



ABB ABILITY™ LOOP CONTROL FOR DISTRIBUTION NETWORKS

LC1000 UniSec solution

Application for ring network reconfiguration
and fault management

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Electricity is absolutely the most versatile form of energy. That is why the electricity industry is leading the global energy transformation process. Electricity is the final form of energy that shows the strongest growth. This means that a safe and reliable electricity distribution system must be created. The LC1000 UniSec solution has been designed to restore ring networks to fully functional conditions following faults and to minimize outage time.

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Ring network management and applications

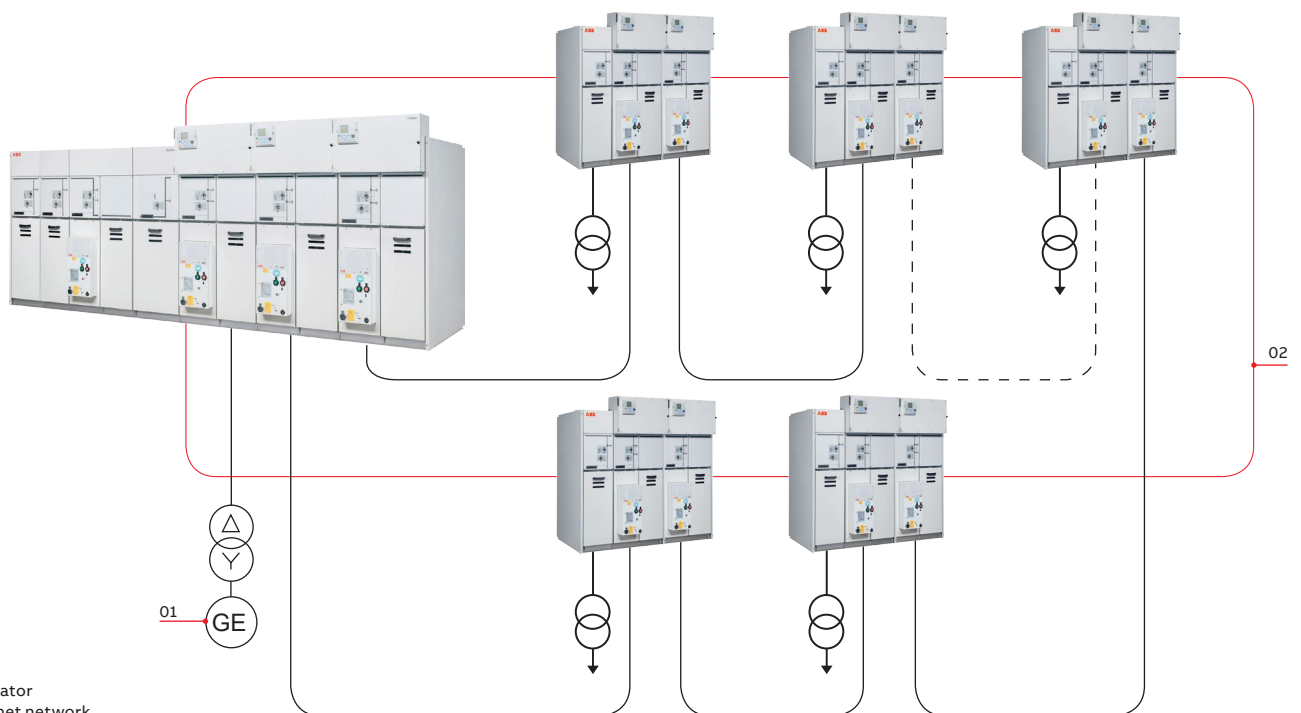
Owing to the significant increase in distributed generation and the growing need for enhanced grid reliability and automatic post-fault recovery, electric grids need to be converted from passive to active. This evolution is internationally known as Smart Grid. The fundamental characteristic of Smart Grids is pervasive use of communication technology for metering and remote control. The most widely used protocol is IEC 61850, the international standard for electrical system automation, which allows both vertical and horizontal communication using GOOSE (Generic Object Oriented Substation Event) messages. The LC1000 UniSec solution for ring network reconfiguration was developed for network applications with extremely stringent reliability and high speed post-fault recovery requirements. The solution allows the fault to be isolated and the network to be reconfigured. It can be applied in networks featuring switchgear with motor-

operated switch-disconnectors or circuit breakers equipped with Relion® relays and current and voltage combi sensors. Applied to UniSec secondary distribution switchgear, the solution guarantees a reaction time, if faults occur, of less than 1 second for localizing and isolating the fault and reconfiguring the network.

The solution comprises:

- supervision and control unit complete with processor and graphic interface able to display grid information in real time
- transformer substations with UniSec switchgear featuring fault indicators or Relion relays for signaling faults plus latest generation current and voltage combi sensors
- Ethernet switch in every substation
- Ethernet communication via optical fiber between substations

Example of an automated open ring network with communication





Applications

The solution is suitable for applications with extremely stringent reliability and high speed fault recovery requirements, such as in hospitals, airports, stadiums, large buildings and data centers. The LC1000 UniSec solution brings service continuity and reliability to the network, and uses an Ethernet connection for fast, reliable and efficient data transmission in compliance with the IEC 61850 standard.

The LC1000 UniSec solution for reconfiguring ring networks with switch-disconnectors

Open ring networks with switch-disconnectors

The solution for ring network reconfiguration includes UniSec switchgear with motor-operated switch-disconnector units (type SDC) and a fault indicator for fault signaling in every transformer substation. It guarantees reliable and uninterrupted open ring network operation by reconfiguring the network after a fault within a reaction time (detection and isolation) shorter than 1s.

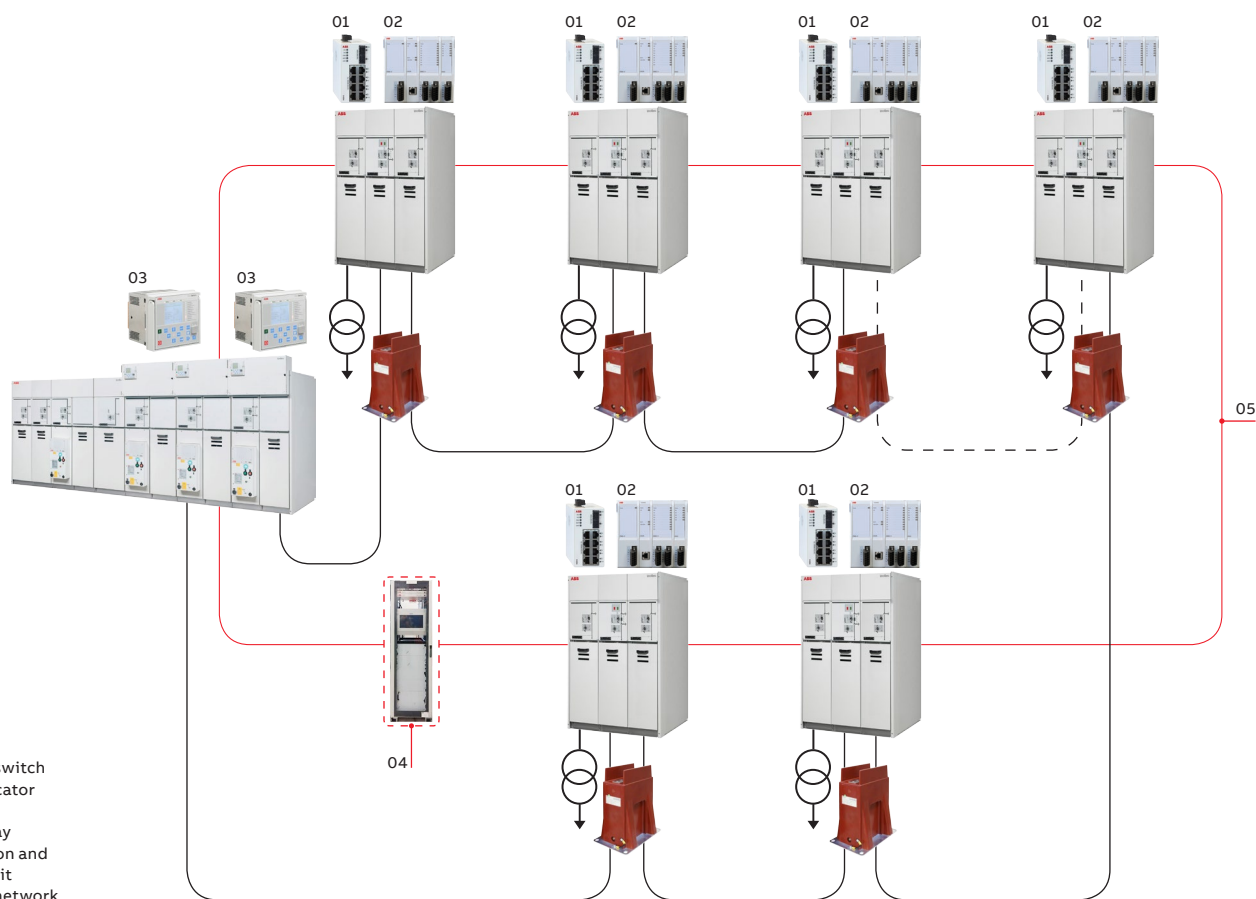
Substation components

Transformer substation with UniSec switchgear in the 2xSDC + 1xSFC configuration:

- 2 UniSec units type SDC with motor-operated switch-disconnector, width 375-500 mm, for substation feeders
- 1 UniSec unit type SFC, motor-operated fuse switch-disconnector, width 375-500 mm, for transformer protection with fuse up to 100A at 24 kV.

Supervision and control unit

The supervision and control unit is a galvanized steel cabinet housing the components for ring reconfiguration logic automation.

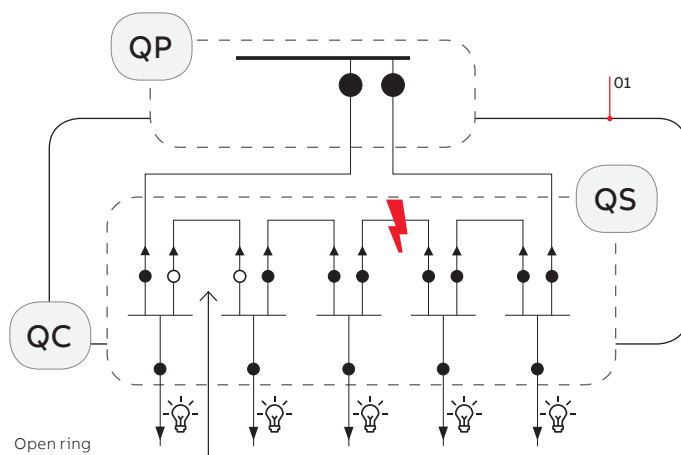


UniSec functional unit with motor-operated switch-disconnector

Simulation of the reconfiguration process for an open ring network with centralized logic

STEP 1

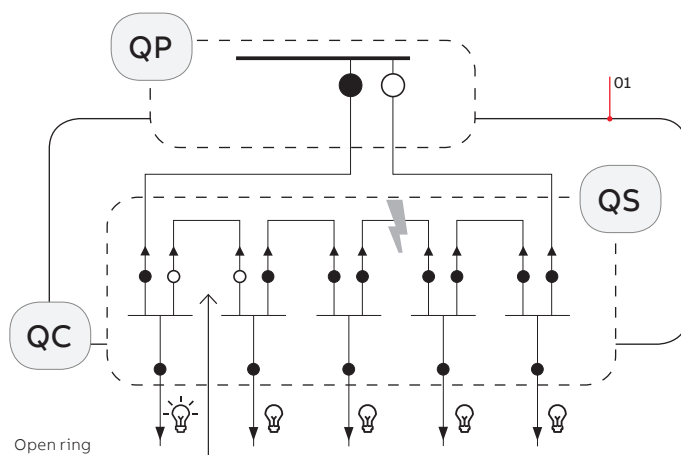
Appearance of fault



STEP 2

Fault interruption

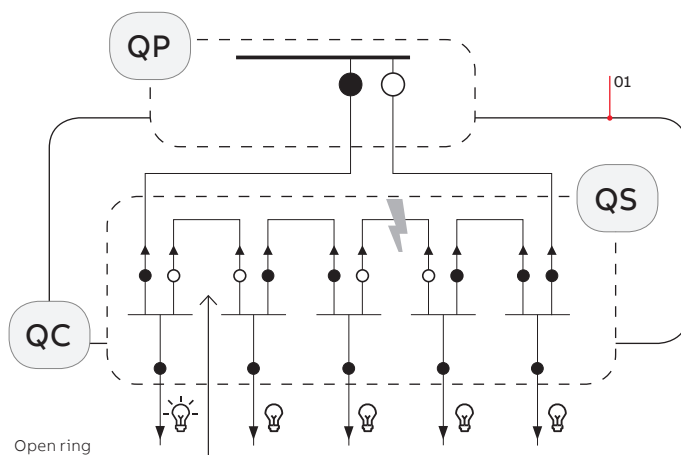
Opening of circuit breaker



STEP 3

Fault isolation

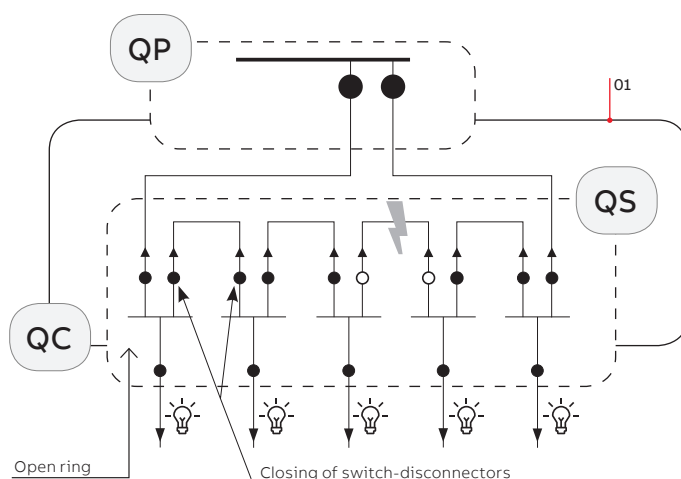
Opening of switch-disconnectors



STEP 4

Ring reconfiguration

Closing of circuit breaker



01 Ethernet network in optical fiber

QP UniSec switchgear with circuit breaker for feeder substation

QC Supervision and control unit

QS UniSec switchgear with switch-disconnector for transformer substation

● Switch-disconnector or circuit breaker closed

○ Switch-disconnector or circuit breaker open

LC1000 UniSec solution for the fault selectivity of ring networks with circuit breakers

Closed ring networks with circuit breakers

The solution for fault selectivity of closed ring networks includes UniSec switchgear with circuit breakers (type SBC or HBC) and Relion relays in each substation. It is suitable for closed ring networks when continuity of service is a fundamental requirement. Thanks to the logic selectivity of protection relays and the IEC 61850 GOOSE communication, the solution guarantees precise fault detection and isolation in less than 0.5s, without interrupting energy transmission within the network.

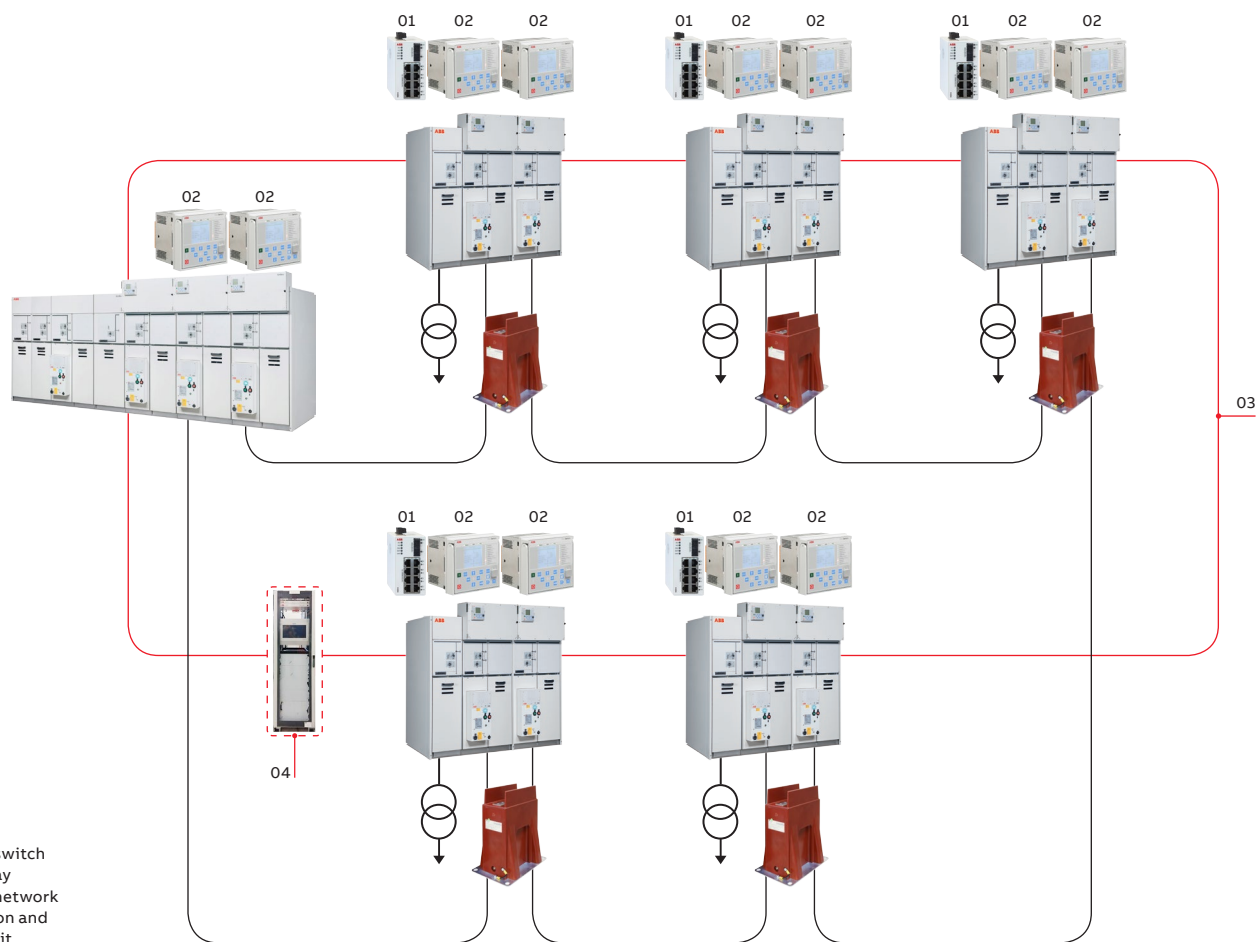
Substation components

Transformer substation with UniSec functional units in the 2xSBC + 1xSFC configuration:

- 2 UniSec units type SBC with circuit breaker, width 750 mm, or type HBC, width 500 mm, for substation feeders
- 1 UniSec unit type SFC with motor-operated fuse switch-disconnector, width 375-500 mm, for transformer protection with fuse up to 100A at 24 kV.

Supervision and control unit

The supervision and control unit is a galvanized steel cabinet housing the components for ring reconfiguration logic automation.



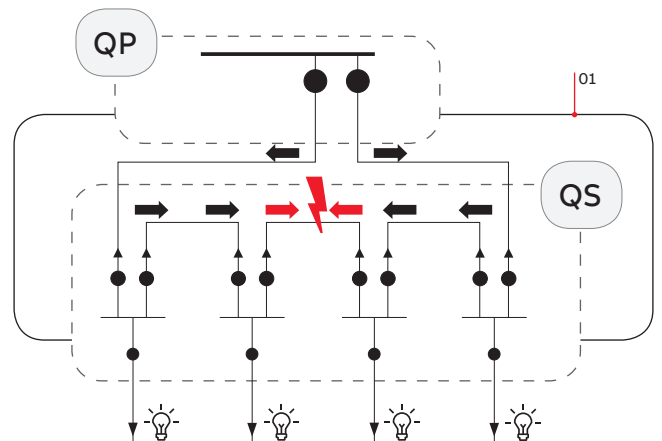
- 01 Ethernet switch
- 02 Relion relay
- 03 Ethernet network
- 04 Supervision and control unit

UniSec functional unit with circuit breaker

Simulation of the logic selectivity process of a closed ring network with decentralized logic

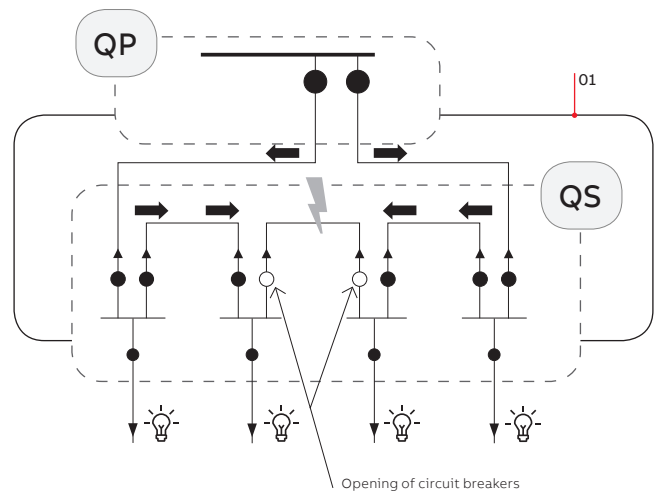
STEP 1

Appearance of fault



STEP 2

Fault interrupted by tripping of directional protection via GOOSE



- Ethernet network in optical fiber
- QP UniSec switchgear with circuit breaker for feeder substation
- QS UniSec switchgear with circuit breaker for transformer substation
- Circuit breaker closed
- Circuit breaker open
- ➡ Energy flow

LC1000 UniSec solution: application for UniSec switchgear



Benefits



Continuity of service

- Class LSC2A and LSC2B panels can be integrated into the same line-up without the need for an adapter panel
- Fault isolation in less than 0.5 seconds in closed ring networks
- Network reconfiguration in less than 1 second in open ring networks



High performance and reliability

- Metallic partitions between the medium voltage compartments
- Switchgears with switch-disconnector featuring 630A - 800A rated current breaking capacity
- High-performance mechanical and electrical life for circuit breakers and switch-disconnectors
- CPU and communication redundancy capability
- Native components compliant with the IEC 61850 communication standard
- Solution featuring medium voltage switchgears fully assembled, wired and factory-tested prior to shipment



Flexibility and service

- Enhanced modularity of UniSec switchgear since installed panels can be expanded
- The HBC panel can be used with HySec multi-function apparatus to obtain a compact, flexible solution that cuts down the number of replacement parts to purchase
- Interchangeability of vacuum and SF6 circuit breakers
- Internal arc filters installed directly on the panels, thus no need for assembly work on site or civil engineering works for the construction of gas exhaust ducts
- Flexibility, since the numerous different components allow each solution to be customized
- Dedicated solutions for each individual application
- Remote assistance provided by ABB technicians
- Technical training for operators
- Prompt supply of replacement parts

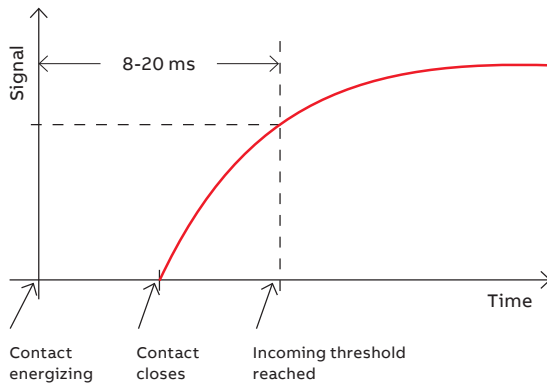
IEC 61850: Communication standard for smart grids

IEC 61850 is a recognized communication standard for electrical substations. It utilizes an Ethernet connection for rapid, reliable and efficient data transmission and supports the future integration of evolving technologies. The various components in the substations can communicate with each other via GOOSE (Generic

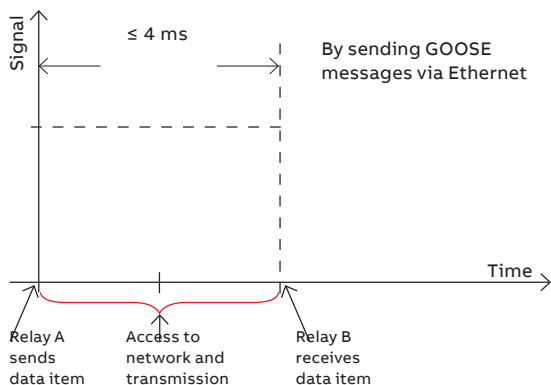
Object Oriented Substation Event) messages, thereby eliminating the majority of conventional cabling.

The LC1000 UniSec solution is based on the IEC 61850 standards with Relion 615, COM600 substation management unit, RIO600 and ACI800M automation processor.

Speed of data transfer using conventional cabling



Speed of data transfer by sending GOOSE messages according to standard IEC 61850



GOOSE messaging

GOOSE messaging is conveyed over an Ethernet connection, and the messages can be exchanged between devices in the same network (horizontal messaging) or with a control system (vertical messaging). Data transfer is faster than when conventional cabling is used (4 ms instead of 8-20 ms).

Thanks to GOOSE messages, connections between devices are monitored via cyclic transmission of data, which takes place even when there are no variations in the state of the components, e.g. the circuit breaker state. When the device detects a data change, the event is immediately transmitted several times to ensure the data is received. If the device that should receive the cyclic GOOSE message fails to receive it within a preset time, an alarm message is sent to warn of a connection problem.

Advantages of standard IEC 61850

- Reliability thanks to enhanced diagnostics
- More information about the devices in the network
- Flexibility and scalability to facilitate changes and expansions after putting into service, without the need for additional cabling
- Integration and interoperability of the most widely used communication technologies.

Network redundancy according to standard IEC 61850

Standard IEC 61850 integrates redundancy functions via the PRP / HSR protocol of standard IEC 62439.

- **HSR** High-availability Seamless Redundancy
- **PRP** Parallel Redundancy Protocol

Thanks to the HSR and PRP protocols, recovery time after a fault occurs is nil or at "zero time".

HSR redundancy

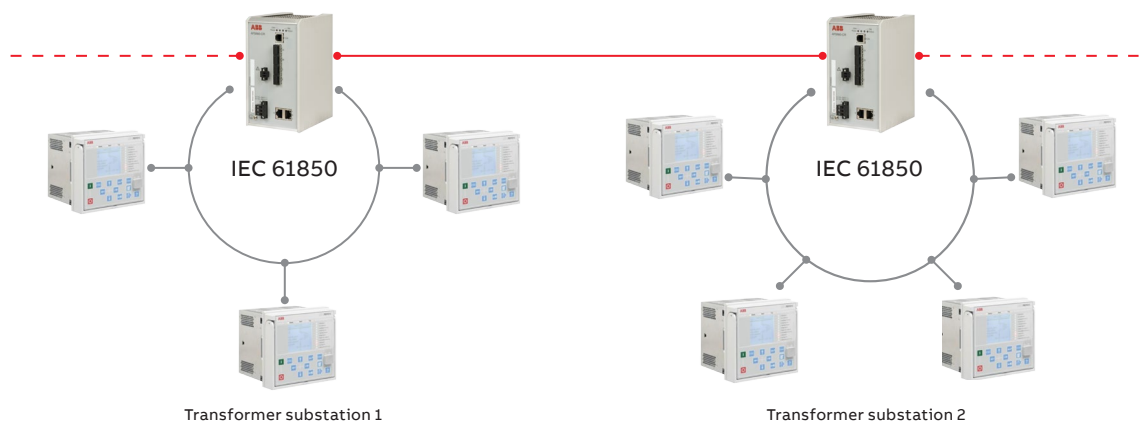
In the case of HSR redundancy, the Relion protection relays and Ethernet AFS660 switch in the substation are connected to the HSR ring with bumpless redundancy and zero recovery time, as are all the Ethernet switches in all the substations and those of the automation

switchgear. Faults in a component of the HSR network (one of the Relion protection relays, an Ethernet AFS660 switch or a copper or optical fiber cable) will not prevent information from immediately reaching its destination.

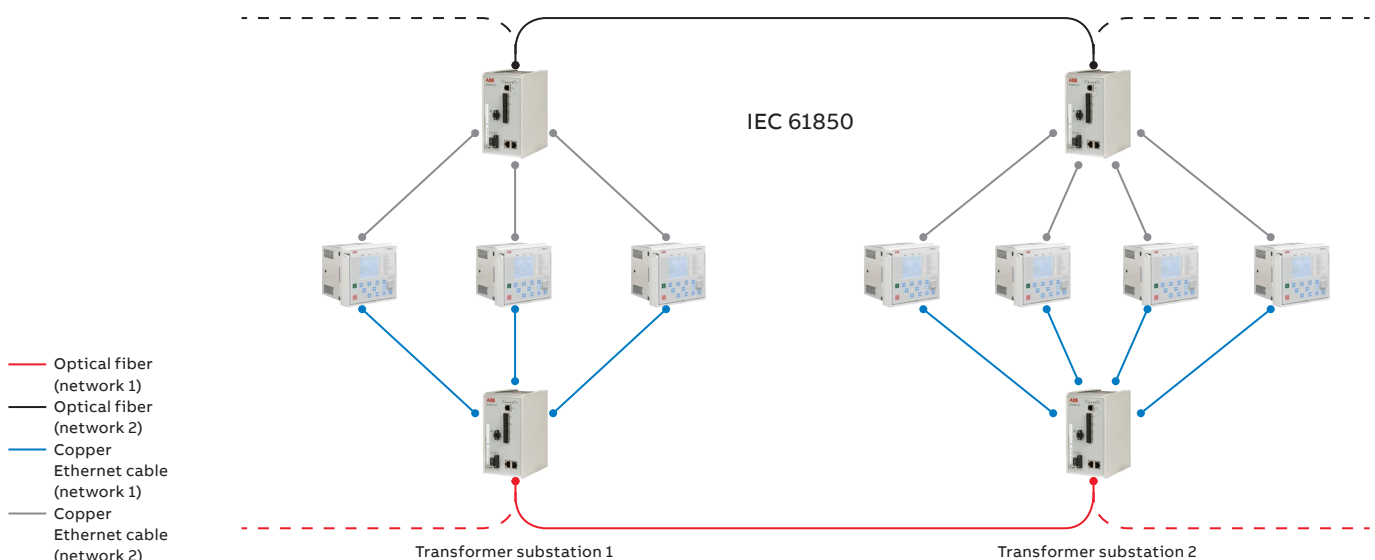
PRP redundancy

In the case of PRP redundancy, the Relion protection relays of the substation are connected to the two Ethernet AFS660 switches, thereby creating two totally independent networks. The PRP protocol represents the maximum level of redundancy of an Ethernet network with zero time recovery after a fault.

Redundancy with HSR protocol



Redundancy with PRP protocol



Description of the components

Fault detection components

The fault indicators in the transformer substations of the ring network are connected directly to the KEVCD current and voltage combi sensors.

RIO600 can be used as a fault indicator device. In addition, the protection relay can substitute RIO600 for the fault indicator function.

RIO 600 directional fault indicator

RIO600 is a modular device. Besides being a fault indicator, it has remote digital and analog input/output modules and supports horizontal communication via GOOSE messages according to standard IEC 61850.



KEVDC combined current and voltage sensor

KEVCD is a latest generation measurement sensor featuring linearity of measurement without saturation even when faults occurs. It saves a lot of space in switchgear by providing both current and voltage measurements. The KEVCD is connected to a indicator RIO600 via RJ45 cable.



Protection relay

Relion protection relays provide the main overcurrent and earth-fault protection for the outgoing line feeders and cables and conform to IEC 61850 standards for communication in substations, including fast GOOSE messaging. Protection relays are used for protecting the circuit breaker on the supply side (delivery substation) in LC1000 UniSec solution with centralized logic.

These relays can also be used as fault indicators instead of RIO600 and support the HSR or PRP redundancy of Ethernet networks according to standard IEC 61850.

Protection relays are used in the solution with decentralized logic to detect and isolate faults. A centralized programming interface API (Application Programming Interface) is not required, since the capacity of the local PLC (Programmable Logic Controller) of each Relion is sufficient (decentralized logic).



Description of the components

Components for ring network automation and management

ABB can provide various solutions for centralized management of ring network reconfiguration. A PC for the COM600 station automation device is all that is needed for the more compact and simple applications. An AC800M PLC is the ideal solution for more complex applications that require additional logic, such as disconnection, connection or processor redundancy.

COM600 substation management unit

COM600 complies with standard IEC 61850 and meets the following requirements:

- automation platform able to perform ring network reconfiguration
- gateway towards other supervision systems (based on Modbus, DNP3, IEC 60870-5101/104)
- "all in one" user interface based on standard IEC 61131-3



AC800M PLC

AC 800M is a modular hardware platform. The standard configuration is described below:

- 1 processor (CPU) type PM861A-eA (possible redundancy)
 - IEC 61850 Ethernet communication modules (possible redundancy)
 - another communication module (Modbus, Profibus, Ethernet/IP, etc.) so as to track back through the information towards another system upstream (possible redundancy)
 - auxiliary feeder module with back-up battery
- Besides providing all the reconfiguration logic of a ring network and for disconnection and connection, the AC800M PLC communicates, in accordance with IEC 61850, directly with the other devices in the grid (especially with the protection relays and fault detectors).



Communication network

Physical network in optical fiber and AFS660

Ethernet switch

Ethernet switches are installed in the switchgear of each substation and in the automation switchgear. They are connected to each other by optical fiber and are equipped with LC or ST ports for multimode or monomode optical fiber. Besides conforming to standard IEC 61850, they propose HSR or PRP redundancy.



Wireless mobile network and wireless Gateway ARG600

The ARG600 gateway belongs to the ABB Arctic family comprising a wide range of products, which can be combined to create reliable, efficient and secure wireless communication solutions. They use the public mobile telephone networks, which offer excellent world-wide coverage at a reasonable cost. ARG600 can be used instead of the Ethernet switch or in addition to it (as a stand-by communication network).



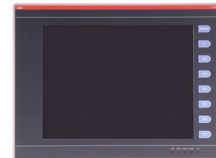
Supervision

ABB proposes an operator interface with touch screen display for the simplest applications. The ABB SD-View supervision system is the ideal solution for applications requiring a fully customizable supervision system or server redundancy.

15" HMI (Human Machine Interface) color touch screen display

The ABB operator interface provides the following functions:

- simple, dynamic line diagram of the entire installation
- information and diagnostics concerning network components in real time
- remote monitoring of circuit breaker
- events and alarm reports
- measurement monitoring
- monitoring of ring network reconfiguration logic behavior
- access to the web-HMI interface of the relays



SD-View supervision system

The SD-View supervision system is a software application that includes control, monitoring and automation functions. It can be managed by a PC with Windows® operating system.

Thanks to SD-View, the PC becomes a real control station which, along with automation processors and protection relays, controls and supervises the entire grid architecture as required by the

customer. The different voltage levels and communicating devices can be controlled. Maximum availability and reliability is guaranteed since the SD-View system includes server redundancy. The operator can access SD-View from every substation via computer, by connecting to a vacant port of Ethernet switch AFS660.

Examples of SD-View graphic pages

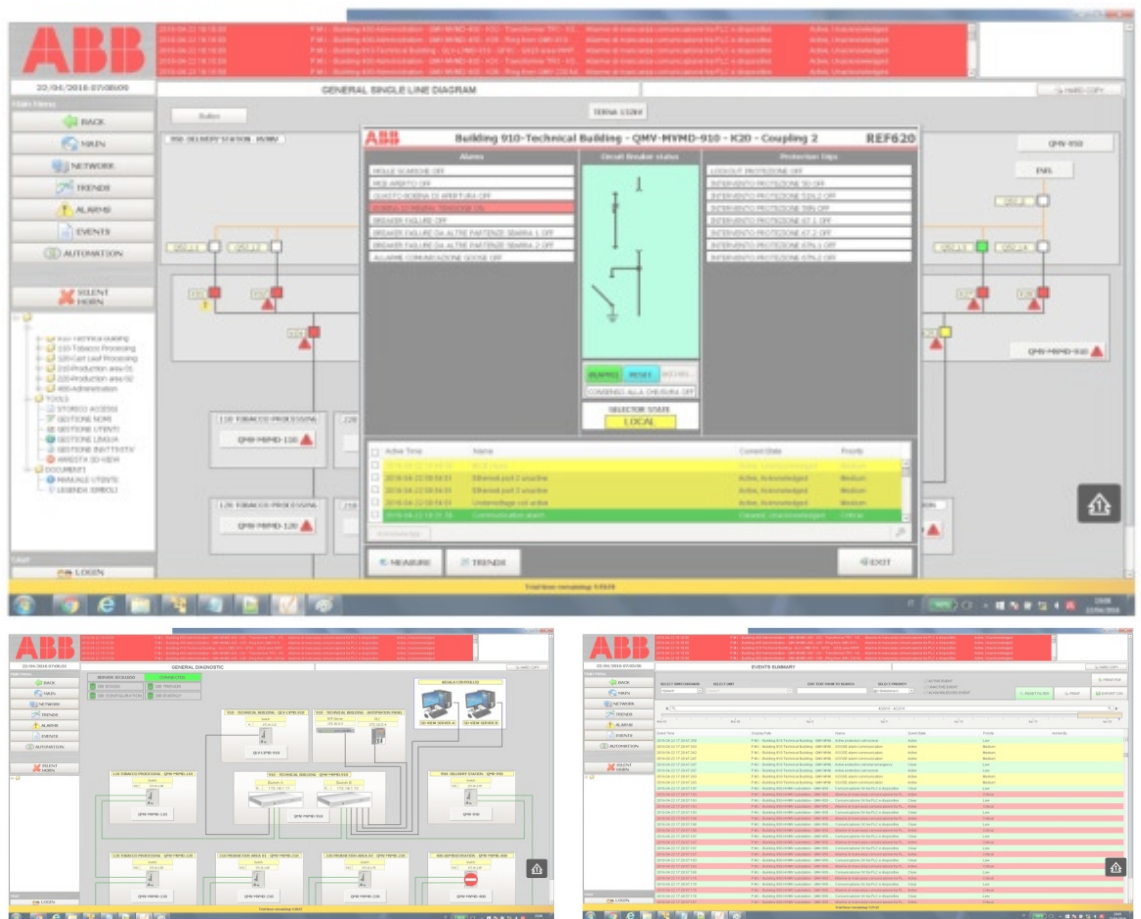


ABB assistance and support

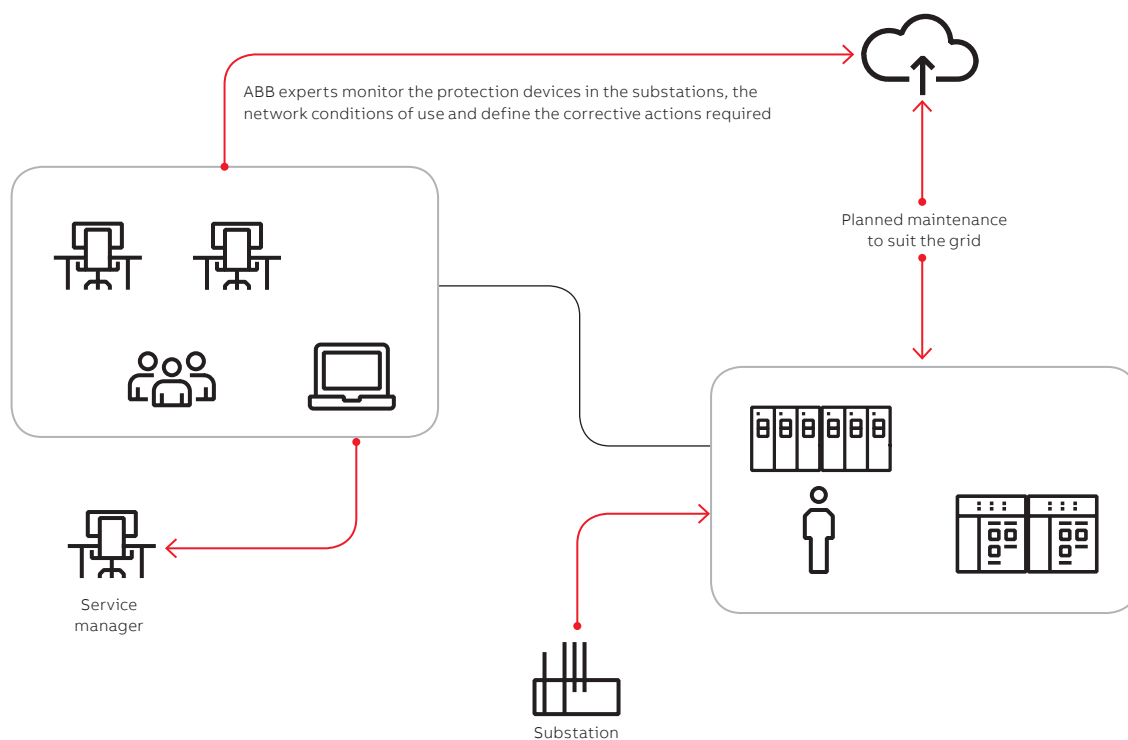
Remote assistance

ABB can provide technical assistance and support by remotely monitoring the grids thanks to the application of a modem with protected VPN (Virtual Private Network).

If faults or other requirements arise, an ABB technician can be called and allowed to access the Ethernet network concerned. The ABB technician can then access the information he needs (events reports, alarms log, measurements, etc.) and run a diagnostic test. The customer's network is accessed in accordance with the ABB's cyber security guidelines.

The assistance service includes:

- diagnosis of operating failures and faults
- technical backup and assistance for technicians in the customer's facility
- minor changes and corrections to the software configuration so as to eliminate the faults detected
- planning of subsequent steps to find the most rapid solution if the problem cannot be resolved remotely.





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