

DISTRIBUTION SOLUTIONS

Recommended offering for medium-voltage switchgear

Digital Substations



Table of contents

2	Table of contents
3	ABB's power protection philosophy
4	Relion® protection and control relays
6	Feeder protection
8	Transformer protection
10	Motor protection
12	Generator protection
14	Voltage protection
16	Capacitor bank protection
18	Busbar protection
20	Arc fault protection
22	Centralized protection and control
24	Remote I/O concept
24	Selection table
26	Fleet management
28	Compact power management
30	Automatic transfer systems
32	Remote I/O concept

ABB's power protection philosophy

Having delivered protection relays to more than 100 countries, ABB fully understands the need for diverse protection philosophies that meet local legislation, safety requirements and engineering practice. Therefore, ABB has developed a power protection philosophy that not only serves the specific needs and requirements of diverse power systems, but also creates confidence and peace of mind for both the power system owners and users.

The main purpose of a protection relay system is to recognize any abnormal power system condition(s), or abnormally operating system component(s). Based on the information gathered, the protection system will initiate corrective actions that return the system to its normal operating state. This provides a safe environment for all.

Protection relays are activated when something abnormal has happened in the power system; they do not prevent network faults from arising. Selecting the right protection functions and methods improves the performance and the reliability of the protection system, thus minimizing the effects of network faults and preventing the disturbance from spreading to the healthy parts of the network.

Advantages of a complete protection system

Close attention must be paid to operating speed, sensitivity, selectivity and reliability of the protection system. There is a strong correlation between the operating speed of the protection

system and the damage and danger caused by a network fault. Substation automation provides remote control and monitoring capabilities, which speed up the location of faults and the restoration of the power supply. Fast operation of the protection relays also minimizes post-fault load peaks. Together with voltage dips, post-fault load peaks increase the risk of the disturbance spreading to healthy parts of the network. The sensitivity of the protection must be adequate to detect relatively high resistance earth faults and short-circuits in the most distant parts of the network. Reliable selectivity is essential to limit the loss of power supply to as small a part of the network as possible, and to allow the faulted part of the network to be reliably located. Corrective actions can then be directed to the faulty part of the network, so that the power supply can be restored as quickly as possible.

The protection system must have a high degree of reliability. This also means that if, for example, the circuit breaker (CB) fails to operate, the back-up protection will clear the fault. Substation automation (SA) puts the operator in complete control of the substation. In addition, SA improves the power quality of the transmission and distribution network under normal operation, but especially in a disturbance situation and during substation maintenance activities. An SA or SCADA brings the full benefits of digital technology into protection and control of the networks. The protection relays are easily set-up and parameterized through easy and safe access from the operator's workplace.

Relion® protection and control relays

The Relion® product family offers the widest range of products for the protection, control, measurement and supervision of power systems for IEC and ANSI applications – from generation and interconnected grids over primary distribution to secondary distribution kiosks.

The ABB Relion protection relays are deeply rooted in ABB's vast experience of developing successful protection and control relays. These relays have been developed during many years and are built on the experience gathered from wide ranging application and functionality requirements of ABB's customers globally.

To ensure interoperable and future-proof solutions, Relion products have been designed to implement the core values of the IEC 61850 standard. The genuine implementation of the IEC 61850 substation modelling and communication standard covers both vertical and horizontal information exchange between protection relays and external systems. The protection and control IED manager PCM600

provides versatile functionality throughout the life cycle of all Relion protection and control relays. PCM600 is IEC 61850 compliant, which ensures smooth engineering of the relays and enables information exchange with other IEC 61850 compliant tools.

With these products, you benefit from ABB's leading-edge technology, global application knowledge and experienced support network. The Relion technology is leading the way and setting the future trends in the field of protection and control systems.

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01 ABB Relion
protection and control
product family



Relion 605 series

The Relion 605 series protection relays feature basic devices that fulfill the essential protection needs in medium-voltage networks. The series is best suited for secondary distribution applications. These relays are well-known for their straight forward approach to protection.

Relion REX610

REX610 covers the full range of basic utility applications. The modular and scalable design makes creating unique protection solutions easy, whereas the extensive range of default functionality, including communication, allows easy alterations with no additional costs nor hardware changes. This makes REX610 not only flexible but also a very cost-effective choice.

Relion 611 series

The Relion 611 series protection relays are powerful and very easy-to-use protection devices in a compact design. The 611 series relays are delivered with a pre-configured application, which can be adapted, to a limited extent, to application-specific needs. The series offers pre-configured solutions, which are ideally suited for utility distribution and industrial applications.

Relion 615 series

The Relion 615 series protection relays can be defined as a compact and versatile solution for power distribution in utility and industrial applications. The 615 series provides standard configurations, which allows you to easily adapt and set-up your applications, still allowing you to adapt the configuration according to application-specific needs. The 615 series combines compactness and powerful features in one smart package.

Relion 620 series

The Relion 620 series protection relays increase flexibility in demanding utility and industrial applications for power distribution. They are delivered with example configurations to ease adaptation into your specific applications. The series offers customization possibilities, which supports higher levels of standardization in the applications. The 620 series extends the hardware possibilities further compared to the 615 series.

Relion 630 series

The pre-configured Relion 630 series protection relays feature flexible and scalable functionality to adapt to different needs in power distribution networks and industrial applications. The 630 series protection relays contain pre-configured application configurations, which can be freely tailored to meet specific requirements for distribution applications.

Relion REX640

REX640 makes protecting all assets in advanced power generation and distribution applications easy. The fully modular design allows unequaled customization and modification flexibility, and easy adaptation to changing protection requirements throughout the relay life cycle.

Feeder protection

Feeder protection, or more exactly protection for overhead lines and cables, is the most used type of protection in power systems. The protection has to ensure that the power grid continues to supply energy. In the event of a fault, it has to be prevented from spreading to healthy parts of the network. The relays also have to minimize the damage to the cables and other connected equipment, as well as ensure safety for operating personnel.

ABB has a large number of feeder protection relays. There are several multifunctional protection relays for different application ranges. Among the protection relays there are some used for general feeder protection (protection against overcurrent) and as back-up protection. There are also more specialized relays, for example, for line differential protection.

The selected protection scheme has to fulfill the application specific requirements regarding sensitivity, selectivity and operating speed. The protection requirements are mainly determined by the physical structure of the network. In most cases the requirements, listed above, can be fulfilled with non-directional/directional overcurrent protection functions.

In power networks with a more complex structure, more advanced protection functions, such as, distance protection or line differential protection, may have to be introduced.

The purpose of the over and undervoltage protection system is to monitor the network's voltage level. If the voltage level deviates from the target value by more than the permitted margin for a specific time period, the voltage protection system limits the duration of the abnormal condition and the stresses caused to the power system or its components.

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

A specific area for applying line differential protection is emerging with feeder applications requiring an absolutely selective unit protection system. The zone-of-protection for a line differential protection system is the feeder section, defined by the location between the current measurement devices (current transformers or Rogowski coils). In certain cases there can be a power transformer within the protection zone. Unit protection guarantees exact and fast isolation of the fault and allows continued operation of the unaffected part of the power network.

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

Product offering

The recommended products for feeder protection are part of ABB's Relion® product family. The Relion product family offers the widest range of products for the protection, control, measurement and supervision of power systems for IEC and ANSI applications.

Relion 605 series

The Relion 605 series protection relays feature basic devices that fulfill the essential protection needs in medium-voltage networks. These relays are well-known for their straight forward approach to protection.

Relion REX610

REX610 is a freely configurable all-in-one protection relay that covers the full range of basic power distribution applications, without forgoing simplicity. The small number of variants translates into easy ordering, set up, use and maintenance. Rich in functionality, with a fully modular hardware unlocking all available functionality, REX610 represents both a flexible and cost-effective choice.

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01 Basic range:
Feeder protection REF601
and self-powered feeder
protection REJ603

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02 Medium range:
Protection and control
REX610, Feeder
protection and control
REF611, Feeder protection
and control REF615

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03 High range:
Feeder protection
and control REF620,
Feeder protection
and control REF630
and Multiapplication
Protection and
Control REX640

Relion 611 series

The Relion 611 series offers a pre-configured solution for power distribution in utility and industrial applications. The series is a suitable choice for protection and control of standard feeders. The protection relays are delivered pre-configured for easier and faster relay engineering and shorter time-to-operation.

Relion 615 series

The Relion 615 series offers a compact and versatile solution for power distribution in utility and industrial applications. The protection relays are delivered with a standard configuration for easier and faster relay engineering and shorter time-to-operation.

Relion 620 series

The Relion 620 series offers flexibility and performance for demanding power distribution in utility and industrial applications. The series offers wider application coverage in one product compared to the 615 series, which enables wider standardization of the product type in your application. The 620 series protection relays are delivered with an example configuration, which helps adaptation to user specific requirements.

Relion 630 series

The Relion 630 series protection relays feature flexible and scalable functionality to adapt to different needs in power distribution networks and industrial applications. The relays contain pre-configured application configurations, which can be tailored to meet the specific requirements for also the most demanding distribution applications.

Relion REX640

The base functionality in REX640 can be enhanced with additional application packages for feeder protection, such as fault locator, line differential protection and line distance protection

For more information, please refer to the following documentation:

- Feeder Protection REF601 Product Guide
- Self-Powered Feeder Protection REJ603
- Product GuidePFeeder Protection and Control REF611 Product Guide
- Protection and Control REX610 Product Guide
- Line Differential Protection and Control RED615 Product Guide
- Feeder Protection and Control REF615 Product Guide
- Feeder Protection and Control REF620 Product Guide
- Feeder Protection and Control REF630 Product Guide
- Multiapplication Protection and Control REX640 Product Guide



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Transformer protection

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

Although high-quality power transformers are very reliable, insulation breakdown faults occasionally occur. These faults appear as short circuits and/or earth faults. They tend to cause severe damage to the windings and transformer core. The damage is proportional to the fault clearing time, so the power transformer must be disconnected as quickly as possible.

For repair, the power transformer has to be transported to a workshop, which is a very time-consuming process. The operation of a power network, where the power transformer is out of service, is always cumbersome. Therefore, a power transformer fault often constitutes a more severe power system fault than a line fault, which usually can be rectified rather quickly. It is extremely important that fast and reliable protection relays are used to detect transformer faults and initiate tripping.

The size, voltage level and importance of the power transformer determine the extent and choice of monitoring and protection devices to be used to limit the damage, when a fault occurs. Compared to the total cost of the power transformer and the costs caused by a power transformer fault, the cost of the protection system is negligible.

Product offering

The recommended products for transformer protection are part of ABB's Relion® product family. The Relion product family offers the widest range of products for the protection, control, measurement and supervision of power systems for IEC and ANSI applications.

Relion 615 series

The Relion 615 series offers a compact and versatile solution for power distribution in utility and industrial applications. The series covers two winding transformer application and automatic voltage regulator function in separate product types. Each protection relay is delivered with a standard configuration for easier and faster relay engineering and shorter time-to-operation.

Relion 620 series

The Relion 620 series offers flexibility and performance for demanding power distribution in utility and industrial applications. The series offers wider application coverage, including transformer application and automatic voltage regulator, in one product. Compared to the 615 series, it enables wider standardization of the product type in the application. The 620 series relays are delivered with an example configuration, which can be pre-adapted to user specific requirements.

Relion 630 series

The Relion 630 series protection relays feature flexible and scalable functionality to adapt to different needs in power distribution networks and industrial applications. The relays contain pre-configured application configurations, which can be tailored to meet the specific requirements for also the most demanding distribution applications. In one easily scalable hardware solution, it includes extensive transformer protection and automatic voltage regulator functions.

Relion REX640

The modular design allows customization and modification flexibility, and easy adaptation to changing protection requirements. The relay can be used for two and three-winding transformer applications. The base functionality is enhanced with power transformer application packages. With the packages also on-load tap changer control can be managed.

01 Transformer protection and control RET615, Transformer protection and control RET620, Transformer protection and control RET630 and Multiapplication Protection and Control REX640

- For more information, please refer to the following documentation:
- Transformer Protection and Control RET615 Product Guide
 - Voltage Protection and Control REU615 Product Guide
 - Transformer Protection and Control RET620 Product Guide
 - Transformer Protection and Control RET630 Product Guide
 - Multiapplication Protection and Control REX640 Product Guide

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Motor protection

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

Motors need to be protected not only against electrical faults, but also against any improper usage. ABB's solutions focus on advanced thermal protection that prevents improper use. Overload conditions of short duration mainly occur during start-up. Improper use of running motors does not necessarily damage the equipment, but shortens its life span. Therefore, a reliable and versatile motor protection system not only protects the motor - it also prolongs its life cycle, which contributes to improving the return of investment of your motor drive.

Product offering

The recommended products for motor protection are part of ABB's Relion® product family. The Relion product family offers the widest range of products for the protection, control, measurement and supervision of power systems for IEC and ANSI applications.

Relion 605 series

The Relion 605 series offers a compact solution for the protection of medium-voltage and low-voltage asynchronous motors in the manufacturing and process industry. The relays offer pre-configured functionality, which facilitates easy and fast commissioning of the switchgear. The relay can be used with both circuit-breaker and contactor-controlled motor drives.

Relion REX610

REX610 is a freely configurable all-in-one protection relay that covers the full range of basic power distribution applications, without forgoing simplicity. The small number of variants translates into easy ordering, set up, use and maintenance. Rich in functionality, with a fully modular hardware unlocking all available functionality, REX610 represents both a flexible and cost-effective choice.

Relion 611 series

The Relion 611 series offers a pre-configured solution for power distribution in utility and industrial applications. This series is a suitable choice for protection and control of small asynchronous motors/drives. The protection relays are delivered pre-configured for easier and faster relay engineering and shorter time-to-operation.

Relion 615 series

The Relion 615 series offers a compact and versatile solution for power distribution in utility and industrial applications. The series is a suitable choice for protection and control of asynchronous motors. Each protection relay is delivered with standard configuration, for easier and faster relay engineering and shorter time-to-operation.

Relion 620 series

The Relion 620 series offers flexibility and performance for demanding power distribution in utility and industrial applications. Compared to the 615 series, the 620 series offers wider application coverage in one product, which enables wider standardization of the product type in your application. The protection relay is delivered with an example configuration, which can be pre-adapted to your specific requirements.

Relion 630 series

The Relion 630 series protection relays feature flexible and scalable functionality to adapt to different needs in power distribution networks and industrial applications. The relays contain pre-configured application configurations, which can be tailored to meet specific requirements for also the most demanding distribution applications. In one easily scalable hardware solution, it includes extensive motor protection including differential protection function.

Relion REX640

The fully modular design allows customization and modification flexibility, and easy adaptation to changing protection requirements. For motor protection the base functionality in REX640 can

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01 Basic range:
Motor protection and
control REM601

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02 Medium range:
Protection and control
REX610, Motor protection
and control REM611,
Motor protection and
control REM615

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03 High range:
Motor protection
and control REM620,
Motor protection
and control REM630
and Multiapplication
Protection and
Control REX640

enhanced with motor application packages. The packages support both synchronous and asynchronous motors.

For more information, please refer to the following documentation.

- Protection and Control REX610 Product Guide
- Motor Protection and Control REM611 Product Guide
- Motor Protection and Control REM615 Product Guide
- Motor Protection and Control REM620 Product Guide
- Motor Protection and Control REM630 Product Guide
- Multiapplication Protection and Control REX640 Product Guide



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Generator protection

Generators or generating units constitute one of the most crucial parts in a power system, making it essential to use a proper protection scheme. A generator has more failure modes than any other component in the power system. It is very important that the protection system detects all faults and that it does so quickly, as they may cause injury to personnel and damage to the equipment.

It is common practice that earth faults, short circuits and other severe faults must be detected by two independent protection devices. The fault must be cleared, even if one switching device fails to operate. The generator protection system must also provide adequate backup protection for the adjacent components.

A synchronous machine is a complex device, which can operate as a generator or as a motor. The armature/stator winding is arranged in three symmetrical phase belts in slots in the stator surface. The magnetic field intensity can be controlled via the DC-current in the rotor/field winding.

The protection of synchronous generators involves the consideration of more possible faults and abnormal conditions than the protection of any other power system component. We have to consider stator faults, rotor faults, abnormal operating conditions and faults in the connected power grid.

Today there are many and varying power station configurations. This makes the use of a uniform and standardized generator protection system very challenging. Besides the varying power station configuration, the following factors influence the design of the generator protection system:

- generator circuit-breaker or not
- earthing of the generator neutral
- location of the voltage transformers
- location of the current transformers

A rotating machine provides a classic application for differential protection. The generator

differential protection gives a fast and absolutely selective detection of generator stator short circuits.

Product offering

The recommended products for generator protection are part of ABB's Relion® product family. The Relion product family offers the widest range of products for the protection, control, measurement and supervision of power systems for IEC and ANSI applications.

Relion 615 series

The Relion 615 series offers a compact and versatile solution for power distribution in utility and industrial applications. The protection relays are delivered with a standard configuration for easier and faster relay engineering and shorter time-to-operation.

The series offers extensive interconnection and compact generator protection for both the generator and the prime mover in various small and medium-sized power plants.

Relion 630 series

The Relion 630 series protection relays feature flexible and scalable functionality to adapt to different needs in power distribution networks and industrial applications. The relays contain pre-configured application configurations, which can be tailored to meet specific requirements for also the most demanding distribution applications. In one easily scalable hardware solution, it includes extensive protection for generator and generator-transformer units used in various power plants.

Relion REX640

The fully modular design allows customization and modification flexibility, and easy adaptation to changing protection requirements. In addition to conventional protection, control, measurement and supervision duties REX640 can also perform both generator and non-generator circuit breaker synchronizing. REX640 includes extensive protection for generator and generator-transformer units used in various power plants.

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01 Generator protection
and control REG615,
Generator protection
and control REG630
and Multiapplication
Protection and
Control REX640

For more information, please refer to the
following documentation:

- Generator and interconnection protection
REG615 Product Guide
- Generator Protection and Control REG630
Product Guide
- Multiapplication Protection and Control REX640
Product Guide



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Voltage protection

Overvoltage in a network occurs either due to the transient surges in the network or due to prolonged power frequency overvoltages. The overvoltage function can be applied to power network elements, such as generators, transformers, motors, busbar and power lines, to protect the system from excessive voltages that could damage the insulation and cause insulation breakdown.

Undervoltage and low voltage conditions are caused by abnormal operation or a fault in the power system. The undervoltage protection function is used to disconnect from the network devices, for example electric motors, which are damaged when subjected to service under low voltage conditions.

Additionally synchro-check function duration mode checks that the voltages on both sides of the circuit breaker are perfectly synchronized. It is used to perform a controlled reconnection of two systems, which are divided after islanding. It is also used to perform a controlled reconnection of the system after reclosing.

The frequency protection function uses positive phasesequence voltage to measure the frequency reliably and accurately. The system frequency stability is one of the main principles in distribution and transmission network maintenance. To protect all frequency-sensitive electrical apparatus in the network, operation above/below the allowed bandwidth for a safe operation should be prevented. To guarantee network frequency stability you need to apply underfrequency, overfrequency or load-shedding schemes.

Another important and common way of regulating the voltage in the power network is using a voltage regulator on the power transformer.

Product offering

The recommended products for voltage protection are part of ABB's Relion® product family. The Relion product family offers the widest range of products for the protection, control, measurement and supervision of power systems for IEC and ANSI applications.

Relion REX610

REX610 is a freely configurable all-in-one protection relay that covers the full range of basic power distribution applications, without forgoing simplicity. The small number of variants translates into easy ordering, set up, use and maintenance. Rich in functionality, with a fully modular hardware unlocking all available functionality, REX610 represents both a flexible and cost-effective choice.

Relion 611 series

The Relion 611 series offers a pre-configured solution for power distribution in utility and industrial applications. The REU611 is designed for overvoltage and undervoltage protection and additional 2-stage frequency protection. The protection relays are delivered pre-configured for easier and faster relay engineering and shorter time-to-operation.

Relion 615 series

The Relion 615 series offers a compact and versatile solution for power distribution in utility and industrial applications. The series is a suitable choice for protection and control of voltage based protection. REU615 standard configuration A is the ideal choice for voltage and frequency based protection, including synchro-check and load-shedding functionality. REU615 standard configuration B offers a dedicated relay with an automatic voltage regulator function for power transformers with on-load tap changer. Each protection relay is delivered with standard configuration, for easier and faster relay engineering and shorter time-to-operation.

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01 Protection and control REX610, Voltage protection and control REU611, Voltage protection and control REU615

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02 Feeder protection and control REF620, Feeder protection and control REF630 and Multiapplication Protection and Control REX640

Relion 620 series

The Relion 620 series offers flexibility and performance for demanding power distribution in utility and industrial applications. Compared to the 615 series, RET620 offers wider application coverage in one product, including voltage and frequency based protection with automatic voltage regulator function. The relays are delivered with an example configuration, which can be pre-adapted to user requirements.

Relion 630 series

The Relion 630 series protection relays feature flexible and scalable functionality to adapt to different needs in power distribution networks and industrial applications. The relays contain pre-configured application configurations, which can be tailored to meet specific requirements for also the most demanding distribution applications. In one easily scalable hardware solution, you gain load-shedding with automatic voltage regulator functions.

Relion REX640

The fully modular design allows customization and modification flexibility, and easy adaptation to changing protection requirements. The base package includes the standard protection functions needed for voltage protection.

For more information, please refer to the following documentation:

- Voltage Protection and Control REU611 Product Guide
- Voltage Protection and Control REU615 Product Guide
- Transformer Protection and Control RET620 Product Guide
- Transformer Protection and Control RET630 Product Guide
- Multiapplication Protection and Control REX640 Product Guide



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Capacitor bank protection

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01 Capacitor bank
protection and
control REV615
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02 Multiapplication
Protection and
Control REX640

Capacitors form an essential part of the network and must be properly protected against overloads, overcurrents or other distortion during their connection to the network.

Capacitor banks are used for reactive power compensation in utility substations and industrial power systems. Most of the loads connected to the distribution feeders have the power factor on the inductive side, for example, motors and arc furnaces. This reactive current component does not contribute the conversion into useful power, but it stresses the network components, introducing additional voltage drops and heat losses. The most favorable approach is to compensate the reactive current as close to the consumption as possible. The compensation can be done locally, at the place where it is needed, for example, at the factory or facility. It can also be done remotely by, for example, a utility organization.

Extra charges are always applied when excess level of reactive load is taken from the network. Therefore, the utilities have to evaluate the reactive power balance within their distribution network and do the necessary compensation at the most suitable location.

Product offering

The recommended products for capacitor bank protection are part of ABB's Relion® product family. The Relion product family offers the widest range of products for the protection, control, measurement and supervision of power systems for IEC and ANSI applications.

Relion 615 series

The Relion 615 series offers a compact and versatile solution for power distribution in utility and industrial applications. The series is a suitable choice for protection and control of capacitor banks. Additionally, it can be applied to harmonic filter protection. Each protection relay is delivered with a standard configuration, for easier and faster relay engineering and shorter time-to-operation.

Relion REX640

The fully modular design allows customization and modification flexibility, and easy adaptation to changing protection requirements. The base functionality in REX640 can be enhanced with a special application package for shunt capacitor protection.

For more information, please refer to the following documentation:

- Capacitor Bank Protection and Control REV615 Product Guide
- Multiapplication Protection and Control REX640 Product Guide



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Busbar protection

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01 Busbar protection
and control REB611
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02 Multiapplication
Protection and
Control REX640
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The last, but not least, part in electrical power systems is defined by the busbar application. The busbar is an aluminum or copper conductor supported by insulators that interconnects the loads and the sources of electric power. For example, in metal enclosed switchgear, it is represented by copper bars in the busbar compartment. The requirements for busbar protection in respect of immunity to mal-operation are very high. For busbar protection it is essential to employ a differential protection principle.

Product offering

The recommended products for busbar protection are part of ABB's Relion® product family. The Relion product family offers the widest range of products for the protection, control, measurement and supervision of power systems for IEC and ANSI applications.

Relion 611 series

The Relion 611 series offers a pre-configured solution for power distribution in utility and industrial applications. It is a suitable choice for high-impedance busbar protection. The protection relays are delivered pre-configured for easier and faster relay engineering and shorter time-to-operation.

Relion REX640

The fully modular design allows customization and modification flexibility, and easy adaptation to changing protection requirements. The base functionality in REX640 can be enhanced with a special application package for busbar high-impedance protection.

For more information, please refer to the following documentation:

- Busbar Protection and Control REB611 Product Guide
- Multiapplication Protection and Control REX640 Product Guide



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Arc fault protection

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01 Arc fault damage as a function of the arc fault energy and the arc fault impact time

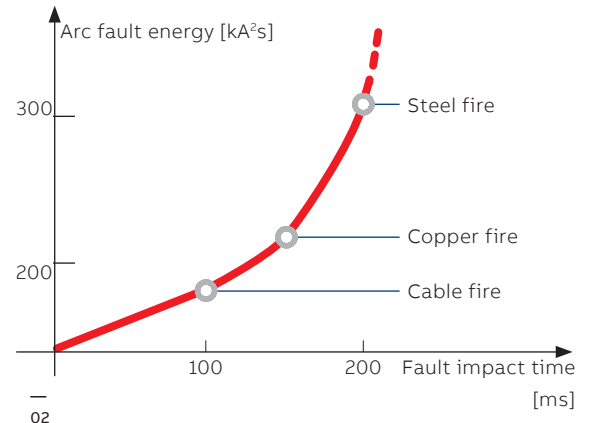
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02 The REA system is a fast and flexible arc fault protection system for air-insulated low voltage and medium-voltage switchgear.

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

An adequate arc protection system protects your substation against arc faults via minimizing the burning time of the arc, thus preventing excessive heat and damage. It minimizes material damage and allows power distribution to be smoothly and safely restored. The system can also bring cost benefits even before an arc fault occurs. As older switchgear is more prone to arc faults, an arc protection system will effectively extend the life of your switchgear enhancing the return on your investment.

Sources of arcing may be insulation faults, mal-operating devices, defective bus or cable joints, overvoltage, corrosion, pollution, moisture, ferro-resonance (instrument transformers) and even ageing due to electrical stress. Most of these arc fault sources could be prevented by sufficient maintenance. However, regardless of precautions taken, human errors can lead to arc faults.

Time is critical when it comes to detecting and minimizing the effects of an electric arc. An arc fault lasting 500 ms may cause severe damage to



the installation. If the burning time of the arc is less than 100 ms the damage is often limited, but if the arc is extinguished in less than 35 ms its effect is almost unnoticeable.

Generally applied protection relays are not fast enough to ensure safe fault clearance times at arc faults. The operation time of the overcurrent relay controlling the incoming circuit breaker may, for instance, have been delayed to hundreds of milliseconds for selectivity reasons. This delay can be avoided by installing an arc protection system. The total fault clearance time can be reduced to a maximum of 2.5 ms plus the circuit breaker's contact travel time. Further, when a cable compartment fault occurs, auto-reclosing can be eliminated by employing arc fault protection.



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03 A redundant and selective arc fault protection system, with a single-busbar, two section switchgear, which is fed from two power transformers. Each Relion 615 series protection relay with integrated arc fault protection is supervising compartments of the metal-enclosed switchgear panels. The selectivity of tripping between the 615 series protection relays is achieved via utilizing IEC 61850 GOOSE communication. The REA 101 main unit is used as the redundant arc protection system for the switchgear bus sections.

Product offering

The recommended products for arc fault protection is the arc fault protection system REA 101 with its extension units REA 103, REA 105 and REA 107 and protection and control relays from ABB's Relion® product family.

REA system

The REA system is a fast and flexible arc fault protection system for switchgear. This type of fast and selective arc fault protection system is a natural constituent of modern switchgear panels, and a safety and security investment for older switchgear panels, to protect human lives and prevent or reduce material damage. The REA system can be described as the fastest operating arc fault protection system in ABB's product portfolio, with trip command time in less than 2.5 ms.

Relion 615 series and 620 series

The Relion® product family offers integrated arc fault protection in its widest range of products for the protection, control, measurement and supervision of power systems for IEC and ANSI applications.

The Relion 615 and 620 series offer integrated three channel arc fault protection – to protect human lives and prevent or reduce material damage of protected switchgear – for power distribution in utility and industrial applications. The arc fault protection function operates with high-speed outputs with operation times down to 4 ms.

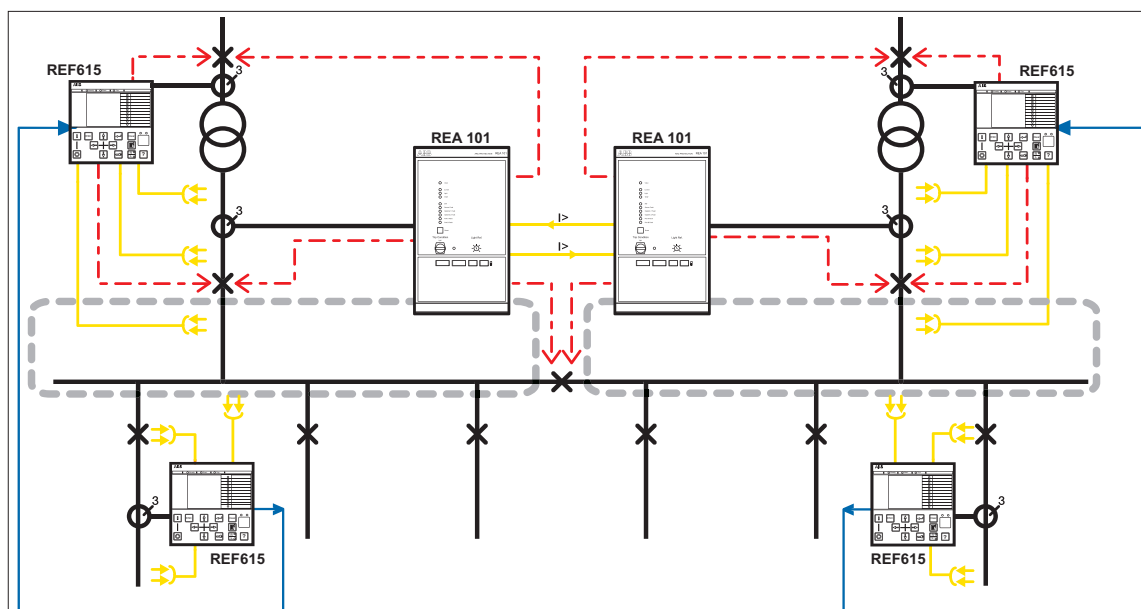
Relion 640

REX640 protection relays are equipped with arc flash sensor card, that supports either loop or lens sensors or a combination thereof, and includes supervision of the sensors. By using suitable sensor combinations for different bays, a selective arc flash protection scheme can be build up for the complete switchgear.

For more information, please refer to the following documentation:

- Arc Fault Protection REA 101 main module Product Guide
- Arc Fault Protection REA 103 extension module Product Guide
- Arc Fault Protection REA 105 extension module Product Guide
- Arc Fault Protection REA 107 extension module Product Guide
- Feeder Protection and Control REF615 Product Guide
- Motor Protection and Control REM615 Product Guide
- Transformer Protection and Control RET615 Product Guide
- Voltage Protection and Control REU615 Product Guide
- Capacitor Bank Protection and Control REV615 Product Guide
- Feeder Protection and Control REF620 Product Guide
- Motor protection and control REM620 Product Guide
- Transformer Protection and Control RET620 Product Guide
- Multiapplication Protection and Control REX640 Product Guide

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03



Centralized protection and control

Advances in communication systems, including time synchronization, their integration to substation applications and the standardization of protocols have facilitated the operation and the diagnosis of failures in complex grids and have enabled new possibilities for protection and control schemes. These advances have opened space for the implementation of the centralized protection and control system.

The centralized protection and control concept is based on the concentration of substation protection and control in a single device and the utilization of communication networks to converse between different components, bays, substations and the related operators. The most substantial protection philosophy change in the system is the total or partial shift of functions from the bay level, i.e., from the relays, to the station level in the substation.

Product offering

ABB Ability™ Smart Substation Control and Protection for electrical systems SSC600

SSC600 is a smart substation device designed for protection, control, measurement and supervision of utility substations and industrial switchgear and equipment. The design of the device has been guided by the IEC 61850 standard for communication and interoperability of substation automation devices. It is fully integrable with Relion series IEDs for creating a complete solution. Optional functionality is available at the time of order for both software and hardware, for example, special application packages and additional communication modules.

Depending on the chosen product options, the device is adapted for:

- Protection for overhead line and cable feeder in isolated neutral, resistance earthed, compensated and solidly earthed networks.
- Protection, control, measurement and supervision of asynchronous motors in manufacturing and process industry.
- Transformer protection and control for power

transformers, unit and step-up transformers including power generator-transformer blocks in utility and industry power distribution systems.

- Busbar differential protection to ensure uninterrupted power supply - protecting the busbar from any electrical faults.
- Protection for shunt capacitor banks
- Arc flash protection to guard the switchgear from damage and personnel from injury in case of an arc flash incident.

Smart Substation Control and Protection SSC600 SW

SSC600 functionality is also available as a virtualized product, SSC600 SW, which enables customers to use the hardware of their choice and gain access to the same proven protection and control functionality as with the turnkey solution.

Substation Merging Unit SMU615

SMU615 is a dedicated substation merging unit intended for measuring current and voltage signals from the instrument transformers and merging them into the standard digital output format that other devices can further use for various power system protection application purposes. SMU615 itself includes no protection functionality but it offers the physical interface into the switchgear primary equipment, that is, circuit breaker, disconnector and earthing switch. SMU615 is a member of ABB's Relion® product family and is characterized by the compactness, simplicity and withdrawable-unit design.

For more information, please refer to the following documentation:

- Smart Substation Control and Protection SSC600 Product Guide
- Substation Merging Unit SMU615 Product Guide

— Smart Substation Control
and Protection SSC600

— Substation Merging
Unit SMU615

— 01 Example of centralized
protection and control

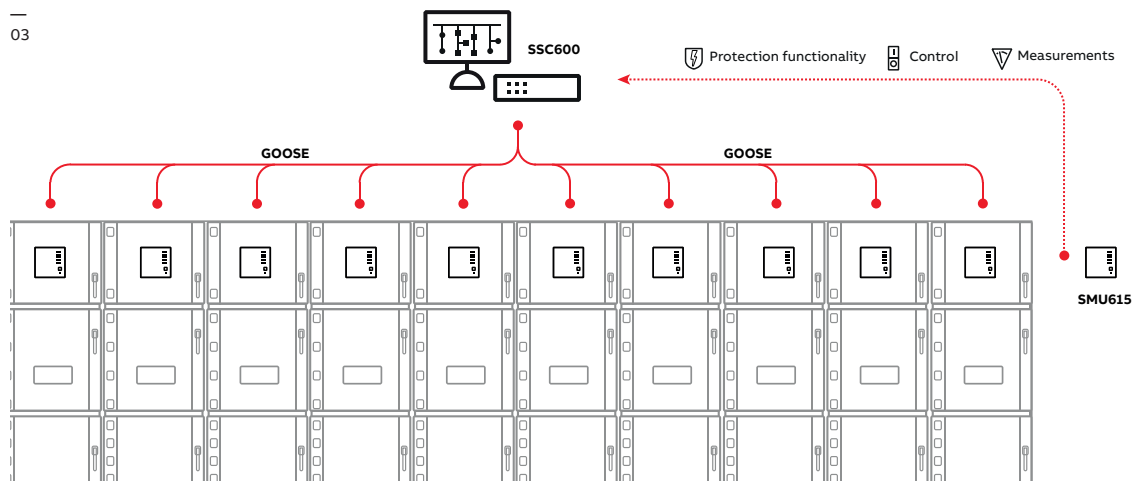


01



02

03



Selection table

	605	605	605	605	610	611	611	611	611	611	615	615	615	615
	REF601	REJ601	REJ603	REM601	REX610	REB611 IEC	REF611 IEC	REM611 IEC	REU611 IEC	REF615 IEC	RED615 IEC	REG615 IEC	REM615 IEC	
Standard														
ANSI	X	X		X	X									
IEC	X	X	X	X	X	X	X	X	X	X	X	X	X	
Application														
Arc fault protection application										O		O	O	
Busbar application						X								
Back-up application	X	X			X	O	X			X				
Capacitor bank application														
Feeder application	X	X	X		X		X		X	X	X			
Generator application												X		
Motor application				X	X	O		X					X	
Petersen coil protection														
Transformer application						O					X			
Functionality														
Autorecloser	X	X		X	X		X			X	X			
Circuit breaker (CB) controllability	X			X	X	X	X	X	X	X	X	X	X	
Condition monitoring	X			X	X	X	X	X		X	X	X	X	
Current-based protection	X	X	X	X	X	X	X	X		X	X	X	X	
Distance protection														
Fault locator										X	X			
Generator differential protection						X						X		
Display with Single Line Diagram (SLD)										X	X	X	X	
Line differential protection (in-zone transf. support)											X			
Load-shedding														
Motor differential protection						X								
On-load tap changer control														
Power quality										X	X	X		
Self-powered protection relay			X											
Synchro-check										X		X		
Generator/non-generator CB synchronizing														
Transformer differential protection						X								
Voltage based protection					X				X	X	X	X	X	
Withdrawable release mechanism					X	X	X	X	X	X	X	X	X	
Hardware														
Analog inputs (CTs/VTs)	4/0	4/0	4/0	4/0	4/4	4/0	4/1	4/0	0/5	4/5	4/5	7/5	4/5	
Analog inputs (sensor channels/CTs)	3/1	3/1		3/1						6/1	6/1		6/1	
Binary inputs/outputs	4/6	4/6	0/2	4/6	6/6	4/6	10/9	4/6	4/6	18/13	18/13	16/10	16/12	
RTD/mA inputs										2/1	2/1	2/1	6/2	
mA outputs														
Communication protocols														
DNP 3.0										X	X	X	X	
IEC 60870-5-103	X	X		X						X	X	X	X	
IEC 61850					X	X	X	X	X	X	X	X	X	
Modbus	X	X		X	X	X	X	X	X	X	X	X	X	
Profibus										X	X	X	X	
Communication media														
Ethernet (RJ-45)					X	X	X	X	X	X	X	X	X	
Ethernet (LC)						X	X	X	X	X	X	X	X	
Ethernet redundant solutions (HSR/PRP/RSTP)						X	X	X	X	X	X	X	X	
Serial (RS 232/485, ST conn.)	X	X		X	X	X	X	X	X	X	X	X	X	

1 Color touch screen

x Function supported

o Function available as option

615	615	615	615	615	615	615	620	620	620	620	620	620	630	630	630	630	640	SSC	615
RET615 IEC	REU615 IEC	REV615 IEC	REF615 ANSI	REF615R ANSI	REM615 ANSI	RET615 ANSI	REF620 IEC	REM620 IEC	RET620 IEC	REF620 ANSI	REM620 ANSI	RET620 ANSI	REF630 IEC	REM630 IEC	RET630 IEC	REG630 IEC	REX640	SSC600	SMU615
			X	X	X	X				X	X	X					X	X	X
X	X	X					X	X	X				X	X	X	X	X	X	X
O	O	O	O	O	O	O	O	O	O	O	O	O					O	O	O
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	X			X			X	X	X	X			X		X	X	X	O	
X						X			X			X					X		
X	X	O	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
X	X	X	X		X	X	X	X	X	X	X	X							
7/5	4/5	7/5	7/6	4/5	7/4	7/6	4/5	7/5	8/9	7/8	7/4	10/4	4/5	8/4	8/3	8/4	12/10		4/3
							6/1										6/2		6/1
14/12	14/12	14/12	18/13	11/7	18/13	14/13	32/18	20/14	16/17	32/18	14/13	16/17	50/45	50/45	50/45	50/45	56/42		8/9
6/2	6/2	6/2			6/2	2/1	6/2	12/4	8/3		14/5	2/1	8	8	8	8	20/4		
													4	4	4	4	4		
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
X	X	X	X	X	X	X	X	X	X	X	X	X					X		
X	X	X	X	X	X	X	X	X	X	X	X	X							
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	O	O
X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	O
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		

Fleet management

ADAM offers fleet management of protection and control devices. Easy-to-use, cybersecure and cloud-based, ADAM provides you with the full view of your devices, complete visibility of your data, and easy device management.

ADAM is a digital solution and it is fully hosted in a cloud environment. Secure communication from the site to the cloud can be flexibly chosen depending on the installation. One possibility for secure wireless communication over mobile network is ABB's Arctic family of wireless communication products.

ADAM can be used in combination with Smart Substation Control and Protection SSC600 and the standalone software version, SSC600 SW, today. ABB will gradually increase support for also other protection and control devices in upcoming releases.

Rich in features and easy to use

Because ADAM is hosted in the cloud, it's always accessible – from anywhere. Any device with internet connectivity and a web browser can be used to get an up-to-date status of all the connected devices and an overall status of substations.

Available features include:

Fleet status

- Versions, variants
- Firmware updates

Fault analysis

- Events
- Disturbance recordings
- Internal logs

Cyber security

- Role-based access control
- Secured communication
- Activity monitoring

Easy configurability

- Configured directly from the relay engineering tool PCM600

Device status information

- Alarm status
- Configuration status with online monitoring
- Measurements

Efficient management of substations

With ADAM customers benefit from improved device management with a full view of substation devices and complete visibility and control of data. Connection from cloud to substation is effective, it's easy to modify and update devices. Taking ADAM into use is straightforward, end users simply have to login to the cloud service to get started.

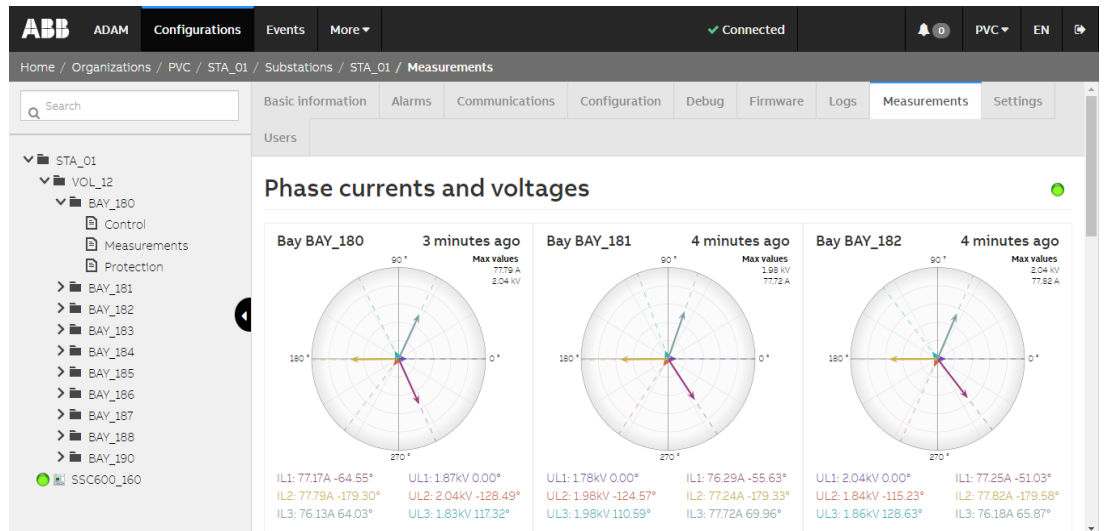
Better decisions with comprehensive data

With fleet management disturbance recordings and fault records are gathered automatically. This means it will always be possible to do post-fault analysis. With full visibility of the substation's status comes also the possibility for fault analysis of the whole installation, providing data to support decision-making. The complete electric grid related process data for a complete substation is available with a single access point from the SSC600.

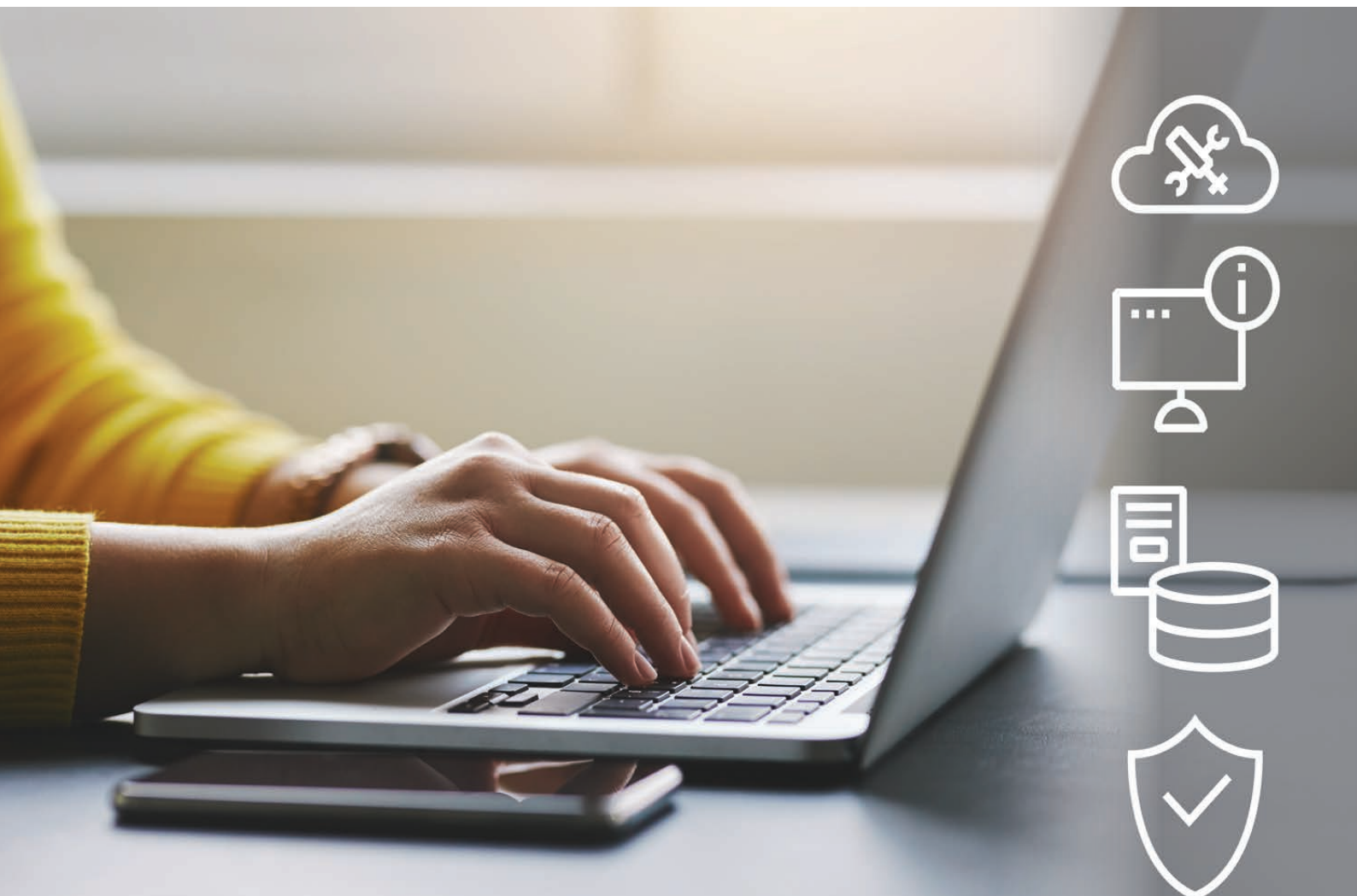
Unlocking fleet management benefits

- Cost-efficient management of protection and control devices
- Full visibility of substation status and available data
- Easy for end-users to use - just login to the cloud service
- Unique possibility for fault analysis covering the complete installation
- Cybersecure end-to-end ABB solution
- Reliable storage for configurations and logs
- Ensure that protection and control devices are updated with the latest firmware

—
ADAM
—
01 Phase currents
and voltages view



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01



Compact power management

01 Load-shedding solution

Power management systems (PMS) are essential for a safe, efficient and reliable operation of a power system within an electrical network. The PMS functionality includes load-shedding generator control, power sharing, network synchronization and power restoration. PMS solutions protect and optimize the stability of industrial systems against disturbances by ensuring power sharing between generators, when the industrial power system is islanded from the grid. These solutions also ensure that the generators meet the required power demand, when the network is grid-connected.

PMS solutions are suitable for industrial power networks:

- With captive power generation, islanded or grid-connected
- With substantial and critical loads
- With unstable grid connectivity
- Without grid connectivity

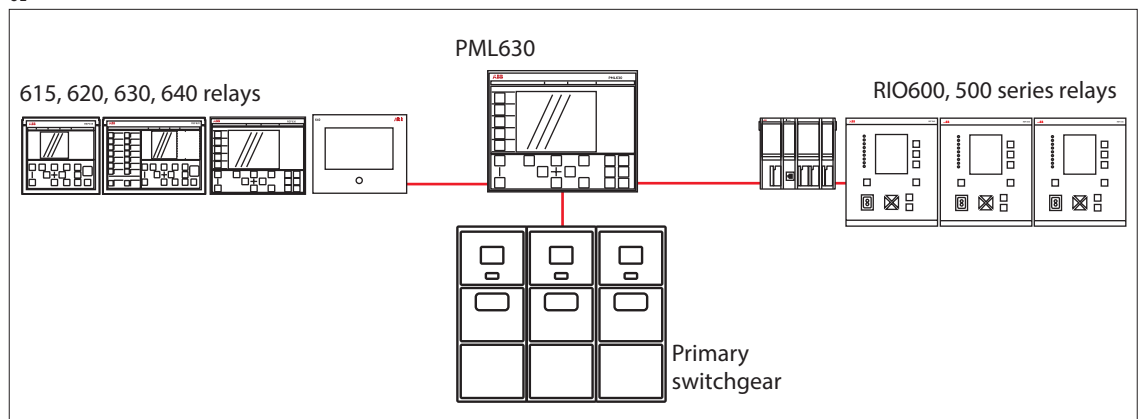
The PMS functionality suite is applicable to various industrial segments, for example, oil and gas, marine, pulp and paper, metals, minerals and building automation.

Load-shedding is required, when the electrical load demand exceeds the capacity of the available power sources, subsequent to the loss of power sources or network dis-integration. The load-shedding system has to ensure availability of electrical power to all essential and, most importantly, critical loads in the plant. This is achieved by switching off the nonessential loads in case of a lack of power in the electrical network or in parts of it (subnetwork or island). The load-shedding functionality can also be deployed in industrial power networks with sole dependency on the utility networks. The lack of electrical power can be caused by a loss of generation capacity or power grid connectivity or the tie line feeding power to the plant.

Based on the shortfall of available power in the power network, the load-shedding action initiated by the system ensures that only identified loads are shed, the system is stable after load-shedding, and the impact on the associated plant operation is minimal. The system allows flexibility to select or deselect the load feeders to be load-shed at any point in time during plant operation.

The load-shedding function must be accurate and selective. It is important that it operates only when necessary.

01



Load-shedding principles

There are two load-shedding system principles: (1) reactive load-shedding (reacts on measurement) and (2) active load-shedding (reacts on cause).

Reactive load-shedding is most commonly used in utility networks in primary distribution substations. Reactive load-shedding reacts based on measuring the system frequency and/or voltage. The system as such can contain several triggering levels for these values. Each triggering level corresponds to one of the load-shedding priority classes or steps, for example, activation of the first triggering level, which sheds the loads belonging to priority class 1. Typically two or three priority classes or steps are used. Restoration of the shed feeders can take place manually or automatically, in a pre-programmed scenario. Selectivity against protection functions has to be secured, for example, the load-shedding system has to have a change to operate before the protection system is initiated.

Active load-shedding is mostly used in industrial distribution networks. Active load-shedding reacts based on measuring power, current values on supply and load feeders (key feeders included). The load-shedding system knows the present loading situation and calculates shedding priorities for different network scenarios, such as tripping or overloading of a generator or a network power source. Knowing the individual loads of feeders, only the necessary amount of load (feeders) will be shed. The reactive load-shedding system can work as a back-up for active load-shedding.

Product offering

ABB's Relion® protection relays are characterized by functional scalability and flexible configurability to perform reactive and active load-shedding.

PML630 is a power management relay that provides a comprehensive load-shedding solution for the power network in an industrial plant. It protects the plant against blackouts and power source outages due to system disturbances. This relay is a member of ABB's Relion product family and a part of its 630 series.

PML630 complies with IEC 61850 and offers seamless connectivity with Relion family protection relays and RIO600 I/O to realize the load-shedding functionality. The protection relays use GOOSE and MMS communication profiles for I/O data exchange with other Relion family protection relays.

PML630 provides system level protection to small or medium-sized industrial systems from the system disturbances. PML630 supports different modes of load-shedding functions:

- Fast load-shedding (active load-shedding)
- Slow (overload or maximum demand violation-based) load-shedding (active load-shedding)
- Manual load-shedding (reactive load-shedding)
- Underfrequency load-shedding as a backup to fast and slow load-shedding (reactive load-shedding)

A network power deficit occurs when a power source such as a generator or a grid transformer trips. There could also be a power shortage, when a network becomes isolated due to trip of a bus coupler or a bus tie breaker. All load-shedding functions can be active concurrently.

For more information, please refer to the following:

- Load-shedding controller PML630 Product Guide
- Digital Systems web page (<https://new.abb.com/medium-voltage/digital-substations/digital-systems>)

Solution offering

The Compact Power Management System (cPMS) is a load-shedding power management solution built on Relion PML630, Remote I/O unit RIO600 and the Relion 615, 620 or 630 series feeder relays.



Automatic transfer systems

01 Single line diagram (SLD) of medium-voltage switchgear architecture applied, suitable for carrying out automatic and manual transfer (ATS).

Automatic transfer systems (ATS) are used to ensure maximum service continuity, supplying the power users uninterruptedly.

All this is possible using various systems based on different kinds of techniques. The most common of these are outlined below, with the relevant average transfer times:

Delayed:	1500 ms
Depending on the residual voltage:	400-1200 ms
Synchronized ATS:	200-500 ms
High speed transfer device:	100 ms
High speed transfer system:	30 ms

The first two systems are the simplest and can also be achieved with conventional logics and instruments. They guarantee average transfer times and can therefore be used in installations where voltage gaps are not particularly critical.

The other three systems: (1) synchronized automatic transfer system, (2) high speed transfer device and (3) high speed transfer system require microprocessor-based apparatus with high technology content. They guarantee fast transfer times. They are used in plants where the process is particularly critical, in which slow transfers would cause serious malfunction or interruption of the process itself.

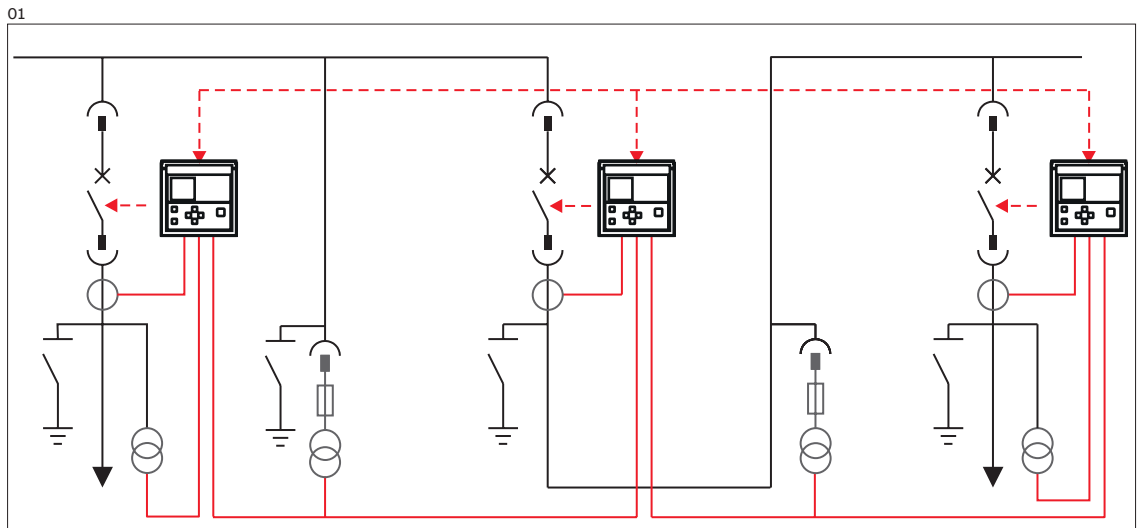
ABB offers all types of transfer systems, from the simplest to the most complex.

Synchronized automatic transfer system

Protection relays from Relion® product family can be used in medium-voltage switchgear to manage automatic and manual transfer between different incoming feeders. The time needed for automatic transfer carried out by means of the Relion family protection relays is between 200 to 300 ms (including the circuit breaker operating times). The time can vary within the range indicated in relation to the complexity of the software transfer logics.

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

It is also possible to carry out the same operation manually from a remote control station, or from the front of the switchgear under user supervision. Manual transfer means making the passage parallel, by means of the synchronism control function (synchro-check) implemented from the protection relay, the power supply lines are closed simultaneously with synchronization of the voltage vectors to then return to being disconnected when the transfer has taken place. The applications described do not require additional instruments.



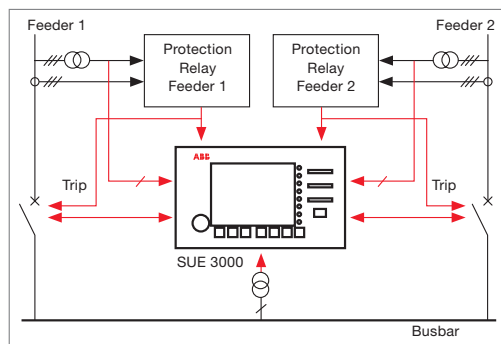
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02 An example
of a switchgear
configuration

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03 SUE 3000 High
Speed Transfer Device

SUE 3000 - High speed transfer device / High speed transfer system

Voltage decrease or complete supply interruptions represent the most crucial and critical problems for the quality of energy supply today. The SUE 3000 High Speed Transfer Device guarantees an optimal safeguarding of energy supply. The device ensures, in combination with the existing circuit breakers, the continued power supply and protects the subsidiary process from expensive stoppage time. Further, the operation of the installation is considerably simplified through the possibility of manually-initiated transfers for targeted clearings.

To achieve the fastest possible transfer time of 30 ms the High Speed Transfer System has to be used. This system is a combination of the SUE 3000 device, special trigger devices and very fast magnetic circuit breakers.



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Application areas

The SUE 3000 High Speed Transfer Device can be used where ever a disturbance of the electrical supply would lead to a breakdown in production, which would have a significant impact on the operating costs.

Possible areas of utilization include:

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

To realize permanent availability, the load is supplied from at least two synchronized feeders, which are independent from one another and equipped with a SUE 3000 device.

SUE 3000 takes on the task of ensuring uninterrupted continuous operation of the connected devices in case of a power supply breakdown. The device takes different physical factors into account and executes the quickest possible transfer to a different feeder, which is kept on stand-by.

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

Permanent network comparisons

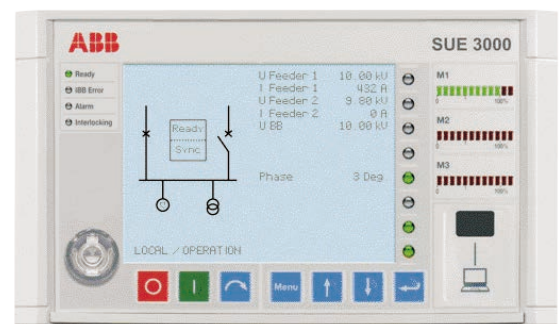
An exceptionally important characteristic, that clearly distinguishes SUE 3000 from competing concepts, is that synchronicity criteria are continuously available, as they are computed online. This is the reason that, in case of an initiation, the appropriate transfer mode is already determined and can be immediately initiated. This means that the probability of a fast transfer is considerably enhanced. Systems which wait for the instant of initiation to start the determination of the network status are not capable to perform a fast transfer with minimum interruption time.

Transfer modes and times

Four different transfer modes are available in detail: (1) fast transfer, (2) transfer at the 1st phase coincidence, (3) residual voltage transfer and (4) time-operated transfer. When a fault occurs, fast transfer is the optimal transfer mode for ensuring that only a minimum interruption of the voltage supply occurs. With fast transfer mode, the total transfer time, counting from a fault in the main feeder until the standby feeder is cut in, is less than 100 ms.

For more information, please refer to the following:

- High Speed Transfer Device SUE 3000 Product Description
- Digital Systems web page (<https://new.abb.com/medium-voltage/digital-substations/digital-systems>)



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03

Remote I/O concept

- 01 Remote I/O unit RIO600
- 02 Urban environment
- 03 Control center
- 04 Harsh environment

ABB's remote I/O concept introduces a new way of extending the I/O capabilities of protection relays. The concept is aimed at increasing the hardware functionality of the protection relays, while still maintaining the relay's compact design. This way remote I/O can be used, when it is needed. The information between the remote I/O units and the main protection relay is exchanged over the latest communication standard IEC 61850. This enables easy integration into the systems and is in line with the latest standards.

The remote I/O concept also benefits from installing the I/O units as close as possible to the place where the signals need to be digitalized, thus limiting extensive wiring within the switchgear, substation or plant. Digitalization of the signals allows users to use information wherever needed, without the need of installing additional auxiliary relays or terminals. IEC 61850 enables signals supervision, thus faster recognition of any errors and proactive operation, if these conditions happen during a critical process.

Product offering

The remote I/O unit RIO600 is designed to expand the digital and analog I/O of ABB's Relion® series protection relays using IEC 61850 communication.

RIO600 is designed using a modular architecture where the amount and type of I/O ports can be added through modules. The RIO600 modules can be stacked on a standard DIN rail to achieve the required configuration.

RIO600 is built on an industrial hardware platform, which provides the same reliability, performance and real-time functionality as ABB's protection relays, withstanding extreme temperatures, electromagnetic interference and stringent industry standards.

RIO600 provides an additional I/O within the switchgear itself by using the Ethernet-based IEC 61850 horizontal GOOSE communication. The signals can be transmitted within the switchgear and to the automation systems. Similarly, signals from the automation systems can be executed through RIO600 connected to numerical protection relays.

For more information, please refer to the following documentation:

- Remote I/O unit RIO600 Product Guide



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04



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