20 kA / 24 kV switch-disconnector panel 20 kA or 25 kA for switch-disconnector with fuse (max. fuse size 40 A)

⁸⁾ 63 kA for 24 kV panel with switch-disconnector with fuse (max. fuse size 40 A)

⁹⁾ 200 ms for PI version without gas duct and closed cable tunnel without possibility of bottom gas pressure release equipped with arc fault current duration limiting devices



ZS8.4

IEC Classification

With the release of the IEC 62271-200 standard, new definitions and classifications of Medium Voltage switchgear have been introduced. One of the most significant changes is that classification of switchgear into metal-enclosed, compartmented and cubicle types has been abandoned.

The revision of switchgear classification rules has been based on the user's point of view, in particular on aspects like service and maintenance of the switchgear, according to the requirements and expectations for proper management, from installation to dismantling. In this context, Loss of Service Continuity (LSC) has been selected as a fundamental parameter for the user.

According to the IEC 62271-200, ZS8.4 switchgear can be defined as follows.

Loss of service continuity

The various LSC categories describe possibility of keeping other compartments and/or panels energized while a compartment in the main circuit is opened. The defined categories are:

- 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-2A: The same as LSC-1 with the exception that the main busbars and the functional units adjacent to the one under maintenance can remain energized
- LSC-2B: The same as LSC-2A with the exception that the cable compartment can remain energized

For detailed information regarding ZS8.4 LSC categories please see table on next page.

Partition Metallic

With regard to the type of partitions or shutters between live parts and an open compartment, a distinction is made between two partition classes:

- Class PM (Partition made of Metal)
- Class PI (Partition made of Insulating material)

The partitions between ZS8.4 compartments are available with either:

- Metallic partitions between adjacent compartments (PM)
- Insulated partitions between adjacent compartments (PI)

Interlock-controlled accessible compartment

The front side of ZS8.4 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.

Internal arc classification

The switchgear units have been tested according to IEC 62271-200 standard (Annex A, accessibility type A, IAC classification AFL and AFLR).

Internal arc fault qualification with additional arrangements. Additional arrangements does mean arc runner on each panel and covers on the endpanels (on top as well behind to close gap between panel and switchgear room wall).

- AFL 25 kA, 1 s: pressure exhaust into the switchgear room

Limited to 200 ms for PI version without gas duct and closed cable tunnel without possibility of bottom gas pressure release equipped with arc fault current duration limiting devices

Internal arc fault qualification with pressure relief duct:

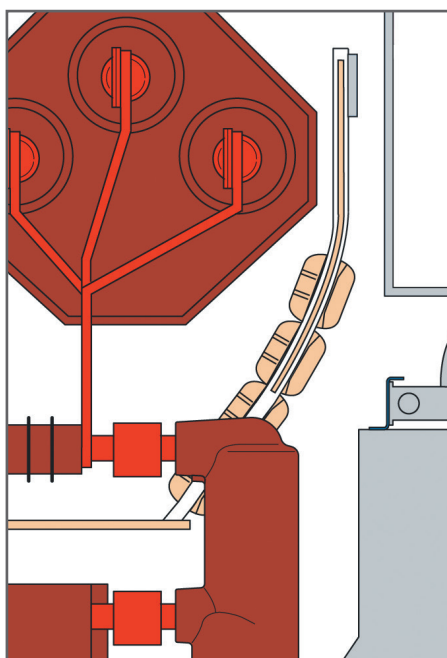
- AFLR 25 kA, 1 s: pressure exhaust outside of the switchgear room
- AFL 21 kA, 1 s: pressure exhaust into the switchgear room (special exhaust equipment as tested in combination with concrete station according to IEC 62271-202)

LSC Classification for each ZS8.4 panel type

Panel type	LSC Classification	Partition
IF Incoming/outgoing	LSC2A	PI
IF Incoming/outgoing	LSC2A	PM
IF Incoming/outgoing	LSC2B	PM
DF Switch-disconnector unit	LSC2A	PI
DF Switch-disconnector unit	LSC2A	PM
IFC Contactor panel	LSC2A	PM
IFD Direct incoming/outgoing	LSC1	-
IFDM Direct incoming/outgoing with measurement	LSC2A	PM
BT Bus-tie	LSC2A	PI
BT Bus-tie	LSC2A	PM
BT Bus-tie	LSC2B	PM
R Riser	LSC1	PI
R Riser	LSC1	PM
RM Riser with measurement	LSC1	PI
RM Riser with measurement	LSC1	PM
M Measurement	LSC2	-

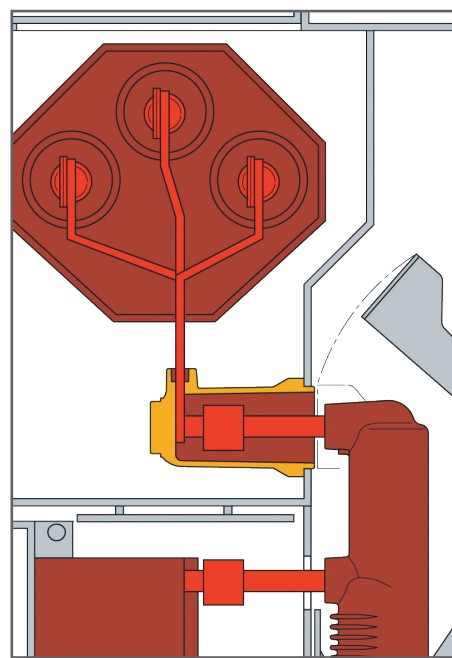
LSC2A, PI

When the earthing switch is closed, the automatic sliding plate moves between the isolating contact of the circuit-breaker to guarantee protection against contact between live parts and the busbar area.



LSC2A, PM

Moving the circuit-breaker on the withdrawable component into the test/disconnected position swings the automatic shutter in front of the isolating tulips and establishes protection against contact with the busbar area.



LSC2A, PM

Moving the circuit-breaker withdrawable component into the test/disconnected position swings the automatic shutter in front of the isolating tulips and establishes protection against contact with the busbar area.

The busbar compartment is separated by a withdrawable metal partition from the switching device/cable termination compartment behind the front door. The shutter is withdrawable for cable installation.

ZS8.4

Design features

Compartments

Each switchgear unit consists of three power compartments: circuit-breaker, busbars and cables.

Each unit is fitted with a low voltage compartment, where all the auxiliary instruments are housed.

Arc-proof switchgear is normally provided with a duct for evacuation of the gases produced by an arc; different types of gas ducts are available.

The partitions between the switchgear compartments are available with either:

- Metallic partitions between adjacent compartments (PM)
- Insulated partitions between adjacent compartments (PI)

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 1250 A the busbars have circular shape.

The busbars are covered with insulating material. There is a single busbar compartment along the whole length of the switchgear up to 25 kA, which optionally can be divided into compartments. Bushings are a optional 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.

For 24 kV they are covered with insulating material.

Earthing switch

Cable compartment can be fitted with an earthing switch for cable earthing.

The same device can also be used to earth 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 earthing switch has short-circuit making capacity.

Control of the earthing switch is from the front of the switchgear with manual operation, and optionally, can also be motor operated.

The position of the earthing switch can be seen from the front of the switchgear by means of a mechanical coupled indicator.

Earthing busbar

The earthing 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.

The insulating bushings are of single-pole type and are made of epoxy resin. For PM version the shutter is metallic and is activated automatically during movement of the circuit-breaker from the racked-out position to the operation position and vice versa.

For PI version shutter is plastic.

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. ZS8.4 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.

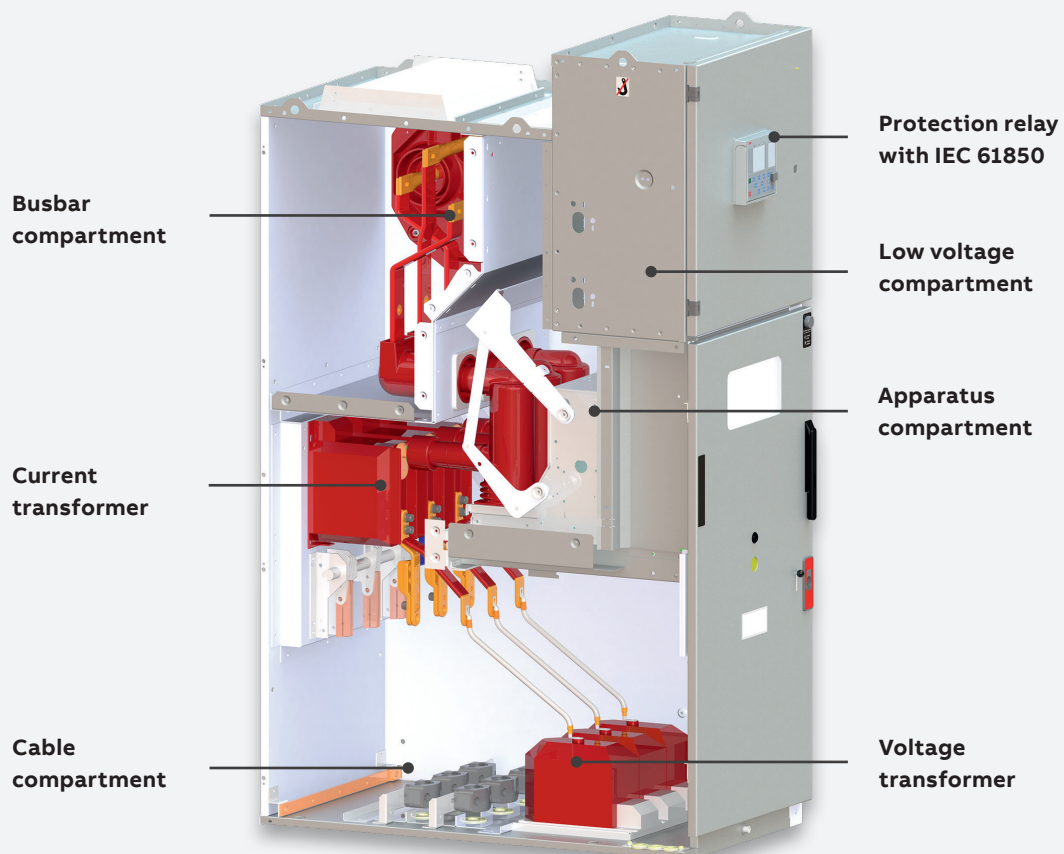
Some installations do not allow evacuation of the gases to the outside of the room and therefore a dedicated solution has been developed to guarantee personnel safety and conformity with the standards, such as pressure exhaust inside the switchgear room and arc runners.

Please contact your ABB sales representative for more information.

Busbar applications

Each switchgear unit can optionally be fitted with an accessory busbar application:

- Voltage transformers for busbar measurements
- Busbar system earthing switch
- Bus duct to make interconnections between different sections of switchgear



ZS8.4

Fully type-tested

ZS8.4 switchgear has undergone all the tests required by the international (IEC) Standards and local Standards organizations (for example Russian GOST standards).

As indicated in these standards, the tests were carried out on the switchgear units considered most sensitive to the effects of the tests and therefore the results were extended across the whole range.

Each switchgear unit is subjected to routine tests in the factory before delivery.

These tests are intended to provide a functional check of the switchgear based on the specific characteristics of each installation.

IEC type tests

- Short-time and peak withstand current
- Temperature rise
- Internal arc capability
- Dielectric test
- Making and breaking capacity of circuit-breaker and contactors
- Earthing switch making capacity
- Mechanical operations of circuit-breaker and earthing switch
- IP protection degree

IEC 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

Description of IEC type tests

Short-time and peak withstand current

The test shows that the main power and the earthing circuits resist the stresses caused by the passage of the short-circuit current without any damage.

It should also be noted that both the earthing system of the withdrawable circuit-breaker and the earthing 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 or contactor it may be fitted with are checked.

Internal arc capability

Please refer to chapter Safety

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.

Circuit-breaker making and breaking capacity

The circuit-breaker or contactor 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.

Earthing switch making capacity

The earthing switch of ZS8.4 switchgear can be closed under short-circuit. Although, the earthing 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 field.

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.

IP protection degree

The IP protection degree is the resistance offered by the ZS8.4 against penetration of solid objects and liquids.

This degree of resistance is indicated by the prefix IP followed by two characters (i.e. IP4X). The first number identifies the degree of protection against the entrance of solid objects, the second one is related to liquids.



ZS8.4

Safety

When developing modern medium voltage switchgear, personnel safety must necessarily take priority.

This is why ZS8.4 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 ZS8.4 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 ZS8.4 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 earthing 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.

ZS8.4 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)

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 ZS8.4 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 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.

Total tripping time is 62,5 ms (2,5 ms REA + 60 ms circuit-breaker).

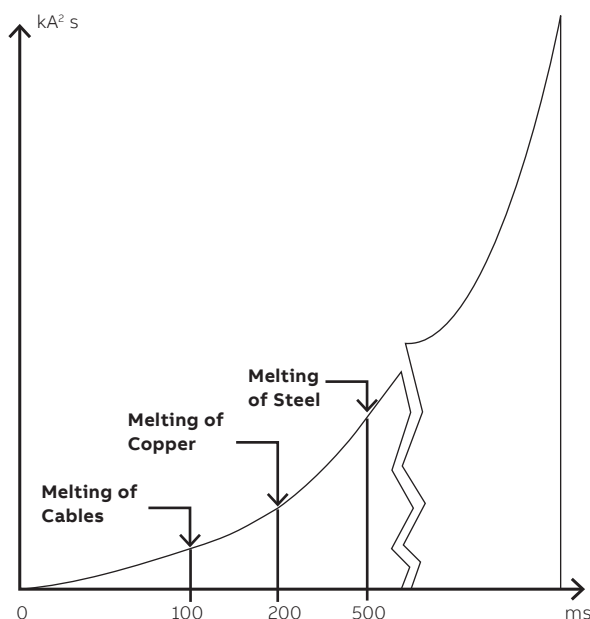
Arc protection in IED

615 series, 620 series IEDs (Intelligent Electronic Device) can optionally be fitted with a fast 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).

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.

—
Arc duration and
damage caused



ZS8.4

Safety

ZS8.4 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÷6], please see the dedicated table on next page.

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 key lock can be applied to MV compartment door [7].

Padlocks

The operations for apparatus racking-in/out [9] and earthing switch opening/closing [10] can be prevented by applying the padlocks to the insertion slots of the relevant operating levers.

The padlock can also be applied to the switch-disconnector [8]. The metallic segregation shutter [11] between circuit-breaker and busbars compartments can be locked by means padlock 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 [12] and the earthing switch closing/opening [13] operations can be interlocked.

This magnet can also be applied to the earthing 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.

Standard safety interlocks (mandatory)

Type	Description		Condition to be met
1	A	Apparatus racking-in/out	Apparatus in OFF position
	B	Apparatus closing	Defined truck position
2	A	Apparatus racking-in	Apparatus multi-contact plug plugged
	B	Apparatus multi-contact plug unplugging	Truck in test position
3	A	Earthing switch closing	Truck in test position
	B	Apparatus racking-in	Earthing switch in ON position
4	A	Switch-disconnector closing	Earthing switch in OFF position
	B	Earthing switch closing	Switch-disconnector in OFF position
5	A	Isolating contact closing	Switch-disconnector in OFF position
	B	Switch-disconnector closing	Isolating contact in test position
6	A	MV compartment door opening	Truck in test position
	B	Apparatus racking-in	MV compartment door closed
	C	MV compartment door opening	Earthing switch in ON position
	D ¹⁾	Earthing switch opening	Cable compartment door closed
	E	MV compartment door opening	Isolating contact in test position
	F	Isolating contact racking-in	MV compartment door closed

Note: Apparatus are circuit-breakers and contactors

1) Interlocking available only with door hinges on the right side only!

Keys (on request)

7	MV compartment door opening	Central handle with locking cylinder
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Padlocks (on request)

8	Insertion of Switch-disconnector C4 hand crank	
9	Insertion of the apparatus racking-in/out crank lever	
10	Insertion of the earthing switch operating lever	
11	Shutter opening or closing	

Locking magnets (on request)

12	Apparatus racking-in/out	Magnet energized
13	Earthing switch closed/open	Magnet energized

Accessory devices

14	Shutters fail-safe	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.
15	Circuit-breaker mechanical operating mechanism	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.

ZS8.4

Vacuum circuit-breaker

—
01 VD4 circuit-breaker
with mechanical
actuator

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, transformers, generators and capacitor banks.

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 contain 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 earthing of the circuit-breaker by means of the metallic structure of the switchgear unit.

The vacuum circuit-breaker truck can be 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 (standard) or rotary (optional) charging device for the operating mechanism springs
- Override selector of the undervoltage release (optional)



ZS8.4

Vacuum contactor

V-Contact VSC medium voltage contactors are apparatus suitable for operating in alternating current and are usually used to control feeders which require a high number of operations per hour.

They are suitable for operating and protecting motors, transformers and power factor correction banks.

Fitted with appropriate fuses, they can be used in circuits with fault levels up to 1000 MVA.

The electrical life of V-Contact VSC contactors is defined as being in category AC3 with 100,000 operations (closing/opening), 400 A interrupted current.

V-Contact VSC is available in ZS8.4 PM version.

V-Contact VSC contactor

The contactors consist of a monobloc of resin containing the following components:

- Vacuum interrupters
- Moving equipment
- Magnetic actuator
- Multivoltage feeder
- Accessories and auxiliary contacts

The V-Contact contactors are provided in the following versions:

- VSC7/P for voltages up to 7.2 kV
- VSC12/P for voltages up to 12 kV

Both versions are available with an operating mechanism with electrical or mechanical latching.

Operating mechanism

Due to the magnetic actuator, V-Contact VSC contactors need negligible auxiliary power in all configurations (15 W inrush - 5 W continuous). The V-Contact VSC is available in three different configurations:

- SCO (single command operation). The contactor closes the supply of auxiliary voltage to the multivoltage feeder input, when the auxiliary is cut the contactor opens.
- DCO (double command operation). The contactor closes the supply of auxiliary voltage to the multivoltage feeder closing input and opens when opening input is supplied; anti pumping function is supplied as a standard.
- DCO configuration is also available, on request, with a delayed undervoltage function. This function enables automatic opening of the contactor when the auxiliary voltage level drops below IEC defined levels. Opening can be delayed from 0 to 5 seconds (customer setting by dip switches).

All configurations are suitable for 1,000,000 mechanical operations.

Fuses

The contactor is fitted with medium voltage fuses for protection of the operated feeders. Coordination between the contactor, fuses and protection unit is guaranteed in accordance with the IEC 62271-106.

The fuse-holder frame is usually preset for installation of a set of three fuses per phase with average dimensions and type of striker, according to the following standards:

- DIN 43625
- BS 2692

The following fuses can be applied:

- DIN type with a length of 192, 292 and 442 mm
- BS type with a length of 235, 305, 410, 454 and 553 mm

The fuse-holder frames are fitted with a device for automatic opening when even just one fuse blows.

This same device does not allow contactor closing when even a single fuse is missing. The ABB range of fuses for transformer protection is called CEF, whereas CMF is for motors and capacitors.

Standards

- IEC 62271-106 for the contactor
- IEC 60282-1 for the fuses

Contactor		VSC7/P	VSC12/P
Rated voltage	[kV]	7.2	12
Rated insulation voltage	[kV]	7.2	12
Rated power frequency withstand voltage	[kV / 1 min]	20	28
Rated lightning impulse withstand voltage	[kV]	60	75
Rated frequency	[Hz]	50 / 60	50 / 60
Rated short-time withstand current	[kA] ¹⁾	...25	...25
Peak current	[kA]	...63	...63
Internal arc withstand current ²⁾	[kA / 1s]	...25	...25
Maximum rated current of the contactor	[A]	400	400

1) Limited by the fuses

2) The internal arc withstand values are guaranteed in the compartments on the supply side of the fuses (busbars and apparatus) by the structure of the switchgear and on the load side (feeder) by the limiting properties of the fuses

Maximum performances of the contactor with fuses		7.2 kV	12 kV
Motors	[kW]	1 800	3 000
Transformers	[kVA]	2 500	2 500
Capacitors	[kVAR]	1 800	3 000

Maximum load currents of the fuses

Feeder	Transformers		Motors		Capacitors	
Rated voltage	Fuse	Maximum load	Fuse	Maximum load	Fuse	Maximum load
7.2 kV	200 A	160 A	315 A	250 A	355 A	285 A
12 kV	200 A	160 A	200 A	160 A	200 A	160 A

— V-Contact VSC contactor



ZS8.4

Switch-disconnector

Rod-type switch-disconnector type C4

C4 rod-type switch-disconnectors are general purpose load switches for indoor use complying with standard DIN VDE 0670 Part 301, VDE 0670 Part 303 and IEC Publication 60265-1.

Due to an optimum contact design and an operating mechanism, which permits high switching speeds, high making currents are safely mastered.

The C4 switch-disconnector is capable of closing onto an existing short-circuit within the limits of its rated capacity with no risk to the operator or the equipment.

- High breaking and making capacity
- Reliable arc quenching by combining the air blasting and the hard gas principle
- Low maintenance
- Capable of switching capacitive currents under earth fault conditions

Main parameters for panels with switch-disconnectors CK4, CS4; ZS8.4 PM

Rated voltage	[kV]	12	24
Rated power frequency withstand voltage	[kV / 1min]	28	50
Rated lightning impulse withstand voltage	[kV]	75	125
Rated frequency	[Hz]	50 / 60	50 / 60
Rated current of busbars	[A]	...1 250	...1 250
Rated current of switch-disconnector	[A]	630	630
Rated current of switch-disconnector ⁽¹⁾	[A]	200	200
Rated peak withstand current	[kA]	...63	...63 ⁽³⁾
Internal arc withstand current	[kA / 1 s]	...25	...25 ⁽⁴⁾
Rated short time current	[kA / 3 s]	...25	...25 ⁽⁴⁾⁽⁵⁾
Auxiliary voltage ⁽²⁾	[V]	... 230 AC, ...220 DC	... 230 AC, ...220 DC

Note: Panels with switch-disconnectors CK4, CS4 are not available for 17,5 kV

(1) Rated short time current is limited by HV HRC fuses

(2) Auxiliary voltages: DC 24, 48, 60, 110, 220 (230 AC) AC / DC

(3) 24 kV switch-disconnector panel 50 kA or 63 kA for switch-disconnector with fuse (max. fuse size 40 A)

(4) 24 kV switch-disconnector panel 20 kA or 25 kA for switch-disconnector with fuse (max. fuse size 40 A)

(5) Earthing switch has been dimensioned and type tested for short-time withstand current of 16 kA for 1 second

Main parameters for panels with switch-disconnectors CK4, CS4; ZS8.4 PI

Rated voltage	[kV]	12	17.5	24
Rated power frequency withstand voltage	[kV / 1min]	28	38	50
Rated lightning impulse withstand voltage	[kV]	75	95	125
Rated frequency	[Hz]	50 / 60	50 / 60	50 / 60
Rated current of busbars	[A]	...1 250	...1 250	...1 250
Rated current of switch-disconnector	[A]	630	630	630
Rated current of switch-disconnector fuse combination ⁽¹⁾	[A]	200	200	200
Rated peak withstand current	[kA]	...63	...50	... 40
Internal arc withstand current ⁽³⁾	[kA / 1 s]	...25	...20	... 16
Rated short time current	[kA / 3 s]	...25	...20	... 16
Auxiliary voltage ⁽²⁾	[V]	... 230 AC, ...220 DC	... 230 AC, ...220 DC	... 230 AC, ...220 DC

(1) Rated short time current is limited by HV HRC fuses

(2) Auxiliary voltages: DC 24, 48, 60, 110, 220 (230 AC) AC / DC

(3) 200 ms for PI version without gas duct and closed cable tunnel without possibility of bottom gas pressure release equipped with arc fault current duration limiting devices



ZS8.4

Ultra Fast Earthing Switch

The Ultra-Fast Earthing Switch (UFES) is an innovative design of an active arc protection device which effectively mitigates the severe mechanical and thermal impacts caused by internal arc faults.

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01 Electronic device for measurement, logic and tripping, type QRU1; Primary switching element type U1

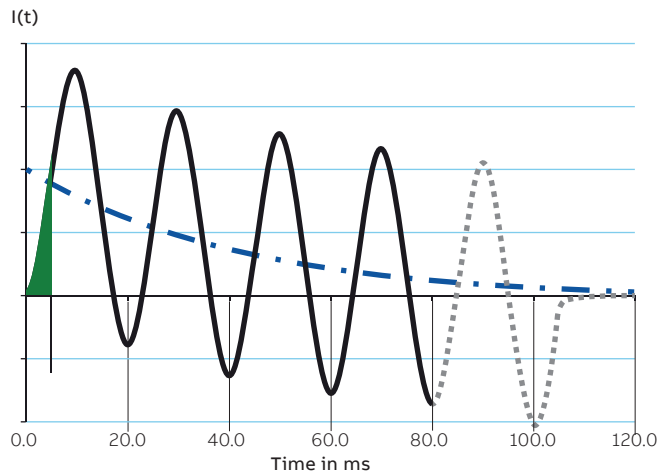
The UFES is a combination of devices consisting of an electronic unit and the corresponding primary switching elements which initiate a three-phase earthing in the event of an arc fault. With operating times of less than 4 ms after detection UFES clears an internal arc fault almost immediately after it arises. Thus arc impacts are reduced to an absolute minimum and safety standards raised to a whole new level.

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
- Minimized secondary effects like light/sound emission or the release of toxic gases
- Solution for pressure sensitive environment with limited pressure relief options

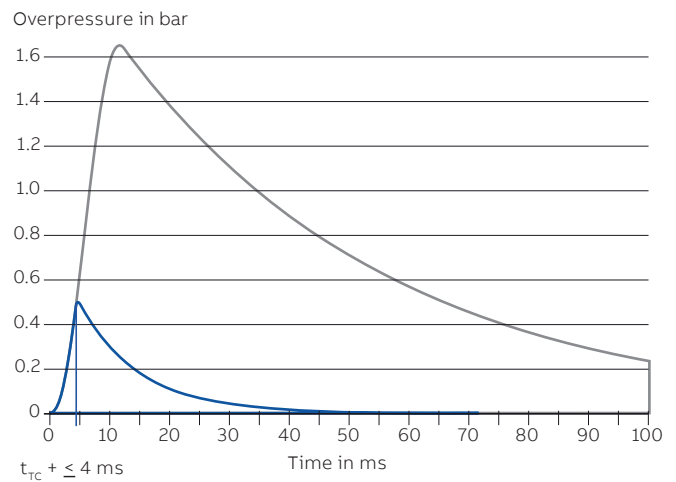
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01





- Short-circuit current I_n
- - - DC component
- Arcing time with UFES
- ... Final clearing of fault current by upstream circuit-breaker - 80 ms + t_{TC}
- t_{TC} Reaching time for tripping criteria

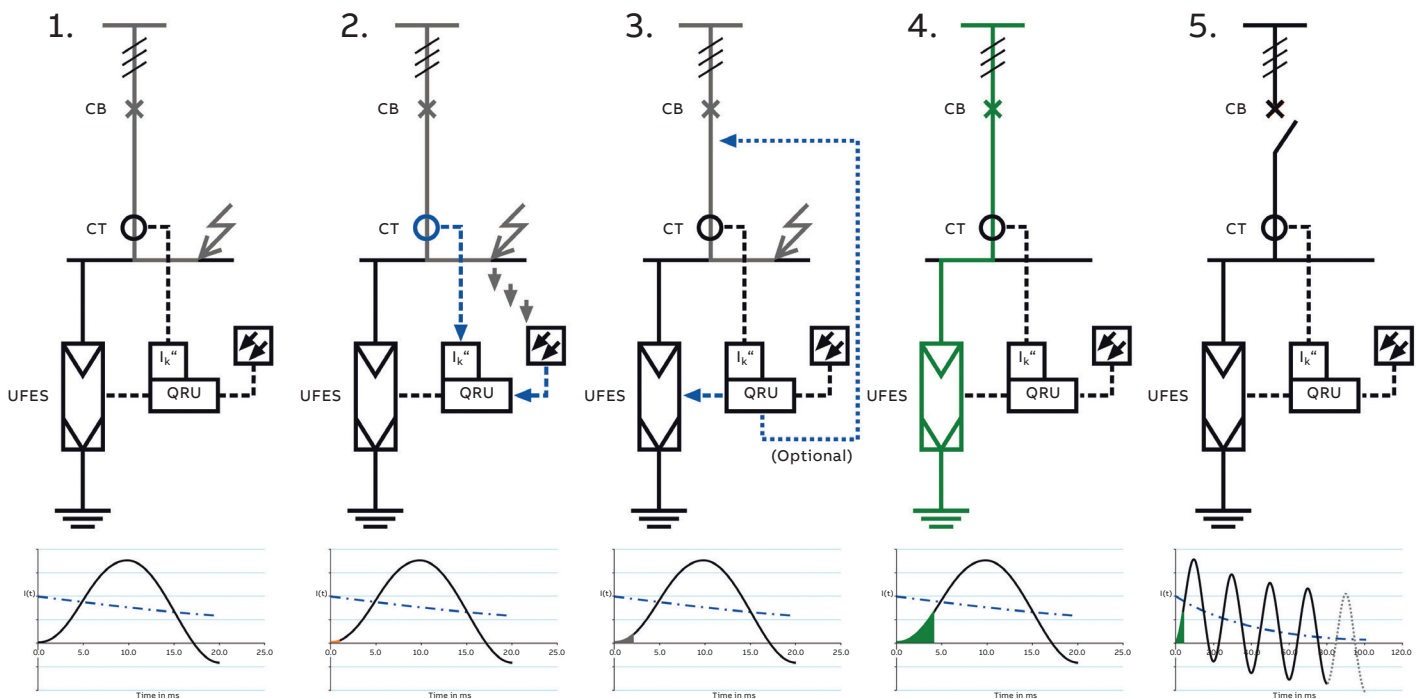
In rare cases, failure inside a switchgear cubicle due either to a defect, an exceptional service condition or mainly by human mal-operation may initiate an internal arc. The faster the arc will be interrupted, the less destruction on the switchgear equipment will occur.



- Pressure curve with UFES (4 ms)
- Pressure curve without UFES
- t_{TC} Reaching time for tripping criteria

Avoidance of the severe effects of an internal arc fault, such as ...

- Rapid temperature rise (up to 20,000 °C)
- Rapid pressure rise (see figure)
- Burning of materials
- ... by fastest possible extinction.



Event sequence description

1. Internal arc formation
2. Arc detection by the electronic device (light and current)
3. ~ 1-2 ms after detection: Tripping signal to the UFES primary switching elements
4. ~ 3-4 ms after detection: Bolted 3-phase earthing by operation of the UFES primary switching elements
 - Interruption of the arc voltage: Immediate extinction of the arc
 - Controlled fault current flow via UFES primary switching elements to earth potential
5. Final clearing of the fault current by the upstream circuit-breaker

ZS8.4

I_s -limiter: fault-current limitation

Short-circuit currents too high?

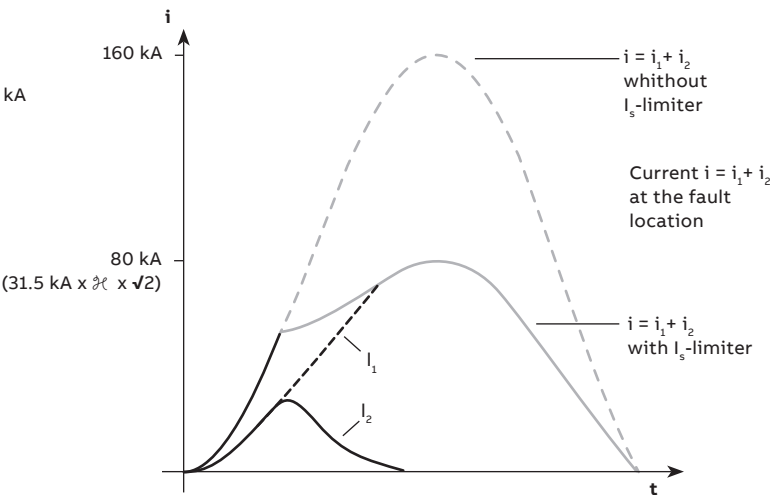
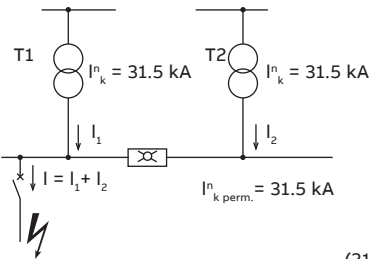
The I_s -limiter, a switching device with extremely short operating time, solves the problem.

The rising global demand for energy requires more powerful or additional transformers and generators, and an increasing interconnection of the individual supply networks. This can lead to the permissible short-circuit currents for the equipment being exceeded causing severe dynamic or thermal damage or even complete destruction. The replacement of existing switchgear and cable connections by new equipment with a higher short-circuit strength is often technically impossible or uneconomical for the user. The use of I_s -limiters reduces the short-circuit current in both new systems and expansions of existing systems, thus saving cost.

A short-circuit downstream from an outgoing feeder breaker is assumed. The oscillogram shown below indicates the course of the short-circuit currents in the first half wave. A short-circuit current of 31.5 kA can flow to the fault location through each transformer. This would result in a total short-circuit current of 63 kA, which is twice as much as the switchgear capability. The course of the current through the I_s -limiter in such an event is shown below as current i_2 . It can be seen that the I_s -limiter operates so rapidly, that there is no contribution via the transformer T2 to the total peak short-circuit current ($i_1 + i_2$). Therefore, a switchgear with a rating of 31.5 kA is suitable for this application.

Technical Data						
Rated voltage	[kV]	12.0		17.5	24.0	36.0 / 40.5
Rated current	[A]	1 250 / 2 000 / 2 500 / 3 000 / 4 000 ¹⁾		1 250 / 2 000 / 2 500 / 3 000 / 4 000 ¹⁾	1 250 / 16 00 / 2 000 / 2 500 ¹⁾ / 3 000 ¹⁾	1 250 / 2 000 / 2 500 ¹⁾
Interrupting current	[kA _{RMS}]	Up to 210		Up to 210	Up to 140	Up to 140
1) with cooling fan						

Single line diagram of a bus tie for a system with $I_n = 31.5$ kA and with an I_s -limiter; I_s -limiter application diagram



Potential applications

Such a fast switching device caters for a variety of applications which cannot be fulfilled by conventional switches. The most important of these are presented below.

Advantages of all I_s -limiter applications:

- Reduction of short-circuit currents at the fault location
- No upgrading of the existing switchgear

Option A

Coupling-parallel operation of two systems.

Advantages:

- Improving power quality
- Increasing the reliability of the system
- Reduction of the network-impedance
- Optimal load flow

Option B

I_s -limiter in the generator feeder to protect the high voltage system.

Advantages:

- Generator can be connected independent of the short-circuit capability of the system
- Existing busbar system does not need to be changed
- No need for expensive generator breaker

Option C

I_s -limiter and reactor connected in parallel.

Advantages:

- Avoid copper losses of the reactor
- Avoid voltage drop over the reactor
- No electro-magnetic field of the reactor

Option D

Station service supply and public network.

Advantages:

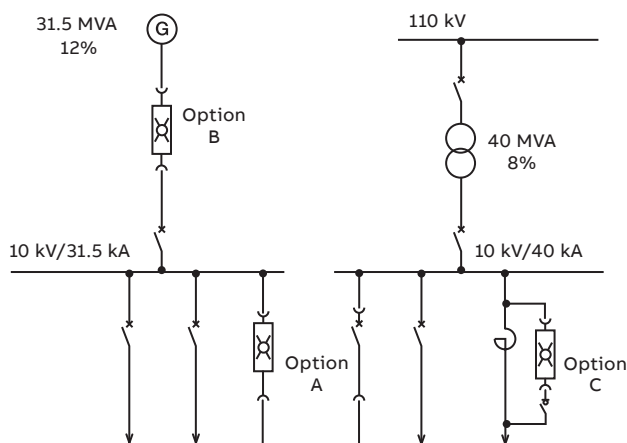
- Private/industrial generator feeder can be connected to the (fully loaded) grid
- Selective tripping of the I_s -limiter (I_s -limiter will operate only for short-circuit faults in the grid)

Option E

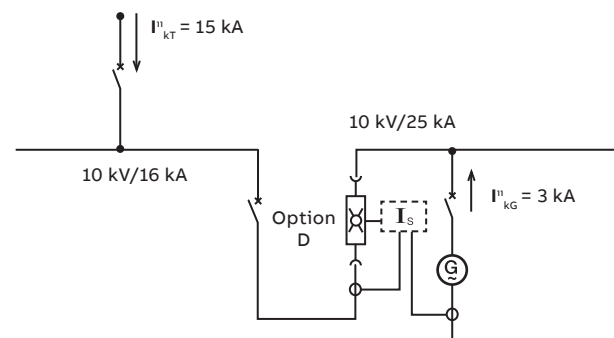
If in the case of two I_s -limiters being installed in a switch-board selective tripping is required, a measurement of the total current becomes necessary.

Advantage: The I_s -limiter trips as follows:

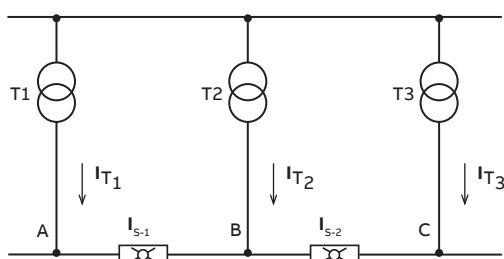
- Short-circuit in section A: Only I_s -limiter no. 1 trips
- Short-circuit in section B: I_s -limiter no. 1 and no. 2 trip
- Short-circuit in section C: Only I_s -limiter no. 2 trips



Three possible applications of I_s -limiters in one figure (Option A, B, C)



I_s -limiter in connecting point with a public supply network (Option D)



Use of more than one I_s -limiter with selectivity (Option E)

ZS8.4

Instrument transformers

- 01 Current transformer TPU
- 02 Voltage transformer TJC
- 03 Current and voltage 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 one or more cores with performance and accuracy classes suitable for the installation requirements. They conform to the IEC 61869-1, IEC 61869-2 which have fully replaced previous standard IEC 60044-1.

Their dimensions are in accordance with the DIN 42600 Standard up to 1250 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. The ABB range of current transformers is designated TPU.

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 fixed assembly or for installation on removable and withdrawable trucks.

They conform to the IEC 61869-1, IEC 61869-3 which have fully replaced previous standard IEC 60044-2.

Their dimensions are in accordance with the DIN 42600 Standard.

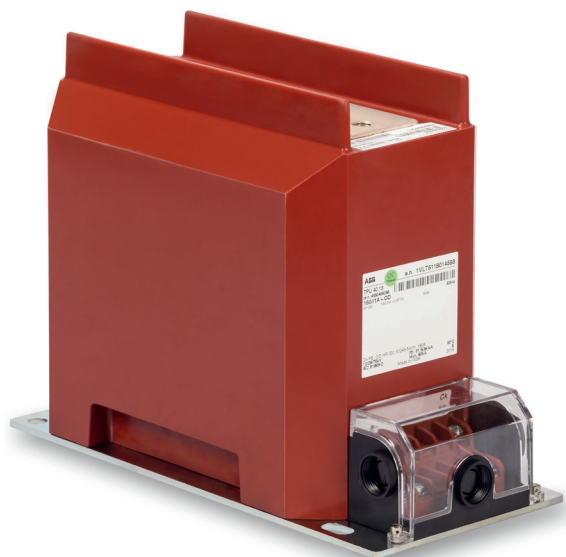
These transformers can have one or two poles, with performance and precision classes suited to the functional requirements of the instruments connected to them.

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 (ZS8.4 PM version).

Fixed voltage transformers can be installed directly on the main busbar system in a dedicated compartment (busbar applications).

The ABB range of voltage transformers is designated TJC, TDC, TJP.

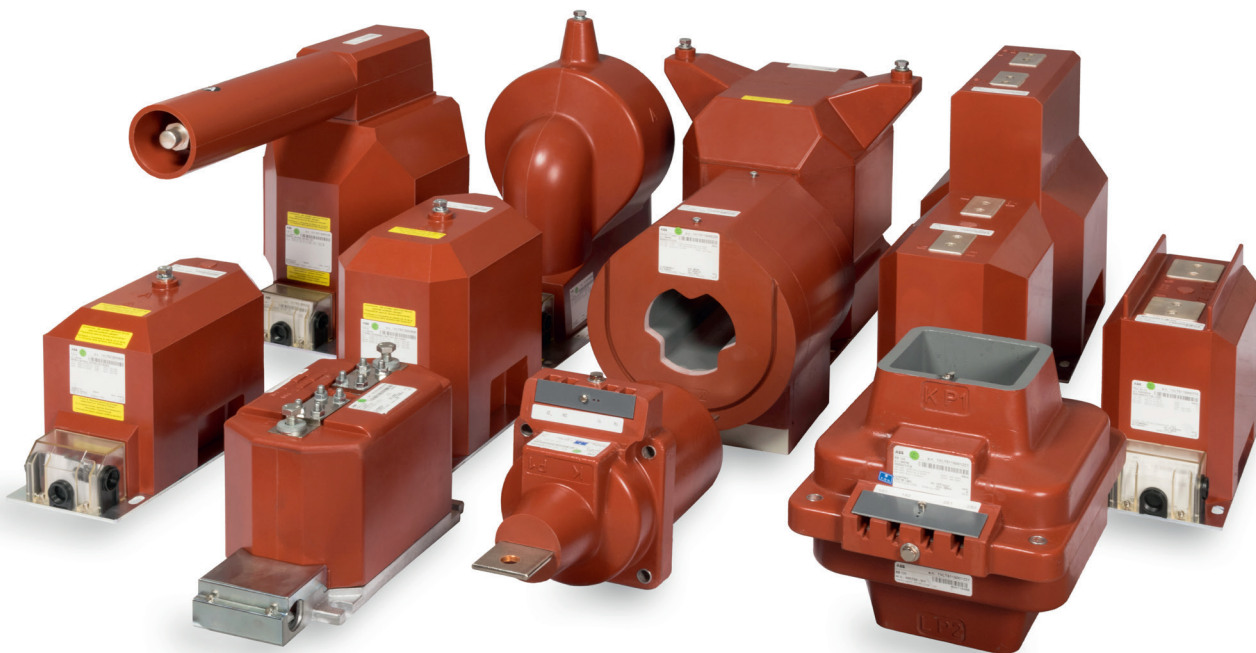


01



02

03



ZS8.4

Current and voltage sensors

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.

—
01 Combined
sensors KEVCD

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. 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.

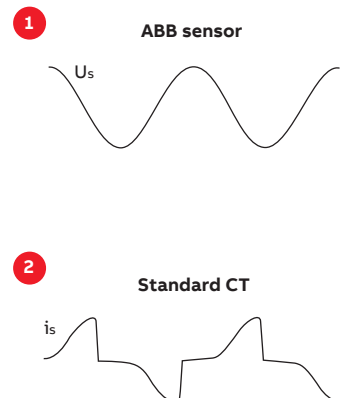
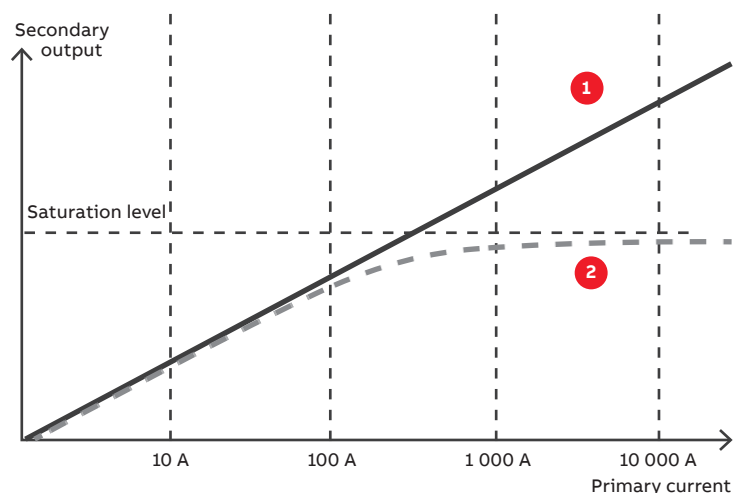
Sensor characteristics

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.

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Performance
comparison between
conventional current
transformer and
current sensor



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.

Combined sensors

Current & voltage measurements and voltage indication integrated in the same compact cast resin part.

KEVCD

For dynamic current measurement (protection purposes) the ABB sensors KEVCD A, fulfill requirements of protection class 5P up to an impressive value reaching the rated short-time thermal current I_{th} .

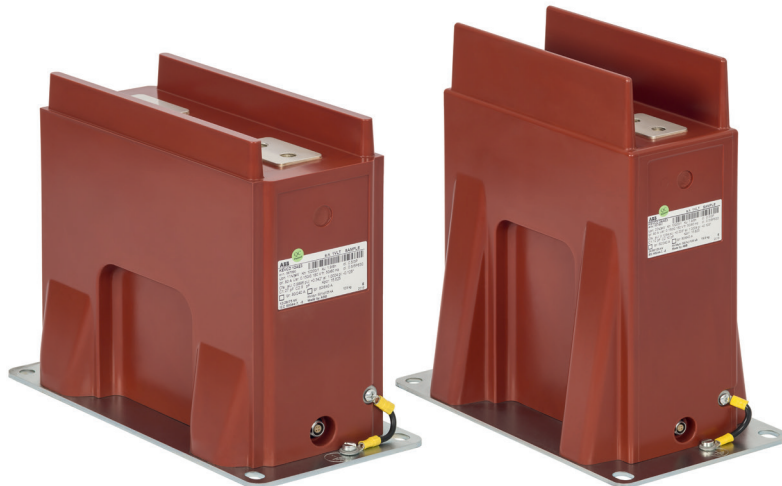
With KEVCD sensors, measuring class 0.5 is reached for continuous current measurement in the extended accuracy range from 5 % of the rated primary current I_{pr} not only up to 120 % of I_{pr} (as being common for conventional current transformers), but even up to the rated continuous thermal current I_{cth} .

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

Technical parameters

- Rated primary current of application:
80 A up to 1 250 A
- Rated primary voltage of application:
 $6/\sqrt{3}$ kV up to $24/\sqrt{3}$ kV

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ZS8.4

Distribution automation

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.



ZS8.4

Distribution automation

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 605 series

The Relion 605 series protection relays feature basic devices that fulfill the essential protection needs in medium-voltage networks. The series is best suited for secondary distribution applications. These relays are well-known for their straight forward approach to protection.

Relion 611 series

The Relion 611 series protection relays are powerful and very easy-to-use protection devices in a compact design. The 611 series relays are delivered with a pre-configured application, which can be adapted, to a limited extent, to application-specific needs. The series offers pre-configured solutions, which are ideally suited for utility distribution and industrial applications.

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 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>.

01 Relion protection and control product family



ZS8.4

Distribution automation

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 overcurrent 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, sub-stations 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 605 series

The Relion 605 series protection relays feature basic devices that fulfill the essential protection needs in medium-voltage networks. These relays are well-known for their straight forward approach to protection.

Relion 611 series

The Relion 611 series offers a pre-configured solution for power distribution in utility and industrial applications. The series is a suitable choice for protection and control of standard feeders. The protection relays are delivered pre-configured for easier and faster relay engineering and shorter time-to-operation.

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.

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01 Basic range:
Feeder protection REF601
and self-powered feeder
protection REJ603

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02 Medium range:
Feeder protection
and control REF611,
Feeder protection
and control REF615

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03 High range:
Feeder protection
and control REF620,
Feeder protection
and control REF630

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 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.

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.

For more information, please refer to the following documentation:

- Feeder Protection REF601 Product Guide
- Self-Powered Feeder Protection REJ603 Product Guide
- Feeder Protection and Control REF611 Product Guide
- 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

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>



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ZS8.4

Distribution automation

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.

—
01 Transformer protection and control RET615, Transformer protection and control RET620 and Transformer protection and control RET630

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>



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ZS8.4

Distribution automation

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 605 series

The Relion 605 series offers a compact solution for the protection of medium-voltage and low-voltage asynchronous motors in the manufacturing and process industry. The relays offer pre-configured functionality, which facilitates easy and fast commissioning of the switchgear. The relay can be used with both circuit-breaker and contactor-controlled motor drives.

Relion 611 series

The Relion 611 series offers a pre-configured solution for power distribution in utility and industrial applications. This series is a suitable choice for protection and control of small asynchronous motors/drives. The protection relays are delivered pre-configured for easier and faster relay engineering and shorter time-to-operation.

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.

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01 Basic range:
Motor protection and
control REM601

—
02 Medium range:
Motor protection
and control REM611,
Motor protection and
control REM615

—
03 High range:
Motor protection
and control REM620,
Motor protection and
control REM630

For more information, please refer to the
following documentation:

- Motor Protection and Control REM611 Product Guide
- 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>



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ZS8.4

Distribution automation

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 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 series offers extensive interconnection and compact generator protection for both the generator and the prime mover in various small and medium-sized power plants.

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.

01 Generator protection and control REG615, Generator protection and control REG630

For more information, please refer to the following documentation:

- Generator and interconnection protection REG615 Product Guide
- 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>



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ZS8.4

Distribution automation

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 phasesequence 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 611 series

The Relion 611 series offers a pre-configured solution for power distribution in utility and industrial applications. The REU611 is designed for overvoltage and undervoltage protection and additional 2-stage frequency protection. The protection relays are delivered pre-configured for easier and faster relay engineering and shorter time-to-operation.

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.

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 requirements.

—
01 Voltage protection
and control REU611,
Voltage protection
and control REU615

—
02 Feeder protection
and control REF620,
Feeder protection
and control REF630

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 REU611 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>



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02



ZS8.4

Distribution automation

01 Capacitor bank protection and control REV615

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>



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Busbar protection

The last, but not least, part in electrical power systems is defined by the busbar application. The busbar is an aluminum or copper conductor supported by insulators that interconnects the loads and the sources of electric power. For example, in metal enclosed switchgear, it is represented by copper bars in the busbar compartment. The requirements for busbar protection in respect of immunity to mal-operation are very high. For busbar protection it is essential to employ a differential protection principle.

Product offering

The recommended products for busbar 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 611 series

The Relion 611 series offers a pre-configured solution for power distribution in utility and industrial applications. It is a suitable choice for high-impedance busbar protection. The

protection relays are delivered pre-configured for easier and faster relay engineering and shorter time-to-operation.

For more information, please refer to the following documentation:

- Busbar Protection and Control REB611 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>



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ZS8.4

Distribution automation

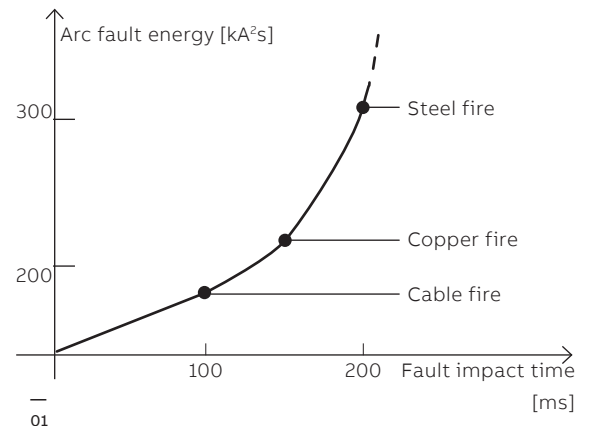
01 Arc fault damage as a function of the arc fault energy and the arc fault impact time

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.

02 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 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>



ZS8.4

Distribution automation

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01 Substation
Management Unit
COM600S

Substation 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. Substation-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

The COM600 series offers versatile substation management units. These units are deployed together with protection and control relays and other communication devices to realize smart substation and grid automation solutions in utility and industrial distribution networks. The COM600 series units perform the combined role of a user interface, a communication gateway and an automation platform in a single physical unit.

The COM600 series accommodates web technology-based functionality, which provides access to substation devices and processes via a web browser-based human machine interface (HMI). All standard substation monitoring and control aspects can be handled using the web-HMI.

The COM600 series integrates substation devices, like protection and control relays, substation controllers and meters, based on the IEC 61850 communication standard, as well as most other commonly used communication standards and legacy protocols. Seamless

connectivity can be established with gateway functionality between the substation devices and external higher-level systems such as the Network Control Center (NCC) or a process such as the Distributed Control System (DCS) using IEC 60870-5, DNP3, Modbus or OPC-based protocols.

The COM600 series hardware platform is based on ruggedized mechanics with no moving parts subject to wear and tear. The compact and robust design is well adapted to harsh environments.

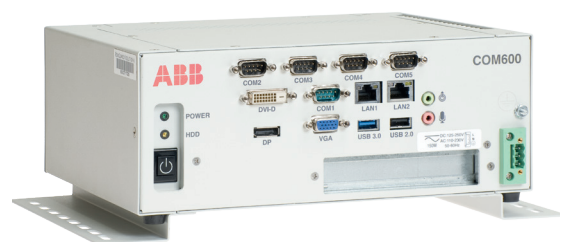
The COM600 series comprises of two products:

- COM600S for Substation Automation (for IEC and ANSI markets)
- COM600F for Feeder Automation (for ANSI markets only)

The COM600S has the capability to function as a combined substation HMI, gateway and process controller in a small to medium-sized substation automation installation. Its HMI feature enables substation monitoring and operations. It integrates various units to provide access to real-time data. It also records process data in its historian to enable access to past data. Its logic processor enables implementation of substation-level automation tasks. The gateway functionality provides a provision to communicate data from protection and control relays in the substation and COM600S itself to higher-level systems and vice versa.

For more information, please refer to the following documentation:

- COM600S Substation Management Unit Product Guide



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 the 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 COM600 series devices using 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

Distribution automation

Selection table

The Relion Interactive Selection Guide (ISG), which covers the entire Relion family, is available online.

Go to: <http://abb.relionisg.com>

In the table:

x = function supported

o = function available as option

	605	605	605	605	611	611	611	611	615	615
	REF601	REJ601	REJ603	REM601	REB611 IEC	REF611 IEC	REM611 IEC	REU611 IEC	REF615 IEC	RED615 IEC
Standard										
ANSI	X	X		X						
IEC	X	X	X	X	X	X	X	X	X	X
Application										
Arc fault protection application									O	
Busbar application					X					
Back-up application	X	X			O	X			X	
Capacitor bank application										
Feeder application	X	X	X			X		X	X	X
Generator application										
Motor application				X	O		X			
Power management/load-shedding application										
Transformer application					O					X
Functionality										
Autorecloser	X	X		X		X			X	X
Circuit breaker controllability	X			X	X	X	X	X	X	X
Condition monitoring	X			X	X	X	X		X	X
Current-based protection	X	X	X	X	X	X	X		X	X
Distance protection										
Fault locator									X	X
Generator differential protection					X					
LCD display with Single Line Diagram (SLD)									X	X
Line differential protection (in-zone transformer support)										X
Load-shedding										
Motor differential protection					X					
On-load tap changer control										
Power quality									X	X
Self-powered protection relay			X							
Synchro-check									X	
Transformer differential protection					X					
Voltage based protection								X	X	X
Withdrawable release mechanism					X	X	X	X	X	X

615	615	615	615	615	615	615	615	615	620	620	620	620	620	620	620	630	630	630	630
REG615 IEC	REM615 IEC	RET615 IEC	REU615 IEC	REV615 IEC	REF615 ANSI	REF615R ANSI	REM615 ANSI	RET615 ANSI	REF620 IEC	REM620 IEC	RET620 IEC	REF620 ANSI	REM620 ANSI	RET620 ANSI	REF630 IEC	REM630 IEC	RET630 IEC	REG630 IEC	

Distribution automation

Selection table

The Relion Interactive Selection Guide (ISG), which covers the entire Relion family, is available online.

Go to: <http://abb.relionisg.com>

In the table:

x = function supported

o = function available as option

	605	605	605	605	611	611	611	611	615	615
	REF601	REJ601	REJ603	REM601	REB611 IEC	REF611 IEC	REM611 IEC	REU611 IEC	REF615 IEC	RED615 IEC
Hardware										
Analog inputs (CTs/VTs)	4/0	4/0	4/0	4/0	4/0	4/1	4/0	0/5	4/5	4/5
Analog inputs (sensor channels/CTs)	3/1	3/1		3/1					6/1	6/1
Binary inputs/outputs	4/6	4/6	0/2	4/6	4/6	10/9	4/6	4/6	18/13	18/13
RTD/mA inputs									2/1	2/1
mA outputs										
Communication protocols										
DNP 3.0									X	X
IEC 60870-5-103	X	X		X					X	X
IEC 61850					X	X	X	X	X	X
Modbus	X	X		X	X	X	X	X	X	X
Profibus									X	X
Communication media										
Ethernet (RJ-45)					X	X	X	X	X	X
Ethernet (LC)					X	X	X	X	X	X
Ethernet redundant solutions (HSR/PRP/RSTP)					X	X	X	X	X	X
Serial (RS 232/485, ST conn.)	X	X		X	X	X	X	X	X	X

[illegible]

ZS8.4

Distribution automation

Compact power management

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 to perform reactive and active load-shedding.

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.

PML630 complies with IEC 61850 and offers seamless connectivity with Relion family protection relays, RIO600 I/O and COM600S units 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 COM600S.

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:

- Load-shedding controller PML630 Product Guide
- Distribution automation solutions web page (<http://new.abb.com/medium-voltage/distribution-automation/distribution-automation-solutions>)

Solution offering

The Compact Power Management System (cPMS) is a load-shedding power management solution built on Relion PML630, Substation Management Unit COM600S, Remote I/O unit RIO600 and the Relion 615, 620 or 630 series feeder 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>



ZS8.4

Distribution automation

01 C Single line diagram (SLD) of medium-voltage switchgear architecture applied, suitable for carrying out automatic and manual transfer (ATS).

Automatic transfer systems

Automatic transfer systems (ATS) 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:	1 500 ms
Depending on the residual voltage:	400-1 200 ms
Synchronized ATS:	200-500 ms
High speed transfer device:	100 ms
High speed transfer system:	30 ms

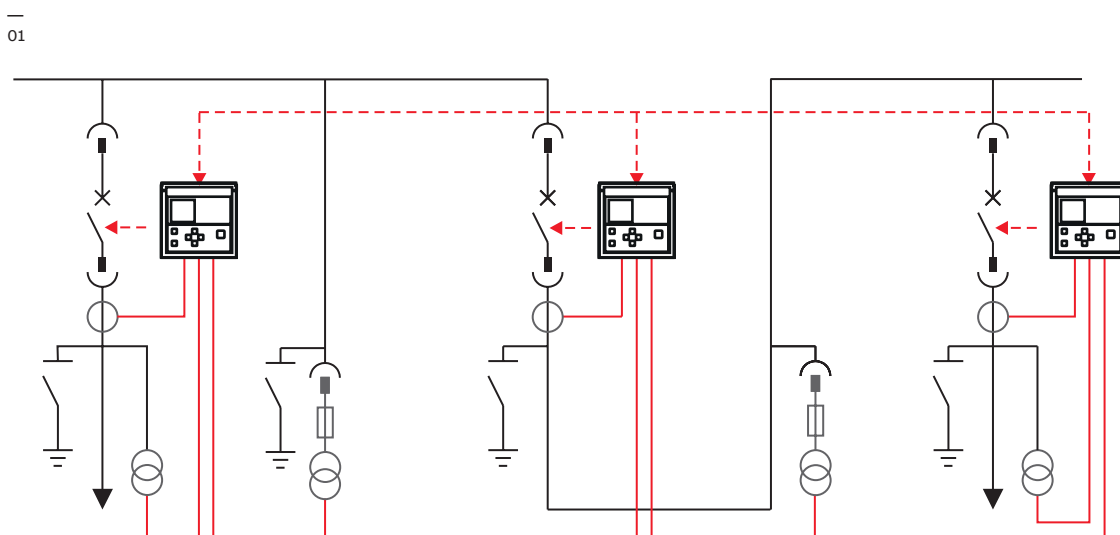
The first two systems are the simplest and can also be achieved with conventional logics and instruments. They guarantee average transfer times and can therefore be used in installations where voltage gaps are not particularly critical. The other three systems: (1) synchronized automatic transfer system, (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

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 synchronization of the voltage vectors to then return to being disconnected when the transfer has taken place. The applications described do not require additional instruments.



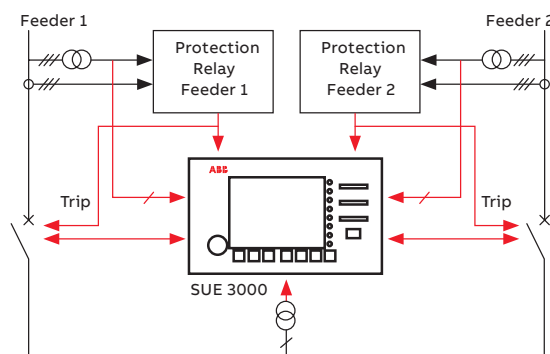
—
02 An example
of a switchgear
configuration

—
03 SUE 3000 High
Speed Transfer Device

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.



02

Application areas

The SUE 3000 High Speed Transfer Device can be used where ever 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:

- Auxiliary installations serving power stations
- Environmental technology installations
- 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

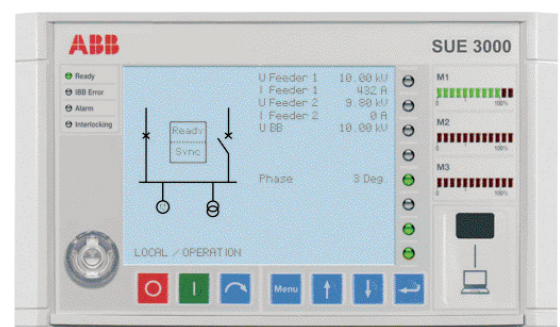
An exceptionally important characteristic, that clearly distinguishes SUE 3000 from competing concepts, is that synchronicity criteria are continuously available, as they are computed online. This is the reason that, in case of an initiation, the appropriate transfer mode is already determined and can 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:

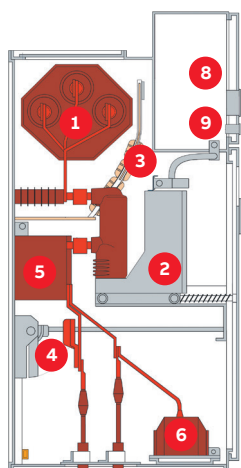
- High Speed Transfer Device SUE 3000 Product Description
- Distribution automation solutions web page (<http://new.abb.com/medium-voltage/distribution-automation/distribution-automation-solutions>)



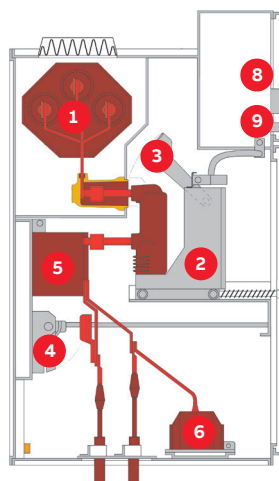
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03

ZS8.4

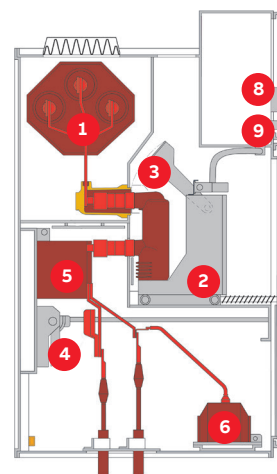
Typical panels overview



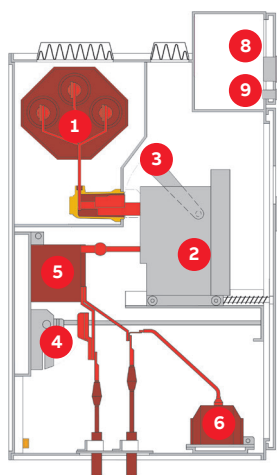
IF - Circuit-breaker panel
LSC2A, PI



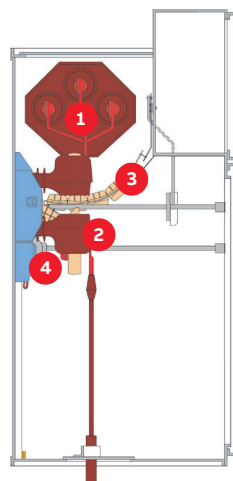
IF - Circuit-breaker panel
LSC2A, PM



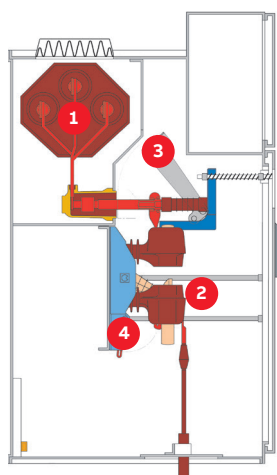
IF - Circuit-breaker panel
LSC2B, PM



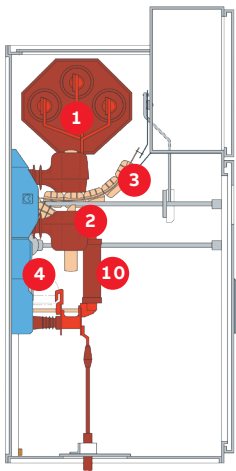
IFC - Contactor panel
LSC2A, PM



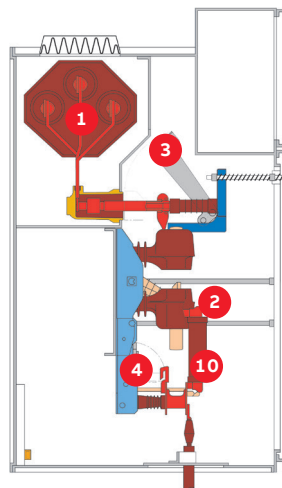
DF - Switch-disconnector panel
LSC2A, PI



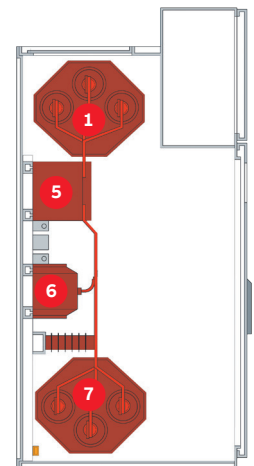
DF - Switch-disconnector panel
LSC2A, PM



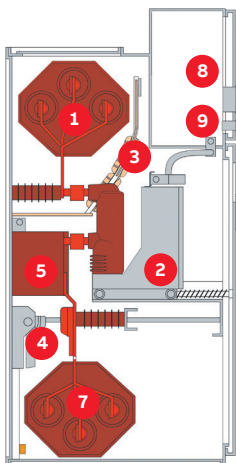
**DF - Switch-disconnector panel
with fuse
LSC2A, PI**



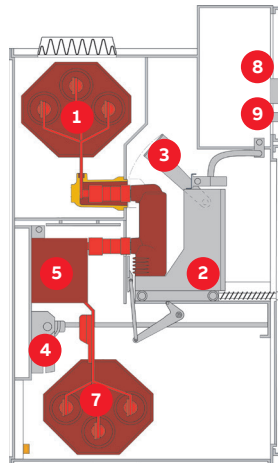
**DF - Switch-disconnector panel
with fuse
LSC2A, PM**



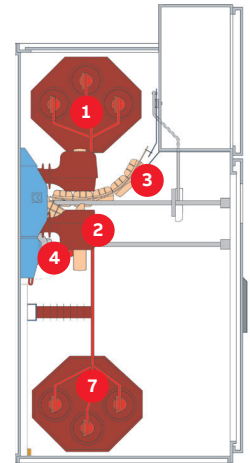
**RM - Riser panel
with measurement
LSC1, PI**



**BT - Circuit-breaker
bus sectionaliser panel
LSC2A, PI**



**BT - Circuit-breaker
bus sectionaliser panel
LSC2B, PM**



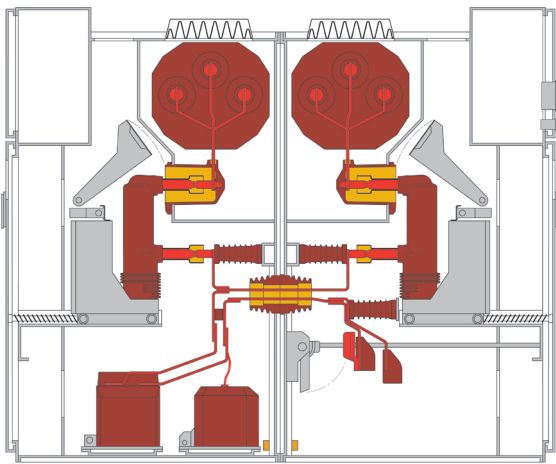
**BT - Switch-disconnector
bus sectionaliser panel
LSC2A, PI**

Legend

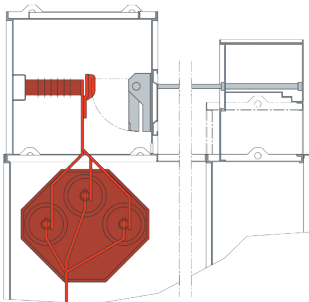
1	Busbars	6	Voltage transformer
2	Circuit-breaker / Switch-disconnector / Contactor	7	Tie bus
3	Automatic sliding plate / Automatic shutter	8	Protection relay
4	Earthing switch	9	Capacitive voltage indication
5	Current transformer	10	Fuse

ZS8.4

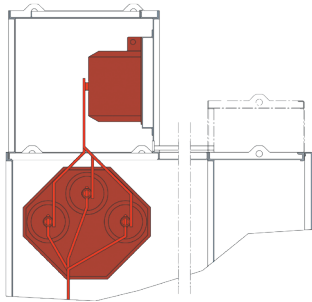
Special panel solutions and top-mounted boxes



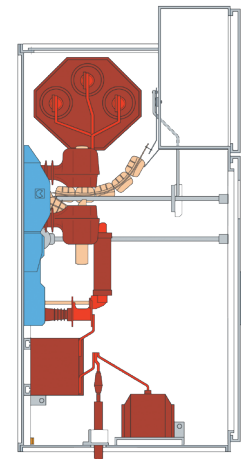
Duplex-circuit-breaker panel



Top-mounted box with earthing switch



Top-mounted box with voltage transformer



Switch-disconnector panel
Partition class PI with fuse, current and voltage transformer

Special panels and top-mounted boxes			
Rated voltage	[kV]	12 ¹⁾	24 ¹⁾
Rated short-time current	[kA / 3 s]	25	25 ²⁾
Height	[mm]	2 300	2 300
Width	[mm]	800	800
Depth	[mm]	2 400	2 400

1) Only CB-panels, for SD-panels please see chapter Description
2) 24 kV switchgear modified for 12 kV



ZS8.4

Smart Solutions

With ZS8.4 Digital you gain unprecedented flexibility for any application.

The digital solution takes full advantage of well-proven components: current and voltage sensors, protection and control relays with IEC 61850 digital communication to ensure a reliable and efficient electrical network.

ZS8.4 Digital benefits

Safe and reliable

- Increased equipment reliability and safety in your substation
- Extended communication supervision functionality

Intelligent and ready for the future

- Implement changes easily as requirements change
- Flexibility towards varying load flows

Simple and efficient

- Minimized lifetime costs
- Late customizations and changes possible

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 typical substation with 14 switchgear panels of ZS8.4 type over 30 years of operation

ZS8.4 Digital

represents an advanced switchgear solution as it meets important requirements of the future:

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

With ZS8.4 Digital you avoid many of the practical challenges you face in today's complex applications - you simply have less to worry about in your electrical network.

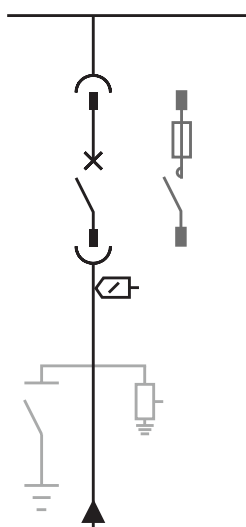
ZS8.4 is an air-insulated switchgear for primary distribution up to 24 kV. It is suitable for indoor installations and it is designed to provide maximum flexibility and the highest possible safety for circuit-breaker systems, switch-disconnector or contactor installations.

Combined current
and voltage sensor

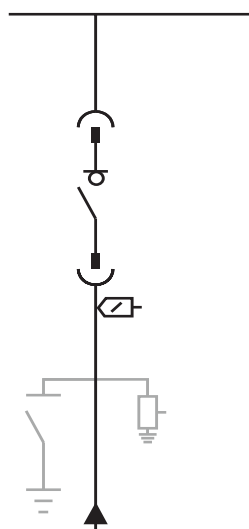


Protection relay
with IEC 61850

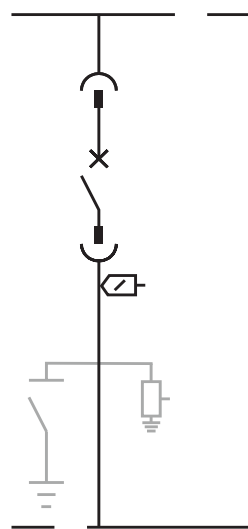
Single-line diagram
of typical units



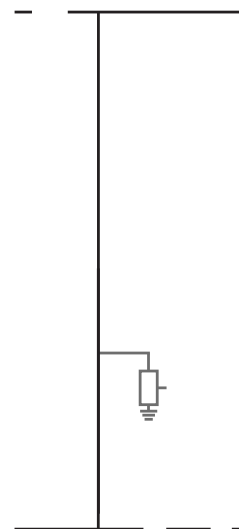
IF - Incoming/outgoing feeder



DF - Switch-disconnector
unit



BT - Bus-tie



R - Riser

ZS8.4

ZS8.4 for factory-assembled substations to IEC 62271-202

Factory-assembled substations are defined as type-tested facilities in a housing which encases the transformer, low voltage and high voltage switchgear, connections and auxiliary installations. They are often situated in publicly accessible locations and therefore need to ensure protection for people according to the specified service conditions. ZS8.4 is an air-insulated medium voltage switchgear system certified to offer the required safety levels following rigorous inspection and testing of an installation in a accessible concrete substation with a ceiling height of 2.4 m. The correct construction and operational behavior of the factory-assembled substation were confirmed through the corresponding internal arc tests.

In addition to the classic type tests for medium voltage switchgear according to IEC 62271-200, the ZS8.4 series has also been tested for internal arc resistance at low ceiling heights for use in substations according to IEC 62271-202. In this context, the application of the IS-limiter – the world's fastest limiting and switching device – with the ZS8.4 series was also field tested.

For proof of internal arc classification according to IEC 62271-200, two tests are necessary. The first test confirms the internal arc classification IAC-A according to the standard. This provides proof of the protection of the operating personnel in the substation (accessibility level type A - access for authorised personnel only). This applies in the case of a accessible substation as described here. The substation door is open during this test. The ZS8.4 panels are attached to the wall of the accessible substation, in which sensors to measure the heating effects of escaping gases are positioned in front of and adjacent to the switchgear. The pressure relief takes place within the switchgear/substation itself, reproducing the critical internal arc case in a substation.

The second test is for the IAC-B internal arc classification. This has already been passed successfully with the same substation to prove protection for the general public in its local area, with unlimited access to all sides of the station (access level type B). During this test, the doors of the station are closed.

The internal arc tests have confirmed classification to the IAC AB 21 kA / 1 s qualification.

With a sealed enclosure in versions to meet the field-separation classes PI and PM, ZS8.4 offers the very highest safety standards and reliable long term operation.

The ZS8.4 offers a self-contained safety concept with its wide range of interlockings, the possibility of loading the circuit-breaker spring operating mechanism with the front door closed and the integrated personnel protection guards on the busbars.

The maintenance-free switch devices and the sealed enclosure guarantee reliable long term operation. The IS-limiter is the ideal device for solving short circuit problems, reducing the system's short circuit current and therefore saving costs as well as increasing the scope of possible uses for the ZS8.4 switchgear.

Rated voltage	[kV]	12	17.5	24
Rated insulation voltage	[kV]	12	17.5	24
Rated power frequency withstand voltage	[kV / 1 min]	28	38	50
Rated lightning impulse withstand voltage	[kV]	75	95	125
Rated frequency	[Hz]	50/60	50/60	50/60
Rated main busbar current (40°C)	[A]	... 1 250	... 1 250	... 1 250
Rated current for branch circuit with LS	[A]	... 1 250	... 1 250	... 1 250
Rated current for branch circuit with LT	[A]	... 630	... 630	... 630
Rated peak withstand current	[kA]	... 63	... 63	... 63
Rated short-time current	[kA / 3s]	16/20/21	16/20/21 ¹⁾	16/20/21 ¹⁾
Ceiling height	[m]	2.4	2.4	2.4
Switch system pressure relief	Inside the substation, on rear side of switch system			
Classification in terms of internal arc	IAC AB 21 kA 1 s ²⁾			

1) 17.5 kV switch-disconnector panel only 20 kA / 24 kV switch-disconnector panel only 16 kA
2) Pursuant to IEC 62271-202 for ZS8.4 in a accessible station from series UF 30 of the company Betonbau



Additional information

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