

# Protection, Monitoring and Control Terminals

for Sub-transmission and Transmission Networks



**ABB**

# ABB Protection and Control makes the dif

ABB is the original source of many innovations that help you enhance the reliability, availability and security of your protection and control system through wide range of products, services and systems solutions. The pioneering spirit and ability to listen to the customers voice have been the driving forces throughout our history of innovation, which started over 100 years ago. This in combination with our local expertise allows us to fulfill all your specific requirements. Today, being the global technology leader, we can serve you with the highest quality standards in the field.

ABB's protection, monitoring and control solutions range from single multifunction units to fully integrated, comprehensive, high-performance substation automation systems. Our business concept is very simple: We offer reliable products with optimized functionality for all customer applications. Or in other words we offer confidence and value.

## **Our product portfolio for generation and transmission includes:**

- Generator Protection
- Transformer Protection
- Busbar Protection
- Line Protection
- Bay Controllers
- Single Function Relays
- Station HMI
- Communication Gateways

ABB's terminals protect and control thousands of substations in more than 100 countries. Through ABB engineering centers, via our external partners or directly to our utility & industry customers we can provide the essential building blocks for efficient Substation Automation as well as retrofit and upgrades of existing installations.

Additionally, we can supply specialized products for phasor measurement, railway applications, FACTS and HVDC. We also support our large installed base of electromechanical and COMBIFLEX relays with spares and replacement parts. In short we are your One-Stop-Shop for all your protection, monitoring and control needs.



# ference

## Continuity

The 100 years experience in protection and control of the power system has given us a unique and proven experience in “The Art of Protective Relaying” including the legacy brands of ASEA, Brown Boveri, ITE, Strömberg and Westinghouse. It has also given us the largest installed base of electromechanical, static and numerical relays compared to any other manufacturer. But most importantly, it has given us the knowledgebase to continuously improve every new design to provide more value at less cost.

## Reliability

Dependability and security are a must in protective relaying and ABB protection and control has a proven high reliability. Our modular type tested and pre-configured software and hardware provide quality on time. Comprehensive self-supervision, self-diagnostics, event and disturbance recording provide efficient emergency tools. In addition we can provide system tests and simulations to verify the correct application and settings to ensure correct operation of your protection and control system to minimize damages and interruptions.

## Performance

The three S, Speed, Sensitivity and Selectivity have always been the fundamentals of a high performing protection. Adaptive measurement, travelling waves, Fourier filtering, transient detection and S-shaped impedance are some of the methods used by ABB to design the fastest and most accurate protections on the market. This enables the power system to operate at higher output and improved availability.

## Functionality

Different applications require different functions for optimum protection, monitoring and control. Applications may also change over time when new functions may be required due to changing system conditions.

ABB’s software library and modular hardware concept for protection and control terminals allows tailored solutions with less engineering and less space without sacrificing performance and redundancy. Consistency and compatibility of data parameters, transmission and collection allow better understanding of the entire process. Multiple processor and communication capabilities prevent separate functions interfering with each other, which improves the reliability and backup capability of the terminals. This provides more value for the money.

## Flexibility

Flexibility is a business approach. For ABB it means the ability to listen to the customer requirements and implement these in a cost efficient protection, monitoring and control terminals. Furthermore, flexibility means that we are willing to offer different delivery options from frame replacement programs to pre-engineered plug-and-play product packages, or from FOB delivery to extended warranty. Just ask us and we will deliver.

# Protection and Control for **wide range of applications** *- for every step you take*

**ABB provides a full range of terminals combined with system-wide backup functionality to allow tremendous flexibility in designing the required protection, control and monitoring systems. This gives design engineers a unique opportunity to improve availability and reliability, and enhances the management of electrical power systems.**

## **Terminals that adapt to your process**

The flexible design of the protection and control terminals allows easy engineering into completely customer-specific solutions with the help of ready to use function blocks logical elements, timers etc. The function blocks offer a wide selection of the protection and monitoring functions required in power networks. Using the advanced CAP engineering, parameter setting and evaluation tools you can easily create an application-specific solution by combining these elements.

Furthermore, you can select functions and hardware according to your needs. Your selection can be given a unique ordering number that can also include your functional configuration. This simplifies the whole process from ordering to commissioning, and enables us to offer you a customized solution for your future orders that is ready to use.

## **Rely on pre-configured solutions**

ABB has designed pre-configured, application-specific solutions that can be used in the most common applications. These proven terminals can be smoothly connected without additional configuration, which speeds up both engineering and commissioning.

## **For new and retrofit installations**

The ABB terminals meet your needs for refurbishing and extending your existing substations, as well as for new installations.

Standard and open communication protocols IEC 60870-5-103, SPA and LON enables easy integration of the terminals in ABB's MicroSCADA Pro and other substation monitoring and control systems.



# Line Distance Protection

## REL 301/302

The REL 301/302 is an extension to REL 300 (MDAR) to specifically address the retrofitting and integrated reclosing for the three-pole trip transmission line market. FT-42 case packaging (for retrofit), programmable output contacts, and reclosing functions are included in the design. The REL 301 addresses non-pilot applications. The REL 302 provides the same functionality as the REL 301 plus the proven MDAR pilot logic.

## REL 316\*4

The numerical line protection REL 316\*4 is designed for the fast, selective protection of distribution as well as sub-transmission and transmission lines with distance protection as main or backup protection. It can operate equally well in solidly earthed, isolated and resistance earthed power systems.

The distance protection for transmission lines is working with all six independent measuring loops and a 5-zone, quadrilateral characteristic that can be set individually.

REL 316\*4 is suitable for the protection of overhead lines and cables, long and short lines, parallel lines, heavily loaded lines, lines with weak infeed and on "short zone" lines. All fault types can be detected, close-up three-phase faults, double phase to earth, evolving faults and high resistance faults.

REL 316\*4 takes into consideration power swings as well as changes in direction of energy flow.

Selecting a specific application library (software key) for the REL 316\*4 allows the customer to multi activate protection functions to perfectly suit his application needs.



## REL 501/511/521/531

The numerical REL 5xx line distance protection terminals are designed for the main and backup protection, monitoring and control of power lines, cables and other primary objects. They can be used in systems with simple or complex network configurations regardless of the type of system earthing. You can easily integrate them into your substation automation system or use them as stand-alone multi-function units.

REL 501 and REL 511 are based on full scheme distance protection function. REL 501 detects phase-to-phase faults, and REL 511 both phase-to-phase and phase-to-earth faults. Both terminals have quadrilateral operating characteristics. A separate general fault criterion with advanced characteristics is used for phase selection and as an overall measuring function, which increases the total operating security and facilitates remote backup applications.

REL 521 terminal is based on a full scheme, quadrilateral, distance protection function performing both phase-to-phase and phase-to-earth fault measurement separately for all zones and for all fault loops. The separate phase selection function enables single, two or three-phase tripping.

REL 531 terminal is based on a full scheme, quadrilateral, distance protection function performing both phase-to-phase and phase-to-earth fault detection. In addition, this terminal provides full-scheme two zone high-speed functionality and is ideal for series compensated networks. Phase segregated communication scheme logic secures phase selective operation for simultaneous faults on multi-circuit and parallel operating lines.

Individual settings for each zone, e.g. the zero-sequence impedance compensation, the separate-phase selection zone, and scheme communication logic functions enable the optimum protection of parallel lines.

## Line Distance Protection

### REL 512

REL 512 is a fully integrated transmission line protection system and breaker control terminal. It is the second-generation product based on new protection concepts, the most advanced functions and flexibility are available to meet your transmission line distance protection application requirements.

The REL 512 utilizes a combination of time and frequency domain algorithms and multiple microprocessors to provide comprehensive high-performance protection with one cycle operating speed and high reach accuracy while providing immunity to transient overreaching. REL 512 includes comprehensive pilot logic, overcurrent protection, reclosing option, breaker failure protection, fault location and DFR recording.

## Line Differential Protection



### REL 316\*4

The numerical line protection REL 316\*4 is designed for the fast, selective protection from distribution to transmission lines with longitudinal differential protection as main/backup protection. It can operate equally well in solidly earthed, isolated and resistance earthed power systems with overhead lines and cables.

The basic function is a phase segregated current differential of master/slave type, evaluating current angle and amplitude on both ends of the line. The fiber optical communication link can be direct fiber or by ABB communication equipment FOX5xx. As backup distance protection function, phase and residual overcurrent functions, single/multi shot autoreclosure with synchro-check can be selected from the library.

Selecting a specific application library (software key) for the REL 316\*4 allows the customer to multi activate protection functions to perfectly suit his application needs.

### REL 350

The REL 350 is a numerical segregated phase comparison transmission line protection system with optional distance backup protection. Although particularly suitable for series compensated lines and single pole tripping, REL 350 provides high speed tripping for any transmission line application.

The current-only measuring principle offers advantages such as insensitivity to power swings, mutuals and problems associated with ccvt's. Communication interfaces for 9600 bps audiotone or 64 kbps direct digital or fiber optic are available. The REL 350 protection system also provides digital fault recording, fault locating and extensive target records.



## REL 352

The REL 352 is a numerical phase comparison transmission line protection system, optimized for operating with power line carrier equipment. It provides high speed relaying and is suitable for application to any voltage level. Its principle of operation makes it ideal for short lines and tapped lines with a power transformer that pose difficulties for distance protections.

The REL 352 can also be used for three terminal applications. The current-only measuring principle offers advantages such as insensitivity to power swings, mutuals and problems associated with cvt's. Either ON/OFF or FSK power line carrier equipment can be used. The REL 352 protection system also provides digital fault recording, fault locating and extensive target records. An optional distance protection can be included to provide backup for a loss of communication channel.

## REL 356

The REL 356 numerical current differential protection provides high-speed protection for long and short lines. It is particularly suitable for lines too short to be effectively protected by distance relays and for tapped load applications. The current-only measuring principle offers advantages such as

insensitivity to power swings, mutuals and problems associated with cvt's.

Communication interfaces for 9600 bps audiotone or 64 kbps direct digital or fiber optic are available. The transfer trip function utilizes the same communication channel and can be selected to operate separate trip contacts. The REL 356 protection system also provides digital fault recording, fault locating and extensive target records.

## REL 551/561

The REL 551 and REL 561 terminals can be used for protection and control of overhead lines and cables in solidly earthed, as well as in isolated high impedance earthed networks.

The basic function in both terminals is the current differential protection of master/master type, evaluating each phase current separately at both ends, using both the current amplitude and phase angle (segregated vector comparison). This ensures maximum sensitivity while maintaining stability.

As an option, REL 561 features a full scheme three-zone distance protection function for backup for the communication channel and for the clearing of faults on the remote busbar.



# Overcurrent and Earth-fault Protection

## REL 505

The REL 505 terminal can be applied as a backup protection for overhead lines and cables. Both directional and non-directional overcurrent and earth-fault protection functions are included. Scheme communication logic, current reversal and WEI logic for both overcurrent and earth-fault protection functions are also included.

## Bay Control



Selecting a specific application library (software key) for the REC 316\*4 allows the customer to multi activate protection functions to perfectly suit his application needs.

## REC 316\*4

The control terminal REC 316\*4 is designed for control, backup protection, monitoring and automation of substations for the transmission and sub-transmission levels. By using the graphical programming tool CAP316 all kind of control, automation and special function can be integrated into this terminal. The flexibility thus makes the special to be used for new installations and retrofit projects.

REC 316\*4 measures the current and voltages provided by the measuring transformers, calculates from them active and reactive power and frequency and transfer the data to the station control system.

## REC 561

The REC 561 terminal provides versatile control and backup protection functionality for circuit breakers, disconnectors and earthing switches in any kind of switchgear and busbar arrangements in a single device. The powerful control capabilities of REC 561 allow controlling of up to 24 high voltage apparatuses. The terminal offers a compact, bay-oriented control solution with communication capabilities replacing conventional control circuits.

Interlocking function that is not dependent on any central function is included to ensure personnel safety and to avoid dangerous or damaging switchgear operations. Meeting the stringent EMC requirements set on protection relays, REC 561 enables secure control of your primary equipment. As part of an substation automation system it minimizes human errors and improves the reliability of your power system.

## Breaker Protection

### REB 551

REB 551 breaker terminals are available in different variants and provide breaker-related functions associated with protection, such as breaker failure protection, autoreclosing, synchronism and energising check, and pole discordance.

REB 551 can be applied to 1½ breaker, double-breaker and ringbus arrangements and execute voltage selection for synchro-check and sequential autoreclosing.

# Transformer Protection

## RET 316\*4

The numerical transformer protection unit RET 316\*4 is designed for the fast, selective protection of two- or three-winding transformers. In addition the applications for the protection of autotransformers and block generator-transformer units are possible. The RET 316\*4 unit will detect all-phase faults, interturn faults and earth-faults where the power transformer starpoint is solidly or low-impedance earthed.

The selective protection function library of the RET 316\*4 includes differential protection with inrush detection and individual current compensation and group selection. For backup the distance protection and a choice of current, voltage and frequency protection functions are available. Together with overexcitation and breaker failure protection the RET 316\*4 gives a comprehensive terminal for transformer protection.

The RET 316\*4 has low requirements with respect to the main CTs. No interposing CTs are required.

Selecting a specific application library (software key) for the RET 316\*4 allows the customer to multi activate protection functions to perfectly suit his application needs.

## RET 521

RET 521 is designed to meet all the protection, monitoring and voltage control requirements of two- and three-winding transformers, autotransformers, generator-transformer units and shunt reactors. Up to five restraint current inputs into differential protection permit multi-breaker substation arrangements on any two sides. The terminal places low requirements on the main CTs and no interposing CTs are needed. Tests in an independent laboratory demonstrated the differential protection features outstanding sensitivity down to 2% for turn-to-turn faults. This together with necessary backup protection functions of RET 521, and fast and sensitive restricted earth-fault protection of stabilized low impedance types with a sensitivity down to 1% of the total number of turns, ensures comprehensive protection for your power transformers.



The multipurpose general functions of RET 521 allow the implementation of different user configured protection functions for any of the involved current and voltage transformers providing inputs to the terminal. Symmetrical components may be used to graphically create the needed protection functions. Up to 12 such functions are available.

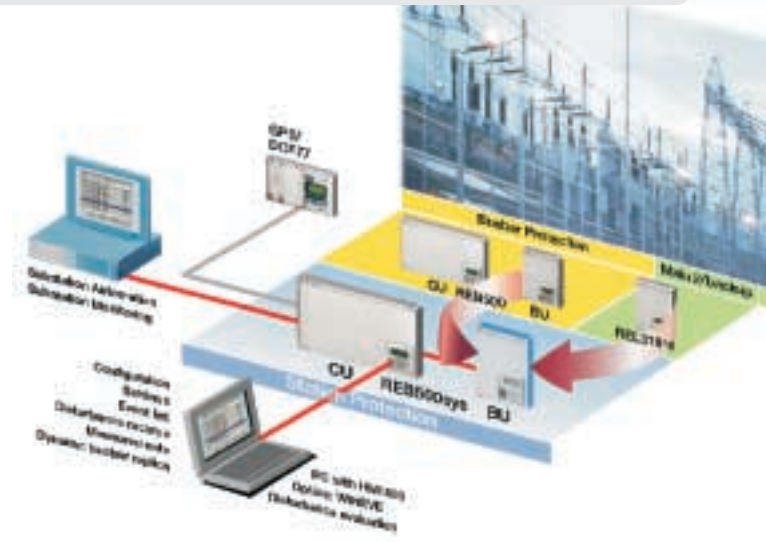
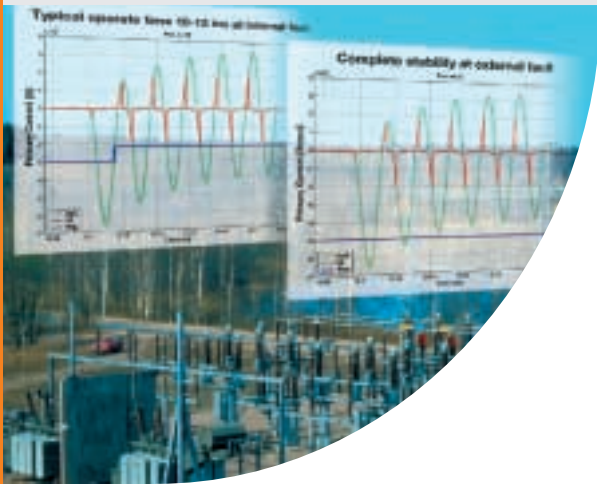
RET 521 terminals can be equipped with advanced voltage control functionality for single and up to eight parallel transformers in any combination of parallel groups. The unique design of this terminal is based on replication of the primary switching in the substation and enables maximum utilization of transformers.

Furthermore, RET 521 has the unique capability to measure voltage on both sides of the transformer. When combined with user-specific logic, this feature helps prevent power system voltage collapse.

## TPU2000R

The TPU2000R is an advanced transformer protection package designed for protection of 3-phase power transformers with up to three restraints available covering the majority of power transformer applications. Sensitive high-speed restrained and unrestrained differential elements protect against internal phase and ground faults. Multiple restraint curves match electronic and electromechanical relays easing retrofits. Flexible harmonic restraint modes prevent false trips during transformer inrush and overexcitation. Phase and ground overcurrent elements for each winding plus disturbance and current level detectors, power metering, digital fault recording and load profile completes a full transformer management system.

# Busbar Protection



**Busbar protection limits the impact of a busbar fault on the entire power network. Busbar protection schemes have to be very dependable to prevent unnecessary tripping and selective to trip only those breakers necessary to clear the busbar fault. The clearing time is important to limit the damage caused by the fault current and the selectivity is crucial to maintain the power system integrity.**

## RED 521

The numerical differential protection terminal RED 521 provides fast and selective phase-segregated protection for busbars, generators, autotransformers, shunt reactors and capacitor banks.

The extremely short operate time of RED 521 is typically 10-15 ms at all internal faults, regardless of the number of connected feeders. At the same time, the terminal maintains complete stability for external faults, even when heavy CT saturation occurs. RED 521 has very low CT requirements, which guarantees stability and correct operation as long as the CT is not saturated for at least two ms during each power system cycle. It is also capable of effectively recognizing and operating correctly for all types of evolving faults.

## REB 500

The REB 500 is a fully numerical distributed busbar- and breaker failure protection with extended functionality and monitoring

capabilities, designed for the high-speed and selective protection of MV, HV and EHV busbar installations at a rated frequency of 50, 60 and 16.7 Hz. The structure of both hardware and software is modular enabling the protection to be easily configured to suit the layout of the primary system. The flexibility of the system enables all configurations of busbars from single busbars to quadruple busbars with transfer buses, ring busbars and 1½ breaker schemes to be protected. The capacity is sufficient for up to 60 feeders (bay units) and a total of 32 busbar zones.

The numerical busbar protection REB 500 detects all phase and ground faults in solidly grounded and resistive-grounded power systems and phase faults in ungrounded systems and systems with Petersen coils. The main CT's supplying the currents to the busbar protection have to fulfill only modest performance requirements. The busbar replica software ensures, that no CT circuits have to be switched externally. The two independent algorithm and busbar replica software allow to avoid the checkzone criteria which might cause an unwanted trip blocking under certain circumstances. The protection operates discriminatively for all faults inside the zone of protection and remains reliably stable for all faults outside the zone of protection.

The distributed structure of REB 500 enhances reliability and performance, saves space and reduces wiring, making it easier to upgrade or extend substations. The improved capability, reduced hardware and many other advantages of numerical technology provide technical and cost benefits for the user over the entire life-cycle of REB 500 protection scheme.

## REB 500 sys

The fully numerical decentralized station protection REB 500 sys combines busbar- and breaker failure protection with integrated line protection incl. station monitoring. REB 500 sys is designed for the high-speed and selective protection of MV, HV and EHV busbar installations at a rated frequency of 50 and 60 Hz. The capacity is sufficient for up to 60 feeders (bay units) and a total of 32 busbar zones and it covers the protection and monitoring of the whole substation, i.e. busbars, line and transformer feeders.

Depending on the voltage level and protection philosophy, the following protection concepts are frequently encountered:

### Main 1 and main 2 protection devices per feeder and one busbar protection

The REB 500 sys station protection enables this protection concept to be simplified, thanks to a higher degree of functional integration. By replacing one of the two main protection devices, the same level of substation protection is maintained whilst cost and space of an extra device are saved and the costs over the complete life-cycle are reduced.

### One main protection device and a backup protection per feeder, no busbar protection

For this situation in the future, REB 500 sys enables the availability of your energy supply to be increased by additional busbar and breaker failure protection in substations where this was not possible up to now for economical reasons.

## Protection and Control for Railway Systems

### REO 517

The numerical multi-functional REO 517 terminal can be used in 50, 60 and 16 $\frac{2}{3}$  Hz systems. It is based on proven ABB knowledge of railway applications, and meets the stringent dependability and security requirements for efficient management of railway power systems. This terminal offers cost-efficient solutions for the protection, control and monitoring of catenary and overhead lines as well as cables feeding the railway power system. It is applicable to single-phase catenaries, autotransformer systems and two-phase feeders.



## Disturbance Recording and Fault Location

### RES 505

The disturbance recorder enables evaluation of different events within the power system and is an important part of a station monitoring system. Any of the recorded analogue channels and binary signals can be programmed to start a recording. Pre-fault and post-fault time can be set in wide ranges. The fault locator provides information about the fault position which enables rapid repair and restored line service. Optimum accuracy is obtained by a measuring principle which eliminates measuring errors caused by infeed of fault current from the remote end, load current prior to the fault and magnitude of fault resistance.

### Indactic 650

Indactic 650 fault analyzing system records the history of a fault and permits its reconstruction and analysis. When a fault occurs, the system stores the waveforms and other states of the equipment. The cause and location of the fault can quickly be determined and the behavior of the associated control and protection equipment can be monitored. Concrete measures can then be deduced from the analysis of such faults, to prevent future failures.

# Substation Monitoring and Control



## Substation Monitoring Systems

Substation Monitoring Systems are your eye into the power process giving you essential information about your electrical transmission and distribution process. Using a public telephone network or a standard TCP/IP network for remote use, such systems provide you the most cost-efficient way to realize substation monitoring. ABB's substation monitoring systems SMS 510 and SMS 530 support the ABB range of products with SPA or LON communication. They can be used either locally at the station or remotely via a modem.

## MicroSCADA Pro for Substation Control

The MicroSCADA Pro product family for Substation Control incorporates a harmonized and consistent product concept, providing you with multiple opportunities to save on engineering, maintenance and training costs.

### Innovative solution

This innovative ABB solution enables you to improve your power distribution productivity. It optimizes the use of assets and maximizes the power distribution network availability. The accurate and easily accessible process and primary equipment information allows for optimized resource allocation and maintenance planning. This results in lower investment and maintenance costs, as well as in reliable power delivery – all benefits which will add direct value to your business.

### Open for constant growth

The MicroSCADA Pro solution for Substation Control is a secure investment. The scalable solution extends from a single communication gateway for efficient remote control of your substation, up to completely redundant systems that combine local control and monitoring functions with remote communication functionalities. This system grows along with your needs, and you can add new functionalities stepwise on top of your existing investment.

### Future-proofed technology

Your MicroSCADA Pro investment is also safe from expiring even when the products and technology evolve. This is because your application as well as its user specific data and configuration will be compatible with future product versions. As a result, you can easily and safely take advantage of new features and technologies. For instance, the MicroSCADA Pro runs smoothly with applications built over a decade ago.

### Seamless integration

The MicroSCADA Pro Substation Control products support an extensive range of communication protocols and other standard interfaces. This enables easy installation in most environments, as well as high-level of integration with other systems, such as IEC 61850, IEC 60870-5-103/101/104, OPC, DNP3.0, ODBC.

The MicroSCADA Pro family also incorporates solutions for Network Control and Distribution Management, which can be seamlessly and efficiently integrated into your Substation Control solutions.

### A selection of products at hand

The MicroSCADA Pro Substation Control solutions can be implemented with the following products:

- MicroSCADA Pro Control System SYS 600
- MicroSCADA Pro Communication Gateway COM 500

## MicroSCADA Pro functions & features

- Control and monitoring of the primary process
- Single line diagram with busbar coloring
- Event and alarm lists
- Trends
- Blocking list
- System supervision
- Setting of relay parameters
- Uploading and evaluation of disturbance record files
- Power-quality monitoring
- Remote parameter setting and disturbance file upload from the MicroSCADA Pro network control solutions
- Data concentration and signal grouping
- Solution libraries for efficient integration of ABB's Substation Automation Intelligent Electronic Devices
- Standard solutions and open interfaces and protocols for integration of 3:rd part IEDs
- Adaptation to customer-specific requirements: displays, signal handling etc.
- Integrated on-line configuration tools
- GPS time synchronization
- Versatile language support, including operator-specific language sets and fonts
- Extensive multi-level user-authorization handling
- High performance and availability
- Remote workstations – (also web-based)
- Standard PC hardware and Microsoft Windows® operating systems
- Master protocols: LON, SPA, IEC 61850, IEC 60870-5-101, IEC 60870-5-103, IEC 60870-5-104, RP-570, RP-571, DNP 3.0, Modbus RTU/ASCII, ANSI X3.28 FD/HD, Modbus TCP/IP, I35/P214
- Slave protocols: IEC 60870-5-101, IEC 60870-5-104, DNP 3.0, Modbus, CDC-II, CPI, RP-570, Modbus TCP/IP, RP-571, F4F (Westinghouse)
- Open interfaces: OPC DA client & server, ODBC client, DDE client, Application programming interfaces for application & communication extensions, ActiveX

## Wide Area Protection, Monitoring and Control

### Phasor Measurement Terminal RES 521

RES 521 terminals installed in critical nodes of power systems enable increasing the transmission capacity without the need to invest in additional transmission lines. At the same time it improves the operational security of the power system.

The superior measurement performance and system-wide data in combination with software tools, such as PSGuard, for monitoring and presentation of power system dynamics provide the operator with real-time phasor information for remedial actions. The information can be utilized to estimate, or in fact, calculate the power system state. In the case of evolving power oscillations, RES 521 provides information for instance about voltages and currents to retain system stability.



# Line Protection

## REL 301/302 - REL 505 C1

Detailed information about functionality is available in **Product Buyer's Guides**.

<sup>1)</sup>REL 316\*4 Line distance protection for sub-transmission applications

<sup>2)</sup>REL 316\*4 Line distance protection for transmission applications

<sup>3)</sup>Synchro-check and energising check only for single circuit breaker

P = Programmable

■ Line distance protection  
■ Line differential protection  
■ Overcurrent and earth-fault protection

IEC	ANSI	Functions	REL 301/302 <sup>3)</sup>	REL 316*4 <sup>1)</sup>	REL 316*4 <sup>2)</sup>	REL 501	REL 501 C1	REL 511	REL 511 C1	REL 511 C2	REL 512 <sup>3)</sup>	REL 521	REL 531	REL 316*4 (87L)	REL 350	REL 352	REL 356	REL 551	REL 551 C1	REL 561	REL 505	REL 505 C1		
Z<	21	<b>Line Distance</b>																						
		General fault-criteria, impedance and current based	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		General fault-criteria, impedance and current based, with phase preference logic																						■
		Full scheme distance protection, 3-zone, phase-to-phase	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Full scheme distance protection, 3-zone, phase-to-earth	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Full scheme distance protection, 3-zone, all phase and ground faults	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Full scheme distance protection, 2-zone, all phase and ground faults	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Zero sequence or negative sequence voltage polarization	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Zero sequence current polarization	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Simplified impedance setting	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Additions for series-compensated network	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Distance protection, 4 or 5 zones	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Additional Pilot Distance forward zone	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Additional Pilot Distance reverse zone	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		dZ/dt	68/78	High-speed protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Phase selection logic	■			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Power-swing detection	■			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Scheme communication logic	■			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Current reversal and WEI logic	■			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Radial feeder protection	■			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Automatic switch onto fault logic	■			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Local acceleration logic	■			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Load Loss trip acceleration logic	■			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Id/I	87L			<b>Line Differential</b>																				
		Line differential protection, phase-segregated	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Line differential protection, combined phase sequence	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Phase comparison protection, phase-segregated	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Phase comparison protection, combined phase sequence	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
I>	50	<b>Current</b>																						
		Instantaneous non-directional phase overcurrent protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Instantaneous non-directional residual (ground) overcurrent protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Definite and/or inverse time non-directional phase overcurrent protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Definite and/or inverse time non-directional residual (ground) overcurrent protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Instantaneous directional phase overcurrent protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Instantaneous directional residual overcurrent protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Definite/inverse time directional phase overcurrent protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Definite/inverse time directional residual (ground) overcurrent protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Instantaneous directional/non-directional negative sequence overcurrent protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Two-step time-delayed non-directional phase overcurrent protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Two-step time-delayed directional phase overcurrent protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Time-delayed directional/non-directional negative sequence overcurrent protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Four-step time-delayed directional residual overcurrent protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Sensitive directional residual overcurrent protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Sensitive directional residual power protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Scheme communication logic for residual overcurrent protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Current reversal and weak-end infeed logic for residual overcurrent protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
I>th	49	Thermal-phase overload protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
		Stub protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Iub	50	Pole-discordance protection, current and contact based	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
		Breaker failure protection	P	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
I>t	50BF	<b>Voltage</b>																						
		Time-delayed under- and overvoltage protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
U<>	27/59	Time-delayed residual overvoltage protection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
		<b>Power System Supervision</b>																						
		Broken conductor check	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
		Loss-of-voltage check	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Overload supervision	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
		Deadline detection	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

# Line Protection

## REL 301/302 - REL 505 C1

Detailed information about functionality is available in Product Buyer's Guides.

- Line distance protection
- Line differential protection
- Overcurrent and earth-fault protection

IEC	ANSI	Cont. Functions	REL 301/302 <sup>30)</sup>	REL 316-4 <sup>1)</sup>	REL 316-4 <sup>2)</sup>	REL 501	REL 501 C1	REL 511	REL 511 C1	REL 511 C2	REL 512 <sup>3)</sup>	REL 531	REL 531 (87L)	REL 350	REL 352	REL 356	REL 551	REL 551 C1	REL 561	REL 505	REL 505 C1
<b>Power System Protection and Control</b>																					
dZ/dt	78	Pole slip protection																			
dZ/dt	78	Out-of-step tripping, selectable Way-in/Way-Out																			
		Low/High active and reactive power protection																			
	7	Sudden change in phase / residual current protection																			
dU/dt		Sudden change in voltage protection																			
U>	59	Overvoltage protection																			
I<	37	Undercurrent protection																			
I>	50	Phase overcurrent protection																			
I>	50N	Residual overcurrent protection																			
<b>Secondary System Supervision</b>																					
		Current circuit supervision, current-based																			
		Fuse failure supervision, negative sequence																			
		Fuse failure supervision, zero sequence																			
		Fuse failure supervision, du/dt and di/dt based																			
		Voltage transformer supervision																			
<b>Control</b>																					
		Single command, 16 signals																			
		CB control																			
	25	Synchro-check with synchronising and energising check, single or double circuit breaker																			
	79	Autorecloser - 1- and/or 3-phase, single circuit breaker																			
	79	Autorecloser - 1- and/or 3-phase, double circuit breaker																			
<b>Logic</b>																					
		Three-pole tripping logic																			
		Additional trip logic																			
		Single, two or three pole tripping logic																			
		High-speed binary output logic																			
		High-speed static binary output																			
		Pole discordance logic, contact based																			
		Additional configurable logic																			
		Communication channel test logic																			
		Binary signal transfer to remote end																			
		Multiple command																			
		Six event counters																			
<b>Monitoring</b>																					
		Disturbance recorder including binary events																			
		Event recorder																			
		Fault locator																			
		Trip-value recorder																			
		Increased accuracy of AC input quantities																			
<b>Metering</b>																					
		Pulse-counter logic for metering																			
<b>HARDWARE</b>																					
		LED indication module multi-color 3-state LEDs or 2-state LEDs																			
<b>Casing</b>																					
		1/2 19" rack																			
		3/4 19" rack																			
		4U 19" rack, REL 512 has 3U																			
		Vertical mount option																			
<b>Analog Input modules</b>																					
		Analog input module with 5 current and voltage inputs																			
		Analog input module with 4 current and voltage inputs																			
		Analog input module with 5 current inputs																			
		Analog input module with 4 current inputs																			
		Analog 3 current and 3 voltage inputs																			
		Analog zero sequence polarizing current input																			
		Additional voltage inputs for synchro-check inputs																			
<b>Power Supply</b>																					
		Power supply																			

# Line Protection

## REL 301/302 - REL 505 C1

Detailed information about functionality is available in **Product Buyer's Guides**.

- Line distance protection
- Line differential protection
- Overcurrent and earth-fault protection

IEC	ANSI	Cont. Functions - Power Supply	REL 301/302 <sup>a)</sup>	REL 316*4 <sup>b)</sup>	REL 316*4 <sup>a)</sup>	REL 501	REL 501 C1	REL 511	REL 511 C1	REL 511 C2	REL 512 <sup>a)</sup>	REL 521	REL 531	REL 531 (87L)	REL 350	REL 352	REL 356	REL 551	REL 551 C1	REL 505	REL 505 C1
		Redundant power supply module																			
		<b>In/Out Modules</b>																			
		4 binary inputs and 5 binary outputs on the power supply module																			
		Binary in/out module, 8 inputs and 12 output relays																			
		Binary input module, 16 inputs																			
		mA input module, 6 channels																			
		Binary output module, 24 output relays																			
		Binary in/out module, 4 inputs and 14 output relays																			
		Binary in/out module, 8 inputs and 8 output relays																			
		Binary in/out module, 14 inputs and 10 output relays																			
		Binary input and outputs, standard schemes																			
		Additional contact output option																			
		Autoreclose option with additional input/outputs for autoreclose																			
		1mA output signals																			
		<b>Remote end data communication modules</b>																			
		Audio modem 9.6kps module																			
		High-speed binary input, output circuits for interface with PLC																			
		Co-directional V.36 galvanic module																			
		Contra-directional V.36 galvanic module																			
		X.21 galvanic module																			
		Co-directional RS530 galvanic module																			
		Contra-directional RS530 galvanic module																			
		Fibre optical module																			
		Short-range galvanic module																			
		Short-range fibre optical module																			
		Co-directional G.703 galvanic module																			
		Communication board for line differential protection																			
		<b>Serial communication</b>																			
		IEC 870-5-103, SPA, LON																			
		ASCII front and rear port communication																			
		INCOI (WinRCP software) front port communication																			
		INCOI (WinRCP software) rear port communication																			
		DNP or IOBus communication, rear port																			
		<b>Second HMI Language</b>																			
		French/German/Italian/Russian/Spanish																			
		French/German																			
		Customer-specified 2nd language																			
		<b>Platform related functions</b>																			
		Self-supervision with internal event recorder																			
		Real-time clock with external time synchronization																			
		IRIG-B real-time clock with external time synchronization																			
		Four parameter setting groups (eight in REL 512)																			
		Configurable logic blocks																			
		Configurable output contacts with selectable signals, delays, AND, OR gates																			
		Service value reading																			
		Event function																			
		Supervision of AC input quantities																			
		Supervision of mA input quantities																			
		I/O system configurator																			
		Blocking of signals during test																			
		Local HMI with optical PC interface and LED indications																			
		Local HMI with LED indications																			

# Breaker and Busbar Protection

## REB 551 - REB 500sys

Detailed information about functionality is available in Product Buyer's Guides.

<sup>4)</sup> 1-phase version of the terminal is also available as summation type, event recorder is an event list with 16 entries, only LON for serial communication, delivered with fixed configuration.

IEC	ANSI	Functions								
			REB 551	REB 551 C1	REB 551 C2	REB 551 C3	REB 551 C4	REB 500	RED 521 <sup>4)</sup>	REB 500sys
		<b>Bus Differential protection</b>								
Id/I	87B	Up to 32 protection zones, phase segregated, up to 60 bays, central or decentralized solution								
	87BN	Measurement of neutral current / neutral current detection								
	87B	One measuring zone for up to six bays								
	87B	Two measuring zones for up to 18 bays, phase segregated (with three terminals)								
	87B	Two measuring zones for up to 18 bays, summation CTs (with one terminal)								
	87T	<b>Transformer differential protection</b>								
	87T	Two winding transformer differential protection bias								
	87T	Three winding transformer differential protection bias								
Z<	21	<b>Distance Protection</b>								
	21	Full-scheme distance protection, 2-5-zone, phase-to-phase, phase-to-earth								
		Phase selection logic								
dZ/dt	78	Power-swing detection								
		Scheme communication logic								
		Automatic switch onto fault logic								
		<b>Current</b>								
I>t	51	Definite/inverse time non-directional phase overcurrent protection								
I <sub>0</sub> >t	51N	Definite/inverse time non-directional residual overcurrent protection								
I>->	67	Instantaneous directional phase overcurrent protection								
I <sub>0</sub> >->	67N	Instantaneous directional residual overcurrent protection								
I>t->	67	Definite/inverse time directional phase overcurrent protection								
I <sub>0</sub> >t->	67N	Definite/inverse time directional residual overcurrent protection								
I>	50	Instantaneous non-directional phase overcurrent protection								
I <sub>2</sub> >	46	Current plausibility check								
I>t	51	Definite time non-directional phase overcurrent protection								
I <sub>th</sub>	49	Thermal-phase overload protection								
I>	50	Stub (End-zone) Protection								
	51/62PD	Pole-discordance protection, current and contact based								
I>t	50BF	Breaker failure protection								
		<b>Voltage</b>								
U<>	27/59	Time-delayed under- and overvoltage protection								
	47	Voltage plausibility check								
		<b>Power System Supervision</b>								
U<		Loss-of-voltage check								
I>		Overload supervision								
U<		Deadline detection								
		<b>Power System Protection and Control</b>								
dZ/dt		Pole slip protection								
		<b>Secondary System Supervision</b>								
		Current circuit supervision, current-based								
		Fuse failure supervision, negative sequence								
		Fuse failure supervision, zero sequence								
		Fuse failure supervision, du/dt and di/dt based								
		Voltage transformer supervision								
		<b>Control</b>								
		Single command, 16 signals								
	25	Synchro-check and energising check, single or double circuit breaker								
	25	Synchro-check with synchronising and energising check, single or double circuit breaker								
	25	Synchro-check and energising check, 1 1/2-breaker arrangement, per breaker								
	79	Autorecloser - 1- and/or 3-phase, single circuit breaker								
	79	Autorecloser - 1- and/or 3-phase, double circuit breaker								
		<b>Logic</b>								
	94RD	Trip command re-direction								
		Single, two or three pole tripping logic								
		Pole discordance logic, contact based								
		Basic configurable logic								
		Communication channel test logic								
		Binary signal transfer to remote end								
		Multiple command								
		Six event counters								
		<b>Monitoring</b>								
		Disturbance recorder								

# Breaker and Busbar Protection

## REB 551 - REB 500sys

Detailed information about functionality is available in **Product Buyer's Guides**.

IEC	ANSI	Cont. Functions - Monitoring	REB 551	REB 551 C1	REB 551 C2	REB 551 C3	REB 551 C4	REB 500	REB 521 <sup>®</sup>	REB 500sys
		<b>Cont. Functions - Monitoring</b>								
		Event recorder	■							
		Trip-value recorder	■							
		Increased accuracy of AC input quantities	■							
		Open CT detection	■					■	■	■
		<b>Metering</b>								
		Pulse-counter logic for metering	■							
		<b>HARDWARE</b>								
		LED indication module with multi-color, 3-state LEDs	■							■
		<b>Casing</b>								
		1/3 of 19" rack bay unit 20 binary inputs /16 binary outputs								■
		1/1 x 19" rack central unit binary in/out module central unit, 12 inputs and 9 output relays								■
		1/2 of 19" rack (Maximum 3 I/O modules)	■	■	■	■				
		3/4 of 19" rack (Maximum 8 I/O modules)	■				■			
		1/1 x 19" rack casing with maximum 13 I/O modules								■
		<b>Analog Input Modules</b>								
		Analog input module with five current and five voltage inputs	■			■	■			
		Analog input module with four currents, no voltage								■
		Analog input module with four currents, five voltages								■
		Analog input module with nine currents, no voltage								■
		<b>Power Supply</b>								
		Power supply	■	■	■	■	■	■	■	■
		Redundant Power Supply Central Unit / Bay Unit								■
		<b>In/Out Modules</b>								
		4 binary inputs and 5 binary outputs on the power supply module	■	■	■	■	■			
		Binary in/out module, 8 inputs and 12 output relays	■	■	■	■	■			
		Binary in/out module central unit, 12 inputs and 9 output relays								■
		Binary input module, 16 inputs	■							■
		mA input module, 6 channels	■							
		Binary output module, 24 output relays	■							■
		<b>Remote end data communication modules</b>								
		Co-directional V.36 galvanic module	■							
		Contra-directional V.36 galvanic module	■							
		X.21 galvanic module	■							
		Co-directional RS530 galvanic module	■							
		Contra-directional RS530 galvanic module	■							
		Fibre optical module	■							
		Short-range galvanic module	■							
		Short-range fibre optical module	■							
		Co-directional G.703 galvanic module	■							
		<b>Serial communication</b>								
		SPA	■	■	■	■	■			
		LON	■	■	■	■	■	■	■	■
		IEC 870-5-103	■	■	■	■	■	■	■	■
		TCP/IP Connection								■
		<b>Second HMI Language</b>								
		French/German/Spanish	■	■	■	■	■	■		■
		Italian / Russian	■	■	■	■	■			
		Customer-specified 2nd language	■	■	■	■	■			
		<b>Platform related functions</b>								
		Self-supervision with internal event recorder	■	■	■	■	■	■	■	■
		Real-time clock with external time synchronization	■	■	■	■	■	■	■	■
		Four parameter setting groups	■	■	■	■	■	■	■	■
		Configurable logic blocks	■	■	■	■	■	■	■	
		Service value reading								■
		Event function	■	■	■	■	■	■	■	■
		Supervision of AC input quantities	■	■	■	■	■			
		Supervision of mA input quantities	■							
		I/O system configurator	■	■	■	■	■	■	■	■
		Blocking of signals during test	■	■	■	■	■	■	■	■
		Local HMI with optical PC interface and LED indications	■	■	■	■	■	■	■	■

■ Breaker protection  
 ■ Busbar protection  
 ■ Station protection

# Transformer Protection

## RET 316\*4 - TPU2000R

Detailed information about functionality is available in **Product Buyer's Guides**.

IEC	ANSI	Functions	<sup>5)</sup> IEC 870-5-103 via SPA/IEC gateway	P = Programmable	RET 316*4 (2W)	RET 316*4 (3W)	RET 521 C1 <sup>9)</sup>	RET 521 C2 <sup>9)</sup>	RET 521 C3 <sup>9)</sup>	TPU2000R
Id/I	87T	<b>Transformer differential protection</b>								
		Two winding transformer differential protection bias			■	■	■	■	■	■
		Three winding transformer differential protection bias			■	■	■	■	■	■
		First and second restricted earth-fault protection, low impedance			■	■	■	■	■	■
		Third restricted earth-fault protection, low impedance			■	■	■	■	■	■
		Restricted earth-fault protection high impedance			■	■	■	■	■	■
Z<	21	<b>Distance Protection</b>								
		Distance protection 4-5 zones			■	■	■	■	■	■
I>t ->	50/51/67	<b>Current</b>								
I>	50	Instantaneous non-directional phase overcurrent protection			■	■	■	■	■	■
I <sub>0</sub> >	50N	Instantaneous non-directional residual (ground) overcurrent protection			■	■	■	■	■	■
I>t	51	Definite/inverse time non-directional phase overcurrent protection			■	■	■	■	■	■
I <sub>0</sub> >t	51N	Definite/inverse time non-directional residual overcurrent protection			■	■	■	■	■	■
I> ->	67	Instantaneous directional phase overcurrent protection			■	■	■	■	■	■
I <sub>0</sub> > ->	67N	Instantaneous directional residual overcurrent protection			■	■	■	■	■	■
I> ->	67	Definite/inverse time directional phase overcurrent protection			■	■	■	■	■	■
I <sub>0</sub> > ->	67N	Definite/inverse time directional residual overcurrent protection			■	■	■	■	■	■
I> I>t ->	50/51/67	Two-step time-delayed non-directional and directional phase overcurrent protection			■	■	■	■	■	■
		First, second and third overcurrent protection, non-directional and directional with inverse and definite time characteristics			■	■	■	■	■	■
		Time-delayed non-directional phase and ground overcurrent protection (RMS or fundamental)			■	■	■	■	■	■
		Time-delayed non-directional negative sequence overcurrent protection (RMS or fundamental)			■	■	■	■	■	■
		Sensitive non-directional ground overcurrent protection (RMS or fundamental)			■	■	■	■	■	■
I <sub>th</sub> >	49	Thermal-phase overload protection			■	■	■	■	■	■
I>t	50/62 BF	Breaker failure protection			■	■	■	■	■	P
U<->	27/59	<b>Voltage</b>								
		Time-delayed under- and overvoltage protection			■	■	■	■	■	■
		Time-delayed residual overvoltage protection			■	■	■	■	■	■
		First time overvoltage protection with inverse and definite time characteristics			■	■	■	■	■	■
		Second time overvoltage protection with inverse and definite time characteristics			■	■	■	■	■	■
		Third, fourth, fifth and sixth time overvoltage protection with inverse and definite time characteristics			■	■	■	■	■	■
		First, second and third undervoltage protection with definite time characteristics			■	■	■	■	■	■
(U/f)>	24	Overfluxing protection			■	■	■	■	■	■
		<b>General functions</b>								
		General functions up to 12 instances (impedance, zero-seq seq, over- undervoltage)			■	■	■	■	■	■
f	81	<b>Frequency</b>								
		Time-delayed under- and overfrequency protection			■	■	■	■	■	■
		Time-delayed gradient of frequency protection			■	■	■	■	■	■
	90	<b>Transformer control</b>								
		Voltage control, single transformer			■	■	■	■	■	■
		Voltage control for up to eighth parallel transformers			■	■	■	■	■	■
		<b>Control</b>								
		CAP316 Fupla for control logic (interlocking, commands, alarms)			■	■	■	■	■	■
		CB control			■	■	■	■	■	■
		<b>Logic</b>								
		Three-pole tripping logic			■	■	■	■	■	■
		Additional configurable logic			■	■	■	■	■	■
		Multiple command			■	■	■	■	■	■
		<b>Monitoring</b>								
		Disturbance recorder			■	■	■	■	■	■
		Event recorder			■	■	■	■	■	■
		Trip-value recorder			■	■	■	■	■	■
		<b>Metering</b>								
		Pulse-counter logic for metering			■	■	■	■	■	■
		Metering with voltage input option			■	■	■	■	■	■
		Load profile feature			■	■	■	■	■	■
		<b>HARDWARE</b>								
		LED indication module with 18 programmable multicolor, 3-state LEDs			■	■	■	■	■	■
		LED indication module with 16 programmable, 2-state LEDs			■	■	■	■	■	■
		LEDs with On/Off indication			■	■	■	■	■	■
		<b>Casing</b>								
		1/2 of 19" rack (Maximum 2 I/O modules)			■	■	■	■	■	■
		3/4 of 19" rack (Maximum 4 I/O modules)			■	■	■	■	■	■
		3U 19" rack			■	■	■	■	■	■
		Vertical mount option			■	■	■	■	■	■
		<b>Analog Input Modules</b>								
		Analog input module with 9 currents, no voltage			■	■	■	■	■	■
		Analog input module with 6 currents, 3 voltage inputs			■	■	■	■	■	■
		Analog input module with 7 currents, 3 voltage inputs			■	■	■	■	■	■
		Analog input module with 8 currents, 2 voltage inputs			■	■	■	■	■	■
		Analog input module with 9 currents, 1 voltage inputs			■	■	■	■	■	■
		Analog input for 2 winding or 3 winding protection			■	■	■	■	■	■
		Voltage input			■	■	■	■	■	■
		Power Supply			■	■	■	■	■	■
		<b>In/Out Modules</b>								
		Binary in/out module, 8 inputs and 12 output relays			■	■	■	■	■	■
		Binary input module, 16 inputs			■	■	■	■	■	■
		mA input module, 6 channels			■	■	■	■	■	■

# Transformer Protection

## RET 316\*4 - TPU2000R

Detailed information about functionality is available in **Product Buyer's Guides**.

IEC	ANSI	Cont. Functions - In/Out Modules	RET 316*4 (2W)	RET 316*4 (3W)	RET 521 C1 (9)	RET 521 C2 (9)	RET 521 C3 (9)	TPU2000R
		Binary output module, 24 output relays						
		Binary in/out module, 4 inputs, 14 output relays	■	■				
		Binary in/out module, 8 inputs and 8 output relays	■	■				
		Binary in/out module, 14 inputs and 10 output relays	■	■				
		<b>Serial communication</b>						
		IEC 870-5-103, SPA, LON	■	■	■	■	■	■
		DNP, Modbus, INCOM, RS232/485						■
		TCP/IP Connection		■	■	■	■	
		<b>Second HMI Language</b>						
		French/German	■	■	■	■	■	■
		Spanish		■	■	■	■	
		Italian/Russian			■	■	■	
		Customer-specified 2nd language			■	■	■	
		<b>Platform related functions</b>						
		Self-supervision with internal event recorder	■	■	■	■	■	■
		Real-time clock with external time synchronisation	■	■	■	■	■	■
		Real-time clock with external IRIG-B time synchronisation						■
		Four parameter setting groups	■	■	■	■	■	■
		Main, Alt1, Alt2 setting groups						■
		Configurable logic blocks	■	■	■	■	■	■
		Service value reading	■	■	■	■	■	■
		Frequency measurement			■	■	■	
		Event function	■	■	■	■	■	■
		Operations record, summary						■
		Supervision of AC input quantities	■	■				
		I/O system configurator	■	■	■	■	■	■
		Blocking of signals during test	■	■	■	■	■	■
		Local HMI with optical PC interface and LED indications	■	■	■	■	■	■
		Local HMI with RS232 (electrical) PC interface and LED indications						■

# Bay Control

## REC 316\*4 - REC 561

Detailed information about functionality is available in **Product Buyer's Guides**.

IEC	ANSI	Functions	REC 316*4	REC 561
I>, I>t	50, 51	<b>Current</b>		
I>	50	Instantaneous non-directional phase overcurrent protection	■	■
I <sub>0</sub> >	51N	Instantaneous non-directional residual/ground overcurrent protection	■	■
I>t	51	Definite/inverse time non-directional phase overcurrent protection	■	■
I <sub>0</sub> >t	51N	Definite/inverse time non-directional residual overcurrent protection	■	■
I> ->	67	Instantaneous directional phase overcurrent protection	■	■
I <sub>0</sub> > ->	67N	Instantaneous directional residual overcurrent protection	■	■
I> ->t	67	Definite/inverse time directional phase overcurrent protection	■	■
I <sub>0</sub> > ->t	67N	Definite/inverse time directional residual overcurrent protection	■	■
		Two-step time-delayed non-directional phase overcurrent protection	■	■
		Two-step time-delayed directional phase overcurrent protection	■	■
		Scheme communication logic for residual overcurrent protection	■	■
		Current reversal and weak-end infeed logic for residual overcurrent protection	■	■
I <sub>th</sub> >	49	Thermal-phase overload protection	■	■
		Pole-discordance protection, current and contact based	■	■
I>t	50/62 BF	Breaker failure protection	■	■
U<>t		<b>Voltage</b>		
		Time-delayed under- and overvoltage protection	■	■
		Time-delayed residual overvoltage protection	■	■
f<>t	81<>	<b>Frequency</b>		
f<>t	81<>	Time-delayed under- and overfrequency protection	■	■
df/dt<>	81<>	Time-delayed gradient of frequency protection	■	■
		<b>Power System Supervision</b>		
U<	27	Loss-of-voltage check	■	■
U<	27	Deadline detection	■	■
		<b>Power System Protection and Control</b>		
dZ/dt	78	Pole slip protection	■	■
		<b>Secondary System Supervision</b>		
		Fuse failure supervision, negative sequence	■	■
		Fuse failure supervision, zero sequence	■	■
		Fuse failure supervision, du/dt and di/dt based	■	■
		Voltage transformer supervision	■	■
		<b>Control</b>		
		CAP316 Fupla for control logic (interlocking, commands, alarms)	■	■
		Apparatus control for up to 12 bays with up to 24 apparatuses incl. single and multiple command function blocks, interlocking modules for two 1½ CB diameters	■	■
		Interlocking modules for three single or two double CB bays or one 1½ CB diameter incl. single and multiple command function blocks	■	■

# Bay Control

## REC 316\*4 - REC 561

Detailed information about functionality is available in Product Buyer's Guides.

IEC	ANSI	Cont. Functions - Control	REC 316*4	REC 561
		Single command, 16 signals		
25		Synchro-check and energising check, single or double circuit breaker		
25		Synchro-check with synchronising and energising check, single or double circuit breaker		
25		Synchro-check and energising-check, 1 1/2-breaker arrangement, per breaker		
25		Synchro-check and energising check 3 bays with single circuit breaker and/or 2 bays with double circuit breaker		
79		Autorecloser - 1- and/or 3-phase, single circuit breaker		
79		Autorecloser - 1- and/or 3-phase, double circuit breaker		
79		Autorecloser - 1- and/or 3-phase, up to four circuit breakers		
79		Autorecloser - 3-phase, up to four circuit breakers		
		Interlocking, common		
		Interlocking for line, bus coupler and transformer bay		
		Interlocking for bus-section breaker, bus-section disconnecter and busbar earthing switch		
		Interlocking for double and 1 1/2 circuit breaker arrangements		
		Bay, switch, command and block control		
		<b>Logic</b>		
		Additional trip logic		
		Single, two or three pole tripping logic		
		Additional configurable logic		
		Binary signal transfer to remote end		
		Multiple Command		
		Six event counters		
		<b>Monitoring</b>		
		Disturbance recorder		
		Event recorder		
		Trip-value recorder		
		Increased accuracy of AC input quantities		
		<b>Metering</b>		
		Pulse-counter logic for metering		
		<b>HARDWARE</b>		
		LED indication module with 18 programmable multicolor, 3-state LEDs		
		LED indication module with 16 programmable, 2-state LEDs		
		<b>Casing</b>		
		1/2 of 19" rack (Maximum 2 I/O modules)		
		1/2 of 19" rack (Maximum 3 I/O modules)		
		3/4 of 19" rack (Maximum 4 I/O modules)		
		3/4 of 19" rack (Maximum 8 I/O modules)		
		1/1 x 19" rack casing with maximum 13 I/O modules		
		<b>Analog Input Modules</b>		
		Analog input module with five current and five voltage inputs		
		Power Supply		
		<b>In/Out Modules</b>		
		Binary in/out module, 8 inputs and 12 output relays		
		Binary input module, 16 inputs		
		mA input module, 6 channels		
		Binary output module, 24 output relays		
		Binary in/out module, 4 inputs, 14 output relays		
		Binary in/out module, 8 inputs and 8 output relays		
		Binary in/out module, 14 inputs and 10 output relays		
		<b>Remote end data communication modules</b>		
		Co-directional V.36 galvanic module		
		Contra-directional V.36 galvanic module		
		X.21 galvanic module		
		Co-directional RS530 galvanic module		
		Contra-directional RS530 galvanic module		
		Fibre optical module		
		Short-range galvanic module		
		Short-range fibre optical module		
		Co-directional G.703 galvanic module		
		<b>Serial communication</b>		
		IEC 870-5-103, SPA, LON		
		<b>Second HMI Language</b>		
		French/German		
		Spanish		
		Italian/Russian		
		Customer-specified 2nd language		
		<b>Platform related functions</b>		
		Self-supervision with internal event recorder		
		Real-time clock with external time synchronization		
		Four parameter setting groups		
		Configurable logic blocks		
		Service value reading		
		Event function		
		Supervision of AC input quantities		
		Supervision of mA input quantities		
		I/O system configurator		
		Blocking of signals during test		
		Local HMI with optical PC interface and LED indications		

# Services with experience for optimized po

## World-class products complemented by a full scope of services

In addition to its broad range of protection and control products and systems, ABB offers a comprehensive selection of services to help you understand and manage your power system behavior under diverse operational and disturbance situations.

With more than 100 years of experience in the protection and control of power systems worldwide, we can serve you with knowledge that enables you to reap the full benefits of your protection and control equipment investment. Our experts, with their approximately 20 years of field experience, will support you at every step you take: from optimized building and correct installation of your power system to its reliable operation.

## Analyze your needs

Our Power System Studies aim to analyze the undisturbed and disturbed conditions of your power system; thus enabling you to take the correct actions in optimizing the design, function and operation of your protection and control system.

The Power System Simulation services will help you study the possible disturbances and know their effects on your power system – even before they occur. Our Network Simulator is able to simulate all fault types, in order to analyze and verify the operation of your protection and control terminals under different conditions. Combined with Power System Studies, simulation systems can be fully adapted to represent your network characteristics. The advanced simulator for substation equipment, such as for on-load tap changers and power transformers, can be used for verifying control devices designed, for instance, for voltage control. As a result, you profit from a correct protection and control strategy and secure power system operations.

## Optimize operation

The configuration and parameter setting of your protection and control terminals including selectivity planning, will help you gain the best advantage from your investment. These services ensure that the terminal functionality meets the requirements of your network, and that the equipment operates correctly in all predictable fault situations.



# that counts – power system operation

## *A versatile package of services adapted to your needs*

When a fault occurs, you can utilize our Disturbance analysis service to analyze your power system and its behavior in a fault situation, as well as the performance of your protection and control system. If required, our experienced specialists will suggest corrective actions to eliminate the weaknesses, to increase the security of your power system.

Versatile standard courses and fully customized training programs enable your engineers and operators to fully utilize the protection and control system. Our training courses include extensive hands-on sessions and well-documented exercises. As a result, your personnel will be well prepared to both handle the equipment in daily operation and meet any type of disturbance situation.

### **Easy access to spare parts**

With the Parts OnLine service you can easily access information about availability and technical details concerning more than 100 000 spare parts, including spare parts for protection and control products. You can search and order spare parts and repair service 24 hours a day. All you need is a PC and internet connection.

By filling in the membership form at [www.abb.com/partsonline](http://www.abb.com/partsonline) you can start using the service to facilitate your spare part management.

### **Combined strengths**

You can freely combine the different services to create a service package that best meets your needs. By combining the skills of our committed specialists with your own power system knowledge you take a decisive step towards optimized power system operation.





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