

Product catalogue

# UniGear ZVC

Arc-proof, air insulated motor control center with fused vacuum contactor



- Safety
- Reliability
- Flexibility
- Economy



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# General

## Compact intelligent MCC and switchgear system



A world without machines? It's unthinkable ever since Tesla invented motors in 1883. Motors are machines that support development activities of our finite natural resources such as hydrocarbons, minerals and water.

Machine operators require the right tools to share information in a real time environment and to manage information centrally, ensuring efficient and more informed decision making. ABB's ZVC family of integrated hardware and software solutions place companies in the best position to optimise their processes, plant and enterprise operations.

For over 30 years, ZVC family has been powering machines by providing products, solutions and services in most countries worldwide. Our specialisation and long experience gained in this field has built up hands-on expertise for all activities related to the motor starters. Products and solutions for motor starters can work standalone or as part of a completely integrated and scalable solution, enabling enterprises to implement new functionalities as operational needs evolve.

It has been found that most faults on medium voltage motors occur in the motor terminal boxes due to moisture ingress. Many industrial organisations have moved away from circuit breakers and returned to fused contactor protection. This being due to experience – generally the motors were destroyed when these faults occurred with circuit breaker protection; where fused contactor protection was used only re-termination of power cables was required.

UniGear ZVC switchgear maintains tried and tested fused contactor technology for the following reasons:

- Switchgear is designed such that low overload currents are cleared by the protection relay and contactor, while high short circuit faults are cleared by the fuses alone
- The contactor does not need high breaking capacity and can be designed for long life under repetitive starting conditions
- Fuses have been used since 1880s due to its reliability as a protection device. It has no moving parts to wear out or become contaminated by dust, oil or corrosion and no nuisance tripping. If a fault occurs, the fuse operates immediately. Fuses require no maintenance
- Compact size fuses offers better utilisation of space compared to larger non-fused protection devices
- Fuses are lower cost than many forms of non-fused protection devices. The fact is there are more fuses in operation worldwide than circuit breakers for cost reasons
- Current limiting fuse limits damage under severe fault conditions and virtually eliminates risk of motor terminal box explosion. Almost all motor terminal boxes are not arc contained or explosion proof type tested
- The current limiting effect makes it possible to size power cables on the basis of load current capability alone rather than necessary rating to survive short circuit faults. This allows major saving in cables cost
- Fuses reduce short circuit currents to a low value by "current limitation". There is no need for complex short circuit system calculations and no concerns about costly future upgrades due to system expansion with increased fault currents
- Fuses see short circuit currents directly; do not need current transformer and protection relay to work. With fuse technology, saturation of current transformers during a short circuit is not an issue. Fuse high speed activation limits significantly the flash hazard at the fault location
- Fuse and contactor are high speed current disconnecting devices that improve network power quality by reducing duration of voltage sags (voltage dips) caused by short-circuit faults. It is common for motors to trip out during voltage dips

“ZVC” brand is synonymous with the worlds Oil and gas, chemical and minerals industries. The current ZVC version is UniGear ZVC Switchgear System, a unique high performance motor starter for continuous process industries. The product is complemented with the capabilities of a strong global team, providing customers with the benefits that a centre of excellence facility has to offer, such as research and design, engineering solutions, project management, manufacturing, testing, service support as well as marketing.

The state of the art UniGear ZVC switchgear system is designed with compactness, wide ranging applications and intelligence in mind. This 5<sup>th</sup> generation of compact switchgear system is fitted with intelligent electronic devices to provide an edge in field bus flexibility, multiple choices on the interface to control systems, power packed protection, measurements, control, supervision and events recording to enhance continuity of your process.

### UniGear ZVC

#### 5<sup>th</sup> Generation

- Late 2000 s Release of integrated remote HV isolation in compact MCC, world's first  
Release of modular substation outdoor MCC and distribution centre, OE-ZVC
- Mid 2000 s Release of medium voltage compact intelligent MCC and switchgear
- Early 2000 s A family member of ABB global UniGear platform  
Combining the features of UniStarter and ZVC fused contactor panel, 325 mm width

### UniStarter ZVC

#### 4<sup>th</sup> Generation

- Early 2000 s A family member of Germany Calor Emag ZS1 platform  
World first medium voltage compact cassette type fused contactor panel, 325 mm width

### ZVC

#### 3<sup>rd</sup> Generation

- Mid 1990 s A family member of Germany Calor Emag ZS1 platform  
Combining the features of fixed and withdrawable fused contactor panel, 325 mm width  
Compact floor rolling type fused contactor truck  
Heavy duty applications up to 5400HP motor and 4000 kVA transformer.

### UVC

#### 2<sup>nd</sup> Generation

- Early 1990 s A family member of Finland UniSwitch platform  
Fixed fused contactor panel, 500 mm width

### RVC

#### 1<sup>st</sup> Generation

- Late 1970 s A family member of Norway NEBB RGB platform  
World smallest medium voltage Withdrawable fused contactor panel, 300 mm width

ABB's ZVC family of integrated hardware and software solutions place companies in the best position to optimise their processes, plant and enterprise operations.

#### The switchgear system built with green values

- Compact equipment footprint means more land for trees, grass and flowers to grow
- Protection of the natural environment is integral to ABB's corporate philosophy
- We care for natural resources, avoid problematic substances, recycling-friendly construction and design long-life product
- Environmental aspects are embraced by an integrated eco-management system certified to ISO 14001

#### The switchgear system is designed for solutions based applications

- UniGear ZVC is a result of many years experience with the design, manufacturing and application of vacuum contactors across the entire range of industrial and utility installations
- Fused contactors are suitable for switching motors and transformers. The vacuum contactors are capable of frequent switching with low switching over voltages
- The switchboard can be configured to meet the actual process requirements
- Most space efficient solution. ABB's most compact air insulated switchgear panel
- Ideal to restricted footprint installations; i.e. containers prefabricated transportable building, ships, off-shore platforms and underground mine

#### The switchgear system with built-in high availability

- Panel is segregated into compartments
- All compartments constructed to withstand high overpressure during internal arc fault
- Increase availability by reducing damage transferring between compartments
- Limited and simple maintenance activities
- Tightly sealed panel protects against ingress of contamination and vermin
- Vacuum contactor is maintenance free
- Field auxiliary wiring cables fit in separate duct and are easily accessible
- Allowance for easy and fast power cable connection

#### The switchgear system with built-in flexibility

- Family member of UniGear Platform. Connect directly with other UniGear platform switchgear panels
- Integrated and coordinated protection systems are provided
- Conventional or intelligent IEDs can be utilised
- Modular structure, easily built up
- Extremely compact. Highly effective use of room space
- Panel can be mounted against the wall

- Power cable entry selection – bottom front and rear, or top rear
- Field control cable entry selection - bottom or top front
- Power cable termination selection - bolt-on or plug-in
- Easy to install. Standard factory preassembled blocks up to 3 cubicles

#### The switchgear system with built-in safety

- Air insulated switchgear
- Metal-clad construction
- Developed with fire proofing in mind; maximising use of fire retardant materials such as epoxy resin, insulation sleeving and metal castings
- Protection against accidental bridging caused by rodents and insects. All live HV parts are insulated
- Type tested to various standards IEC and GB/T
- Arc fault containment (arc resistance) up to 50 kA, up to 1 sec
- High service continuity, LSC2A-PM
- Fault current limitation by HRC fuses
- Low voltage compartment is completely separated from high voltage sections
- Fault make earthing switch used for short-circuiting and earthing
- All operations behind closed compartment doors
- Start-up, maintenance and service operations can be carried out from the front
- Simple fail safe mechanical interlocks prevent mal-operation
- Earth switch blade position is easily visible through viewing window in the front door
- Front panel indication

UniGear ZVC has been tested to the full range of type tests laid out in IEC.

All operations on the switchgear are carried out with the doors closed, protecting the operator in the unlikely event of an internal arc fault. Metal shutters provide positive isolation when the fused contactor is in the "ISOLATE and TEST" position.

UniGear ZVC has a simple, comprehensive interlocking system to ensure that:

- Movement of the contactor truck between SERVICE and TEST position, and vice versa, is prevented when the contactor is closed
- The high voltage compartment door must be closed before the contactor truck can be moved to the SERVICE position
- The fault make earthing switch can only be closed when the fused contactor is in the ISOLATED/TEST position

- The high voltage compartment door can only be opened when the contactor truck is in the ISOLATED/TEST position and earthing switch closed
- The contactor truck cannot be moved to the SERVICE position when the earth switch is closed
- The control transformer secondary, when fitted, is isolated whenever the contactor truck is moved from the SERVICE position, to the ISOLATED position

Complete coordination between HRC fuses, protection relay systems and the vacuum contactor is provided in accordance with IEC 60470. The coordination classification is type 'C'.



The UniGear switchgear is fitted with all the interlocks and accessories needed to guarantee the highest level of safety and reliability both for the installation and operators.

#### Interlocks

The safety interlocks are standard features. Their presence guarantees the highest level of reliability even in the case of an accidental error and allows what ABB defines as a fail safe system of interlocks.

#### Key locks

The use of optional key interlocks is very important in realising the interlocking logics between units of the same switchgear or to external equipment.

The fused contactor truck can be locked in the racked-out position and the relevant lock key can only be removed with the fused contactor truck in this position.

The earthing switch closing and opening operations can be locked by means of keys.

Lock type : Castell Mini FS

#### Padlocks

Both high and low voltage compartment doors can be locked in the closed position by means of padlocks.

The operations for fused contactor truck racking-in/out and earthing switch opening/closing can be prevented by applying the padlocks to the insertion slots of the relevant operating levers.

The metallic segregation shutters can be locked by means of two independent padlocks in both the open and closed positions.

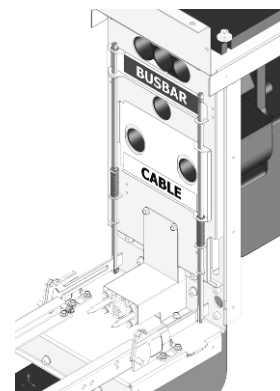
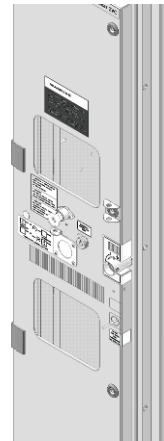
The switchgear is preset for using padlocks with 8 mm diameter.

#### Locking magnets

The locking magnets are used to make automatic interlock logics without human intervention.

The fused contactor truck racking-in/out and the earthing switch opening/closing operations can be prevented.

The magnets operate with active logics (fail safe) therefore the loss of auxiliary voltage makes the lock become inoperable.





### The switchgear system with intelligent capability

- Cost benefits of intelligent versus conventional systems are widely documented in the public sphere
- Intelligent electronic devices (IEDs) selected are simple to use, easy to program and in drawout case
- Switchgear integrated IED protects your processes, optimise efficiency, provide event reports for better decision making, troubleshooting ease and decrease unexpected downtime
- IEDs are perfectly aligned for protection, measurement, control, supervision and communication
- IEDs allow maximum flexibility in design, engineering and manufacture without finalise load list, control and interlocking concept. Only a general control philosophy is required during design engineering. The exact control logic can be programmed and parameterised when known at site
- Minimum inter-panel cabling with use of IEC 61850 IEDs capable for peer-to-peer serial communication
- IEDs permit site commissioning changes with less impact on cost and delivery. There is no need to replace switchgear hardware or the documentation as a result of the change to engineering design

### The switchgear system with many applications

Wide range of functional units available for various installation applications.

- Motor starter (direct on line)
- Slip ring induction starter
- Conveyor belt double motor feeder
- Transformer feeder
- Cable to bus

### The switchgear system built for process chemical, oil and gas

- On-shore platform
- LNG, LPG trains
- Refinery
- Petrochemicals
- Pipeline

### Minerals

- Smelters
- Metallurgy
- Mills
- Mining – open pit
- Mining – underground
- Quarrying
- Cement

### Water

- Pump stations
- Pipeline
- Sewage treatment
- Desalination

### Power plant

- Nuclear
- Combined cycle
- Combined heat power
- Coal
- Hydroelectric
- Thermal
- Biogas

### Industry

- District cooling
- Pulp and paper
- Food
- Automotive
- Food

### Railway

- Heating and load power
- Traction

### UniGear platform

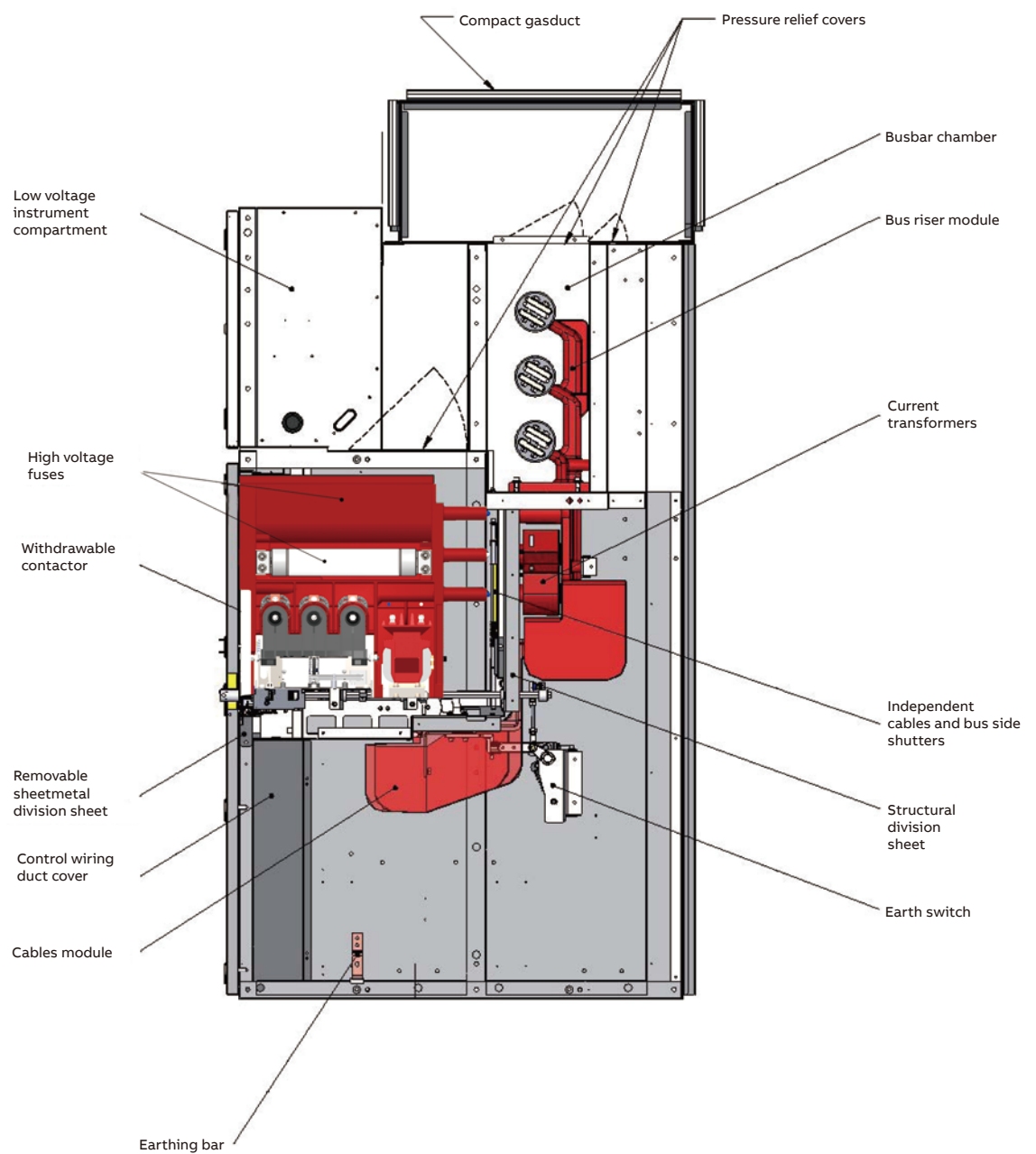
This platform comprises the following switchgear families. Each family member focuses on separate technology expertise to provide end users with innovative wide ranging application solutions.

- ZVC
- ZS1
- 550
- 500R

UniGear platform families share certain design and construction features:

- Same bus compartment design. Extendibility of UniGear switchgear panels is guaranteed. Bus transition panel not necessary
- Same interlocking features. Safety level of UniGear switchgears are the same (maximum)
- Same operational and installation method. One trained operator good for all UniGear switchgears
- Same look and feel. UniGear switchgears are designed to have similar visual appearance

## Components



### Compartments

Each unit consists of three power compartments: apparatus, busbar and feeder. The apparatus and feeder compartments are accessible from the front by means of a single access door. Door closing is carried out with screws. Each unit is fitted with an auxiliary compartment, where all the instruments and cabling are housed. The arc proof switchboard may be fitted with a duct for evacuation of the gases produced by an arc. All the units are accessible from the front and maintenance and service operations can therefore also be carried out with the switchboard wall-mounted. The compartments are segregated from each other by metallic partitions.

### Integration of the components

The switchboard is built up around three basic functional structures, consisting of monoblocks of epoxy resin where the components of the switchgear are incorporated. The top block contains the whole system of branch connections (towards the main busbars and towards the cable terminals) and the fixed contacts (for connection of the contactor to the busbar and feeder compartment). The bottom block creates the insulation required between the phases at cable terminal level and that of the fixed contacts of the earthing switch. The third block is represented by the main body of the withdrawable contactor.

Segregation between the apparatus, busbar and feeder compartments is carried out by means of a system of metallic shutters. These are activated automatically during movement of the apparatus from the racked-out position to the service position and vice versa. In the case where back feed of the unit from the cable side is not possible, the bottom segregation shutter of the latter could be deleted. Even in the unlikely case of back feed, safety of the operating personnel is guaranteed in any case by the presence of an interlock only allowing the unit door to be opened after the power cable earthing switch has been closed. This interlock can be removed during manufacture if not required.

The current transformers are normally coupled onto the bottom branch connections of the top monobloc. They are of the toroidal type and are completely insulated from the medium voltage system. They can also be replaced from the front of the switchboard after having removed the contactor and the shutter segregation system. The unit can also be equipped with toroidal transformers placed on the power cables in the feeder compartment.

Each unit is equipped with an earthing switch to earth the cables. The earthing switch is fitted with short-circuit making capacity up to 31.5kA peak. The apparatus is controlled 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 an indicator. The characteristics of the busbar system, earthing busbar and gas exhaust duct are the same as those of the other UniGear units. A maximum of two single and three-core cables per phase can be used, depending on the rated voltage and on the cross-section of the cables.

### Contactor

The apparatus is dedicated to use in this typical unit. The epoxy resin monoblock contains the connections embedded between the top isolating contacts, the fuse connections, vacuum interrupters and finally the bottom isolating contacts. This structure also houses the following components: vacuum interrupters, moving equipment, control electromagnet, multivoltage feeder and auxiliary contacts. The contactor can be fitted with an operating mechanism with electrical or mechanical latching. The contactor can be fitted with a two-pole control power transformer complete with protection fuses. The control power transformer may be used for supplying the coils of the contactor operating mechanism. The contactor is fitted with medium voltage fuses for protection of the operated feeders.

Coordination between contactor, fuses and protection unit is guaranteed in accordance with the IEC 60470 standards for apparatus in class C.

The monobloc also acts as a fuse-holder frame and is preset for installation of one or two (sets of three) fuses per phase with average type of dimensions and striker, according to the BS 2692 Standard, with a maximum length of 454 mm. The contactor has an automatic opening device when a single fuse blows.

The auxiliary connection of the contactor dedicated to this unit uses an automatic coupling system. This is activated automatically during movement of the apparatus from the racked-out position to the service position and vice versa.

# General

## Type testing and certification

UniGear ZVC has successfully passed the tests required by international (IEC), various local Standards (for example the Chinese GB/T). In addition, each switchgear unit is subjected to routine tests in the factory before delivery. These tests are aimed at a functional check of the switchgear based on the specific characteristics of each installation.

### Type tests

- Short-time and peak withstand current
- Temperature rise and main circuit impedance measurements
- Dielectric test on main and auxiliary circuits
- Making and breaking capacity of the contactor
- Earthing switch making capacity
- Mechanical operations
- Degree of protection
- Coordination with SCPDs
- Overload current
- Internal arc test

### 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 apparatus and the earthing busbar of the switchboard 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 shortcircuit. Effects of the tests and therefore the results were extended to the whole range.

### Temperature rise

The temperature rise test is carried out at the rated current of the switchgear unit and shows that the temperature is not excessive. During the test, both the switchboard and the contactor are checked.

Contactor subject to testing in free air is able to withstand higher rated current than inserted in a panel; therefore the rated current of the contactor depends on the characteristics of the switchboard and on the relevant ventilation system (non-ventilated or natural ventilation).

### Dielectric

These tests check that the switchboard 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 is also routinely carried out on every switchgear unit manufactured.

### Making and breaking capacity

The fused contactor is subjected to the rated current and short-circuits current breaking tests.

### Earthing switch making capacity

The earthing switch of the UniGear ZVC switchgear can be closed under short-circuit. In actual fact, 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, safety of the personnel operating the installation would be fully safeguarded.

### Mechanical operations

The mechanical life tests of all the operating parts highlight the reliability of the apparatus. The switchgear and apparatus it contains are tested by carrying out a high number of operations- higher than those which are normally carried out in installations in service.

### Degree of protection

Protection test of persons provided by UniGear ZVC enclosure against access to hazardous parts of the main circuit, control and/or circuits and to any hazardous moving parts meets minimum IP4X (external housing) and IP2X (between the compartments).

### Coordination with SCPDs

These tests are for contactors associated with overload and/or short-circuit protective devices (SCPD). It takes into account fused contactor coordination of circuit protective device take over current, cut-off current operating time, pre-arcing time, internal time and thermal performance.

**Overload current**

The fused contactor is tested to withstand overload currents as required for utilization category AC-3 and AC-4 as specified on IEC 60470.

**Internal arc fault containment**

Nowadays when developing new medium voltage switchgear, personnel safety is most important and this is why UniGear ZVC has been designed and tested to withstand an internal arc due to a short-circuit current of the same level as the maximum fault level.

The tests show that the metal housing of the UniGear ZVC switchboard is able to protect personnel operating near the switchboard in the case of a fault which evolves as far as striking an internal arc. An internal arc is among the most unlikely of faults, although it can theoretically be caused by various factors, such as:

- Insulation defects due to quality deterioration of the components. As an example the causes can be adverse environmental conditions and a highly polluted atmosphere
- Overvoltages of atmospheric origin or generated by operation of switchgear element
- Incorrect operations due to not respecting the procedures or to 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 vermin/insects in the switchgear
- Material left behind inside the switchboard during maintenance operations

The characteristics of the UniGear ZVC switchboard notably reduce the incidence of these causes in generating faults, but some of them cannot 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 switchboard structure
- Melting, decomposition and vaporising of materials

Unless suitably controlled, these can have very serious consequences for the operators, such as wounds (due to the shock wave, flying parts and the doors opening) and burns (due to emission of hot gases).

The test checks that the compartment doors remain closed and that no components are ejected from the switchgear even when subjected to very high pressures, flames or incandescent gases do not cause fires, thereby ensuring the physical safety of the personnel operating near the switchboard. Moreover that no holes are produced in the external, freely accessible parts, of the housing and finally that all the connections to the earthing circuit remain effective to guarantee the safety of personnel who access to the switchboard after the fault.

When installing the switchgear, some fundamental points must be taken into consideration.

- Level of the fault current (16...50 kA)
- Duration of the fault (0.1...1 s)
- Escape routes for the hot and toxic gases given off by combustion of materials
- Dimensions of the room, with special attention to the ceiling height

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.

# General

## Arc flash protection

### Arc flash

The potential risks of arc flash or internal arcing faults have become a major safety discussion point. There are three standards used for "arc flash", all North American in origin; OSHA, IEEE and National Fire Prevention Standards. None are compatible with IEC Standard.

The requirement for arc flash analysis is driven by requirement of OHS and plant insurers. PPE alone does not provide 100% protection against arc flash. The suit only protects against the heat and can only be regarded as flame resistance.

What about operators:

- Eyes – to protect against arc flash, need a welders face mask
- Lungs – the toxic gases associated with an arc flash can damage operator lungs, sense of taste and smell
- Hearing – the noise associated with arc flash can result in headaches, loss of hearing and tinnitus
- Physical damage – the pressure wave associated with arc flash can blow operator across the room resulting in broken bones

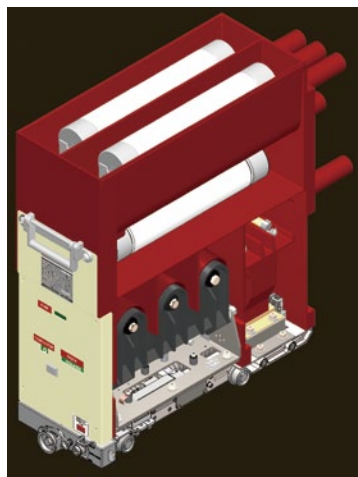
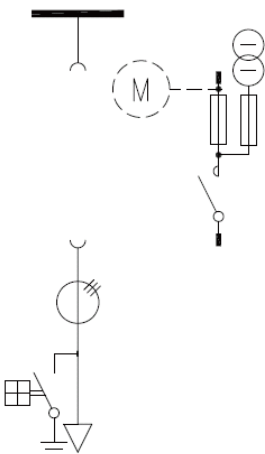
The actual analysis relates to the energy of an arc, time of arc and distance from the seat of the arc, the energy at that point is measured in kCal/cm<sup>2</sup> relating to the flash points of the respective categories of PPE required eg. Category 0 to 4. The highest category of PPE (PPE 4) is the "moonsuit", hood, gloves etc, which itself has a limitation to arc exposure and almost certainly not suitable for 40 kA at 6.6 kV without any form of arc fault mitigation.

Switchgear panels that are type tested according to IEC (Annex A, criteria 1 to 5) should negate arc flash requirement unless work is to be done with switchgear door or covers open, safety device interlock defeated, forced operation, a situation which invariably would according to IEEE not be allowable for live work for this level.



### What happens when things go wrong?

Events such as modifications of type tested panels outside of manufacturers design tolerance during operational life and poor maintenance by non accredited service technicians are real life occurrences. This of course necessitates the requirement of adequate arc flash protection in plants, i.e. mandatory PPE, remote motorised HV isolation activated in separate control room to keep operators outside the arc flash boundary. It is important to consider the effect of arc flash propagation to surrounding cubicles inside the substation.



**Protection against arc flash – are we serious?**  
We most definitely are!



Unfortunately some people have been subjected to the full forces of an arc flash. The outcome is never good! You don't have to ever experience this, but you've got to make the right decisions at the front end.

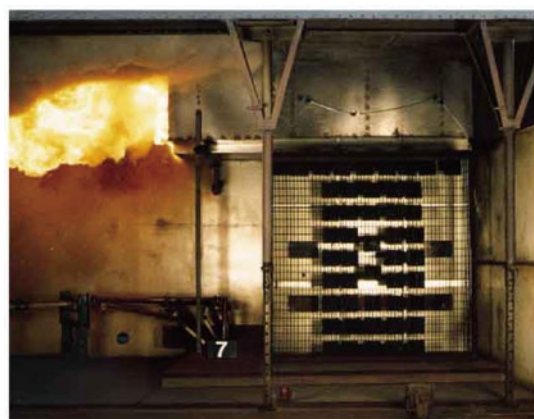
High fault levels and questionable operating techniques are a DANGEROUS MIX, a waiting time bomb. Can you gamble with safety of operators and plant? Without all the safety requirements being legislated you may regret the outcome.

With UniGear ZVC switchgear system, it really is the three inherent design features to ensure maximum safety when you really need it.

- Stay outside arc flash boundary. Perform remotely – switch power off and isolate HV equipment. Local equipment interfacing when necessary is done with compartment doors closed and fully interlocked
- Containment of arc flash. Importance of metal-clad and block construction. All four functional zones are fully segregated to ensure Arc Flash does not transfer to adjacent block or compartments
- Arc flash relief system. All blocks are equipped with separate overpressure vents, common arc resistance duct (plenum) arc flash relief device venting safely away from operators

IEC 62271-200 lists five separate criteria for successfully passing an arc fault test procedure. If the equipment design does not incorporate the three inherent design features above, the integrity of the original test should be seriously questioned.

Refer photo below of Internal arc type test 40 kA, 1 s with exhaust gas duct. We are with you all the way!



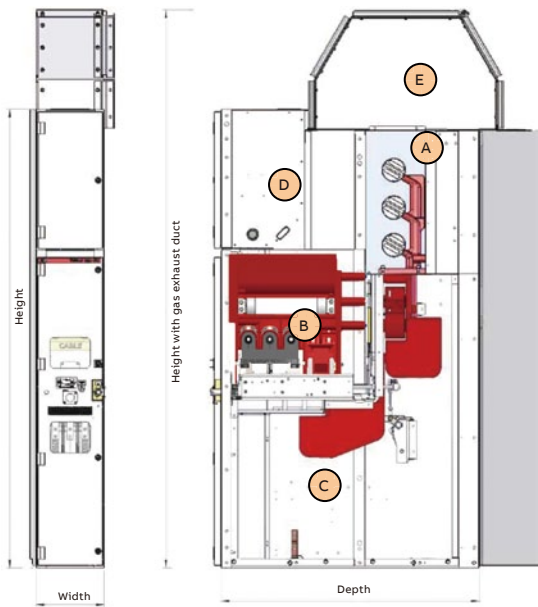
#### Practical designs for reducing arc flash hazard

1	Use arc fault containment (arc resistant) switchgear
2	Use insulated busbar
3	Use current limiting fuses
4	Use remote motorised HV isolation racking
5	Use on-line temperature monitoring instead of local infrared viewing ports
6	Use arc detection and protection scheme



# Technical data

## Panel



- A - Busbar compartment
- B - Contactor and HRC fuses compartment
- C - Cable compartment
- D - Low voltage compartment
- E - Gas exhaust duct

Degree of protection

The degree of protection of the panel conforms to IEC60529. UniGear ZVC panel are normally supplied with the following standard degrees of protection.

- IP4X on the external housing
- IP2X <sup>[1]</sup> between internal compartments

Standard colour of the external surfaces  
ABB standard RAL7035 light grey

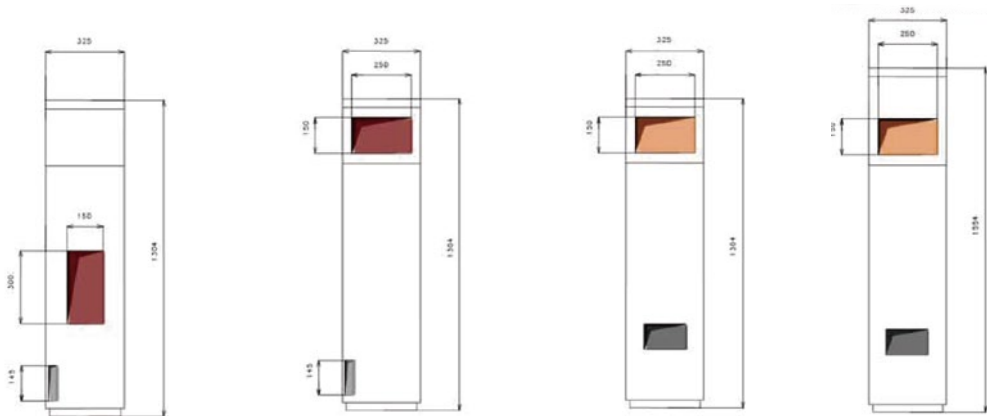
Width (mm)	325
Height (mm)	2200
LV box height (mm)	665
Height with arc duct (mm)	2530

External dimensions:

Depth (mm)	1304	1304	1304	1554
Power cble entry	Bottom entry	Bottom entry	Top entry	Top entry
	Front access	Rear access	Rear access	Rear access
Control csable entry	Bottom entry	Bottom entry	Top entry	Top entry
	Front access	Front access	Front access	Front access
Arc duct	Yes/No	Yes/No	No	Yes/No

Floor plan

- Power cable
- Top entry
  - Bottom entry
- Control cable:
- Top entry
  - Bottom entry



[1] IP3X on request.



Panel type		ZVC	ZVC
Rating	A	400	400
Rated frequency	Hz	50/60	50/60
Rated voltage	kV	7.2	7.2
Power frequency withstand	kV	20 (32) <sup>[1]</sup>	20 (32) <sup>[1]</sup>
Lightning impulse withstand	kVpk	60	60
Maximum busbar current	A	4000	4000
Short time current – 3 sec	kA	31.5	50
Peak withstand current	kApk	80	125 (150) <sup>[2]</sup>
Arc fault containment – 1 sec <sup>[3]</sup>	kA	31.5	50

[1] Enhanced rating.

[2] Enhanced rating.

[3] The internal arc withstand values are guaranteed in the compartments of the supply side of the fuses (busbars and apparatus), by the structure of the switchboard and on the loads side(feeder) by the fault limiting properties of the fuses.

# Technical data

## Fused contactor truck

### Utilization categories

Contactors are mechanical switching devices capable of connecting, conducting and disconnecting currents in the circuit under service conditions, including operational overload. They have a long operational life especially suitable for high switching frequencies and can accommodate a wide starting current profile, i.e. motor starter applications. Contactors are suitable for switching in accordance with the utilisation categories. Protection against short circuits is to be ensured by short circuit protection devices (SCPDs).

Switching loads particularly motors are selected by utilization categories as shown below. Ratings such as voltage, current, ambient temperature and control voltage are to be considered. In addition background conditions such as switching frequency, type of coordination, short circuit level, start up conditions, contact life and fault limitation need to be taken into account.

Curves below illustrate utilization categories in accordance to standards IEC 60470 UniGear ZVC is equipped with contactor tested to AC-3.

### Value of vacuum interrupters

- No SF<sub>6</sub> green house gas
- Maintenance free throughout a long service life
- Fast and reliable arc-quenching in the entire current range
- Fast dielectric recovery

- Extremely low contact erosion hence high accumulated short circuit current
- Highly suitable for frequent switching of operating and short circuit currents
- Reliable on auto-reclosing and multi-shot auto-reclosing operations
- No fire risk
- Absolutely no environmental pollution during switching operations

### Standards

UniGear ZVC contactor is equipped with ABB vacuum interrupters and complies with IEC 60470.

High voltage fuses are fitted in the UniGear ZVC contactor to protect the operated devices. The fuses comply with IEC 60282-1.

### Interruption principle

The main contacts operate inside the vacuum interrupters (the level of vacuum is extremely high:  $13 \times 10^{-5}$  Pa). On opening, there is rapid separation of the fixed and moving contacts in each contactor interrupter. Overheating of the contacts, generated at the moment they separate, causes formation of metallic vapours which allow the electric arc to be sustained up to the first passage through zero current. On passage of zero current, cooling of the metallic vapours allows recovery of high dielectric resistance able to withstand high values of the return voltage. For motor switching, the value of the chopping current is very low with extremely limited overvoltages.



**General**

V7/ZVC truck consists of an epoxy resin moulding containing fuse holders that accept parallel HV fuses, vacuum interrupters, the moving apparatus, the electromagnet, the multi-voltage control feeder and auxiliary accessories. The load & line side connectors for the withdrawable portion are moulded into the epoxy resin. Closing of main contacts is carried out by means of the control electromagnet. Opening is carried out by means of a special opposing spring. Construction is compact and sturdy and ensures very long electrical and mechanical life.

**Versions available:**

V7/ZVC can be of the electrically held type or the mechanically latched type.

**Standard equipment**

- Operating mechanism
- Fuse blown indicator with 1 N/O auxiliary
- Mechanical operation counter
- 3 N/O & 3 N/C contactor auxiliary contacts
- 24 way automatic connection plug
- Contactor ISOLATED and SERVICE indicator
- Contactor On-Off (I-O) indicator

**Optional equipment**

- Control voltage transformer
- Mechanical latch coil
- Trip circuit supervision provision
- Racking blocking coil (only for mechanically latched)
- Emergency trip provision



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**Technical data**

Fused contactor truck type		V7/ZVC	
HRC HV fuse (per phase)		Two (parallel)	
Rated current: contactor AC-4	A	400	
Maximum fuse rating	A	315	
Rated frequency	Hz	50/60	
Rated voltage	kV	3.6	7.2
Power frequency withstand-1 min	kV	10 (25)	20 (32)
Lightning impulse withstand	kVpk	40	60
Short time current – 3 sec <sup>[1]</sup>	kA	50	50
Overload current (w/o fuse) –1 sec	kA	6	6
Withstand current (w/o fuse) – 30 sec	kA	2.5	2.5
Peak withstand current	kApk	125 (150) <sup>[2]</sup>	125 (150) <sup>[2]</sup>
Load switching: motor <sup>[3]</sup>	kW	2000	4000
Transformer	HP	2700	5400
Endurance: Electrical – contactor	kVA	2000	4000
	AC-3	100000	100000
Mechanical – mechanism	Ops	300000	300000
Mechanical – truck Isolation/racking	Ops	100000	100000
Opening time	ms	≤30	≤30
Closing time	ms	≤80	≤80
Control supply: closing circuit	Vdc	24-60, 100-250, 88-124	
Truck blocking coil	Vac	24-60, 100-250	
	Vdc/ac	24, 30, 48, 60, 110, 125, 220, 240	
Current interlock <sup>[4]</sup>	Code	1-4	1-4

[1] Limited by the fuses.

[2] Enhanced rating.

[3] Maximum rating depending on full load current, locked rotor current and run up time of motor.

[4] To prevent interchange-ability of fused contactor truck with different ratings or construction.

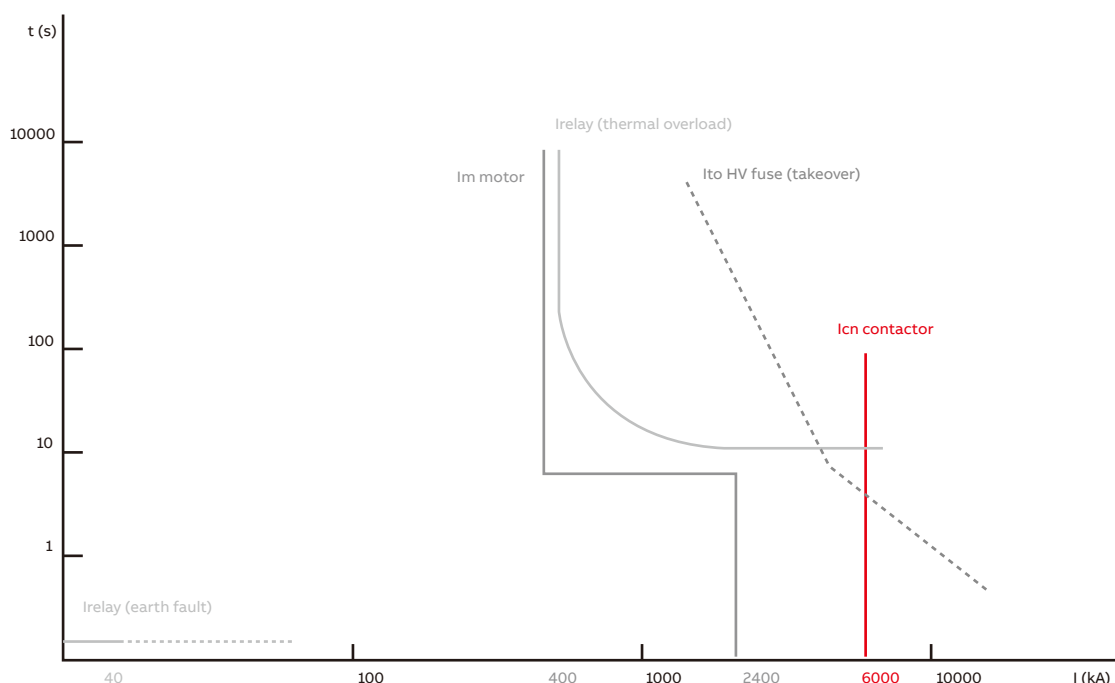
# Technical data

## Short circuit protection device coordination

UniGear ZVC switchgear system provides complete coordination between protective and switching devices. This coordination has been type tested in PEHLA laboratory to IEC 60470 standards. The coordination classification is type “C” and the risk of contact welding is practically negligible.

Protection is provided by:

- HRC HV fuses for short circuit currents above the breaking capacity of the contactor through to the rated short circuit capacity of the switchgear
- Protective relay systems for the overload and short circuit currents up to the breaking capacity of the contactor



Typical S.C.P.D. coordination characteristic

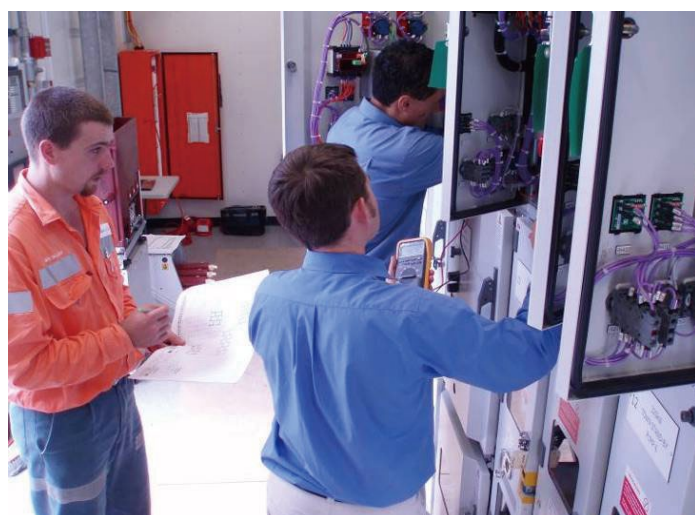
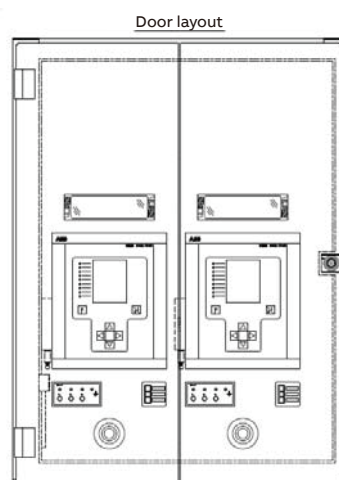
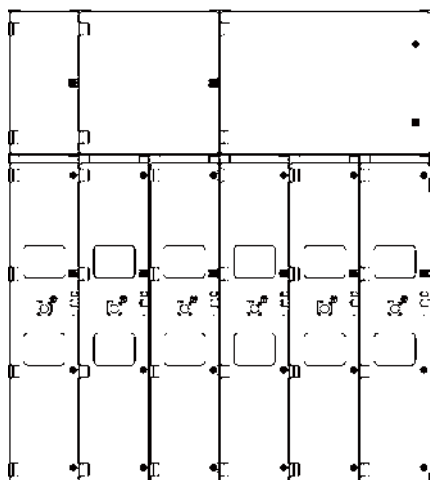
Motor	$I_m$	Motor rated current	400 A
		Motor starting current	2400 A
		Motor starting time	6 sec
Contactor	$I_{cn}$	Contactor short circuit breaking current	6000 A
Relay	$I_{relay}$	Motor thermal overload protection curve	10% FLC
		Motor earth fault protection curve	
HV fuse	$I_{to}$	Take over point between fuse and contactor	

# Technical data

## Low voltage compartment

The low voltage compartment is a self-contained unit, isolated electrically and pressure protected from the high voltage chambers. Various height and width designs are available, which allows it to accommodate combinations of equipment. Protection relays, instruments and push buttons can be fitted on the rigid door.

Low voltage compartment type		Single door	Double door	Triple door
Width	mm	325	650	975
Padlocking facility		Yes	Yes	Yes
Lock (double bit)		One	One	Two
Fluorescent lamp		Option	Option	Option

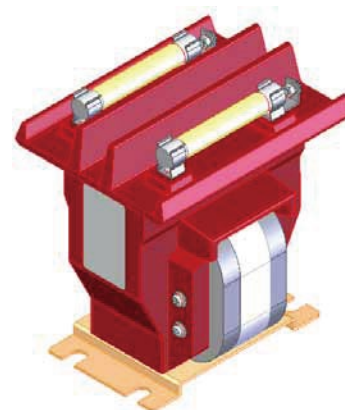


# Technical data

## Control power transformer

Auxiliary power for each contactor can be provided by an individual integrated control transformer. This transformer derives control power from bus mains; thus providing capital cost and space savings with smaller rating external AC UPS or DC battery power systems.

The high voltage side of control transformer is equipped with a fuse in each phase. These fuses are in addition to main circuit fuses.



Control power transformer type		JDZ1			
Rated frequency	Hz	50/60			
Rated voltage	kV	3.6		7.2	
Service voltage	kV	3.3		4.16	6.0 6.6
Power frequency withstand	kV	10		20	
Lightning impulse withstand	kVpk	40		60	
Thermal burden	VA	100			
Secondary voltage	V	110, 220, 230, 240			
Primary fuse link	A	1			



# Technical data

## Instrument transformer

**Current transformer**  
Current transformer is designed to comply with standard IEC 60044-1. Compliance to AS 60044-1 is available.

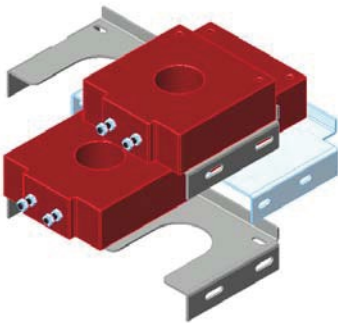
UniGear ZVC switchgear is equipped with selection of three standard current transformer protection and metering cores.



Type	ZVCII	ZVCII	ZVCII	ZVCII
Ratio	50/1/1 A	75/100/150/1/1 A	200/300/400/1/1 A	Design on request
Core 1	Cl.10P10	Cl.10P20	Cl.10P20	Design on request
	0.75 VA	0.75 VA	0.75 VA	
Core 2	Cl.3	Cl.3	Cl.3	Design on request
	3 VA	3 VA	3 VA	

Additionally, UniGear ZVC switchgear allows fitting of second set high burden current transformer. These current transformers are available for top and bottom power cable entry panel.

Type	ZVC/BCT1	ZVC/DMC
Ratio	...4000/1/1/1 A	...4000/5/5/5 A
Core 1	Design on request	Design on request
Core 2	Design on request	Design on request



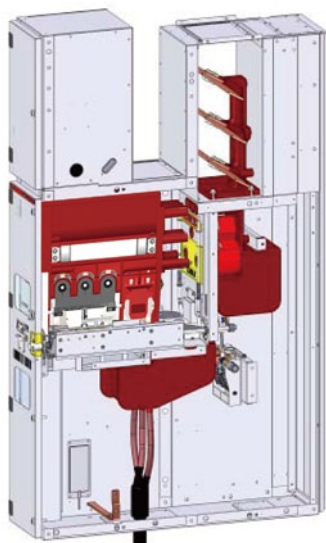


# Technical data

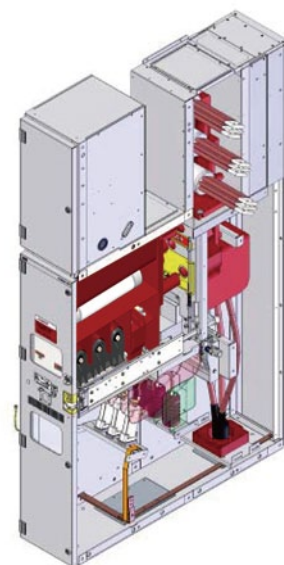
## Power cable entry

- 01 Bottom front (bolt-on termination)
- 02 Bottom rear (bolt-on connection)
- 03 Top rear (bolt-on termination)
- 04 Top rear (plug-in termination)

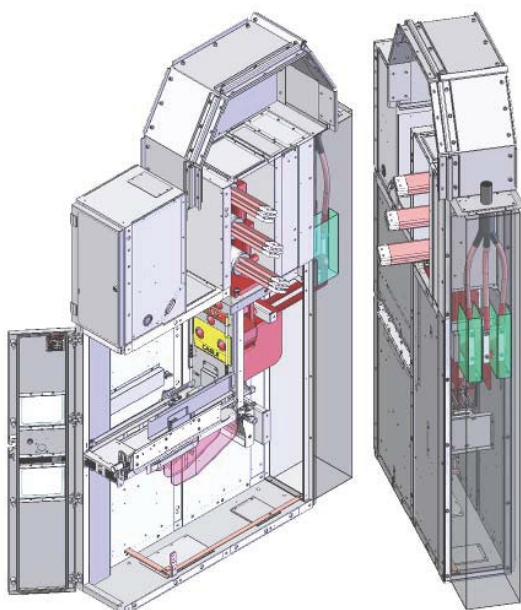
The power cable termination compartment is accessible from the front, rear or top. Two types of cable termination are available, i.e. bolt-on or plug-in.



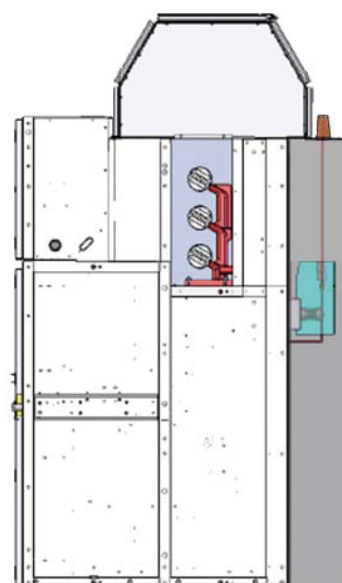
01



02



03



04

# Technical data

## Power cable entry



### Cable termination for bolt-on connection

#### Cable lug

Cable is a shear bolt type for Aluminium and Copper Conductors.

#### Integrated top sealing

Seals towards the cable lug, with sealing mastic due to active pressure from the rubber.

#### Insulation layer

Made of silicone rubber with proven performance. Ozone, UV-radiation and tracking resistant.

#### Field grading

The electric field is controlled by an integrated layer of a material with a non-linear resistivity. The termination utilises a combination of refractive and resistive field control.

#### Expanded lower seal

Seals around the cable with sealing mastic, the mastic embeds the screen wires for a reliable seal.

**Note:** Cable termination kits are supplied with 1.5 meter tails and cable lugs.

1. Cold-applied
2. Can be used in small spaces
3. No special tools
4. Prefabricated for easy and safe installation
5. Minimal cable stripping
6. Active pressure
7. Few components
8. Long shelf life

### Cable termination selection for cables with rated voltages 3.3/6.6 kV

Designation	XLPE-Ø (mm)	Conductor cross section (mm²)	Weight (kg/kit)
3-core/three 1-core			
SOT 101-3	10.5-15	10-35	0.2
SOT 102-3	12.9-25.8	50-185	0.2
SOT 103-3	21.4-34.9	185-500	0.2

### Cable termination for plug-in connection

1. Pin contact SOC 250 TP: Consists of a silver-plated copper pin, and a tinned aluminium connecting clamp and conductor guide. The conductor is guided to its position and fixed by means of a hexagonal spanner size 7 and a torque wrench. SOC 250 STP: Consists of a silver-plated copper pin, a tinned aluminium connecting clamp and two bolts made of brass. The pin contact is installed on the conductor by means of an allen key size 6 and a torque wrench.
2. Bail restraint: Consists of stainless steel, used to secure the connector to the bushing.
3. Inner conductive layer: Creates a Faraday cage around the connector. This ensures a stable electrical potential and eliminates the need for filling material in cavities and between the conductor and pin contact.
4. Insulating layer: High electrical strength, a thickness of min 10 mm and the elasticity of the material ensures the function with active pressure on all interfaces. Premoulded together with the inner and outer conductive layer. Electrical properties are ensured by routine test.
5. Outer conductive layer: UV-, Ozone- and tracking-resistant. UV-resistance tested for 3000 h in a xenon radiator. Thickness 2 mm on its thinnest part. When connected to the cable screen, the connector meets international requirements for a fully screened system.
6. Adapter: Made of flexible insulating rubber with an integrated resistive stress control part.
7. Capacitive test point: A metallic part

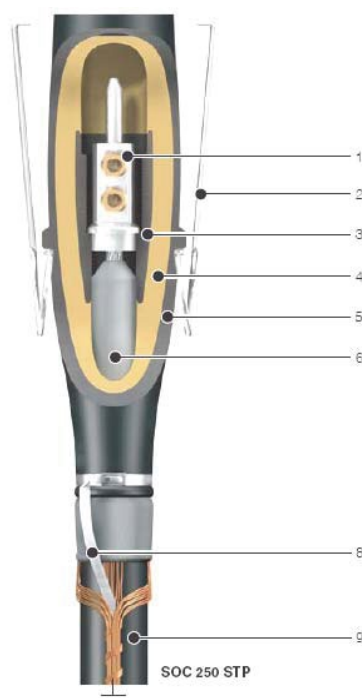
vulcanized into the insulating layer to allow voltage indication when readout is made with suitable high impedance measuring devices. Covered by a cap of conductive rubber which ensures a touch proof system.

8. Earth connection: The conductive layer is connected to the cable screen via a stainless steel band strip. The band strip can temporarily be removed from the cable screen, which makes it possible to perform cable sheath tests without disconnecting the connector from the bushing.
9. Designed for polymeric insulated cables: SOC screened connectors can be installed on XLPE as screened separable plug-in connector for XLPE-insulated 1- or 3-core cable with Al or Cu conductor. The connectors are supplied in kits of three. The connector fits standard bushings in accordance with EN 50181, type outer cone.

### Design

The connector is made of rubber in three layers: inner conductive layer, insulating layer and outer conductive layer. A metallic part is moulded into the insulation which makes it possible to perform a voltage check. The metallic part is protected by a cover which is easily removed when checking the voltage. The connector meets the requirements for being touch-proof. Supplied complete with screw cable lug for the cable.

Designation	XLPE-Ø (mm)	Conductor cross section (mm²)	Weight (kg/kit)
Angled connector with capacitive test point			
SOC 250 TP	12.5-25.8	25-95	2.2
Straight connector with capacitive test point			
SOC 250 STP	12.9-25.8	25-95	2.2

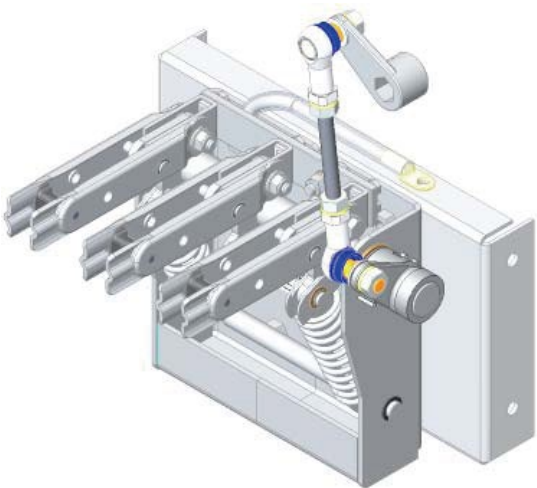


1. Cold-applied
2. No special tools
3. Prefabricated for simple and safe installation
4. Minimal cable stripping
5. Active pressure
6. Few sizes
7. Long shelf life

05 Earth switch view window

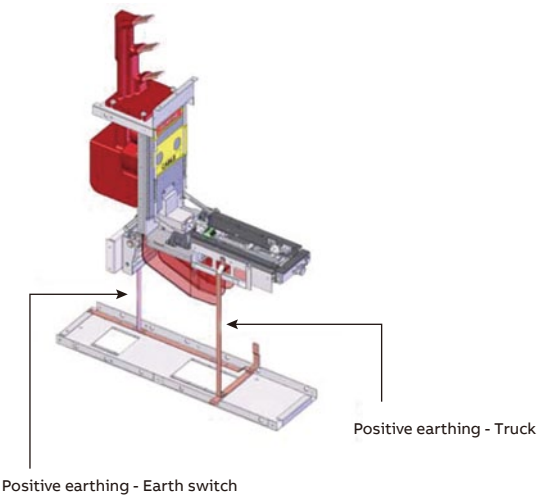
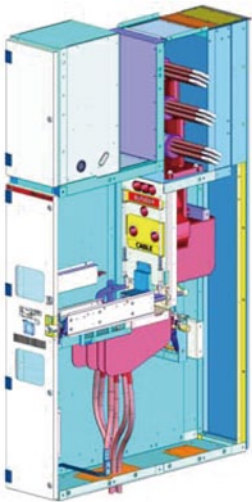
Earthing switch type ZVCE7 conforms to the requirements of IEC 60251-1.They are fitted with manual snap-action operating mechanisms for positive high-speed closing and sufficiently dimensioned to conduct the rated short circuit making current up to 50kA when coordinated with HV HRC fuses. The speed of the snap-action closing operation is independent of the operator. The earthing switch is supplied as pre-assembled active part in UniGear ZVC panel.

Positive view of earth switch blade can be achieved with operator shining torch light over door viewing window. In addition, yellow fluorescent paint on earth switch blade is available as an option.



Earth switch type		ZVCE7
Rated frequency	Hz	50/60
Rated voltage	kV	7.2
Power frequency withstand	kV	20 (32) <sup>[1]</sup>
Lightning impulse withstand	kVpk	60
Short time current – 3 sec	kA	50
Peak withstand current	kA <sub>pk</sub>	125 (150) <sup>[2]</sup>
Making capacity <sup>[3]</sup>	kA	31.5

[1] Enhanced rating.  
[2] Enhanced rating.  
[3] Limited by the fuses.



# Technical data

## Arc duct

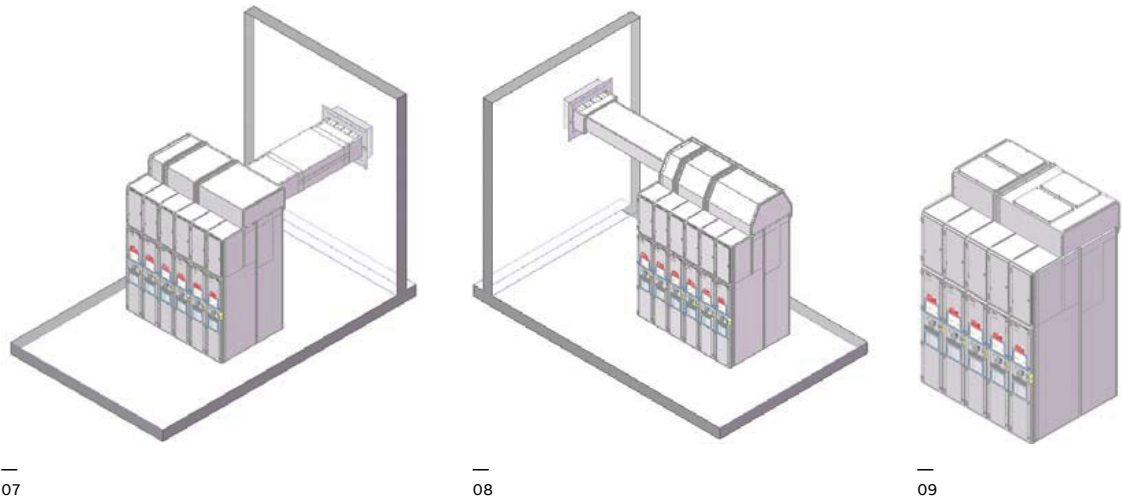
- 07 Compact version
- 08 Standard version
- 09 Top chimney version

Arc fault explosion need to be removed in a controlled manner, to an area safely away from surrounding equipment and operators. Various arc explosion venting systems are available to optimise safety, protect surrounding equipment and switchroom layout.

UniGear ZVC switchgear system arc duct channel is type tested to 50 kA fault overpressure, can be used to direct hazardous gasses away from operators and surrounding equipment. Contact ABB for recommendation on best solution for your installation.

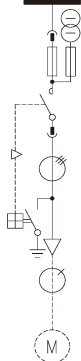
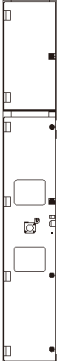
Arc duct type	Standard	Compact	Top chimney	None <sup>[1]</sup>
Ceiling height				
≥4 m	AFLR 50 kA (...1 sec)	AFLR 50 kA (...1 sec)	AFLR 50 kA (...1 sec)	AFL 50kA <sup>[2]</sup>
≥3 m	AFLR 50 kA (...1 sec)	AFLR 50 kA (...1 sec)	AFLR 50 kA (...1 sec)	AFL 50kA <sup>[2]</sup>
≥2.8 m	Not available	AFLR 50 kA (...1 sec)	AFLR 50 kA (...1 sec)	AFL 25 kA (0.5 sec)
≥2.5 m	Not available	Not available	Not available	AFL 25 kA (0.5 sec)

[1] No arc duct.  
[2] Contact us for duration recommendation.



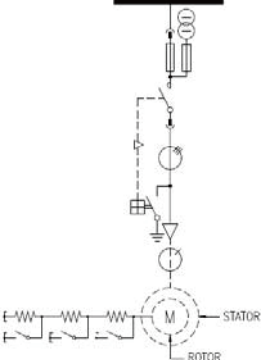

# Applications

Motor starter (direct on line)

Motor starter (DOL)	ZVC	Ratings		
		Circuit full load current	A	..400
		Rated frequency	Hz	50/60
		Rated voltage	kV	..7.2
		Power frequency withstand	kV	..32
		Lightning impulse withstand	kVpk	..60
		Short time current – 3 sec	kA	..50
		Width	mm	325
		Depth <sup>[1]</sup>	mm	1304
		Height <sup>[2]</sup>	mm	2200

[1] Bottom power cable entry version. Top cable power entry version 1304 or 1554 mm.  
[2] Larger LV compartment with corresponding total panel height 2400 and 2596 mm available.

Slip ring induction starter

Slip ring induction	ZVC-SRI	Ratings		
		Circuit full load current	A	..400
		Rated frequency	Hz	50/60
		Rated voltage	kV	..7.2
		Power frequency withstand	kV	..32
		Lightning impulse withstand	kVpk	..60
		Short time current – 3 sec	kA	..50
		Width	mm	325
		Depth <sup>[1]</sup>	mm	1304
		Height <sup>[2]</sup>	mm	2200
		Note: External secondary resistor		

[1] Bottom power cable entry version. Top cable power entry version 1304 or 1554 mm.  
[2] Larger LV compartment with corresponding total panel height 2400 and 2596 mm available.

**Slip ring induction starter type ZVC-SRI**  
Slip ring or wound rotor motor is an induction machine where the rotor comprises a set of coils that are terminated in slip rings to which external resistors can be connected. The stator is the same as is used with a standard squirrel cage motor.

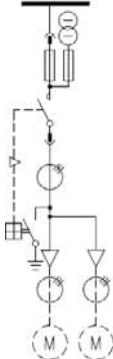
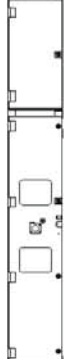
- Types of resistors are available:
- Liquid resistance
  - Resistors in air housing

- Typical applications:
- Mills
  - Crusher






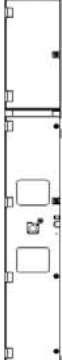
Conveyor belt double motor feeder

Double feeder	ZVC-DF	Ratings		
		Circuit full load current	A	..400
		Rated frequency	Hz	50/60
		Rated voltage	kV	..7.2
		Power frequency withstand	kV	..32
		Lightning impulse withstand	kVpk	..60
		Short time current – 3 sec	kA	..50
		Width	mm	325
		Depth <sup>[1]</sup>	mm	1304
		Height <sup>[2]</sup>	mm	2200

[1] Bottom power cable entry version. Contact us for Top cable power entry version.  
[2] Larger LV compartment with corresponding total panel height 2400 and 2596 mm available.

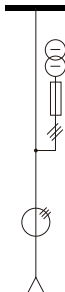



Transformer feeder

Transformer feeder	ZVC	Ratings		
		Circuit full load current	A	..400
		Rated frequency	Hz	50/60
		Rated voltage	kV	..7.2
		Power frequency withstand	kV	..32
		Lightning impulse withstand	kVpk	..60
		Short time current – 3 sec	kA	..50
		Width	mm	325
		Depth <sup>[1]</sup>	mm	1304
		Height <sup>[2]</sup>	mm	2200

[1] Bottom power cable entry version. Top cable power entry version 1304 or 1554 mm.  
[2] Larger LV compartment with corresponding total panel height 2400 and 2596 mm available.

Cable to bus

Cable to bus	ZVC-CTB	Ratings		
		Circuit full load current	A	..2000
		Rated frequency	Hz	50/60
		Rated voltage	kV	..7.2
		Power frequency withstand	kV	..32
		Lightning impulse withstand	kVpk	..60
		Short time current – 3 sec	kA	..31.5
		Width	mm	325
		Depth <sup>[1]</sup>	mm	1304
		Height <sup>[2]</sup>	mm	2200

[1] Bottom power cable entry version. Top cable power entry version 1304 or 1554 mm.  
[2] Larger LV compartment with corresponding total panel height 2400 and 2596 mm available.



# Appendices

## 1 - current transformer

### Selection

The application of a UniGear ZVC fused contactor to motor starter duty has significant influence on the parameters used for CT selection.

The compact design and dimensions of the switchgear provides limited space for accommodating current transformers and control and protection devices. The design is targeted at the use of multi-function microprocessor based control and protection apparatus.

Typical of microprocessor based protection devices is ABB REM615 that will accept 1.0 amp or 5.0 amp input current. One amp rated current is selected to minimize voltage drop in the connections between CT and relay and also to optimize CT design to be compatible with the compact space allocated in the switchgear.

Standard current transformers are designed to comply with the requirements of standard IEC 60044-1.

Protection current transformers are specified in terms of composite error, classification, accuracy limit factor and rated burden, for example, for lowest ratio 50/1 A Class 10P10, 0.75 VA where:

Class 10	Composite error selected appropriate to the application from preferred standard values nominated by the standard
P	Classification, i.e. protection
10	Accuracy limit factor selected appropriate to the application from preferred standard values nominated by the standard
0.75 VA	Rated value of external burden appropriate to the application connected to the CT terminals

A motor starter is a terminal feeder. The common wisdom is that extreme accuracy is not essential for motor protection and indication functions so a 10% composite error is normally specified to be consistent with economical design and adequate performance. This selection also provides for a 3% current error at rated current making it suitable for load indicating purposes.

The CT is not required to operate a short circuit protection device. The high voltage fuse is selected to interrupt fault currents exceeding the stall current and contactor breaking capacity. Motor

overload and stall currents have values in a range up to a nominal 7 x full load current so an accuracy limit factor of 10 provides a generous range of performance.

The connected burden comprises the protective relay and the wires connecting the relay to the CT. The REM615 multi function relay has a 0.1 ohm internal burden of the input circuit, that is, 0.1 VA burden at 1.0 amp rated current. This burden is linear across the operating range. Connecting wires between the current transformer terminals and the protection relay terminals are 1.0 mm<sup>2</sup> flexible copper conductors comprising a total route loop length of 2.0 metres. Resistance of this loop is 0.04 ohms representing a lead burden of 0.04 VA at 1.0 amp rated current.

Therefore the theoretical connected burden on the CT is 0.1+0.04=0.14 VA.

A rated burden of 0.75 VA has been nominated for the CT to allow for variations in the loop resistance, variations in relay burdens across make and models and to provide a reasonable safety margin of performance beyond the theoretical values.

Metering current transformers are specified in terms of composite error, classification, accuracy limit factor and rated burden, for example, Class 3, 3.0 VA where:

Class 3	Accuracy class, i.e. the highest permissible percentage error at rated current, selected appropriate to the application from preferred standard values nominated by the standard
3.0 VA	Rated value of external burden appropriate to the application connected to the CT terminals

Traditional practice uses an analogue ammeter to provide visual indication that starting current is initiated when the motor is switched "on" and then decays to a normal load current. The meter is not used for reading or recording true values of phase current rather it is used as an indicator of "normal" condition. Class 3 that is 3% accuracy, of the CT is widely accepted to satisfy the needs of current indication.

An industrial grade ammeter usually has a burden of approximately 1.0 VA. The recommended rated

burden of 3.0 VA metering offers adequate design margin for variations in the connected burden beyond the theoretical values of loop resistance and meter burden.

An increasing trend in modern control philosophy is to delete the analogue ammeter and interrogate the microprocessor to read phase current values and starting current values. This practice fully utilizes the features provided by most modern protection relays and eliminates the need for a dedicated metering current transformer.

UniGear ZVC current transformers are available in the following three winding categories.

50/1 A	150-100-75/1 A	400-300-200/1 A
--------	----------------	-----------------

### Standard ratings

The standard current transformers used in UniGear ZVC are uniquely dimensioned, single-phase, epoxy resin encapsulated, 660 V ring type toroids designed for installation on the cable side spout bushings.

#### General Specification -

Rated frequency:	50/60 Hz
Rated secondary current:	1.0 A
Thermal rating:	1.2 A
Rated insulation level:	0.6/2.0 kV (7.2/20/60 kV installed)
Applicable standard:	IEC 60044-1

Three standard design versions are available to adequately cover the full range of permissible circuit load currents.

Ratio:	400-300-200/1/1 A	Core 1:	Cl. 10P20, 0.75 VA
		Core 2:	Cl. 3.0, 3.0 VA
Ratio:	150-100-75/1/1 A	Core 1:	Cl. 10P20, 0.75 VA
		Core 2:	Cl. 3.0, 3.0 VA
Ratio:	50/1/1 A	Core 1:	Cl. 10P10, 0.75 VA
		Core 2:	Cl. 3.0, 3.0 VA

The ratio, class and burden have been selected to adequately match modern microprocessor based electronic protection and metering devices.

50/1 A is the lowest ratio available and will suit applications with full load current as low as approximately 15 A when coupled with modern microprocessor based electronic protection and metering devices.

Five ampere secondary windings are not available nor are they suitable when considering remote metering applications.

The protection core, core 1, is located at the 'P1' primary end of the toroid and the CT is installed over the primary conductor with 'P1' facing the direction of the main busbars and 'P2' facing the cables.

Following are the main design features:

- The primary winding is provided by the conductor embedded in the spout bushing
- Frame dimensions of the toroid are optimised to suit the space available around the spout bushings
- An earth screen is embedded in the bore of the toroid to provide a secure screen between the high voltage primary conductor and the low voltage secondary winding
- The start, finish and intermediate taps of the secondary winding comprise a 3.0 metre long flying lead of tinned copper multi-core flexible cable securely anchored in the epoxy encapsulation of the toroid. No loose joints or broken conductors are possible
- Flying lead conductors form part of the secondary winding, which is, the start and finish of the winding is 3.0 metre from the toroid. This feature allows the secondary terminal of the CT to be located in the LV control compartment. (The secondary terminal usually takes the form of a rail mounted test link). Voltage drop in conductors connecting CTs to meters and relays is no longer a consideration with the flying lead concept
- Internal burden of the CT includes the resistance of the flying leads and all mandatory tests for accuracy and class are conducted by connecting the test equipment to the free end of the flying lead. The free end of the flying lead is indelibly marked with the secondary terminal marking according to the applicable standard
- 2.5 mm<sup>2</sup> (32/0.20) conductor, insulation colour green/yellow, is used for the screen earth wire and 1.0 mm<sup>2</sup> (50/0.25) conductor, insulation colour black, is used for the secondary winding taps
- PVC insulation is used on the flexible flying leads and a PVC sheath covers a multi-core group. All insulation is halogen free
- Installation and wiring of the toroids is a simple, tidy and efficient task





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