



Grid Automation packaged solutions Optimal automation of medium voltage grids

Application principles of the Zone concept

Grid Automation (GA) packaged solutions

The zone concept offers a method to analyze and plan the layout of a distribution grid in order to improve supply performance and operation efficiency of power distribution. In the Zone concept the distribution grid is divided into zones where the zone borders are determined by vulnerability for faults, power consumption and location of distributed energy resources.

Between the zones are intelligent grid components called zone dividers, and depending on the capability of the zone divider the zone on the downside is either a protection zone or control zone. The packaged solutions are developed to provide the functionality required by the various zone dividers.

A common feature of all the zone dividers is their capability to communicate with the overall control system. Thus local functionality like protection, measurements etc. can be used for fast local automation but the information is at the same time available in the overall system. Thereby the information can be utilized for central analysis, decisions and required control actions – manual or automatic.

Key advantages of the zone concept with intelligent and communicating zone dividers:

- Improved operation efficiency and improved power quality
- Improved utilization of the network investments with less stress on the equipment
- Adapts to changes in the environment, grow with the needs and can be implemented step-by-step

General features of the GA packaged solutions

The packaged solutions include both primary and secondary equipment as well as wireless data communication. The packages are factory tested as complete solutions, where the main components are:

- Primary components like circuit breakers, switches, disconnectors, switchgear, housing etc. to fit to the needs at a certain node in an overhead or underground distribution grid.
- Secondary technology to carry out the functionality needed at a certain node. Main components are:
 - Multifunctional IED (Intelligent Electronic Device) with a combination of measuring, protection, monitoring, recording and control functions as required by the application
 - Backup battery with charging and supervision
 - Communication unit with internal VPN and firewall for secure wireless communication over GPRS/EDGE networks as standard, optional customer specific solutions are possible

- Local Control
- Equipment for environmental control
- Accessories for different installation options
- Services, available as agreed, covering stages from network planning to phases in life cycle support

Key advantages of the packaged solutions are:

- Built using field proven primary and secondary products
- Configured, documented and factory tested as a complete package
- Ready for hassle-free installation and fast start-up
- Communication facilitating easy integration into the overall control system
- Long life design

A range of packages has been developed in order to fulfil the needs in the distribution networks.

GA package for outdoor circuit breaker

The solution includes a three-phase vacuum circuit breaker with bi-stable magnetic actuators and a separate Intelligent Control Cabinet. In addition to the pure circuit breaker solution there are two additional variants with one respectively two air-insulated line disconnectors. The circuit breaker has built-in current transformers and voltage sensors. A standard pluggable cable is delivered for the connection between the circuit breaker and the Intelligent Control Cabinet. Secure GPRS/EDGE communication to the network control system is provided via the built-in communication unit.

Key features:

- Long life circuit breaker construction that allows 10 000 full load operations without any maintenance
- Circuit breaker with pole assemblies of HCEP material, which gives low leakage currents and low flash-over probability
- Local and remote control
- Protection and auto-reclosing

- Measurements and registration of fault values
- Disturbance recorder
- Power quality measurements
- Condition monitoring of both primary and secondary equipment
- Secure communication with internal VPN and firewall over GPRS/EDGE
- IEC 60870-5-104 communication protocol
- Operator independent IP addressing with Viola M2M Gateway
- Communication supervision

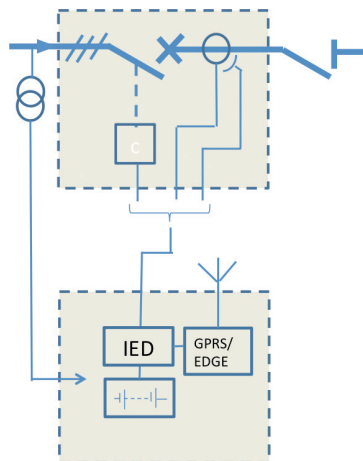
Application highlights:

The solution is intended to be used as zone divider in front of a protection zone. Due to stricter rules for continuity of power supply, enforced by the applied regulator models and by the customer compensation rules, improved distribution grid automation is needed. Introduction of the zone concept, including installation of outdoor circuit breakers, will significantly improve the quality of supply in an overhead network and provide fast investment payback.

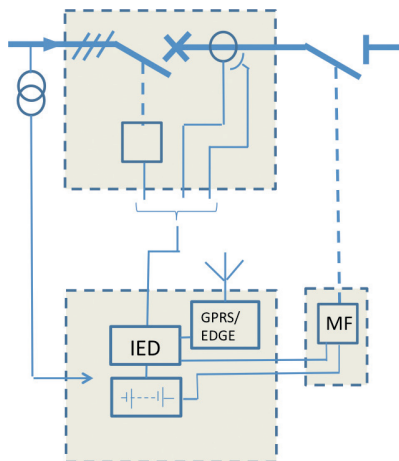


Principle diagrams of the outdoor circuit breakers solutions

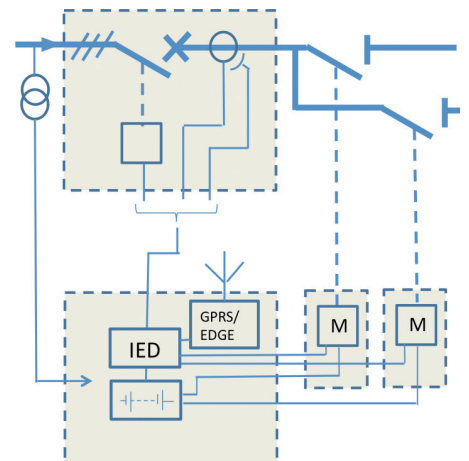
Circuit breaker and 1 hand operated line disconnector
Type 1.0



Circuit breaker and 1 motor operated line disconnector
Type 1.1



Circuit breaker and 2 line motor operated disconnectors
Type 1.2



GA Package for outdoor switch-disconnector With Intelligent Control Cabinet

The solution includes a three-phase gas-insulated (SF6) load-break switch and a separate Intelligent Control Cabinet. Two basic solution variants are developed, one single switch solution and one 3-way solution, built of three switches. Both solution variants are provided with three-position (ON-OFF-EARTH) switches. The EARTH position is always manually operated. Secure GPRS/EDGE communication to the network control system is provided via the built-in communication unit.

Key features:

- Closed and weather protected construction for reliable operation in difficult climate conditions
- Guaranteed load break- fault make capability based on a patented double spring mechanism
- Provided with trip coil for trip of fault currents within load range
- Integrated disconnector and earth switch functionality
- Local and remote control
- Protection and autoreclosing functions

- Can optionally act as an automatic, current or voltage based sectionalizer
- Measurements and registration of fault values
- Disturbance recorder
- Power quality measurements
- Condition monitoring of both primary and secondary equipment
- Secure communication with internal VPN and firewall over GPRS/EDGE
- IEC 60870-5-104 communication protocol
- Operator independent IP addressing with Viola M2M Gateway
- Communication supervision

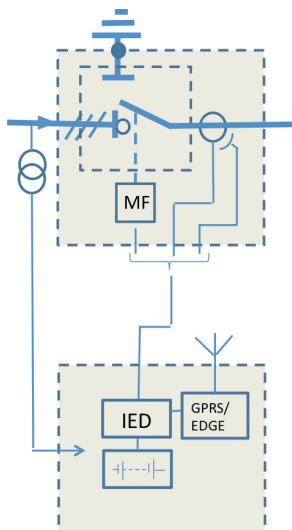
Application highlights:

The solution is intended for a wide range of control applications, where the load-break capability is ideal in live network reconfigurations. Built-in trip coil in the switch-disconnector and the protection functions in the multifunctional IED facilitate the use of the solution in front of a downstream protection zone - for fault currents within its breaking capability. Higher fault currents will be handled by the upstream circuit breaker.

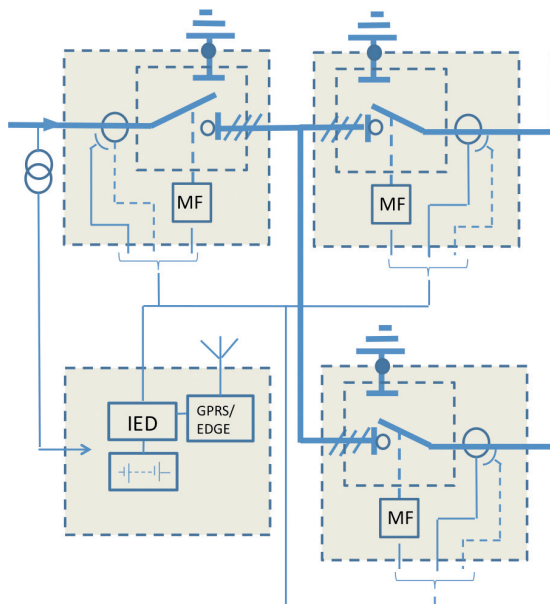


Principle diagrams of the outdoor switch-disconnector solutions with Intelligent Control Cabinet

Single switch-disconnector solution
Type 2.0



Three-way switch-disconnector solution
Type 2.1



GA Package for outdoor switch-disconnector With Remote Control Cabinet

The solution is based on a three-phase air-insulated disconnector, which can be equipped with a breaking chamber that also gives fast closing of the disconnector. For remote operation a remote control cabinet, with a multifunctional IED communicating over GPRS/EDGE and a motor control unit, are included. The IED is able to control three disconnectors, thus a node with three disconnectors can be controlled with one master control cabinet and two slave motor control units. Two three-disconnector solutions can be handled with one communication connection, thus a six-way disconnector solution can be built in one node.

Key features:

- Unique K5-breaking chamber with independent spring assisted making capacity (8 kA/50C) allows closing against short-circuits
- Local and remote control
- Built-in supervision of the actuator current prevents damage in case of blocked disconnector (e.g. by ice)

- Battery charging, monitoring and deep discharge protection
- Secure communication with internal VPN and firewall over GPRS/EDGE
- IEC 60870-5-104 communication protocol
- Operator independent IP addressing with Viola M2M Gateway
- Communication supervision

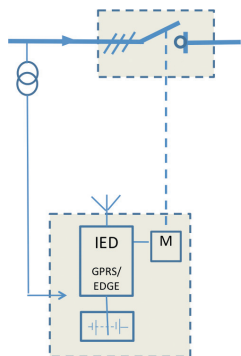
Application highlights:

Installation of remotely controlled switch-disconnectors increases the number of control zones that can efficiently be handled from the control center. After the installation it will be easy to make required network reconfigurations and to limit outages to smallest possible network sections. The high closing against short-circuit capability makes it possible for trial connection of a feeder without danger for equipment break down.

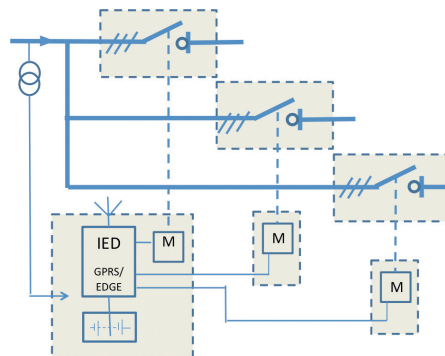


Principle diagrams of the switch-disconnector solutions with Remote Control Cabinet

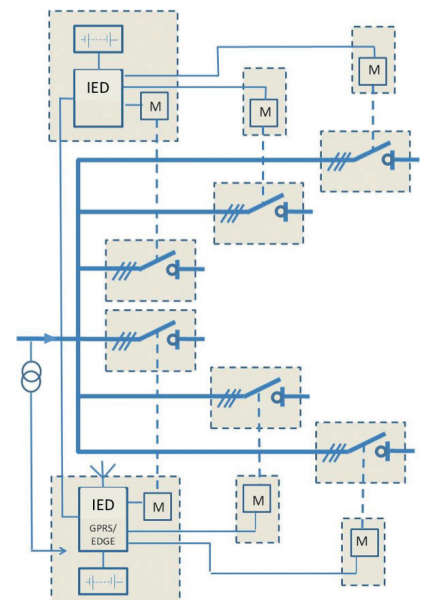
Single disconnector solution
Type 3.0



Three-way disconnector solution
Type 3.1



Six-way disconnector solution
Type 3.2



GA Package for switch-disconnector station

The solution consists of the switchgear with one incomer bay and two outgoing feeder bays in a weather proof housing for pad mounting. A version combined with a distribution transformer and related low-voltage switchboard is also available. As in all the package solutions wireless GPRS/EDGE is offered as the standard communication. The bays are equipped with air insulated switch-disconnectors having load-break capability and the multifunctional IED includes protection and autoreclosing functions. Thus the zone downstream from the station can be a protection zone (Type 4.1 and 4.2) as long as the fault currents are within the breaking capability of the switch disconnector.

Key features:

- Switchgear in a weather proof, easy to attend construction
- Switch disconnectors with load break capability
- Local and remote control

- Protection and autoreclosing facilitate clearing of faults within the load range
- For larger fault currents the station can act as an automatic sectionalizer in cooperation with an upstream circuit breaker
- Measurements and registration of fault values can be used for fault localization, load supervision etc.
- Disturbance recorder
- Power quality measurements
- Transformer protection and monitoring
- Condition monitoring of both primary and secondary equipment
- Secure communication with internal VPN and firewall over GPRS/EDGE
- IEC 60870-5-104 communication protocol
- Operator independent IP addressing with Viola M2M Gateway
- Communication supervision
- Battery charging and monitoring
- Easy and fast installation

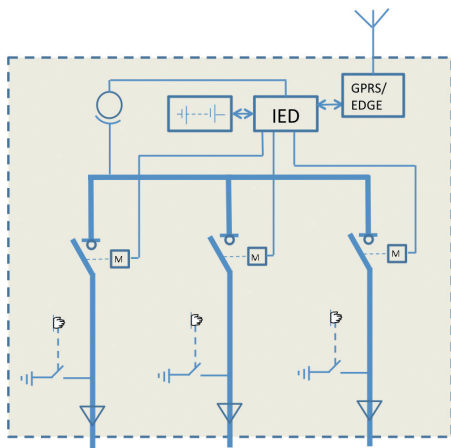
Application highlights:

The typical application is branching of a main feeder into two feeders. The load-break capability of the switch-disconnectors in the feeder bays is useful during network reconfiguration. Furthermore it allows use of protection and autoreclosing when the fault current is within the breaking capability. Thus a zone below the station is, depending on the fault current, either a control zone or a protection zone.

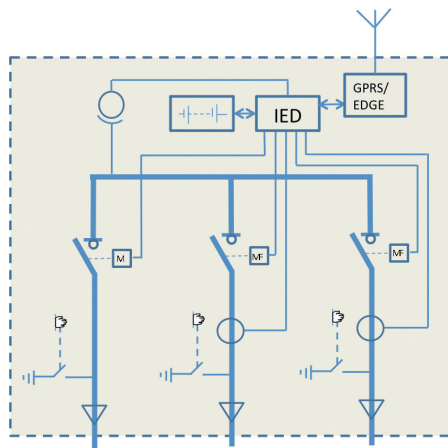


Principle diagrams of the switch-disconnector station solutions

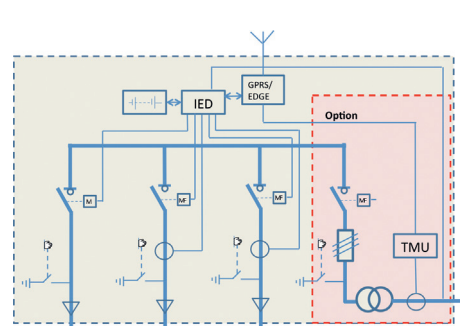
Branching, control only
Type 4.0



Branching
Type 4.1



Branching combined with a distribution transformer
Type 4.2



GA Package for circuit breaker station

The solution consists of the switchgear with one incomer and two outgoing feeders provided with vacuum circuit breakers. Alternatively the switchgear has two incomers for a looped ring feeder and one outgoing branch feeder, optionally combined with a MV/LV distribution transformer. The switchgear is mounted into a weather proof steel or concrete housing.



Key features:

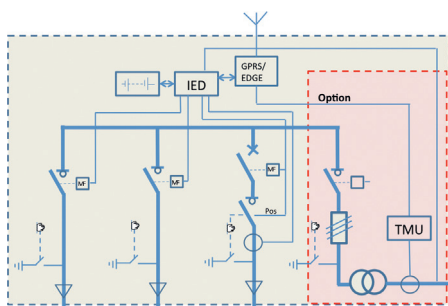
- Switchgear in a weather proof, easy to attend construction
- Vacuum circuit breakers in the feeders
- Local and remote control
- Protection and autoreclosing
- Measurements and registration of fault values for load supervision, fault localization, etc.
- Disturbance recorder
- Power quality measurements
- Condition monitoring of both primary and secondary equipment
- Secure communication with internal VPN and firewall over GPRS/EDGE
- IEC 60870-5-104 communication protocol
- Operator independent IP addressing with Viola M2M Gateway
- Communication supervision

Application highlights:

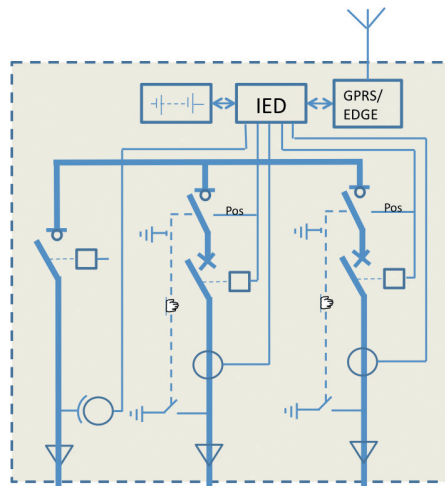
The circuit breaker station solutions are intended to be used as nodes in a looped feeder or for dividing of a main feeder into two branches. A further application is when distributed generation is connected to the network. When the feeders are provided with circuit breakers the zones on their downside are protection zones. The solutions are used in cable networks and as pad mounted nodes in overhead network when weather proof solutions with easy access are preferred.

Principle diagrams of the circuit breaker station solutions

Station with two incomers for a ring feeder and one outgoing feeder. Option with MV/LV transformer
Type 5.1



Station with one incomer and two outgoing feeders
Type 5.2



Wireless communication and Services

Wireless communication

Wireless GPRS/EDGE is the standard communication in all the packaged solutions. The equipment has the capabilities to provide seamless communication between the field units and a modern TCP/IP based IEC 60870-5-104 control system. GPRS is provided as standard but EDGE is available on request.

Features:

- Internal VPN and firewall for secure communication
- Mobile operator independent static IP addressing with the Viola M2M Gateway
- Local polling of IEC 60870-5-101 devices save communication costs as only arising events need to be sent to the IEC 60870-5-104 network
- Packet compressor for sending multiple events in a single TCP/IP packet instead of individually
- Self diagnostics for communication and the device

Key advantages:

- No need for planning and maintaining a communication network
- Location independent communication allows integration of the package solutions into the network control system already in the factory, which guarantees fast installation and startup
- No installation charges since the products use a local public network
- Low cost always-on communication, uses ordinary SIM cards provided by the local operator
- Operator independent

Availability

High availability of communication is critical in order to have full information from and control of the distribution network. During bad weather, with disturbances in the power supply, the communication availability is at test as the network is depending on working base stations. Both field research and practical experiences show that GPRS/EDGE over the public mobile network fulfils the availability requirement also in exceptional situations as:

- Heavy load of normal phone traffic in the communication network does not block the communication for grid automation as the operators have reserved a certain capacity for GPRS/EDGE
- Most of the communicating nodes in the network are reached from more than one base station
- Practical experiences from bad disturbances in the power network shows that grid automation still has been kept alive
- Repair priorities of the network companies affect the situation in large disturbance situations; by prioritizing the recovery of power supply to base station areas the communication is secured not only for GPRS/EDGE but also for the normal phone traffic.

Security

The built in GPRS/EDGE units have internal VPN and firewall and the encrypted communication is completely safe.

Services

ABB and partners offer a full range of services supporting the implementation of the zone concept and the intelligent solution packages. These services ranges from expert services related to network planning, communication and control system integration to various life cycle services for the products in the packaged solutions.

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