Product Catalogue

UniGear ZVC – Indoor and Outdoor Compact Intelligent MCC and Switchgear System to Power and Control your Process

Power and productivity
for a better world™

Contents

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 such as SHELL and others 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 occured 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:

1. 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.

2. The contactor does not need high breaking capacity and can be designed for long life under repetitive starting conditions. Electrical life of the interrupter is 1,000,000 operations.

3. 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.

4. Compact size fuses offers better utilisation of space compared to larger non-fused protection devices.

5. 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.

6. 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.

7. 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.

8. 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.

9. 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.

10. 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 located in Sydney Australia, 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 5th 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
5th Generation

Late 2000s	Release of integrated Remote HV Isolation in compact MCC, world's first.
	Release of modular substation Outdoor MCC and Distribution Centre, OE-ZVC
Mid 2000s	Release of Medium Voltage Compact Intelligent MCC and Switchgear
Early 2000s	A family member of ABB Global UniGear platform
	Combining the features of UniStarter and ZVC fused contactor panel, 325mm width

UniStarter ZVC
4th Generation

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

ZVC
3rd Generation

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

UVC
2nd Generation

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

RVC
1st Generation

Late 1970s	A family member of Norway NEBB RGB platform
	World smallest Medium Voltage Withdrawable fused contactor panel, 300mm 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, transformers, capacitors and drives. 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 transfering between compartments.
- Limited and simple maintenance activities.
- Tightly sealed panel protects against ingress of contamination and vermin.
- Vacuum contactor is maintenance free.
- Isolation or Truck disconnection feature exceeds the mechanical endurance requirements for isolators. Isolation up to 10000 racking cycles, IEC standards call for 1000 racking cycles.
- 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 62271-200, AS/NZ and GB.
- Compatible with NEMA, ANSI and IEEE standards (Can be type tested on request)
- Arc fault containment (arc resistance) up to 50kA, up to 1sec.
- 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. In addition, UniGear ZVC with certain options meets the additional safety requirements of the Shell DEP specification and has been approved by Shell for use in their installations worldwide.

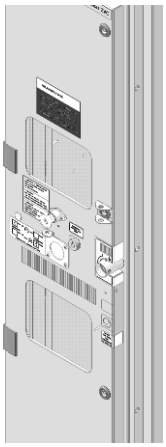
All operations on the switchgear are carried out with the doors closed, protecting the operator in the unlikely event of an internal arc fault. Metal shutters provide positive isolation when the fused contactor is in the “ISOLATE and TEST” position.

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

- Movement of the contactor truck between SERVICE and TEST position, and vise 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’.

UniGear ZVC with certain options meets the additional safety requirements of the Shell DEP specification and has been approved by Shell for use in their installations worldwide.



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.

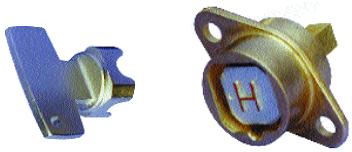
Key Locks

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



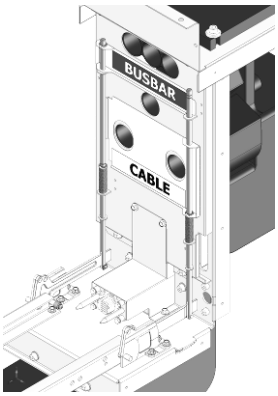
Padlocks

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 inoperatable.

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)
- Motor Starter with Power Factor Correction
- Primary Reactor Starter
- Primary Resistor Starter
- Slip Ring Induction Starter
- Star Delta Starter
- Forward Reverse Starter
- Brake
- Two Speed Starter
- Conveyor Belt Double Motor Feeder
- Auto Transformer Starter
- Soft Starter
- Multi-Motor Starter for Drives and Soft Starter
- Transformer Feeder
- Capacitor Feeder
- Preassemble Panels
- Cable to Bus
- Metering
- Fixed Contactor
- Railway
- AC Power System
- DC Power System
- Arc Terminator System

The Switchgear System built for Process

Chemical, Oil and Gas

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

Marine

- Off-shore platforms
- Drill rigs
- FPSOs
- Tankers
- Container ships
- Passenger ships
- Ferries

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

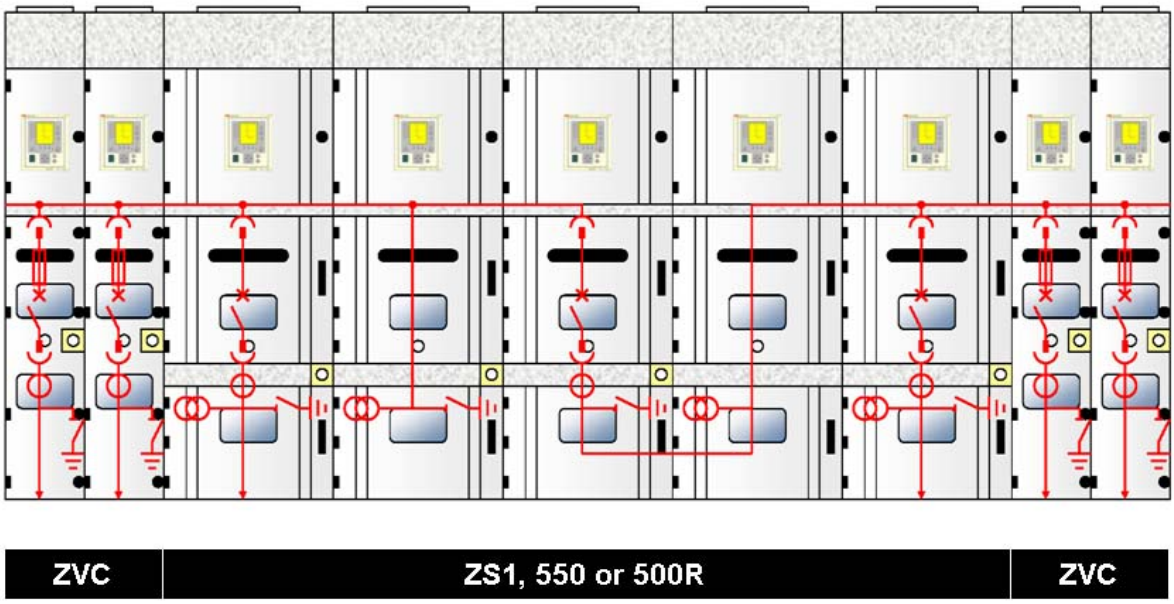
UniGear Platform

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.

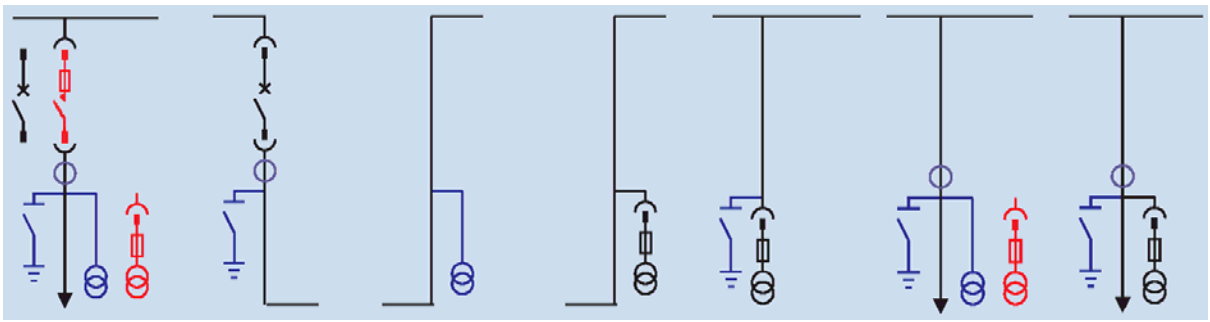
- ZVC
- ZS1
- 550
- 500R

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.



Typical Single Line Diagram

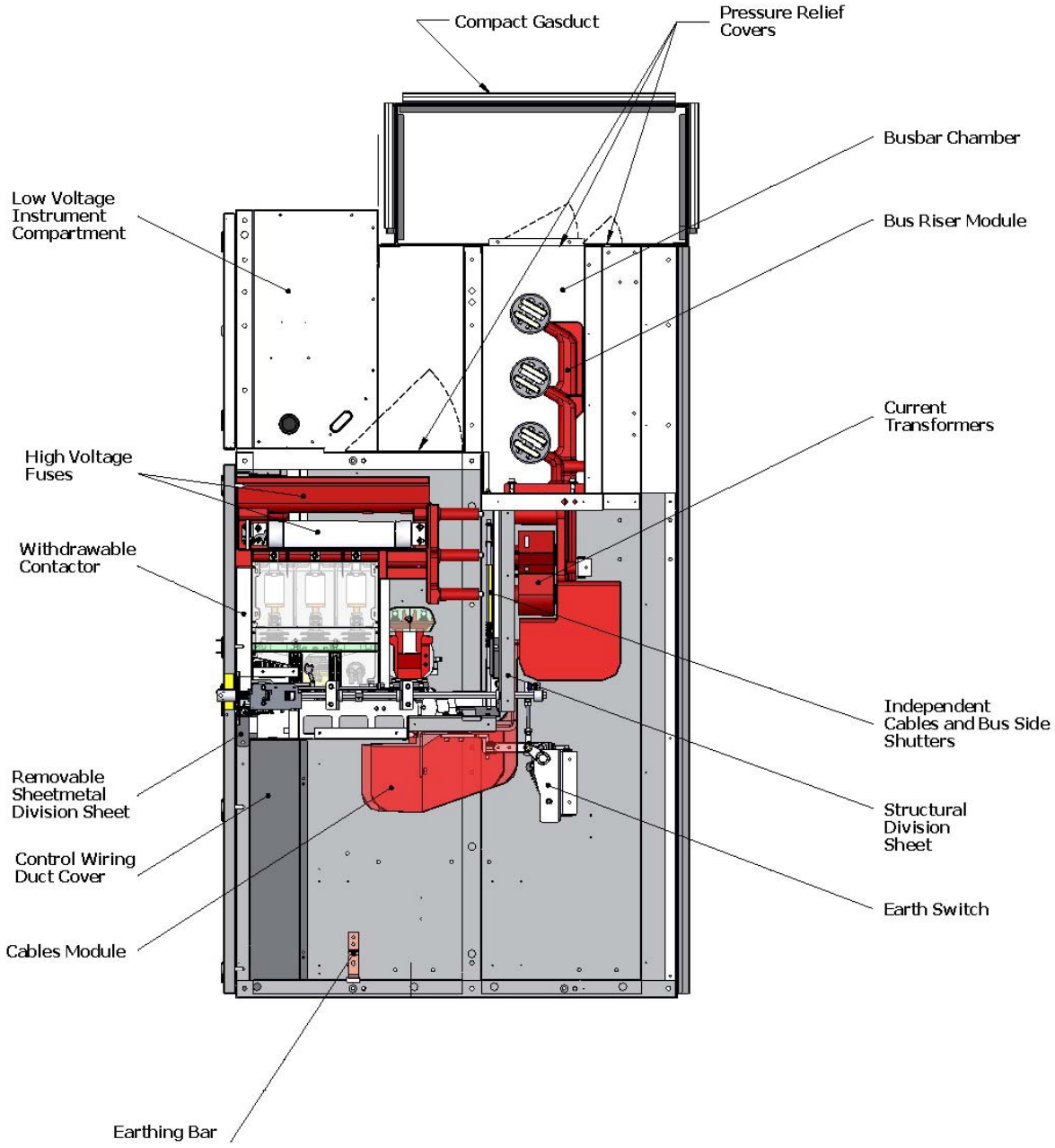


Platform		UniGear			
Types		ZVC[1]	ZS1	550	500R
Application		MCC	Distribution	Distribution	Distribution
Apparatus:					
Fused Contactor (vacuum) – Withdrawable		✓	✓	⚠	⚠
Circuit Breaker (vacuum) – Withdrawable		✓	✓	✓	⚠
Circuit Breaker (gas SF6) – Withdrawable		✓	✓	⚠	⚠
Circuit Breaker (vacuum) – Fixed		✓	⚠	⚠	✓
Circuit Breaker (gas SF6) – Fixed		✓	⚠	⚠	⚠
Switch Disconnector (Air) – Fixed		⚠	✓	⚠	⚠
Switch Fuse Disconnector (Air) – Fixed		⚠	✓	⚠	⚠
Fault Current Limiter – Drawout		⚠	✓	⚠	⚠
Rated Voltage	kV	…7.2	…17.5	…17.5	…17.5
Power Frequency Withstand – 1 min	kV	…32	…38	…38	…38
Lightning Impulse Withstand	kVpk	…60	…95	…95	…95
Rated Main Bus Current	A	…4000	…4000	…4000	…4000
Rated Circuit Current	A	…400/800[2]	…4000	…1250	…1250
Rated Frequency	Hz	50-60	50-60	50-60	50-60
Short Time Current – 3 sec	kA	…50	…50	…31.5	…31.5
Arc Fault Containment, AFLR …1 sec	kA	…50	…50	…31.5	…31.5
Peak Withstand Current	kApk	…150	…125	…80	…80
Dimension[2]:					
Width	mm	325 650 975 1325 1650 1975	650 800 1000	550	500
Depth	mm	1304 1340 1554 1800	1340 1840	1340 1840	1340
Height	mm	2200 2400 2595	2200 2400 2595	2200 2400 2595	2200 2400 2595

[1] Some ZVC variants have the similar ratings as ZS1.
[2] Parallel circuits.
[3] Depending on ratings and applications. Refer Applications section.

Size matters. Less is more. Compact dimension saves building cost

Components


Compact Gasduct
Pressure Relief Covers
Busbar Chamber
Low Voltage Instrument Compartment
Bus Riser Module
Current Transformers
High Voltage Fuses
Withdrawable Contactor
Independent Cables and Bus Side Shutters
Removable Sheetmetal Division Sheet
Structural Division Sheet
Control Wiring Duct Cover
Earth Switch
Cables Module
Earthing Bar

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 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.

Intelligent MCC and Switchgear

A good process produces cost effective and high quality product. Several key elements influence the output - safety, energy costs, unexpected equipment downtime, size of operating and maintenance team, OPEX and CAPEX. The pressure of continuous production coupled with a limited budget to support key elements above mean you need real time information and automated equipment to identify issues before they escalate into production disturbances. Monitoring and protection functions are built in to the intelligent devices.

Philosophy

Medium voltage distribution and motor control centres are fitted with intelligent electronic devices to enable local and remote control of switching devices via serial connections to the plant level control system. Status information pertaining to all station devices is available to the plant level control system via the serial links.

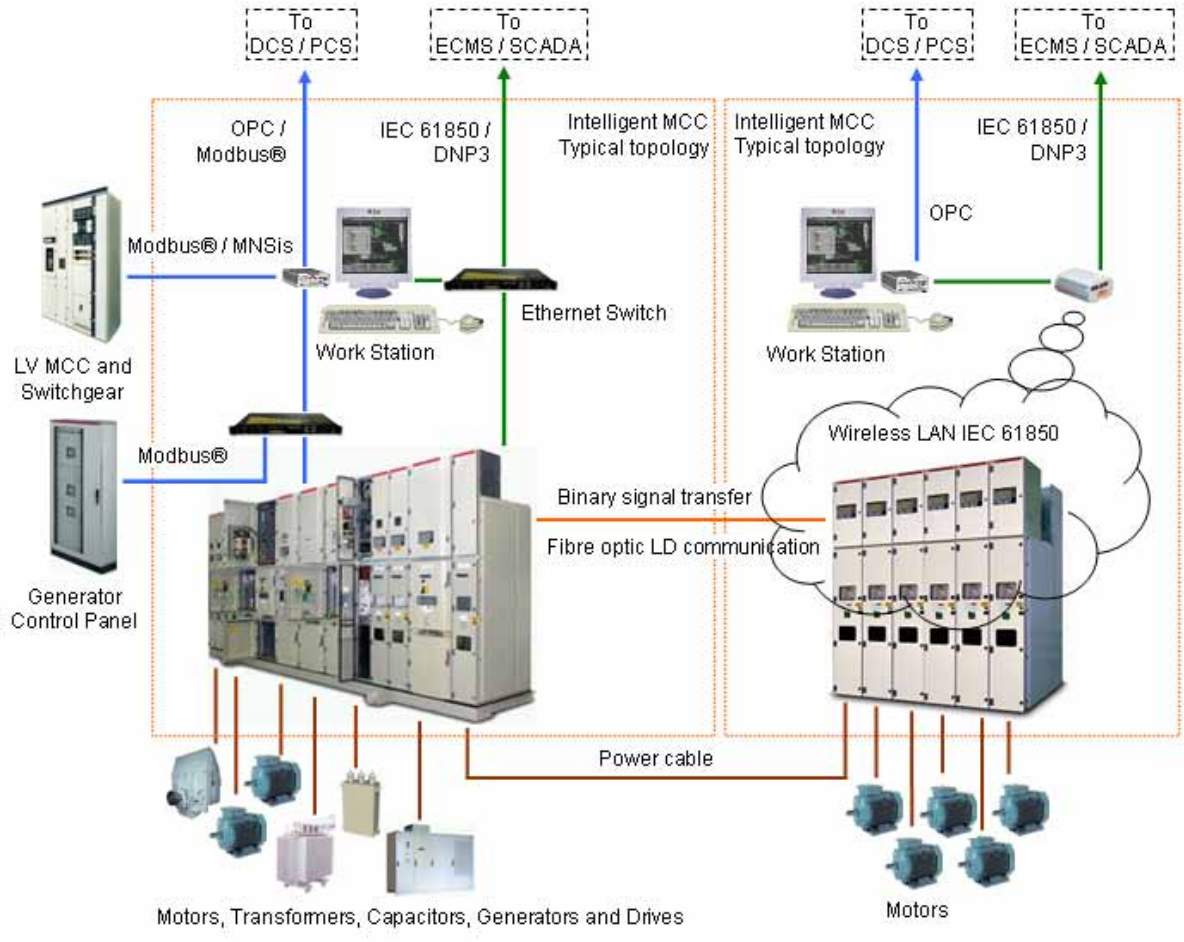
The connections between the station and plant level control systems are with up to two non redundant serial data link. These links is independent to other communications interfaces.

Provision also exists for connection of the plant emergency shutdown system via a hardwire connection, that directly trips the power switching device in the event of emergency situation. This hardwire connection directly trips the switching device in the power circuit.

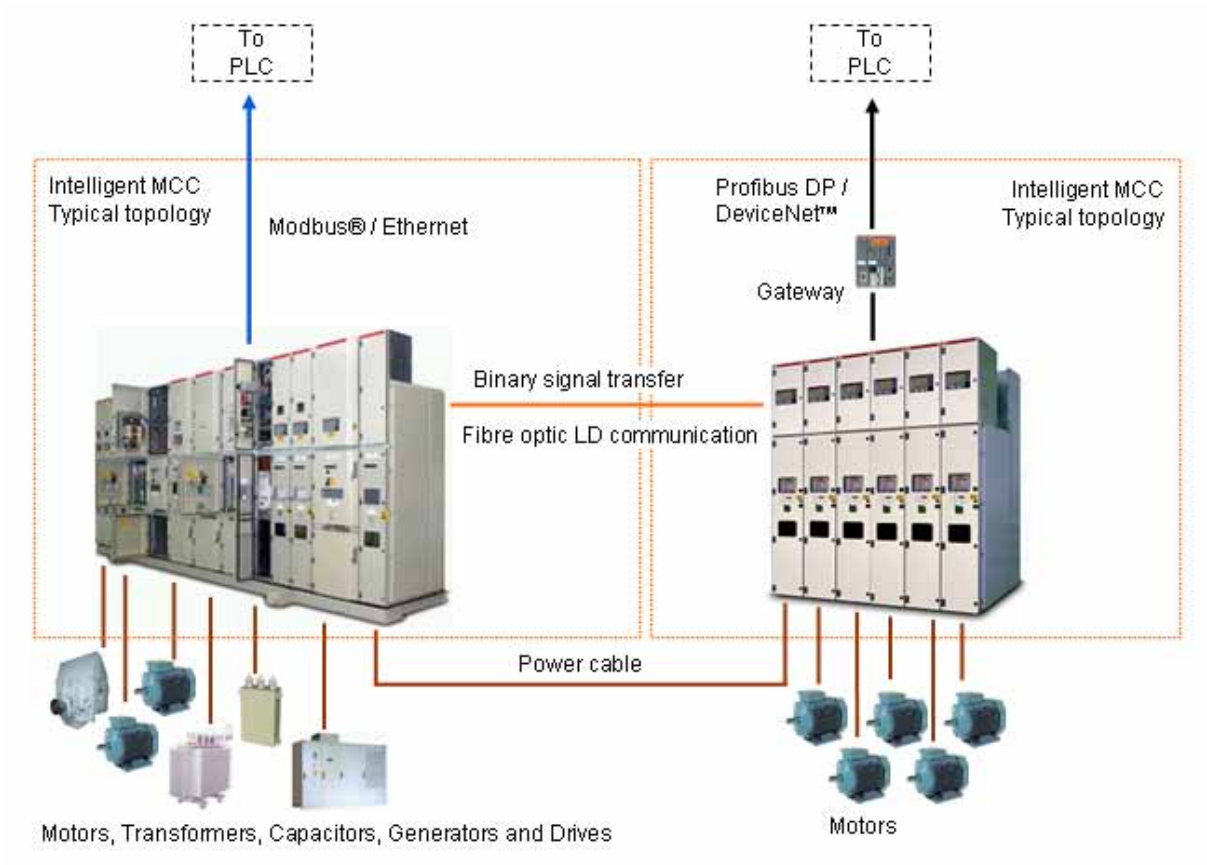
Topology

Intelligent MCC and switchgear provide IEDs combining protection, measurement, control, supervision and communication facilities with serial interface to the higher level control systems.

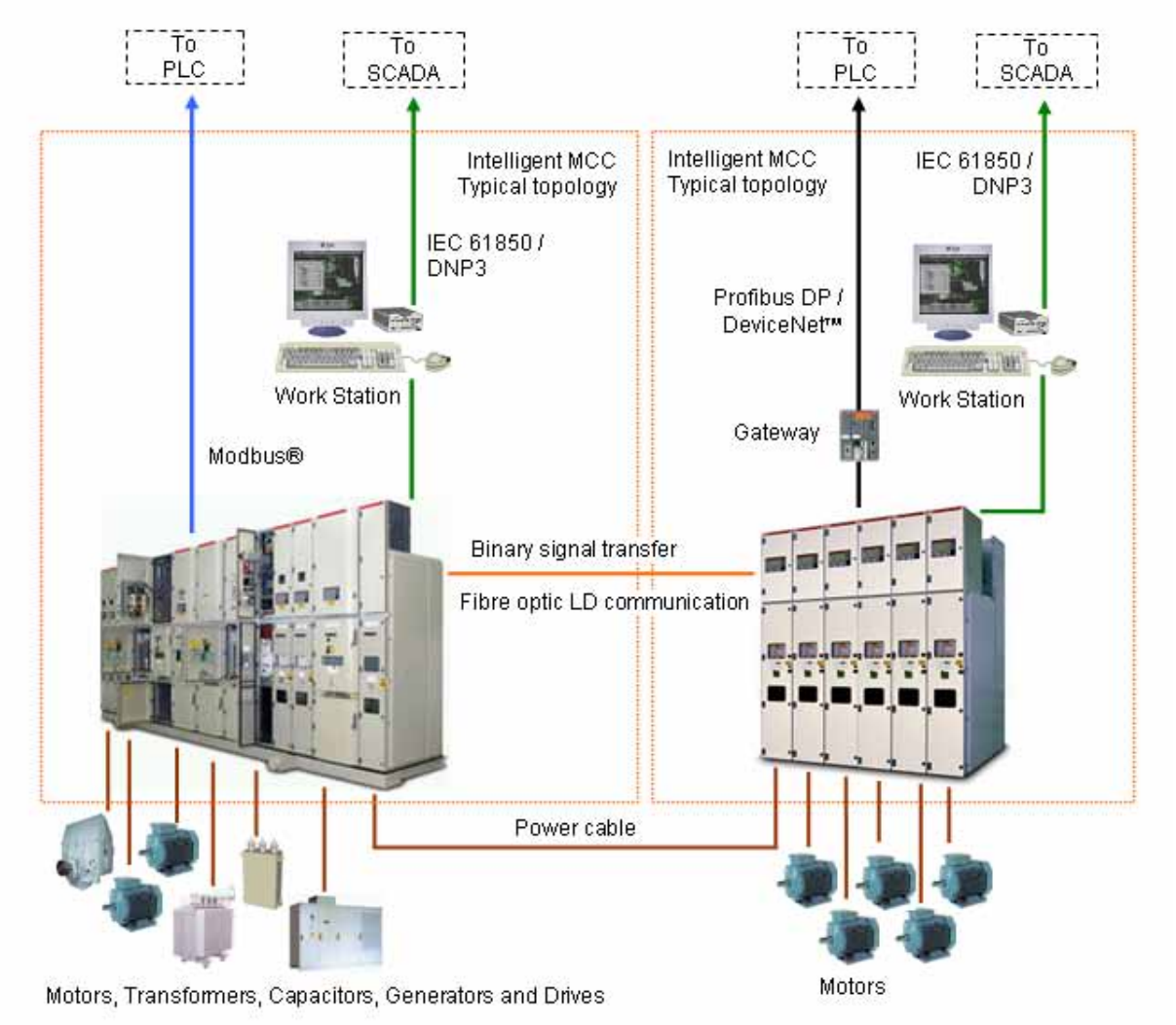
Architecture for Process Automation Plant

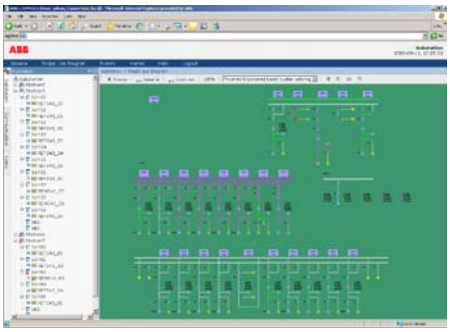


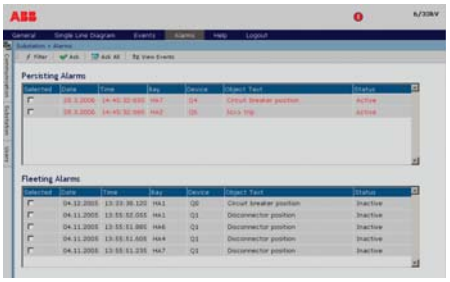
Architecture for Process Manufacturing Plant

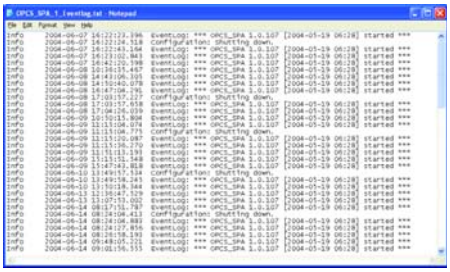


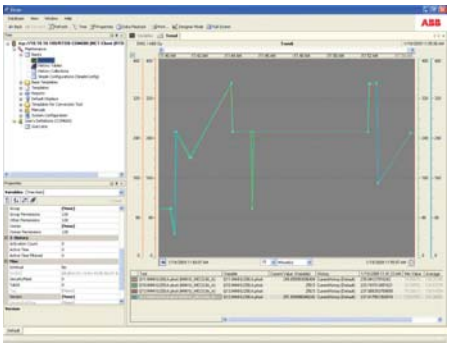
Architecture for Hybrid Process Plant











Work Station

The work station can be used as ESW or OWS, and is capable of sending and receiving data from all of the intelligent electronic devices. The interface between the workstation and intelligent electronic devices is based on serial digital communication links. Typically work station resides in the substation and typical features include but not limited to the following:

- Graphical displays of the status of the substation medium voltage distribution and motor control centres network. This will be a dynamic single line display where selection of individual items will enable a detailed display of those items.
- Visual displays of the status of all IEDs.
- Individual parameterisation, control and monitor configuration of all intelligent electronic devices.
- Trending of analogue type data for distribution circuits and motors.
- Power quality measurement and analysis of events recording.
- Four level role based user authentication password to protect from unauthorized access and maintain integrity of process information.
- Multi-lingual support

The work station provides a graphical interface for operation of the medium voltage distribution and motor control centres network, all commands, status and fault monitoring is through the serial links. These alarms and indications are presented on the workstation as a part of the graphical (e.g. single line) displays. Alarm and event logging are available for all status, alarm and fault signals at the work station as a sequence of event recorder. The resolution ≤ 1 ms, but alarms received through serial links are time stamped. Information gathered includes:

Status Information

- Open
- Close
- Run
- Stop
- Locked out
- Trip

Protection Information

- Overload
- Short circuit
- Earth fault

Measurement Information

- Current
- Voltage (per group bus bar)
- Power (per group bus bar)
- Power factor (per group bus bar)
- Frequency (per group bus bar)

Intelligent Electronic Devices (IED)

IEDs are microprocessor based devices created for protection, measurement, control, supervision and communication. It receives data from sensors, provide analysis and can issue control commands. Standard types of IEDs are available but not limited to the following.

IED Types	
Motor	REM615
Feeder and Drives	REF615
Transformer	RET615
Line	RED615
Gateway	AC500
Work Station	COM600

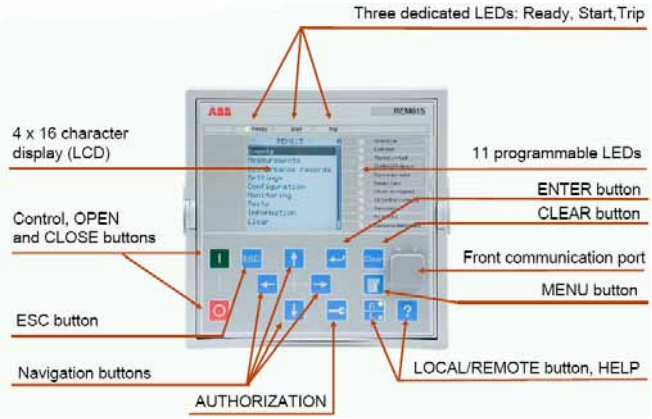
IED hardware comprises:

- HMI – Fitted on low voltage compartment door
- Base Unit – Fitted on standard IED drawout casing
- Case – Fitted on low voltage compartment door

Alternatively, IED hardware can be fitted on separate protection control panel.

Human Machine Interface (HMI)

The HMI LCD display shows operating conditions, measured values and alarms/trips of the previously selected. It can be used for local control and parameterisation. LCD displays offer full front-panel user interface functionality with menu navigation and menu views.



Base Unit

The base unit in drawout case provides the control, protection, measurement, supervision, time synchronisation and communication hardware. Both vertical and horizontal (peer-to-peer) communication is available with use of IEC 61850 protocol. Two independent / different serial communication protocols are possible. It has a sealable pull-out handle is to prevent unauthorised withdrawal of the drawout base unit.

Control
Contactor (CB) control with interlocking
Contactor (CB) position indication
Remote Isolation control with interlocking
Isolated position indication
Earthing switch indication
Auto-reclosing
Emergency start-up

Measurement
Disturbance recorder
3ph current
Current sequence components
Residual current
3ph voltage
Voltage sequence components
Residual voltage
3ph power and energy, power factor

Supervision
Contactor (CB) condition monitoring
Trip circuit supervision
Current circuit supervision
Fuse failure supervision
Motor runtime counter

Time synchronisation possibilities include:

Time synchronization
SNTP
IRIG-B

Serial communication possibilities include:

Communication
IEC 61850
DNP3
Ethernet
OPC
Modbus®
Profibus DP
DeviceNet™

Protections possibilities include:

Motor Protection	
Thermal overload protection	49M
Motor start-up supervision	49,66,48,51LR
Negative-sequence overcurrent	46M
Directional earth-fault protection	67N
Non-directional earth fault protection	51N
Motor load jam	51LR
Non-directional overcurrent	50P/51P
Loss of load supervision	37
Phase reversal	46R
Three-phase undervoltage	27
Positive-sequence undervoltage	47U+
Negative-sequence overvoltage	47O-
Differential[1]	87M
Contactor (CB) failure	51BF/51NBF
Master trip	94/86
Arc protection with three sensors	50L/50NL
Bearing-Stator-Ambient temperature, RTD[2]	38/49

[1] Add on module. Refer Appendix 2.
[2] Add on module.

Feeder and Drives Protection	
Non-directional overcurrent	50P/51P
Directional overcurrent	67
Directional earth-fault, (SEF)	67N
Non-directional earth-fault	51N
Transient/intermittent earth-fault	67N-IEF
Non-directional earth-fault, (SEF)	51N
Non-directional earth-fault	50N/51N
Negative-sequence overcurrent	46
Phase discontinuity	46PD
Thermal overload	49F
Contactor (CB) failure	51BF/51NBF
Three-phase overvoltage	59-1
Positive sequence undervoltage	47U+
Negative sequence overvoltage	47O-
Residual overvoltage	59G
Three-phase undervoltage	27
Three-phase inrush current detection	68
Master trip	94/86
Arc protection with three sensors	50L/50NL

Transformer Protection	
Transformer differential	87T
Low impedance restricted earth-fault	87NL
High impedance restricted earth-fault	87NH
Master trip	94/86
HV-side protection	
Non-directional overcurrent	50P/51P
Non-directional earth-fault	51N
Negative-sequence overcurrent	46
Thermal overload	49T
Contactor (CB) failure	51BF/51NBF
LV-side protection	
Non-directional overcurrent	50P/51P
Non-directional earth-fault	51N
Negative-sequence overcurrent	46
Arc protection with three sensors	50L/50NL

Line Protection	
Line differential	87L
Non-directional overcurrent	50P/51P
Non-directional earth-fault, (SEF)	50N/51N
Directional earth-fault, (SEF)	67N
Transient / intermittent earth-fault	67NIEF
Non-directional earth fault	51N
Negative-sequence overcurrent	46
Phase discontinuity protection	46PD
Thermal protection	49F
Binary signal transfer	BST
Contactor (CB) failure	51BF/51NBF
Three-phase inrush detector	68
Master trip	94/86

Busbar Protection	
Bus zone differential[1]	87B
Master trip	94/86

[1] IEC 61850 GOOSE communication. Refer Appendix 3.

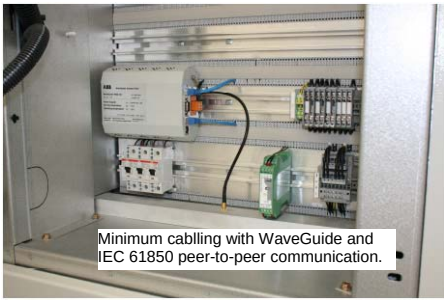
Case

The case with drawout facility provides “hot swap” base unit. It has a built in configurable mechanical coding system for preventing insertion of a wrong base unit in a case.

Wireless LAN technology

WaveGuide is a wireless, reliable, fast (no delay), multi-channel (24 channels, 56Mbit/s each) and ageing resistant transmission technology. It is a closed-system with low power broadband communication in hollow conductors. With the hollow conductor, the radio signals are optimally protected from external interference and vice versa – the environment is protected from the radio signals. Between panels, the small gaps between the hollow conductor are hermetically sealed with sleeves so that no contamination from outside can enter the conductor.

Commonly internal communication links are loop from switchboard panel to panel – irrespective of whether serial or binary signals are to be transmitted. Depending on installation size, complexity of the interlock system and the operator’s need for control functions and information, this can involve over 60 individual cable cores. Adding or changing signals in the loop cables immediately means complex rewiring and high costs.



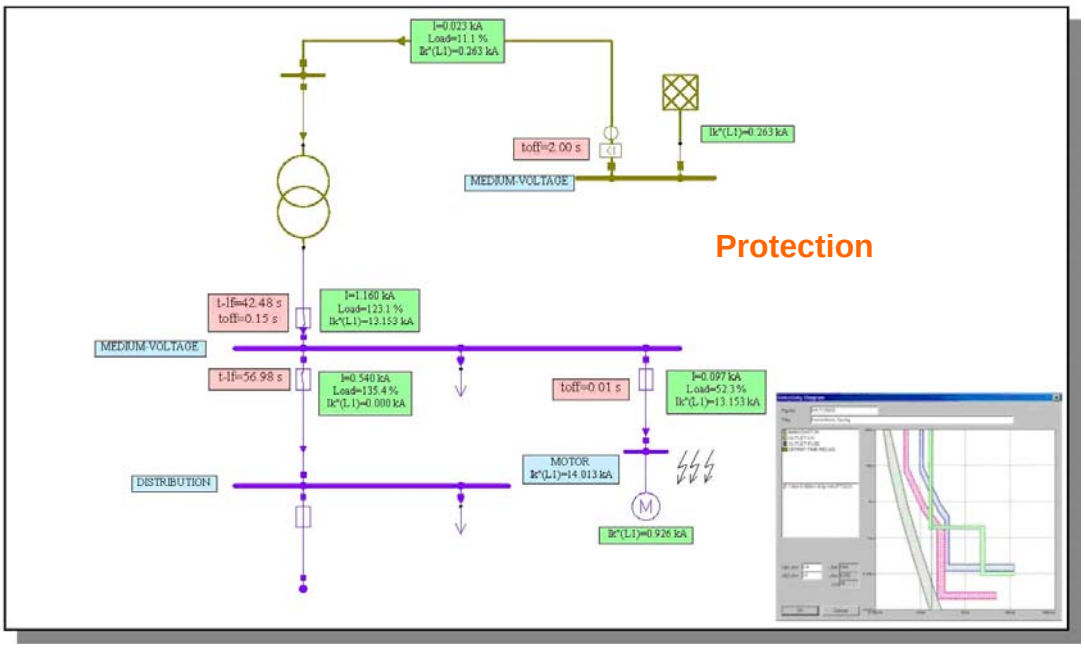
Minimum cablling with WaveGuide and IEC 61850 peer-to-peer communication.

Only the use of high speed serial communications techniques can reduce the number of loop cables. With WaveGuide IEC 61850 transmission method the control and status signals, and measured values are transmitted serially to the relevant IEDs in both vertical and horizontal communication (peer-to-peer).

A Partnership for Success

In addition to normal MCC applications, we are in position to have our experts team up with your staff to develop technically and economically optimised solutions. NEPLAN® (formerly known as Calpos) is our advanced software system which we use for analysing electrical networks. Professional studies that can be performed by UniGear ZVC centre of excellence includes, but not limited to:

- Short-circuit current calculation
- Protection system design and selectivity analysis



OneFuse

This is a methodology where one HRC fuse size is compatible for different load applications and ratings when used in an Intelligent MCC and switchgear system. It utilises “Fuse Rationalisation” scheme to eliminate unnecessary complications of having multiple fuse ratings and load matching characteristics. This provides design flexibility with wide load list operating range and eliminates calculation of fuse sizing. Please check with ABB on approved OneFuse manufacturers.

In a motor control centre it is common to find additional fused contactors included in the line-up as transformer and capacitor feeders. Traditionally fuse ratings are specified in accordance to different load characteristics. It is also normal to find motor starting duty HRC fuses in transformer and capacitor feeders. When fused contactor is used as non-motor starter feeder, protection relay is retained to monitor overload and earth fault conditions and the contactor still performs the task of switching. HRC fuse remains the sole interrupter for short circuit currents. It is clear that the fuse selected to protect motor starter will offer the same protection when the contactor is applied as a transformer or capacitor feeder. In addition, fuse blown trip contact can be used as back-up protection for relay.

Eliminate risk of engineering miscalculation	✓
No fuse sizing necessary	✓
Allows MCC design without final load list	✓
One standard spare part	✓

OneFuse example below recommends HRC fuse 315A for complete MCC switchboard. Fuse selection criteria is fault current.

Fuse selection and rationalisation for a typical 6.6kV project

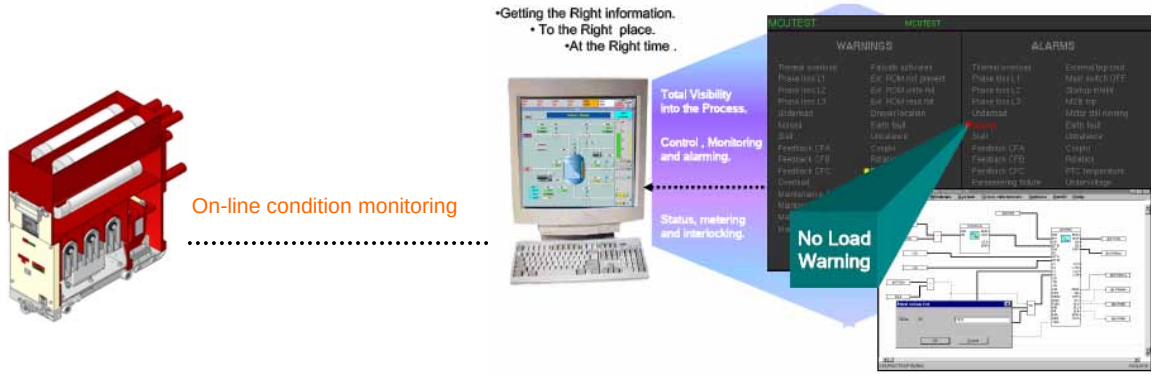
Requirements of load					Selection based on load		Rationalization		
Device	Full load current	Starting current	Run up time	Starts per hour	First selection	Starts per hour	Second selection	Starts per hour	Remarks
Motor	267A	1300A	15s	3	400 (2x225)	6-8	2x250	8-12	Parallel fuses
Motor	209A	1000A	15s	3	315	4-6	315	4-6	
Motor	165A	960A	6s	4	225	3-4	250	6-10	
Motor	68A	400A	6s	8	100	2-3	125	8-10	
Motor	45A	270A	6s	8	63	2	125	32	
Transformer	209A	209A	-	2	315	2	315	2	

Contactor Condition Monitoring

Process availability and the life cycle of MCC switchgear can be increased with use of integrated condition monitoring. Intelligent UniGear ZVC switchgear system can be equipped with self-diagnosis features. Alarms are generated for pending issues or for scheduling maintenance. Local and remote serial communications are available.

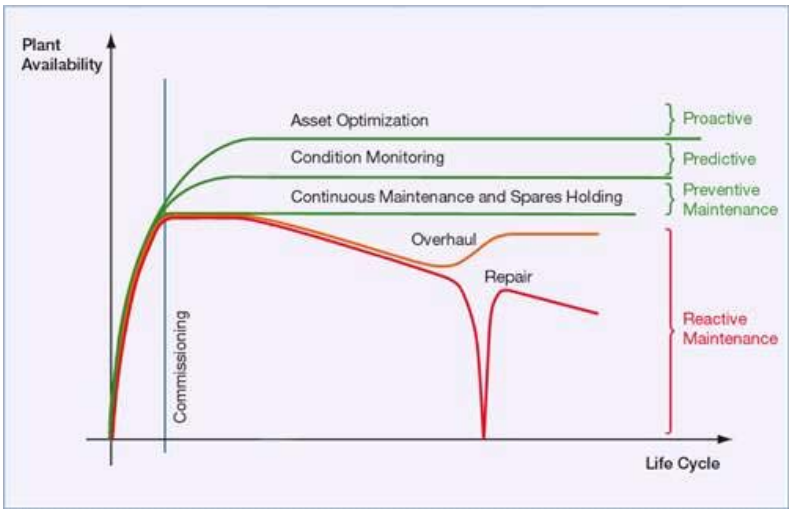
Open Circuit Current Transformer Protection

UniGear ZVC Intelligent Switchgear System has an integrated protection against the danger of high voltage created by open circuiting current transformer secondary. The IED includes open circuit current transformer supervision feature. Current circuit supervision is used for detecting faults in the current transformer secondary circuits. On detecting of a fault the current circuit supervision function activates an alarm LED, blocks certain protection functions to avoid unintended operation and provide remote alarms for servicing. The current circuit supervision function calculates the sum of the phase currents from the protection cores and compares the sum with the measured single reference current from a core balance current transformer.



Condition Monitoring

Continuous health check	Status		Decision making
Contactor trip circuit	✓	⚠	Do not energise. Automatic block command.
Essential control circuit	✓	⚠	Problem with control and protection circuit.
HRC Protection Fuse failure	✓	⚠	Fuse blown fails to trip. Striker fails. Replace fuse.
Contactor wear and tear (ops.)	✓	⚠	Plan maintenance on contactor.
Contactor travel time	✓	⚠	Plan maintenance on contactor.
Motor runtime counter	✓	⚠	Plan maintenance on electric motors.



Motor voltage dip ride through

Short duration voltage dips are the most common power disturbance. In industrial plants, it is not unusual to see several voltage dips per year. Voltage dips are caused by abrupt increases in loads such as short circuits or faults, motors starting, etc. In some processes, it is vital to maintain motor speed and torque during the brief supply disturbance.

UniGear ZVC switchgear system can be equipped with motor voltage dip ride through facility to reduce interruptions in process due to momentary power swing. A ride through facility can prevent electrically latch contactor from opening during short time voltage loss. The ride through facility has the following setting:

- Voltage dip level
- Time for voltage dip ride through
- Healthy Reset / Open contactor

Contactors should not rely on mechanical latch mechanism or external power source to accomplish the motor voltage dip ride through.

Motor automatic restart facility

Power interruption can cause extensive damage in industrial plants where continuity of supply is vital to its process. Motors should be restarted immediately or in stages after power failure to limit production losses and damage. Even brief power cut to processes can give rise to longer machine shutdown or reset time.

UniGear ZVC switchgear system can be equipped with motor automatic restart facility to reduce stoppages in process due to power failure. An automatic restart facility is able restart the motor after power failure. The automatic restart facility has the following settings:

- Voltage dip level
- Voltage restoration level
- Time for immediate restart after voltage dips
- Time for delayed restart after voltage dips with steps

Self Power System

UniGear ZVC intelligent MCC and switchgear system can be integrated with a sophisticated DC & AC auxiliary power system for internal control supply.

The DC power add-on extendible cubicle generally comprises of batteries and rectifier connected to the DC distribution bus, functioning as parallel sources of power for the connected loads. Status and alarm signals to control system are with serial communication and free contacts.

The rectifier in addition to charging the batteries carries the normal continuous load of the application. Mains input connection can be single phase of three phases depending on load. Battery output (DC), capacity (Ah) and autonomy time (hrs) is designed to suit MCC application.

The AC power add-on extendible cubicle generally comprises of HV protection fuses, control power transformers and its secondary terminals connected to the AC distribution board. Status and alarm signals to control system are with serial communication and free contacts.

The supply transformers are used for control and anti-condensation heater supply, in addition to charging the battery rectifier. Mains input connections are three phases (3…17.5kV) depending on network voltage. AC output capacity is designed to suit MCC application. Changeover switch for external redundant supply is available on request.

Measures to interrupt Low Voltage Arc Fault

It is not unusual to find electrical fires set off by low voltage arc fault inside control compartment. Low voltage arc faults can be caused by worn electrical insulation or damaged wire, misapplied or damaged appliance cords and equipment, loose electrical connections, wet connections or conduit, wires or cords in contact with vibrating metal, overheated or stressed electrical cords and wires, or flashover due to bolt inadvertently close to uninsulated wire strands.

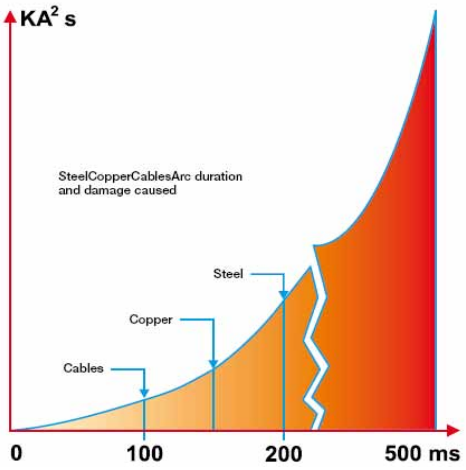
UniGear ZVC can be fitted with Arc Fault Circuit Interrupter to protect against electrical fires by detecting arc fault among secondary wiring in low voltage compartment and disconnect power before the arc starts a fire. The advanced electronics detect sudden bursts of electrical current and interrupts in milliseconds.

Arc Fault Circuit Interrupter offers the following benefits:

- Provide additional protection to operators from low voltage arc flash
- Prevent switchboard being damaged from electrical fire.

Arc Terminator System

Why invest heavily in MCC switchgear when a high voltage arc fault can destroy it completely. Like your car insurance, would not it be wise to spend additional 10% to make your MCC switchgear usable after arc fault? Your continuous process output revenue definitely is worth the payback. UniGear ZVC switchgear system can be fitted with an extremely fast acting switch, able to ground all phases within 5 ms from the instant of receiving confirmation of arc occurrence in the MCC. Arc requires a voltage of at least some 100 V in order to persist. After the contacts are closed the voltage drops suddenly to a value of which the arc cannot persist.

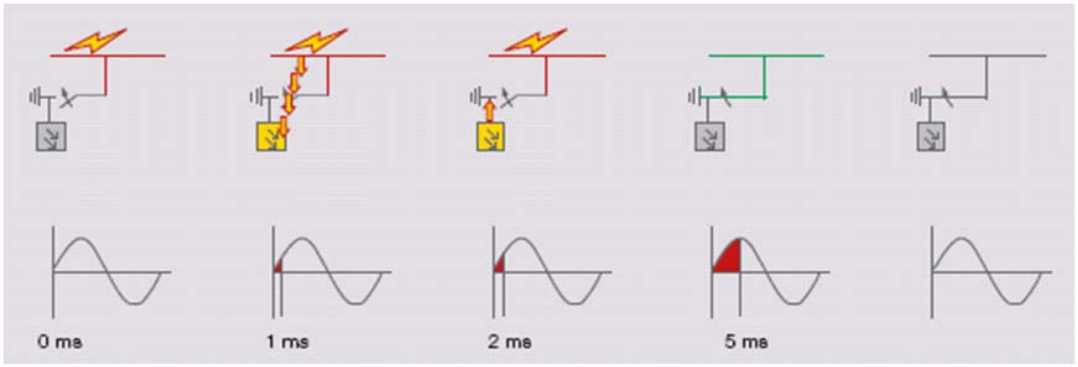


The very fast operation means not only that the thermal damage by the extreme heat of the arc is totally omitted, but also that the pressure increase due to heating of the air is drastically reduced. A conventional arc light detector and current check mechanism triggers the operation. After an operation recharging is done electrically, the switchgear is ready to power up your process in less than 1 hour.

An open arc in switchgear is a severe event, normally destroying the equipment totally.

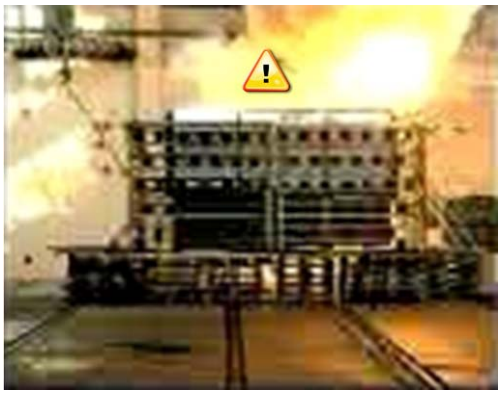
Arc Terminator System offers value to your process:

- Reduce arc flash to the minimum. Investment payback from guaranteed operator safety, limits arcing flash in explosive installations and in confined switchrooms such as container substations.
- Very short time for the switchgear to be taken back into service again after an arc fault. This gives important savings in repair costs and production down time.
- Due to the limitation in pressure increase, no external pressure relief system is necessary, which simplifies the arc blast design and reduces the total cost for buildings.

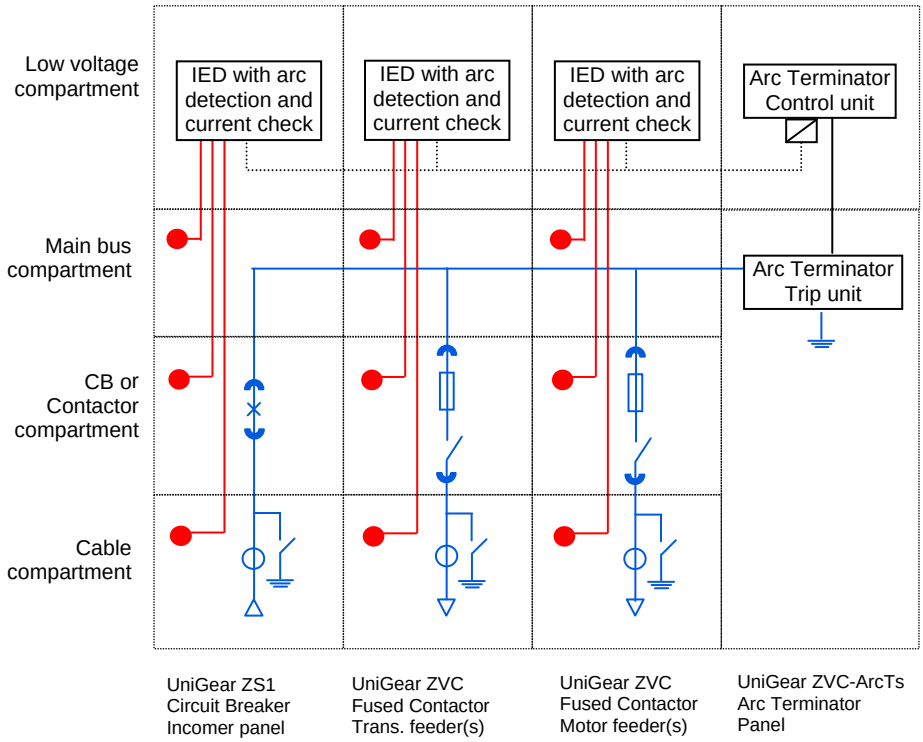


Comparison with and without Arc Termination System – 40kA internal arc fault test without arc duct

Internal Arc Fault with Arc Termination System



Internal Arc Fault without Arc Termination System

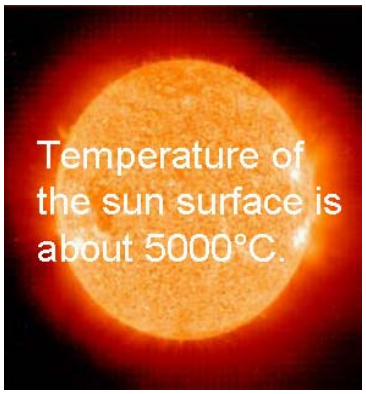


Flameproof Enclosure to Zone 1 and 2 (Exd to IEC 60079-1)

Reduce arc energy by 90% – Arc Terminator System significantly lowers construction and type testing cost of flameproof enclosure commonly used in underground mining, sewage, chemical, oil and gas plants.

Arc fault is the most catastrophic event that can occur in electrical flameproof enclosure and switchgear. When arc fault occurs, thermal energy up to five times the surface temperature of the sun (20,000°C) is released – ignoring energy contribution from combustion of hazardous gasses.

The temperature heats up and expands the air in the enclosure. Pressure inside the enclosure increases and can exceed the explosion pressure determined in flameproof testing. If the overpressure is not contained, the enclosure will fail catastrophically; expel hot gases and particles into the surrounding atmosphere.



Amount of arc energy released is dependent on the duration of bolted fault before upstream protection system clears the fault. For extended fault durations, it is difficult to construct flameproof enclosure with sufficient mechanical strength to contain the pressure generated by a fault in the enclosure.

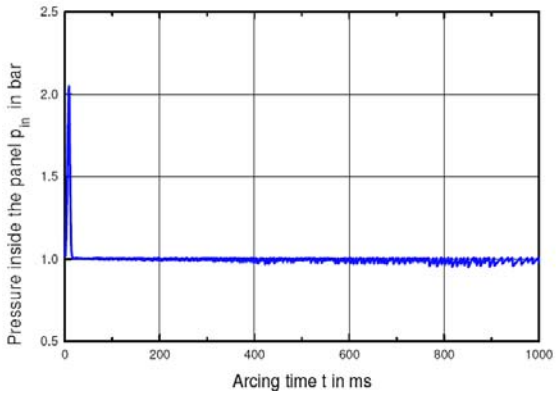
UniGear ZVC Switchgear System centre of excellence in Sydney Australia has the engineering capability to provide arc fault overpressure calculations to assist flameproof enclosure design and construction

Recommendations to minimise thermal and overpressure:

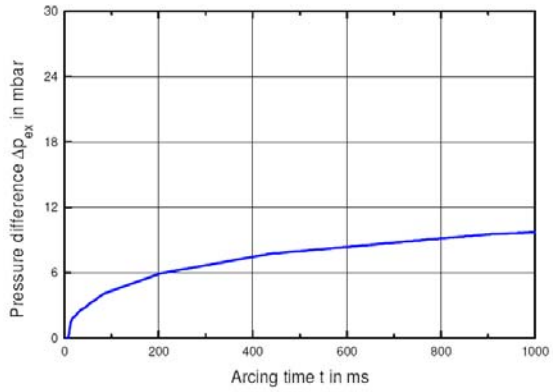
- Use of fast acting (~5ms) Arc Termination System to limit arc energy
- Use of fast acting (~5ms) HRC current limiting fuses to limit arc energy

UniGear ZVC Switchgear System centre of excellence in Sydney Australia has the engineering capability to provide arc fault overpressure calculations to assist flameproof enclosure design and construction.

Overpressure discharged by switchgear



Overpressure seen by Flameproof enclosure



Type Testing and Certification

UniGear ZVC has successfully passed the tests required by international (IEC), Australian Standards and various local Standards (for example the Chinese GB). 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.

In accordance with IEC 62271-200 the Unigear ZVC complies with partition class PM, loss of service continuity category LSC2A and internal arc classification AFL or AFLR when a gas duct is fitted.

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
- Partial discharge
- 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 then 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. Furthermore, they are also subjected to the opening and closing of capacitive and inductive loads, capacitor banks and cable lines.

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.

Partial discharge
The measurements of partial discharge to defect solid material insulation strength are a useful complement to the dielectric test.

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...1s)
- 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.

Type tests required by the shipping registers
- High ambient temperatures
- Inclination
- Vibration
- Seismic

High ambient temperatures
The service conditions of the electrical apparatus in shipping installations are generally more severe than those in normal land applications.

The temperature is certainly one of these factors and for this reason the shipping register regulations require the switchgear to be able to operate at higher ambient temperatures (45 °C, but even higher) than those foreseen in the IEC Standards (40 °C).

Inclination
The test is carried out by inclining the switchgear for a defined time up to 25° alternatively on all four sides and operating the fused contactor.

The test proves that the switchgear is able to resist these extreme service conditions and that all the apparatus it contains can be operated without any problems and without being damaged.

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.

Vibration

The reliability and sturdiness of the UniGear ZVC switchgear has been definitively proven by the result of the withstand test to mechanical stresses due to vibration. The service conditions on shipping installations and marine platforms require the switchgear to work in environments strongly affected by vibrations, such as those caused by the operating motors on board large cruise ships or on the drilling plants of oil rigs. The switchgear has undergone the vibration test with a frequency band from 2 to 100 Hz and with the following motion with:

- 1 mm amplitude in the frequency range between 2 and 13.2 Hz.
- 0.7 g acceleration amplitude in the frequency range between 13.2 and 100 Hz.

Seismic

The toughness of the UniGear ZVC is evidenced by the result of the withstand test to mechanical stress due to earthquake forces.

Routine factory tests:

- Mechanical sequence operations
- Circuitry check
- Electrical sequence operations
- Insulation test
- Measurement of the resistance of the main circuits
- Confirmation of operating limits

Certificate of conformity:

- ISO 9001:2008
- ISO 14001:2008
- Shell DEP (33.67.51.31-Gen)
- Saudi Aramco (Plant ID:30004796)
- Kuwait National Petroleum Co. (Vendor ID: 117009)
- Lloyd's shipping register (05/00042)
- GOST R (single shipment certificate)
- CNNC Nuclear power plant approval

Arc Flash Protection and Remote HV Isolation

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^2 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 40kA at 6.6kV without any form of arc fault mitigation.

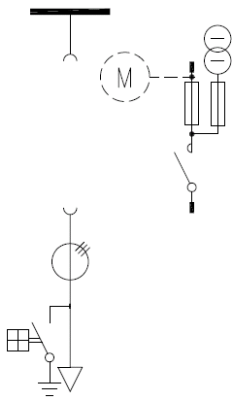
Switchgear panels that are type tested according to IEC 62271-200 (Annex A, criteria 1 to 5) should negate Arc Flash requirement unless work is to be done with switchgear door or covers open, safety device interlock defeated, forced operation, a situation which invariably would according to IEEE not be allowable for live work for this level.

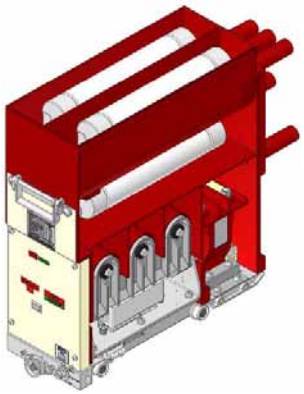
What happens when things go wrong? Events such as modifications of type tested panels outside of manufacturers design tolerance during operational life and poor maintenance by non accredited service technicians are real life occurrences. This of course necessitates the requirement of adequate Arc Flash 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.

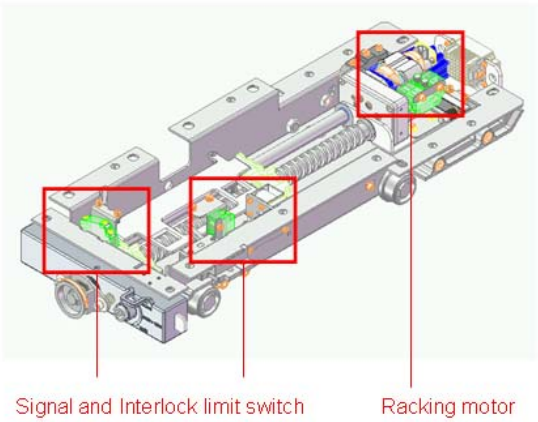
Remote Motorised HV Isolation

Arc Flash protection offered by the UniGear ZVC panel construction should be sufficient for Category 0 PPE as defined in the IEEE for areas accessible to authorised personnel, and is maintained (with doors closed, covers intact) with similar condition to the type test. The remote motorised HV isolation feature reduces operator risk of being exposed to Arc Flash incident by working outside the arc flash boundary.

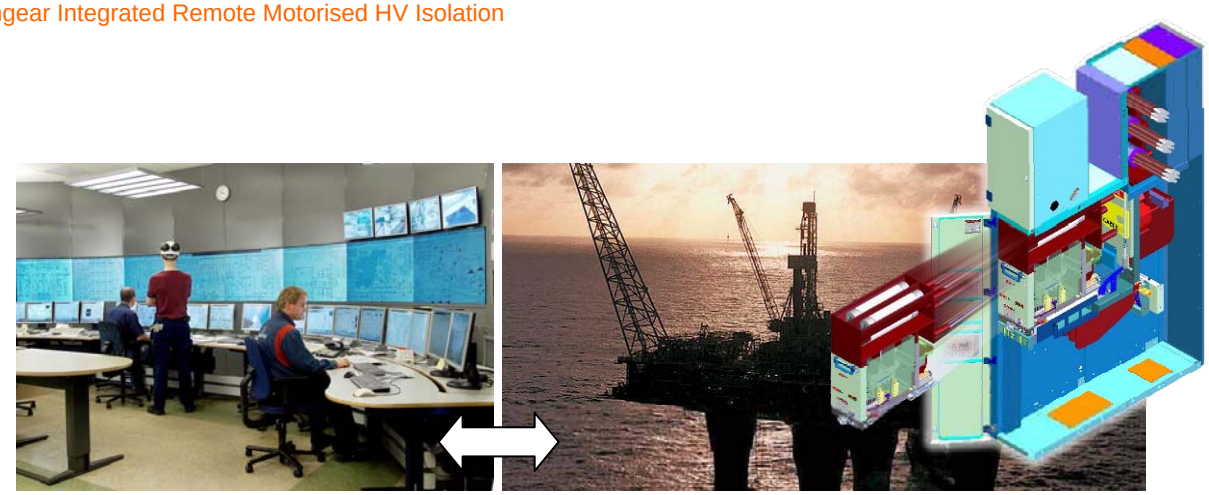
The motor drive should be type tested for long operation life up to 10000 cycles, permits emergency manual isolation in event of loss power supply, do not defeat built-in switchgear panel safety control interlocks, integrated in withdrawable truck, and not as an after-market hardware.







Switchgear Integrated Remote Motorised HV Isolation



Control room operates remote motorised HV isolation. Common applications: remote and unmanned plants.

Non-Integrated after-market motorised HV Isolation hardware

Operator in PPE4 “moonsuit”.

After-market tools

Arc Flash

Duty of Care to Operators

The foremost consensus standard on electrical safety is the US NFPA 70E “Standard for Electrical Safety Requirements for Employee Workplaces”.

In this standard, it clearly states that workers should not work on or be near exposed live parts except for two reasons, as stated in NFPA 70E-2000 Part II 2-1.1.1):

- When de-energizing introduces additional or increased hazards (such as cutting ventilation to a hazardous location)
- When equipment design or operational limitations (such as when voltage testing is required for diagnostics) make it otherwise difficult.

In the US, non-adherence to these regulations and practices is considered a violation of law and is punishable by a fine and/or imprisonment.

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.

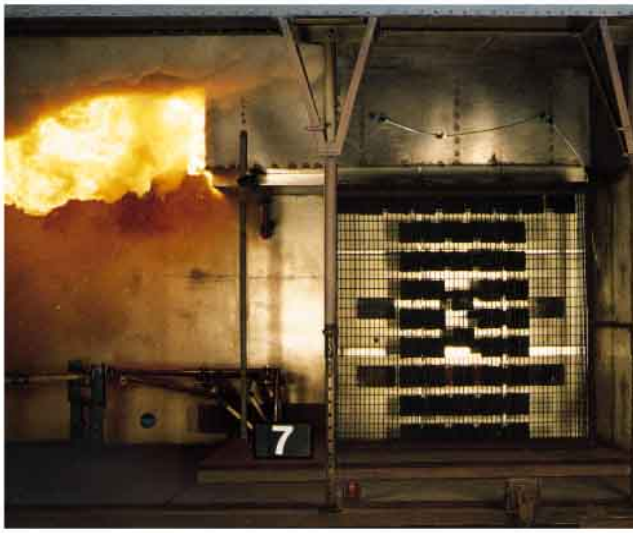
High fault levels and questionable operating techniques are a DANGEROUS MIX, a waiting time bomb. Can you gamble with safety of operators and plant? Without all the safety requirements being legislated you may regret the outcome.

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

1. 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.
2. 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.
3. Arc flash relief system. All blocks are equipped with separate overpressure vents, common arc resistance duct (plenum) and outdoor 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, 1s 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
7	Use arc killer (Arc Terminator)
8	Use PPE

The centre of excellent team in Australia can provide calculated incident energy, arc flash boundary and PPE requirements on UniGear ZVC switchboard, following the NFPA 70E and IEEE 1584 standards. The above studies are performed using SKM software.

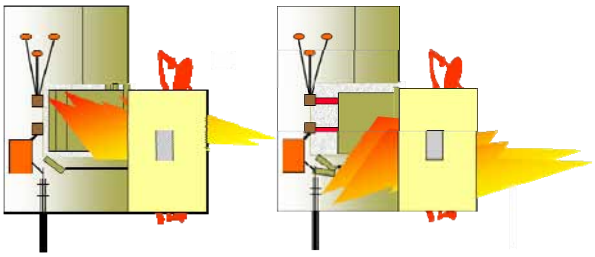
Safety comes with a cost.
Negligence is even more costly.

1 – Stay out of harms way

With UniGear ZVC switchgear system, protection against Arc Flash is maintained because it does not require the operator to interface with the equipment whilst the front door is open. All compartment doors are closed during the following dangerous operating conditions:

- Whilst withdrawing the moving portion from service to isolated position.
- Whilst switching the device OPEN or CLOSED.
- Whilst applying or removing the integral earthing switch.
- Interlocks are also provided between switching device and earthing switch to prevent mal-operation.

With your switchgear are Compartment Doors required to be open for isolation or insertion procedures, what if something is not quite right?



If your switchgear necessitates being operated with compartment doors open, you cannot rely on being protected by pressure relief vents, they won't operate. With UniGear ZVC switchgear system, we are with you all the way!

Maximum Operator Safety at all times:

- *Remote* Switching and Isolation of HV equipment in central control room (Outside of arc flash boundary).
- *Local* Switching and Isolation performed behind closed doors (Doors act as arc proof barrier).

With your switchgear are Compartment Doors required to be open for earthing procedures, what if something is not quite right?

Example to illustrate importance of all switchgear operations behind type tested closed doors and Remote HV Isolation to operator safety and the follow on benefit of minimum disruption to critical continuous process. Process disruption costs millions of dollars and more in duty of care / human negligence legal cases.

Possible scenario #1

1. One switchgear panel was in service and maintenance mode.
2. Circuit breaker "Trip / Open" coil did not open when remotely activated either due to burned coil or failure in DC battery power system.
3. Operator has to manually "Trip / Open" the circuit breaker.
4. The manual "Trip / Open" mechanism was located on the circuit breaker truck.
5. The circuit breaker compartment door was opened to access the manual mechanism.
6. Operator manually pressed the push button.
7. Arc flash occurred.
8. You can prevent this at the beginning with correct specification. Make sure all switchgear operations must be behind closed arc proof door. Pressure relief, gas duct and arc detection are not effective when power doors are open.

Possible scenario #2

1. One switchgear panel was in service and maintenance mode.
2. Operator has to manually rack out and "Isolate" the circuit breaker.
3. Racking out was only possible when circuit breaker compartment door is open.
4. The circuit breaker compartment door was opened to access breaker truck.
5. Arc flash occurred when operator was racking out the breaker.
6. You can prevent this at the beginning with correct specification. Make sure all switchgear operations must be behind closed arc proof door. Pressure relief, gas duct and arc detection are not effective when power doors are open.

Almost always it's more important to be SAFE, than to cut costs.

2 – Contain arc flash to that zone

With UniGear ZVC switchgear system, protection against Arc Flash propagation is maintained because all compartments are block segregated and can contain generated arc energy to respective zone.

The four zones/blocks are:

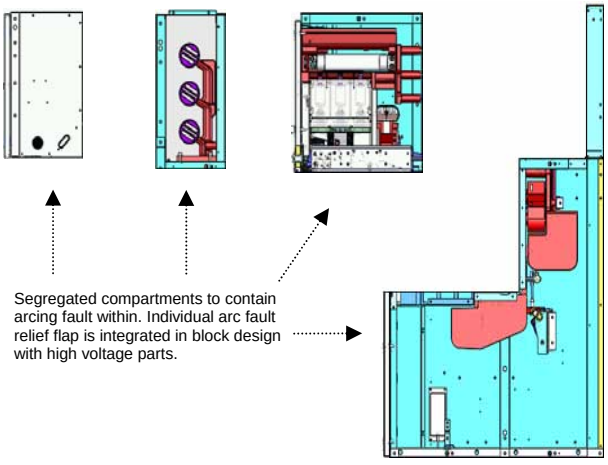
- Main bus compartment.
- Fused contactor compartment.
- Power cable compartment.
- Low voltage compartment.

With an switchgear are the Compartments segregated to contain an arc flash incident, what if something is not quite right? Are the compartments type tested for arc flash energy, what kCal /cm^2?

If your switchgear is of metal-enclosed design or non-segregated construction then an arc flash occurrence can propagate within the housing, you cannot rely on being protected by pressure relief vents, they won't operate. With UniGear ZVC switchgear system, we are with you all the way!

Maximum Operator Safety at all times:

- Metal-clad block design to contain arc flash.
- Complete segregation between compartments with individual pressure relief vent.



3 – Divert arc flash away to "REALLY" safe area

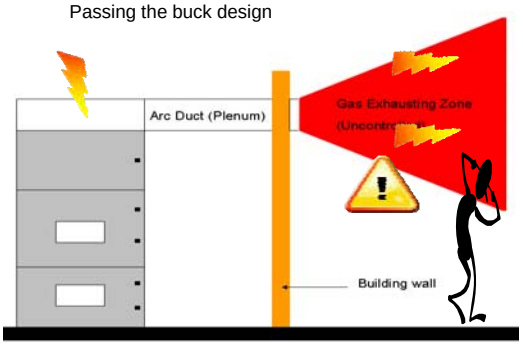
Arc flash relief system can have a significant safety and financial impact on your business. We understand that safety is the number one priority and arc flash relief system is a specialised field. Our expertise and experience in this field will ensure safe operating limits of your process.

Arc flash energy must be controlled and its hazardous materials contained to ensure safety of operators and equipment. Hazardous materials generated by arc flash are shock waves, hot gasses and burning particles. Therefore correctly designed and installed arc flash relief systems are critical to business performance – plant safety and production availability.

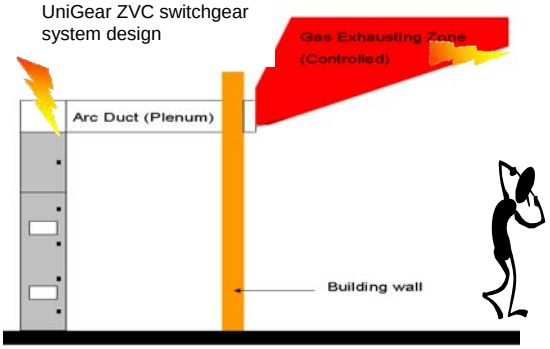
UniGear ZVC standard type tested relief system provides a satisfactory method to deal with arc flash. Sometimes real situations are too complex for the standard method and in these situations calculation modelling can provide valuable insights into the behaviour of the relief system.

UniGear ZVC switchgear system employs a sophisticated relief device design where arcing flash is diverted upwards away from operator, walkway, transformer, other equipment or surrounding building.

Passing the buck design



UniGear ZVC switchgear system design



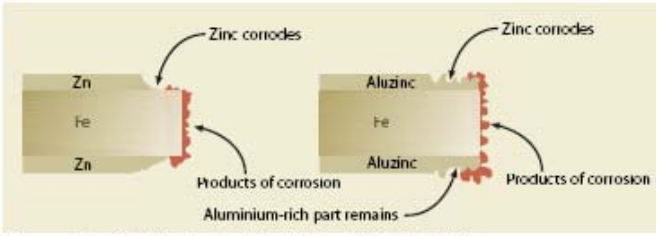
Marine and Corrosive Environment

UniGear ZVC steel structure is made of type AluZinc sheet metal suitable for severe marine and corrosive environment installation. AluZinc is a metal-coated sheet steel that combines the best properties of steel, aluminium and zinc. Steel provides strength, aluminium gives protection from corrosion, and zinc safe-guards the steel at edges and scratches by virtue of its cathodic action.

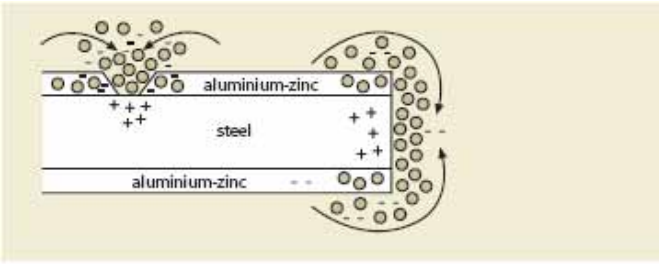
Cathodic Protection

AluZinc provides cathodic protection for the steel at cut edges and scratches. This form of protection comes into operation when the sheet is exposed to moisture and a galvanic cell is formed. The steel will then function as the anode, with the moisture acting as the electrolyte.

Since the zinc serves as a sacrificial anode it will be consumed. The rate of consumption will rise with any increase in the area of steel that has to be protected. The aluminium rich part in the metal coating protects the steel as the zinc is sacrificed. There is no enlargement of the area of the steel to be protected.



Edge corrosion of hot-dip galvanized steel (left) and of Aluzinc (right).



Example of galvanic corrosion at a damaged area of the coating and at the cut edge.

Extremely long useful life

The corrosion rate, i.e. the thickness of the coating that is lost every year in a normal environment to which AluZinc is freely exposed, is a maximum of 20% of one micron (0.2 µm). In theory the useful life of AluZinc in a normal environment is more than 100 years. In real life AluZinc has lasted more than 20 years in severe marine environment.

Protection against mechanical damage

AluZinc can be scratched and damaged mechanically, but it will still retain its good resistance to corrosion, its long useful life and its attractive surface.

The surface retains its appearance

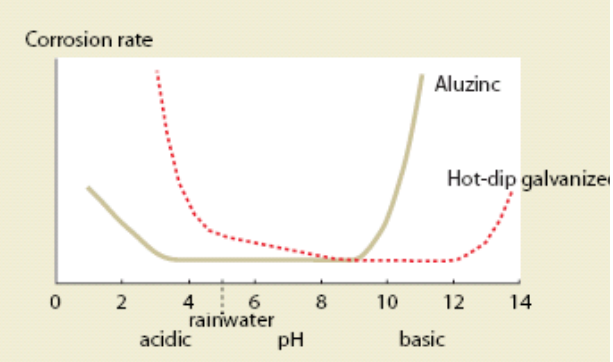
Since 80 percent of the volume of the coating is aluminium, the surface will retain its appearance for many years, dulling off slowly, depending on atmospheric contaminants.

Hard surface

The surface of AluZinc is twice as hard as that of hotdip galvanized steel. The hard surface has high wear resistance, which increases the life length.

AluZinc versus hot-dip galvanized steel

Corrosion of AluZinc is 3-7 times lower than that of hot-dip galvanized steel.



Seismic and Vibration Environment

UniGear platform family members, ZVC and ZS1, are the world's leading medium voltage MCC and switchgear. Possibly the only one able to withstand the component-crunching effects of earthquakes and the endless grind of vibrations commonly found in ships.

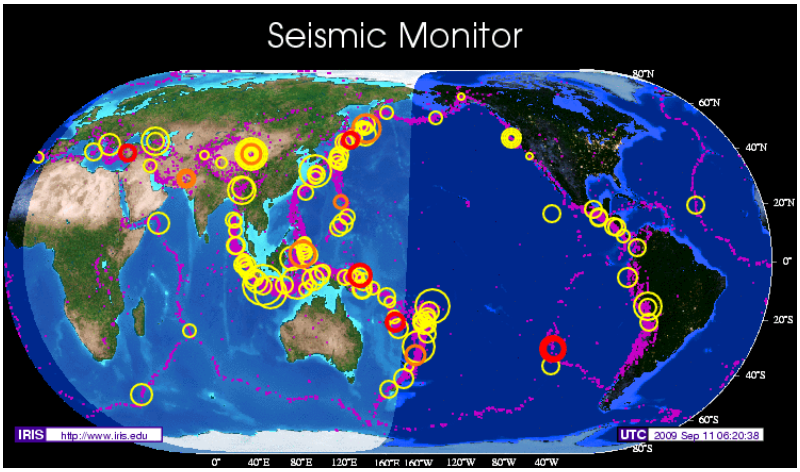
Other switchgear brands claim robust performance based on engineering calculations, but UniGear is the only MCC and switchgear to have successfully passed the laboratory tests of international agencies certifying its suitability in seismically active locations and moving vibrating plants.

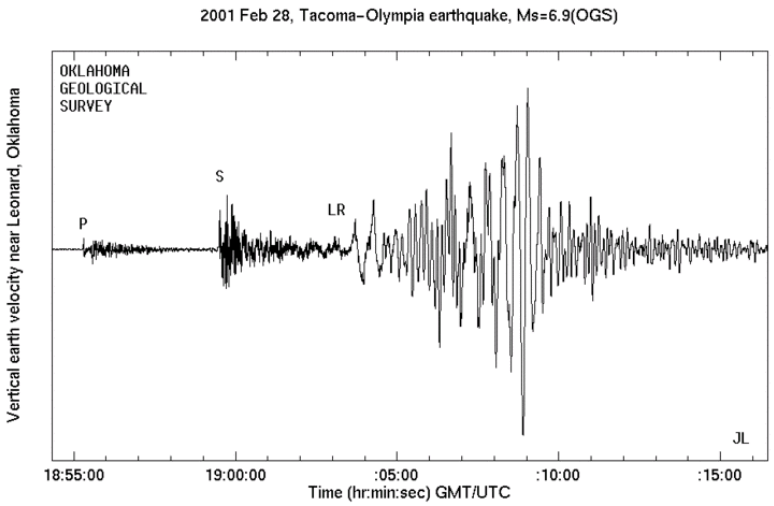
UniGear complies with the standards of IEEE 693-1997 and Lloyd's Register for withstanding the effects of high levels of seismic activity and ship vibrations.

Earthquake Engineering

So you want to preserve your power supply against earthquakes. So who decides a MCC structure can be considered 'earthquake-safe'? Type tests can only go so far with length of switchboard, acceleration and safety factors, dynamic loads and elasticity strength of support structures. The engineering profession has to make this decision, guided by local standards and by balancing what is reasonably achievable against the cost. Designers of essential facilities in earthquake prone regions are increasingly turning to local earthquake codes and design calculations for higher levels of certainty in protection.

When requested in earthquake installation, UniGear ZVC Switchgear System centre of excellence employs the "Non-linear Static Analysis" method commonly used in the seismic design and assessment of buildings structures. "Dynamic Analysis" calculation can be performed on request. The accuracies of both results are comparable.





High Altitude and Lightning Environment

Have you paid for excessive insulation just to operate switchgear at high altitude, say 5000m asl? Do you have 17.5kV rated switchgear operating on a 7.2kV system only to avoid flashover overvoltages? What a waste of investment, but there is a more economical solution.

And nobody expects to be left without power every time there is a lightning storm, although such storms can cause nightmarish overvoltages in the power grid. But how exactly do supply systems survive such massive surges and keep the power flowing to your process?

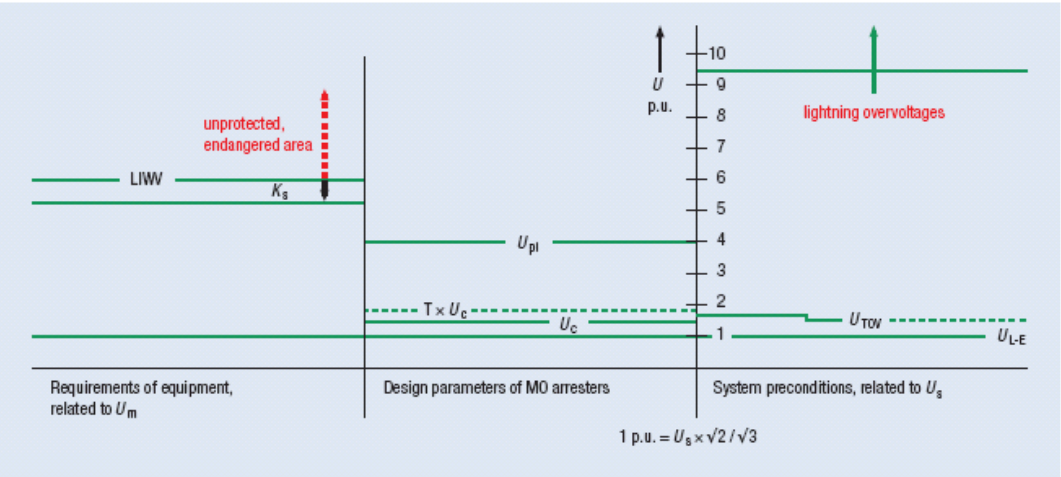
Overvoltages in electrical supply systems result from the effects of lightning incidents and switching actions cannot be avoided. They endanger the electrical equipment because for economic reasons the insulation cannot be designed to withstand all the possible overvoltages in a system.

It is meaningful to distinguish between three types of overvoltages:

1. Temporary overvoltages occur during load rejection or because of faults with earth connection. The duration of these overvoltages can be between 0.1 seconds and several hours.
2. Switching overvoltages (slow front overvoltages) occur during switching actions and consist mostly of heavily damped oscillations with frequencies up to several kHz.
3. Lightning overvoltages (fast front overvoltages) originate in atmospheric discharges. They reach their peak value within a few microseconds and subsequently decay very rapidly.

Arresters are one key element. Another is ‘insulation coordination’, in which the insulation properties of all the power system equipment are configured in such a way that they cannot be damaged by overvoltages. This is underlined by the IEC 60071-2 definition of insulation coordination as ‘the correlation of insulation of equipment with the characteristics of the protective devices such that the insulation is protected against overvoltages’. In such a context, arresters form the traditional ‘first line of defence’ to ensure that the maximum voltage that appears at the electrical equipment always stays below the guaranteed withstand value of the insulation of an electrical device.

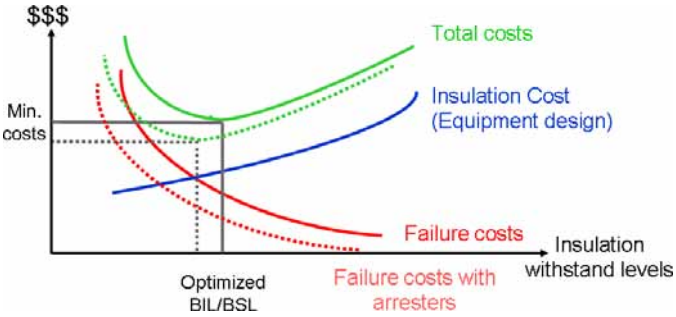
We have in-house “insulation coordination” expertise to effectively position and match arrester characteristics with UniGear ZVC Compact Intelligent MCC and switchgear system.



Comparison of the possible occurring voltages in the system, the withstand voltages of the electrical equipment and the parameters of the MO arrester. The lightning overvoltages are decisive in medium voltage systems. That is why are shown only the parameters for the lightning overvoltages.

Insulation Coordination

The selection of insulation strength consistent with expected overvoltages to obtain an acceptable risk/cost of failure



Insulation rating

Rating the dielectric withstand of equipment is based on the expected dielectric stresses. This is a combination of the stress caused by the power-frequency continuous voltage and the stress caused by the mostly short-term overvoltages.

“Insulation coordination” to IEC 60071-1 is the selection of the dielectric withstand required for equipment that is to be used at a specific site in a network. This process requires knowledge of the operational conditions in the network and the planned overvoltage protection devices, and the probability of an insulation fault on equipment which can be accepted under economic and operational aspects.

“Dielectric withstand” is defined by a rated insulation level or by a standard insulation level. A rated insulation level is considered any combination of standard withstand voltages. A standard insulation level is defined in IEC standard. Dielectric withstand is not associated with specific operational conditions.

Switchgear		UniGear ZVC	
Panel Version		Standard	Insulation Coordinated
Operating altitude – above sea level	m	≤ 1000	5000
Rated Voltage	kV	…7.2	…7.2
Operating Power Frequency Withstand – 1 min	kV	…32	…32
Operating Lightning Impulse Withstand	kVpk	…60	…95 (with matching surge arresters)
Rated Main Bus Current	A	…4000	…4000
Rated Circuit Current	A	…400/800	…400/800
Rated Frequency	Hz	50-60	50-60
Short Time Current – 3 sec	kA	…50	…50
Arc Fault Containment, AFLR – 1 sec	kA	…50	…50
Peak Withstand Current	kApk	…125	…125
Dimension[1]:			
Width	mm	325 650 975 1325 1650 1975	325 650 975 1325 1650 1975
Depth	mm	1304 1340 1554 1800	1304 1340 1554 1800
Height	mm	2200 2400 2595	2200 2400 2595

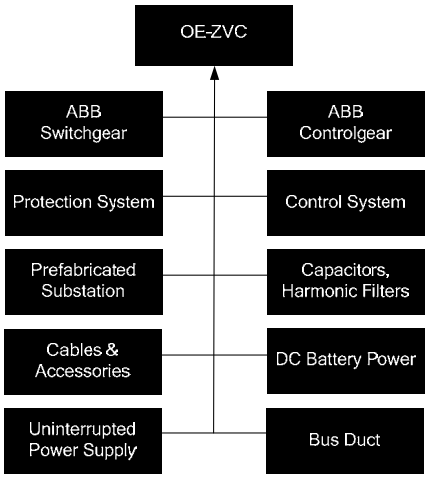
[1] Depending on ratings and applications. Refer Applications section.

Outdoor MCC and Prefabricated Substation

OE-ZVC is an Outdoor MCC and Prefabricated Substation with type-tested internal equipment. The OE-ZVC is constructed keeping in mind high levels of operator safety and harsh operating environments. Designed in accordance with IEC 62271-202 standards.

Features	Benefits
Simplicity and Flexibility	Can accommodate clients needs
Single source of supply	Eliminated complex coordination of diverse suppliers by clients
Versatile	Building can accommodate the complete range of Switchgear, Controlgear including transformers.
Modular	Shipping sections can be docked together on site to for a substation complex
Safety	Featuring type tested arc containment ducting with pressure relief device
Factory assembled and tested	Ensures that substation is pre-commissioned and fully functional prior to despatch
Minimum of on-site activities	Relief clients of building trade coordination, industrial problems etc. No delays due to weather.
Standard structural steel is Galvanised or Stainless Steel	Building long life expectancy minimised life-maintenance. Building will survive same period as equipment.
Certified building structure	Building approval is not required
Building stress analysis	Ensures that no transport distortion or damage can occur. Substation equipment delivered safely without multi-handling problems
Building standardised dimensions	Size to comply with statutory transportation limits for vehicles and loads
Total System Engineering and Integration	Multi discipline interaction eliminated
Minimal civil works	Prefabricated. No surprises, weather or site union issues.
Quality Assurance	ABB ISO9001 Quality Assurance for manufactured and 3rd party products.

Construction	OE-ZVC
Types	Walk-In or Non Walk-In
Standard	IEC62271-202
Protection	IP54 …. IP66
Material	Carbon, galvanised or stainless steel
Base	Channel, skid or legs
Floor	Painted steel or vinyl
Painting	Powder-coated
	None for stainless steel
Wall	Exterior (Ext) only
	Hollow (Ext. plus Int.) for insulation
Ceiling	Carbon, galvanised or stainless steel
Roof	Carbon, galvanised or stainless steel
	Rain canopy
	Angle to suit
Door (Personnel)	Exterior (Ext) only
	Hollow (Ext. plus Int.) for insulation
	Pad-lockable
Cover (Equipment)	Exterior (Ext) only
	Hollow (Ext. plus Int.) for insulation
	For equipment rear and side access
	For equipment removal or addition
Lighting	Fluorescent with switch near door
	Emergency lights - Battery powered
	Exit Sign - Used to mark door
	External - Weatherproof near door
GP Outlet	RCD 10A
Auxiliary	Integrated Light and Power MCBs
	Separate Light and Power DB
Earthing	Internal - Metal base as earth point
	External - Earth bar to system earth
Environmental Control (Thermostat)	Cooling - Wall mount or split units
	Heating - Wall mount or split units
	Ventilation - Wall mount fans, filtered.
Cable Tray	Overhead suspended from ceiling.
	Separate tray for power cables
	Separate tray for control cables
	Separate tray for communication link
Cabling	Internal connection via cable trays.
	Field cables from bottom, top or side
Minimum space (Personnel)	500 mm
Minimum space (Equipment)	To suit equipment Arc Fault Containment type tested design in laboratory; IEC62271-200 and 202.
Stairs, Platforms, & Landing	Custom designed to suit
Fire Rating	None
	Optional - Powerhouse™ to 120/120/120
Lifting facility	On the base
Shipping sections	For designs too large to ship as a single piece. Reconnection at site by others.
Pressure vents	Custom designed to suit.
Site Foundation (By others, i.e. civil contractors)	Concrete piers.
	Concrete pad
	Metal frames, platform or scaffolding)




HEAVY HAULAGE

EMC and Harmonic Noise Immunity

Many operators have experienced problems on site in the past with spurious alarms and mal-operations of equipment due to Harmonics and EMC.

Modern continuous process plants commonly use drives and power electronic technologies. It is well known that these non-linear loads can create harmonic distortion and RFI interference leading to nuisance alarms, trips, lock out or freezing of electrical and/or computer control based equipment.

These types of events are often unexplained and difficult to detect as they are random and momentary. Often once the event has occurred resetting of the devices may be necessary.

ABB proposes the following additional measures to manage these phenomena. These recommendations are made in order to improve the system reliability and performance of the plant electrical system.

ABB Lessons Learned

Key concerns are listed below.

1. Communication faults between the DCS and ECS
2. Corruption of data between substation electrical equipment and control system.
3. Spurious alarms and trips

Possible Causes

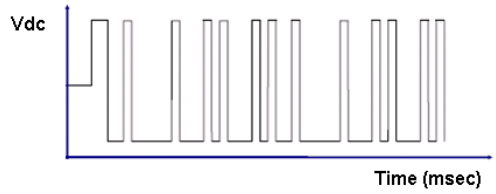
From previous experiences, we highlight possible areas that can create these types of phenomena and as such substation design needs to address these issues.

1. Poor selection of drives, improper installation of power and control cables.
2. No shielding or unscreened cables for DC supply and communications cabling.
3. Lack of segregation of MV drives and control cabling.
4. No segregation of power and essential supply cabling.
5. Poor design of power supply system, undersized wiring and battery backup, that can lead to voltage drop issues and under voltage swings.
6. Poor selection of communications cabling; not twisted pair, not screened and earthed in accordance with best practices and manufacturers guidelines.
7. Poor installation of communications cabling, mixed up with customer AC voltage field cabling.
8. Poor installation and termination of optical cables causing noise problems on DCS and ECS interface communications bus.
9. Faulty Connectors on Optical Cables causing noise problems on the DCS and ECS communications bus.
10. Severe bending radius on fibre optic patch panels, terminations splices and communication panels doors dislodging connections.

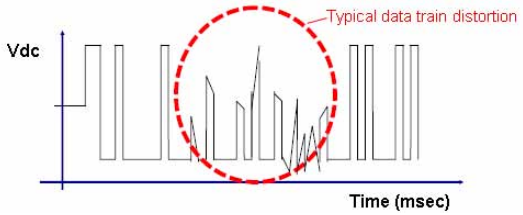
Communication Signals

This issue if not considered in design and installation phase can lead to mal-operation, spurious operation, loss of communications and false alarms.

Typical communications bus signal telegram healthy and noise free

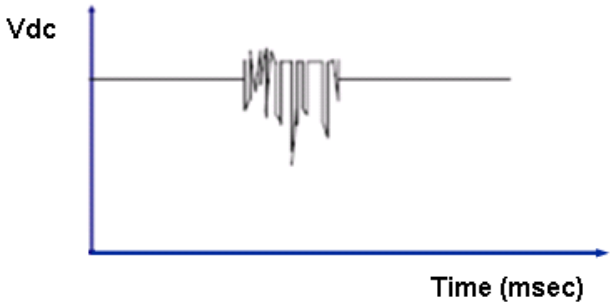


Typical communications bus signal telegram excessive signal distortion



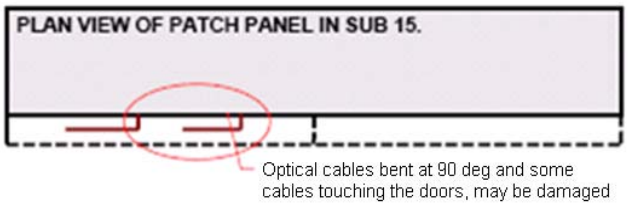
DC and Auxiliary Control Supplies

EMC and RFI interference on control supplies to IEDs can in some instances have negative and positive high frequency voltage spikes present on control line supplies. Depending on the noise immunity of the IED and the severity of the disturbance, this in some instances can lead to a temporary reset or shutdown of the device. The net result can be a temporary loss of communications, spurious alarms and trips or even a lockout of the IEDs. This may require a power down to clear the fault and restore the system.



Fibre Optic Cables and Patch Panels

In some cases although fibre optic interfaces are run in order to improve noise immunity of the installation; poor terminations, severe bending radius on fibre optic cables and mechanical damage can render these interfaces to be a source of communications alarms and faults.



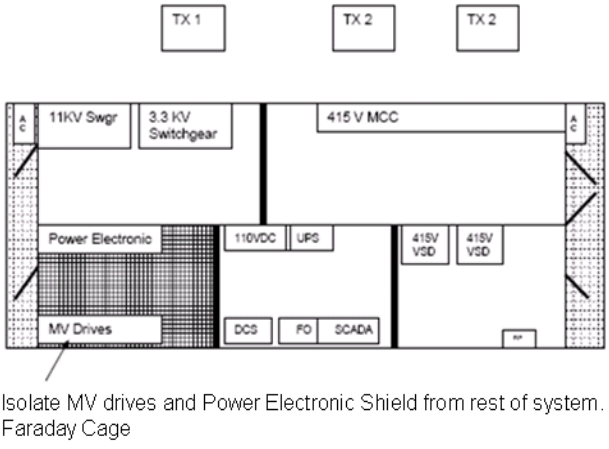
Additional Measures

ABB proposes the following measures in order to reduce the risk of EMC and Harmonics from affecting the reliability and performance of the equipment within the substation.

Isolate EMC and Harmonic Generators

ABB proposes to place all the MV drives and power electronic devices in a separate section from other susceptible equipment within the substation.

These drives and power electronic devices would be contained within a faraday cage type construction with all walls, floors of a steel construction bonded and earthed. Refer conceptual sketch as below.

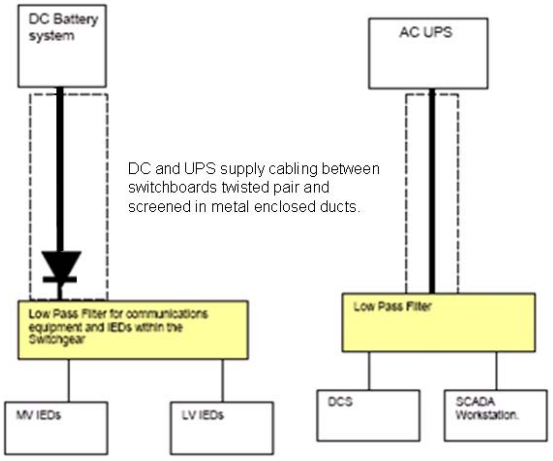


Filter DC & UPS Control Power Supplies

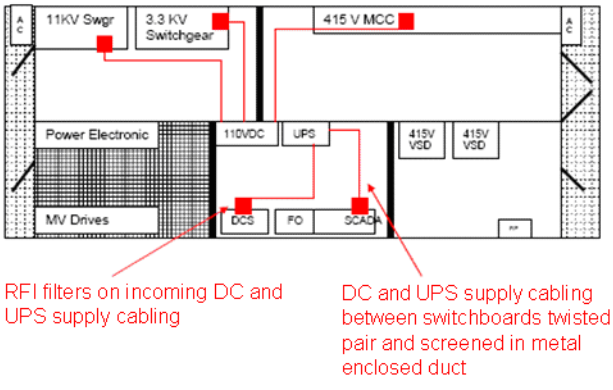
DC & UPS control power supply system would be designed in the configuration as shown in block diagram below. All DC and UPS cabling to be installed in metal duct to provide a shield and protect the cabling from any stray RFI.

In addition the cabling would be segregated from other power cables and use of twisted pair screened cabling would provide additional security for the essential auxiliary supplies. These ducts could be labelled or provided in a colour to clearly identify their purpose within the substation.

As an insurance measure, low pass filters would be installed in the incoming sections of the relevant MV switchboard power supplies to again filter out any possible RFI from affecting performance of the system.



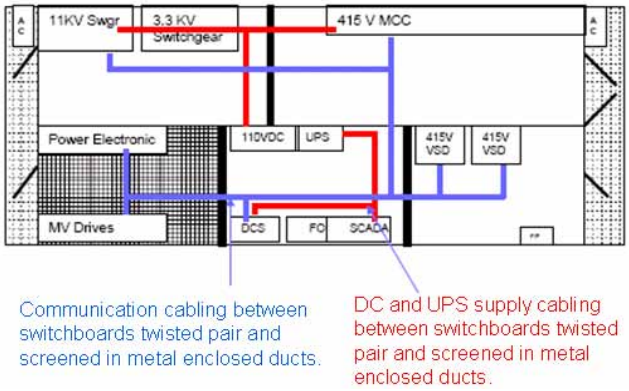
DC and AC UPS Low Pass Filters



Shield and Screen Communication Cable

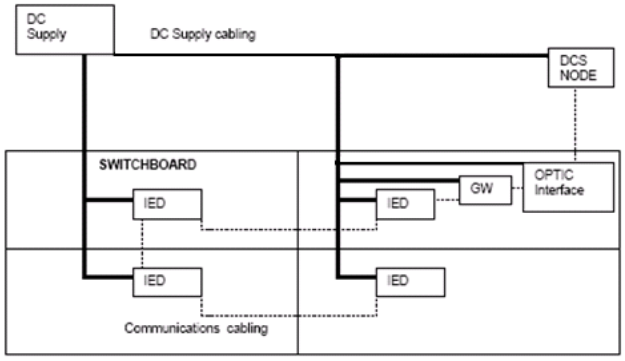
Communications cabling would be designed in the configuration as shown in the block diagram below. All communications cabling to be installed in metal duct to provide a shield and protect the cabling from any stray RFI.

In addition the cabling would be segregated from other power cables and use of twisted pair screened cabling would provide additional security for the essential auxiliary supplies. These ducts could be labelled or provided in a colour to clearly identify their purpose within the substation.



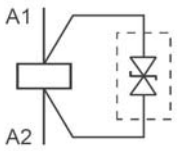
Group Common Power Supply

It would be recommended that the power supplies be configured such that IED Gateways where required, optic interfaces and nodes are grouped on a common power supply, for example as shown below.



Minimise DC Voltage Spikes

Wherever possible, DC control relays within the substation to have free wheeling diodes installed across relay coils to minimise risk of voltage spikes on the DC supply system upon de-energisation of these relays.



Substation Earthing and Screening – Best Practice

Preferably ABB would be supplying equipment as part of the substation contract. The testing of complete substation interfacing and assembly including installation earthing and necessary screening practice to address Harmonics and EMC would be fulfilled.

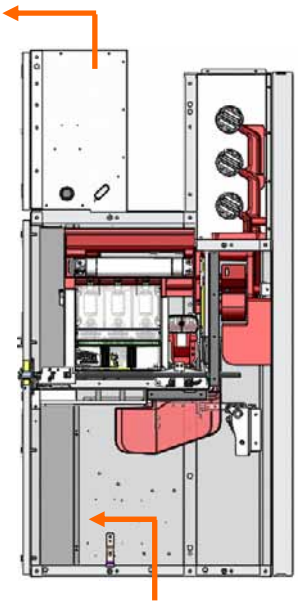
Segregate Power, Control and Communication Cables

UniGear ZVC Switchgear panel has been designed for total safety with full arc containment design and also high noise immunity management system. The concept of segregating instrument and power sections of the switchgear has not only been designed with safety in mind but also to provide maximum segregation of the power, control and communications cabling.

This segregation provides separation of power cabling, metal screens/ducts/pipes shielding of control and communications cabling minimise the risks of RFI interference due to harmonics within the electrical system or high frequency EMC.

DC and Communications cabling internal to substation run through top of compartment. Maximum complete segregation to medium voltage power cabling.

Low Voltage and control compartment. Protection relays and other electronic devices installed in this segregated metal area.



Medium voltage power cabling. Use bottom entry separate gland plates. Complete segregation between power and control cabling

Total Cost of Ownership

ABB recognises the need to offer products and solutions which lower the total cost of ownership, reducing hidden start-up and running costs. UniGear ZVC compact intelligent MCC and switchgear system is developed on this basis to meet arduous conditions of the Chemical Oil and Gas, Nuclear Power Plants, Heavy Continuous Process Industries and Marine where safety, availability and quality are of critical importance.

Total cost of ownership has different meaning to various user groups. UniGear ZVC user groups are:
1. Owners and Operators
2. Consultants and engineers
3. Contractors and installers
4. Purchasers

1. Owners and Operators
The focuses are on safety, minimum downtime, maintenance and green footprint.

Safety
UniGear ZVC switchgear system is type tested to withstand the effects of internal arcing faults ensuring protection to the operating staffs, adjacent cubicles and surrounding equipment. Arc duct improves safety and lower cost of repair reducing the cost of ownership.

Remote Motorised HV Isolation
Historically the most common setting of operators being subjected to the full forces of an arcing flash is while racking in and out of withdrawable trucks. The outcome is never good. UniGear ZVC switchgear system can eliminate this risk by using remote motorised HV (truck) isolation. Your operators do not have to ever experience this, but you've got to make the right decisions on cost of ownership at the front end.

Fire Proofing
UniGear ZVC switchgear system maximises the use of fire retardant materials such as epoxy resin, insulation sleeving and metal castings to lower the risk of fire propagation.

Withdrawability
UniGear ZVC switchgear system uses fully withdrawable fused contactors truck. It shall be possible to replace a fuse contactor truck in 5 minutes to minimise process disruption. This allows the withdrawable truck to be removed and taken to the safety of a workshop for service and maintenance. This feature significantly increases the safety and also reduces the cost of maintenance lowering the total cost of ownership.

Increased Availability
Intelligent Switchgear can be used as a proactive tool to prevent potential problems from occurring by providing protection warnings so corrective action can be taken prior to developing into a problem. This is achieved by reacting to the following information:
* overload warning at 105% of rated current
* underload warning which can be adjusted between 20 and 80%
* earth fault warning
* motor temperature warning
* motor stalling

IED significantly increases the availability of the switchgear. If there are changes to the process which require modifications to the switchgear, in general this can be done on line. There is no need to shutdown the switchgear.

IED allows for changes in motor sizes by simply inputting the new motor parameter. There is no need to change hardware providing it is within its range.

Increased availability is a significant factor in lowering the total cost of ownership.

Vacuum Technology
No other kind of technology is more reliable, more widely used, requires less maintenance and environmentally kinder. Vacuum interrupter reduces cost of ownership by eliminating additional safety needs to service, maintain, operate and dispose hazardous SF6 greenhouse gas.

Maintenance
Motor starters do a great deal of work in continuous process plants with many switching operations and isolations. Regular maintenance is required on motor starters to check that they are in good working order.

Non-Intelligent switchgear does not generally provide indications of gradual deterioration or failure of component parts, or to the damages that may result from lack of maintenance.

Intelligent switchgear incorporating a planned maintenance programme reduces the likelihood of internal faults within the switchgear and therefore ensures a high level of equipment availability. Planned maintenance reduces total cost of ownership.

IED, Re_615 series can provide valuable maintenance information based on the number of hours in service and a number of operating cycles. Maintenance warnings can be provided when a preset number of operations are reached. This means that corrective maintenance can be done on motor starters that require some action. Incomers or feeders which have lower duties and therefore do not require maintenance and remain in service.

Non Moving Portions
Panel (and bolted parts) are non moving parts where maintenance is not so critical. Here the panel is not subject to the same arduous switching conditions. UniGear ZVC switchgear system busbars are maintenance free as the busbar bolts and nuts are factory torque and sealed. Belleville washers are provided under the heads of the bolts which allow for differential expansion due to thermal cycling. The same applies for instrument transformers.

Moving Portions
Switchgear moving portions are fused contactor and earth switch. Our products have high operation cycles and only require minimal servicing. It is advisable to carry-out periodic checks like a visual examination after 4 years, 5000 operations or after fault clearance.

Vacuum Interrupter
The inherent advantages of vacuum interrupters: (i) minimal maintenance, (ii) environmental friendliness – are primarily due to the fact that they have fewer and simpler parts than other types of interrupter and are sealed for life.

Globally it has been recognised and accepted that to continuously check for vacuum loss is not necessary thus vacuum indication is not available. It is simple to test the integrity of vacuum interrupter. Hardware required is commonly available AC (power frequency) voltage test set. If there is air in an interrupter chamber, flashover occurs between the contacts.

Predictive Maintenance
Planned preventative maintenance is a big factor in lower cost of ownership.

The use of continuous temperature online monitoring system should be considered on main bus and cable termination compartment to protect against any resultant fire caused by over-heating.

The use of continuous partial discharge online monitoring system should be considered to guard against flashover due to insulation aging and deterioration over time.

Above preventative maintenance systems reduce total cost of ownership by minimising potential damage to switchgear and surrounding environment. Online systems should be connected to ECS for alarm and trip control.

Made In ABB
Immediate global access to factories, quality processes, world class design engineers, laboratories, research and development centres are vital to support your process and maintenance activities. ABB has all the resources readily available at your fingertips. This reduces cost of ownership.

Your continuous process plant, operating and maintenance team do not have to ever experience poorly supported products, but you've got to make the right decisions on cost of ownership at the front end.

2. Consultants and Engineers
The focus are on engineering applications, flexibility to customise solution, product quality and system design safety.

Quality
UniGear ZVC switchgear system is developed entirely in quality accredited offices in Australia where quality was built into the design. Engineering, final assembly and testing of the switchgear are carried out in our ISO 9001 Quality Accredited Workshop. Quality may increase the initial cost of the switchgear. However, reduces the total cost of ownership through extended life, less maintenance and fewer breakdowns.

Type Tests
UniGear ZVC switchgear system is fully tested to variety of standards including IEC 62271, 60694 and 60298 to verify suitability to the intended applications.

Seismic Tests
UniGear ZVC switchgear system is tested to DIN IEC 50A (CO) 175 and DIN 40046, part 35.

Vibration and 25^0 Inclination Tests
UniGear ZVC switchgear system is tested to standards IEEE 693-1997, IEC 68-2-6 and 68-2-57.

Shipping Registers
UniGear ZVC switchgear system is tested and approved under guidelines of Lloyds Register of Shipping for use onboard ships. The switchgear installations are vibration-proof for a frequency range from 5 up to 100 Hz.

Engineered Solutions
Refer catalog section on Applications – Indoor and Outdoor.

Design, Engineer and Manufacture
IEDs allows the design, engineering and manufacture of the motor control centres, incomers and feeders without finalised 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. Thus after sales changes have less impact on cost and delivery. There is no need to change hardware or the documentation as a result of the change. Flexible Intelligent Switchgear reduces the total cost of ownership.

Fault Current Limitation
HRC HV fuses should be considered over circuit breakers as they significantly reduce the cost of ownership. In event of an external fault the peak current and energy let through are limited by HRC HV fuse. This minimises potential damage to the equipment and any resultant fire caused by a short circuit. HRC HV fuse provide fastest clearing time ~5ms, does not need auxiliary power thus provide protection even in loss of control supply scenario. Normally protective device requires secure DC/AC control power for fail safe operation.

Fault current limitation provided by HRC HV fuses permit the feeder cables to be reduced in size. This lowers the cost of ownership as can be shown from this typical example:

"We may consider a situation at 3.3kV, 43.7kA fault level (using 48.1kA to compensate for dc offset). For a 1100kW motor connected to a circuit breaker the cable size required would be 300mm². Equally for a 1100kW motor in the case of fuse contactor switchgear, the cable size would be 95mm². This provides an approximate cost saving of € 3,700 per 100m of cable run."

All Operations behind Closed Doors
UniGear ZVC switchgear system is designed on the principle that all operations in the switchgear are performed with the compartment doors firmly secured. Racking in, racking out of fused contactor and operation of the earth switch can be done in complete safety. In the event of a fault occurring during this process, there will be no danger to the operating personnel. The front door is fitted with viewing windows for checking the grounding conditions of the cable terminations. The switching status of the earthing switch blade may also be observed directly through this window.

Rapid Arc Fault Detection and Limitation
UniGear ZVC switchgear system offers protection against the effects of internal arc by means of its construction structure extinguish (…50kA, …1s). In addition, ABB has a suite of enhanced switchgear protection systems to detect and extinguish arc fault in <50ms.

Time is critical to minimise arc effects. Generally, combination protection relay and circuit breaker are not fast enough to ensure optimum fault clearance times at arc faults. HRC HV fuses provide fastest clearing time ~5ms, do not need auxiliary power thus provide protection even in loss of control supply scenario. Normally protective device requires secure DC/AC control power for fail safe operation.

Rapid fault clearance increases availability, reduces damage incurred and repair reducing cost of ownership.

Fully Insulated Busbars
UniGear ZVC switchgear system not only reduces the damage caused by arc faults, it is also designed to minimise the risk of arcs occurring in the first place lowering cost on ownership. All HV busbars are insulated with insulation sleeves or epoxy resin to provide an additional protection against faults and accidental bridging caused by rodents and insects. Insulation ageing tests confirmed > 100 year life.

3. Contractors and Installers
The focus are on package cost on project management, installation, commissioning support and reliability track record.

Compactness
UniGear ZVC switchgear is arguably the most configurable compact MCC and switchboard system. The cost benefit of small dimension is well documented in the public sphere. On average, UniGear ZVC saves 41% floor space compared to non-compact equivalents. This equates to typical savings € $3000/m^2$ on cost of switchroom.

Footprint and weight on an offshore platform, drilling rig, nuclear power plant, FPSO or ships are critical design concerns and comes at a high cost. UniGear ZVC switchgear system is extremely compact and on average is between 30 and 50% smaller than other products. Our switchgear is front accessible which allows it to be located against a wall. This represents a significant saving in space and therefore in the total cost of ownership.

Intelligent Motor Control Centre and Switchgear

ABB Intelligent Electronic Device, RE_615 series reduces the total cost of ownership. IED may increase the initial cost of the switchgear however studies have shown that it can reduce the total cost of ownership between 20-30%. A typical calculation takes the total cost of ownership up to an installed basis eliminating:

- the DCS & ECS interfacing relays
- the marshalling panels
- the I/O cabling between the MCC and DCS & ECS
- the DCS & ECS I/O cards

Intelligent Compact MCC and Switchgear provides additional savings in project management, installation, commissioning, increased availability and preventative maintenance.

Installation

Access to main busbars is from the top after dismounting of pressure relief plate. Insulating cover cap is used on relevant busbar bolted joint. The connection of silver or tin plated busbars is carried out on “stabilised connections”. This means that quality of connections does not change over time and it is not necessary to inspect tightness of busbar connections regularly. Total cost of ownership is reduced.

UniGear ZVC switchgear system power cable termination chamber is generously dimensioned and easily accessible from the front when the withdrawable truck and the horizontal partition are removed. The air gaps provided between the connection points, even with several parallel cables, contribute to greater reliability. The height of the connections ensures that in all cases the cable termination connections can be installed within the cubicles. They are thus on the one hand protected from influences of the environment outside cubicles, on other hand the cubicles are fire and arc protected partitioned from cable level.

The duration of other work to be carried out on the cables is a decisive factor in the security and cost-effectiveness of a switchgear installation. Our switchgear design therefore includes a series of work saving features in the cable connection area, no dismantling in the cable termination chamber is necessary for DC tests on the cables.

Off-Site Installation

UniGear ZVC switchgear system outdoor MCC or PDC, called OE-ZVC can provide flexible substation solutions that will save time and money. OE-ZVC construction allows for all equipment to be installed, tested and pre-commissioned in manufacturing factory before arriving to site, removing the risks, complications and delays associated with building in-situ. Using our in-house expertise and taking ABB standard switchgear footprints, we can optimise station designs and significantly reduce overall station sizes. OE-ZVC customise solutions lower total cost of ownership.

Commissioning

There are many worldwide examples where IED has saved the day when it came to commissioning, reducing the time by providing valuable fault finding information where the type and nature of the fault can be displayed, for example:

* emergency stop operated
* protection trip
* OFF - not ready
* withdrawn

The superior functions of IED were clearly demonstrated on Shell Pearl GTL project in Ras Laffan, Qatar where the onshore gas processing plant has standardised on Flexible Intelligent Switchgear for all medium voltage control and protection.

UniGear ZVC compact intelligent MCC and switchgear system is developed on this basis to meet arduous conditions of the Chemical Oil and Gas, Nuclear Power Plants, Heavy Continuous Process Industries and Marine where safety, availability and quality are of critical importance.

4. Purchasers

The focus are on contract compliance, cost competitiveness and delivery lead time.

ABB understands some commercial contracts mandate local content due to financing, insurance or governmental undertakings. UniGear ZVC have in place global manufacturing centres to comply with this requirements. Typical requirements are: (i) Local manufacture, (ii) OECD place of manufacture, (iii) Japan place of manufacture, (iv) China place of manufacture

Global Factory – The Centre of Excellence

The quality control, designers, research, development, engineering, project management, purchasing, assembly, wiring and final testing are provided/located in Sydney Australia, all under one roof. This factory supplies UniGear ZVC product globally.

Major hardware components include cubicle sheet metal, vacuum contactor, HRC fuses, current transformer, voltage transformer and Intelligent Electronic Devices are manufactured in OECD countries.

Regional or Local Factories

The quality control, engineering, project management, purchasing, assembly, wiring and final testing are provided/located in regional or local factory. This factory purchases UniGear ZVC power kit (major parts) from Sydney global factory for local customisation.

Local supplied hardware components include sheet metal, HRC fuses, current transformer and protection relays are usually manufactured locally (EU, Japan, South Korea) or in low cost countries (China, Malaysia, Vietnam, South Africa, South America).

Cost Competitiveness

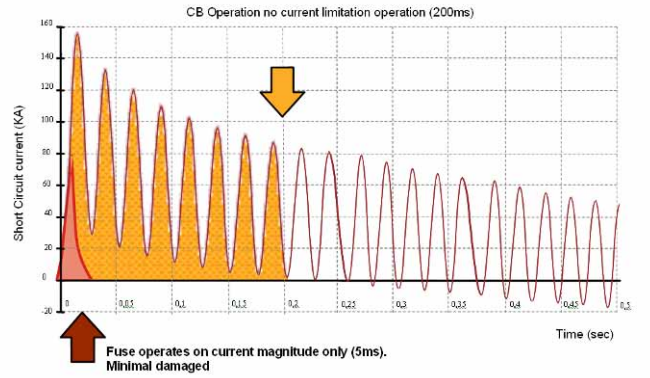
When low cost is the primary project driver, soft elements (such as engineering, assembly, wiring and testing) and hard elements (such as sheet metal, HRC fuses, current transformer and protection relays) should be sourced from low cost countries (India, China, Malaysia, Vietnam). The centre of excellence in Sydney Australia has in place systems and project structures to manage this undertaking.

Comparisons

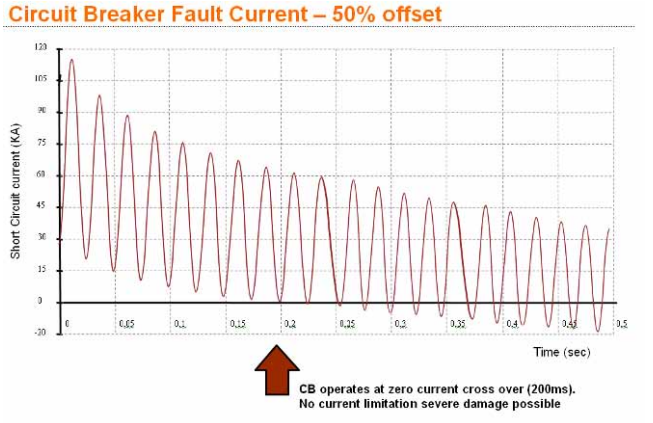
Benefits of UniGear ZVC Switchgear

- ✓ The UniGear platform is completed by the compact contactor ZVC with HRC fuses. It can be used in installations with fault currents up to 50kA with the use of HRC fuses as the main means of short circuit protection.
- ✓ ZVC is able to combine maximum accessibility of all the components with the most limited dimensions available on the market today for MV Switchgear. The innovative integration of the components offers a solution with extremely reduced weight and footprint, allowing efficient use of space in electrical installations.
- ✓ The most evident characteristic of this unit is it's extreme compactness, just 325mm wide therefore finds ideal application in installations with a large number of contactor outgoing feeders in situations with very limited space available, expensive real estate or civil works.
- ✓ Lower cost of ownership. Intelligent switchgear allows greater access to information, allowing optimisation of the process, electrical system, increased plant availability and flexibility.
- ✓ The performance of the contactor unit with fuses (utilization category AC-1, AC-2, AC-3 and AC-4) is preferable to a circuit breaker when a high number of daily operations are required. The contactor interrupters guarantee an extremely high number of closing and opening operations under normal load conditions and with a maximum rated short time withstand current of 6kA.
- ✓ Fuse contactor limits fault current stress and damage to motor, transformer or capacitor.
- ✓ Smaller power cables. Reduced size due to the reduced let through energy of the fused contactor, hence savings in copper cost.
- ✓ This characteristic also helps to project cables and connected machine from the harmful mechanical and electrical effects of a fault by interrupting short circuit currents in half cycle. For the same reason, UniGear ZVC can use earthing switch with reduced capacities compared to the rest of the switchboard components.

Fused Contactor – High Fault Current Interruption



Circuit Breaker Fault Current – 50% offset



Comparison of performance

Evaluating UniGear ZVC Fused Vacuum Contactor technology to conventional Circuit Breaker technology for switching applications:

UniGear ZVC		Circuit Breaker
Fault current limited due to HRC fuses.	↔	No fault current limiting capability.
Fault clearing time is typically <5ms at full fault current.	↔	CB fault break at first natural current zero ≥200ms.
Reduced let through energy allows reduced cable size.	↔	Cable needs to be sized to maximum system short circuit level.
Reduced thermal stresses on motor and rapid fault clearing time minimise damage.	↔	Thermal stresses consistent with system short circuit level and clearing time result in severe damage.
Up to 1,000,000 operations provides extended service life.	↔	Up to 30,000 operations service life.
Small footprint totalling 0.42 sq m.	↔	Average footprint 1.05 sq m.

TYPICAL CABLE COST COMPARISON

Motor FLC (A)	31.5kA				50kA			
	Fused Contactor Panel		Circuit Breaker Panel		Fused Contactor Panel		Circuit Breaker Panel	
	Cable csa sq mm	**Cable Cost 100m**	**Cable csa sq mm**	**Cable Cost [1] 100m**	**Cable csa sq mm**	**Cable Cost 100m**	**Cable csa sq mm**	**Cable Cost [1] 100m**
45	35	€ 1,600	185	€ 4,800	35	€ 1,600	300	€ 7,500
60	35	€ 1,600	185	€ 4,800	50	€ 2,000	300	€ 7,500
75	35	€ 1,600	185	€ 4,800	50	€ 2,000	300	€ 7,500
90	50	€ 2,000	185	€ 4,800	50	€ 2,000	300	€ 7,500
120	50	€ 2,000	185	€ 4,800	70	€ 2,900	300	€ 7,500
150	50	€ 2,000	185	€ 4,800	70	€ 2,900	300	€ 7,500
165	50	€ 2,000	185	€ 4,800	70	€ 2,900	300	€ 7,500
185	50	€ 2,000	185	€ 4,800	70	€ 2,900	300	€ 7,500
225	70	€ 3,800	185	€ 4,800	95	€ 3,800	300	€ 7,500

TYPICAL FLOOR SPACE COMPARISON

Panel Width (mm)	Panel Depth (mm)	Area (sq m)	Construction cost [2]
325	1300	0.42	€ 1,268
400	1300	0.52	€ 1,560
500	1300	0.65	€ 1,950
600	1300	0.78	€ 2,340
700	1300	0.91	€ 2,730
800	1300	1.04	€ 3,120
900	1300	1.17	€ 3,510
1000	1300	1.30	€ 3,900
1200	1300	1.56	€ 4,680

[1] Cable cost in yr. 2008.
[2] Construction cost in yr. 2008.

In practice MCC load lists are dominated with loads ≤ 2000kW @ 7.2kV and ≤ 1000kW @ 3.6kV. UniGear ZVC switchgear is well suited to take advantage of its minimal heat loss characteristic, allowing significant reduction in cooling system and running costs.

TYPICAL HEAT LOSS COMPARISON

7.2kV	UniGear ZVC panel		Circuit Breaker panel
Load[1] Rating	Fuse Rating	Heat Loss[2]	Heat Loss[3]
200 kW	100 A	10 W	200 W
300 kW	100 A	22 W	200 W
400 kW	100 A	38 W	200 W
450 kW	100 A	48 W	200 W
500 kW	160 A	27 W	200 W
600 kW	160 A	39 W	200 W
700 kW	160 A	53 W	200 W
800 kW	160 A	69 W	200 W
900 kW	250 A	51 W	200 W
1000 kW	250 A	63 W	200 W
1250 kW	250 A	98 W	200 W
1500 kW	250 A	141 W	200 W
1800 kW	250 A	198 W	200 W
2000 kW	315 A	203 W	200 W
2250 kW	315 A	251 W	200 W
2500 kW	315 A	310 W	200 W
3000 kW	2 x 250 A	338 W	200 W
3500 kW	2 x 250 A	460 W	200 W
4000 kW	2 x 315 A	498 W	200 W

TYPICAL HEAT LOSS COMPARISON

3.6kV	UniGear ZVC panel		Circuit Breaker panel
Load[1] Rating	Fuse Rating	Heat Loss[2]	Heat Loss[3]
200 kW	100 A	20 W	200 W
250 kW	160 A	26 W	200 W
300 kW	160 A	29 W	200 W
400 kW	160 A	45 W	200 W
500 kW	250 A	51 W	200 W
600 kW	250 A	65 W	200 W
700 kW	250 A	89 W	200 W
800 kW	250 A	116 W	200 W
900 kW	250 A	146 W	200 W
1000 kW	315 A	148 W	200 W
1100 kW	315 A	179 W	200 W
1250 kW	315 A	227 W	200 W
1400 kW	2 x 250 A	230 W	200 W
1500 kW	2 x 250 A	260 W	200 W
1600 kW	2 x 250 A	296 W	200 W
1750 kW	2 x 250 A	321 W	200 W
1800 kW	2 x 315 A	354 W	200 W
2000 kW	2 x 315 A	396 W	200 W

[1] Loads equivalent for motor, transformer or capacitor.
[2] Values on power circuit with SIBA HRC fuses.
[3] Typical power circuit values.

Design loads or weight control is a key fabrication cost consideration in many installations, i.e. FPSO hull and topside[1] structure, nuclear power plant seismic or earthquake brick building, transportable E-Houses, etc. Selection preference is for light evenly distributed weight equipment.

TYPICAL WEIGHT COMPARISON

3.6-7.2kV	UniGear ZVC panel		Circuit Breaker panel	
Load[2] Rating	Weight		Weight[3]	
400 A, ≤ 31.5kA	400 kg	0.4 ton	800kg	0.8 ton
400 A, ≤ 50kA	400 kg	0.4 ton	1000 kg	1 ton

[1] Converted tanker FPSO has limited topside load carrying capacity of existing webs, typically 500 tonnes.
[2] Loads equivalent for motor, transformer or capacitor.
[3] Typical values.

Speed is an important element for switchgear protection against internal flashover. Arc damage to switchgear is almost negligible provided the flashover is cleared < 35 ms. After flashover, a simple visual check, cleaning and reuse is possible reducing plant downtime. If flashover is not cleared after 100 ms, small to severe repairs are expected, adding to plant downtime and replacement costs.

HRC fuses provide fastest clearing time ~5ms, do not need auxiliary power thus provide protection even in loss of control supply scenario. Normally protection relay requires secure DC/AC control power for fail safe operation.

TYPICAL ARC FAULT CLEARING SPEED COMPARISON

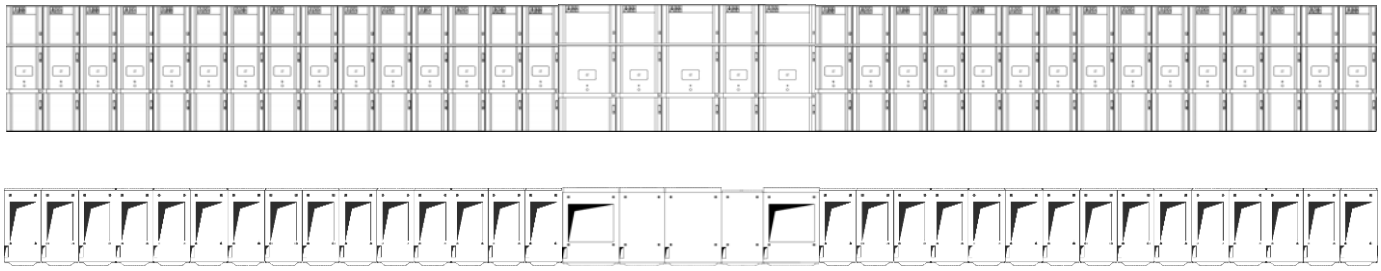
3.6-7.2kV	UniGear ZVC	Circuit Breaker
Fault Clearing	Speed	Speed[1]
Switching Device Open or Trip[2]	≤ 30 ms	60 ms

[1] Typical values.
[2] Time excludes relay and other activation devices.

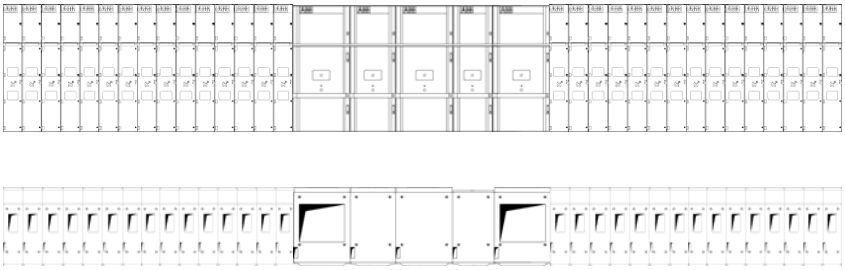
Project Savings

Typical FPSO Switchboard 6.6kV, 3150A, 40kA comprising:
2 off Incomer panel
1 off Bus Riser panel
1 off Bus Section (Tie) panel
1 off Bus Metering panel
15 off Transformer Feeder panel
15 off Motor Feeder panel

Conventional Switchboard



Compact ZVC Switchboard



ENGINEERING DESIGN ELEMENTS

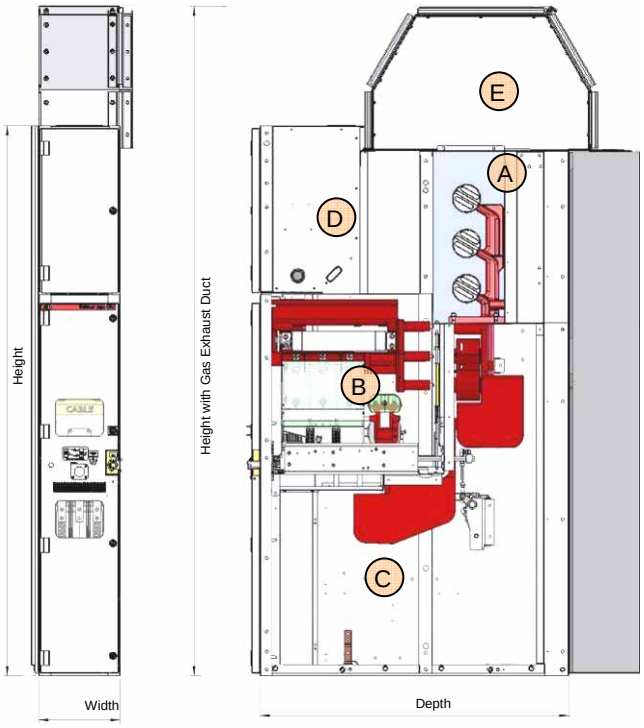
MCC Switchboard	Floor Area	Cable[1]	Heat Loss[2]	Weight	Clear Fault
Circuit breaker solution	32 m^2	300 mm^2	5.1 kW	29 tonnes	60 ms
Compact UniGear ZVC solution	19 m^2	95 mm^2	4.8 kW	17 tonnes	20 ms

OVERALL PROJECT COST COMPARISON

	Cost				
MCC Switchboard	Floor Area[3]	Cable[4]	Heat Loss	Weight	Clear Fault
Circuit breaker solution	€ 96,000	€ 225,000	5.1 kWh	29 tonnes	60 ms
Compact UniGear ZVC solution	€ 57,000	€ 114,000	4.8 kWh	17 tonnes	20 ms
Difference (Δ) with UniGear ZVC	Less 41 %	Less 50 %	Less 6 %	Less 70 %	Faster 300 %
Savings in plant purchasing cost	€ 39,000	€ 52,500	Varies[5]	Significant[7]	Negligible[8]
Savings in plant running cost	-	-	Varies[6]	-	-
Savings in plant spare part	-	-	-	-	Significant[9]

[1] Power cables based on differences of motor and transformer feeder. Same power cable for Incomer.
[2] Heat loss based on motor load 1000 kW and transformer 1000 kVA.
[3] Floor space construction cost based on € 3000 /m^2 (average for E-Houses – yr. 2008)
[4] Cable cost based on average length 100 m each.
[5] Depends on air conditioning system to cool switchgear heat loss generated.
[6] Depends on energy and greenhouse cost, plant specific.
[7] Depends on installations, i.e. on or off-shore, seismic (earthquake), vibration, wind loads, remoteness, etc
[8] Similar manufacturing cost for fused contactor and circuit breaker technology.
[9] Depends on operation and fault severity. Worst case – equipment replacement may be necessary.

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 [1] between internal compartments

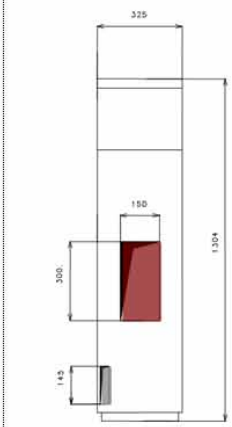
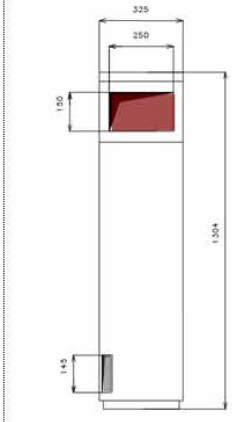
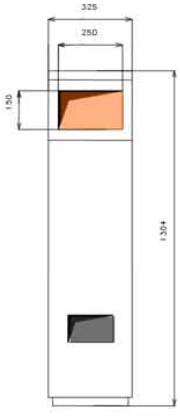
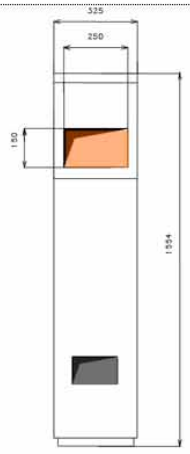
On request, the external housing can be supplied with different degrees of protection up to a maximum of IP66. The electrical characteristics of the switchboard can vary for ambient conditions other than those described and for higher degrees of protection than the standard ones.

Standard Colour of the external surfaces

ABB standard RAL7035 light grey

Width (mm)	325		
Height (mm)	2200	2400	2595
LV Box Height (mm)	665	865	1060
Height with Arc Duct (mm)	2680 (2530 available)		

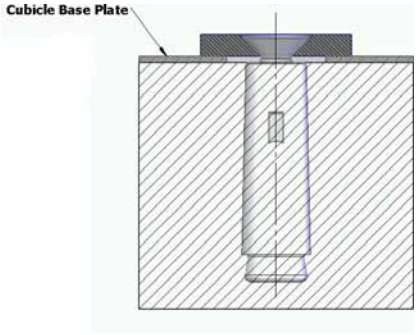
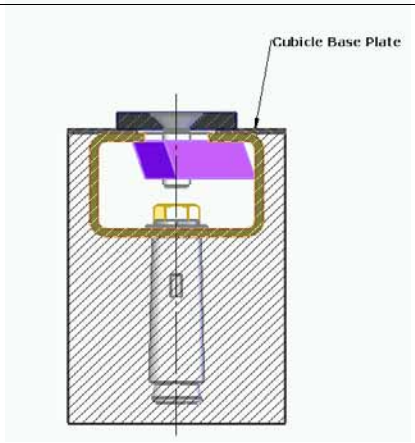
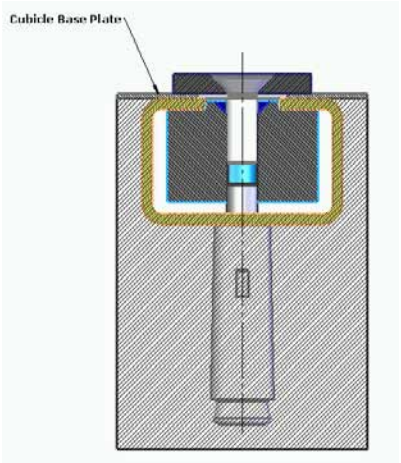
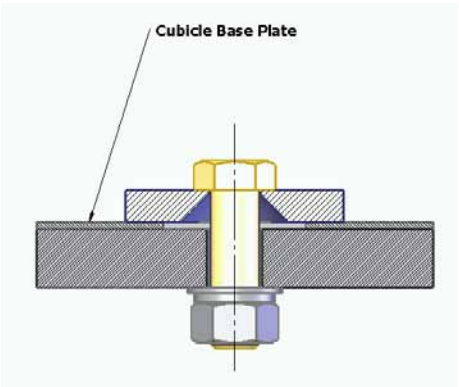
External dimensions:

Depth (mm)	1304	1304	1304	1554
Power cable entry	Bottom Entry Front Access	Bottom Entry Rear Access	Top Entry Rear Access	Top Entry Rear Access
Control cable entry	Bottom Entry Front Access	Bottom Entry Front Access	Top Entry Front Access	Top Entry 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] IP30 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)[1]	20 (32)[1]
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)[2]
Arc Fault Containment – 1 sec [4]	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.

Floor Mounting Type	
Concrete	Steel Profile
	
Seismic and Marine	Marine
	

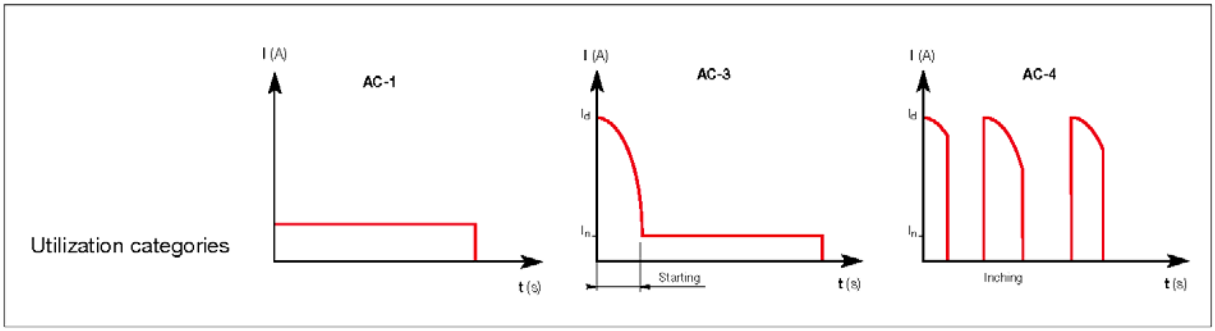
Fused Contactor Truck

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 and AS 60470. IEC contactors may have a NEMA rating. Refer standard NEMA ICS 2.4 for contactors with IEC markings in NEMA application. UniGear ZVC is equipped with contactor tested to AC-1, AC-3 and AC-4.



AC-1	Non-inductive or slightly inductive loads, resistance furnaces. This applies to all AC loads where the power factor is at least 0.95. These are primarily non-inductive or slightly inductive loads. Breaking remains easy.
AC-2	Slip-ring motors: starting, switching off. It is common to combine lesser used Utilization Category AC-2 with AC-3.
AC-3	Cage motors: starting, switching off running motors. This applies to cage motors where the breaking of the power contacts would occur while the motor is running. On closing, the contactor experiences an inrush which is 5-8 times the nominal current, and at this instant the voltage at the terminals is approximately 20% or the line voltage. Breaking remains easy.
AC-4	Cage motors: starting, plugging[2], inching (jogging)[3]. This applies to the starting and breaking of a cage motor during an inch or plug reverse operation. On closing, the contactor closes on an inrush current approx. 5-8 times the nominal current of the motor. On opening, the contactor breaks the same magnitude of nominal current at a voltage that can be equal to the supply voltage. Breaking is severe. It is common to detail lesser used Utilization Category AC-4 as a fraction of AC-3 value.

[1] Devices for Utilization Category AC-3 may be used for occasional jogging or plug-breaking for a limited period. The number of actuations in these circumstances shall not exceed 5 per minute and 10 per ten minutes.
[2] Plugging – Stopping a load rapidly by reversing the primary power connections.
[3] Inching – Energizing a load repeatedly for short periods to obtain small incremental movements.

Value of Vacuum Interrupters

- No SF6 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 x 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 less than 0.5 A 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 + 1 N/C 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
- Heavy duty racking mechanism (10,000 isolation operations)
- Motorized truck racking
- Emergency trip provision

General

VSC7/ZVC contactors are apparatus suitable for operating in MV installations and are normally used to control loads requiring a high frecuency of operations.
The VSC7/ZVC contactor introduces the drive with permanent magnets, already widely used and appreciated in medium voltage circuit-breakers and medium voltage contactors.
The experience acquired by ABB in the field of medium voltage circuit-breakers fitted with “MABS” permanent magnet drives, has made it possible to develop an optimised version of the actuator (bistable MAC drive) for medium voltage contactors.
The permanent magnet drive is activated by means of an electronic multi-voltage feeder.

Versions available:

- **SCO** (Single Command Operate): Closing takes place by supplying auxiliary power to the special input of the multi-voltage feeder. Opening takes place when the auxiliary power is either voluntarily cut off (by means of a command) or involuntarily (due to lack of auxiliary power in the installation). The SCO version is similar to the ellectrically latched drive of the conventional contactor.

- **DCO** (Double Command Operate): Closing takes place by supplying the input of the closing command of the apparatus a small pulse of power. Opening takes place when the input of the opening command of the contactor is supplied a small pulse of power.

Standard Fittings

- SCO Operating Mechanism
- Fuse blown indicator with 1N/O + 1 N/C Auxiliary.
- Mechanical operation counter
- 2N/O & 2 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
- DCO operating mechanism
- Racking blocking coil
- Heavy duty racking mechanism (10,000 isolation operations)
- Emergency trip provision

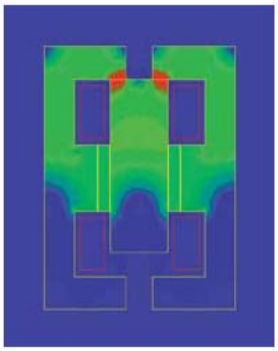


Fig. A - Magnetic circuit in the closed position.

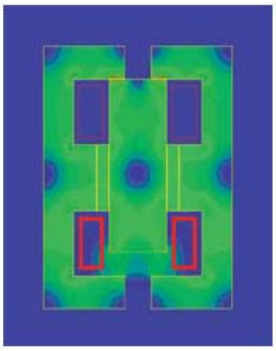


Fig. B - Magnetic circuit with the opening coil supplied.

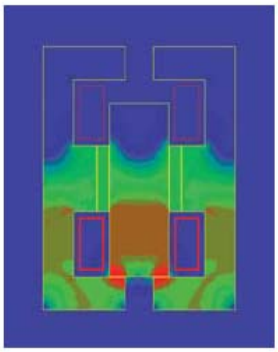


Fig. C - Magnetic circuit in the open position.

"MAC" magnetic drive

ABB has implemented this technology in the field of contactors on the basis of experience gained in the field of circuit-breakers with magnetic drive.

The magnetic drive adapts perfectly to this type of apparatus thanks to its precise linear travel.

The bistable drive, is fitted with an opening and a closing coil. The two coils, individually energized, allow the drive mobile armature to be moved to one of the two stable positions.

The drive shaft is solid with the mobile armature and held in position in a field generated by two permanent magnets, the magnetic field is generated, which attracts and moves the mobile Armature into the opposite position.

Every opening and closing operation creates a magnetic field concurrent with the one generated by the permanent magnets, with the advantage of keeping the intensity of the field itself constant during service, regardless of the number of operations carried out.

The energy needed for operation is not supplied directly by the auxiliary power supply, but is always "stored" in the capacitor which acts as an energy accumulator, and therefore operation always takes place with constant speeds and times, independently of the variation of the power supply voltage from the auxiliary source.

The auxiliary power supply serves to keep the capacitor charged. Consumption is therefore minimal. The power required is less than 5W. In order to recharge capacitor after an operation, there is an inrush of 15W for duration of a few tens of milliseconds.

For the reasons indicated above, both for the DCO and for the SCO versions it is necessary to supply the auxiliary circuits which recharge the capacitor with a continuous auxiliary power supply of 5W. Careful selection of the components and a precise design make the electronic multi-voltage feeder extremely reliable, unaffected by electromagnetic interference generated by the surrounding environment and free of any emissions which may affect other apparatus located in the vicinity.

These characteristics have made it possible for the VSC contactors to pass the electromagnetic compatibility tests (EMC) and obtain the CE mark.

Technical Data

Fused Contactor Truck Type		V7/ZVC		VSC7/ZVC	
HRC HV Fuse (per phase)		Two (Parallel)		One	
Rated Current: Contactor AC-4	A	400		400	
Maximum Fuse Rating	A	550		315	
Fused Contactor Full Load Current	A	400		315	
Rated Frequency	Hz	50-60		50-60	
Rated Voltage	kV	3.6	7.2	3.6	7.2
Power Frequency Withstand – 1 min	kV	10 (16)	20 (32)	10 (16)	20 (32)
Lightning Impulse Withstand	kVpk	40	60	40	60
Short Time Current – 3 sec [1]	kA	50	50	50	50
Overload current (w/o fuse) – 1 sec	kA	6	6	6	6
Withstand Current (w/o fuse) – 30 sec	kA	2.5	2.5	2.5	2.5
Peak Withstand Current	kApk	125 (150)[2]	125 (150)[2]	125 (150)[2]	125 (150)[2]
Load Switching: Motor[3]	kW	2000	4000	1000	2000
	HP	2700	5400	1300	2700
Transformer	kVA	2000	4000	1000	2000
Capacitor (back to back)	kVAR	1000	2000	-	-
Endurance: Electrical – Contactor	AC-1	1000000	1000000	1000000	1000000
	AC-2	100000	100000	100000	100000
	AC-3	100000	100000	100000	100000
	AC-4	[4]	[4]	[4]	[4]
Mechanical – Mechanism	Ops	100000	100000	100000	100000
Mechanical – Truck Isolation / Racking	Ops	1000[5]	1000[5]	1000[5]	1000[5]
Opening Time	ms	12-30	12-30	12-30	12-30
Closing Time	ms	40-80	40-80	40-80	40-80
Control Supply: Contactor hold coil	Vdc	24-60, 100-250			
	Vac	100-250			
Contactor latch coil	Vdc	24-60, 100-250			
	Vac	100-250			
Truck blocking coil	Vdc	24, 30, 48, 60, 110, 125, 220, 240			
	Vac	110, 120, 220, 230, 240			
Under voltage release[6]	Vdc	Not available		24-60, 100-250	
	Vac	Not available		100-250	
Truck racking motor (Remote HV isolation)	Vdc/ac	24, 30, 48, 60, 110, 125, 220, 240		Not available	
	Vac	110, 120, 220, 230, 240		Not available	
Current Interlock[7]	Code	1-4	1-4	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] Standard contactor is suitable for Utilization Categories AC-4. Endurance is a fraction of AC-3.
[5] Heavy duty version, 10,000 isolation racking available on request.
[6] Selectable delays of 0 to 5 sec.
[7] To prevent interchange-ability of fused contactor truck with different ratings or construction

Maximum load currents of the fuses for V7/ZVC Truck

Feeder	Transformers		Motors		Capacitors	
Rated Voltage	Fuse	Max. Load	Fuse	Max. Load	Fuse	Max. Load
3.6kV	550A (2x315)	400A	550A (2x315)	400A	315A	225A
7.2kV	550A (2x315)	400A	550A (2x315)	400A	315A	225A

Maximum load currents of the fuses for VSC7/ZVC Truck

Feeder	Transformers		Motors	
Rated Voltage	Fuse	Max. Load	Fuse	Max. Load
3.6kV	315A	200A	315A	200A
7.2kV	315A	200A	315A	200A

Operating Characteristics

- Ambient temperature: -5ºC…+40ºC
- Relative humidity:<95% (without condensation)
- Altitude: <1000 m a.s.l.

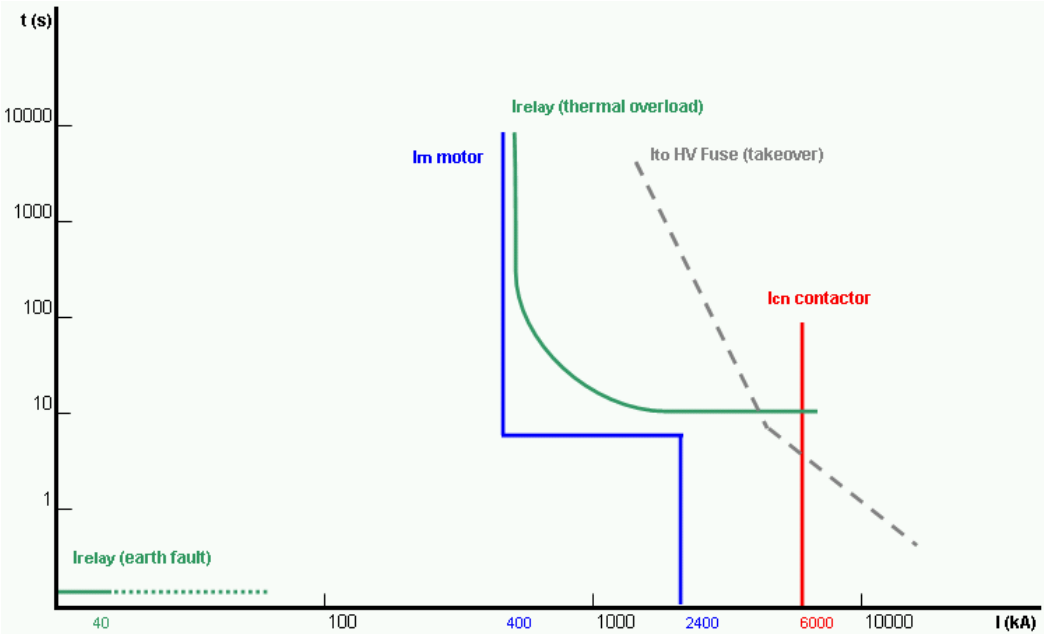
For other conditions, please contact us.

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	Im	Motor rated current Motor starting current Motor starting time	400A 2400A 6 sec
Contactor	Icn	Contactor short circuit breaking current	6000A
Relay	Irelay	Motor thermal overload protection curve Motor earth fault protection curve	10% FLC
HV Fuse	Ito	Take over point between fuse and contactor	

HRC HV Fuse Selection

There are two methods to fuse selection:
1. Plug and Play (OneFuse)
2. Conventional

Refer section on Intelligent MCC and Switchgear system for Plug and Play methodology, where the fuse selection criteria is fault current.

Conventional fuse sizing generally applies to non-Intelligent MCC or where the HV HRC fuses are selected to perform “overload” function. Fuse selection criteria is both load current and fault current.

Motors

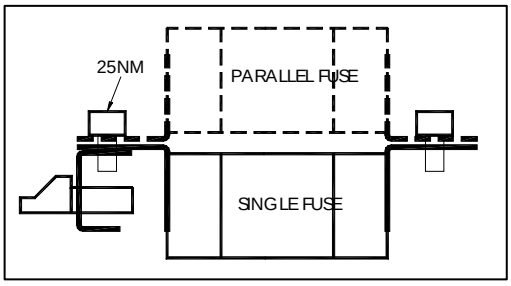
- Fuse Rated Current
  Rated current must be greater than 130% of rated full load motor current.

- Starting (Inrush) Current
  Fuse must meet the requirements for starts per hour at rated run up time. (Note: selection charts are based on 2 starts in succession - remainder evenly spaced).

Transformers

- Fuse Rated Current
  Rated current must be greater than 150% of transformer full load current to allow for normal overcurrent conditions.

- Inrush Current
  (a) Single Phase Transformers < 100 kVA
  Intersection point of 15 times full load current and 0.1 sec. must be to the left side of fuses time current (T.C.) characteristics.
  (b) Other Transformers
  Intersection point of 12 times full load current and 0.15 sec. must be to the left side of fuses time current (T.C.) characteristics.

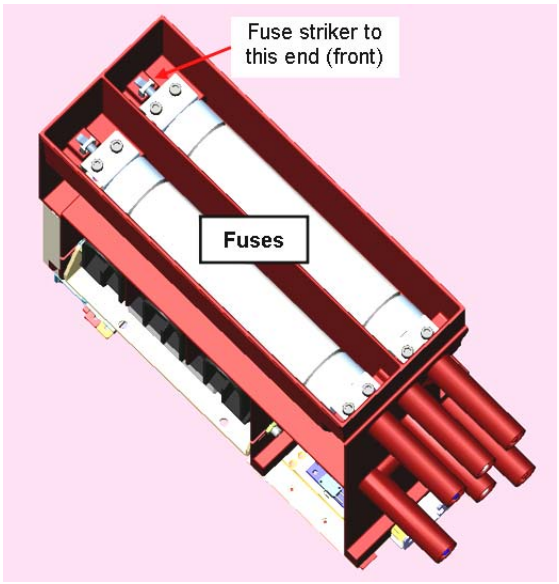


Capacitors

- Fuse Rated Current
  (a) < 350 kVA
  Rated current must be greater than 1.43 times the capacitor rated current where series reactors are not used.
  (b) Other Capacitors
  Rated current must be greater than 1.30 times the capacitor rated current where series reactors are used.

  NOTE: Series reactors of 6% or 7% MUST be used for capacitors above 350 kVA.

- Inrush Current
  (a) No Series Reactor
  Intersection point of 70 times full load current and 0.1 sec. must be to left of T.C. Characteristics.
  (b) Series Reactor
  Intersection point of 5 times full load current and 0.1 sec. must be to left of T.C. Characteristics.



Fuse selection. Service voltage 3300V

Fuse Rating (A)	Transformers		Motors		Capacitors	
	F.L.C.	kVA	F.L.C.	kW	F.L.C.	kVA
63	40A	200	45A	200	40A	250
80	50A	250	60A	280	60A	300
100	65A	325	75A	350	75A	400
125	80A	400	90A	425	90A	500
160	100A	500	120A	550	120A	600
200	130A	700	150A	700	150A	800
225	150A	800	165A	750	165A	900
250	165A	900	185A	800	185A	1000
315	210A	1000	225A	1100	225A	1000
350	230A	1250	270A	1300	225A	1000
400 (2x225)	260A	1400	-	-	-	-
400 (2x225)	300A	1500	300A	1500	-	-
450 (2x250)	360A	2000	335A	1650	-	-
550 (2x315)	400A	2200	400A	2000	-	-

Fuse rated current

Transformer: Fuse rating is 1.5 times max. current
Motors: Fuse rating is 1.3 times max. current
Capacitors: Fuse rating is 1.3 times max. current

Inrush current

Transformer: Time current characteristics must be to the right of the point 12 x F.L.C, 0.1 sec
Motors: Fuse must meet requirements for starts per hour at rated run up time
(Note: selection charts are based on 2 starts in succession - remainder evenly spaced)
Fuse must be selected on basis of F.L.C not kW.
Capacitors: Ratings are based on 6% or 7% reactors in series with capacitors.

Fuse selection. Service voltage 6600V

Fuse Rating (A)	Transformers		Motors		Capacitors	
	F.L.C.	kVA	F.L.C.	kW	F.L.C.	kVAR
63	40A	400	45A	400	40A	500
80	50A	500	60A	550	60A	600
100	65A	750	75A	710	75A	800
125	80A	800	90A	850	90A	1000
160	100A	1000	120A	1100	120A	1200
200	130A	1250	150A	1400	150A	1600
225	150A	1600	165A	1500	165A	1800
250	165A	1750	185A	1750	185A	2000
315	210A	2000	225A	2100	225A	2000
400 (2x225)	260A	2750	-	-	-	-
400 (2x225)	300A	3050	300A	3000	-	-
450 (2x250)	360A	4000	335A	3300	-	-
550 (2x315)	400A	4400	400A	4000	-	-

Fuse Options for ZVC

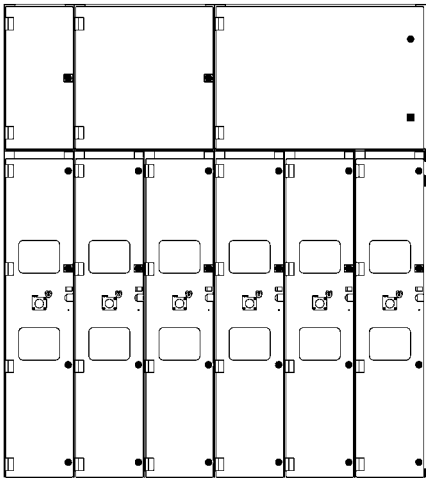
Manufacturer	Order Code/Part No.	Size	Rated Voltage (kV)	Current Range (A)	Maximum Breaking Current (kA)
SIBA	30 269 56	TA2	3.6	50…315	50
SIBA	30 271 56	TA4	7.2	50…315	50
GEC ALSTHOM	K81PEX	TA2	3.6	100…350	40
GEC ALSTHOM	K81SDX	TA4	7.2	50…315	45
Cooper Bussman	3.6WDFHO	TA2	3.6	50…125	50
Cooper Bussman	3.6WFFHO	TA2	3.6	160…200	50
Cooper Bussman	3.6WKFHO	TA2	3.6	250…400	50
Cooper Bussman	7.2WFNHO	TA4	7.2	25…315	40
Cooper Bussman	7.2MROSA	TA4	7.2	50…315	50
XiRong	WFNDF	TA2	3.6	50…400	50
XiRong	WFNDF	TA4	7.2	25…315	50

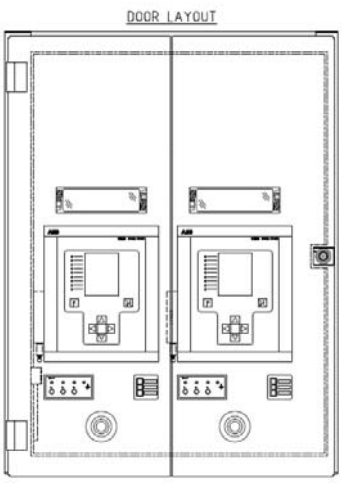
Milisecond counts. Operator safety and equipment protection depends on fault clearing speed.

Low Voltage Compartment

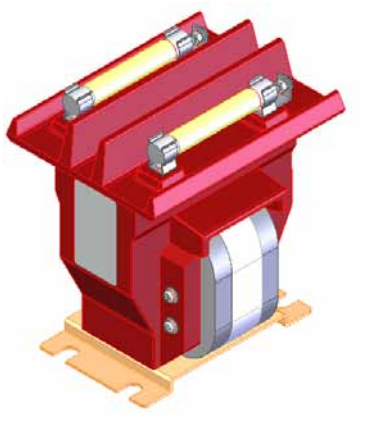
The low voltage compartment is a self-contained unit, isolated electrically and pressure protected from the high voltage chambers. Various height and width designs are available, which allows it to accommodate combinations of equipment. Protection relays, instruments and push buttons can be fitted on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





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		ZVC/RP-612N					
Rated Frequency	Hz	50/60					
Rated Voltage	kV	3.6			7.2		
Service Voltage	kV	2.4	3	3.3	4.16	6.0	6.6
Power Frequency Withstand	kV	10 (16)[1]			20 (32)[1]		
Lightning Impulse Withstand	kVpk	40			60		
Thermal Burden	VA	…300 [2]					
Secondary Voltage	V	110, 120, 220, 230, 240					
Primary Fuse Link	A	1					

[1] Enhanced rating.
[2] Higher thermal burden on request.

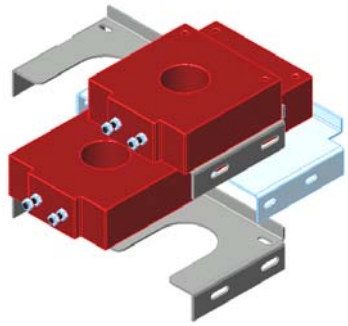
Instrument Transformer

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



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	…4000/1/1/1A	…4000/5/5/5A
Core 1	Design on request	Design on request
Core 2	Design on request	Design on request

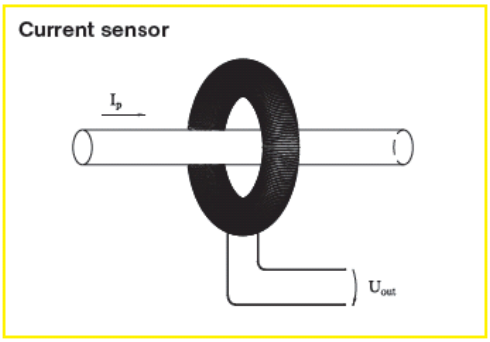
When required a 3-phase current transformer module can be fitted and has been proven to be useful in high impedance differential protection scheme (Cl. PX). It can be mounted in top and bottom power cable entry panel.

Type	ZVC/3TP	ZVC/3TP
Ratio	…4000/1/1/1A	…4000/5/5/5A
Core 1	Cl.PX	Cl.PX
Core 2	Cl.PX	Cl.PX

Current Sensor

Current sensor is designed to comply with standard IEC 60044-8.

The measurement of currents is based on the Rogowski coil principle. A Rogowski coil is a toroidal coil without an iron core placed around the primary conductor in the same way as the secondary winding in a current transformer. A signal reproducing the actual primary current waveform is obtained by integrating the transmitted signal to the matching IED relay for protective and metering functions.

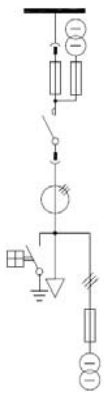


Type	ZVC/KECA
Class	5P30 /1

Voltage Transformer

Voltage transformer is designed to comply with standard IEC 60044-2. Compliance to AS 60044-2 is available.

UniGear ZVC switchgear can be equipped with voltage transformer on load side for protection and measurements.

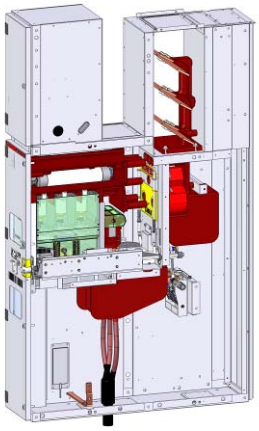


Control Power Transformer Type		ZVC/RP-612N					
Rated Frequency	Hz	50/60					
Rated Voltage	kV	3.6			7.2		
Service Voltage	kV	2.4	3	3.3	4.16	6.0	6.6
Power Frequency Withstand	kV	10 (16)[1]			20 (32)[1]		
Lightning Impulse Withstand	kVpk	40			60		
Voltage Factor (continuous)		1.2					
Accuracy Class		1					
Minimum Burden	VA	50 [2]					
Secondary Voltage	V	110, 120, 220, 230, 240					
Primary Fuse Link	A	1					

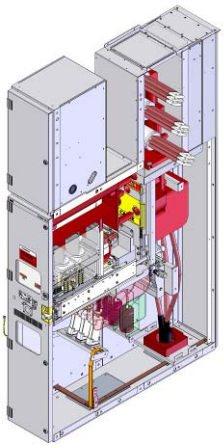
[1] Enhanced rating.
[2] Higher burden on request.

Power Cable Entry

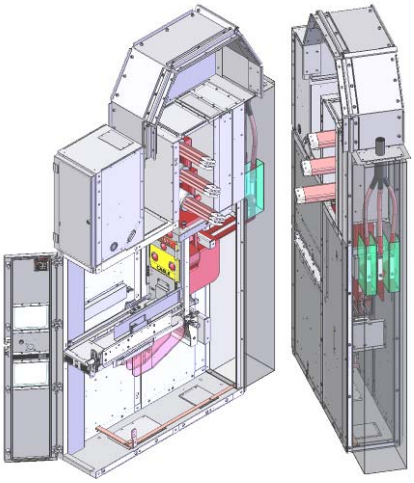
The power cable termination compartment is accessible from the front, rear or top. Two types of cable termination are available, i.e. bolt-on or plug-in.



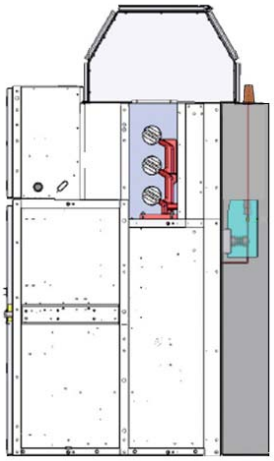
Bottom Front (bolt-on termination)



Bottom Rear (bolt-on connection)

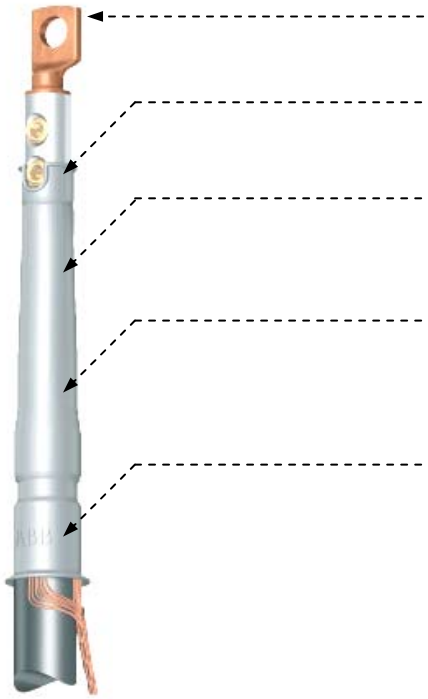


Top Rear (bolt-on termination)



Top Rear (plug-in termination)

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 amaterial 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 masticembeds the screen wires for a reliable seal.

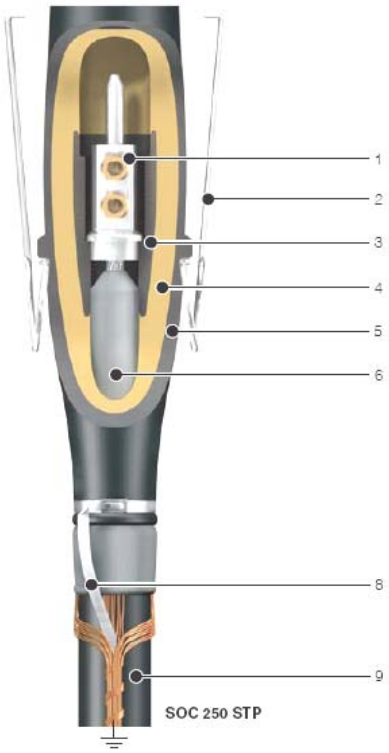
Note: Cable termination kits are supplied with 1.5 meter tails and cable lugs.

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 3.3/6.6kV

Designation	XLPE-ϕ (mm)	Conductor cross section (mm^2)	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. 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

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 fi xed 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.

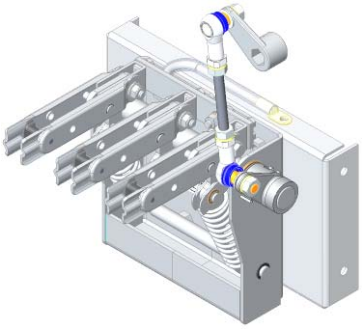
9. **Designed for polymeric insulated cables:** SOC screened connectors can be installed on XLPE as screened separable plug-in connector for XLPE-insulated 1- or 3-core cable with Al or Cu conductor. The connectors are supplied in kits of three. The connector fits standard bushings in accordance with 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. Can be installed indoors as well as outdoors. Supplied complete with screw cable lug for the cable.

Designation	XLPE-ϕ (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

Earth Switch

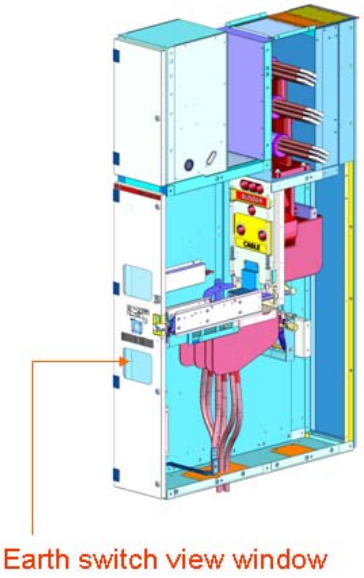


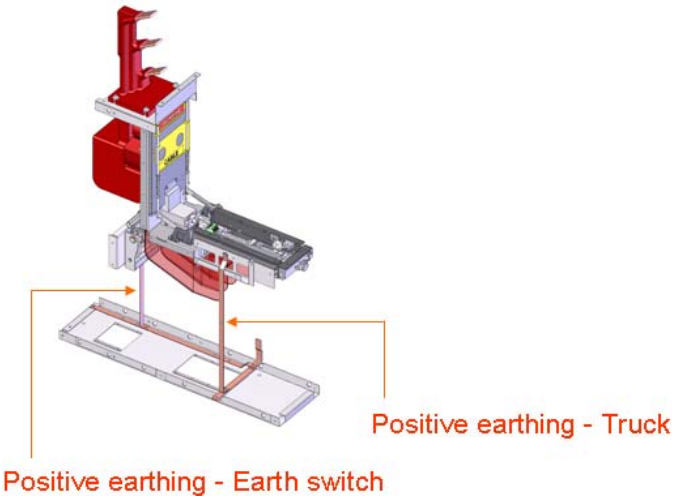
Earthing switch type ZVCE7 conforms to the requirements of IEC 60251-1.They are fitted with manual snap-action operating mechanisms for positive high-speed closing and sufficiently dimensioned to conduct the rated short circuit making current up to 50kA when coordinated with HV HRC fuses. The speed of 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)[1]
Lightning Impulse Withstand	kVpk	60
Short Time Current – 3 sec	kA	50
Peak Withstand Current	kApk	125 (150)[2]
Making capacity[3]	kA	50
Control Supply – Blocking coil	Vdc	24, 30, 48, 60, 110, 125, 220, 240
	Vac	110, 120, 220, 230, 240

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

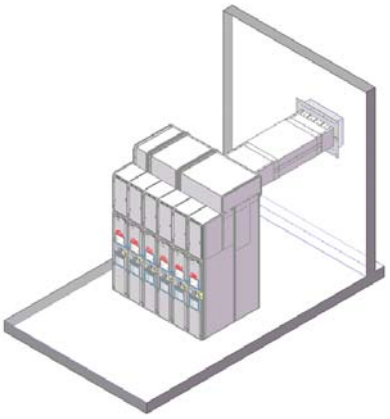




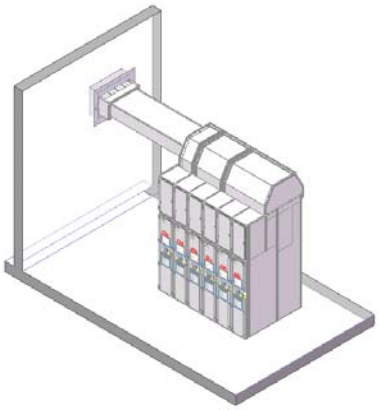
Arc Duct

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.

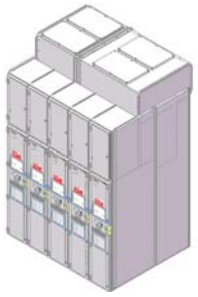
UniGear ZVC switchgear system arc duct channel is type tested to 50kA fault overpressure, can be used to direct hazardous gasses away from operators and surrounding equipment. Contact ABB for recommendation on best solution for your installation.



Compact Version



Standard Version



Top Chimney Version

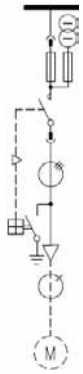
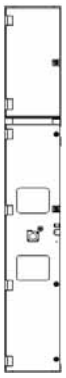
Arc Duct Type	Standard	Compact	Top Chimney	None[1]	None[2]
Ceiling height					
≥ 4 m	AFLR 50kA (…1 sec)	AFLR 50kA (…1 sec)	AFLR 50kA (…1 sec)	AFL 50kA (0.1 sec)	AFL 50kA[3]
≥ 3 m	AFLR 50kA (…1 sec)	AFLR 50kA (…1 sec)	AFLR 50kA (…1 sec)	AFL 50kA (0.1 sec)	AFL 50kA[3]
≥ 2.8 m	Not available	AFLR 50kA (…1 sec)	AFLR 50kA (…1 sec)	AFL 50kA (0.1 sec)	AFL 25kA (0.5 sec)
≥ 2.5 m	Not available	Not available	Not available	AFL 50kA (0.1 sec)	AFL 25kA (0.5 sec)

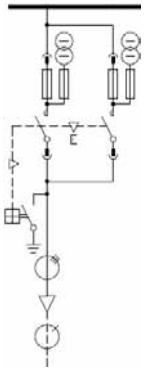
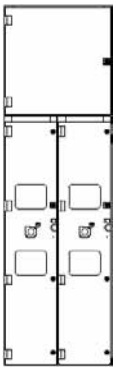
[1] No arc duct but with extra measure I_{TH}-Limitation.
[2] No arc duct.
[3] Contact us for duration recommendation.

UniGear ZVC switchgear system arc duct channel is type tested to 50kA fault overpressure, can be used to direct hazardous gasses away from operators and surrounding equipment.

Applications – Indoor and Outdoor

Motor Starter (Direct On Line)

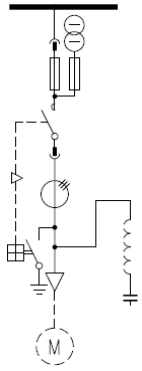
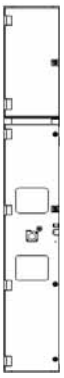
Motor Starter (DOL)	ZVC	Ratings		
		Circuit Full Load Current	A	..400
		Rated Frequency	Hz	50-60
		Rated Voltage	kV	..7.2
		Power Frequency Withstand	kV	..32
		Lightning Impulse Withstand	kVpk	..60
		Short Time Current – 3 sec	kA	..50
		Width	mm	325
		Depth[1]	mm	1304
		Height[2]	mm	2200

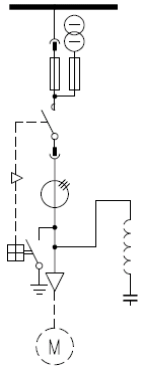
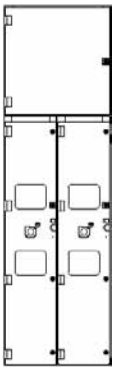
Motor Starter (DOL)	ZVC	Ratings		
		Circuit Full Load Current	A	..800
		Rated Frequency	Hz	50-60
		Rated Voltage	kV	..7.2
		Power Frequency Withstand	kV	..32
		Lightning Impulse Withstand	kVpk	..60
		Short Time Current – 3 sec	kA	..50
		Width	mm	650
		Depth[1]	mm	1304
		Height[2]	mm	2200
		Note: Parallel circuits		

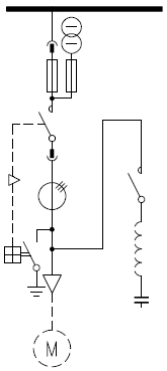
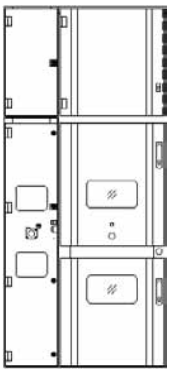
[1] Bottom power cable entry version. Top cable power entry version 1304 or 1554mm.
[2] Larger LV compartment with corresponding total panel height 2400 and 2596mm available.

Shell prefers ZVC product for its track record and after sales support – Pearl GTL, Qatar

Motor Starter with Power Factor Correction

Motor Starter with PFC	ZVC-PFC3	Ratings		
		Circuit Full Load Current[3]	A	..260
		Rated Frequency	Hz	50-60
		Rated Voltage	kV	..3.6
		Power Frequency Withstand	kV	..10
		Lightning Impulse Withstand	kVpk	..40
		Short Time Current – 3 sec	kA	..50
		Width	mm	325
		Depth[1]	mm	1304
		Height[2]	mm	2200
		Note: Integrated capacitor and reactor		

Motor Starter with PFC	ZVC-PFC6	Ratings		
		Circuit Full Load Current[3]	A	..260
		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	650
		Depth[1]	mm	1304
		Height[2]	mm	2200
		Note: Integrated capacitor and reactor		

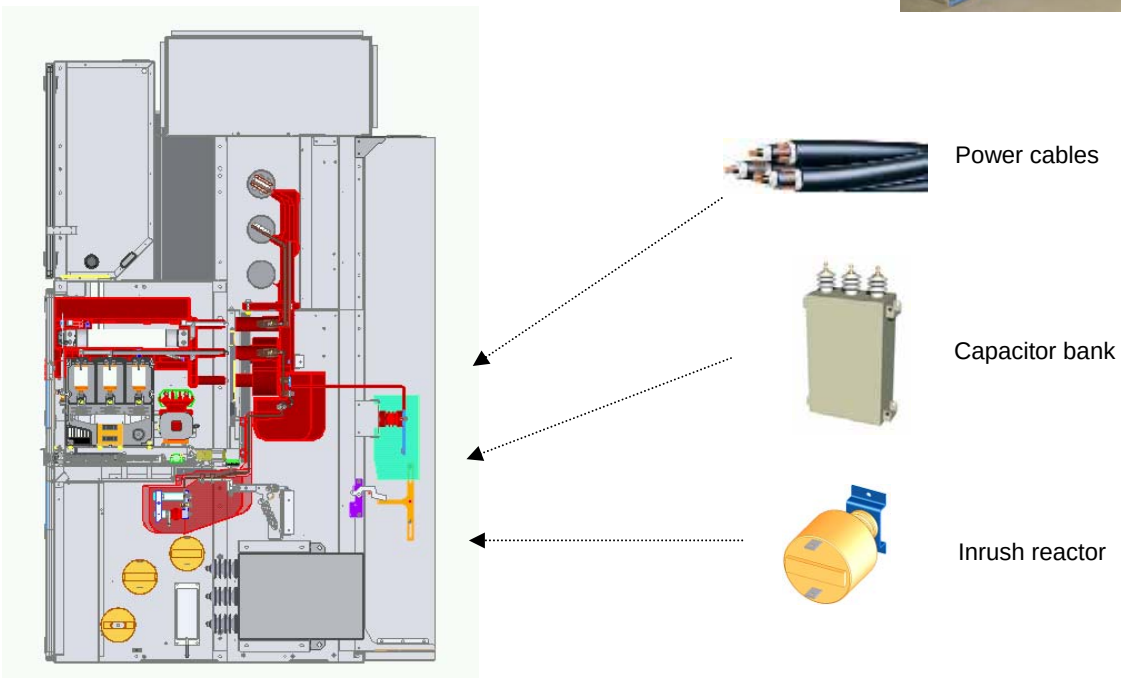
Feeder with PFC+Cont	ZVC-PFCC	Ratings		
		Circuit Full Load Current[3]	A	..260
		Rated Frequency	Hz	50-60
		Rated Voltage	kV	..7.2
		Power Frequency Withstand	kV	..32
		Lightning Impulse Withstand	kVpk	..60
		Short Time Current – 3 sec	kA	..50
		Width	mm	975
		Depth[1]	mm	1340
		Height[2]	mm	2200
		Note: Integrated capacitor and reactor		

[1] Bottom power cable entry version. Top cable power entry version 1304 or 1554mm.
[2] Larger LV compartment with corresponding total panel height 2400 and 2596mm available.
[3] Maximum back to back capacitor switching 260A.

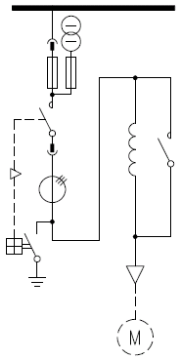
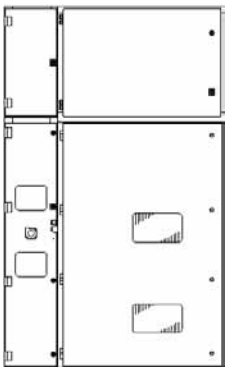
Motor Starter with Power Factor Correction type ZVC-PFC3

UniGear ZVC panel can be equipped with capacitor bank and inrush limiting reactor. Benefits are:

- Minimise site work by maximising factory installation, cabling and test
- Can be delivered to site in 3 preassemble units
- Top or bottom entry
- Cost competitive compare to conventional systems, especially in remote locations

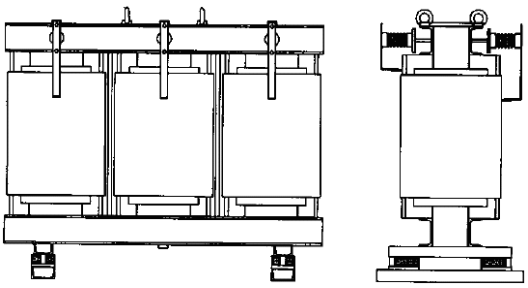


Primary Reactor Starter

Reactor Starter	ZVC-REA	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	1325
		Depth[1]	mm	1800
		Height[2]	mm	2200
		Note: Integrated primary reactor		

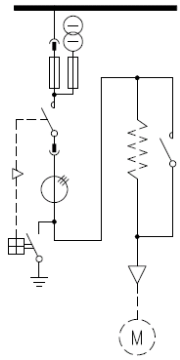
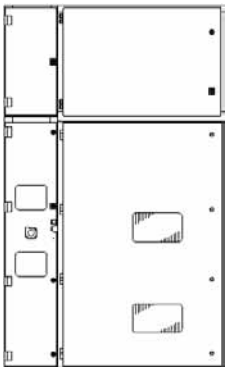
[1] Bottom power cable entry version. Top cable power entry version 1840mm.
[2] Larger LV compartment with corresponding total panel height 2400 and 2596mm available.

Reactor starter have a three phase reactor to limit the starting current which during start, are connected in series with the supply to the motor. The reactor limits starting current drawn by the motor thus reduce the starting torque of the motor



Dalrymple Bay Coal Terminal, one of the workd's largest coal export port chose ZVC with integrated capacitor bank and reactor to power its processes – Hay Point, Australia

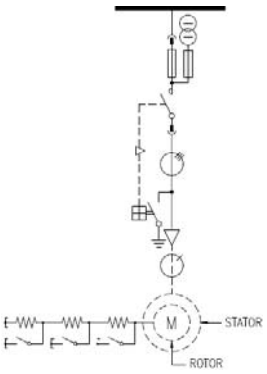
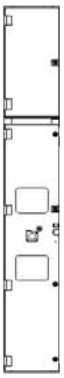
Primary Resistor Starter

Resistor Starter	ZVC-RES	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	1325
		Depth[1]	mm	1800
		Height[2]	mm	2200
		Note: Integrated primary resistor		

[1] Bottom power cable entry version. Top cable power entry version 1840mm.
[2] Larger LV compartment with corresponding total panel height 2400 and 2596mm available.

China National Nuclear Corporation decided on ZVC for its compactness and reliability – Qinshan, China.

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[1]	mm	1304
		Height[2]	mm	2200
		Note: External secondary resistor		

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

Slip Ring Induction Starter type ZVC-SRI

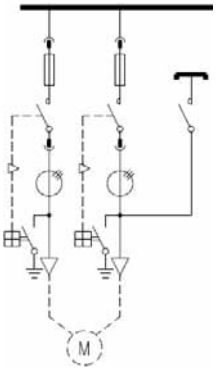
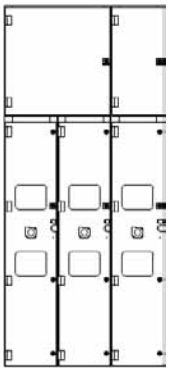
Slip ring or wound rotor motor is an induction machine where the rotor comprises a set of coils that are terminated in slip rings to which external resistors can be connected. The stator is the same as is used with a standard squirrel cage motor.

Types of resistors are available:
(1) Liquid Resistance
(2) Resistors in air housing

Typical applications:
(1) Mills
(2) Crusher

Resistor banks in housing

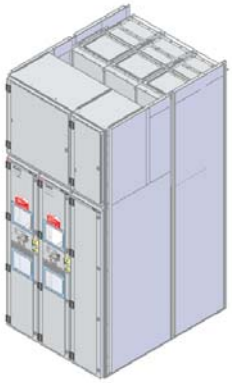
Star Delta Starter

Star Delta Starter	ZVC-SD	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	975
		Depth[1]	mm	1304
		Height[2]	mm	2200

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

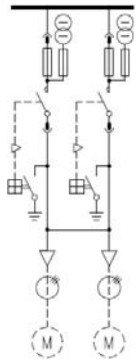
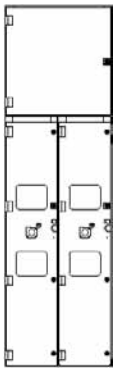
Star Delta Starter type ZVC-SD

Star/Delta starters are probably the most common reduced voltage starters in the 50Hz world, (known as Wye/Delta starters in the 60Hz world). They are used in an attempt to reduce the start current applied to the motor during start as a means of reducing the disturbances and interference on the electrical supply. Star/Delta (or Wye/Delta) starter is one of the lowest cost reduced voltage starters that can be applied and this is why it has been so popular.

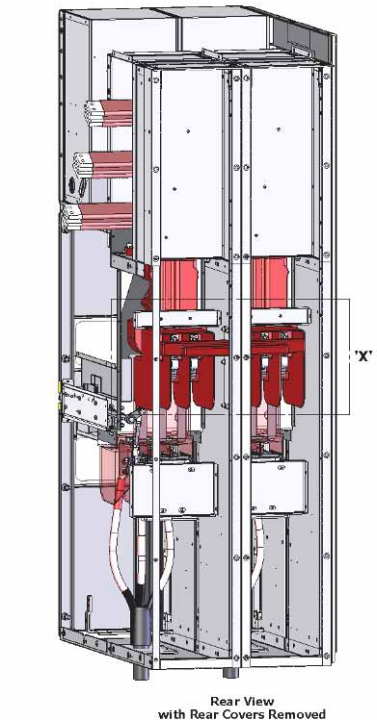


Port Waratah Coal services operate the world's largest and most efficient coal handling operation with ZVC brakes – Newcastle - Australia

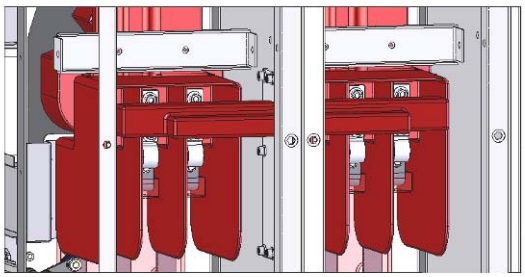
Forward Reverse Starter

Forward Reverse	ZVC-RS	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	650
		Depth[1]	mm	1304
		Height[2]	mm	2200

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

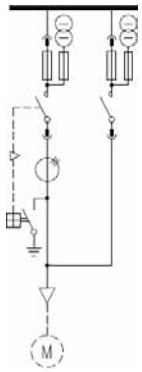
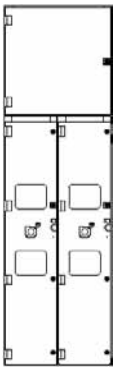


Rear View
with Rear Covers Removed

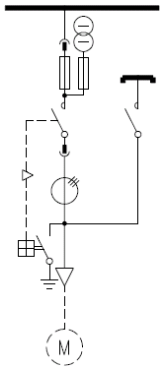
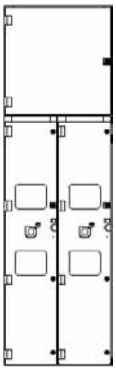

Detail 'X'

Brake

Plug Brake[1]

Plug Brake	ZVC-BP	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	650
		Depth[2]	mm	1304
		Height[3]	mm	2200

DC Injection Brake

DC Brake	ZVC-BDC	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	650
		Depth[2]	mm	1304
		Height[3]	mm	2200
		Note: DC limit: …1000V, …400A		

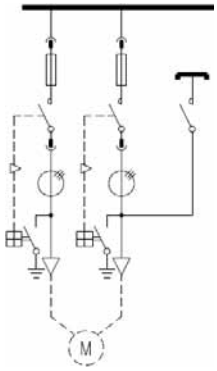
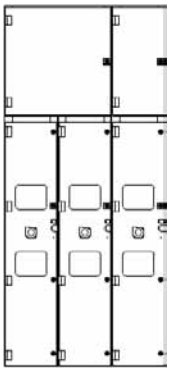
[1] Also known as Dynamic or AC Brake.
[2] Bottom power cable entry version. Top cable power entry version 1304 or 1554mm.
[3] Larger LV compartment with corresponding total panel height 2400 and 2596mm available.

Applications

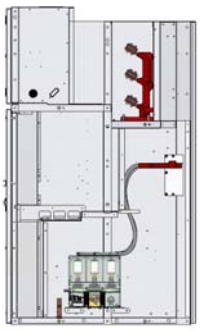
Being able to stop safely and precisely is as important as being able to start quickly. Obvious examples include conveyors, hoists, cranes, elevators, feed lines and many other processes. An electrical brake system is often used as the main brake during normal operation to decelerate the machine from high to zero speed in order to avoid excessive wear of the mechanical brake. Mechanical brake takes over in shutdown and emergency situations.

Plug brake applies a heavy reverse braking torque at the instant of switching over.
DC brake applies an adjustable controlled braking torque to suit the requirements. DC injection braking can be performed without a frequency converter. The same effect can be achieved using suitable DC excitation equipment.

Two Speed Starter

Two Speed Starter	ZVC-2S	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	975
		Depth[1]	mm	1304
		Height[2]	mm	2200

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

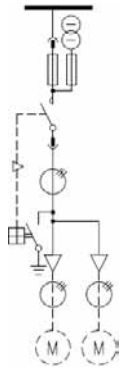
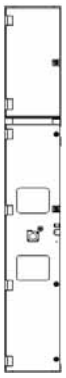


Two Speed Starter type ZVC-2S

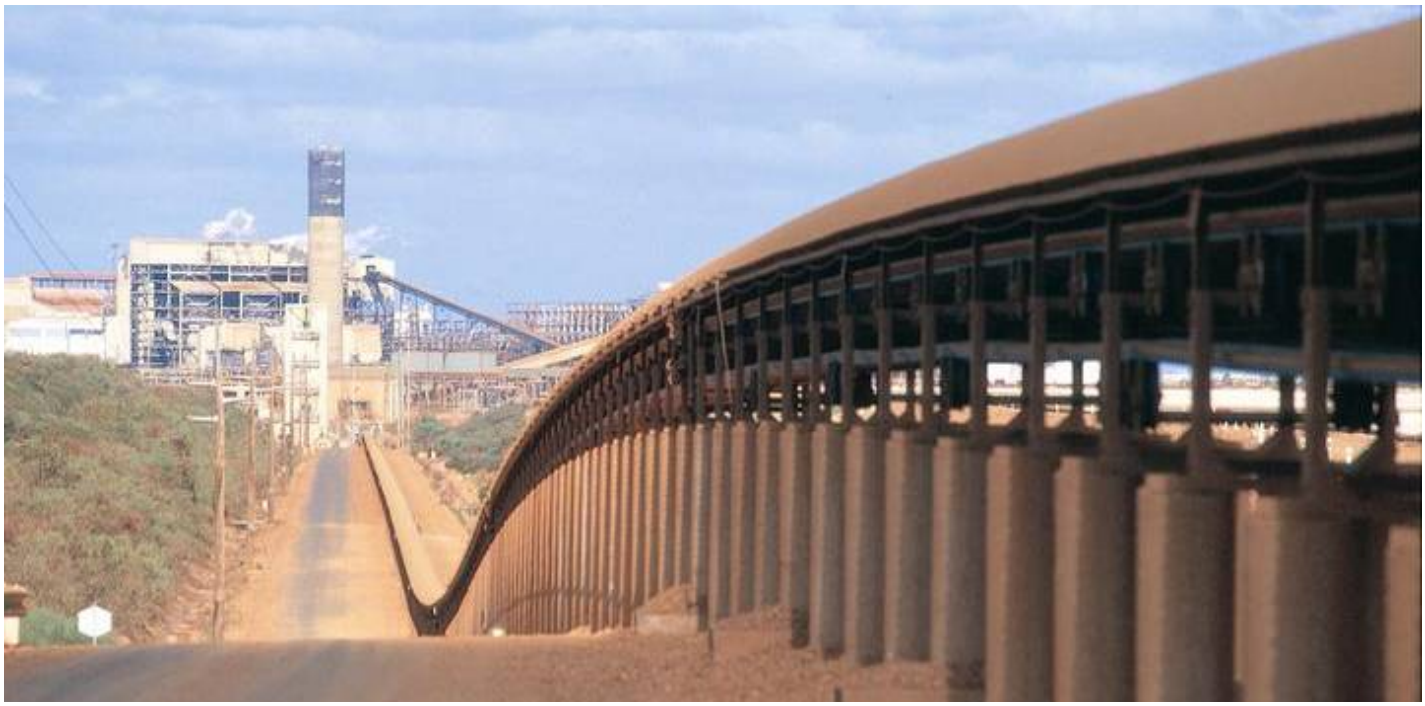
Two speed single winding variable torque motors are commonly used for air coolers in industrial processes. These applications require a limited amount of speed control but the application does not warrant adjustable speed drives.

Shell chose ZVC-2S two speed starter to control the ethylene cracker process – Jurong Island, Singapore

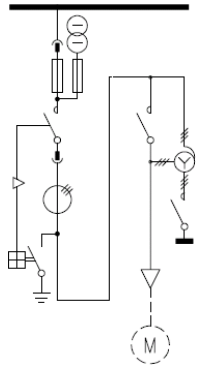
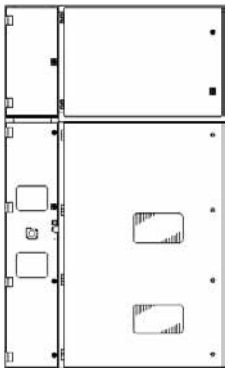
Conveyor Belt Double Motor Feeder

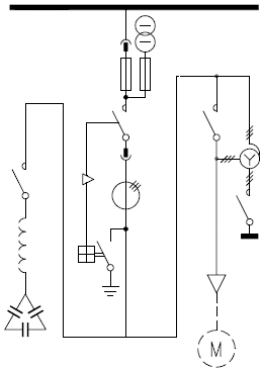
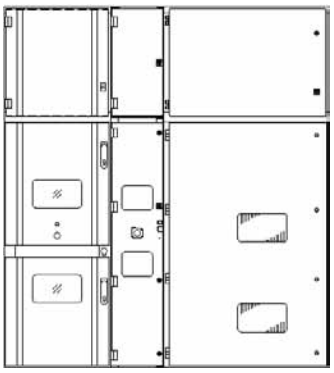
Double Feeder	ZVC-DF	Ratings		
		Circuit Full Load Current	A	..400
		Rated Frequency	Hz	50-60
		Rated Voltage	kV	..7.2
		Power Frequency Withstand	kV	..32
		Lightning Impulse Withstand	kVpk	..60
		Short Time Current – 3 sec	kA	..50
		Width	mm	325
		Depth[1]	mm	1304
		Height[2]	mm	2200

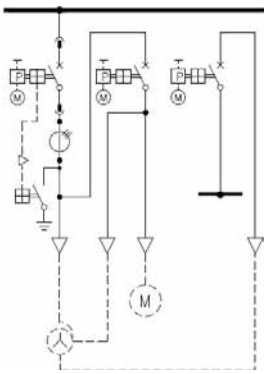
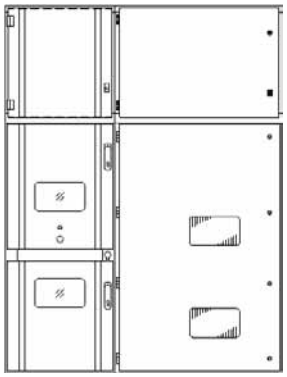
[1] Bottom power cable entry version. Contact us for Top cable power entry version.
[2] Larger LV compartment with corresponding total panel height 2400 and 2596mm available.



Auto-Transformer Starter

Auto-Transformer	ZVC-AT	Ratings		
		Circuit Full Load Current	A	..300
		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	1325
		Depth[1]	mm	1800
		Height[2]	mm	2200
		Note: Integrated auto-transformer		

Auto-Transformer PFC	ZVC-ATC	Ratings		
		Circuit Full Load Current	A	..300
		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	1975
		Depth[1]	mm	1800
		Height[2]	mm	2200
		Note: Integrated auto-transformer and capacitor		

Auto-Transformer	ZVC-AT17	Ratings		
		Circuit Full Load Current	A	..1250
		Rated Frequency	Hz	50-60
		Rated Voltage	kV	..17.5
		Power Frequency Withstand	kV	..38
		Lightning Impulse Withstand	kVpk	..95
		Short Time Current – 3 sec	kA	..50
		Width[3]	mm	1650
		Depth[1]	mm	1800
		Height[2]	mm	2200
		Note: External auto-transformer. Capacitor on request.		

[1] Bottom power cable entry version. Top cable power entry version has the same depth.
[2] Larger LV compartment with corresponding total panel height 2400 and 2596mm available.
[3] Width for short time current 31.5kA version 1650mm. Width for 50kA version 1850mm

Auto-Transformer Starter

Auto transformer starter uses an auto transformer to reduce the voltage applied to a motor during start. The auto transformer may have a number of output taps and be set-up to provide a single stage starter, or a multistage starter.

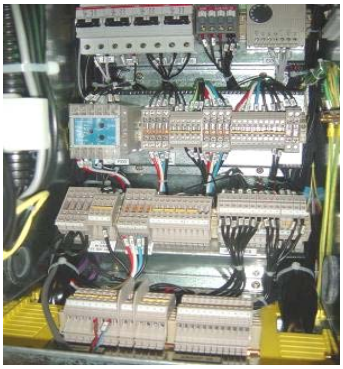
Typically, the auto transformer would have taps at 50%, 65% and 80% voltage, enabling the motor to be started at one or more of these settings.

Construction of UniGear type ZVC-AT



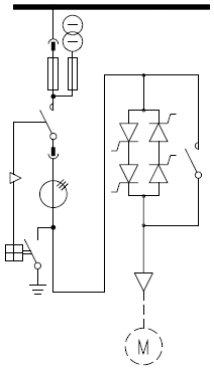
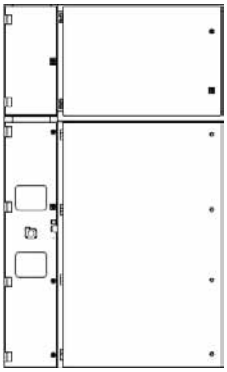


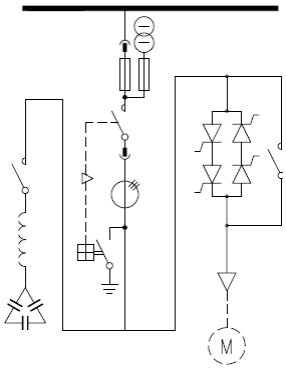
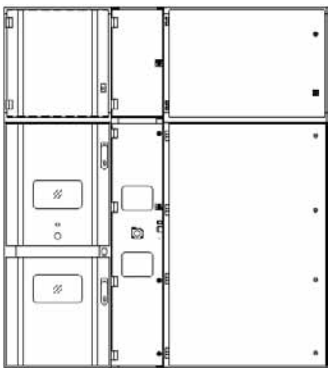




Soft Starter

Soft Starter	ZVC-SS	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	1325
		Depth[1]	mm	1554
		Height[2]	mm	2200
		Note: Integrated soft start power electronics		

Soft Starter with PFC	ZVC-SSC	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	1975
		Depth[1]	mm	1554
		Height[2]	mm	2200
		Note: Integrated soft start, capacitor, reactor		

[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 2596mm available.
[3] Width for short time current 31.5kA version 800mm. Width for 50kA version 1000mm
[4] Contact us for higher current rating.

Soft Starter type ZVC-SS

Soft starter is another form of reduced voltage motor starter. The soft starter employs solid state devices to control the current flow and therefore the voltage applied to the motor.

Control	
Constant current	
Current ramp	
Kick start	
Coast to stop	
Timed voltage ramp	
Pump control stop	
Customised acceleration and deceleration profile	

Communication	
Profibus DP	
Modbus®	
DeviceNet	
Others, please contact ABB	

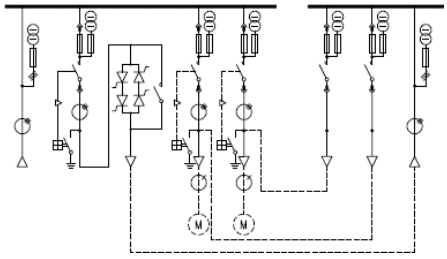
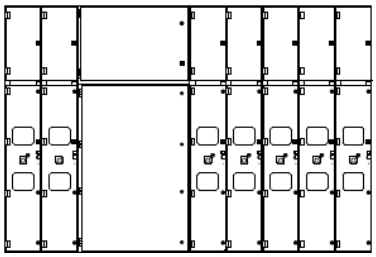
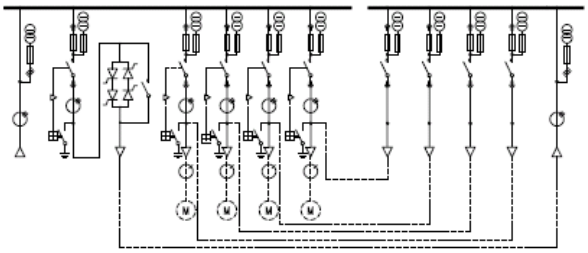
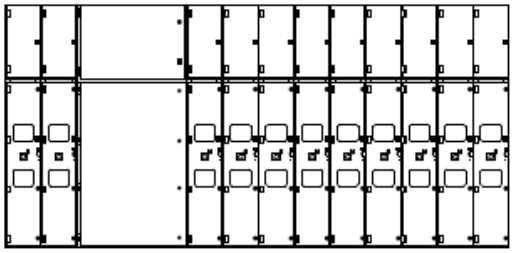
Soft Starter Protection and Control	
Maximum start time	48
Too many starts	66
Undercurrent	37
Load Increase (alarm)	51L
Overcurrent - jam	51R
Overcurrent - short	50
Thermal overload	49/51
Current imbalance	46
Positive/negative phase sequence	
Undervoltage	27
Overvoltage	59
Phase loss	47
Phase sequence	47
Ground fault	50G
Communications failure	3
Internal failure	3
Ext. fault 1/code - 1	86/97
Ext. fault 1/code - 2	
Motor overtemperature	38
Stator winding overtemperature	49

Multi-Motor Starter for Drives and Soft Starter

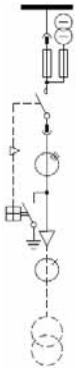
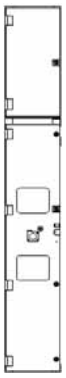
It is common in large plants to find one motor starter driving multiple loads. This multi-motor starter method is utilised to reduce investment cost of expensive starters by minimising quantity of drives and/or soft starter. It is also normal to find multi-motor starter with reactor, resistor or auto-transformer. UniGear ZVC-MMS with its unique control and configurability is well equipped to provide this economical solution.

There are few key considerations when using this motor starter method:

1. Number of motors sharing one single starter
2. Multiple motors with same starting characteristics
3. Multiple motors with different starting characteristic
4. Only one motor start at a time
5. Redundancy of multi-motor starter

Multi-Motor Starter (2 motors)	ZVC-MMS2
	
Multi-Motor Starter (4 motors)	ZVC-MMS4
	

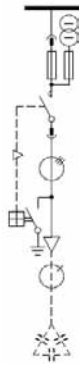
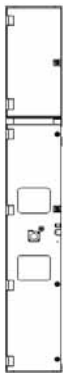
Transformer Feeder

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[1]	mm	1304
		Height[2]	mm	2200

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

BP elected to use ZVC product technology for it's most efficient PTA plant – Zhuhai, China.

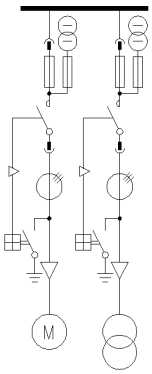
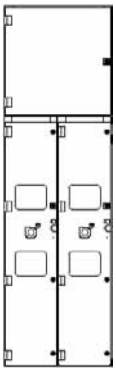
Capacitor Feeder

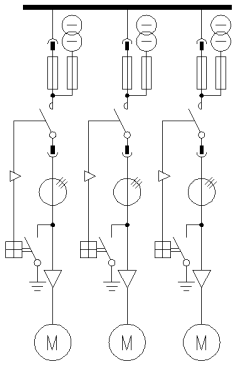
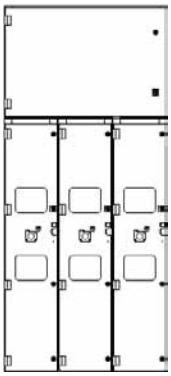
Capacitor Feeder	ZVC	Ratings		
		Circuit Full Load Current	A	..260
		Rated Frequency	Hz	50-60
		Rated Voltage	kV	..7.2
		Power Frequency Withstand	kV	..32
		Lightning Impulse Withstand	kVpk	..60
		Short Time Current – 3 sec	kA	..50
		Width	mm	325
		Depth[1]	mm	1304
		Height[2]	mm	2200

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

ConocoPhillips has ZVC powering the floating platform and on-shore Darwin LNG plant – Bayu Undan, Timor Sea.

Preassembled Module

Preassembled Module	ZVC-2P	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	650
		Depth[1]	mm	1304
		Height[2]	mm	2200

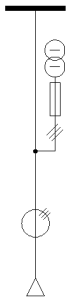
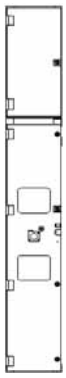
Preassembled Module	ZVC-3P	Ratings		
		Circuit Full Load Current	A	..400
		Rated Frequency	Hz	50-60
		Rated Voltage	kV	..7.2
		Power Frequency Withstand	kV	..32
		Lightning Impulse Withstand	kVpk	..60
		Short Time Current – 3 sec	kA	..50
		Width	mm	975
		Depth[1]	mm	1304
		Height[2]	mm	2200

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

Today's projects demand a quick delivery schedule. The ability to energise faster may mean profit generation of millions of dollars. ZVC-2P and ZVC-3P are designed to meet these challenges, factory assembled and tested delivered direct to site.

ZVC-3P is a direct replacement of the superseded product ABB UniMotor, making it especially suitable to the Marine industry. Three (3) contactors are delivered in one compact module. ***Compared to UniMotor, ZVC-3P has the advantage of smaller dimensions and can be mounted against the wall, i.e does not require rear cabling space.***

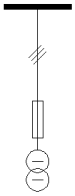
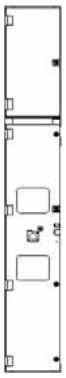
Cable to Bus

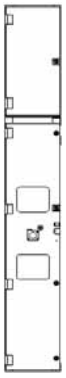
Cable to Bus	ZVC-CTB	Ratings		
		Circuit Full Load Current	A	..2000
		Rated Frequency	Hz	50-60
		Rated Voltage	kV	..7.2
		Power Frequency Withstand	kV	..32
		Lightning Impulse Withstand	kVpk	..60
		Short Time Current – 3 sec	kA	..31.5
		Width	mm	325
		Depth[1]	mm	1304
		Height[2]	mm	2200

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

BHP Billiton opted for ZVC integrated continuous temperature monitoring technology – Port Hedland, Australia.

Metering

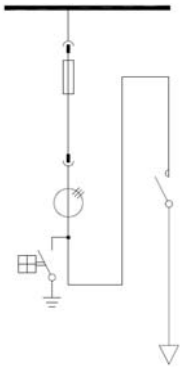
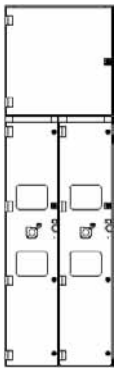
Metering	ZVC-MF	Ratings		
		Circuit Full Load Current	A	N/A
		Rated Frequency	Hz	50-60
		Rated Voltage	kV	..7.2
		Power Frequency Withstand	kV	..32
		Lightning Impulse Withstand	kVpk	..60
		Short Time Current – 3 sec	kA	..50
		Width	mm	325
		Depth	mm	1304
		Height[1]	mm	2200

Metering	ZVC-MW	Ratings		
		Circuit Full Load Current	A	N/A
		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	mm	1304
		Height[1]	mm	2200

[1] Larger LV compartment with corresponding total panel height 2400 and 2596mm available.

One of the world's largest dragline "Bucyrus 8750" has one of the world's most compact MCC "UniGear ZVC" providing control and power – Ensham Bowen Basin, Aunstralia

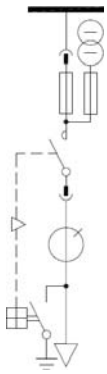
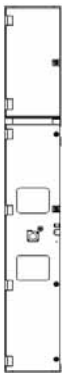
Fixed Contactor

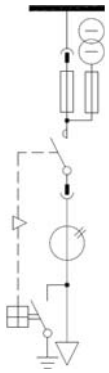
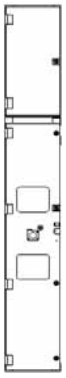
Fixed Contactor	ZVC-F	Ratings		
		Circuit Full Load Current	A	..400
		Rated Frequency	Hz	50-60
		Rated Voltage	kV	..7.2
		Power Frequency Withstand	kV	..32
		Lightning Impulse Withstand	kVpk	..60
		Short Time Current – 3 sec	kA	..50
		Width	mm	650
		Depth	mm	1304
		Height[1]	mm	2200

[1] Larger LV compartment with corresponding total panel height 2400 and 2596mm available.

Woodside has been using ZVC for more than 20 years – Enfield FPSO, Australia.

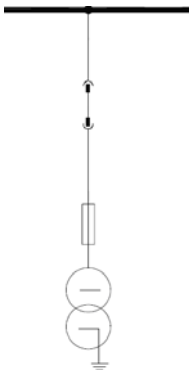
Railway

Railway Heating Load	ZVC-R1	Ratings		
		Circuit Full Load Current	A	..1200
		Rated Frequency	Hz	50-60
		Service Voltage	kV	..1.5
		Power Frequency Withstand	kV	..32
		Lightning Impulse Withstand	kVpk	..60
		Short Time Current – 3 sec	kA	..50
		Width	mm	325
		Depth[1]	mm	1304
		Height[2]	mm	2200
		Note: One pole		

Railway Traction	ZVC-R2	Ratings		
		Circuit Full Load Current	A	..400
		Rated Frequency	Hz	50-60
		Service Voltage	kV	..2.2
		Power Frequency Withstand	kV	..32
		Lightning Impulse Withstand	kVpk	..60
		Short Time Current – 3 sec	kA	..50
		Width	mm	325
		Depth[1]	mm	1304
		Height[2]	mm	2200
		Note: Two pole		

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

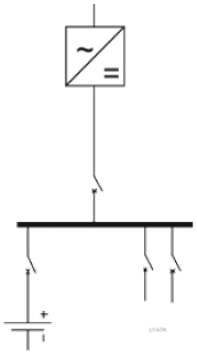
AC Power System

AC Power	ZVC-ACP	Ratings		
		Power	kVA	..5
		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	650
		Depth[1]	mm	1340
		Height[2]	mm	2200
		Note: Integrated withdrawable isolation link truck		

[1] Depth 1554 and 1800 available for larger size control power transformer.
[2] Larger LV compartment with corresponding total panel height 2400 and 2596mm available.

Rio Tinto selected compact ZVC for its underground mine – Argyle Diamond, Australia

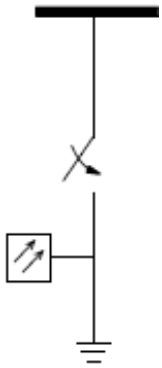
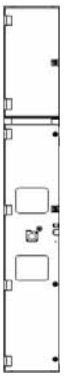
DC Power System

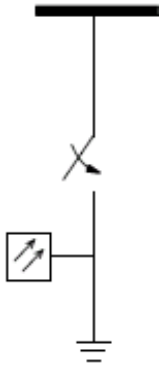
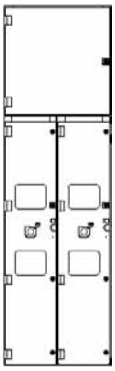
DC Power	ZVC-DCP	Ratings		
		Charger or Rectifier Input	Vac	[4]
		Battery Output[5]	Vdc	[4]
		Capacity	Ah	[4]
		Autonomy time	hrs	[4]
		Battery type	[4]	
		Discharge resistor	Yes / No	
		Width[3]	mm	650
		Depth[1]	mm	1340
		Height[2]	mm	2200
		Note: Integrated battery, charger or rectifier		

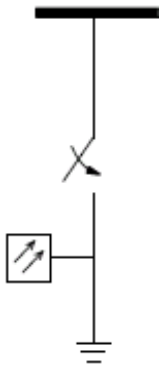
[1] Depth 1554 and 1800 available for larger size battery rack.
[2] Larger LV compartment with corresponding total panel height 2400 and 2596mm available.
[3] Width 800 and 1000 available for larger size battery rack.
[4] Project specific rating.

ExxonMobil chose ZVC for its performance in extreme conditions – Sakhalin. Russia

Arc Terminator System

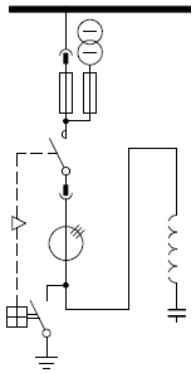
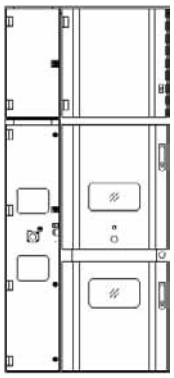
Arc Terminator	ZVC-ArcTS	Ratings		
		Rated Voltage	kV	..7.2
		Power Frequency Withstand	kV	..32
		Lightning Impulse Withstand	kVpk	..60
		Rated Frequency	Hz	50-60
		Short Time Current – 3 sec	kA	..40
		Width	mm	325
		Depth	mm	1304
		Height[2]	mm	2200
		Note: Double LV Box required.		

Arc Terminator	ZVC-ArcTS	Ratings		
		Rated Voltage	kV	..7.2
		Power Frequency Withstand	kV	..32
		Lightning Impulse Withstand	kVpk	..60
		Rated Frequency	Hz	50-60
		Short Time Current – 3 sec	kA	..50[1]
		Width	mm	650
		Depth	mm	1304
		Height[2]	mm	2200

Arc Terminator	ZVC-ArcTS	Ratings		
		Rated Voltage	kV	..17.5
		Power Frequency Withstand	kV	..38
		Lightning Impulse Withstand	kVpk	..95
		Rated Frequency	Hz	50-60
		Short Time Current – 3 sec	kA	..50[1]
		Width	mm	650
		Depth	mm	1340
		Height[2]	mm	2200
		Note: Extension to other switchgear on request.		

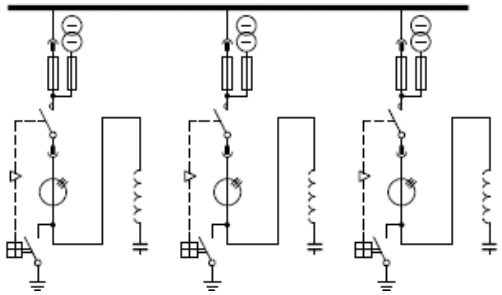
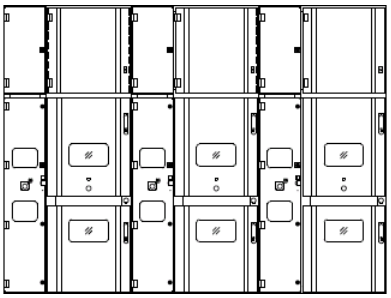
[1] Higher rating on request
[2] Larger LV compartment with corresponding total panel height 2400 and 2596mm available.

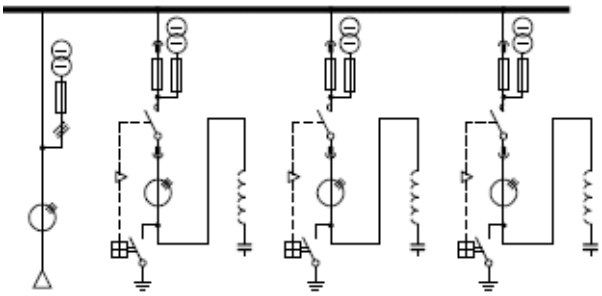
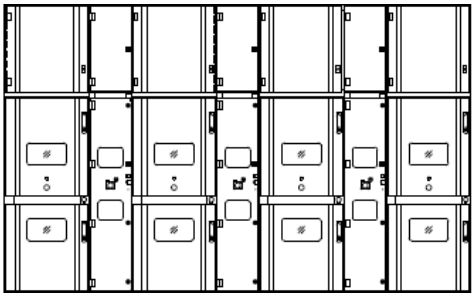
Reactive Power Compensation

Individual Compensation	ZVC-RPCI	Ratings		
		Individual Circuit Full Load Current[1]	A	..400
		Rated Frequency	Hz	50-60
		Rated Voltage[1]	kV	..7.2
		Power Frequency Withstand	kV	..32
		Lightning Impulse Withstand	kVpk	..60
		Short Time Current – 3 sec	kA	..50
		Width[2]	mm	975
		Depth[3]	mm	1304
		Height[4]	mm	2200
		Note: Modules are extendible with step switches		

[1] Higher ratings on request.
[2] Wider panel available with 1125 or 1325mm.
[3] Deeper panel available with 1554 or 1800mm.
[4] Larger LV compartment with corresponding total panel height 2400 and 2596mm available.

Queensland Alumina selected ZVC with integrated reactive power compensation to provide the world's best grade alumina – Gladstone, Australia

Group Compensation	ZVC-RPCG
	

Central Compensation	ZVC-RPCC
	

Predictive Maintenance

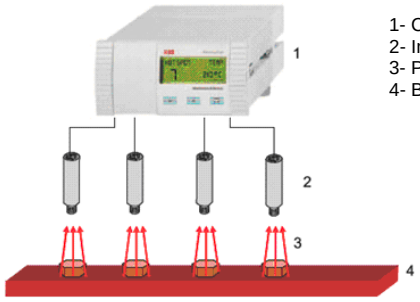
Switchboard Temperature Monitoring

Poor operating conditions lead to abnormal temperature changes. Standards such as IEC 62271-200 describe the limits of temperature for various parts, materials and dielectrics of switchgear.

Conditions	Symptoms	Uncontrolled outcomes
Incorrect torque on bolt. Loose connection.	Hot spot. Temperature rise.	Flashover. Fire.
Dirty contact due to pollutants. Contact corrosion from acidic gas. Harmonics.	Heating. Sparks.	Nuisance tripping. Fire.
Operation outside equipment temperature limits, i.e. HVAC failure. Poor maintenance.	Heating	Fire. Flashover. Explosion.
Anti-condensation heater failure. High humidity compare to ambient.	Cold spot. Abnormal temperature swing.	Flashover. Explosion.

Fast detection (< 1 second) on the presence of hot or cold spots in an early stage is an important element of predictive maintenance. Continuous real time information and trend recording allows early stage decision making therefore reduces the potential of switchboard failure.

UniGear ZVC switchgear system can be equipped with a complete on-line temperature monitoring system with controller, infrared sensors on HV busbar connection and power cable termination points. The monitoring is achieved without live parts contact therefore immune to switching shock and vibrations. This is crucial for reliable monitoring, avoiding nuisance tripping and not exposing operators to arc flash boundary.



1- Controller
2- Infrared sensors
3- Point of contact
4- Busbar or Cable flag

Features

- Continuous temperature monitoring of live parts
- Freely configurable values for warning and emergency limits
- Analog output for max. temperature value (alternatively: Modbus ®)
- 3 potential free outputs for alarm, pre-alarm and error signal
- No PVC cables used
- All parts completely shielded against EMI/RFI
- Possible connection of a Pt 100 temperature sensor for measuring the ambient temperature
- The controller can be fitted on the switchgear cabinet door.
- All relevant parameters locally indicated on a multiline graphic display
- Indication of all measuring points and maximum temperature values with tag numbers
- Data logger function with real time clock for all temperature and limit values
- Error is recorded with current date and time when configured limit value is exceeded

Problems with Thermo Viewing windows in HV Switchgear

The limitation and problems come down to the ability of the thermographic window assembly to withstand internal arc faults up to 50kA in HV switchgear zones. Typically the fault and energy levels in 1kV to 17.5kV indoor equipment provide for difficulty in maintaining safety (arc fault containment) in the event of internal arc faults. Thermo viewing windows are not proven or tested to limits of standard IEC 62271-200.

Switchboard Partial Discharge Monitoring

Manufacturing error, lack of maintenance and aging accelerate partial discharges (small electrical sparks) that indicate early stage deteriorating of high voltage electrical insulation. Partial discharge is a measure of switchgear quality and longevity. Standards such as IEC 62271-200 describe the limits of dielectrics of switchgear.

Conditions	Symptoms	Uncontrolled outcomes
Sharp steel edges. Poor manufacturing.	Partial discharge – Immediate	Flashover. Protection trip.
Air gaps in cast resin moulding and sleeving. Poor quality parts and inspection process.	Partial discharge – Slow built up. Accelerate aging.	Nuisance tripping. Fire.
Cracks in moulding. Mishandling and operator errors.	Partial discharge – Immediate if damage. Delay symptoms if hairline crack exist.	Flashover. Explosion.
Dust and moisture	Partial discharge – Slow built up.	Burning of coils. Nuisance tripping. Flashover

Continuous real time information on the presence of partial discharge is an important element of predictive maintenance. Abnormal trend recording allows early stage decision making therefore reduces the potential of switchboard failure.

UniGear ZVC switchgear system can be equipped with a complete on-line partial discharge monitoring system with partial discharge sensors on power cable compartment. The sensors are crucial for reliable monitoring, avoid human “guess work” with portable partial discharge probes and do not exposed operators to arc flash boundary.

The main purpose of a continuous partial discharge monitoring system is to alert the end user that they have a pending problem and to provide some historical data to assist in the diagnosis. Beyond that, the manufacturer should be employed to perform additional fault finding testing.

Continuous Partial Discharge Controller

Partial discharge sensors are connected to the controller in order to continuously monitor the discharge levels. The controller have electronic noise discrimination, Modbus ® communication and 4 contact outputs for alarms, and be connected to station computer for trend display, record and diagnosis.

Partial Discharge Sensors

Partial discharge sensors are mounted into the cable compartment and connected to the vertical busbars. The signals from the couplers are wired to the controller fitted on the control low voltage compartment.

UniGear ZVC switchgear system can be equipped with a complete on-line temperature monitoring system with controller, infrared sensors on HV busbar connection and power cable termination points. This is crucial for reliable monitoring, avoiding nuisance tripping and not exposing operators to arc flash boundary.

Circuit Breaker

UniGear platform circuit breaker panels can be coupled directly with UniGear ZVC switchgear system without the need of bus transition chamber, and with the facility for future extension on both ends of the switchboard.

Three types of withdrawable cassette circuit breaker can be fitted in UniGear ZS1 switchgear panel.

Circuit Breaker Type		VD4	VM1	HD4
Interrupting Medium		Vacuum	Vacuum	Gas SF6
Rated Current	A	…4000	…4000	…4000
Rated Frequency	Hz	50-60	50-60	50-60
Rated Voltage	kV	…17.5	…17.5	…17.5
Power Frequency Withstand – 1 min	kV	…38[1]	…38	…38
Lightning Impulse Withstand	kVpk	…95	…95	…95
Short Time Current – 3 sec	kA	…50	…50	…50
Peak Withstand Current	kApk	…125	…125	…125
Endurance:				
Electrical	Ops	30000	30000	10000
Mechanical – Mechanism	Ops	30000	100000	10000
Mechanical – Truck Isolation / Racking	Ops	1000	1000	1000
Motor Truck racking (Remote HV isolation)		Yes	Yes	Not available

One type of withdrawable cassette circuit breaker can be fitted in UniGear 550 switchgear panel.

Circuit Breaker Type		VMax
Interrupting Medium		Vacuum
Rated Current	A	…1250
Rated Frequency	Hz	50-60
Rated Voltage	kV	…17.5
Power Frequency Withstand – 1 min	kV	…38[1]
Lightning Impulse Withstand	kVpk	…95
Short Time Current – 3 sec	kA	…31.5
Peak Withstand Current	kApk	…80
Endurance:		
Electrical	Ops	30000
Mechanical – Mechanism	Ops	30000
Motor Truck racking (Remote HV isolation)		Not available

One type of fixed cassette circuit breaker can be fitted in UniGear 500R switchgear panel.

Circuit Breaker Type		VMax/F
Interrupting Medium		Vacuum
Rated Current	A	…1250
Rated Frequency	Hz	50-60
Rated Voltage	kV	…17.5
Power Frequency Withstand – 1 min	kV	…38
Lightning Impulse Withstand	kVpk	…95
Short Time Current – 3 sec	kA	…31.5
Peak Withstand Current	kApk	…80
Endurance:		
Electrical	Ops	30000
Mechanical	Ops	30000

[1] Rating 42kV available on request.

Fault Current Limiter

UniGear platform drawout fault current limiter panels can be coupled directly with UniGear ZVC and ZS1 switchgears without the need of bus transition chamber, and with the facility for future extension on both ends of the switchboard.

Fault Current Limiter Type		Is-Limiter
Rated Current	A	...4000
Rated Frequency	Hz	50-60
Rated Voltage	kV	…17.5
Power Frequency Withstand – 1 min	kV	…38
Lightning Impulse Withstand	kVpk	…95
Interrupting current	kA_{RMS}	…210
Motor Truck racking (Remote HV isolation)		Not available

Fault Current Limiter in UniGear platform

Switch (Fuse) Disconnector

UniGear platform fixed switch (fuse) disconnector panels can be coupled directly with UniGear ZVC switchgear system without the need of bus transition chamber, and with the facility for future extension on both ends of the switchboard.

Switch Disconnector Type		NAL
Interrupting Medium		Air
Rated Current	A	...1250
Rated Frequency	Hz	50-60
Rated Voltage	kV	…17.5
Power Frequency Withstand – 1 min	kV	…38[1]
Lightning Impulse Withstand	kVpk	…95
Short Time Current – 3 sec	kA	…31.5
Peak Withstand Current	kApk	…80
Endurance:		
Electrical	Ops	1000
Mechanical – mechanism	Ops	1000

Switch Fuse Disconnector Type		NALF
Interrupting Medium		Air
Rated Current:	A	
Switch Disconnector	A	…1250
Maximum Fuse Rating	A	…100
Switch Fuse Full Load Current	A	…63
Rated Frequency	Hz	50-60
Rated Voltage	kV	…17.5
Power Frequency Withstand – 1 min	kV	…38[1]
Lightning Impulse Withstand	kVpk	…95
Short Time Current – 3 sec	kA	…31.5
Peak Withstand Current	kApk	…80
Endurance:		
Electrical	Ops	1000
Mechanical – mechanism	Ops	1000

[1] Rating 42kV available on request.

Fused Contactor

UniGear platform 12kV withdrawable fused contactor panels can be coupled directly with UniGear ZVC switchgear system without the need of bus transition chamber, and with the facility for future extension on both ends of the switchboard.

Fused Contactor Truck Type		V12	VSC12
HRC HV Fuse (per phase)		One	One
Rated Current:			
Contactor AC-4	A	400	400
Maximum Fuse Rating	A	…200	…200
Fused Contactor Full Load Current	A	…160	…160
Rated Frequency	Hz	50-60	50-60
Rated Voltage	kV	12	12
Power Frequency Withstand – 1 min	kV	28	28[1]
Lightning Impulse Withstand	kVpk	75	75
Short Time Current – 3 sec[2]	kA	50	50
Peak Withstand Current	kApk	125	125
Load Switching:			
Motor[3]	kW	2500	2500
	HP	3400	3400
Transformer	kVA	2500	2500
Capacitor (back to back)	kVAR	2400	2400
Endurance:			
Electrical – Contactor	AC-1	1000000	1000000
	AC-2	100000	100000
	AC-3	100000	100000
	AC-4	[4]	[4]
Mechanical – Mechanism	Ops	100000	100000
Mechanical – Truck Isolation / Racking	Ops	1000	1000
Motor Truck racking (Remote HV isolation)		Not available	Yes

[1] Rating 42kV available on request.
[2] Limited by the fuses
[3] Maximum rating depending on full load current, locked rotor current and run up time of motor.
[4] Standard contactor is suitable for Utilization Categories AC-4. Endurance is a fraction of AC-3.

Appendix 1 – Order Code

Order Code | | | | ZVC | | | | | | | | | | | | |

Operating Conditions

Temperature	Environment		
deg Celsius	Standard	25	a
	Lightning	30	b
	High Altitude	35	c
	Seismic and Vibration	40	d
	Seismic, Vibration and Lightning	45	e
	Seismic, Vibration, Lightning and High Altitude	50	f
		55	
		60	

Installation

Indoor	Ind
Outdoor (IP54). Plinth base	Oa
Outdoor (IP54). Padmount base	Ob
Outdoor (IP54). Skid base	Oc
Outdoor (IP54). Plinth base. Walk in facility.	OWa
Outdoor (IP54). Padmount base. Walk in facility.	OWb
Outdoor (IP54). Skid base. Walk in facility.	OWc

Applications

Motor Starter	DOL
Power Factor Correction	PFC
Reactor Starter	REA
Resistor Starter	RES
Slip Ring Induction (Secondary Resistor) Starter	SRI
Star Delta Starter	SD
Forward Reverse Starter	RS
Plug Brake	BP
DC Injection Brake	BDC
Two Speed Starter	2S
Double (Conveyor) Feeder	DF
Auto-Transformer Starter	AT
Auto-Transformer Starter with Power Factor Correction	ATC
Soft Starter	SS
Multi-Motor Starter for Drives and Soft Starter (2 motors)	MMS2
Multi-Motor Starter for Drives and Soft Starter (4 motors)	MMS4
Soft Starter with Power Factor Correction	SSC
Transformer Feeder	TX
Capacitor Feeder	CAP
Preassembled (2 panels)	2P
Preassembled (3 panels)	3P
Cable to Bus	CTB
Metering (Fixed)	MF
Metering (Withdrawable)	MW
Fixed Contactor	F
Railway Heating	R1
Railway Traction	R2
AC Power	ACP
DC Power	DCP
Arc Terminator	ArcTs

Load Ratings

Us (kV)	FLC (A)	STC (kA)
	2	50 31
	4	150 50
	7	400
	12	630
	17	800
		1250

where -
Us : Rated Voltage
FLC : Full Load Current
STC : Short Time Current (3sec)

Additional Arc Flash Mitigation (for operator)

None	n
Arc Duct	a
Arc Duct and Remote motorised HV Isolation	b
Remote motorised HV Isolation	c

Additional Arc Flash Protection (for equipment)

None	n
Arc Detection (Pressure)	a
Arc Detection (Current). Also known as Bus Zone Protection (87B).	b
Arc Detection (Light). Must be selected when using Arc Terminator System.	c

Intelligent MCC and Switchgear

None	n	n	n	n	n	n	
Intelligent with integrated IED	a						
Intelligent with integrated IED and OneFuse	b						
Intelligent with integrated IED, OneFuse and Condition Monitoring	c						
Intelligent with integrated IED, OneFuse, Condition Monitoring and Motor voltage dip ride through	d						
Intelligent with integrated IED, OneFuse, Condition Monitoring, Motor voltage dip ride through and Motor auto restart	e						

Work Station

None	n
Engineering	a
Operator	b

Communication to high level control system (first and second serial port)

None	None	n	n
Modbus®	Modbus®	a	a
DNP3	DNP3	b	b
Ethernet	Ethernet	c	c
Profibus DP	Profibus DP	d	d
DeviceNet™	DeviceNet™	e	e
IEC 61850	IEC 61850	f	f
OPC	OPC	g	g

Wireless LAN

None			n
WaveGuide (first serial port)	f		a
WaveGuide (second serial port)		f	b
WaveGuide (first and second serial port)	f	f	c

Predictive Maintenance

None	n
Temperature Monitoring	a
Partial Discharge	b

Appendix 2 – Motor Differential Protection

Large motors in some cases are protected by differential relay to clear internal faults, i.e. motor insulation breakdown resulting in stator winding earth fault. Motor windings are generally surrounded by earthed metal.

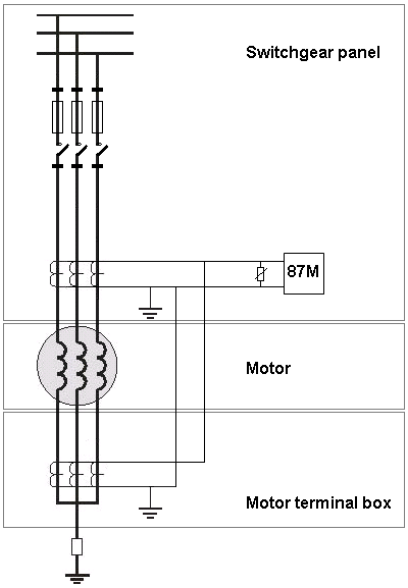
There are two alternatives in motor differential protection:

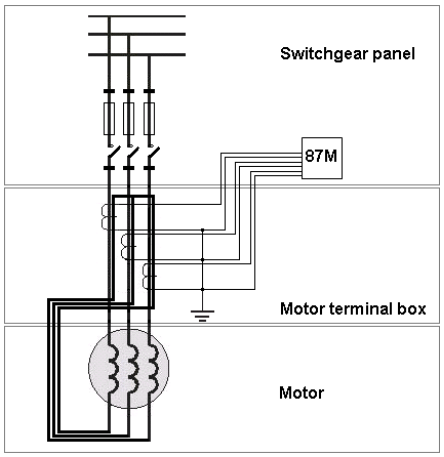
* 6 current transformers (biased, high or low impedance method)
* 3 current transformers (flux-balance, also known as core balance method)

SCPDs coordination:

* HRC HV fuses ~ High speed phase fault on switchgear and power cables
* Motor protection relay ~ Thermal overload, unbalance, etc on motor
  ~ Earth fault on motor and power cables
* Differential prot. relay ~ Earth fault on motor stator winding

In practice it is impossible to summate 6 or 3 current transformers perfectly identical (zero sum) due to inherent composite error and spill current. To take this into account reasonable differential setting has to be considered in order to avoid nuisance tripping.





High Impedance Differential

SPAE is a sensitive current sensing relay suitable for high impedance differential protection. It is characterized by their simple setting, compactness and fixed design. Use 3 phase unit (L1--L2--L3 each) if higher sensitivity is required, normally determined by protection calculation study.

Protection	
High impedance differential	87M

Flux-Balance Differential

REF615 is a current sensing relay suitable for flux-balance differential protection.

Protection	
Flux-balance differential	87M

Appendix 3 – Switchgear Protection

The majority of switchgear arc faults involve single phase to earth and inter-phase flashover. In fact, a large proportion of arc faults result from external influences rather than the failure of a switchgear component. The risk of an arc fault occurring on modern metal-clad category LSC2A switchgear is very small, but can not be ignored. Switchgear protection is about limiting the effects of internal arc damage to allow rapid re-energising with minimal component replacement. A number of prevention, limitation, detection and extinction protective schemes have been devised for this purpose.

Arc duration	Damage to switchgear
< 35 ms	Almost negligible. Check to reuse.
< 100 ms	Small. Repair possible
> 500 ms	Severe. Replacement necessary.

Insulated Busbar

Minimise risk of arc fault occurring in the first place. All busbars are insulated with fire resistant sleeves or epoxy resin to provide protection against internal flashover.

Fault Current Limitation

HRC fuse limits fault current and energy let through to minimise potential damage to the equipment and any resultant fire caused by the short circuit. HRC fuse provide fastest clearing time ~ 5ms, do not need auxiliary power thus provide protection even in loss of control supply scenario.

I_{TH}-Limitation

Pressure sensors detect arc fault shock wave then signal contactor to trip. Overcurrent check is included to prevent nuisance tripping. Total fault clear time ~ 40ms.

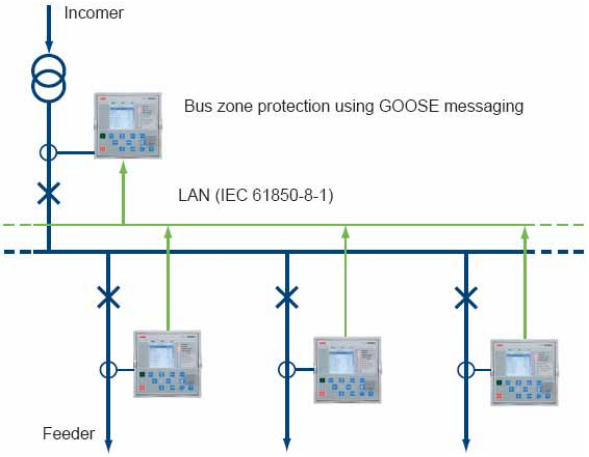
Arc Detection

Light sensors detect arc flash light then signal contactor to trip. Overcurrent check is included to prevent nuisance tripping. Total fault clear time ~ 30ms.

Bus Zone Protection

Intelligent Electronic Devices RE_615 series relay supports IEC 61850 standard including horizontal GOOSE communication (Generic Object Oriented Substation Event). The peer to peer communication using GOOSE over a substation-wide switched Ethernet LAN enables high speed current interlocking-based bus zone protection scheme. Total fault clear time ~ 60ms.

Interlocking schemes are a simple, clear and cost-effective way of implementing bus zone protection in substations.



Protection schemes based on interlocking are well-known and widely accepted. When a fault arises on an outgoing feeder the protection relays of both the incoming feeder and the faulty outgoing feeder start. On starting, the relay of the outgoing feeder, however, blocks the fast-acting stage of the relay of the incoming feeder. On the contrary, should a fault arise on the busbar system, the relays of the outgoing feeders will not start and the relay of the incoming feeder is allowed to operate after a short coordination time and trip the switching device of the incoming feeder.

By transferring GOOSE messages between the relays interconnected with a local area network (LAN) the blocking signals can be sent directly from relay-to-relay without additional delay from auxiliary relays or input filters.

By applying GOOSE messaging blocking signals can be transferred to all the involved relays at once. The relay(s) to be blocked pick(s) up the blocking signal from the message. When using GOOSE messaging the total operating time of the bus zone protection is independent of the number of protection relays involved and the complexity of the bus zone protection system.

Appendix 4 - 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 50/1A Class 10P10, 0.75VA 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
0.75VA	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, 0.1VA 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^2 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 0.04VA at 1.0amp rated current.

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

A rated burden of 0.75VA 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, 3.0VA 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
3.0VA	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 1.0VA. The recommended rated burden of 3.0VA 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;

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

Standard Ratings

The standard current transformers used in UniGear ZVC are uniquely dimensioned, single-phase, epoxy resin encapsulated, 660V 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:	400-300-200/1/1A	Core 1:	Cl. 10P20, 0.75VA
		Core 2:	Cl. 3.0, 3.0VA
Ratio:	150-100-75/1/1A	Core 1:	Cl. 10P20, 0.75VA
		Core 2:	Cl. 3.0, 3.0VA
Ratio:	50/1/1A	Core 1:	Cl. 10P10, 0.75VA
		Core 2:	Cl. 3.0, 3.0VA.

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

50/1A is the lowest ratio available and will suit applications with full load current as low as approximately 15A 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^2 (32/0.20) conductor, insulation colour green/yellow, is used for the screen earth wire and 1.0 mm^2 (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.

Appendix 5 – The Use of HRC Fuses in Parallel

Introduction

Occasionally, for some low voltage and high voltage applications, it is necessary for two or more fuses to be connected in parallel in each phase of a circuit, usually for the purpose of obtaining sufficiently high current rating. It has been the practice for many years to use fuses in parallel without the need for formal testing of such combinations, provided that:

- the paralleled fuses are of the same type and rating.
- the individual fuse has been subjected to satisfactory short circuit tests.

As higher current rating fuses contain a number of parallel elements, the use of parallel fuses only extends the principle of parallel elements. This article explains various aspects of parallel arrangement of fuses, and shows how technical data for such arrangements can be derived from the data available on single fuses.

Maximum Interrupting Current

In general, HRC fuses have a substantially flat I^2t/prospective current characteristic. Therefore the effect of paralleling fuses is to increase the maximum short circuit capability because fuse performance is dependent on the current density of the elements in concurrent operation. Conversely, for a given prospective short circuit current, the duty on parallel fuses is eased, as the current in each fuse is inversely proportional to the number in parallel.

Maximum Arc Energy Condition

Single fuses are tested to withstand their maximum arc energy condition, which usually occurs at a level significantly less than maximum interrupting current. For fuses in parallel, the current required for this condition increases directly in proportion to the number of fuses. If, for whatever reason, unequal sharing of this current occurs then the current in each individual fuse moves away from the maximum arc energy condition, and the duty on each fuse is eased.

Arc Voltage

The arc voltage can be considered independent of the number of fuses in parallel, and is that associated with a single fuse.

Mounting Arrangement and Rated Current

For optimum thermal performance, the mounting arrangement needs due consideration (bolted tag fuses offer more certain connection than ferrule types). An ideal parallel arrangement will give equal current sharing, but even if completely balanced paths are not achieved, a small degree of self compensation will occur.

A full thermal test on the equipment in its intended environment is ideal but usually impractical. Derating is necessary because two fuses in close proximity radiate heat less effectively then single fuses. As a general rule, fuse manufacturers recommend a minimum reduction in rated current of 10% for 2 fuses in parallel (20% for 3 or 4 fuses in parallel) and the combination assigned a rated current of nearest preferred number from R10 or R20 given in standards IEC/AS; for example, 2 x 800A fuses in parallel = 2 x 800A x 0.9 = 1440A (= 1400A nearest preferred number).

Time/Current Characteristics

On the basis that equal current sharing occurs between fuses in parallel, the time/current characteristics can be determined by either of the two following methods:

(1) Applying a multiplier to the prospective current axis of the published time/current curve for the single fuse, equal to the ratio of the parallel fuse arrangement assigned rated current (refer above) divided by the single fuse rated current. Corresponding pre-arcing times for the parallel fuse arrangement are then represented by the single fuse curve. This is illustrated by using the above 2 x 800A parallel fuse example, and for say 3500A load current, then:

Multiplier for 2 x 800A parallel fuses = 1400/800 = 1.75
Equivalent current for each fuse = 3500/1.75 = 2000A
Therefore pre-arcing time for parallel arrangement = 650 sec.

By comparison, for 800A single fuse with 3500A load current, pre-arcing time is 60 sec.

(2) Alternatively, another time/current curve is plotted parallel to the single fuse published time/current curve, by applying the same multiplier as (1) above to various points on the single fuse curve. The pre-arcing time and prospective current axis remain unchanged. For example, using the same 2 x 800A parallel fuses, then:

Pre-arcing time on published 800A T/C curve[1]	Corresponding current for 800A fuse	Corresponding current for 2 x 800A fuses
10000 sec.	1400A	2450A (say 2500A)
1000 sec.	1800A	3150A (say 3200A)
100 sec.	3100A	5425A (say 5400A)
10 sec.	5500A	9625A (say 9600A)
1,0 sec.	10000A	17500A (say 18000A)
0,1 sec.	18000A	31500A (say 32000A)
0,01 sec.	29000A	50750A (say 51000A)

[1] Based on GEC Alstom HRC fuse

Pre-Arcing And Total Operating I^2t Values

In general, for fuses that have a substantially flat I^2t/prospective current characteristic, the minimum pre-arcing I^2t are proportional to the square of the number of fuses in parallel. For the same example of 2 x 800A parallel fuses, I^2t values are:

800A single fuse:
Published pre-arcing I^2t = 4400×10^3 A^2 sec
Published total I^2t (at 415V) = 9600×10^3 A^2 sec

2 x 800A parallel fuses:
Pre-arcing I^2t = $2^2 \times 4400 \times 10^3$ A^2 sec
Total I^2t (at 415V) = $2^2 \times 9600 \times 10^3$ A^2 sec

Cut-Off Current

The cut-off current for two or more parallel fuses is determined by the following method:

- The short circuit prospective rms current I_F is divided by number of single fuses in parallel N, giving I_F/N.
- For this value of I_F/N, the cut-off current peak for the single fuse is found from the published cut-off current characteristic.
- This value of cut-off current peak is multiplied by the number of single fuses in parallel N, giving the cut-off current peak for the parallel fuses.

As an example, for 2 x 800A parallel fuses and 50kA rms prospective current, the cut-off current peak is:

Fault current per fuse = I_F/N = 50kA/2 = 25kA rms
For 800A single fuse at 25kA rms, published I_{co} = 54kA peak
Therefore 2 x 800A parallel fuses at 50kA, I_{co} = 2 x 54kA = 108kA peak.

By comparison, for the 800A single fuse at 50kA, the published I_{co} is 64kA. Also, the threshold for exhibiting cut-off for the 800A single fuse is 24kA rms prospective, compared to 48kA rms prospective for 2 x 800A parallel fuses.

Conclusion

The foregoing information is based on known principles applicable to the paralleling of fuses, and the examples given are relevant to common HRC fuses. A unique computer prediction programme is used for specific applications requiring more infinite analysis of single or parallel fuse performance.

Appendix 6 – Application of Circuit Breakers & Fused Contactors in Nuclear Power Plants

1. FUNCTIONAL REQUIREMENTS:

Circuit Breakers
A circuit breaker must be able to firstly, make and break fault currents and, secondly, switch load currents.

Fused Contactors
The combination of fuse and contactor must meet the same requirements as listed above for a circuit breaker. However, the fuse breaks fault currents and the contactor switches load currents.

2. IMPLICATIONS ON DESIGN:

Circuit Breakers
Making and breaking of large fault currents requires high operational energies and a contact material which will not weld due to peak currents (> 100 kA).

Switching of load currents requires a low operational energy and contact materials that limit switching overvoltages (current chopping) and provide an extended lifetime.

These two requirements conflict. The design is therefore a compromise.

Fused Contactors
The HRC fuse limits fault currents during making and breaking (< 30kA pk). The fuse design is optimised for “peak current” and “energy let through” limitation.

The contactor switches load currents. The contactor design is optimised to reduce switching overvoltages and extend lifetime.

There is no conflict in design. The two components, fuse and contactor, handle the full range of duties working as a team.

3. SELECTED TECHNICAL DATA:

	F-C	VCB
Peak fault current (250A fuse)	< 30kA pk	< 125kA pk
Energy Let Through (100 mSec fault)	< $1.8x10^6$ A^2 Secs	< $200x10^6$ A^2 Secs
Electrical life (operations)	100,000	20,000
Mechanical life	1,000,000	20,000
Switch Overvoltage (200kW Motor)	< 2.0 p.u.	3.0 p.u

4. ADVANTAGES OF FUSED CONTACTORS:

4.1 Fault Current and Energy Limitation:

- A fault on a feeder protected by an F-C has little impact on the system. System stability is not a consideration due to ***fault current limitation*** of F-C.

F-C	30kA pk; < 10mSec.
VCB	50kA RMS, 125kA pk; 100 to 200 mSec.

- A fault in the switchgear on the cable side (CTs or cable termination) results in limited damage due to energy limitation of F-C.

	Specific Energy Restoration Time	**Main**
F-C	< $1.8x10^6$ A^2 Secs	~ 5 hrs (minor damage)
VCB	<$200x10^6$ A^2 Secs	~ 40 hrs (severe damage)

- A fault in equipment (motor or transformer terminal box) results in limited damage due to energy limitation of F-C

	Specific Energy Restoration Time	**Main**
F-C	< $1.8x10^6$ A^2 Secs	~ 5 hrs
VCB	<$200x10^6$ A^2 Secs	replacement

Limitation of fault energy means less damage t the surrounding environment in the event of a fault in switchgear, cable, or equipment. Damage to personnel, associated plant and the process is limited.

4.2 Advantages due to Switching:

- ***Low switching overvoltages*** mean surge protection is not required (motors down to 100kW). MTBF is significantly improved as surge arresters are eliminated.

- ***Long mechanical and electrical life*** means little maintenance is required and MTBF increased.

5. DISADVANTAGE OF FUSED CONTACTORS:

HRC fuses are “consumable” and must be replaced after a fault. Cost is around € 500 per set.

Note: - Most faults are interrupted by the contactor (up to 4kA).

- Replacement cost of € 500 is insignificant with respect to potential savings – up to € millions.

6. LIFETIME:

The lifetime of appropriately selected VCB’s and F-Cs has been established as 40 years.

Appropriate selection is of vital importance. Reduced operating temperature equates to long life.

Fuse selection is an important process and the selection criteria is fault current, not load current. Fuses must be of a sufficient rating to eliminate aging of elements due to starting, overload or normal load currents.

7. APPLICATION OF FUSED CONTACTORS IN NUCLEAR POWER PLANTS

Most European plants (based on French designs) use fused contactors for the safety system feeders.

Extract from RCC-E C.2000
“…….all safety related load feeders are protected by fused contactors”

8. REFERENCES FOR FUSED CONTACTORS IN CHINA:

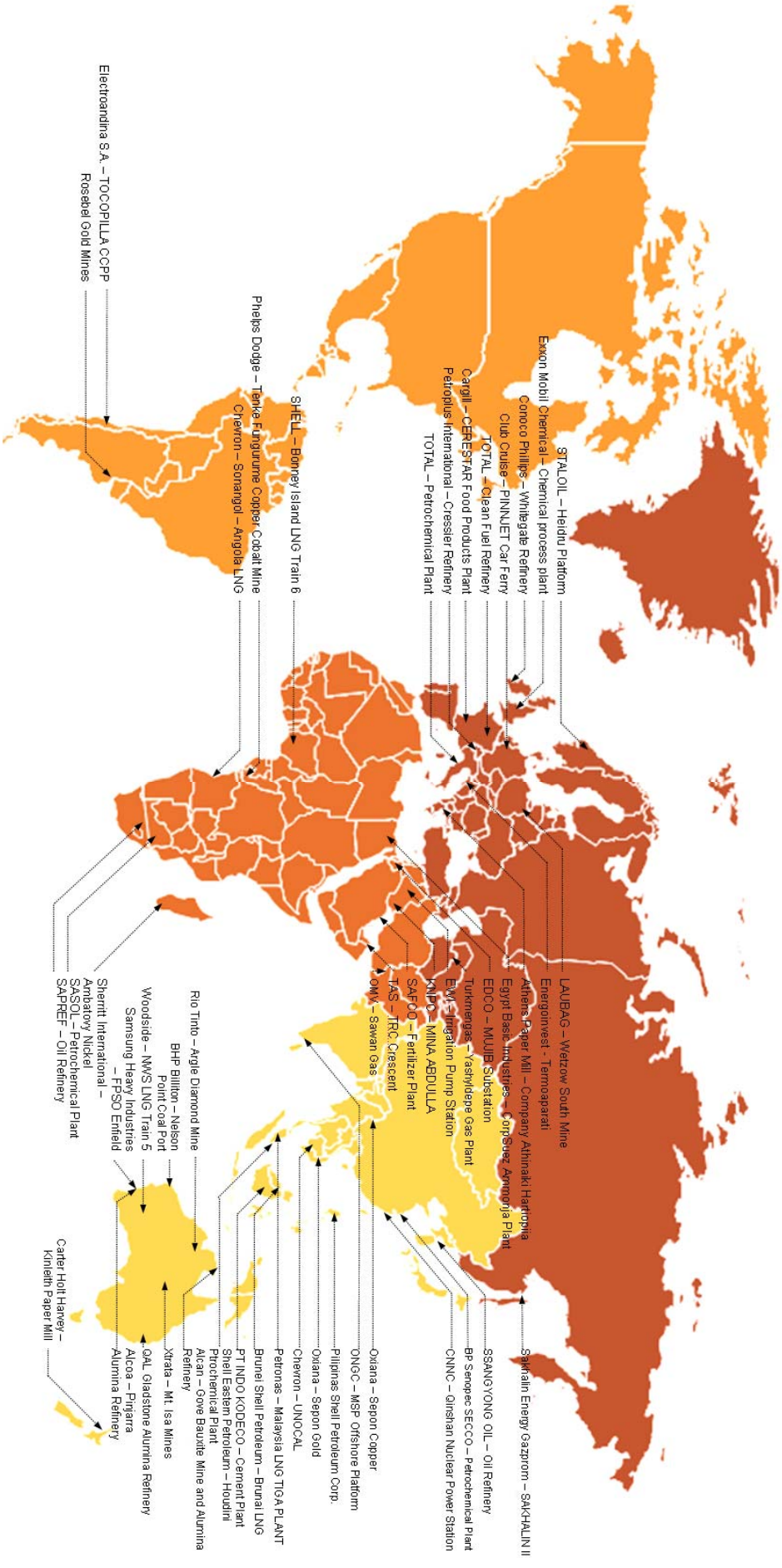
- Daya Bay Nuclear Power Plant
- Qinshan II Nuclear Power Plant
- Yangjiang Nuclear Power Plant
- Fuqing Nuclear Power Plant
- Fangjiashan Nuclear Power Plant

Appendix 7 – Overview of UniGear switching Technology

					
Model	VD4/P	VM1/P	VSC/P	V7/ZVC	VSC7/ZVC
Rated voltage (kV)	…24	…24	…12	…7.2	…7.2
Full load current (A)	…4000	…4000	400 (contactor) …200 (fuse)	400 (contactor) …630 (fuses)	400 (contactor) …315 (fuse)
Rated short time current (kA / 3sec)	…50	…50	…50	…50	…50
Peak withstand current (kApk)	…125	…125	…125	…150	…150
Panel width (mm)	650…1000	650…1000	650	325	325
Panel switchroom floor area (m^2)	0.85…1.3	0.85…1.3	0.85	0.42	0.42
Weight (kg)	80…300	80…300	65	90	90
Interrupter type	Vacuum	Vacuum	Vacuum	Vacuum	Vacuum
No. of operations (interrupter)	…30,000	…30,000	…1,000,000	…1,000,000	…1,000,000
Operating mechanism	Motor spring charge, coils	Magnetic actuator	Magnetic actuator	spring, coils	Magnetic actuator
No. of operations (mechanism)	…10,000	…100,000	…100,000	…100,000	…100,000
Auxiliary power	External supply	External supply	External supply	Self Powered	Self Powered
Total break time (ms)	≤ 60	≤ 60	20…30	20…30	20…30
Closing time (ms)	Approx. 60	45…60	20…30	20…30	20…30
Remote motor racking	Yes	Yes	No	Yes	No
Fault limitation capacity	CB break ~ 200ms	CB break ~ 200ms	Fuse interrupt ~ 5ms	Fuse interrupt ~ 5ms	Fuse interrupt ~ 5ms
Power cable sizing	Full fault rated, 185…630mm^2	Full fault rated, 185…630mm^2	Fault limited, 35…95mm^2	Fault limited, 35…95mm^2	Fault limited, 35…95mm^2

Appendix 8 – Global Project Footprint

ABB is one of the world's leading power and automation engineering companies. We provide solutions for secure, energy-efficient generation, transmission and distribution of electricity, and for increasing productivity in industrial, commercial and utility operations.



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