

DISTRIBUTION SOLUTIONS

Recommended offering for medium-voltage switchgear

Protection and control



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ABB's power protection philosophy

ABB has delivered protection relays and solutions to more than 100 countries and 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 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 is activated when something abnormal happens in the power system. 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 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. 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® family offers the widest range of products for 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.

ABB's 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 from ABB's customers globally.

To ensure interoperable and future-proof solutions, the 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.

01 ABB Relion protection and control product family



The Relion product family includes:

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 and industrial 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 REX615

REX615 is a freely configurable all in-one protection relay for power generation and distribution applications, representing the next step for ABB's 615 and 620 series relays. Multiapplication coverage combined with a fully modular and scalable hardware and software ensures maximum flexibility and optimal cost-effectivity throughout the relay life cycle.

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.

Smart substation control and protection SSC600

SSC600 offers centralized protection and control for distribution substations. It builds on ABB's solid and proven technological foundation manifested in the renowned Relion product family.

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's wide offering for feeder protection suits different requirements. The offering ranges from protection relays for general feeder protection (protection against overcurrent) and products for back-up protection purposes, on to multifunctional relays for different applications and products for centralized protection and control. The offering also includes specialized applications, such as line differential protection and line distance 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 many cases the requirements can be fulfilled with non-directional/directional over-current 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, substations 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 for ABB's protection and control devices.

Product offering

The recommended products for feeder protection are:

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 straightforward 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.

Relion REX615

REX615 offers flexibility and performance for power distribution in utility and industrial applications. The modular design allows customization and modification flexibility, and easy adaptation to changing protection requirements. The base functionality offers possibility to use REX615 as a measurement and control device or merging unit without protection

- 01 Basic range:
Feeder protection REF601
and self-powered feeder
protection REJ603
- 02 Medium range:
Protection and control
REX610, Protection
and control REX615
standard and wide
- 03 High range:
Multiapplication
Protection and Control
REX640 and Smart
Substation Control and
Protection SSC600

functions. The REX615 with base functionality can be enhanced with application packages for feeder protection, fault location, line differential protection and interconnection feeder protection.

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.

Smart Substation Control and Protection SSC600
SSC600 represents a new approach to protection and control in distribution networks – centralizing all protection and control functionality in one single device on the substation level.

For more information, please refer to the following documentation:

- Feeder Protection REF601 Product Guide
- Self-Powered Feeder Protection REJ603
- Protection and Control REX610 Product Guide
- Protection and Control REX615 Product Guide
- Multiapplication Protection and Control REX640 Product Guide
- Smart Substation Control and Protection SSC600 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 is 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:

Relion REX615

REX615 offers flexibility and performance for power distribution in utility and industrial applications. The modular design allows customization and modification flexibility, and easy adaptation to changing protection requirements. REX615 offers extensive protection functionality for transformer protection, including two-winding transformer protection, on-load tap-changer control and automatic voltage regulator functionality, in one device.

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.

Smart Substation Control and Protection SSC600

SSC600 represents a new approach to protection and control in distribution networks – centralizing all protection and control functionality in one single device on the substation level.

For more information, please refer to the following documentation:

- Protection and Control REX615 Product Guide
- Multiapplication Protection and Control REX640 Product Guide
- Smart Substation Control and Protection SSC600 Product Guide

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01 Protection and control
REX615 standard and wide

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02 Multiapplication
Protection and Control
REX640 and Smart
Substation Control and
Protection SSC600



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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:

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 REX615

REX615 offers flexibility and performance for power distribution in utility and industrial applications. The modular design allows customization and modification flexibility, and easy adaptation to changing protection requirements. REX615 offers extensive protection functionality for motor protection. When the machine protection package has been selected, REX615 can be enhanced with an add-on package for either machine differential protection or synchronous machine protection.

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

Smart Substation Control and Protection SSC600

SSC600 represents a new approach to protection and control in distribution networks – centralizing all protection and control functionality in one single device on the substation level.

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01 Basic range:
Motor protection and
control REM601

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02 Medium range:
Protection and control
REX610, Protection
and control REX615
standard and wide

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03 High range:
Multiapplication
Protection and Control
REX640 and Smart
Substation Control and
Protection SSC600

For more information, please refer to the
following documentation.

- Protection and Control REX610 Product Guide
- Protection and Control REX615 Product Guide
- Multiapplication Protection and Control REX640 Product Guide
- Smart Substation Control and Protection SSC600 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:

Relion REX615

REX615 offers flexibility and performance for power distribution in utility and industrial applications. The modular design allows customization and modification flexibility, and easy adaptation to changing protection requirements. REX615 offers extensive protection for generator and generator-transformer units used in various small and medium-sized 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 Protection and control REX615 standard and wide, Multiapplication Protection and Control REX640

For more information, please refer to the following documentation:

- Protection and Control REX615 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 the 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:

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 REX615

REX615 offers flexibility and performance for power distribution in utility and industrial applications. The modular design allows customization and modification flexibility, and easy adaptation to changing protection requirements. REX615 can be easily customized for conventional voltage protection applications by selecting hardware with voltage inputs and a voltage protection application package, which offers an extensive range of voltage and frequency-based 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.

Smart Substation Control and Protection SSC600

SSC600 represents a new approach to protection and control in distribution networks – centralizing all protection and control functionality in one single device on the substation level.

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01 Protection and control
REX610, Protection
and control REX615
standard and wide

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02 Multiapplication
Protection and Control
REX640 and Smart
Substation Control and
Protection SSC600

For more information, please refer to the
following documentation:

- Protection and Control REX610
- Protection and Control REX615 Product Guide
- Multiapplication Protection and Control REX640 Product Guide
- Smart Substation Control and Protection SSC600 Product Guide



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Capacitor bank protection

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 electrical 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 to 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 grid operator.

Extra charges are always applied when an 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:

Relion REX615

REX615 offers flexibility and performance for power distribution in utility and industrial applications. The modular design allows customization and modification flexibility, and easy adaptation to changing protection requirements. REX615 can be enhanced with an application package for shunt capacitor protection.

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.

Smart Substation Control and Protection SSC600

SSC600 represents a new approach to protection and control in distribution networks – centralizing all protection and control functionality in one single device on the substation level.

For more information, please refer to the following documentation:

- Protection and Control REX615 Product Guide
- Multiapplication Protection and Control REX640 Product Guide
- Smart Substation Control and Protection SSC600 Product Guide

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 01 Protection and control
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 Protection and Control
 REX640 and Smart
 Substation Control and
 Protection SSC600

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Busbar protection

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:

Relion REX615

REX615 offers flexibility and performance for power distribution in utility and industrial applications. The modular design allows customization and modification flexibility, and easy adaptation to changing protection requirements. REX615 can be enhanced with an application package for high-impedance based busbar protection.

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.

Smart Substation Control and Protection SSC600

SSC600 represents a new approach to protection and control in distribution networks – centralizing all protection and control functionality in one single device on the substation level. SSC600 can be enhanced with a special application package for busbar low-impedance protection.

For more information, please refer to the following documentation:

- Protection and Control REX615 Product Guide
- Multiapplication Protection and Control REX640 Product Guide
- Smart Substation Control and Protection SSC600 Product Guide

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01 Protection and control
REX615 standard and
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Protection and Control
REX640 and Smart
Substation Control and
Protection SSC600

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Arc fault protection

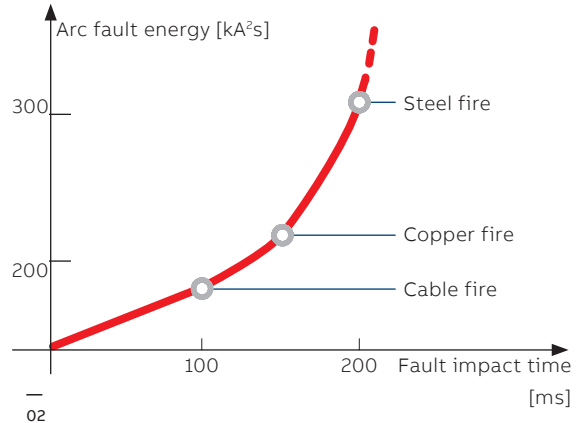
- 01 Arc fault damage as a function of the arc fault energy and the arc fault impact time
- 02 The REA system is a fast and flexible arc fault protection system for low- and medium-voltage switchgear.

An electric arc short-circuit in a switchgear installation is normally caused by a foreign object entering the switchgear panel 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 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.



— 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 REX615 protection relay with integrated arc fault protection is supervising compartments of the metal-enclosed switchgear panels. The selectivity of tripping between the REX615 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 ABB's Relion protection relays.

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.

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

Relion REX610

The arc-fault protection sensor interface in the REX610 relay is available on an optional communication module. The module supports connection up to 3 lens sensors.

Relion REX615

The arc-fault protection sensor interface in the REX615 relay is available on the optional communication module. The module supports connection up to 3 lens sensors. Fast tripping increases staff safety and limits material damage, therefore it is recommended to use high-speed outputs (HSO) instead of normal power outputs (PO). This typically decreases the total operating time with 4..6 ms compared to the normal power outputs.

Relion REX640

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.

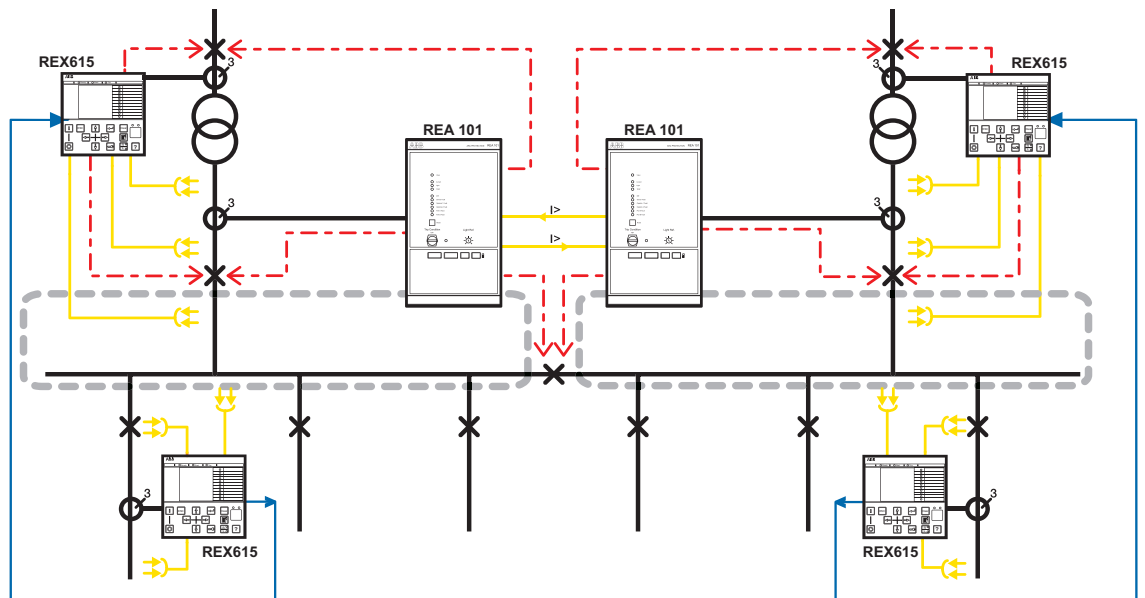
Smart Substation Control and Protection SSC600

The arc protection in SSC600 is a station-wide arc protection, processing current measurements and light indications received from several bay level relays or merging units.

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
- Protection and Control REX615 Product Guide
- Multiapplication Protection and Control REX640 Product Guide
- Smart Substation Control and Protection SSC600 Product Guide

— 03



Centralized protection and control

With a centralized protection and control (P&C) approach, all P&C functionality is centralized into one single device on the substation level. With this approach, you gain the ability to protect and control a wide variety of utility and industrial applications from a single device, resulting in convenient station-wide visibility, minimal engineering, and easy and cost-efficient process management.

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.

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.

Product offering

Smart Substation Control and Protection SSC600

SSC600 offers protection, control, measurement and supervision of a wide variety of applications. As an IEC 61850 standard-compliant solution, SSC600 offers unprecedented flexibility throughout the substation's entire lifetime. Fully modular software allows the flexibility to change with the evolving grid and meet the challenge of increasing digitalization. Up to 15 percent savings in substation life cycle costs can be achieved as SSC600 can handle new network functionalities as required.

Customizable, cost-effective turnkey P&C solutions can be made combining SSC600 with ABB's merging units.

SSC600 offers:

- Protection for overhead line and cable feeders 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 critical harm.
- 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 you to use the hardware of your 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 sensors 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, disconnect 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

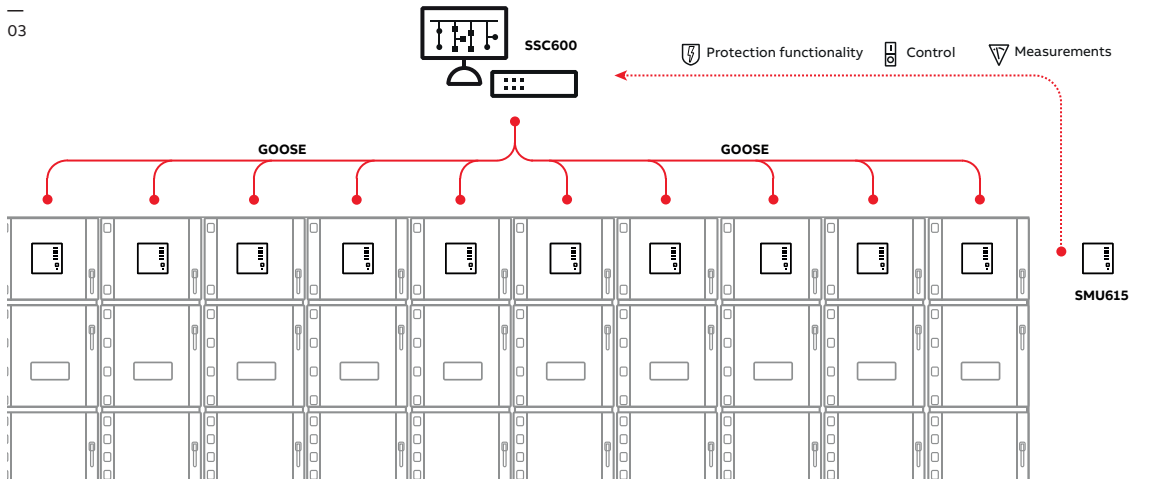
- 01 Smart Substation Control and Protection SSC600
- 02 Substation Merging Unit SMU615
- 03 Example of centralized protection and control



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Selection table

| | 605 | 605 | 605 | 605 | 610 | 615 | 640 | SSC | 615 |
|--|--------|--------|--------|--------|--------|----------------|----------------|--------|--------|
| | REF601 | REJ601 | REJ603 | REM601 | REX610 | REX615 | REX640 | SSC600 | SMU615 |
| Standard | | | | | | | | | |
| ANSI | X | X | | X | X | X | X | X | X |
| IEC | X | X | X | X | X | X | X | X | X |
| Application | | | | | | | | | |
| Arc fault protection application | | | | | O | O | O | O | O |
| Busbar application | | | | | | X | O | O | |
| Back-up application | X | X | | | X | X | X | X | |
| Capacitor bank application | | | | | | X | O | O | |
| Feeder application | X | X | X | | X | X | X | O | |
| Generator application | | | | | | X | O | | |
| Motor application | | | | X | X | X | O | O | |
| Petersen coil protection | | | | | | | X | | |
| Transformer application | | | | | | X | O | O | |
| Functionality | | | | | | | | | |
| Autorecloser | X | X | | X | X | X | X | X | |
| Circuit breaker (CB) controllability | X | | | X | X | X | X | X | |
| Condition monitoring | X | | | X | X | X | X | X | X |
| Current-based protection | X | X | X | X | X | O | X | X | |
| Distance protection | | | | | | | O | O | |
| Fault locator | | | | | | O | O | O | |
| Generator differential protection | | | | | | O | O | | |
| Display with Single Line Diagram (SLD) | | | | | | X | O ¹ | | |
| Line differential protection (in-zone transf. support) | | | | | | O | O | | |
| Load-shedding | | | | | | O | X | O | |
| Motor differential protection | | | | | | O | O | | |
| On-load tap changer control | | | | | | O | O | O | |
| Power quality | | | | | | X | X | O | |
| Self-powered protection relay | | | X | | | | | | |
| Synchro-check | | | | | | O | X | O | |
| Generator/non-generator CB synchronizing | | | | | | | X | | |
| Transformer differential protection | | | | | | O | O | O | |
| Voltage based protection | | | | | X | O | X | X | |
| Withdrawable release mechanism | | | | | X | X | | | |
| Hardware | | | | | | | | | |
| Analog inputs (CTs/VTs) | 4/0 | 4/0 | 4/0 | 4/0 | 4/4 | 7/8 8/8 | 12/10 6/5 | | 4/3 |
| Analog inputs (sensor channels/CTs) | 3/1 | 3/1 | | 3/1 | | 6/1 6/1 | 6/2 3/1 | | 6/1 |
| Binary inputs/outputs | 4/6 | 4/6 | 0/2 | 4/6 | 6/6 | 18/13 32/21 | 56/42 28/26 | | 8/9 |
| RTD/mA inputs | | | | | | 6/2 14/5 | 20/12 10/6 | | |
| mA outputs | | | | | | | 4 | | |
| Communication protocols | | | | | | | | | |
| DNP 3.0 | | | | | | X | X | | |
| IEC 60870-5-103 | X | X | | X | | X | X | | |
| IEC 60870-5-104 | | | | | | O | O | O | |
| IEC 61850 | | | | | X | X | X | X | X |
| Modbus | X | X | | X | X | X | X | | |
| Profibus | | | | | | O | O | | |
| Communication media | | | | | | | | | |
| Ethernet (RJ-45) | | | | | X | X | X | X | X |
| Ethernet (LC) | | | | | | X | X | O | O |
| Ethernet redundant solutions (HSR/PRP/RSTP) | | | | | | X | X | X | O |
| Serial (RS 232/485, ST conn.) | X | X | | X | X | X | X | | |

¹ Color touch screen

x Function supported

o Function available as option



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.

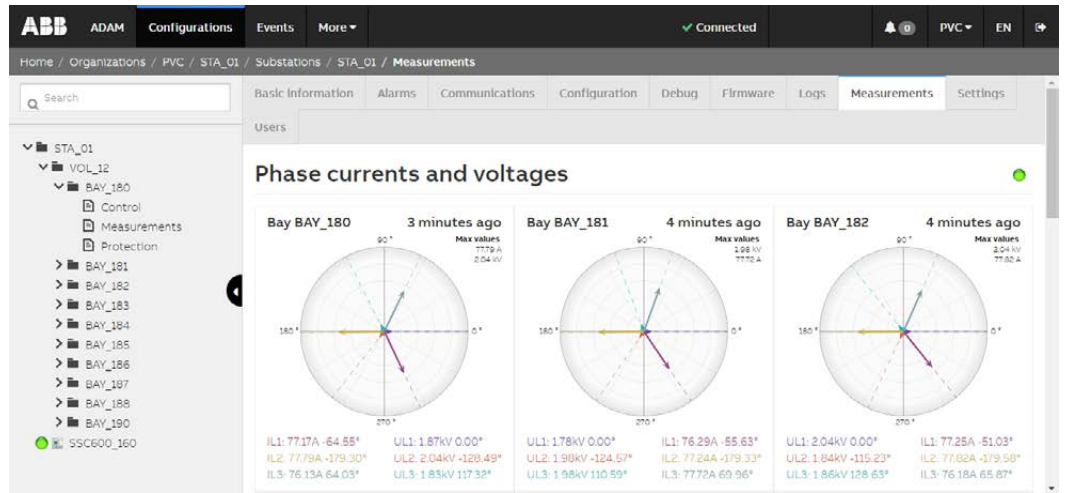
Unlocking fleet management benefits

- 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

01 Phase currents and voltages view

02 ADAM

01



02



Automatic transfer systems

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

Automatic transfer systems (ATS) are used to ensure maximum service continuity, supplying the power without interruption.

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 |

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 systems, synchronized automatic transfer system and high speed transfer device, 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.

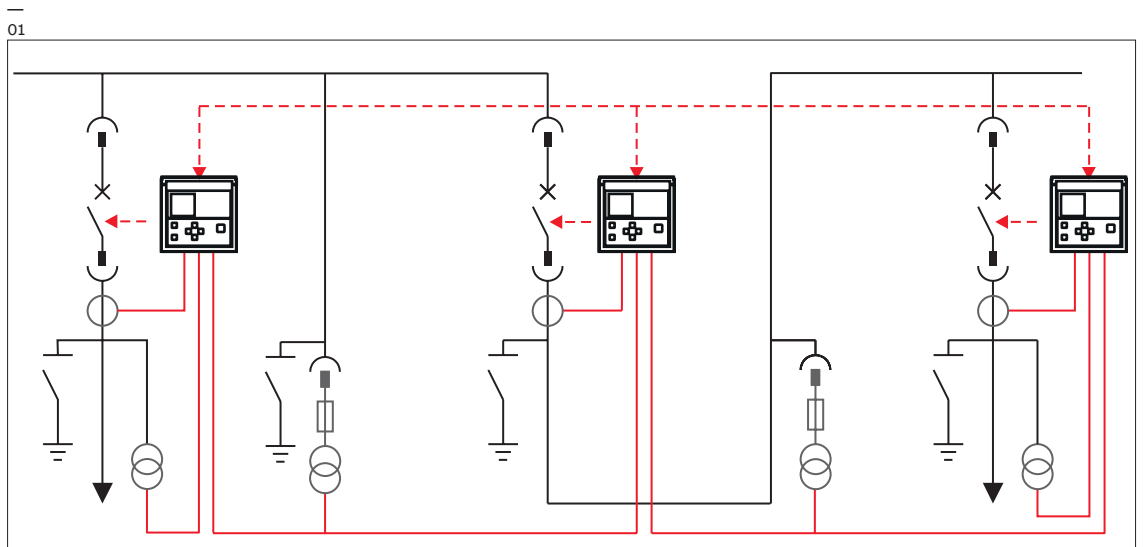
ABB offers all types of transfer systems, from the simplest to the most complex.

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 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
—

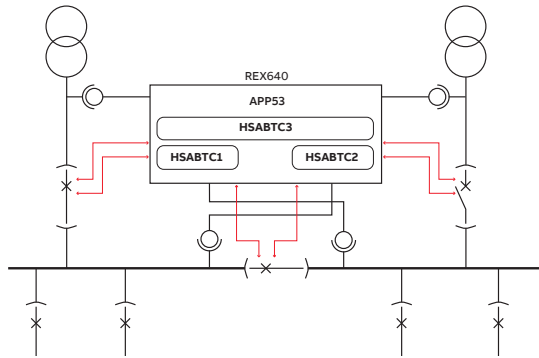
03 Multiapplication
Protection and
Control REX640
—

Relion REX640

Voltage decrease or complete supply interruptions represent the most crucial and critical problems for the quality of energy supply today. ABB's Relion REX640 guarantees an optimal safeguarding of energy supply. The protection relay 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.

Application areas

REX640 can perform automatic high-speed transfer functionality. In the industry the functionality is also referred as high-speed busbar transfer (HSBT), motor bus transfer (MBT), high-speed motor bus transfer (HSMBT) and automatic bus transfer (ABT).



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02

The high-speed transfer is typically required in processes where the electrical supply for the critical system parts must be secured by connecting alternative (stand-by) feeder online. Such processes are typically found in petrochemical, pharmaceutical, semiconductor manufacturing industries and in electrical power generation plants. Common feature for these examples is that there are motors fed by the switchgear, these motors will back-feed the busbar once the grid connection is lost. The declining busbar voltage and frequency must be considered carefully to determine the correct closing moment for the alternative feeder.

To ensure optimal utilization of the REX640 as a high-speed transfer device, the following prerequisites should be fulfilled:

- Existence of at least two synchronous feeders, which are independent of one another during normal operation
- Circuit breakers with less than 100ms operating time
- Switchgear assembly and load suitable for network transfers
- Fast protection relays to initiate transfer externally, if used
- Rotating loads (motors) back feeding the busbar during the transfer sequence

Transfer modes and times

Four different transfer modes are available in detail: (1) fast transfer, (2) transfer at the first 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:

- Multiapplication Protection and Control REX640 Product guide



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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 IEC 61850 standard for communication. This enables easy integration into the system.

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 the need to install 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 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 (Generic Object Oriented Substation Event) 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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03



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