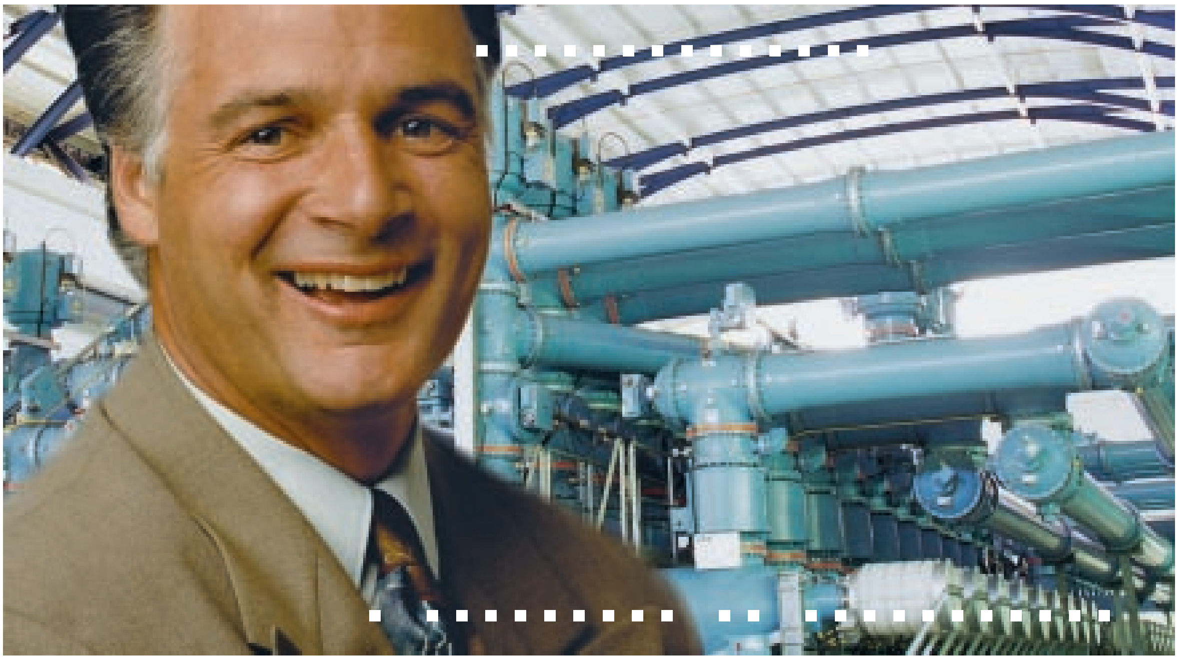
Industrial^{IT}

For numerical busbar protection systems



Numerical Protection Systems for Busbars

Busbar Protection Improves Power System Stability

Power supply disruptions not only have a severe impact on the economy, they also cause transitory or permanent phenomena likely to affect complete or partial power system stability as well as the security of the entire power system. The impact of such incidents are increasingly serious due to the dependence of the industrial processes on the availability of the power supply as well as on the power quality.

In this context, busbar protection systems become much more important to the stability and availability of the entire power system. A single incident involving a busbar or a failure of a circuit breaker to clear a line fault can affect the performance of the entire substation and hence many consumers.

Numerical busbar protection has to be reliable, sensitive and stable in every busbar scheme, no matter how complex it is. Numerical busbar protection techniques offers the following benefits:

- Reliable clearance of busbar faults
- Mitigation of the impact of busbar faults
- Increase of substations availability
- Improvement of overall power system availability and reliability

The typical applications of busbar protection are

Power utilities	Sub-transmission and transmission level
Industries	Industry plants with distribution substations
Power Plants	with associated sub-transmission and transmission substations

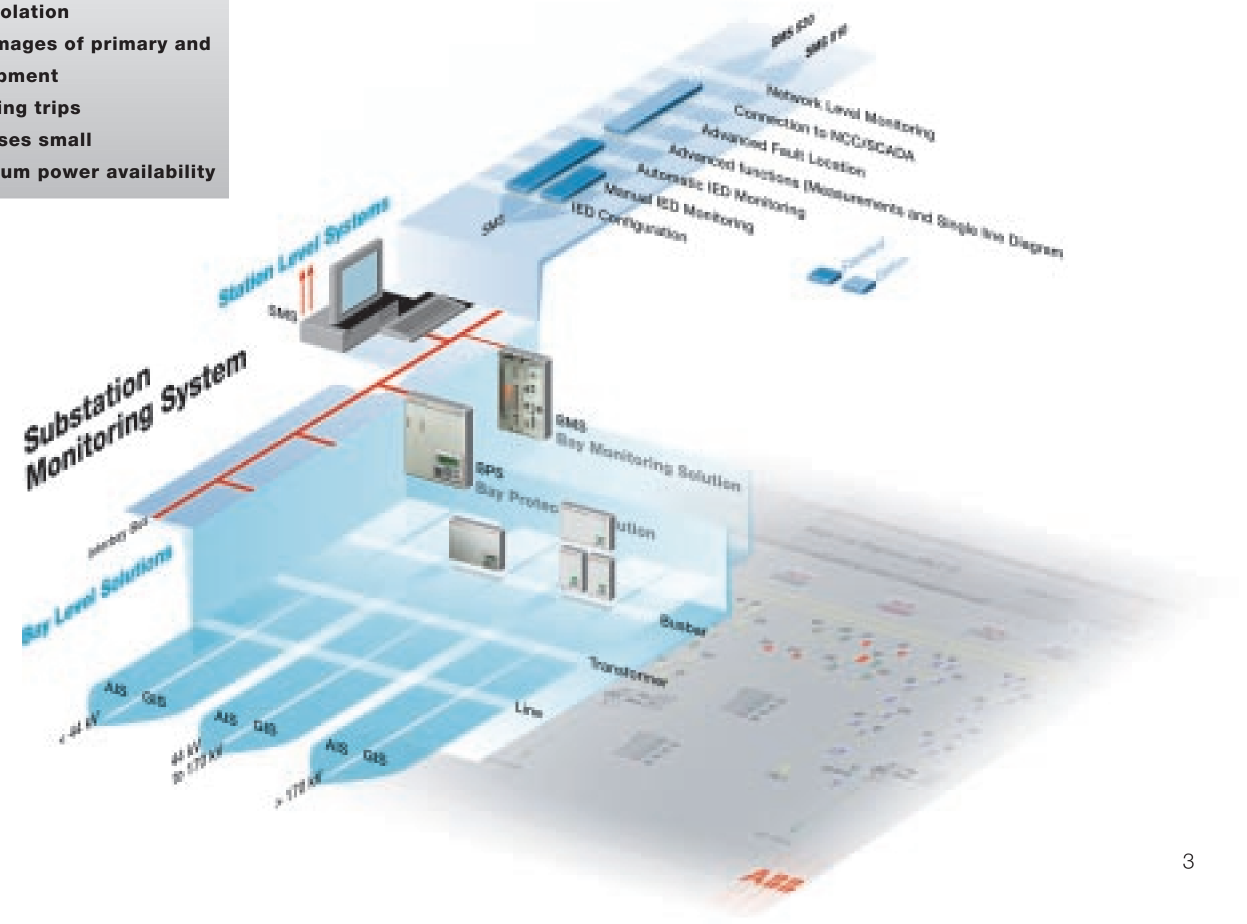
Examples:

- New air- or SF_6 gas-insulated sub-transmission or transmission substation
- Refurbishing an existing substation for higher availability and less impact of busbar faults
- Substitution of legacy busbar protection schemes for more reliability and data acquisition

Industrial[IT] is the ABB commitment to the real-time integration of automation and information systems across the business enterprise.

Highlights

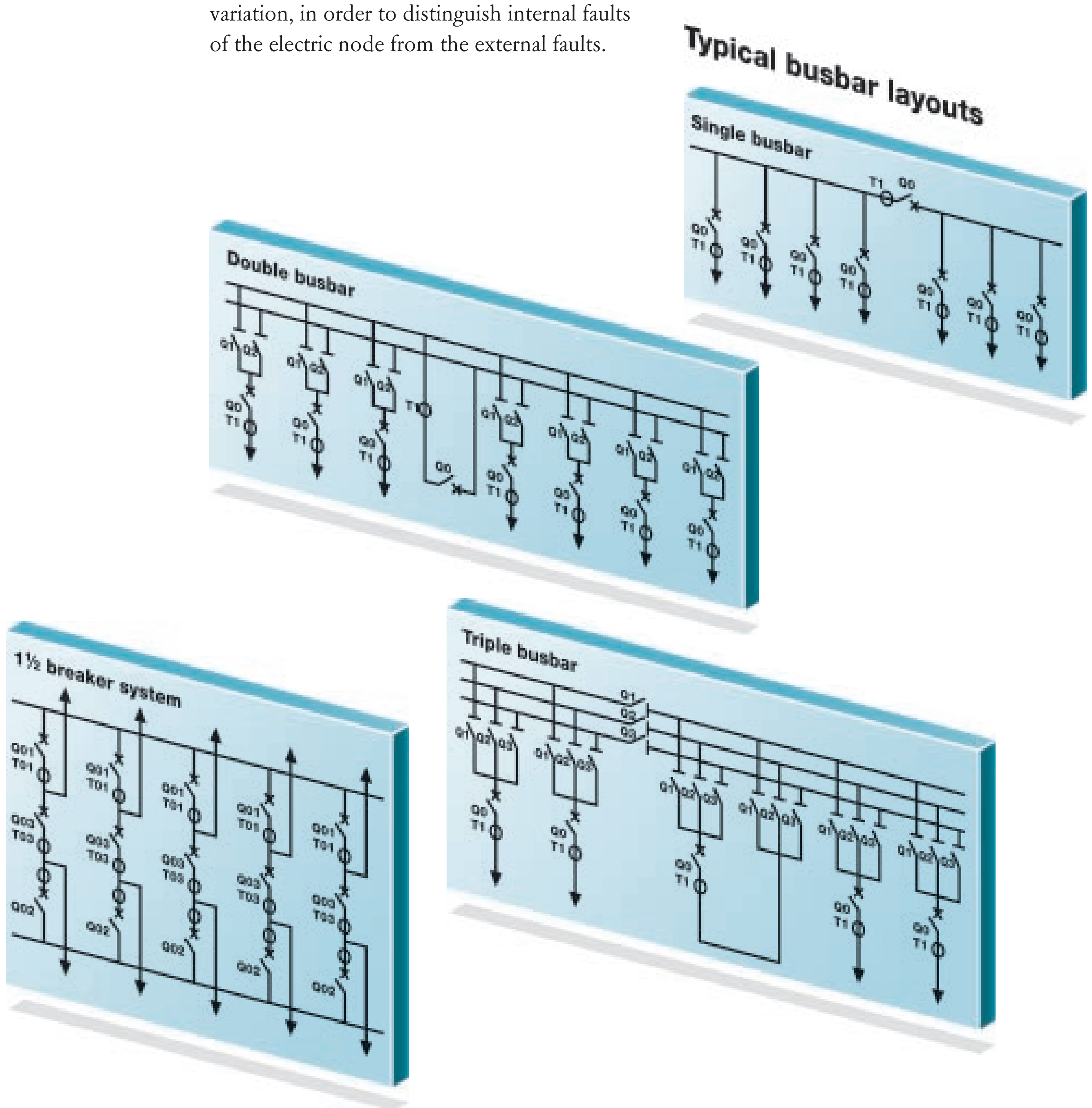
- Fast clearance of busbar faults
- Reliable fault isolation
- Avoid heavy damages of primary and secondary equipment
- Prevent cascading trips
- Keep power losses small
- Maintain maximum power availability



Numerical busbar protection protects the sensitive node in your network, the substation

A substation is a node in the power supply network where several lines are connected. Within the substation, there may also be several nodes, connected or isolated depending on the position of the bus section isolators and bus coupler circuit breakers. The differential protection ensures the protection of the electric nodes, based on the laws such as Kirchhoff, the impedance variation, the admittance variation, in order to distinguish internal faults of the electric node from the external faults.

The overall power system stability will rely to a large extent on the performance of these protections for its speed, its reliability, its co-ordination with other protection of the network as well with the sensitivity to detect and analyse the electric faults as much as adaptability to various substation topologies.



Numerical Busbar protection has to be designed for:

all types of primary equipment

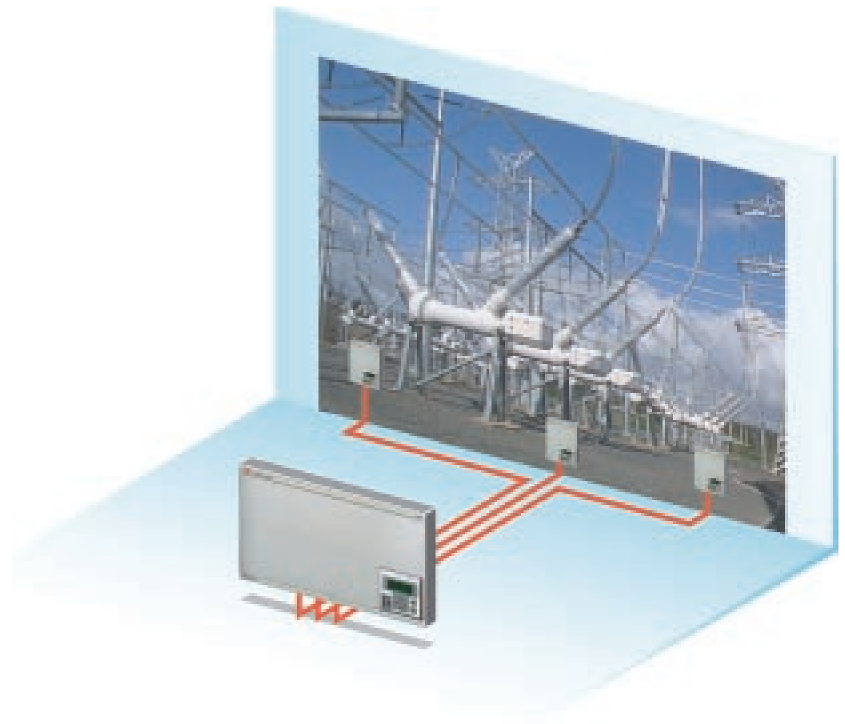
- Gas- or air-isolated substations
- Intelligent switchgear
- Refurbishment of existing substations
- Indoor / Outdoor Kiosk

all types of substations

- Single busbars
- Double busbars
- Triple busbars
- Quadruple busbars with or without transfer bus
- $1^1/_2$ Circuit breaker systems
- Ring bus

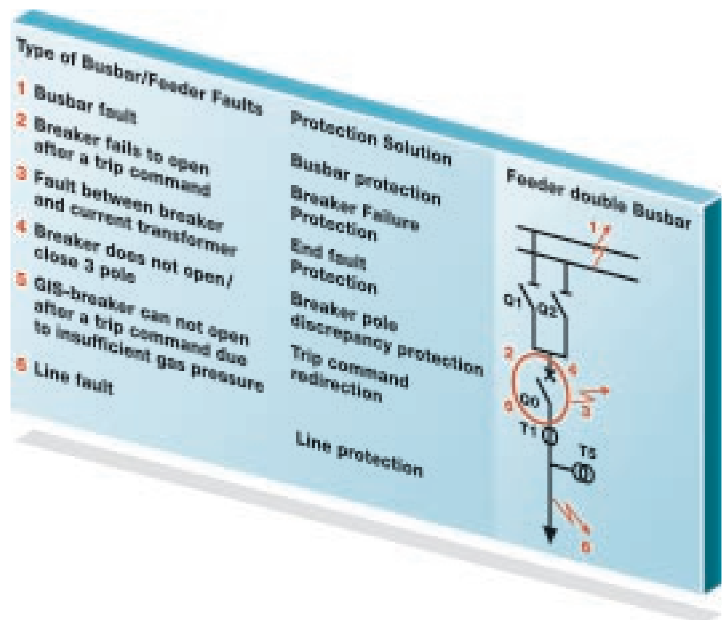
all types of networks:

- Solidly earthed networks
- Isolated networks
- Resistive earthed networks



Important features are:

- Multiple and reliable measurement criteria to achieve maximum security
- Continuous self-supervision enhances reliability and availability
- Modular design reduces spares stocking levels
- Functionality is mainly defined by software
- Integrated disturbance recording for optimal fault evaluation
- Integrated event recording for sequence of events analysis



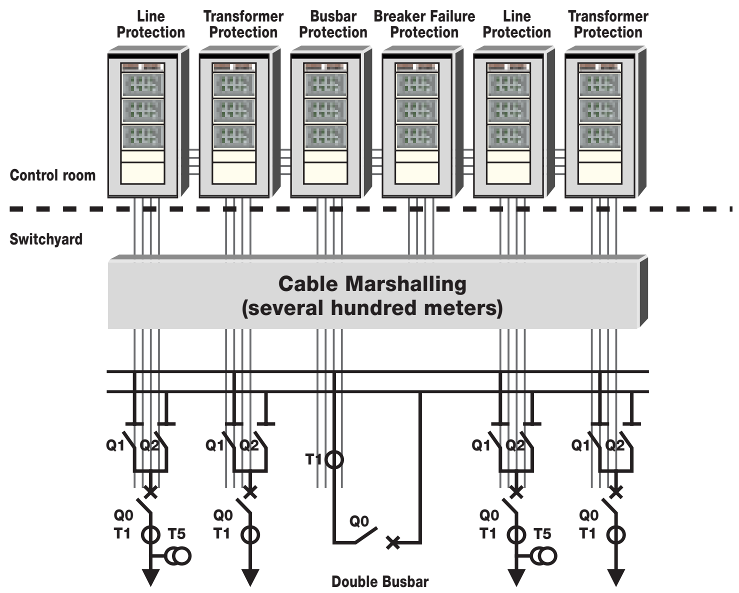
Protection arrangements in substations

Conventional central arrangement

In conventional protection schemes, one dedicated protection device is installed for each protection function. All information, required by the protection devices, needs to be wired via copper cable over several hundred meters. As a consequence of this, material, engineering, commissioning and maintenance is very expensive, inflexible and time-consuming.

A typical panel comprises discrete relays for

- **Line Protection Main 1 / Main 2 and / or Backup Protection**
- **Transformer Protection Main 1 / Main 2 and / or Backup Protection**
- **Busbar Protection**
- **Breaker Failure Protection**
- **Line Protection Main 1 / Main 2 and / or Backup Protection**
- **Transformer Protection Main 1 / Main 2 and / or Backup Protection**



Numerical central arrangement

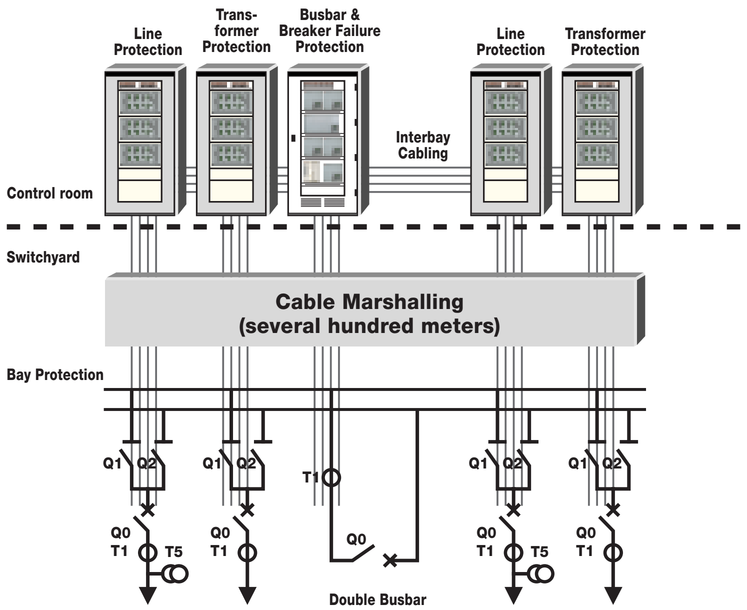
In cases where the secondary cabling does not need to be replaced, the numerical central arrangement fits perfectly for substation refurbishment.

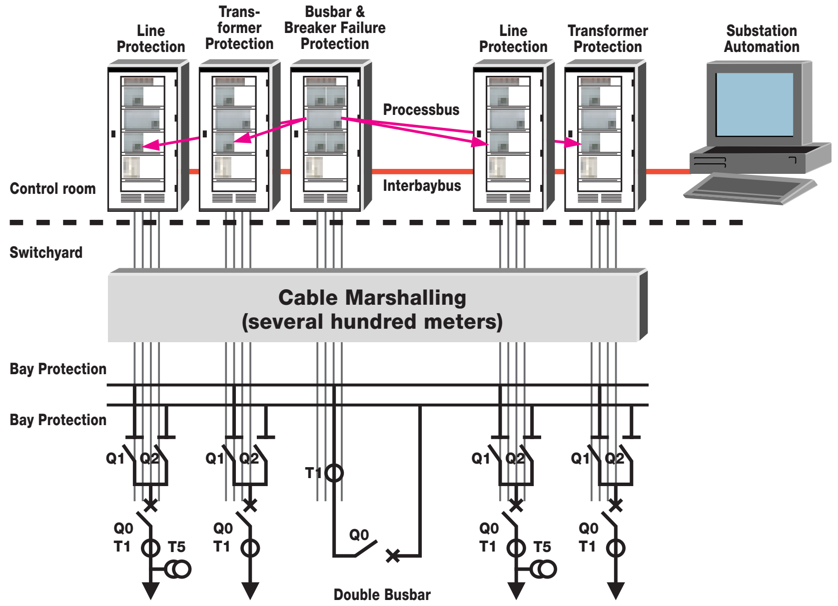
Rationalization of protection

Using the numerical busbar protection offers the following advantages

- **Integrated breaker failure protection**
- **Integrated event recording**
- **Integrated disturbance recorder**
- **Reduced hardware with more functionality**

If the existing cables are in poor condition, it is recommended to install a decentralized protection arrangement with all its advantages.



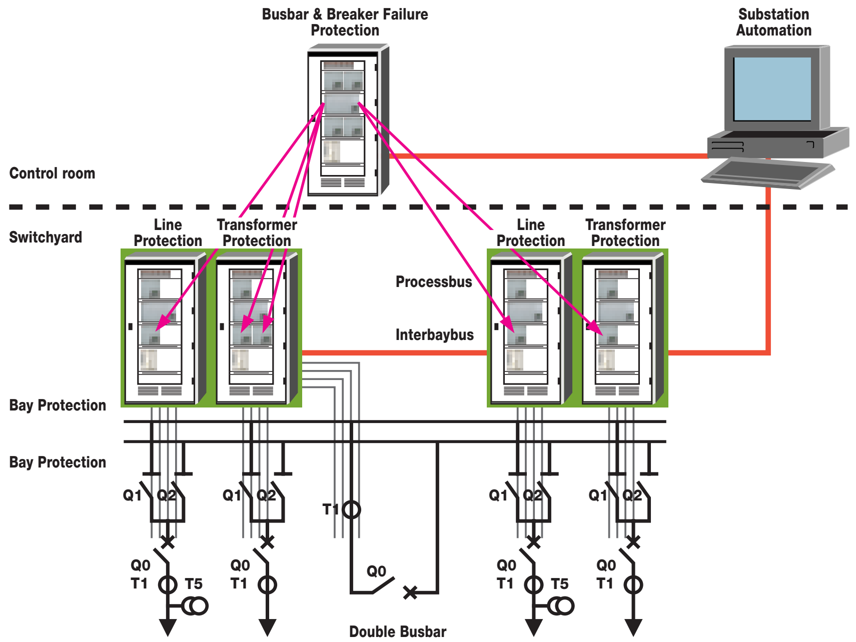


Numerical decentralized arrangement

is preferred in cases of modern substation automation systems with distributed numerical protection and control devices.

Discrete relays for each function are no longer necessary. In modern protection concepts and philosophies, several functions are combined with main protection schemes.

This does not only reduce the hardware and engineering costs but also provides for a level of redundancy of functionality that was not possible with conventional protection schemes.



Advanced numerical decentralized arrangement

In order to safe cabling and civil work costs, the protection and control kiosks can also be installed in switchbay houses close to the HV switchgear. The copper cabling is substituted by fibre-optic.

Nowadays decentralized protection systems with the independent bay-oriented functions allow the upgrade to a reliable and comprehensive Station Protection with all its advantages. These Station Protection schemes are comprising:

- **Busbar protection**
- **Integrated breaker failure protection**
- **Integrated line protection as main 2 or backup protection**
- **Integrated distributed synchrocheck and auto-reclosure**
- **Integrated disturbance recorder**
- **Further reduction of hardware and process wiring**
- **Lower hardware installation costs**
- **Less interface definitions and easier co-ordination of functions**
- **Less different types of hardware**
- **Less spare parts**
- **Lower maintenance costs**
- **Improved system availability for the complete system due to increased MTBF**

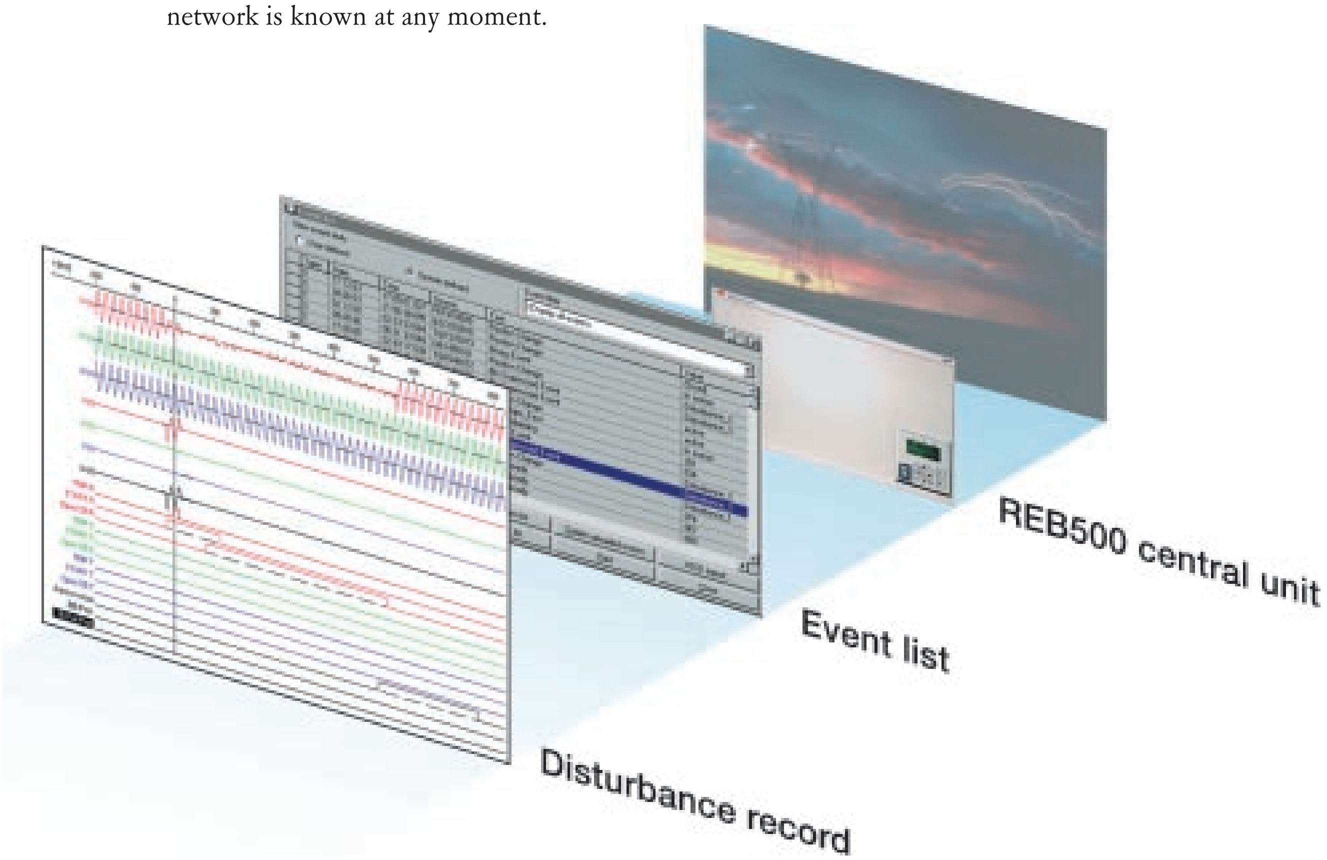
Independent functions per feeder can be added at any time

Achievements of numerical protection system

Sensitivity
The sensitivity of the protection to detect the faults single-phase or multi-phase is essential for the total safety of the network. In addition, this sensitivity of protection must be combined with its capability to identify the direction of a fault on each line in order to preserve the tripping selectivity associated with the protection scheme. The digital techniques take these constraints into account.

Adaptability
The topological analysis in real-time of the substation condition is one of the primary factors for the reliability of busbar differential protection. Thus in case of a power system fault, this analysis determines the section of the substation affected by the fault and to take only those sections out of service. The algorithm of topological analysis has to make it possible that the real state of the electrical supply network is known at any moment.

Integrated disturbance recorder and event recorder
The integrated functionality of disturbance and event recorder allows a quick and optimal fault evaluation for a fast power restoration.



Installations of numerical protection systems

Decentralized arrangement
In the decentralized arrangement the bay units which collect analogue and binary data are installed per bay, close to the switchgear, i.e. together with the bay control or protection equipment.

They are connected to the Central Unit by fibre-optic cables. The Central Unit manages the co-ordinated operation, computes the busbar protection algorithm and makes the trip decision in case of a busbar fault.

The Central Unit is normally built into a cubicle in a centrally located relay room.

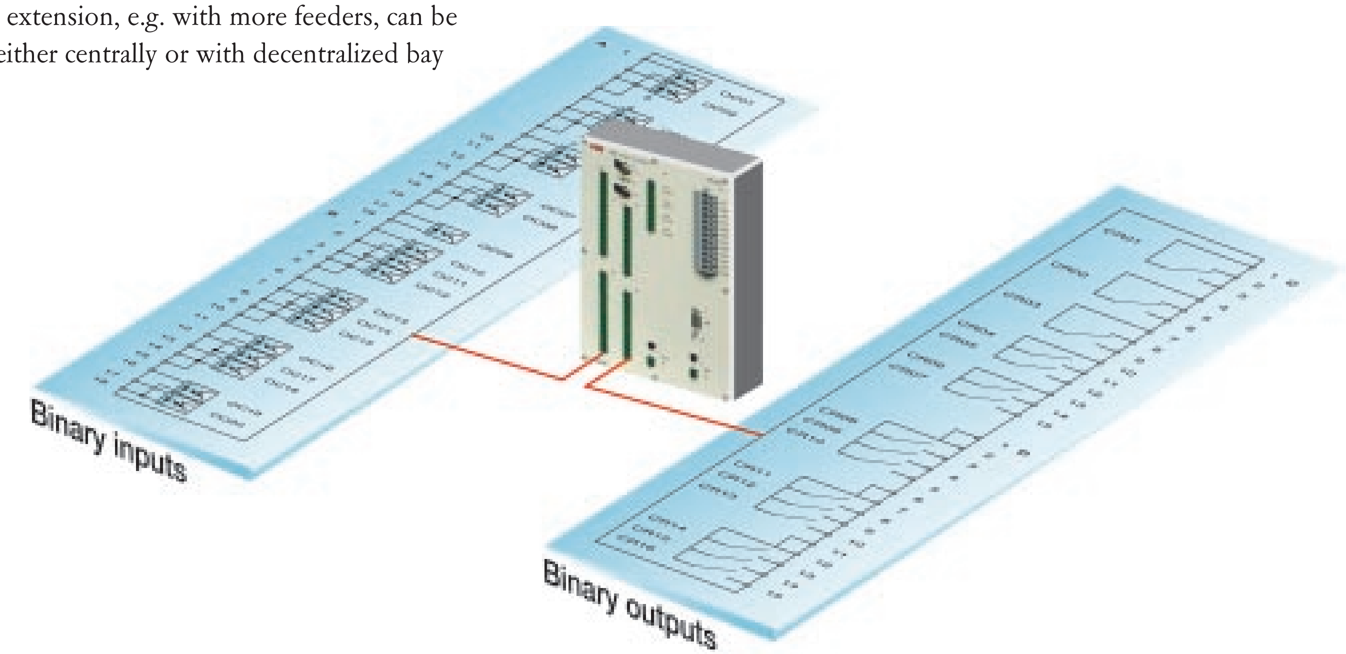
Bay-oriented protection functions are allocated to the bay unit and operate independently from the central unit.

Centralized arrangement
In the centralized arrangement the bay units are installed in 19" racks in one or more cubicles together with the central unit. This arrangement is well-suited for retrofit of conventional busbar protection schemes if the secondary cabling is in good condition. Only minor modifications have to be made in the primary process wiring.

Future extension, e.g. with more feeders, can be made either centrally or with decentralized bay units.

Different options for redundancy
In order to achieve higher availability, it is recommended to use a redundant power supply for the central unit and the bay units. This is of particular importance in case of a weak station battery. Apart from this, bay-oriented protection functions can be implemented, providing backup or redundancy, to operate independently of the central unit, even if the communication to the central unit is not functioning. The numerical protection concept allows easy adaptation to any philosophy.

Binary Inputs and Outputs
The tripping outputs are equipped with heavy-duty contacts and can be used as signalling or trip outputs without additional interposing. A software matrix assures that the binary inputs/outputs can be freely allocated according to the station requirements.



Advantages of numerical protection systems

Reduced time for installation

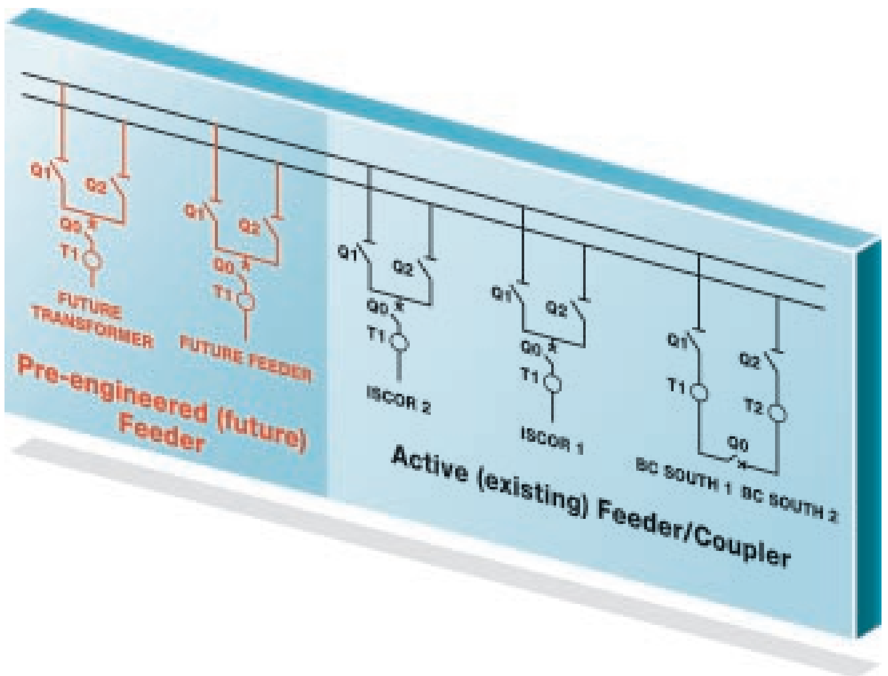
The time for installation is reduced with a decentralized arrangement. Cabling required for the current measurements, isolator replica and trip outputs is substituted by one glass fibre optic cable. For both decentralized and centralized arrangements the time required to configure the installed system is reduced by the aid of a portable PC.

Reduced installation costs

For the centralized arrangement, the installation costs are substantially reduced because of the higher functionality and reduced space requirements compared to conventional busbar protection systems. In the decentralized arrangement significant cost reduction is achieved by substituting the extensive cabling by fibre optics. The shorter wiring between the switchgear and the bay units allows to use cables with reduced wire cross section.

Easily extendible

Because of the modularity in software and hardware more advanced system functionality, i.e. breaker failure protection, disturbance recording or extensions with more feeders, can easily be implemented at a later stage.



Basic Protection Functions

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.

A busbar protection has to fulfil the following requirement to ensure a save and reliable operation:

- **Fast fault detection**
- **Fast and selective operating time irrespective of station size and configuration**
- **High dependability to avoid false tripping**
- **Minimum c.t. performance requirements**
- **High through-fault stability even when c.t.s saturate**
- **High stability in case of external faults in the vicinity of the substation**

Measurement of neutral current / neutral current detection

In networks which are grounded via an impedance or resistance, ground fault currents are limited to magnitudes close to the nominal current. Therefore, the measurement of the neutral current makes the detection of single phase to ground faults more secure. Further trip criteria can be added; e.g. Voltage Check

Breaker failure protection

Breaker failure protection limits the impact of a fault towards the whole power network. If a circuit breaker fails after a trip command. Overcurrent detectors with fast pick-up and reset time are implemented in the Bay Unit. The breaker failure protection has phase selective starting and two individual timers. The function can be triggered internally from the busbar protection algorithm or externally via the binary inputs.

Hence the topology of the substation is available in the System, a selective inter-tripping after the second-time step is carried out.

End-fault protection

The end-fault protection detects faults between a circuit breaker and the c.t.s that cannot be cleared by the busbar protection on its own. In such a case the adjacent circuit breakers of a remote station is tripped to clear the fault.

Overcurrent protection

The time-overcurrent protection function operates entirely independently of the other protection functions in each of the bay units.

Breaker pole discrepancy

The breaker pole discrepancy protection supervises the simultaneous operation of the three-phase switches. In case of a breaker malfunctioning, it will activate the breaker failure protection.

Voltage check

A voltage check function can be configured to activate a busbar trip if the voltage drops or rises below or over a predefined limit. This function is located in the bay unit and acts as additional criteria for tripping the busbar.

Overcurrent check

The overcurrent check function operates also as additional trip criteria. The trip is only released in the allocated circuit breaker, if pre-set current level is reached.

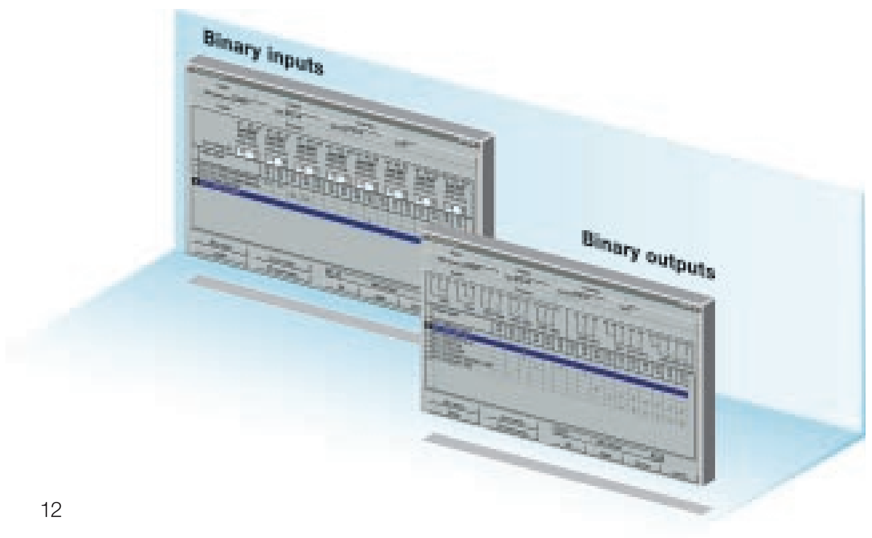
Basic Functions

Busbar replica software
The busbar replica is realized in software, which means that a change in the primary process is immediately recognized and taken into account by the measurement algorithms, thus improving the selectivity of the protection system.

Supervision of isolator positions
In view of the crucial role of the busbar image for the correct functioning of the protection algorithm, the positions of the busbar isolators are taken and supervised as double auxiliary contact indications. In case of inconsistent indications, an alarm is generated accordingly.

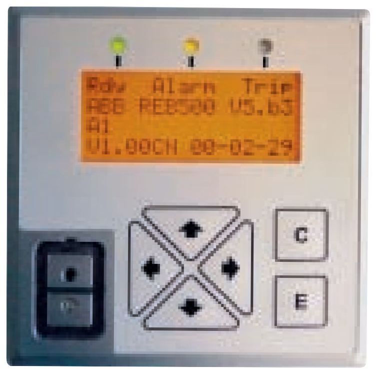
Differential current supervision
A loss of a CT core or the CT wiring causes a differential current which causes after some time delay blocking of the affected protection zone to avoid a wrong current measurement interpretation.

Selectivity
The selectivity in the busbar and breaker failure protection is maintained by the correct topology image of the substation, which is available in the protection system. It ensures that the only faulty areas will be cleared. Furthermore, a selective blocking-per-protection zone can be applied which responds to an isolator alarm or differential current alarm.



Comprehensive self-supervision
The security and availability of the protection system is significantly enhanced by the continuous self-supervision of the different system parts. An important protection principle is that any failures that could cause mal-operation are omitted. Alarms generated by the local self-supervision enable selective fault tracing.

User-friendly HMI (Human Machine Interface)
A local Human Machine Interface is integrated giving information about isolator positions, service values, alarms and trip indications.
The information is presented on an LCD in combination with LEDs. For tasks requiring a better overview and support, i.e. commissioning and parameterization, an external PC is connected. Parameters in the HMI can be set to block the smallest part of the system under different operating conditions.



SW Configuration Tool
All setting of the numerical protection can be done offline with a Windows PC. Inputs and outputs can be freely allocated on a matrix to optocoupler and command relays. CT/VT ratios and circuit breaker times can be set in the tool as well as all protection parameters.
In addition the single-line diagram and hardware information is displayed. All setting can be documented with a report.

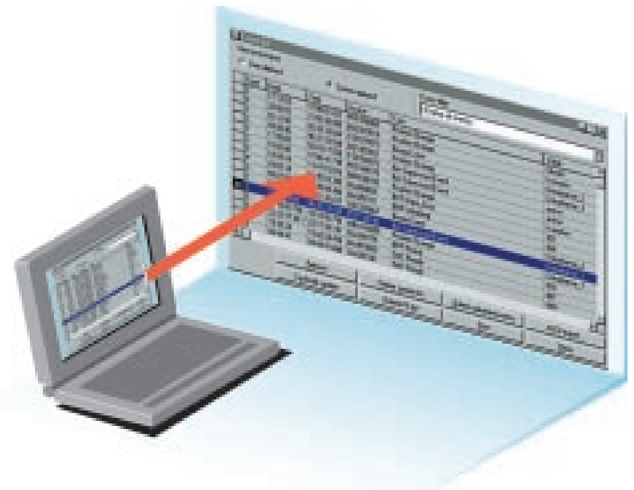
Basic Monitoring Functions

The system monitoring function provides a quick information for more effective planning and fault analysis of the power network, due to the coverage of the whole busbar with one decentralized protection system.

Event recording
The integrated event recorder allows to analyse the sequence of fault or switch actions on the busbar. This is useful for the analysis of correct system behaviour. All events are time-tagged with a resolution of 1 ms. Events should be categorized according to the following attributes:

- **System events**
- **Protection events**
- **Test events**

A storage of 100 events per bay and 1000 per central unit provides a good history for the analysis of any occurrence and is essential to find weaknesses in the system.



Time synchronization
A time synchronization is absolutely necessary for the proper fault analysis.
The time synchronization of the protection system is possible via

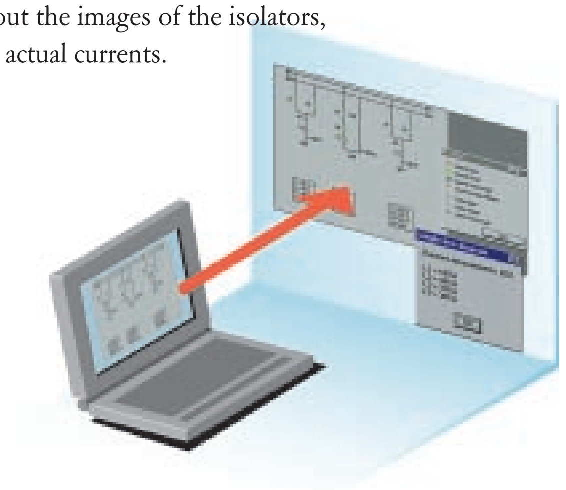
- **Radio or satellite clock**
- **Interbay bus**
- **Minute pulse (periodic pulse onto an optocoupler)**

Disturbance recording
A powerful integrated disturbance recorder is very useful for later evaluation of a disturbance.

Studies about the behaviour of system and network during a fault together with the event records are possible. This is essential to improve the power network by eliminating its weaknesses.

Disturbance recorder data inclusive voltages are acquired locally by the bay units. The maximum duration of a record with a rate of 48 samples per cycle is 10 s (corresponds to 2400 Hz at power frequency 50 Hz / 2880 Hz at power frequency 60 Hz). The recording duration can be extended to 24 s by reducing the sampling rate.
The number of records and the duration for pre- and post-faults can be easily adjusted in the HMI (Human Machine Interface). The disturbance recorder function can be triggered by an internal protection function or external by one or several binary inputs.

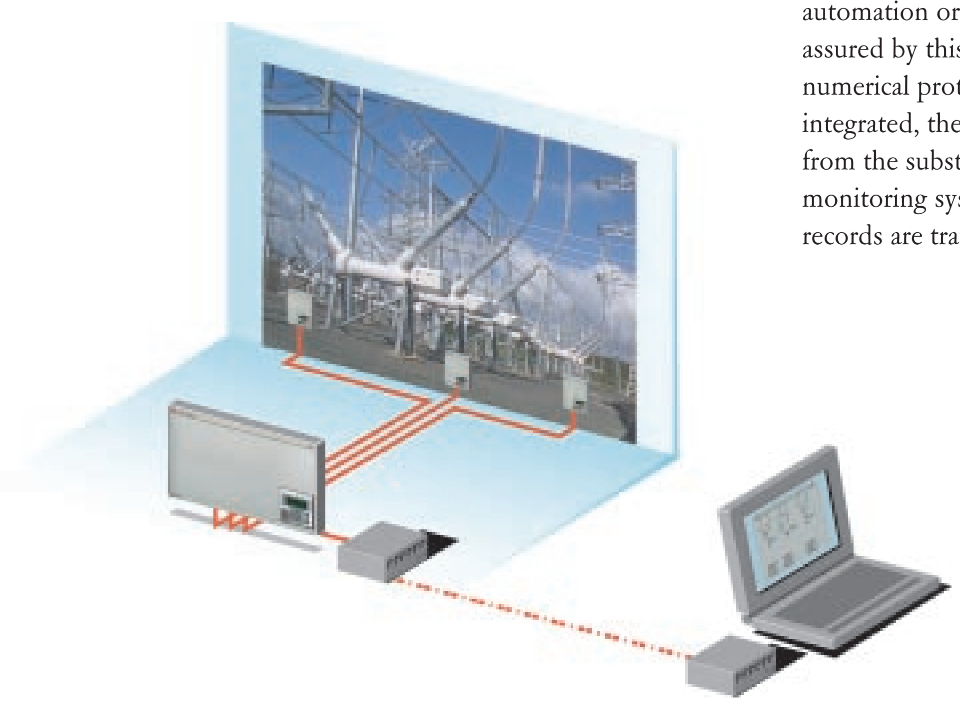
Dynamic busbar replica with display of currents and bus differential currents
The dynamic busbar replica with display of currents is part of the HMI (Human Machine Interface) which runs on an external PC and allows to monitor the current situation of the busbar even from remote. Furthermore, during commissioning and maintenance this helpful feature allows to get easy an overview about the images of the isolators, breakers and actual currents.



Test generator for commissioning
A test generator forms part of the HMI (Human Machine Interface) which runs on an external PC and is used for commissioning, service and maintenance purposes. It provides facility for simulating binary inputs and outputs and checking the response of the protection.

Basic Communication Functions

Remote access
A remote dial-up of the numerical system is fundamental as soon as the substation is in a remote place and unmanned. Using a fibre optic cable or a modem for distant places, the HMI (Human Machine Interface) can be operated the same way as it is now done locally.



Integration in substation automation or substation monitoring
The interface to a substation automation or substation monitoring system is a hardware module, which can be added to the Central Unit. The integration of a numerical protection system in existing as well as in future substation automation or substation monitoring systems is assured by this modular approach. When a numerical protection system scheme is integrated, the absolute time is taken normally from the substation automation or substation monitoring system. All event and disturbance records are transferred to these systems.

System-enhanced Functions

Additional trip criteria
Additional trip criteria / release criteria can be added via optocoupler input if special network conditions apply.

Trip command re-direction
In SF_6 gas-insulated switchgear a dangerous situation might occur with a circuit breaker due to insufficient operating pressure. The circuit breaker is then blocked and, in a case of a fault, the circuit breaker can not open. This information should be available in the protection system. As soon as a trip command is given, all allocated feeders in that protection zone receive direct intertripping and a remote trip is send to the opposite connected breaker.

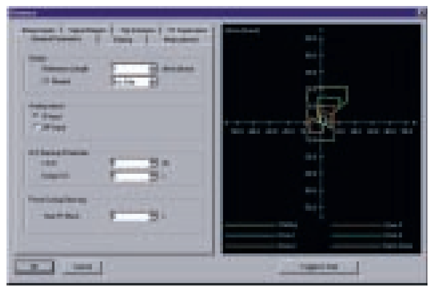
System Protection for Intelligent switchgears
The numerical protection with its functionality can also be used for intelligent current and voltage sensors used in PASS Switchgears (ABB). The process bus connections are made with fibre-optic cables.

Advanced Integrated Protection Functions / Station Protection

With the integration of further protection functions into the decentralized numerical busbar and breaker failure protection, the protection system can be updated to a station protection comprising:

Distance Protection
The integrated distance protection function can be used as main 2 or back-up for line as well as for transformer bays. It contains all the relevant additional functions which are normally required with a distance protection scheme:

- **Power swing blocking function**
- **HF schemes with the logics for transient blocking (parallel lines), echo, etc**
- **Switch-onto-fault**
- **Voltage circuit supervision**



Sensitive Ground Fault Protection
A directional ground fault function based on the measurement of neutral current and voltage is provided for the detection of high-resistance ground faults in solidly or low-resistance grounded systems. The scheme operates either in a permissive or blocking mode and can be used in conjunction with an inverse time ground fault overcurrent function.

Autoreclosure Function
The reclosure function permits up to four three-phase autoreclosure cycles, each with an independently adjustable dead time for fast and slow autoreclosure. The first cycle can be single or three phase.

Synchrocheck Function
The synchrocheck function determines the difference between the amplitudes, phase angles and frequencies of two voltage vectors. The synchrocheck function contains also the dead line check, the dead bus check and the dead line/bus mode of operation.

Definite Time Over-/Undervoltage Function
The voltage function can be set to operate on overvoltage or undervoltage with a definite time delay. Single- or three-phase measurements can be performed.

Definite Time Overcurrent Function
The current function can be set to operate on overcurrent or undercurrent with a definite time delay. Either single- or three-phase measurements can be performed.

Inverse Definite Minimum Time Overcurrent Function
Four different characteristics according to British Standard 142 designated normal inverse, very inverse, extremely inverse and long time inverse but with an extended setting range are provided. The function can be configured for single-phase measurement or a combined three-phase measurement with detection of the highest phase current.

Inverse Definite Minimum Time Ground Overcurrent Function
The inverse definite minimum time ground overcurrent function monitors the neutral current of the system which is either measured via a neutral current input transformer or derived internally from the three-phase currents. Four different characteristics according to British Standard 142 designated normal inverse, very inverse, extremely inverse and long time inverse but with an extended setting range are provided.

Three-phase Current Plausibility
The current plausibility function facilitates the detection of system asymmetries, e.g. in the secondary circuits of c.t.s.

Three-phase Voltage Plausibility
The voltage plausibility function facilitates the detection of system asymmetries, e.g. in the secondary circuits of v.t.s.

Directional Definite Time Overcurrent Function
Directional overcurrent function for detecting phase faults on ring lines or as backup protection for a distance protection scheme. Comprises a directionally sensitive three-phase phase fault protection with voltage memory feature for close faults.

Directional Inverse Time Overcurrent Function
As for Directional Definite Time Overcurrent Function but with operating characteristics according to British Standard 142: normal inverse, very inverse and long time earth fault, extremely inverse.

Binary Logic and Flip-flop Functions
Logical combination of binary input signals or of output signals from protection functions. Can be used as AND or OR gate with 4 I/Ps, R/S flip-flop with 2 I/Ps for setting and 2 I/Ps for resetting.

Delay Function
General purpose timer with separately adjustable pick-up and drop-off delays. Can also be used to integrate pulsating binary signals.

Description REB500

The REB 500 is a fully numerical distributed busbar protection and breaker failure protection with extended functionality and monitoring capability. The system performs acquisition and preprocessing of data at the bay level before the trip decision at station level is made.
Independent functions per feeder can be added at any time. This makes REB 500 suitable for all kind and sizes of substations.
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.

Important features are

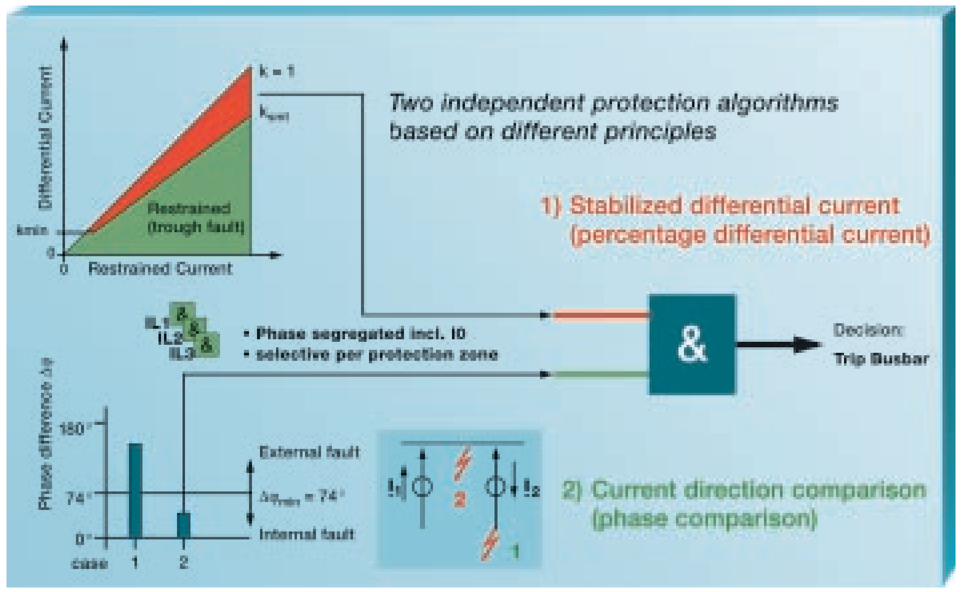
- **Multiple measurement criteria to achieve maximum security.**
- **Continuous self-supervision enhances reliability and availability.**
- **Modular design reduces spares stocking levels.**
- **Functionality is mainly defined by software.**

The algorithm is based on established measurement principles:

- **Current differential with stabilizing factor**
- **Current directional comparison**

The measurement is carried out individually for each phase and protection zone. The algorithm is preprocessed in the bay unit by applying Fourier analysis to the phasor value of the fundamental frequency component. The results of all the feeders are transmitted to the central unit, which evaluates them in either a tripping or restraining sense. A stability during CT saturation is secured.

The busbar replica software ensures that no CT circuits have to be switched externally. The two independent algorithms and busbar replica software allow to avoid the check zone criteria which might cause an unwanted trip blocking under certain circumstances.



Key features
Busbars are the nodes in transmission and distribution systems that control the supply of power to wide areas. They are therefore crucial for the availability of supply. A busbar protection scheme monitors and can trip many feeders and must therefore be especially reliable and stable, and must yet follow the changing configuration of the primary switchgear. Through-fault stability is the most important requirement for busbar protection. In the REB 500, stability has been raised to a high level by merging the advantages of microprocessors and the absolute immunity of optical fibre communication to electrical interference.

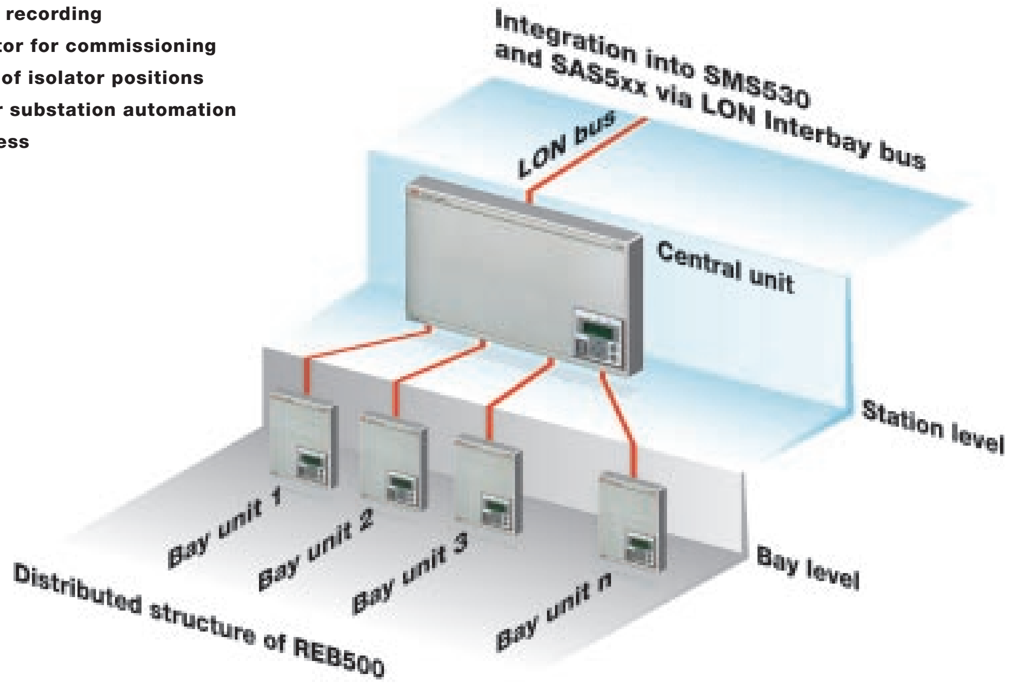
Basic Functions

- **Busbar protection**
- **Breaker failure protection**
- **Overcurrent protection**
- **End-fault protection**
- **Measurement of neutral current**
- **Event recording**
- **Disturbance recording**
- **Test generator for commissioning**
- **Supervision of isolator positions**
- **Interface for substation automation**
- **Remote access**

Application
The busbar protection is designed for high-speed selective protection of single, double, triple and quadruple busbar configurations, including a transfer bus and 1½ breaker systems in 50 and 60 Hz medium voltage (MV), high voltage (HV) and extra high voltage (EHV) substations.

The power system may be ungrounded, grounded or resistance-grounded.
The scheme has a maximum capacity of four busbars and a transfer bus divided into 8 sections with a total of 32 busbar zones and 59 feeders.

REB 500 is suitable for installation in new substations or for upgrading existing ones.



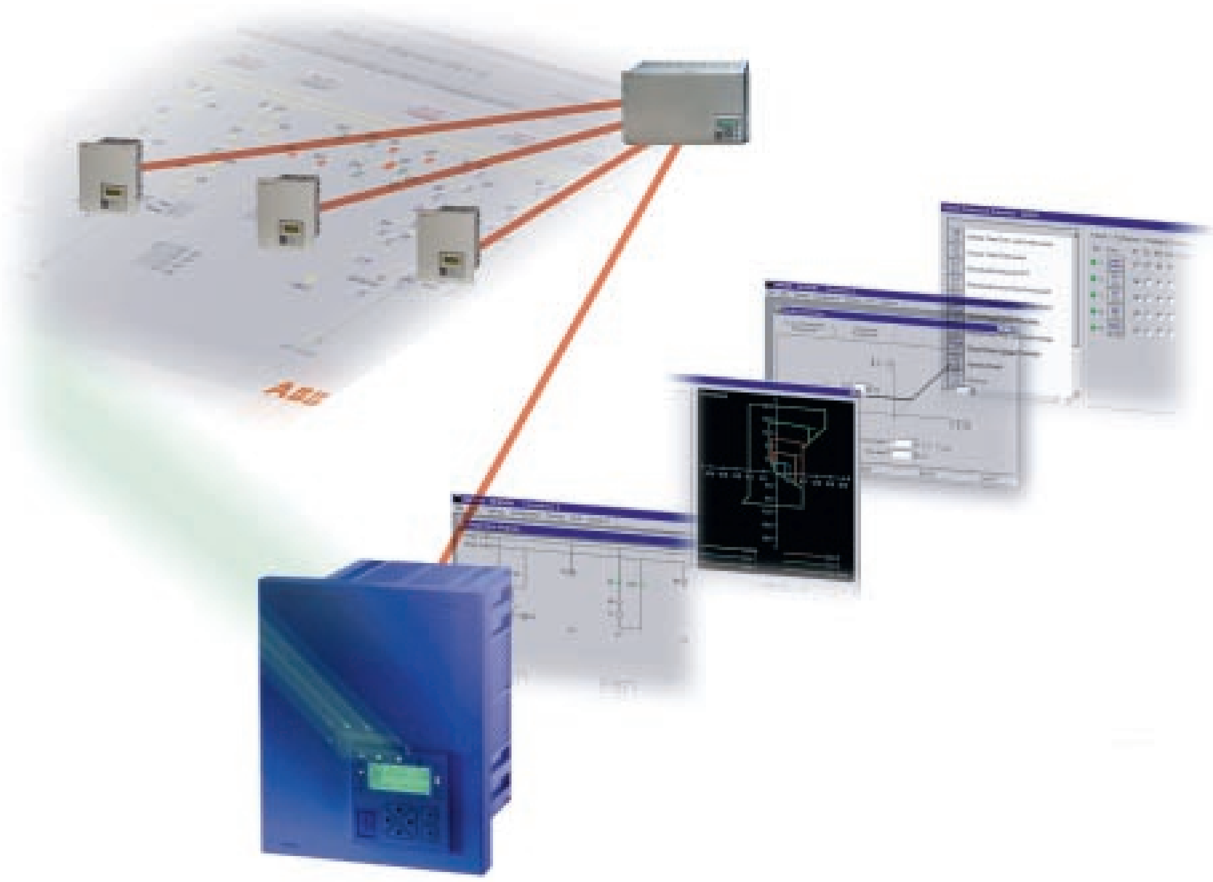
Description REB500sys

A combined protection system for complete station protection
The **REB500sys** opens a new chapter in the history of protection technology. For the first time, busbar and breaker failure protection is combined with line protection. ABB has brought together the functionality of the worldwide successful protection devices REB500 and REL316*4 and raised them to a higher level with the REB500sys. The protection concept is simpler and at the same time provides an increase in security. **One** system provides comprehensive protection of busbars, switchgear and lines.

The new station protection REB500sys contains the well-proven ABB software algorithms that have already been successfully used worldwide for many years. REB500sys integrates the well-known functions of the busbar and breaker failure protection REB500 as well as existing line protection functions from REL316*4.

REB500sys application
Depending on the voltage level and protection philosophy, the following two protection concepts are frequently encountered. The new concept has been created to cover both of these situations for single and double busbars. The power system may be solidly grounded or low-resistance-grounded.

Main 1 and main 2 protection devices per feeder and an (optional) busbar protection
The new REB500sys 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 costs over the complete life cycle are reduced.



One main protection device and a back-up protection per feeder, no busbar protection

For this situation in the future, REB500sys 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 commercial reasons.

Key features

Improved availability of your energy supply

- The event and fault recording covering the complete substation supports a quick analysis of fault situations.
- All measurements such as current, voltage, busbar zone differential currents, etc. are displayed centrally for status monitoring.
- The monitoring of breaker and isolator positions, transducers and of the REB500sys itself permits a reduction in periodic maintenance work, but nevertheless provides an immediate recognition of failures.

Reduction of the total project costs and project execution time

- ABB supplies predefined, type-tested standard configurations.
- The installation is simplified and is more economic thanks to reduced hardware, cabling and space requirements.
- All applications are covered by a common PC-based configuration and setting program.
- The system is more uniform due to the reduction in the number and type of devices.

REB500sys Basic Functions

- Contains all REB500 Basic Functions plus
- Distance Protection
- Sensitive Ground Fault Protection
- Autoreclosure Function
- Synchrocheck Function
- Definite Time Over-/Undervoltage Function
- Definite Time Overcurrent Function
- Inverse Definite Minimum Time Ground Overcurrent Function
- Inverse Definite Minimum Time Overcurrent Function
- Three-phase Current Plausibility
- Three-phase Voltage Plausibility
- Directional Definite Time Overcurrent Function
- Directional Inverse Time Overcurrent Function
- Binary Logic and Flip-flop Functions
- Delay Function

Description RED521

The numerical centralized differential protection terminal RED 521 is designed for the selective, reliable and fast protection of busbars. Future switchgear extensions can be either pre-engineered in the original scheme design or the auxiliary equipment can be easily added at a later stage. If the overall required number of CT inputs are included in RED 521 hardware at the ordering stage, no software changes are required within the RED 521 terminals to facilitate these extensions.

Important features are

- Phase-segregated measurement
- Continuous self-monitoring and -diagnostics
- No interposing current transformers
- Fixed, factory pre-configured input/output configuration

Application

The busbar protection is designed for high-speed selective protection of single, double and $1^1/_2$ breaker systems in 50 and 60 Hz medium voltage (MV), high voltage (HV) and extra high voltage (EHV) substations.

The scheme has a maximum capacity of

- Single busbar up to 6 feeder with RED521 three-phase version (REB551 if breaker failure protection is required)
- Single busbar up to 18 feeder with RED521 one-phase version
- Double busbar up to 6 feeder with RED521 three-phase version
- $1^1/_2$ breaker system up to 3 diameter with RED521 three-phase version (REB551 if breaker failure protection is required)

RED521 is suitable for installation in new substations or for upgrading existing ones.

Key features

The terminal can detect all types of internal phase-to-phase and phase-to-ground faults in solidly grounded or low-impedance grounded power systems, as well as all internal phase-to-phase faults in isolated or high-impedance grounded power systems. Stability is ensured for through faults also at heavy CT saturation. No separate check zone or extra measuring criteria are necessary due to an operating algorithm providing stability for open CT circuits.

RED 521 has low requirements on the main current transformers and no interposing current transformers are necessary. For all applications, it is possible to include and mix main CTs with 1A and 5A rated secondary current within the same protection zone. Typically, CTs with up to 10:1 ratio difference can be used within the same differential protection zone. Compensation of different main CT ratios is achieved numerically by a parameter setting.

RED521 Basic Functions

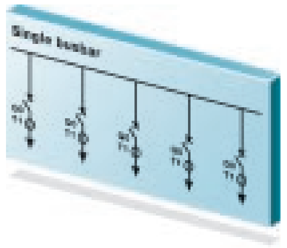
- Busbar protection
- Event list with the last 16 events
- LON bus interface for substation automation

Selection Guide

Examples for selecting a busbar protection type:

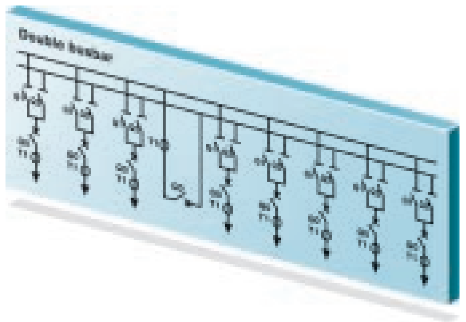
- **5 Feeder single busbar; central arrangement, busbar protection, time synchronization**

  ‣ Result: RED521 3-phase



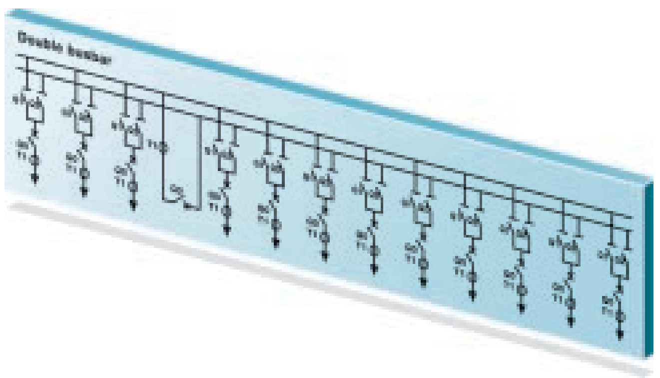
- **8 Feeder and 1 bus coupler, double busbar; decentral or central arrangement, busbar protection, breaker failure protection, busbar replica software, isolator supervision, event recorder with 1000 events, disturbance recorder, time synchronization, IEC 870-5-103 communication**

  ‣ Result: REB500



- **12 Feeder and 1 bus coupler, double busbar; decentral or central arrangement, busbar protection, breaker failure protection, busbar replica software, isolator supervision, event recorder with 1000 events, disturbance recorder, time synchronization, line protection main 2, synchrocheck and autroreclosure**

  ‣ Result: REB500sys Package 4



Busbar Configuration	1BB				2BB				3BB		4BB		1½BB		
Bays/Diameter	2–6 Bays	6–18 Bays	>18 Bays	Transfer Bus	2–6 Bays	6–18 Bays	>18 Bays	Transfer Bus	2–59 Bays	Transfer Bus	2–59 Bays	Transfer Bus	1–3 Diameter	3–15 Diameter	Solution
Installations of numerical protection systems															
Decentral arrangement	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Central arrangement			x	x		x	x	x	x	x	x	x		x	REB500
	x*)				x*)								x*)		RED521 3Phase
		x*)													RED521 1Phase
Redundant Power Supply	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Software Matrix for Inputs/Outputs	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Basic Protection Functions															
Busbar Protection			x	x		x	x	x	x	x	x	x		x	REB500
	x*)				x*)								x*)		RED521 3Phase
		x*)													RED521 1Phase
One measurement Criterion	x	x			x								x		RED521
Two independent measurement Criteria	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Breaker Failure Protection	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
	x*)												x*)		RED521 3Phase & REB551
Measurement of neutral current/neutral current detection	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
End-fault protection	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Overcurrent protection (definite time)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Breaker pole discrepancy	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Low-voltage check feature	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Overcurrent check feature	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Basic Functions															
Busbar replica software	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Isolator supervision	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Differential Current supervision	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
	x	x			x								x		RED521
Selectivity	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
	x*)	x*)			x*)								x*)		RED521
Comprehensive self-supervision	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
	x	x			x								x		RED521
SW-Setting via Personal Computer	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Basic Monitoring Functions															
Event Recording up to 1000 Events	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Event Recording up to 16 fix Events	x	x			x								x		RED521
Time synchronization	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
	x	x			x								x		RED521
Disturbance recording	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Dynamic Busbar replica with display of currents	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Testgenerator	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Basic Communication Functions															
Remote Access	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Communication LON	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
	x	x			x								x		RED521
Communication IEC 870-5-103	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Advanced Integrated Protection Functions															
Additional trip criteria	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Trip command redirection	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
System Protection for Intelligent switchgears	x	x	x	x	x	x	x	x	x	x	x	x	x	x	REB500
Advanced Integrated Protection Functions / Station Protection															
Distance Protection	x	x	x		x	x	x								REB500sys (V2,3,4)
Sensitive Ground Fault Protection	x	x	x		x	x	x								REB500sys (V2,3,4)
Autoreclosure Function	x	x	x		x	x	x								REB500sys (V3,4,5)
Synchrocheck Function	x	x	x		x	x	x								REB500sys (V4,5)
Definite Time Over-/Undervoltage Function	x	x	x		x	x	x								REB500sys (base)
Definite Time Overcurrent Function	x	x	x		x	x	x								REB500sys (base)
Inverse Definite Minimum Time Ground Overcurrent Function	x	x	x		x	x	x								REB500sys (base)
Inverse Definite Minimum Time Overcurrent Function	x	x	x		x	x	x								REB500sys (base)
Three-phase Current Plausibility	x	x	x		x	x	x								REB500sys (base)
Three-phase Voltage Plausibility	x	x	x		x	x	x								REB500sys (base)
Directional Definite Time Overcurrent Function	x	x	x		x	x	x								REB500sys (base)
Directional Inverse Time Overcurrent Function	x	x	x		x	x	x								REB500sys (base)
Binary Logic and Flip-flop Functions	x	x	x		x	x	x								REB500sys (base)
Delay Function	x	x	x		x	x	x								REB500sys (base)

x*) Auxiliary relays required

ABB Switzerland Ltd
Utility Automation
Brown Boveri Strasse 6
CH-5400 Baden/Switzerland
Phone +41-58-585 77 44
Fax +41-58-585 55 77
e.Mail substation.automation@ch.abb.com

www.abb.com/substationautomation

1KHA - 000 739 - SEN
2000 - 12.01 - Printed in Switzerland