



Medium Voltage Products

## UniGear ZS2

36 kV, 3150A, 31.5 kA Medium voltage, arc-proof,  
air insulated switchgear



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# 1. UniGear ZS2

## Description

- Each UniGear ZS2 panel consists of a single unit which can be equipped with a circuit-breaker, withdrawable fused device, off load disconnecter, as well as with all the accessories available for conventional switchgear units.
- The panel incorporates a compartment in its upper level to house the auxiliary instrumentation.
- Units can be coupled together directly with double busbar units, with the possibility for further extension on both sides of the switchgear.
- The switchgear does not require rear access for installation or maintenance.
- All the service operations are carried out from the front.







## Applications

### Utilities and Power Plants

- Power generation stations
- Transformer stations
- Main and auxiliary switchgear

### Industry

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

### Transport

- Airports
- Ports
- Railways
- Underground transport

### Infrastructure

- Supermarkets
- Shopping malls
- Hospitals
- Large infrastructure and civil works

# 1. UniGear ZS2

## Air-insulated

From power stations down to distribution substations, ABB provides a reliable, high quality solutions for products, systems and services.

As a single source partner, ABB is the world's largest and most complete supplier of switchgear and systems for electric power transmission and distribution applications.

ABB substations, cables, transformers, control systems and switchgear enable our customers to make efficient and effective use of electric power.



As a word-leading company in research, development and innovation, ABB is able to provide the most comprehensive and suitable range of solutions to meet the present and future needs of producers, distributors and users of electric power. Medium voltage switchgear is one of the most important links in the electric distribution chain and ABB has developed the UniGear ZS2 switchgear with the aim of satisfying all requirements. UniGear ZS2 combines consolidated solutions and innovative components, based on ABB's leading-edge technology.

UniGear ZS2 is medium voltage metal-clad switchgear with a metal enclosure, suitable for indoor installations.

Metal partitions segregate the compartments from each other and the live parts are air-insulated. The switchgear is modular and this provides a coordinated approach that enables the ideal solution for each installation to be built up by placing standardised units side by side.

The switchgear is simple to configure and selection of the correct apparatus and instruments for specific applications does not require dedicated solutions.

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 startup, maintenance and service 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 wall-mounted. The range of apparatus available for UniGear ZS2 switchgear is the most complete on the market, including vacuum and gas circuit-breakers. All this apparatus is interchangeable inside the same switchgear unit. This makes it possible to offer a single switchgear-user interface, with the same service and maintenance procedures and operations. The switchgear can be fitted with conventional (transformers and releases) or innovative (sensors and multi-purpose unit) measurement and protection components.

Apart from the traditional functional units, the UniGear ZS2 switchgear is fitted with double busbar systems. The use of these units allows extremely efficient use of space.

### Standards

The switchboard and main apparatus it contains 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 60071-2 for the insulation coordination.
- IEC 62271-100 for the circuit-breakers.
- IEC 60529 for degree of protection.

### Normal service conditions

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

- Minimum ambient temperature:  $-5\text{ }^{\circ}\text{C}$
- Maximum ambient temperature:  $+40\text{ }^{\circ}\text{C}$
- Ambient humidity:
  - Maximum 24h average of relative humidity 95% RH
  - Maximum 24h 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 operation site altitude is up to 1000 m above sea level.

Presence of normal, non-corrosive and uncontaminated atmosphere.

## Electrical characteristics

Rated voltage kV	[kV]	36
Rated insulation voltage	[kV]	36
Rated power frequency withstand voltage	kV 1min	70
Rated lightning impulse withstand voltage	kV	170
Rated frequency	Hz	50-60
Rated short time withstand current	kA 3	...31.5
Peak current	kA	...80
Internal arc withstand current	kA 1 s	...31.5
Main busbars rated current	A	1250
		1600
		2000
		2500
		3150
		1250
Branch connections rated current	A	1600
		2000
		2500
Branch connection rated current with forced ventilation with fan	A	3150
Branch connection rated current with forced ventilation with fans (available only with VD4 vacuum Circuit Breaker)	A	3150

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

## Degrees of protection

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

UniGear ZS2 switchgear is normally supplied with the following standard degrees of protection:

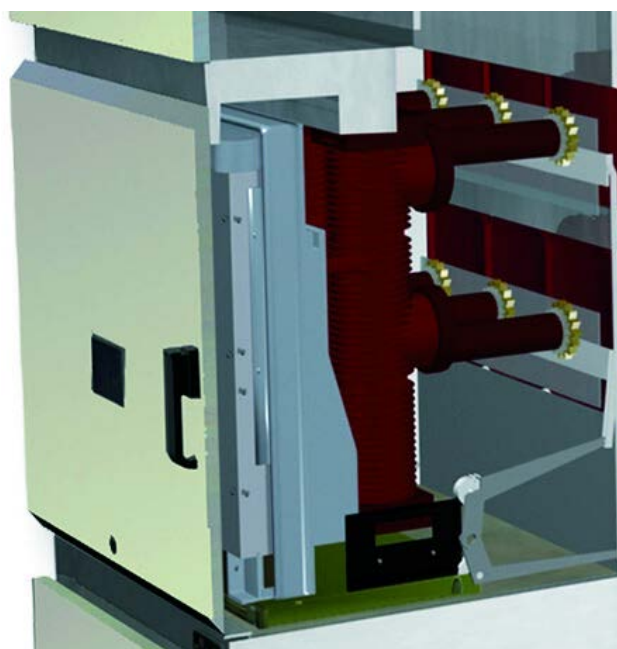
- IP4X for the enclosure.
- IP2X for the partition between compartments.

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

## Colour of the external surfaces

RAL7035 - light grey (front doors).

Other colours available on request.



Circuit-breaker compartment



# 1. UniGear ZS2

## 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-clad, 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, UniGear ZS2 switchgear can be defined as follows.

### 1. LSC-2B

The busbars, circuit-breaker and cable compartments are physically and electrically segregated.

This is the category that defines the possibility of accessing the circuit-breaker compartment with the busbars and cables energized.

### 2. Partition Class

Switchgear providing continuous metallic partitions and shutters, intended to be earthed between opened accessible compartments and live parts of the main circuit.

Metallic partitions and shutters or metallic parts of them shall be connected to the earthing point of the switchgear.

### 3. Interlock-controlled accessible compartment

Compartment containing high-voltage parts, intended to be opened for normal operation and/or normal maintenance, in which access is controlled by the integral design of the switchgear.

### 4. Tool-based accessible compartment

Compartment containing high-voltage parts, that may be opened, but not for normal operation and maintenance. Special procedures are required. Tools are necessary for opening.

### 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 optionally provided with a duct for evacuation of the gases produced by an arc; different types of gas ducts are available.

All the compartments are accessible from the front and maintenance operations can correctly be carried out with the switchgear installed up against a wall.

The compartments are segregated from each other by metallic partitions.

### Main busbars

The busbar compartment contains the main busbar system connected to the upper isolating contacts of the circuit-breaker by means of branch connections.

The main busbars are made of electrolytic copper.

For ratings up to 2000A, the busbars are tubular bars; while for currents between 2500A and 3150A, a flat busbar is used.

The busbars are covered with insulating material.

There is a single busbar compartment along the whole length of the switchgear, which optionally can be divided into compartments.

### Feeder 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 round busbars for the whole range of currents.

They are covered with insulating material.

### Earthing switch

Each 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).

The earthing switch has short-circuit making capacity.

Control of the earthing switch is from the front of the switchgear with manual operation.

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 and cable compartment respectively. The insulating bushings are of single-pole type and are made of epoxy resin. The shutters are metallic and are activated automatically during movement of the circuit-breaker from the racked-out position to the operation position and vice versa.

### Cables

Single core cables up to a maximum of four per phase can be used depending on the rated voltage, the unit dimensions and the cable cross section (please refer to page 44).

The switchgear can be wall-mounted as the cables are easily accessible from the front.

### Gas exhaust duct

The gas exhaust duct is positioned above the switchgear and runs along its whole length.

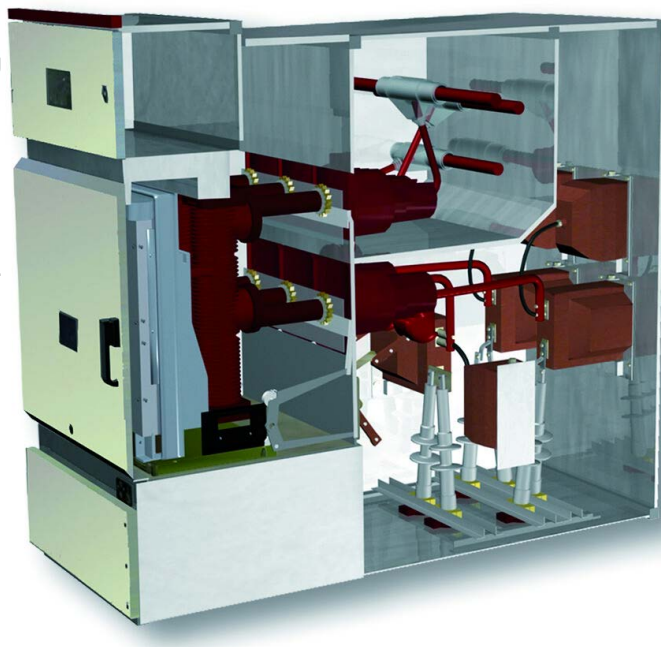
Each power compartment is fitted with a flap on its top surface. The pressure generated by the fault makes it open, allowing the gas to pass into the duct.

Evacuation from the room of the hot gases and incandescent particles produced by the internal arc must normally be carried out. The UniGear ZS2 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 rear are requested. Please contact your ABB sales representative for more information.

### Busbar applications

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

- current or voltage transformers for busbar measurements.
- top entry duct to make interconnections between different sections of switchgear.



Single level section view

# 1. UniGear ZS2

## Type-tested

The UniGear ZS2 switchgear has undergone all the tests required by the international (IEC) Standards and local Standards organizations.

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
- Earthing switch making capacity
- Mechanical operations of circuit-breaker and earthing switch

### IEC routine factory tests

Visual inspection and check

- Mechanical sequence operations
- Cabling check
- Electrical sequence operations
- Power frequency
- Measurement of the resistance of the main circuits
- Secondary insulation test
- IP degree (optional)

## 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 it may be fitted with are checked.

### Internal arc capability

Please refer to page 12.

### 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.



UniGear ZS2 during internal arc test

#### Circuit-breaker making and breaking capacity

The circuit-breaker is subjected to the rated current and short-circuit current breaking tests.

Furthermore, it is also subjected to the opening and closing of capacitive and inductive loads, capacitor banks and/or cable lines.

#### Earthing switch making capacity

The EK6/ST earthing switch of the UniGear ZS2 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 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 operation.

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.



Internal arc test.

# 1. UniGear ZS2

## Arc-proof

When developing modern medium voltage switchgear, personnel safety must necessarily take priority. This is why the UniGear ZS2 switchgear has been designed and tested to withstand an internal arc due to a short-circuit current of the same current level as the maximum short-time withstand level.

The tests show that the metal housing of UniGear ZS2 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 operations.

The characteristics of the UniGear ZS2 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 wounding (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.

The UniGear ZS2 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 (initials for Internal Arc Classified)
- Accessibility: A, B or C (switchgear accessible to authorized personnel only (A), to all (B), not accessible due to installation (C))
- F, L, R: access from the front (F – Front), from the sides (L – Lateral) and from the rear (R – rear).
- Test values: test current in kiloamperes (kA), and duration in seconds (s).

UniGear ZS2 switchgear is classified IAC AFLR.

When the switchgear is specified and installed, some fundamental points must be taken into consideration:

- Level of the fault current (31.5 kA).
- Duration of the fault (1s).
- Escape routes for the hot and toxic gases produced by combustion of materials.
- Dimensions of the room, with special attention to the height.

Please consult your ABB representatives for detailed information.

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

### Fault limiting systems

The structure of the UniGear ZS2 switchgear offers complete passive type protection against the effects of a fault due to an



internal arc for a time of 1 s for 31.5 kA.

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

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

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

The limiting systems are based on sensors which exploit the pressure or light generated by the arc fault.

#### ITH

The ITH sensors consist of micro-switches positioned on the top of the switchgear near the gas exhaust flaps of the two power compartments (busbars and circuit-breaker/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: 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: 2 ms TVOC + 60 ms circuit-breaker.

#### REA

This system offers the same functionality as TVOC. The REA system consists of the main unit (REA 101) and optional extension units (REA 103, 105, 107) which make it possible to

create customized solutions with selective tripping.

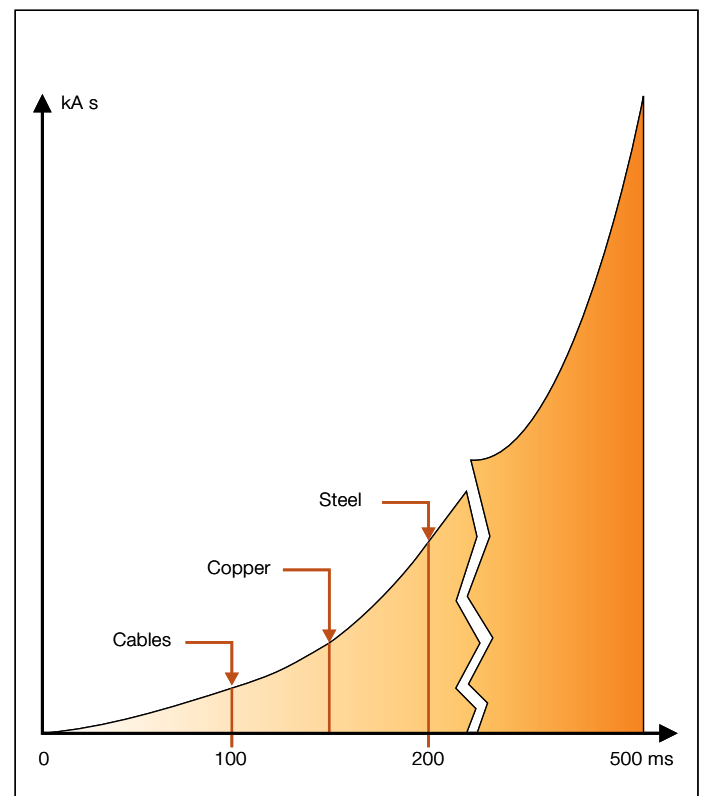
For more information, please see the dedicated chapter at page 38.

Total tripping time: 2,5 ms REA + 60 ms circuit-breaker.

#### Arc protection in IED

The REF615, RET615, REM615 and REF610 IEDs (Intelligent Electronic Device) can optionally be fitted with a fast and selective arc flash protection. It offers a two- to three-channel arc-fault protection system for arc flash supervision of the circuit breaker, cable and busbar compartment of switchgear panels.

Total tripping time: 12 ms IED + 60 ms circuit-breaker.



Arc duration and damage caused

# 1. UniGear ZS2

## Safety

The UniGear ZS2 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÷4A]. They are set out by the IEC standards and are therefore necessary to guarantee the correct operation sequence. The presence of ABB safety interlocks guarantees the highest level of reliability, even in the case of an accidental error, and provide an “error-free” system of interlocks.

### Keys

The use of key interlocks is very important in realising the interlocking logics between panels of the same switchgear, or of other medium, low and high voltage switchgear. The logics are realised by means of distributors or by ringing the keys. The apparatus truck [6] can be locked in the racked-out position and the relevant lock key can only be removed with the apparatus in this position.

The earthing switch closing [7] and opening [8] operations can be locked by means of keys.

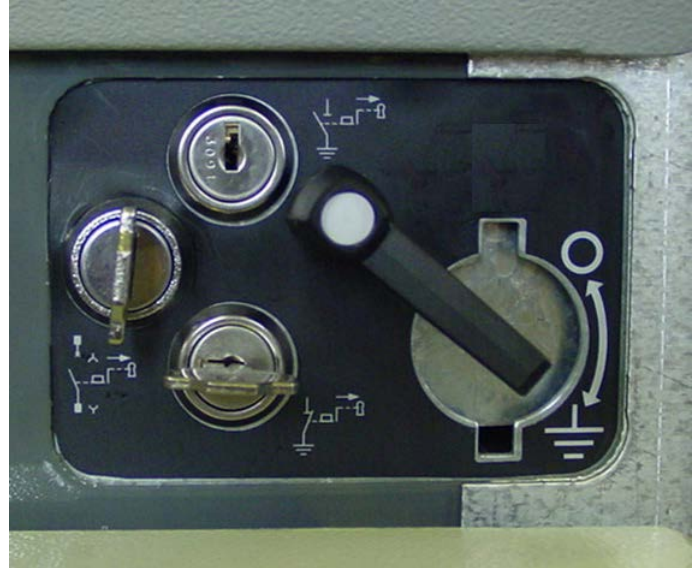
The latter can only be removed with the earthing switch in an opposed position to the lock to be made. These locks can also be applied to the earthing switch of busbar applications. The circuit-breaker racking-in/out operations [9] and earthing switch opening/closing [10] can be prevented by means of key locks, which prevent insertion of the relevant operating levers.

The key lock can also be applied to the earthing switch of busbar applications. The keys can always be removed.

### Padlocks

The circuit-breaker [11] and cables [12] compartment doors can be locked in the closed position by means of padlocks. The operations for apparatus racking-in/out [13] and earthing switch opening/closing [14] can be prevented by applying the padlocks to the insertion slots of the relevant operating levers. The padlock can also be applied to the earthing switch of busbar applications.

The metallic segregation shutters [15] between circuit-breaker, busbars and cables compartments can be locked by means



Triple key lock on earthing switch

of two independent padlocks in both the open and closed positions.

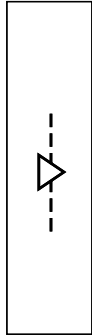
Padlocks from 4 to 8 mm diameter can be accommodated.

### Locking magnets

The locking magnets enable automatic interlocking logics without human intervention.

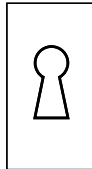
The circuit-breaker racking-in/out [16] and the earthing switch ON/OFF [17] operations can be interlocked. This magnet can also be applied to the earthing switch of busbar applications. The magnets operate with active logics and therefore the lack of auxiliary voltage leaves the interlocking system active (in safety condition).

#### Standard safety interlocks



Type	Description	Condition to be fulfilled
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 OFF position
4	A Apparatus racking-in	Apparatus compartment door closed
	B Apparatus compartment door opening	Truck in test position
5	A Feeder compartment door opening	Earthing switch in OFF position
	B Earthing switch opening	Cable compartment door closed

#### Keys (on request)



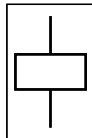
6	Apparatus racking-in lock	Can only be removed with the truck in the racked-out position
7	Earthing switch closing lock	Can only be removed with the earthing switch open
8	Earthing switch opening lock	Can only be removed with the earthing closed
9	Insertion of the apparatus racking-in/out crank lever	Can always be removed
10	Insertion of the earthing switch operating lever	Can always be removed

#### Padlocks (on request)



11	Apparatus compartment door opening	
12	Cable compartment door opening	
13	Insertion of the apparatus racking-in/out crank lever	
14	Insertion of the earthing switch operating lever	
15	Shutters opening or closing	

#### Locking magnets (on request)



16	Apparatus racking-in/out	Magnet energized
17	Earthing switch ON/OFF	Magnet energized

#### Standard accessory devices

18	Apparatus-switchgear unit compatibility matrix	The apparatus multi-contact plug and relative switchgear unit socket are equipped with a mechanical matrix, that disables apparatus racking-in into a switchgear unit with an inappropriate rated current.
19	Circuit-breaker mechanical operating mechanism ( Open push button )	The apparatus compartment is equipped with a mechanical device, that enables circuit-breaker opening directly by means of the front operating mechanism pushbutton, keeping the door closed. The controls can be operated with the circuit-breakers in the service and racked-out position.

#### Optional accessory devices

20	Circuit-breaker mechanical operating mechanism ( Close push button )	The apparatus compartment is equipped with a mechanical device, that enables circuit-breaker closing directly by means of the front operating mechanism pushbuttons, keeping the door closed. The controls can be operated with the circuit-breakers in the service and racked-out position.
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# 1. UniGear ZS2

## Vacuum circuit-breaker

UniGear ZS2 switchgear can be fitted with the widest range of apparatus available on the market today, and of these the vacuum circuit-breaker now occupies a position of prime importance in all sectors of primary distribution. Vacuum circuit-breakers cover the whole range of switchgear parameters and therefore the whole range of applications. In standard version circuit breakers are withdrawable cassette type.

In case of need floor tract type circuit breakers also can be provided as an option. 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 the 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 in electrical distribution for control and protection of cables, overhead lines, transformer and distribution substations, 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 performance 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 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-



VD4 circuit-breaker

# 1. UniGear ZS2

## Vacuum circuit-breaker

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 pressure systems and do not require any maintenance.

### Operating mechanism

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

The free trip 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 charging device for the operating mechanism springs.
- Override selector of the undervoltage release (optional).

### Standards

IEC 62271-100 for the circuit-breaker.



VD4 circuit-breaker



Interchangeable Vacuum circuit-breaker and SF6 circuit-breaker with UniGear ZS2.

# 1. UniGear ZS2

## Gas circuit-breaker

UniGear ZS2 switchgear can be fitted either with vacuum circuit-breakers or with SF6 circuit-breakers.

The ABB vacuum and gas series of circuit-breakers are mechanically interchangeable and the same switchgear unit can therefore take either type of apparatus. Only ABB can offer apparatus representing both techniques for the whole range of applications, voltage levels (36 kV), rated current (1250...2500 A) and breaking capacity (16...31.5 kA). This makes it possible to specify the optimum solution for the installation characteristics and the feeders to be switched and protected.

ABB's long practical experience shows that the two types of circuit-breakers are equally valid and complementary.

The HD4 medium voltage circuit-breakers use sulphur hexafluoride gas (SF6) to extinguish the electric arc and as the insulating medium.

Thanks to the excellent properties of SF6 gas, interruption of the currents takes place without arc chopping and overvoltages. There is no restriking phenomenon after interruption and the dielectric properties following interruption are recovered extremely rapidly.

Circuit-breakers are available for all electric power distribution applications. They are particularly recommended for use on capacitor banks, motors, transformers insulated in oil and

in installations where components which are particularly sensitive to dielectric and dynamic stresses are installed (for example, old cables or transformers).

### Poles

The HD4 circuit-breaker poles use the autopuffer breaking system, combining the compression and self-blast techniques in a single solution.

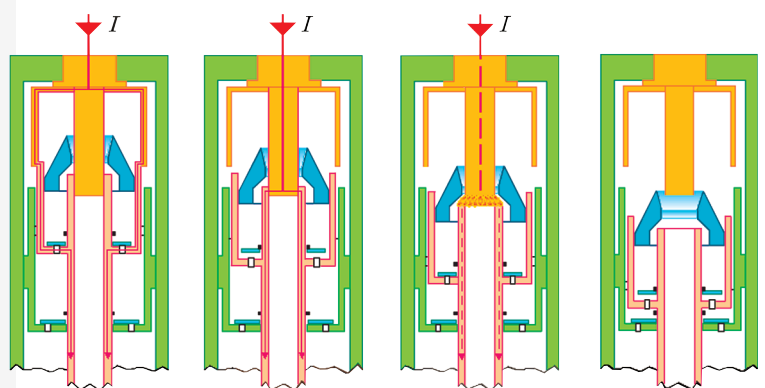
The autopuffer system is the most innovative technique in the field of gas circuit-breakers and originates from high voltage apparatus.

The combination of the compression and self-blast techniques allows the best performance to be obtained at all current values. Both techniques are always present, but whereas the former operates optimally in switching low currents, the latter acts effectively during operation at higher current values. The autopuffer technique allows the use of a smaller quantity of gas than that required by circuit-breakers based on other techniques. For the same reason, the gas pressure is also considerably reduced. The autopuffer technique guarantees the insulating withstand voltage and the breaking capacity up to 30% of the rated value, even with zero relative pressure.

SF6 gas pressure level monitoring is not necessary, since the circuit-breaker poles are sealed-for-life pressure systems and



HD4 circuit-breaker





are maintenance-free. They are fitted with a pressure control device for checking that the characteristics are not altered due to transport or incorrect operations.

### Operating mechanism

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

The operating mechanism spring system can be recharged either manually or by means of a geared motor. The operating mechanism is of the same type for the whole series and has a standardised range of accessories and spare parts. All the accessory components can easily be replaced by means of plug-socket connectors.

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

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

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

The truck is provided with a wheel system which makes the operations for racking the apparatus out of and into the switchgear unit possible with the door closed. The truck allows effective earthing of the circuit-breaker by means of the metallic structure of the switchgear unit.

### Apparatus-operator interface

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

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

### Standards

IEC 62271-100 for the circuit-breaker.

IEC 60376 for the SF6 gas.



HD4 circuit-breaker



# 1. UniGear ZS2

## Service trucks

The UniGear ZS2 range is equipped with all the service trucks needed to complete the switchgear and required for service and maintenance operations.

The trucks are divided into five different types:

- Earthing without making capacity.
- Power cable test.
- Isolation without making capacity.
- Fused without making capacity.
- Shutter test.

### Earthing truck without making capacity

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

This truck is available in two versions:

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

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

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

### Power cable test truck

These trucks allow the insulation tests on the power cables to be carried out without accessing the feeder compartment or disconnecting the cables from the switchgear. The use of these trucks anticipates removal of the apparatus from the switchgear (circuit-breaker) and its replacement with the truck.

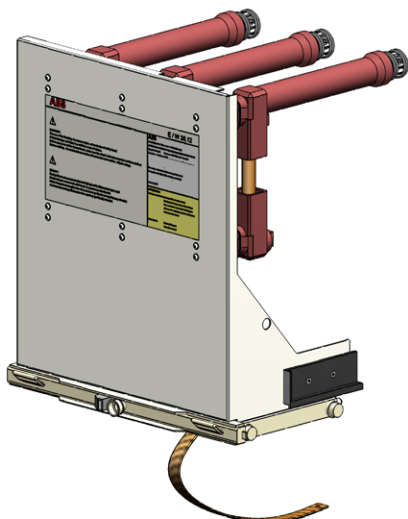
The truck, during the racking-in phase, only activates the bottom shutter and, by means of the connectors it is fitted with, allows connection of the test apparatus cables.

This truck can only be used in the incoming/outgoing feeders with the door open.

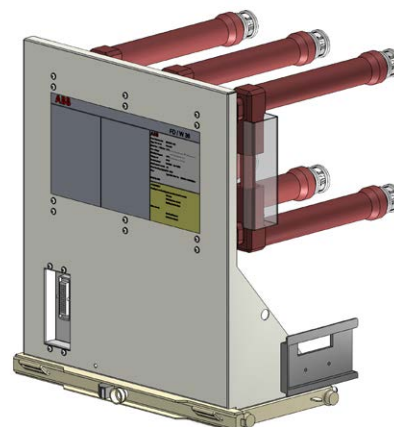
### Isolating truck without making capacity

The isolating truck allows the top switchgear contacts to be connected directly to the bottom ones. Connection is made safe by using the poles to insulate the connection busbars from the external environment.

In the incoming/outgoing feeder units it connects the main busbar system to the power cables, whereas in the bus-tie, to the two sides of the busbar system. This truck has its application in UniGear ZS2 switchgear for making incoming/outgoing feeders without a circuit-breaker in radial networks, for making cable connections between two items of switchgear placed in front of each other, in making interconnection units and in creating the bus-tie riser configuration with double insulation (in this case, both the units are made up of bus-ties, the former fitted with a circuit-



Busbar earthing truck without making capacity



Fused truck without making capacity

breaker and the latter with an isolating truck).

#### Fused truck without making capacity

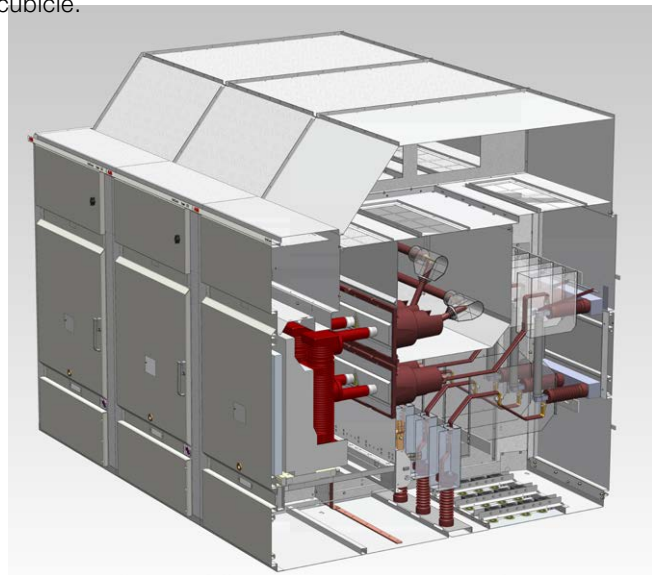
The fused truck can be used to protect small power transformers up to 50 kVA with 4 A fuses. It is developed to provide cost effective and technically best possible solution for small transformers. It is developed and tested according to IEC 62271 with M0 class. Fuse breaking capacity of apparatus is 40 kA. The fused truck needs to be electrically interlocked with downstream LV circuit breaker to protect racking in/out while the down stream circuit breaker is on.

#### Shutter test truck

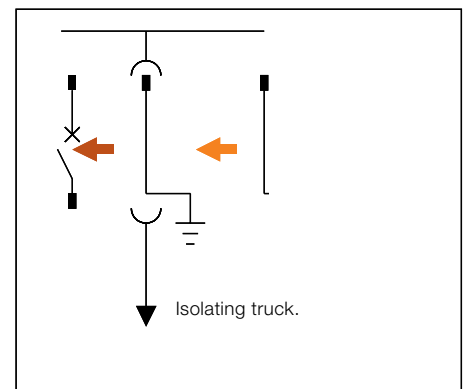
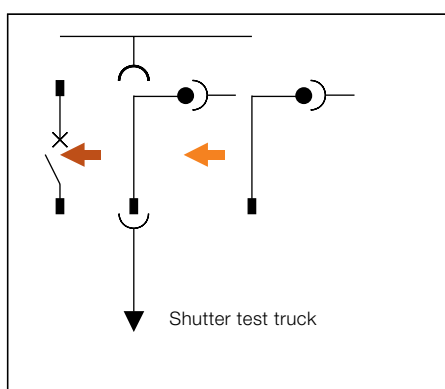
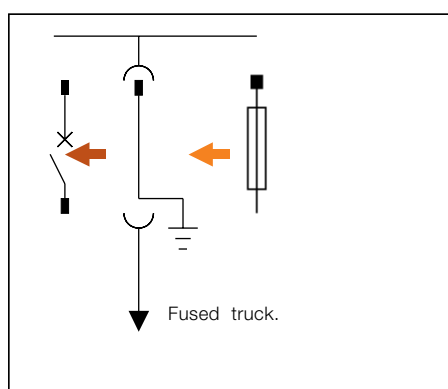
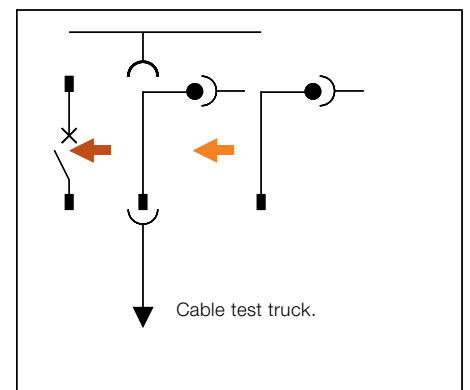
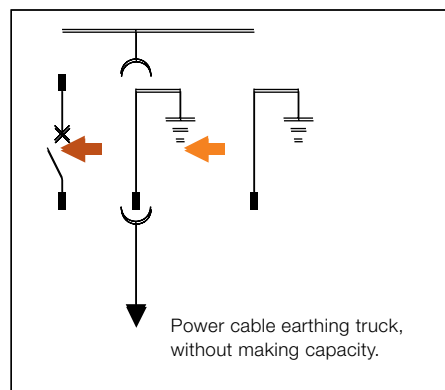
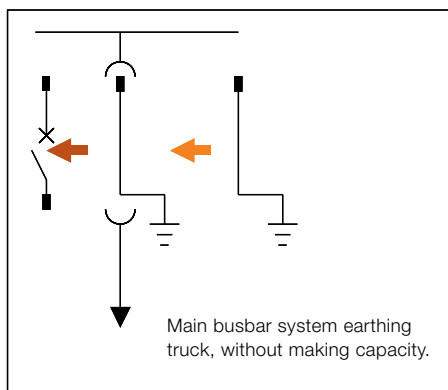
These truck allow the shutter tests on the shutter to be carried out without accessing the feeder compartment. The use of these trucks anticipates removal of the apparatus from the switchgear (circuit-breaker) and its replacement with the truck. The truck, during the racking-in phase, activates the upper and bottom shutter. This truck can be used in the incoming/outgoing feeders with the door closed.

#### Fused Switch (Circuit Breaker) feeder

Fused switch (circuit breaker feeder) can be used with fuses up to 200A to protect transformers and lines. This solution gives LSC2B solution for transformers protection also with a fuse blown indication. Vacuum or SF6 circuit breaker is used to switch the line also to trip the feeder with fuse blown contact. This solution is available only with 1200 mm width cubicle.



Fused Switch (Circuit Breaker ) feeder



# 1. UniGear ZS2

## Instrument transformers

### Block type current transformers

The block type current transformers are epoxy resin insulated and used to supply the measurement devices and protection instruments. These transformers can have a wound core or a bushing bar with one or more cores, with performance and accuracy classes suitable for the installation requirements. They conform to the IEC 60044-1 Standards.

Their dimensions are in accordance with the DIN 42600 Narrow Type Standard, in the Medium and Long Size versions up to 3150 A,

The current transformers can also be provided with a capacitive socket for connection to voltage signalling devices. The current transformers are normally fitted on the load side of the apparatus compartment for measurement of the phase currents of the switchgear unit. Fitting on the supply side of the apparatus compartment is also possible (busbar applications) for measuring the busbar currents or for realising particular protection schemes.



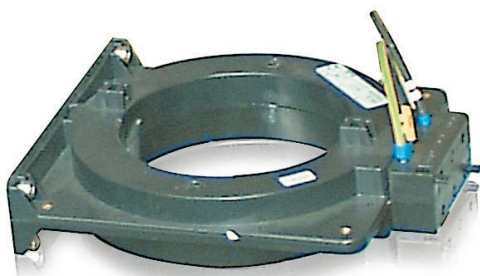
1250 A

### Ring core current transformers

The toroidal transformers are of the epoxy resin insulated type and are used to supply measurement and protection devices. These transformers can feature either a closed or openable core. They can be used both for measuring phase currents or for detecting the earth fault current. They conform with the IEC 60044-1 Standards.



2500 A



Toroidal current transformer



### 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 with the IEC 60044-2 Standards.

Their dimensions are in accordance with the DIN 42600

Narrow type 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.

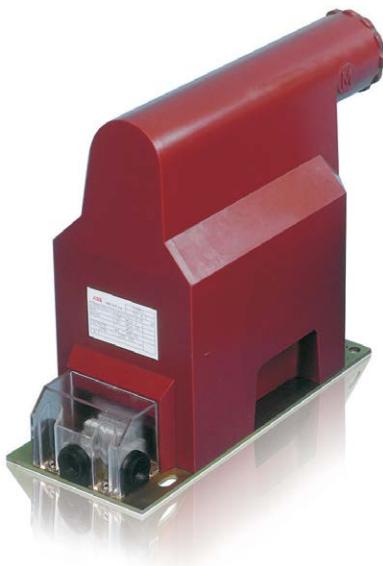
The withdrawable trucks also allow replacement of the fuses with the switchgear in service. Truck racking-out with the door closed automatically operates closure of a metallic segregation shutter between the live parts of the switchgear and the instrument compartment.

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

Withdrawable type voltage transformers can be installed in to the cable compartments of incoming/outgoing feeders for power cable side voltage measuring.



Single pole VTs



Single-pole VTs with fuse -



Double-pole VTs

# 1. UniGear ZS2

## Measurement sensors

### Sensors – Electronic instrument transformers

An alternative solution for measuring currents is an electronic instrument transformer, called a “sensor” for short. This product can replace conventional instrument transformers of both block and ring core types.

The characteristic feature of ABB sensors is the level of output signal, which is analogue voltage signal. The output signal level depends on the principle used and can be:

- In the range of mV for current sensor (typical value is 150 mV at rated 80 A primary current)

The UniGear ZS2 can be fitted with 2 sensor types:

- KECA 250B1 – ring type current sensor.
- KECA A – ring type current sensor.

### Characteristics of the sensors

- Linear response over the whole measurement field.
- Excellent frequency response.
- No hysteresis phenomenon.
- High degree of immunity to electromagnetic disturbance.
- A single instrument for protection and measurement devices.
- Cl.1 overall class of measurement (sensors and multi purpose unit).
- Any short-circuits or interruptions of the secondary circuit do not cause any damage.
- The output signal remains very low even in primary fault situations.
- Test terminal blocks are not required.
- Connection between the sensor and the measurement and protection instrument is made with shielded cables and connectors.

### Benefits provided by the sensors

- Improvement of selectivity.
- More efficient fault location.
- Perfecting of fault analysis.
- Simplification of engineering tasks.



KECA ring core type sensor

- More rapid and less costly switchgear modifications and upgrading.
- Simple and safe test maintenance operations.
- Reduction in faults in the measurement and protection apparatus.
- Safety for operators due to elimination of accidental opening of secondary CT's circuits.
- Optimisation of maintenance programmes.
- Reduction in the number of spare parts.
- Lower life cycle cost.

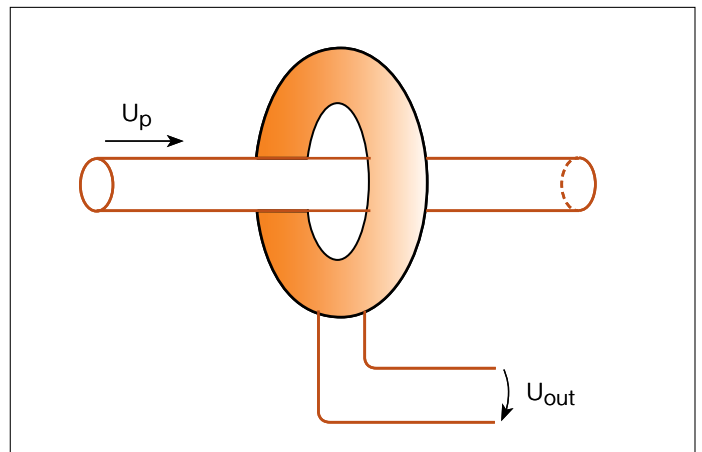
### Current sensor

The current sensor consists of a Rogowski coil without the ferromagnetic core.

The coil is formed by a uniform winding over a closed non-magnetic core of constant cross section. The induced voltage in the secondary circuit is directly proportional to the variation in the let-through current. The multi-purpose device integrates the signal to obtain the current value.

They conform to the IEC 60044-8 Standards.

### Rogowski coil



The output signal ( $U_{out}$ ) is a voltage (150 mV at 50Hz and 180mV at 60Hz) proportional to the variation in the current time ( $I_p$ ); the current measurement is obtained by integrating the signal.

$$U_{out} = M \frac{dI_p}{dt}$$

### Characteristics of the current sensors

- No saturation phenomenon.
- Precise measurement of the fault currents.
- The sensor winding can remain open even with the switchgear in service.
- Just two coils cover the range from 0 to 2500 A.



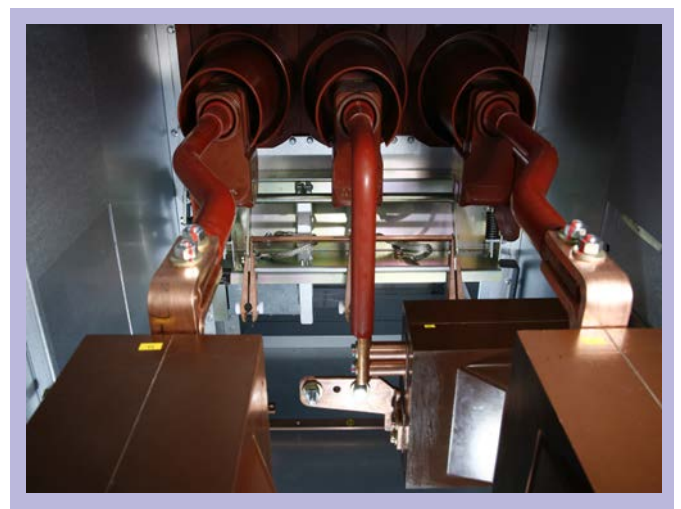
Circuit breaker with trolley



Busbar compartment



Circuit breaker compartment with shutters



Cable compartment with current transformers

# 1. UniGear ZS2

## Distribution automation

### ABB protection philosophy

Having delivered protection IEDs to more than 70 countries, ABB fully understands the need for diverse protection philosophies that meet local legislation, safety requirements and engineering practice.

The main purpose of an IED protection system is to recognize any abnormal power system condition, or abnormally operating system component. Based on the information gathered, the protection system will initiate corrective actions that return the system to its normal operating state.

IED protection does not prevent network faults from arising, but it is activated only when something abnormal has occurred in the power system. However, careful selection of 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

Operating speed, sensitivity, selectivity and reliability of the protection system need close attention. 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 IEDs also minimizes post-fault load peaks, which together with voltage dips 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 in order to limit the loss of power





supply to as small an area as possible, and to allow the faulted part of the network to be reliably identified. Corrective actions can then be directed to the faulty part of the network, so that the supply can be restored as rapidly as possible.

The protection system must have a high degree of reliability. This also means that if, for example, the CB fails to operate, the back up protection will clear the fault.

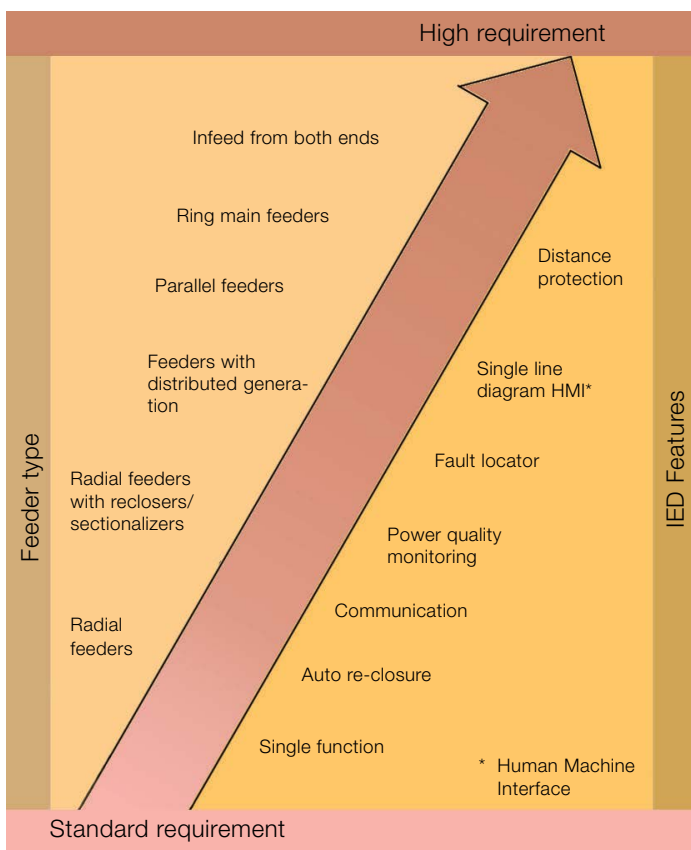
Substation automation (SA) puts the operator in perfect control of the substation. In addition, the SA system improves the power quality of the transmission and distribution network under normal operation, but especially in a situation of disturbance and during substation maintenance. An SA system or SCADA brings the full benefits of digital technology into protection and control of networks. The terminals are easily setup and parameterized through easy and safe access via the operator's workplace.

#### Single-function and multi-function terminals

Correct protection methods and comprehensive functionality

increase the performance of the protection system. The definition of comprehensive functionality varies with the requirements of the protected network. While single-function protection IEDs are sufficient for some network applications, more complex networks need advanced multi-functional IEDs. Single-function IEDs include a set of protection functions for a specific feeder application type. The main advantages of these IEDs are redundancy and price. One or more single-function IEDs provide sufficient protection in most application areas.

Multi-function terminals include a large number of protection functions that meet the needs of a wide range of applications. In addition, they include control, measurement, power quality monitoring and condition monitoring functions. The use of one single IED incorporating all these functions increases system usability, reduces costs and minimises the need for wiring in the switchgear.



Comparison between standard and high requirement feeders

# 1. UniGear ZS2

## Distribution automation

### Feeder protection

The protection applications can be roughly divided into two categories, namely standard applications utilizing basic current based protection and high requirement applications utilizing current and voltage based protection and their combinations (see table on next page).

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 above requirements can be fulfilled with non-directional/directional overcurrent IEDs. In networks with a more complex structure more advanced protection functions like distance protection or line differential protection may have to be introduced.

The purpose of the over- and under-voltage protection system is to monitor the voltage level of the network. 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.

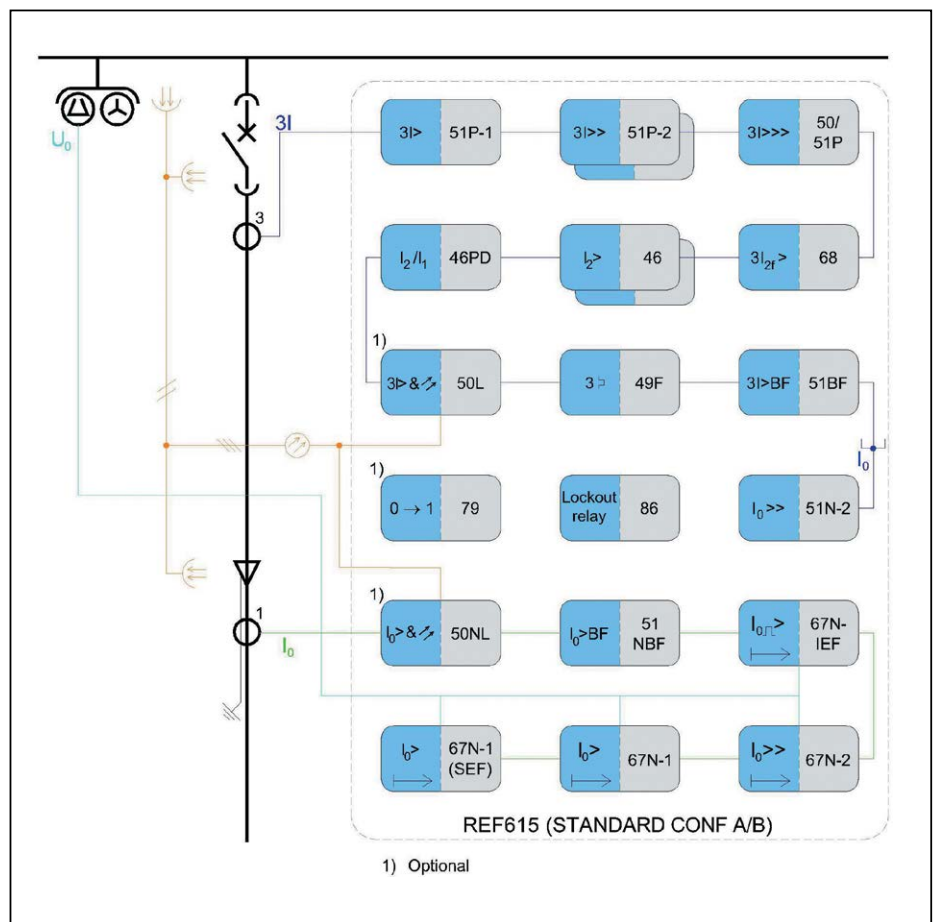
To prevent major outages due to frequency disturbances, the substations are usually equipped with underfrequency protection IEDs, which in turn control various load-shedding schemes.

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

### Applications and features

Depending on the requirements a suitable IED type can be selected and configured in such a way that an overall solution can be found for different feeder types.

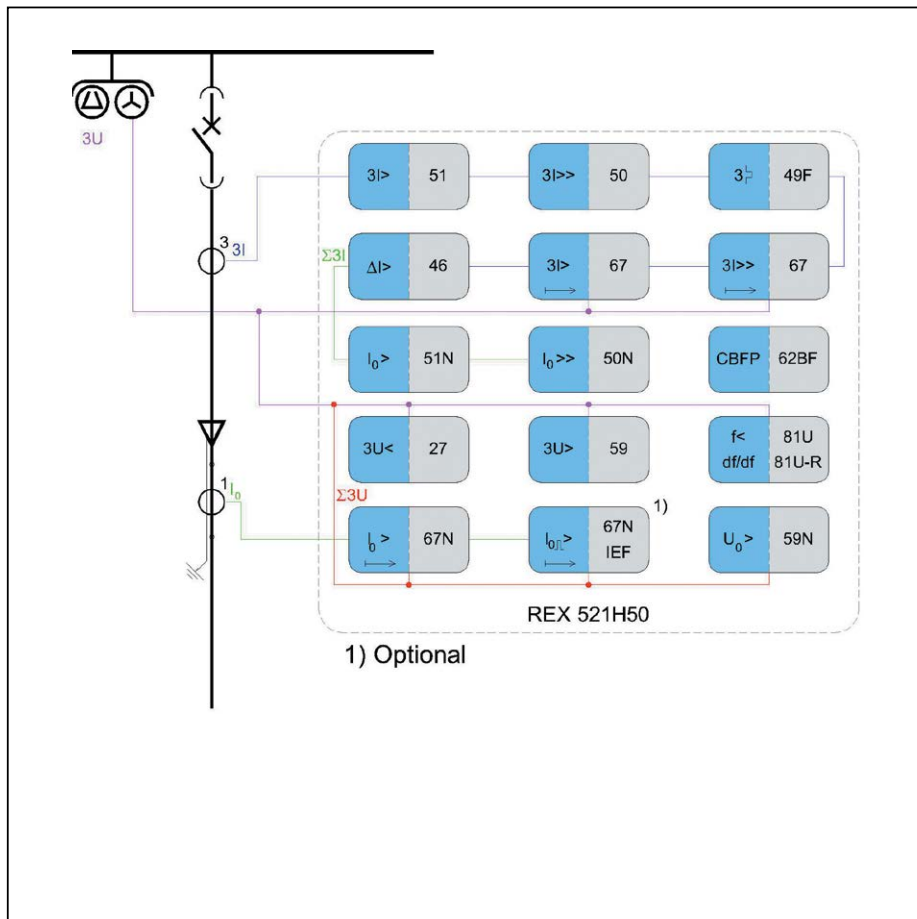
Generally, the required protection functionality of the above feeder types differs very much from each other depending on, for instance, the characteristics of the fault current sources and the types of more advanced functions that may be needed to fulfill the basic requirements of the protection application. In the following a few examples are given to illustrate the requirement level.



Typical standard feeder

### Recommended products

ABB supplies a wide range of feeder protection and control devices and terminals to fulfill the requirements of each discrete application. For an application with standard requirements and a basic need for additional features, the REF615 and REX 521 units are excellent choices. For applications with higher functionality requirements, the multifunction terminals REF 54\_ should be selected. Especially for applications requiring absolutely selective feeder protection (unit type of protection), the line differential IED RED615 can be applied. This IED maintains selectivity even in cases where the fault current magnitude varies and fault current can be fed from several sources. This is usually the case in closed loop, ring type and meshed networks.



Typical high requirement feeder

# 1. UniGear ZS2

## Distribution automation

### Transformer protection

The power transformer is an important component and one of the most valuable discrete units in the power distribution network. A high availability of the power transformer is therefore of particular importance for preventing disturbances in the power distribution system.

Although high-quality power transformers are highly reliable, insulation breakdown faults sometimes occur. These faults appearing as short circuits and/or earth faults generally 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.

The power transformer has to be transported to a workshop for repair, 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 IEDs 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 at a possible fault. When 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.

### Applications and features

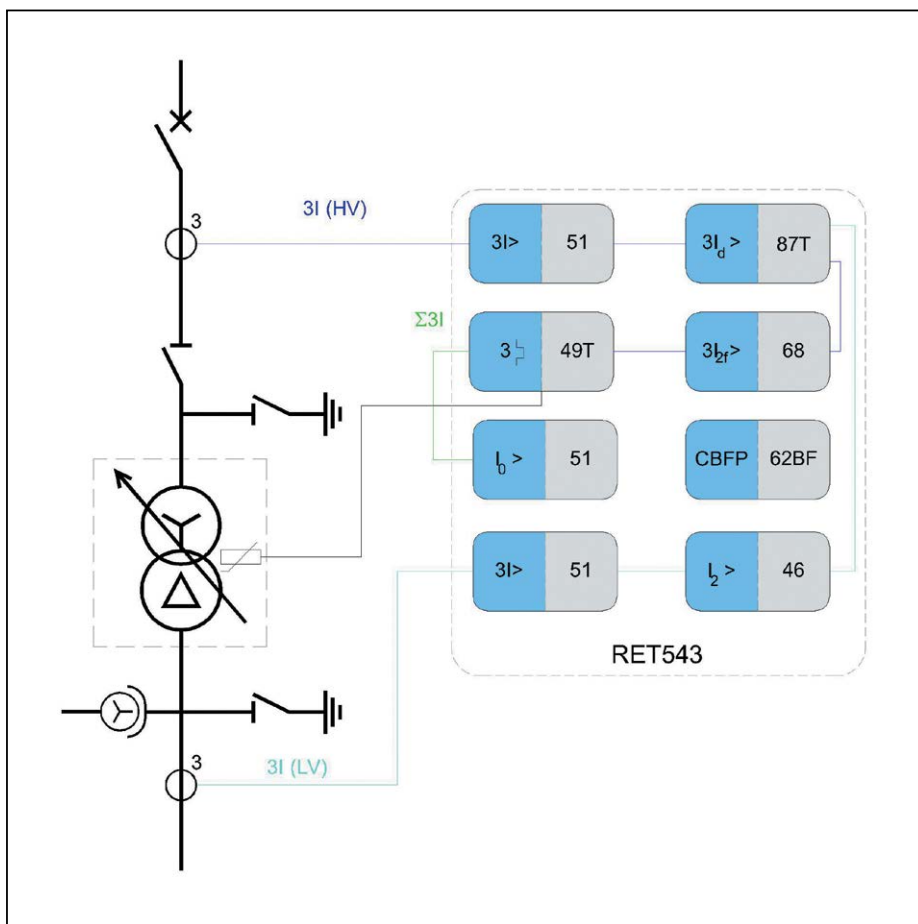
ABB divides transformer protection applications into standard transformer protection application and high requirement transformer applications.

The core functionality levels are as below:

- Standard requirement –Sudden pressure (Buchholz) -IED
- Differential protection
- Overcurrent protection
- Earth fault protection
- Overload protection
- Unbalance protection
- Oil level monitor

High requirement functionality levels are:

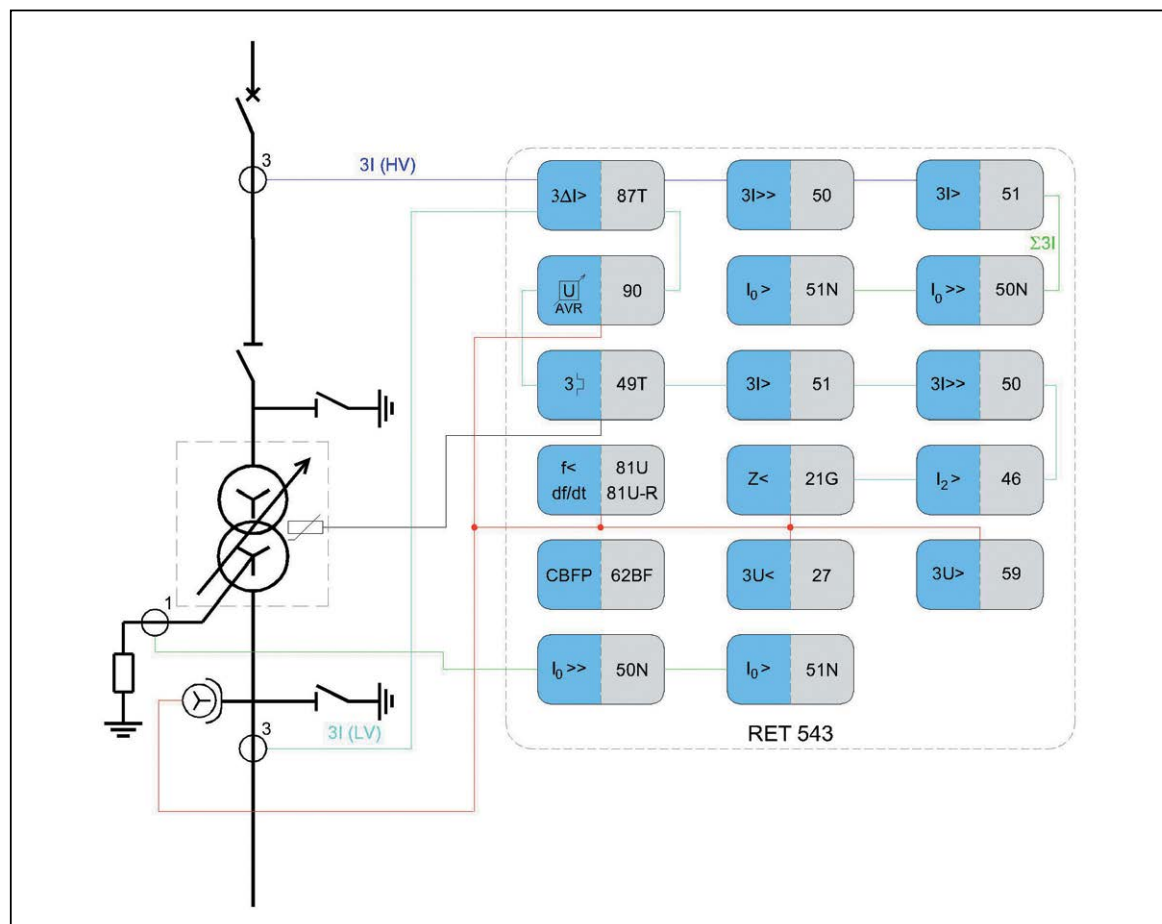
- Sudden pressure (Buchholz) -IED
- Differential protection
- Overcurrent protection
- Restricted earth fault (REF) protection
- Overload protection



Typical standard transformer protection



- ## Recommended products

[illegible]

### Typical high requirement transformer protection

# 1. UniGear ZS2

## Distribution automation

### Motor protection

Motor protection is generally expected to provide overcurrent, unbalance, earth-fault and short-circuit protection. However, the fundamental issue for motors is thermal protection, as overheating is the worst threat for the motor.

Motors need to be protected not only against electrical faults but also against any improper way of running them. ABB's solutions focus on advanced thermal protection that prevents improper use of the motors. The thermal overload protection is needed to protect the motor against both short-time and long-time overload and so it is of great importance for the performance of the motor. Overload conditions of short duration mainly occur during motor start-up.

There are four crucial elements in thermal motor protection.

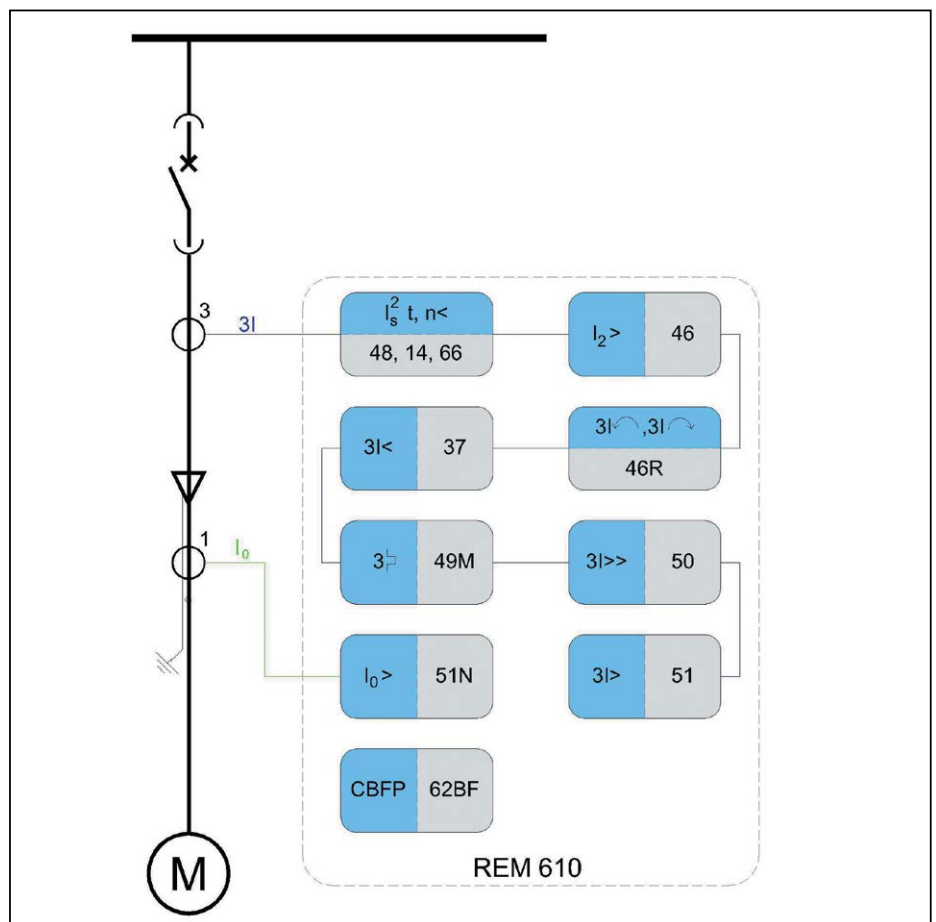
- The thermal overload protection is the most important protection function of the motor as it monitors the thermal load and memorizes the related events.
- A cumulative start-up time counter supporting the overload protection limits the number of consecutive cold starts.

- The thermal stress during any single start-up condition is monitored by the start-up supervision function, which protects the motor against locked rotor situations and over long start-up times.
- The fourth element in thermal motor protection is thermal protection based on RTD (Resistance Temperature Detector) sensors. As RTD sensors directly measure the temperature of the stator winding, bearings, etc., this type of thermal protection is especially useful if the motor's cooling system is blocked.

Improper use of running motors does not necessarily damage the equipment but shortens its lifetime. Therefore, a reliable and versatile motor protection system not only protects the motor but it also prolongs its life-cycle, which contributes to improving the return on investment of your motor drive.

### Applications and features

Thanks to comprehensive communication protocols, including



Typical standard motor protection



# 1. UniGear ZS2

## Distribution automation

### Station Automation COM600 Series

The Station Automation COM600 Series is a dedicated system for providing inter-operability between industrial or utility substation IEDs (Intelligent Electronic Devices) and local or higher-level systems, such as local operator interfaces or higher-level Network Control Centers (NCC) or Distributed Control Systems (DCS). The series features gateway functionality supporting a variety of commonly used substation device communication protocols.

### Products

The Station Automation COM600 Series offers web server functionality, providing a human machine interface (HMI) for local substation monitoring and control. Secure communication enables access to the substation HMI over the internet or LAN/WAN for any authorized user with a standard PC and a web browser. By connecting a laptop computer to the unit locally, an HMI for full monitoring and control functionality is obtained at the substation level. The Station Automation COM600 Series also provides gateway functions for mapping data and signals between substation and higher-level systems such as SCADA, DSC. The entire COM600 series is designed for smooth system integration and interoperability based on pre-configured solutions utilizing connectivity packages for ABB IEDs.

### Advantages

Open access to real-time information.

The COM600 series products incorporate OPC Server functionality, which provides one entry point to all the substation information, and the IEC 61850 support enables connectivity and seamless communication with application-specific equipment.

### Full IEC 61850 compliance

The COM600 series products are fully compliant with the IEC 61850 standard for distribution automation. This means that they provide full interoperability with any IEC 61850 compliant IEDs, tools and systems, which simplifies system design and commissioning.



### Fast commissioning of ABB IEDs

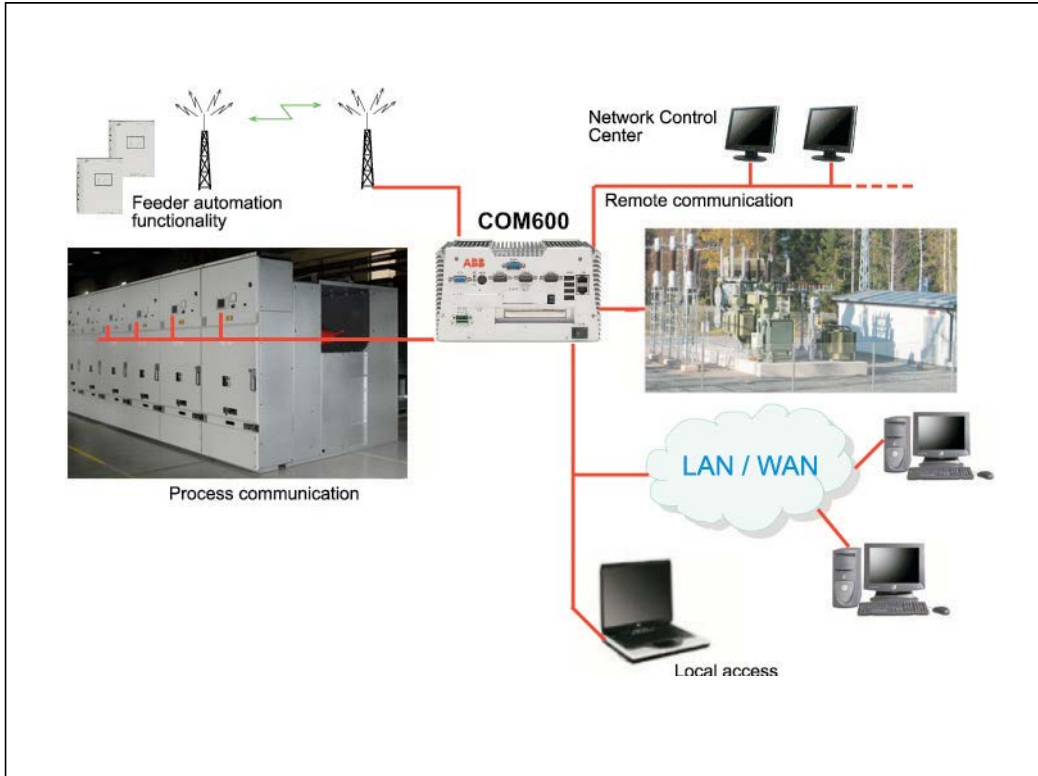
The commissioning of ABB IEDs is straight forward due to the support of ABB's unique connectivity package concept, which simplifies system configuration and reduces the risk of errors in the system integration, minimizing device configuration and set-up times.

### Application and features

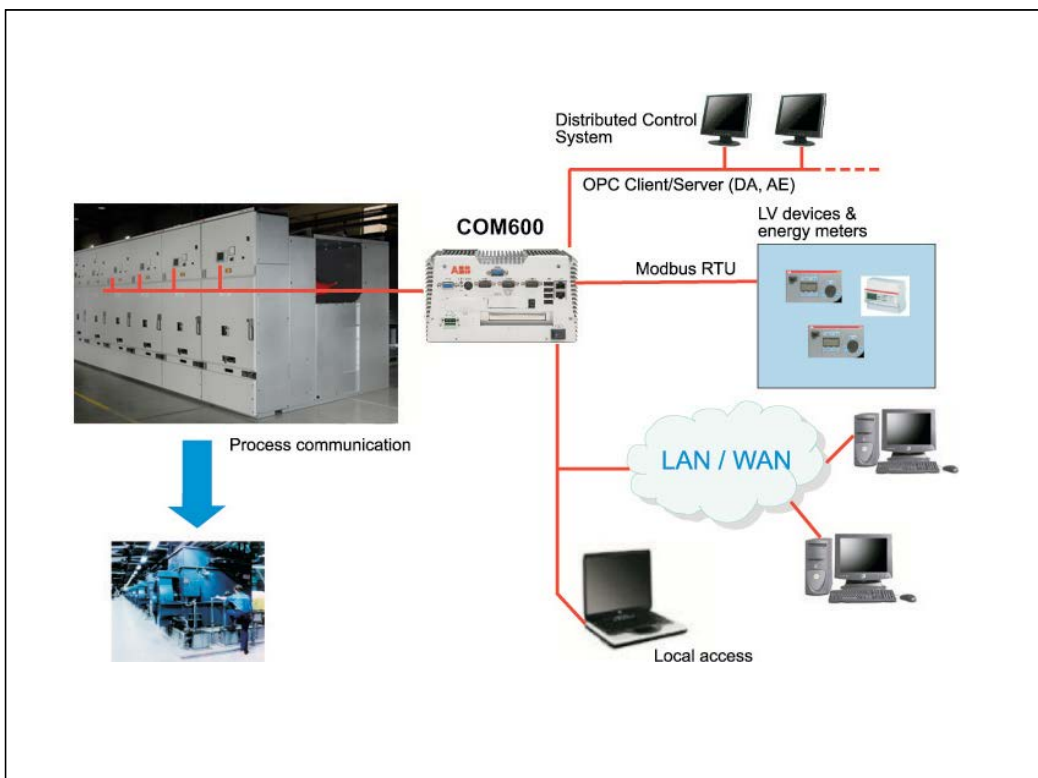
With their compact and robust design, the COM600 series products are well adapted for harsh environments. They meet the IP4x degree of protection by enclosure and contain no moving parts subject to wear and tear. The COM600 series products are based on embedded technology for durability and maximum availability.

The features and compact dimensions of the COM600 series products enable them to be easily installed in the low voltage compartment of UniGear ZS2 panels. COM600 series products are suitable for both industrial and utility applications.





Utility Application



Industrial Application

# 1. UniGear ZS2

## Distribution automation

### Arc protection

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

An adequate arc protection system protects your substation against arc faults by 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. But what is even more important, this technology can help save lives.

### Applications and features

Sources of arcing may be insulation faults, mal-operating devices, defective bus or cable joints, over-voltage, 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, in spite of the 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 smaller, but if the arc is extinguished in less than 35 ms its effect is almost unnoticeable.

Generally applied protection IEDs are not fast enough to ensure safe fault clearance times at arc faults. The operation

time of the over-current IED controlling the incoming CB 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.

Furthermore, at cable compartment faults, auto-reclosures can be eliminated by employing arc protection.

### Recommended products

The arc protection system REA 101 with its extension units REA 103, REA 105 and REA 107 is designed to be used for the protection of medium and low-voltage air-insulated switchgear. The central unit type REA 101 operates independently or together with other REA 101 units. REA is the fastest arc protection system on the market, providing tripping times down to 2.5 ms. REA is equipped with a fast integrated overcurrent-sensing element and it therefore works independently from other feeder protection units.

The REF615 feeder protection IED includes an optional arc protection function for the feeder cubicle. Enhanced with an optional plug-in card, the IED offers a three-channel arc-fault protection system for supervision of the switchgear CB, cable and busbar compartment. It provides tripping times down to 10-12 ms. This fast arc-fault protection increases personnel safety, reduces material damages within the switchgear and minimizes system down-time.

For a high level of switchgear arc protection we recommend a combination of REF615 and REA arc protection.

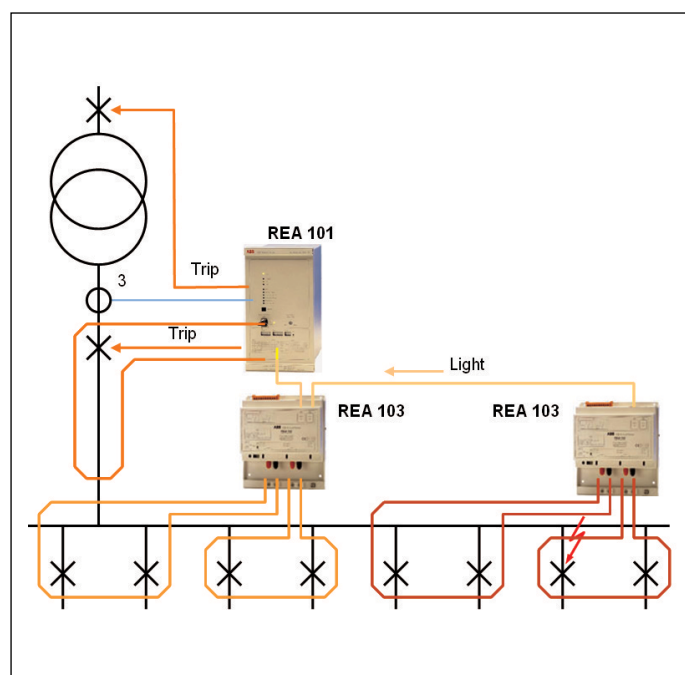


Fig. 10 Typical setup with REA 101 and subunits 103

“For more information on Distribution Automation please visit [www.abb.com/substationautomation](http://www.abb.com/substationautomation)”.

## Selection table



	REF 615	REX 521	REF 54_	RET 54_	REM 54_	REM 610	REA 10_	RED 615
<b>Application</b>								
Feeder application	•	•						
High requirement feeder application		•	•					
Transformer application			•	•				
High requirement transformer application				•				
Motor protection		(•)	(•)		•	•		
High requirement motor application					•			
Generator & synchronous motor					•			
Distance protection			•					
Line differential protection								•
Arc protection for feeder cubicle		•			•		•	
Arc protection system							•	
<b>Communication protocols</b>								
IEC 61850-8-1	•	• *	• *	• *	• *	• *		•
IEC 60870-5-103		•	•	•		•		
DNP 3.0			•	•				
SPA		•	•	•	•	•		
LON		•	•	•	•	• *		
Modbus	•		•	•	•	•		•
Profibus		• *	• *	• *	• *	• *		
<b>Additional functionality</b>								
Fault locator			•					
CAN interface			•					
On load tap changer control				•				
Disturbance recording	•	•	•	•	•	•		•
Withdrawable release mechanics	•					•		•
Condition monitoring	•	•	•	•	•	•		
Single line diagram HMI **	•		•	•	•			
Local control	•		•	•	•			•
Remote control	•	•	•	•	•			•
Power quality monitoring		•	•					
Sensor inputs	•	•	•	•	•			
Auto re-closure	5 shots	5 shots	5 shots					5 shots
RTD *** inputs	8		8	8	8	6		

\* With interface adapter

\*\* HMI - Human Machine Interface

\*\*\* RTD - Resistive Temperature Detector

# 1. UniGear ZS2

## Automatic transfer systems

Automatic transfer systems are used to ensure maximum service continuity, supplying the power users uninterruptedly. All this is possible using various systems based on different kinds of techniques.

The most common of these are outlined below, with the relevant average transfer times:

- Delayed: 1500 ms
- Depending on the residual voltage: 400-1200 ms
- Synchronised (ATS): 200-500 ms
- High speed (HSTS): 30-120 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. On the other hand, the other two systems (ATS – Automatic Transfer System and HSTS – High Speed Transfer System) require microprocessor-based apparatus with high technology content.

They guarantee fast transfer times and their application is in plants where the process is particularly critical, so that transfers which are not extremely fast would cause serious malfunctions or interruption of the process itself.

ABB is able to offer all the transfer systems, from the simplest to the most complex.

### ATS

The REF542plus unit can be used in medium voltage

switchgear to manage automatic and manual transfer between two different incoming feeders.

The time needed for automatic transfer carried out by means of the REF542plus unit is between 200 and 300 milliseconds (including the circuit-breaker operating times).

This time can vary within the range indicated in relation to the complexity of the software transfer logics.

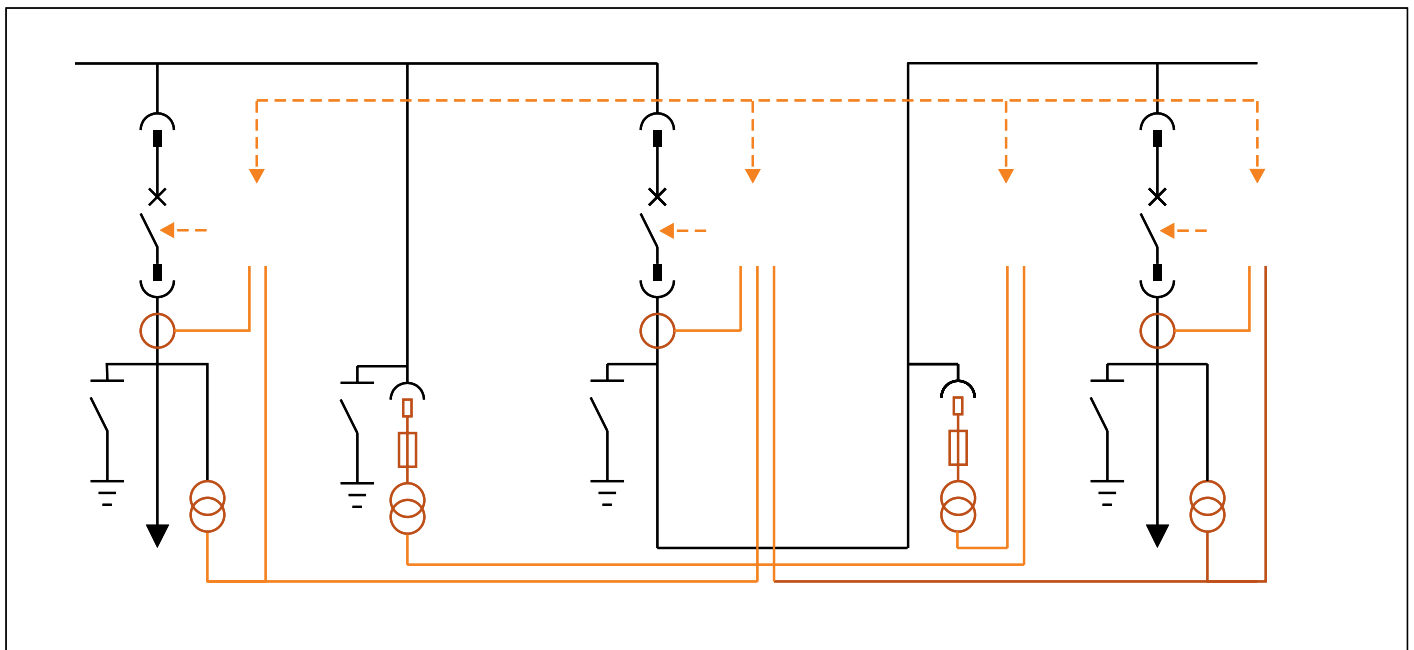
Switchgear equipped with REF542plus, suitably programmed, are complete and efficient systems able to manage transfer between one power supply system and an alternative one, or to reconfigure the network, passing from double radial distribution to a simple system, in a fully automatic way.

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 – code 25) implemented from the REF542plus, the power supply lines are closed simultaneously with synchronisation of the voltage vectors to then return to being disconnected when transfer has taken place. The applications described do not require additional instruments.

### HSTS (High speed transfer device) - SUE 3000

Voltage decreases or complete supply interruptions represent the most important and critical problems for the quality of



Single-line diagram of UniGear ZS2 switchgear with REF542plus architecture applied, suitable for carrying out automatic and manual transfer (ATS), as well as the switchgear protections and measurements

energy supply today. The SUE 3000 High Speed Transfer Device guarantees an optimum safeguarding of energy supply. The device ensures the continued supply to the consumer through automatic transferring to a stand-by feeder and protects the subsidiary process from expensive stoppage time. Furthermore, through the possibility of manually-initiated transfers – for targeted – clearings, for example – the operation of the installation is considerably simplified.

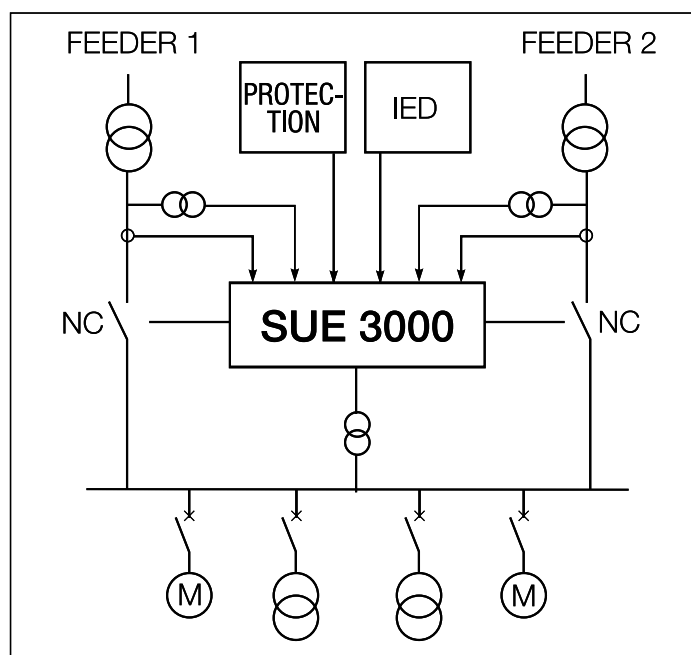
### Application areas

The SUE 3000 High Speed Transfer Device can be implemented everywhere where a disturbance of the electrical supply would lead to a breakdown in production, which would impact on operating costs. Possible areas of utilization include for example:

1. Auxiliary installation serving power stations
2. Environmental technology installations
3. Voltage supply to continuous industrial processes.

In order to realize a permanent availability, the load is supplied from at least two synchronized feeders which are independent from one another and which are equipped with High Speed Transfer Devices.

HSTS system in the configuration with three circuit-breakers with bus-tie: when the lack of voltage in one of the two power supply units is detected, the closing command of the bus-tie and the opening command for the switchgear unit without voltage are launched simultaneously.



SUE 3000 High Speed Transfer Device

The High Speed Transfer Device takes on the task of ensuring uninterrupted continuous operation of the connected devices in case of a power supply breakdown, taking into account different physical factors, through the most rapid possible transfer to a different feeder kept on standby.

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

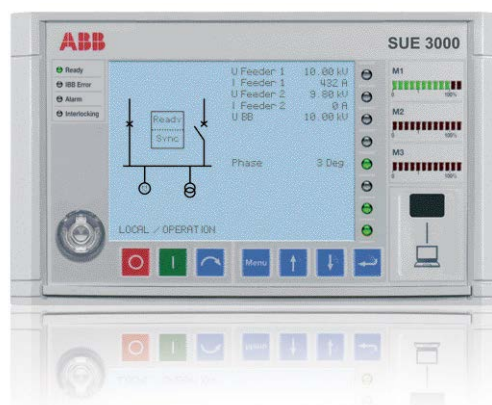
### Permanent network comparisons

An exceptionally important characteristic, that clearly distinguishes the High Speed Transfer Device SUE 3000 from competing concepts, is that synchronicity criteria are continuously available, e.g. that they are computed online by the SUE 3000.

For this reason, 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, considering the physical parameters, to perform a fast transfer with minimum interruption time.

### Transfer modes and times

Four different transfer modes are available in detail: Fast transfer, Transfer at the 1st phase coincidence, Residual voltage transfer, Time-operated transfer. The fast transfer is the optimum transfer mode for ensuring in case of fault that only a minimum interruption of the voltage supply occurs. In case of fast transfer the total transfer time, counting from a fault in the main feeder until the standby feeder is cut in, is less than 100ms.



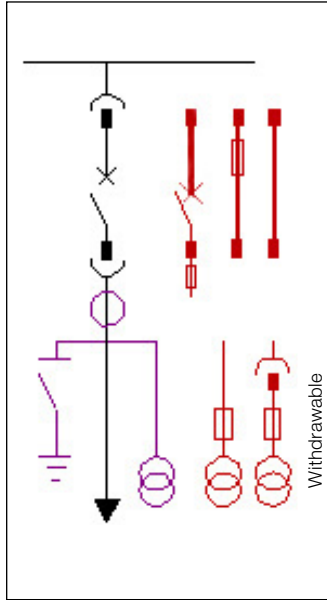
An example of switchgear configuration



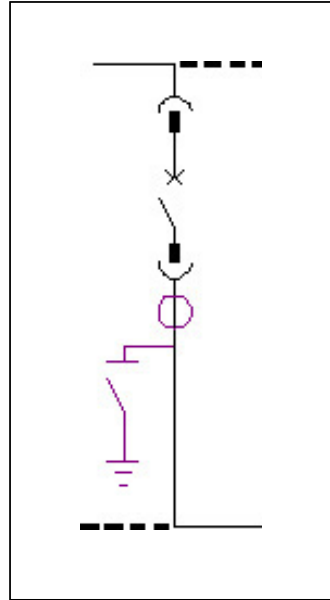
# 1. UniGear ZS2

## Typical units and technical data

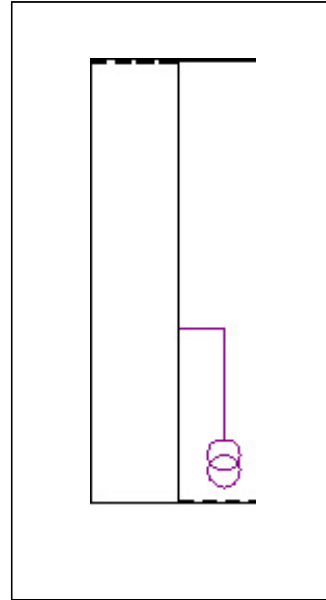
Single-line diagram of typical units



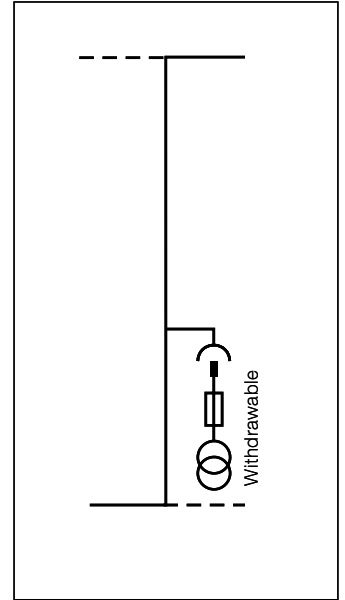
IF - Incoming/outgoing feeder



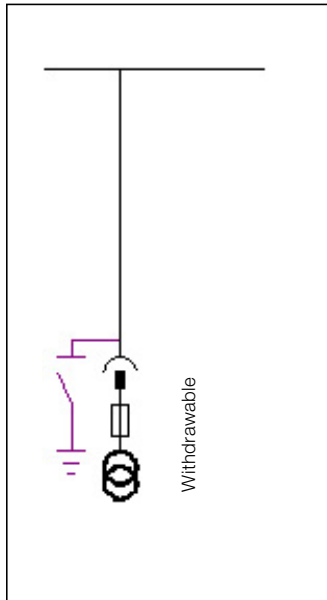
BT - Bus-tie



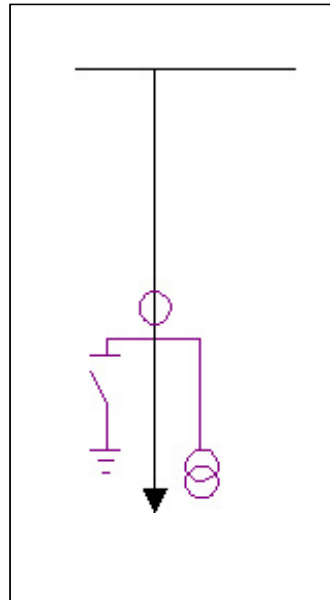
R - Riser



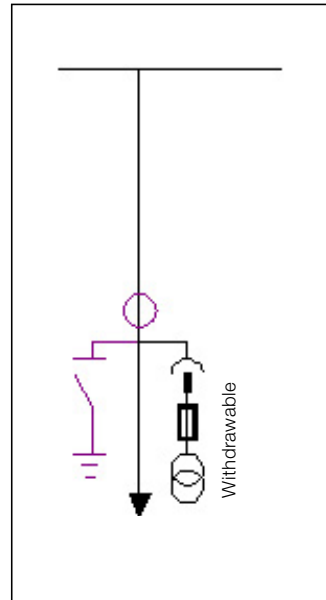
RM - Riser with measurements



M - Measurements



IFD - Direct incoming/outgoing feeder



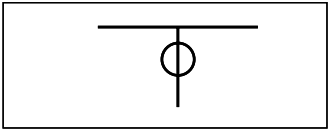
IFDM - Direct incoming/ outgoing feeder with measurements

Earthing switch position will be between circuit breaker and current transformers for units up to 31.5 kA 1 sec due to usage of ST US 36.  
For 31.5 kA 3 sec EK6 type earthing switch will be used on cable side of units as shown in above illustrations.

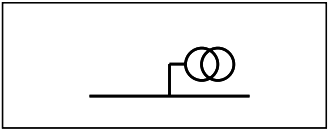
Key to components

- Standard components
- Accessories
- Alternative solutions

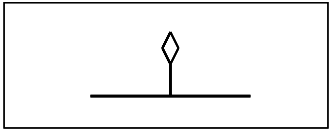
Single-line diagram of the busbar applications



Current transformers

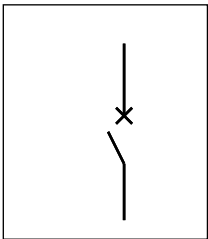


Voltage transformers

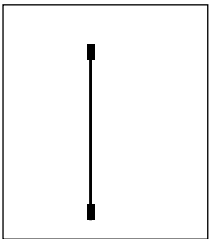


Duct entry

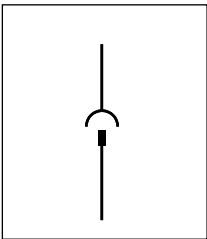
Graphical symbols



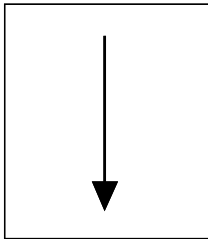
Circuit-breaker



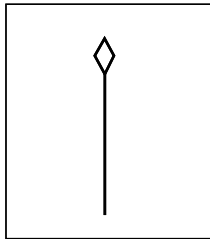
Isolating bar



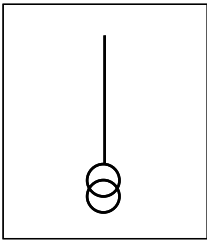
Socket and plug



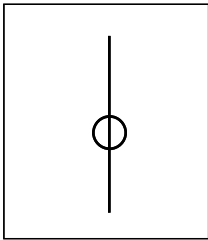
Cable entry



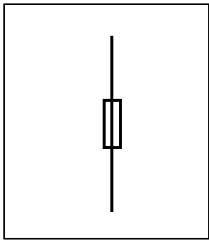
Busbar entry



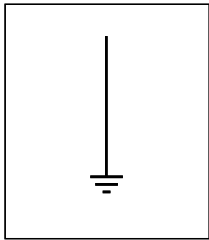
Voltage transformers



Current transformers



Fuse



Earth

# 1. UniGear ZS2

## Typical units and technical data

... 36 kV - ... 31.5 kA

Depth (mm)		2400				2600				
Height (mm)		2310				2310				
Height with gas exhaust duct (mm)		2662				2662				
Width (mm)		1000				1200				
Rated current (A)		1250	1600	2000	2500*	1250	1600	2000	2500*	3150*
IF	Incoming/outgoing									
	with Fixed Voltage Transformers									
	with Fixed fused Voltage Transformers									
	with Withdrawable fused Voltage Transformers									
	Fused Switch (Circuit Breaker Feeder)									
BT	Bus-tie									
R	Riser									
RM	Riser with measurements									
M	Measurements									
IFD	Direct incoming/outgoing									
IFDM	Direct incoming/outgoing with measurement ( with Withdrawable fused Voltage Transformers )									

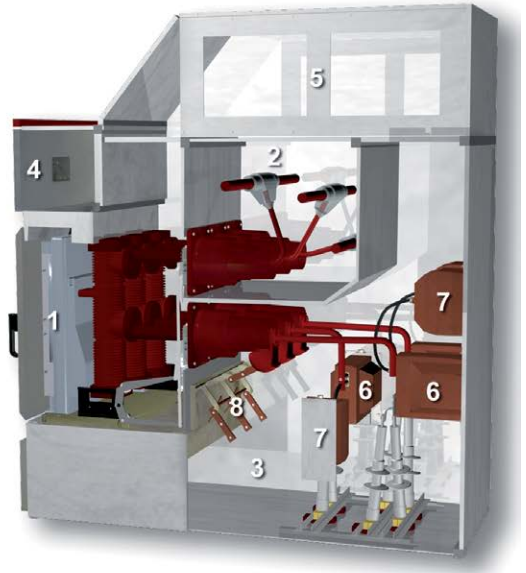
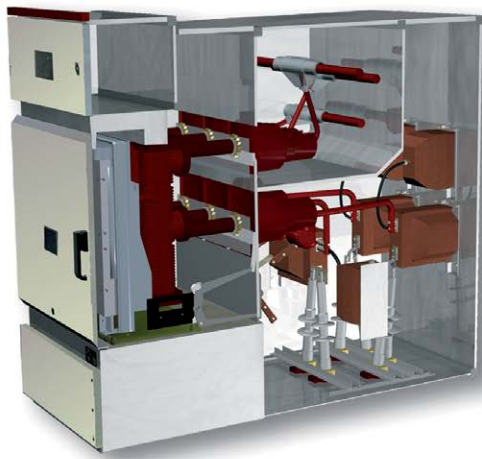
### Connections

Connection suitable for power cables up to 2x400mm <sup>2</sup> per phase**										
Connection suitable for power cables up to 4x630mm <sup>2</sup> per phase**										
Top busbar connection	Please consult ABB for details									
Top cable entry	Please consult ABB for details									

\* Available with forced cooling fans

\*\* In case of surge arrestor or removable VT usage, connectable cable per phase should be reduced 1 for each.

Colored cells indicates availability



#### Unit compartments

- 1 Circuit breaker compartment
- 2 Busbar compartment
- 3 Cable compartment
- 4 Low voltage compartment
- 5 Optional Arc channel
- 6 Current transformers
- 7 Voltage transformers
- 8 Earthing switch



The completed assembly of arc vent duct for middle panel with flap channel (total height of the switchgear is 2662 mm)

## 2. UniGear ZS2 Double Busbar System Description

Most switchgear used in installations with normal service conditions is based on single busbar systems.

When compared with double busbar switchgear, single busbar switchgear is definitely easier to operate and maintain, requires less space and the total cost of the installation is lower (equipment, site procedures, maintenance, footprint etc.).

The use of double busbar switchgear may be necessary when some of the following features are required:

- Operation of incoming feeders with non-synchronised circuit-breakers.
- Load shedding of outgoing feeders with a different level of importance during emergency conditions.
- Isolation of particular outgoing feeders from the normal network.
- Outgoing feeders balancing on two busbar systems during normal service.
- Flexibility during inspection and maintenance procedures without load interruption.
- Extension without switchgear shutdown.

The double busbar system is based on the following scheme:

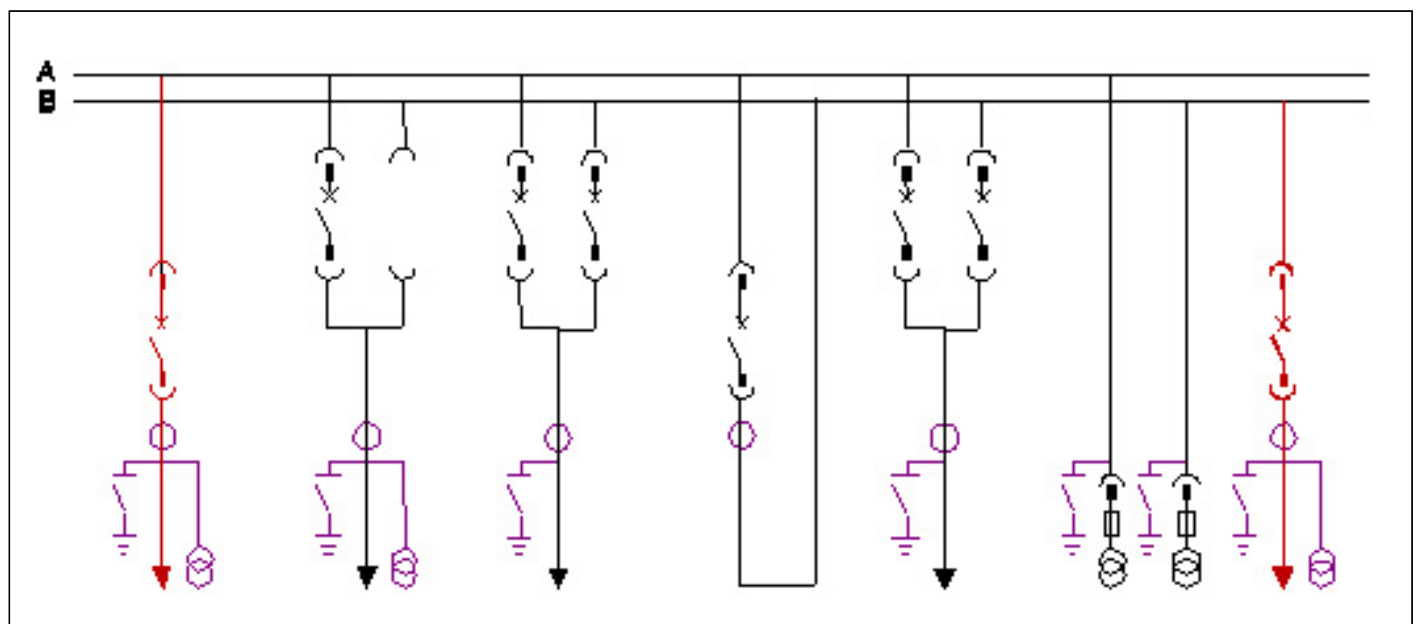
- Two busbar systems, two circuit-breakers compartments with one or two circuit breakers (duplex system).

This scheme provides full busbar system redundancy (physical isolation between source busbar systems) and allows uninterrupted and reliable service conditions.

This solution has two main advantages :



- Incoming feeders and the most important outgoing feeders can be equipped with two circuit-breakers in order to allow apparatus redundancy .
- Circuit-breaker maintenance and testing without feeder shutdown.
- Fewer number of components and less switching apparatus. Thanks to the numerous standard units available, the switchgear can be suitably configured to satisfy all installation



Single Busbar Section

Earthing switch position will be between circuit breaker and current transformers for units up to 31.5 kA 1 sec due to usage of ST US 36.

For 31.5 kA 3 sec EK6 type earthing switch will be used on cable side of units as shown in above illustrations.



requirements.

Each unit can be equipped with circuit-breakers or fused disconnectors, as well as with all the accessories available for conventional switchgear units.

All the significant components are identical to those used for the single level units and therefore the same service and maintenance procedures are guaranteed.

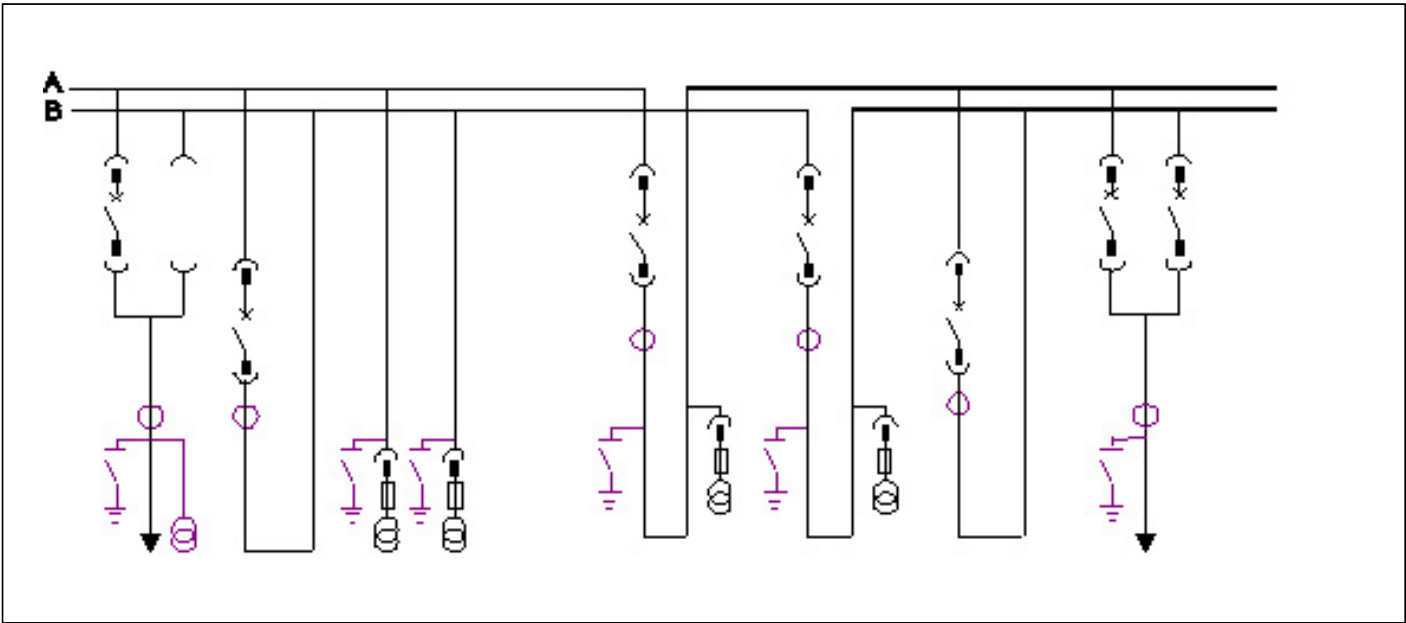
The units can be arranged as required by the installation requirements, but, according to the technical literature, the switchgear must be configurable as per the following two schemes:

- Single busbar section.
- Double busbar section.

IEC electrical characteristics

Rated voltage	[kV]		36
Test voltage (50-60 Hz/1min)	[kV]		70
Impulse withstand voltage	[kV]		170
Rated frequency	[Hz]		50-60
Rated short-time withstand current	[kV 3 s]	up to	31.5
Peak withstand current	[kA]	up to	80
Internal arc withstand current	[kV 1 s]	up to	31.5
Rated current of the main busbars	[A]	up to	3150
Rated circuit-breaker thermal current *	[A]	up to	3150
Double busbar feeders rated current*	[A]		3150

\*2500A and 3150A ratings are available only with forced cooling fans.



Double Busbar Section

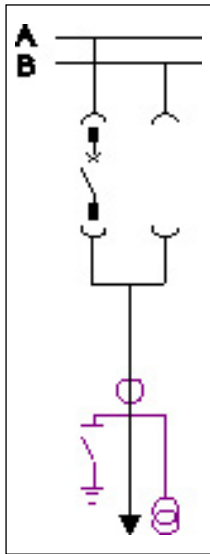
Earthing switch position will be between circuit breaker and current transformers for units up to 31.5 kA 1 sec due to usage of ST US 36.

For 31.5 kA 3 sec EK6 type earthing switch will be used on cable side of units as shown in above illustrations.

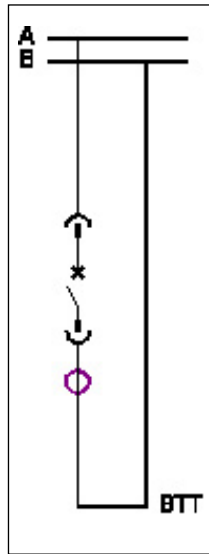
## 2. UniGear ZS2 Double Busbar System

### Typical units and technical data

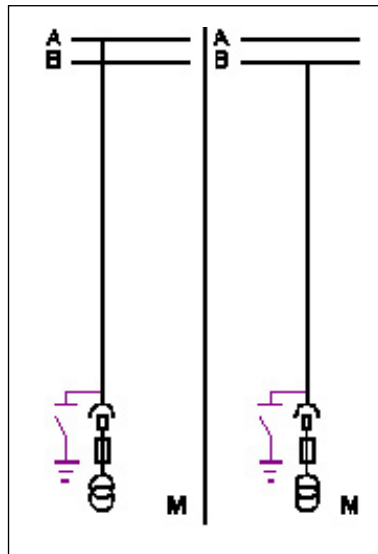
Single-line diagram of typical units



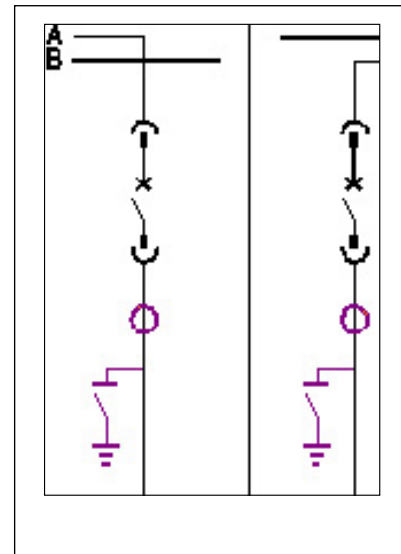
DIF - Incoming/Outgoing



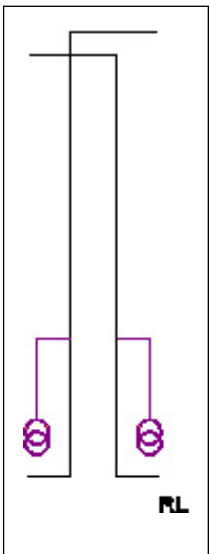
DBT - Transv. Bus Tie



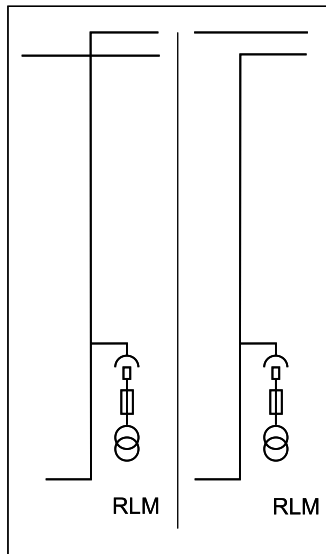
DM - Measurements



DBTL - Longitudinal Bus Tie



DRL - Bus Riser Long.



DRLM - Bus Riser Long. with Metering

Earthing switch position will be between circuit breaker and current transformers for units up to 31.5 kA 1 sec due to usage of ST US 36.  
For 31.5 kA 3 sec EK6 type earthing switch will be used on cable side of units as shown in above illustrations.

... 36 kV - ... 31.5 kA

Depth (mm)		3820				3820				
Height (mm)		2310				2310				
Height with gas exhaust duct (mm)		2662				2662				
Width (mm)		1000				1200				
Rated current (A)		1250	1600	2000	2500*	1250	1600	2000	2500*	3150*
DIF	Incoming/outgoing feeder with measurements									
DBT	Bus-tie									
DM	Measurements									
DBTL	Longitudinal bus-tie	(1)	(1)	(1)	(1)					
DRL	Longitudinal riser	(1)	(1)	(1)	(1)					
DRML	Longitudinal riser with measurements	(1)	(1)	(1)	(1)					

(1) Two pieces units are required to complete the configuration.

\* 2500A and 3150A ratings are available with forced cooling fans only

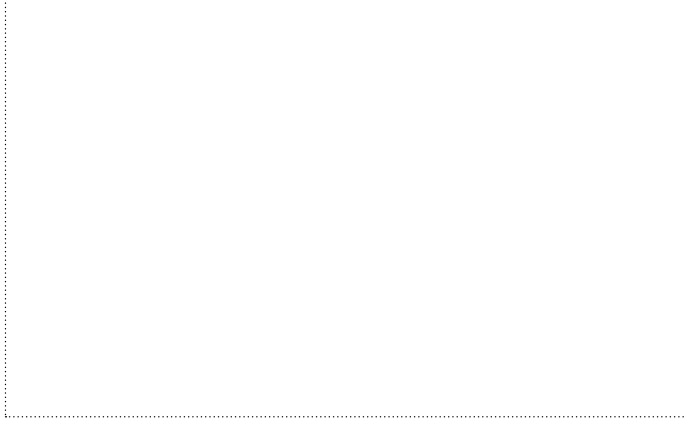


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Handwriting practice lines consisting of 25 horizontal dotted lines.



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