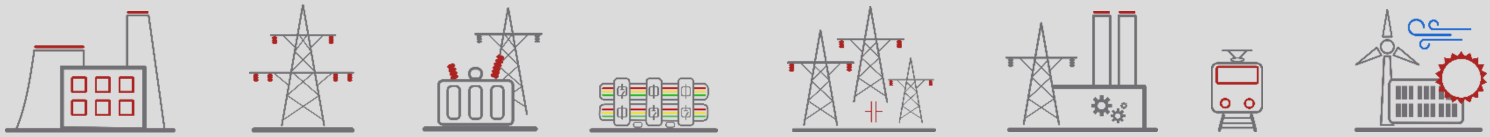
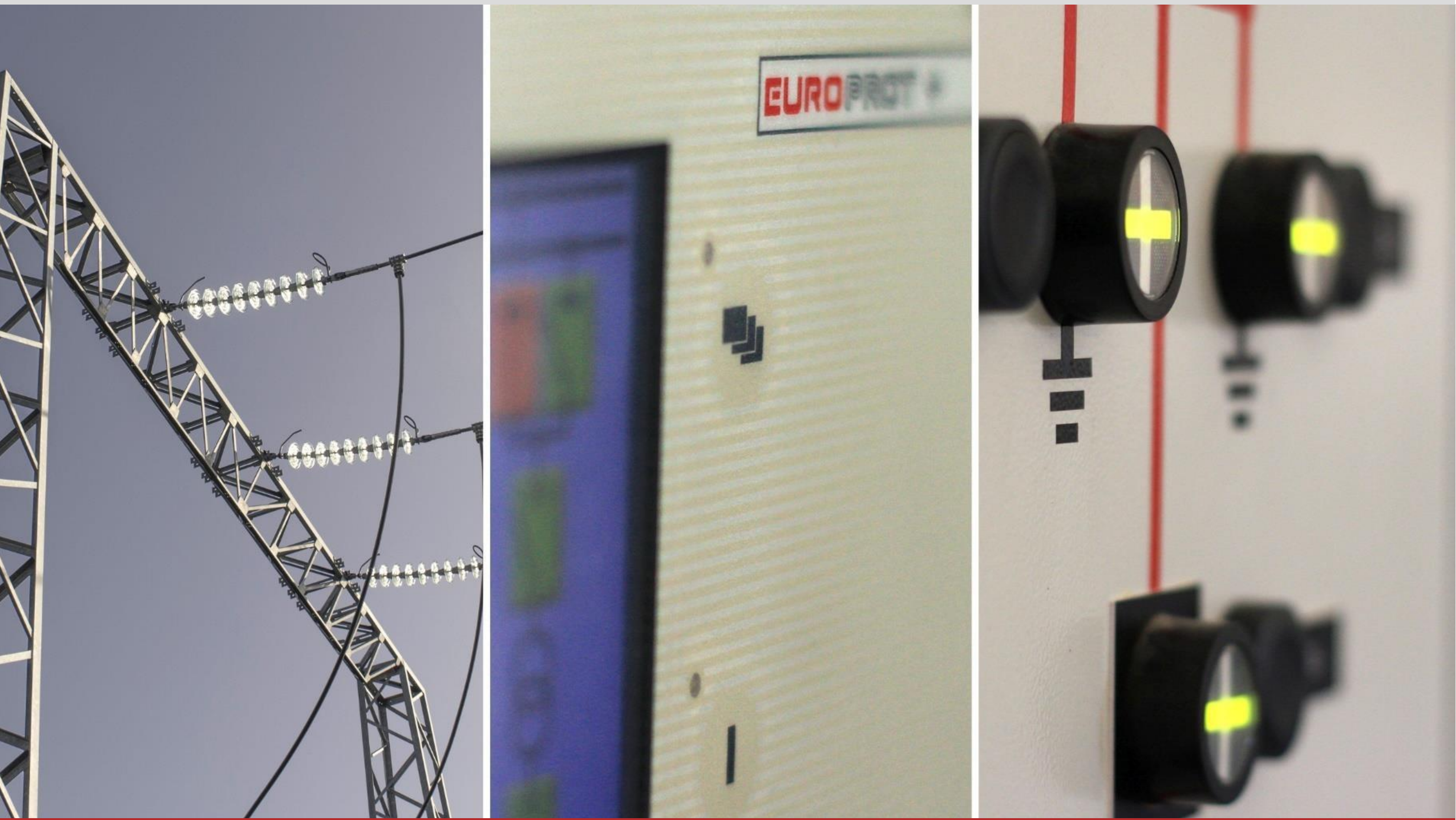




TYPE DESCRIPTION

EuroProt+ Smart Line S24

IED-EP+S/S24

FEEDER MANAGEMENT RELAY

PROTECTA HUNGARY

EUROPROT+ SMART LINE S24 SERIES
FEEDER MANAGEMENT RELAY

OVERVIEW

The **IED EP+ S24** Series is member of the **EuroProt+** numerical protection relay, made by Protecta Co. Ltd. The **EuroProt+** type complex protection in respect of hardware and software is a modular device. The modules are assembled and configured according to the requirements, and then the software determines the functions. The **IED EP+ S24** Series is contained a special selection of the EuroProt+ modules, bearing in mind the cost effective realization. The **IED EP+ S24** Series is divided into several different variants corresponding to the scope of application.

The **IED EP+ S24** Series can be used as the main or backup protection of overhead lines and cable networks.

GENERAL FEATURES

- Native IEC 61850 IED with Edition 1 & 2 compatibility
- Module layouts with options
- 24 HP wide rack size (height: 3U)
- The pre-defined factory configuration can be customized to the user's specification with the powerful EuroCAP tool
- Flexible protection and control functionality to meet special customer requirements
- Different HMI Types: advanced HMI with color touchscreen and black-and-white display with 4 tactile push buttons. An embedded web server and extended measuring, control and monitoring functions are also available for both types
- User configurable LCD user screens, which can display SLDs (Single Line Diagrams) with switchgear position indication and control as well as measuring values and several types of controllable objects
- 8 setting groups available
- Enhanced breaker monitoring and control
- High capacity disturbance recorder (DRE) and event logging:
  - DRE for up to 32 analogue and 64 digital signal channels with duration up to 10s and sampling rate up to 2kHz.
  - Event recorder can store more than 10,000 events.
- Several mounting methods: Rack; Flush mounting; Semi-flush mounting; Wall mounting; Wall-mounting with terminals; Flush mounting with IP54 rated cover.
- Wide range of communication protocols:
  - Ethernet-based communication protocol: IEC61850, DNP3.0 TCP, IEC60870-5-104, Modbus TCP
  - Serial communication protocol: DNP3.0, IEC60870-5-101, IEC60870-5-103, MODBUS, SPA
- Legacy network based protocols via 100Base-FX and 10/100Base-TX (RJ45)

- Optional communication ports: Fiber optical Ethernet (MM/ST, SM/FC), RJ45, Serial POF, Serial glass fiber, RS-485/422
- Handling of several communication protocols simultaneously
- Built-in self-monitoring to detect internal hardware or software errors
- Time synchronization protocol: NTP/SNTP, Minute pulse, Legacy protocol, IRIG-B

APPLICATION

The **IED-EP+ S24** protection device is a member of the EuroProt+ product line, made by Protecta Co. Ltd. The EuroProt+ type complex protection in respect of hardware and software is a several variant device. The modules are assembled and configured according to the requirements, and then the software determines the functions.

The **IED-EP+ S24** Series is available in four predefined standard configurations to suit the most common feeder management application.

- **Variant 0** serves as a simple bay control unit.
- **Variant 1** is configed for non-directional overcurrent protection relay.
- **Variant 2** is configed for directional overcurrent protection relay.
- **Variant 6** is dedicated for those application where is only voltage and frequency based protection functions are required.

Available detailed protection function for each variant can be found in selection guide.

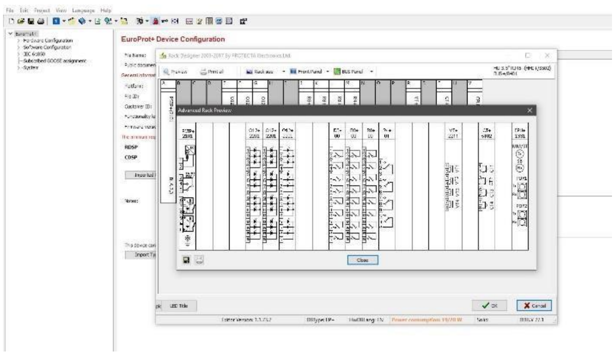
SCOPE OF APPLICATION

- Three-phase and residual overcurrent and directional overcurrent, thermal overload protection functions for overhead lines and cable networks
- Over- and undervoltage protection functions
- The implemented protection functions provide back-up protection for downstream equipment (e.g. feeders, cables etc.)
- Optional restricted earth fault protection function for the simple protection of small transformers
- Automatic reclosing function
- Synchro check function
- Breaker failure protection function
- Definite time overvoltage protection
- Definite time overvoltage protection
- Residual overvoltage protection
- Overfrequency protection
- Underfrequency protection
- Rate of change of frequency protection
- Synchro check
- Fuse failure supervision function
- Current unbalance detection of CT's
- VT supervision function
- Programmable interlocking schemes

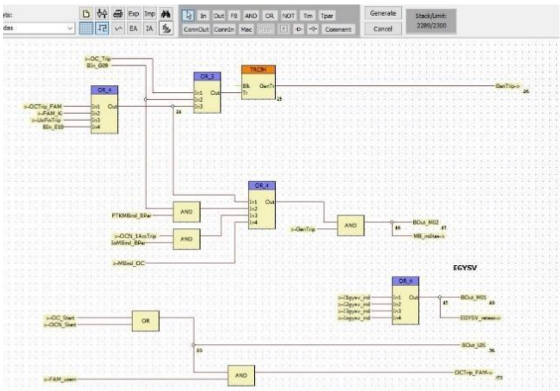
EUROCAP CONFIGURATION TOOL

The EuroCAP configuration tool, which is available free of charge, offers a user-friendly and flexible application for protection, control and measurement functions to ensure that the IED-EP+ devices are fully customisable.

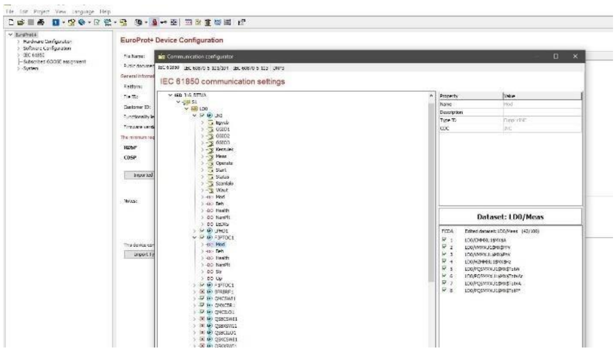
- **HW configuration**
  - View the exciting hardware configuration of the IED including card information and slot position
  - Modify (add or change) certain HW modules
  - Digital and analogue I/O signal definition



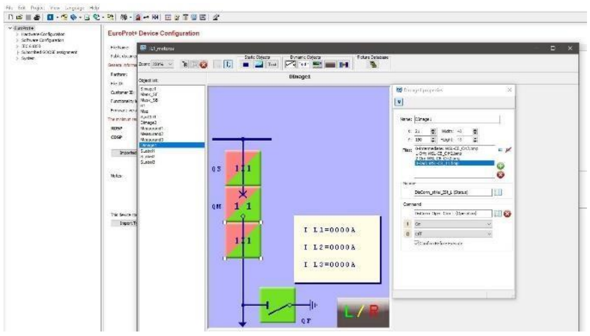
- **Logic editor**
  - Create/manage logical sheets
  - Factory pre-configured logical schemes to speed up the commissioning process



- **Communication configurator**
  - Set up IEC 61850, 101-104, 103, DNP3 communication protocols
  - Configure dataset, report and goose control block properties for IEC 61850 horizontal and vertical communication
  - GOOSE configuration between IEDs



- **LCD configurator (available with color TFT displays)**
  - Create/modify user screens with Single Line Diagrams, measuring or status values
  - Icon library for effective configuration Own, user-defined symbols can be created as well



- **Feedback documentation**

Automatic documentation of the configured IED, which can contain the actual connection assignment, on-line measurements, all recorded event channels, all recorded disturbance channels, LED assignment, Logical sheets and the relevant communication settings and collect the protection, control and monitoring parameters.

- **Offline Parameter Set Editor**
  - View, set, compare and save the setting of the IED parameters
  - Import existing parameter settings into the Offline parameter set editor from the IED
  - Import/Export parameters in xlsx format
  - Generate and save parameters in RIO/XRIO format for relay tester

PROTECTION & CONTROL FUNCTION

The **IED EP+ S24** Series configuration measures three phase currents, the residual current component and additionally three phase voltages and the busbar voltage. These measurements allow, in addition to the current- or voltage-based functions, directionality extension of the configured phase and residual overcurrent functions. It is intended to protect overhead line or cable networks. The choice of the functions is extended with the automatic reclosing function and synchrocheck. The configuration is designed to meet the requirements of a medium voltage field unit. Based on the voltage measurement also the frequency is evaluated to realize frequency-based protection functions. The configured protection functions are listed in the table below.

THE IMPLEMENTED PROTECTION & CONTROL FUNCTIONS	IEC	ANSI	*Inst.	Var. 0	Var. 1	Var. 2	Var. 6
Three-phase instantaneous overcurrent protection	I >>>	50	1		✓	✓	
Three-phase time overcurrent protection	I >, I >>	51	3		✓	✓	
Three-phase directional overcurrent protection	I Dir > >, I Dir >>	67	4			✓	
Residual instantaneous overcurrent protection	Io >>>	50N	1		✓	✓	
Residual time overcurrent protection	Io >, Io >>	51N	3		✓	✓	
Residual directional overcurrent protection	Io Dir > >, Io Dir >>	67N	4			✓	
Voltage dependent overcurrent protection	I> U<	51V	1		✓	✓	
Negative sequence overcurrent protection	I2 >	46	1		✓	✓	
Inrush detection	I2h >	68	1		✓	✓	
Thermal protection	T >	49	1		✓	✓	
Definite time overvoltage protection	U >, U >>	59	4			✓	✓
Definite time undervoltage protection	U <, U <<	27	4			✓	✓
Residual overvoltage protection	Uo >, Uo >>	59N	4			✓	✓
Negative sequence overvoltage protection	U2 >	47	1			✓	✓
Overfrequency protection	f >, f >>	81O	4			✓	✓
Underfrequency protection	f <, f <<	81U	4			✓	✓
Rate of change of frequency protection	df/dt	81R	2			✓	✓
Vector jump protection		78	1			✓	
Auto-reclose	0 - > 1	79	1		✓	✓	
Breaker failure protection	CBFP	50BF	1		✓	✓	
Current unbalance protection		60	1		✓	✓	
Sync check		25	1		✓	✓	✓
Switch on to fault		SOTF	1		✓	✓	
Broken conductor protection		46BC			✓	✓	
Voltage transformer supervision function		60					✓

**The Inst. column contains the numbers of the pre-configured function blocks in the factory configuration. These numbers may be different in order to meet the user's requirements.*

- **Three-phase instantaneous overcurrent protection (50)**

The three-phase instantaneous overcurrent protection function (50) operates immediately if the phase currents are higher than the setting value. The setting value is a parameter, and it can be doubled by graphic programming of the dedicated input binary signal defined by the user. The function is based on peak value selection or on the RMS values of the Fourier basic harmonic calculation, according to the parameter setting. The fundamental Fourier components are results of an external function block.

Parameter for type selection has selection range of Off, Peak value and Fundamental value. When Fourier calculation is selected then the accuracy of the operation is high, the operation time however is above one period of the network frequency. If the operation is based on peak values then fast sub-cycle operation can be expected, but the transient overreach can be high.

The function generates trip commands without additional time delay if the detected values are above the current setting value. The function generates trip commands for the three phases individually and a general trip command as well.

The instantaneous overcurrent protection function has a binary input signal, which serves the purpose of disabling the function. The conditions of disabling are defined by the user, applying the graphic equation editor.

- **Three-phase time overcurrent protection (51)**

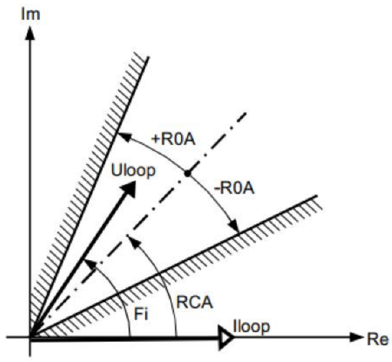
The overcurrent protection function realizes definite time or inverse time characteristics according to IEC or IEEE standards, based on three phase currents. The characteristics are harmonized with IEC 60255-151, Edition 1.0, 2009-08. This function can be applied as main protection for medium-voltage applications or backup or overload protection for high-voltage network elements. The definite (independent) time characteristic has a fixed time delay when the current is above the starting current Is previously set as a parameter.

The binary output status signals of the three-phase overcurrent protection function are starting signals of the three phases individually, a general starting signal and a general trip command.

The overcurrent protection function has a binary input signal, which serves the purpose of disabling the function. The conditions of disabling are defined by the user, applying the graphic equation editor.

- **Three-phase directional overcurrent protection (67)**

The directional three-phase delayed overcurrent protection function can be applied when the overcurrent protection must be supplemented with a directional decision. The inputs of the function are the Fourier basic harmonic components of the three phase currents and those of the three phase voltages and the three line-to-line voltages. Based on the measured voltages and currents from among the six loops (L1L2, L2L3, L3L1, L1N, L2N, L3N), the function selects the one with the smallest calculated loop impedance. Based on the loop voltage and loop current of the selected loop, the directional decision generates a signal of TRUE value if the voltage and the current is sufficient for directional decision, and the angle difference between the vectors is within the setting range. This decision enables the output start and trip signal of a non-directional three-phase overcurrent protection function block, based on the selected current.



The function can be enabled or disabled by a parameter. The status signal of the VTS (voltage transformer supervision) function can also disable the directional operation.

The voltage must be above 5% of the rated voltage and the current must also be measurable. If the voltages are below 5% of the rated voltage then the algorithm substitutes the small values with the voltages stored in the memory. The directional decision module calculates the phase angle between the selected loop voltage and the loop current. The reference signal is the current according to Figure.

The additional input binary signal enables the operation of the OC function if the directional decision module generates a logic TRUE value, indicating that the phase angle is in the range defined by the preset parameters or that non-directional operation is set by a parameter

- **Residual instantaneous overcurrent protection (50N)**

The residual instantaneous overcurrent protection function (50N) block operates immediately if the residual current (3Io) is above the setting value. The setting value is a parameter, and it can be doubled by a dedicated binary input signal defined by the user applying the graphic programming. The function is based on peak value selection or on the RMS values of the Fourier basic harmonic component of the residual current, according to the parameter setting. The fundamental Fourier component calculation is not part of the 50N function. Parameter for type selection has selection range of Off, Peak value and Fundamental value.

The function generates a trip commands without additional time delay if the detected values are above the current setting value.

The residual instantaneous overcurrent protection function has a binary input signal, which serves the purpose of disabling the function. The conditions of disabling are defined by the user, applying the graphic equation editor

- **Residual overcurrent protection (51N)**

The residual delayed overcurrent protection function can realize definite time or inverse time characteristics according to IEC or IEEE standards, based on the RMS value of the fundamental Fourier component of a single measured current, which can be the measured residual current at the neutral point (3Io) or the calculated zero sequence current component. The characteristics are harmonized with IEC 60255-151, Edition 1.0, 2009-08. The definite (independent) time characteristic has a fixed time delay when the current is above the starting current Is previously set as a parameter.

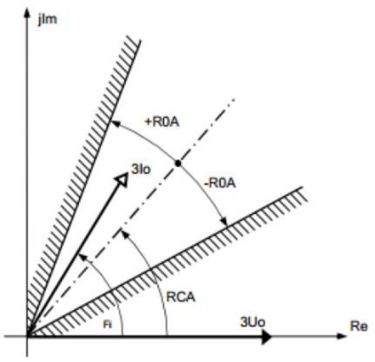
The binary output status signals of the residual overcurrent protection function are the general starting signal and the general trip command if the time delay determined by the characteristics expired.

The residual overcurrent protection function has a binary input signal, which serves the purpose of disabling the function. The conditions of disabling are defined by the user, applying the graphic equation editor

- **Residual directional overcurrent protection (67N)**

The main application area of the directional residual delayed overcurrent protection function is an earth-fault protection.

The inputs of the function are the RMS value of the Fourier basic harmonic components of the zero sequence current (IN=3Io) and those of the zero sequence voltage (UN=3Uo).



The block of the directional decision generates a signal of TRUE value if the $U_N=3U_o$ zero sequence voltage and the $I_N=3I_o$ zero sequence current are above the limits needed for correct directional decision, and the angle difference between the vectors is within the preset range. The decision enables the output start and trip signal of an overcurrent protection function block (51N). This non- directional residual overcurrent protection function block is described in a separate document. The directional decision module calculates the phase angle between the residual voltage and the residual current. The reference signal is the residual voltage according to the Figure.

The output of the directional decision module is OK, namely it is TRUE if the phase angle between the residual voltage and the residual current is within the limit range defined by the preset parameter OR if non-directional operation is selected by the preset parameter (Direction=NonDir).

- **Voltage dependent overcurrent protection (51V)**

When overcurrent protection function is applied and the current in normal operation can be high, related to the lowest fault current then the correct setting is not possible based on current values only. In this case however, if the voltage during fault is considerably below the lowest voltage during operation then the voltage can be applied to distinguish between faulty state and normal operating state. This is the application area of the voltage dependent overcurrent protection function.

The function has two modes of operation, depending on the parameter setting:

- Voltage restrained
- Voltage controlled.

The overcurrent protection function realizes definite time characteristic based on three phase currents. The operation is restrained or controlled by three phase voltages. The function operates in three phases individually, but the generated general start signal and the general trip command is the OR relationship of the three decisions.

The function can be blocked by a user-defined signal or by the voltage transformer supervision function block, if the measured voltage is not available.

- **Negative sequence overcurrent protection (46)**

The negative sequence overcurrent protection function (46) block operates if the negative sequence current is higher than the preset starting value. In the negative sequence overcurrent protection function, definite-time or inverse-time characteristics are implemented, according to IEC or IEEE standards. The function evaluates a single measured current, which is the RMS value of the fundamental Fourier component of the negative sequence current. The characteristics are harmonized with IEC 60255-151, Edition 1.0, 2009-08. The definite (independent) time characteristic has a fixed delaying time when the current is above the starting current Gs previously set as a parameter. The negative phase sequence components calculation is based on the Fourier components of the phase currents.

The binary output status signals of the negative sequence overcurrent protection function are the general starting and the general trip command of the function.

The negative sequence overcurrent protection function has a binary input signal, which serves the purpose of disabling the function. The conditions of disabling are defined by the user, applying the graphic equation editor.

- **Inrush detection (68)**

When an inductive element with an iron core (transformer, reactor, etc.) is energized, high current peak values can be detected. This is caused by the transient asymmetric saturation of the iron core as a nonlinear element in the power network. The sizing of the iron core is usually sufficient to keep the steady state magnetic flux values below the saturation point of the iron core, so the inrush transient slowly dies out. These current peaks depend also on random factors such as the phase angle at energizing. Depending on the shape of the magnetization curve of the iron core, the detected peaks can be several times above the rated current peaks. Additionally, in medium or high voltage networks, where losses and damping are low, the indicated high current values may be sustained at length. The function operates independently using all three phase currents individually, and additionally, a general inrush detection signal is generated if any of the phases detects inrush current.

The function can be disabled by the binary input Disable. This signal is the result of logic equations graphically edited by the user. Using the inrush detection binary signals, other protection functions can be blocked during the transient period so as to avoid the unwanted trip.

- **Thermal protection (49)**

Basically, thermal protection measures the three sampled phase currents. RMS values are calculated and the temperature calculation is based on the highest RMS value of the phase currents. The temperature calculation is based on the step-by-step solution of the thermal differential equation. This method yields “over temperature”, meaning the temperature above the ambient temperature. Accordingly, the temperature of the protected object is the sum of the calculated “over temperature” and the ambient temperature.

If the calculated temperature (calculated “over temperature” + ambient temperature) is above the threshold values, alarm, trip and restart blocking status signals are generated.

- **Definite time overvoltage protection (59)**

The definite time overvoltage protection function measures three voltages. The measured values of the characteristic quantity are the RMS values of the basic Fourier components of the phase voltages. The Fourier calculation inputs are the sampled values of the three phase voltages (UL1, UL2, UL3), and the outputs are the basic Fourier components of the analyzed voltages (UL1Four, UL2Four, UL3Four). They are not part of the 59 function; they belong to the preparatory phase.

The function generates start signals for the phases individually. The general start signal is generated if the voltage in any of the three measured voltages is above the level defined by parameter setting value. The function generates a trip command only if the definite time delay has expired and the parameter selection requires a trip command as well.

The overvoltage protection function has a binary input signal, which serves the purpose of disabling the function. The conditions of disabling are defined by the user, applying the graphic equation editor.

- **Definite time undervoltage protection (27)**

The definite time undervoltage protection function measures the RMS values of the fundamental Fourier component of three phase voltages. The Fourier calculation inputs are the sampled values of the three phase voltages (UL1, UL2, UL3), and the outputs are the basic Fourier components of the analyzed voltages (UL1Four, UL2Four, UL3Four). They are not part of the TUV27 function; they belong to the preparatory phase.

The function generates start signals for the phases individually. The general start signal is generated if the voltage is below the preset starting level parameter setting value and above the defined blocking level. The function generates a trip command only if the definite time delay has expired and the parameter selection requires a trip command as well.

The operation mode can be chosen by the type selection parameter. The function can be disabled, and can be set to “1 out of 3”, “2 out of 3”, and “All”.

The overvoltage protection function has a binary input signal, which serves the purpose of disabling the function. The conditions of disabling are defined by the user, applying the graphic equation editor.

- **Residual definite time overvoltage protection (59N)**

The residual definite time overvoltage protection function operates according to definite time characteristics, using the RMS values of the fundamental Fourier component of the zero sequence voltage (UN=3Uo). The Fourier calculation inputs are the sampled values of the residual or neutral voltage (UN=3Uo) and the outputs are the RMS value of the basic Fourier components of those.

The function generates start signal if the residual voltage is above the level defined by parameter setting value. The function generates a trip command only if the definite time delay has expired and the parameter selection requires a trip command as well.

The residual overvoltage protection function has a binary input signal, which serves the purpose of disabling the function. The conditions of disabling are defined by the user, applying the graphic equation editor.

- **Negative sequence definite time overvoltage protection (47)**

The definite time negative sequence overvoltage protection function measures three voltages and calculates the negative sequence component. If the negative sequence component is above the level defined by parameter setting, then a start signal is generated. The function generates a start signal. The general start signal is generated if the negative sequence voltage component is above the level defined by parameter setting value. The function generates a trip command only if the time delay has expired and the parameter selection requires a trip command as well.

The function can be disabled by parameter setting or by an external signal, edited by the graphic logic editor.

- **Over-frequency protection (81O)**

The deviation of the frequency from the rated system frequency indicates unbalance between the generated power and the load demand. If the available generation is large compared to the consumption by the load connected to the power system, then the system frequency is above the rated value. The over-frequency protection function is usually applied to decrease generation to control the system frequency. Another possible application is the detection of unintended island operation of distributed generation and some consumers. In the island, there is low probability that the power generated is the same as consumption; accordingly, the detection of high frequency can be one of the indication of island operation.

The over-frequency protection function generates a start signal if at least five measured frequency values are above the preset level. Time delay can also be set.

The function can be enabled/disabled by a parameter.

The over-frequency protection function has a binary input signal. The conditions of the input signal are defined by the user, applying the graphic equation editor. The signal can block the under-frequency protection function.

- **Underfrequency protection (81U)**

The deviation of the frequency from the rated system frequency indicates unbalance between the generated power and the load demand. If the available generation is small compared to the consumption by the load connected to the power system, then the system frequency is below the rated value. The under-frequency protection function is usually applied to increase generation or for load shedding to control the system frequency. Another possible application is the detection of unintended island operation of distributed generation and some consumers. In the island, there is low probability that the power generated is the same as consumption; accordingly, the detection of low frequency can be one of the indications of island operation. Accurate frequency measurement is also the criterion for the synchro-check and synchro- switch functions.

The under-frequency protection function generates a start signal if at least five measured frequency values are below the setting value.Time delay can also be set.

The function can be enabled/disabled by a parameter.

The under-frequency protection function has a binary input signal. The conditions of the input signal are defined by the user, applying the graphic equation editor. The signal can block the under-frequency protection function.

- **Rate of change of frequency protection (81R)**

The deviation of the frequency from the rated system frequency indicates unbalance between the generated power and the load demand. If the available generation is large compared to the consumption by the load connected to the power system, then the system frequency is above the rated value, and if it is small, the frequency is below the rated value. If the unbalance is large, then the frequency changes rapidly. The rate of change of frequency protection function is usually applied to reset the balance between generation and consumption to control the system frequency. Another possible application is the detection of unintended island operation of distributed generation and some consumers. In the island, there is low probability that the power generated is the same as consumption; accordingly, the detection of a high rate of change of frequency can be an indication of island operation.

The rate of change of frequency protection function generates a start signal if the df/dt value is above the setting value. The rate of change of frequency is calculated as the difference of the frequency at the present sampling and at three periods earlier. Time delay can also be set.

The function can be enabled/disabled by a parameter.

The rate of change of frequency protection function has a binary input signal. The conditions of the input signal are defined by the user, applying the graphic equation editor. The signal can block the rate of change of frequency protection function.

- **Vector jump protection (78)**

The modern electric power systems include an increasing number of small generators (distributed generation system). There can be several events in the network resulting that the small generators get disconnected from the system, and the small generator supplies some consumer only, remaining in the electric “island” (unintended islanding).

If a small generator remains in an island with some consumers, it is highly possible that the balance of the generated and consumed active and reactive power is not fulfilled. This results changing of the frequency and/or voltage, accordingly the voltage vector position of the island is changing, related to that of the disconnected grid. An automatic reclosing of the circuit breaker at an unfavorable vector position can result high currents and serious damages. To prevent these damages a protection is needed to detect the islanding and to disconnect the generator from the island.

One of the protection methods to detect unintended islanding is this vector jump protection function.

- **Auto-reclose protection (79)**

The automatic reclosing function can realize up to four shots of reclosing. The dead time can be set individually for each reclosing and separately for earth faults and for multi-phase faults. All shots are of three phase reclosing. The starting signal of the cycles can be generated by any combination of the protection functions or external signals of the binary inputs.

The automatic reclosing function is triggered if as a consequence of a fault a protection function generates a trip command to the circuit breaker and the protection function resets because the fault current drops to zero or the circuit breaker's auxiliary contact signals open state. According to the preset parameter values, either of these two conditions starts counting the dead time, at the end of which the automatic reclosing function generates a close command automatically. If the fault still exits or reappears, then within the "Reclaim time" the protection functions picks up again and the subsequent cycle is started. If the fault still exists at the end of the last cycle, the automatic reclosing function trips and generates the signal for final trip. If no pickup is detected within this time, then the automatic reclosing cycle resets and a new fault will start the procedure with the first cycle again.

At the moment of generating the close command, the circuit breaker must be ready for operation, which is signaled via the binary input "CB Ready". The preset parameter value "CB Supervision time" decides how long the automatic reclosing function is allowed to wait at the end of the dead time for this signal. If the signal is not received during this dead time extension, then the automatic reclosing function terminates.

Depending on binary parameter settings, the automatic reclosing function block can accelerate trip commands of the individual reclosing cycles. This function needs user-programmed graphic equations to generate the accelerated trip command. The automatic reclosing function can be blocked by a binary input. The conditions are defined by the user applying the graphic equation editor

- **Synchro check, synchro switch function (25)**

Several problems can occur in the electric power system if the circuit breaker closes and connects two systems operating asynchronously. The high current surge can cause damage in the interconnecting elements, the accelerating forces can overstress the shafts of rotating machines or, at last, the actions taken by the protective system can result in the unwanted separation of parts of the electric power system. To prevent such problems, this function checks whether the systems to be interconnected are operating synchronously. If yes, then the close command is transmitted to the circuit breaker. In case of asynchronous operation, the close command is delayed to wait for the appropriate vector position of the voltage vectors on both sides of the circuit breaker. If the conditions for safe closing cannot be fulfilled within an expected time, then closing is declined.
There are three modes of operation:

- Energizing check:
  - Dead bus, live line,
  - Live bus, dead line,
  - Any Energizing Case (including Dead bus, dead line).
- Synchro check (Live line, live bus)
- Synchro switch (Live line, live bus)

The function can be started by the switching request signals initiated both the automatic reclosing and the manual closing. The binary input signals are defined by the user, applying the graphic equation editor.

Blocking signal of the function are defined by the user, applying the graphic equation editor. Blocking signal of the voltage transformer supervision function for all voltage sources are defined by the user, applying the graphic equation editor.

Signal to interrupt (cancel) the automatic or the manual switching procedure are defined by the user, applying the graphic equation editor.

- **Breaker failure protection (50BF)**

After a protection function generates a trip command, it is expected that the circuit breaker opens and the fault current drops below the pre-defined normal level. If not, then an additional trip command must be generated for all backup circuit breakers to clear the fault. At the same time, if required, a repeated trip command can be generated to the circuit breakers which are a priori expected to open. The breaker failure protection function can be applied to perform this task.

The starting signal of the breaker failure protection function is usually the trip command of any other protection function. Dedicated timer starts at the rising edge of the general start signal for the backup trip command. During the running time of the timer the function optionally monitors the currents, the closed state of the circuit breakers or both, according to the user's choice. The selection is made using an enumerated parameter.

If current supervision is selected by the user then the current limit values must be set correctly. The binary input indicating the status of the circuit breaker has no meaning.

If contact supervision is selected by the user then the current limit values have no meaning. The binary input indicating the status of the circuit breaker must be programmed correctly using the graphic equation editor.

If the parameter selection is "Current/Contact", the current parameters and the status signal must be set correctly. The breaker failure protection function resets only if all conditions for faultless state are fulfilled.

If at the end of the running time of the backup timer the currents do not drop below the pre- defined level, and/or the monitored circuit breaker is still in closed position, then a backup trip command is generated.

The pulse duration of the trip command is not shorter than the time defined by setting the parameter Pulse length.

The breaker failure protection function can be disabled by setting the enabling parameter to "Off".

Dynamic blocking (inhibition) is possible using the binary input Block. The conditions are to be programmed by the user, using the graphic equation editor.

- **Current unbalance function (60)**

The current unbalance protection function (60) can be applied to detect unexpected asymmetry in current measurement. The applied method selects maximum and minimum phase currents (RMS value of the fundamental Fourier components). If the difference between them is above the setting limit, the function generates a start signal. It is a necessary precondition of start signal generation that the maximum of the currents be above 10 % of the rated current and below 150% of the rated current. The Fourier calculation modules calculate the RMS value of the basic Fourier current components of the phase currents individually. They are not part of the VCB60 function; they belong to the preparatory phase.

The decision logic module combines the status signals to generate the starting signal and the trip command of the function. The trip command is generated after the defined time delay if trip command is enabled by the Boolean parameter setting.

The function can be disabled by parameter setting, and by an input signal programmed by the user with the graphic programming tool.

- **Switch-onto-fault preparation function**

Some protection functions, e.g. distance protection, directional overcurrent protection, etc. need to decide the direction of the fault. This decision is based on the angle between the voltage and the current. In case of close-up faults, however, the voltage of the faulty loop is near zero: it is not sufficient for a directional decision. If there are no healthy phases, then the voltage samples stored in the memory are applied to decide if the fault is forward or reverse.

If the protected object is energized, the close command for the circuit breaker is received in "dead" condition. This means that the voltage samples stored in the memory have zero values. In this case the decision on the trip command is based on the programming of the protection function for the "switch-onto-fault" condition.

This "switch-onto-fault" detection function prepares the conditions for the subsequent decision. The function can handle both automatic and manual close commands.

- **Broken conductor protection (46BC)**

The broken conductor protection function can be applied to detect a power lines and cables broken conductor condition or a single-pole breaker malfunction condition.

By measuring the phase current input signals and compares the ratio of negative phase sequence current (I2) to positive phase sequence current (I1). If the I2/I1 ratio is above the setting limit, the function generates a start signal. It is a necessary precondition of start signal generation that the positive phase sequence current (I1) must be between 6.67% and 100% of the rated current.

The function can be disabled by parameter setting, and by an input signal programmed by the user with the graphic programming tool. The trip command is generated after the defined time delay if trip command is enabled by parameter setting.

- **Voltage transformer supervision function (VTS60)**

The voltage transformer supervision function generates a signal to indicate an error in the voltage transformer secondary circuit. This signal can serve, for example, as a warning, indicating disturbances in the measurement, or it can disable the operation of the distance protection function if appropriate measured voltage signals are not available for a distance decision.

The voltage transformer supervision function is designed to detect faulty asymmetrical states of the voltage transformer circuit caused, for example, by a broken conductor in the secondary circuit. The user has to generate graphic equations for the application of the signal of this voltage transformer supervision function.

The voltage transformer supervision function can be used in three different modes of application:

- Zero sequence detection (for typical applications in systems with grounded neutral): "VT failure" signal is generated if the residual voltage (3Uo) is above the preset voltage value AND the residual current (3Io) is below the preset current value.
- Negative sequence detection (for typical applications in

systems with isolated or resonant grounded (Petersen) neutral): "VT failure" signal is generated if the negative sequence voltage component (U2) is above the preset voltage value AND the negative sequence current component (I2) is below the preset current value.

- Special application: "VT failure" signal is generated if the residual voltage (3Uo) is above the preset voltage value AND the residual current (3Io) AND the negative sequence current component (I2) are below the preset current values.

The voltage transformer supervision function can be activated if "Live line" status is detected for at least 200 ms. This delay avoids mal-operation at line energizing if the poles of the circuit breaker make contact with a time delay. The function is set to be inactive if "Dead line" status is detected.

If the conditions specified by the selected mode of operation are fulfilled (for at least 4 milliseconds) then the voltage transformer supervision function is activated and the operation signal is generated. (When evaluating this time delay, the natural operating time of the applied Fourier algorithm must also be considered.

MEASUREMENTS FUNCTION

- **Measurements function**

Based on the hardware inputs the measurements listed in Table below are available.

Measurement functions	Variant 0	Variant 1	Variant 2	Variant 6
Current (I1, I2, I3, Io)		X	X	
Voltage (U1, U2, U3, U12, U23, U31, Uo, Useq) and frequency			X	X
Power (P, Q, S, pf) and Energy (E+, E-, Eq+, Eq-)			X	
Circuit breaker wear	X	X	X	
Supervised trip contacts (TCS)	X	X	X	

The measurement functions of the Variant 2 configuration

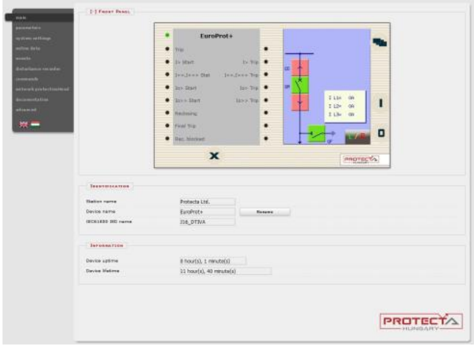
- **Monitoring function**

The **IED EP+ S24** Series product line can monitor and detect current and voltage harmonics and short duration system disturbances such as:

- Harmonics contents of each voltage and current channel (order 1 to order 13)
- Current total demand distortion (TDD)
- Voltage total harmonic distortion (THD)
- Sags (Dips), Swells and Interrupts

HMI AND COMMUNICATION TASK

- **Embedded WEB-server:**



- Firmware upgrade possibility
- Modification of user parameters
- Events list and disturbance records
- Password management
- Online data measurement
- Commands
- Administrative tasks

- **Front panel HMI:**

IED EP+S24 B&W HMI front panel

There are two type of front panel HMI:

- **HMI+2504**:
  - 128x64pixels, black and white
  - 4 x tactile user keys
  - RJ45 10/100Mbit/s
- **HMI+2404** (optional):
  - 320 × 240 pixel TFT display with Resistive touchscreen interface
  - 4 x tactile user keys
  - RJ45 10/100Mbit/s

IED EP+S24 True color HMI front panel

- **Communication:**
  - The built-in 5-port Ethernet switch allows EuroProt+ to connect to IP/Ethernet-based network. The following Ethernet ports are available:
    - Station bus (100Base-FX Ethernet) SBW
    - Redundant station bus (100Base-FX Ethernet) SBR
    - Proprietary process bus (100Base-FX Ethernet)
    - RJ-45 Ethernet user interface
    - Optional 10/100Base-T port via RJ-45 connector
  - PRP/HSR seamless redundancy for Ethernet networking (100Base-FX Ethernet)
  - Other communication:
    - RS422/RS485 interfaces (galvanic interface to support legacy or other serial protocols, ASIF)
    - Plastic or glass fiber interfaces to support legacy protocols, ASIF

FUNCTIONAL PARAMETERS

Three-phase instantaneous overcurrent protection (50)	
Operation Start current	Off, Peak value, Fundamental value 5-3000% in 1% steps
Three-phase time overcurrent protection (51)	
Operation Start current Time Multiplier Minimum time delay for the inverse char. Definite time delay for definite type char. Reset time delay for the IEC type inverse char.	Off, Definite Time, IEC Inv, IEC VeryInv, IEC ExtInv, IEC LongInv, ANSI0.95 Inv, ANSI ModInv, ANSI VeryInv, ANSI ExtInv, ANSI LongInv, ANSI LongVeryInv, ANSI LongExtInv 5-3000% in 1% steps 0.05-999 in 0.01 steps 40-60000ms in 1ms steps 40-60000ms in 1ms steps 60-60000ms in 1ms steps
Three-phase directional overcurrent protection (67)	
Direction Operation Operating Angle Characteristic Angle Start Current Time Multiplier Minimum time delay for the inverse char. Definite time delay Reset time	NonDir, Forward, Backward Off, DefiniteTime, IEC Inv,IEC VeryInv, IEC ExtInv,IEC LongInv, ANSI Inv, ANSI ModInv, ANSI VeryInv, ANSI ExtInv, ANSI LongInv, ANSI LongVeryInv, ANSI LongExtInv 30-80º in 1º steps 40-90º in 1º steps 5-3000% in 1% steps 0.05-999 in 0.01 steps 30-60000ms in 1ms steps 30-60000ms in 1ms steps 60-60000ms in 1ms steps
Residual instantaneous overcurrent protection (50N)	
Operation Start Current	Off, Peak value, Fundamental value0.85 5-3000% in 1% steps
Residual time overcurrent protection (51N)	
Operation Start current In = 1A or 5A In = 200mA or 1A Time Multiplier Minimum time delay for the inverse char. Definite time delay for definite type char. Reset time delay for the inverse char.	Off, DefiniteTime, IEC Inv,IEC VeryInv, IEC ExtInv,IEC LongInv, ANSI Inv, ANSI ModInv, ANSI VeryInv, ANSI ExtInv, ANSI LongInv, ANSI LongVeryInv, ANSI LongExtInv 5-3000% in 1% steps 5-3000% in 1% steps 0.05-999 in 0.01 steps 40-60000ms in 1ms steps 40-60000ms in 1ms steps 60-60000ms in 1ms steps
Residual directional overcurrent protection (67N)	
Direction	NonDir, Forward - Angle, Backward Angle, Forward I*cos(fi), Backward- Angle, Forward-I*cos(fi), Backward - I*sin(fi), Forward-I*sin(fi+45), Backward - I*sin(fi+45)

Operation	Off, DefiniteTime, IEC Inv,IEC VeryInv, IEC ExtInv,IEC LongInv, ANSI Inv, ANSI ModInv, ANSI VeryInv, ANSI ExtInv, ANSI LongInv, ANSI LongVeryInv, ANSI LongExtInv
Start Current	5-3000% in 1% steps
URes Min	1-20% in 1% steps
IRes Min	1-50% in 1% steps
Operating Angle	30-85° in 1° steps
Characteristic Angle	-180-180° in 1° steps
Time Multiplier	0.05-999 in 0.01 step
Minimal time delay for the inverse char.	30-60000ms in 1ms steps
Definite time delay	30-60000ms in 1ms steps
Reset time delay for the inverse char.	30-60000ms in 1ms steps
Voltage dependent overcurrent protection (51V)	
Operation	Off, On
Restr. Mode	Restrained, Controlled
Start Current	20-3000% in 1% steps
U_lowlimit	20-60% in 1% steps
U_highlimit	60-110% in 1% steps
Ik_limit	20-60% in 1% steps
Time delay	0-60000ms in 1ms steps
Negative sequence overcurrent protection (46)	
Operation	Off, DefiniteTime, IEC Inv,IEC VeryInv, IEC ExtInv,IEC LongInv, ANSI Inv, ANSI ModInv, ANSI VeryInv, ANSI ExtInv, ANSI LongInv, ANSI LongVeryInv, ANSI LongExtInv
Start Current	5-3000% in 1% steps
Time Multiplier	0.05-999 in 0.01 steps
Minimal time delay for the inverse char.	0-60000ms in 1ms steps
Definite time delay	0-60000ms in 1ms steps
Reset time delay for the inverse char	0-60000ms in 1ms steps
Inrush detection (68)	
Operation	Off, On
2nd Harm Ratio	5-50% in 1% steps
Basic sensitivity of the function	20-100% in 1% steps
Thermal protection (49)	
Operation	Off, Pulsed, Locked
Alarm Temperature	60-200deg in 1deg steps
Trip Temperature	60-200deg in 1deg steps
Rated Temperature	60-200deg in 1deg steps
Base Temperature	0-40deg in 1deg steps
Unlock Temperature	20-200deg in 1deg steps
Ambient Temperature	0-40deg in 1deg steps
Startup Term	0-60% in 1% steps
Rated Load Current	20-150% in 1% steps
Time Constan	1-999min in 1min step
Definite time overvoltage protection (59)	
Operation	Off, On

Start Voltage Reset Ratio Time Delay	30-130% in 1% steps 1-10% in 1% steps 0-60000ms in 1ms steps
Definite time undervoltage protection (27)	
Operation Start Voltage Block Voltage Reset Ratio Time Delay	Off, 1 out of 3, 2 out of 3, All 30-130% in 1% steps 0-20% in 1% steps 1-10% in 1% steps 50-60000ms in 1ms steps
Residual overvoltage protection (59N)	
Operation Start Voltage Time Delay	Off, On 2-60% in 1% steps 0-60000ms in 1ms steps
Negative sequence overvoltage protection (47)	
Operation Start Voltage Time Delay	Off, On 2-40% in 1% steps 50-60000ms in 1ms steps
Overfrequency protection (81O) Undefrequency protection (81U)	
Operation Start signal only Start frequency Time Delay Voltage limit	Off, On False, True 40-70Hz in 0.01Hz steps 0-60000ms in 1ms steps 0.3-1.0 Un
Rate of change of frequency protection (81R)	
Operation Start signal only Start df/dt Time Delay	Off, On False, True -5.00-5.00Hz/s in 0.01Hz/s steps 0-60000ms in 1ms steps
Vector jump protection (78)	
Operation PhaseDiff Limit Max NegSeq Voltage Time Delay Max ZeroSeq Voltage Pulse Duration	Off, On 5-25deg in 1deg steps 10-100% in 1% steps 5-50% in 1% steps 1-30% in 1% steps 150-500ms in 1ms steps
Auto-reclose (79)	
Operation EarthFault RecCycle PhaseFault RecCycle Reclosing Started by 1. Dead Time Ph	Off, On Disabled, 1. Enabled, 1.2. Enabled, 1.2.3. Enabled, 1.2.3.4. Enabled Disabled, 1. Enabled, 1.2. Enabled, 1.2.3. Enabled, 1.2.3.4. Enabled Trip reset, CB open 0-100000ms in 10ms steps

2. Dead Time Ph	10-100000ms in 10ms steps
3. Dead Time Ph	10-100000ms in 10ms steps
4. Dead Time Ph	10-100000ms in 10ms steps
1. Dead Time EF	0-100000ms in 10ms steps
2. Dead Time EF	10-100000ms in 10ms steps
3. Dead Time EF	10-100000ms in 10ms steps
4. Dead Time EF	10-100000ms in 10ms steps
Reclaim Time	100-300000ms in 10ms steps
Close Command Time	10-10000ms in 10ms steps
Dynamic Blocking Time	10-100000ms in 10ms steps
Block after Man Close	0-100000ms in 10ms steps
Action Time	0-20000ms in 10ms steps
Start Signal Max Time	0-10000ms in 10ms steps
DeadTime Max Delay	0-100000ms in 10ms steps
CB Supervision Time	10-100000ms in 10ms steps
SynCheck Max Time	500-100000ms in 10ms steps
SynCheck Max Time	500-100000ms in 10ms steps
CB State Monitoring	False, True
Accelerate 1.Trip	False, True
Accelerate 2.Trip	False, True
Accelerate 3.Trip	False, True
Accelerate 4.Trip	False, True
Synchro check (25)	
Voltage Select	L1-N, L2-N, L3-N, L1-L2, L2-L3, L3-L1
Voltage Select	Off, On, ByPass
SynSW Auto	Off, On
Energizing Auto	Off, DeadBus LiveLine, LiveBus DeadLine, Any energ case
Operation Man	Off, On, ByPass
SynSW Man	Off, On
Energizing Man	Off,DeadBus LiveLine, LiveBus DeadLine, Any energ case
U Live	60-110% in 1% steps
U Dead	10-60% in 1% steps
Udiff Syncheck auto	5-30% in 1% steps
Udiff SynSW auto	5-30% in 1% steps
MaxPhaseDiff auto	5-80º in 1º steps
Udiff SynCheck Man	5-30% in 1% steps
Udiff SynSW Man	5-30% in 1% steps
MaxPhaseDiff Man	5-80º in 1º steps
FrDiff SynCheck Auto	0.02-0.5Hz in 0.02Hz steps
FrDiff SynSW Auto	0.10-1.00Hz in 0.2Hz steps
FrDiff SynCheck Man	0.02-0.5Hz in 0.02Hz steps
FrDiff SynSW Man	0.10-1.00Hz in 0.2Hz steps
Breaker Time	0-500ms in 1ms steps
Close Pulse	10-60000ms in 1ms steps
Max Switch Time	100-60000ms in 1ms steps
Breaker failure protection (50BF)	
Operation	Off, Current, Contact, Current/Contact ±5 ms
Start Ph Current	20-200% in 1% steps
Start Res Current	10-200% in 1% steps
Backup Time Delay	60-1000ms in 1ms steps

Pulse Duration	0-60000ms in 1ms steps
Current unbalance protection (60)	
Operation Start Signal Only Start Current Diff Time Delay	Off, On False, True 10-90% in 1% steps 100-60000ms in 1ms steps
Switch-onto-fault preparation (SOTF)	
Operation SOTF Drop Delay	Off, On 10-10000ms in 1ms steps
Broken conductor protection (46BC)	
Operation Start signal only Start current Time Delay	Off, On False, True 10-90% in 1% steps 100-60000ms in 1ms steps
Voltage transformer supervision function (VTS60)	
Operation Min Operate Voltage Min Operate Current Start URes Start IRes Start UNeg Start INeg	Off, Zero sequence, Negative sequence, Special 10-100% in 1% steps 2-100% in 1% steps 5-50% in 1% steps 10-50% in 1% steps 5-50% in 1% steps 10-50% in 1% steps

TECHNICAL DATA

HARDWARE	
Analog Inputs (Current & Voltage Input Modules)	
Rated current In Rated voltage Vn Rated frequency Overload rating Current inputs Voltage inputs Burden Phase current inputs Voltage inputs	1A or 5A (selectable) 110V (± 10%) 50Hz or 60Hz 20A continuous, 175A for 10s, 500A for 1s, 1200A for 10ms 0-250VAC/VDC continuous, 275VAC/350VDC for 1s 0.01VA at In = 1A, 0.25VA at In = 5A 0.61VA at 200V, 0.2VA at 100V
Power Supply	
Rated auxiliary voltage Power consumption	24/48/60VD (Operative range: 19.2 -72Vdc) 110/220Vdc (Operative range: 88 - 264Vdc or 80-250Vac) 20W
Binary Inputs	
Input circuit DC voltage Pickup voltage Drop voltage Power consumption	24VDC (Thermal withstand voltage: 72VDC) 48VDC (Thermal withstand voltage: 100VDC) 110VDC (Thermal withstand voltage: 250VDC) 220VDC (Thermal withstand voltage: 320VDC) 0.8Un 0.64Un max. 1.6 mA per channel at 220VDC max. 1.8 mA per channel at 110VDC max. 2 mA per channel at 48VDC max. 3 mA per channel at 24VDC
Binary Outputs	
Rated voltage Continuous carry Maximum switching voltage Breaking capacity Short time carrying capacity Operating time	250VAC/DC 8A 400VAC (L/R=40 ms) 0.2A at 220VDC, 0.3A at 110VDC 2000VA max 35A for 1s Typically 10ms
Mechanical Design	
Installation Case Protection class	Flush mounting 24 HP (height:3U) IP4x from front side, IP2x from rear side IP54 Rated mounting kit
Key & LED	
Device keys Capacitive touch key LEDS Number of configurable LED	Capacitive touch keys 4 pcs yellow, 3 mm circular LEDs indicating touch key actions 16

Device status LED	1 piece three-color, 3 mm circular LED Green: normal device operation Yellow: device is in warning state Red: device is in error state
Local Interface	
Service port on front panel	10/100-Base-T interface with RJ-45 type connector
System Interface	
10/100-Base-TX 100Base-FX Serial Interface	IP56 rated with RJ-45 connector MM/ST 1300 nm, 50/62.5/125 µm connector, (up to 2 km) fiber SM/FC 1550 nm, 9/125 µm connector, (up to 120 km) SM/FC 1550 nm, 9/125 µm connector, (up to 50 km) MM/LC 1300 nm, 50/62.5/125 µm connector, (up to 2 km) fiber Plastic optical fiber (ASIF-POF) Glass with ST connector (ASIF-GS) Galvanic RS485/422 (ASIF-G)
PROTECTION & CONTROL FUNCTION	
Three-phase instantaneous overcurrent protection (50)	
Using peak value calculation	
Operating characteristic Reset ratio Operate time at $2*I_S$ Reset time Transient overreach	Instantaneous, accuracy < 6 % 0.85 <15 ms <40 ms 90%
Using Fourier basic harmonic calculation	
Operating characteristic Reset ratio Operate time at $2*I_S$ Reset time Transient overreach	Instantaneous, accuracy < 2 % 0.85 <25 ms <60 ms 15%
Three-phase time overcurrent protection (51)	
Operating accuracy Operate time accuracy Reset ratio Reset time Dependent time char. Definite time char. Reset time accuracy Transient overreach Pickup time * Overshot time Dependent time char. Definite time char. Influence of time varying value of the input current (IEC 60255-151)	<2% (when $20 \le G_S \le 1000$) ±5% or ±15 ms, whichever is greater 0.95 Dependent time char. Approx 60 ms < 2% or ±35 ms, whichever is greater < 2 % < 40 ms 30 ms 50 ms < 4 %
Three-phase directional overcurrent protection (67)	

Operating accuracy	< 2 %
Operating accuracy	If Time multiplier is >0.1: ±5% or ±15 ms, whichever is greater
Accuracy in minimum time range	±35 ms
Reset ratio	0.95
Reset time	Approx 100 ms
Transient overreach	2 %
Pickup time	<100 ms
Memory storage time span	
50Hz	70 ms
60Hz	60 ms
Angular accuracy	<3º
Residual instantaneous overcurrent protection (50N)	
Using peak value calculation	
Operating characteristic (I>0.1 In)	Instantaneous, accuracy <6%
Reset ratio	0.85
Operate time at 2*I_S	< 15 ms
Reset time *	< 35 ms
Transient overreach	85 %
Using Fourier basic harmonic calculation	
Operating characteristic (I>0.1 In)	Instantaneous, accuracy <6%
Reset ratio	0.85
Operate time at 2*I_S	< 25 ms
Reset time *	< 60 ms
Transient overreach	15 %
Residual time overcurrent protection (51N)	
Operating accuracy	<3% (when $20 \leq G_S \leq 1000$)
Operate time accuracy	±5% or ±15 ms, whichever is greater
Reset ratio	0.95
Reset time	
Dependent time char.	Dependent time char.
Definite time char.	Approx 60 ms
Reset accuracy time	< 2% or ±35 ms, whichever is greater
Transient overreach	< 2 %
Pickup time *	≤ 40 ms
Overshot time	
Dependent time char.	30 ms
Definite time char.	50 ms
Influence of time varying value of the input current (IEC 60255-151) accuracy	< 4 %
Residual directional overcurrent protection (67N)	
Operating accuracy	< ±2 %
Operating accuracy	±5% or ±15 ms, whichever is greater 0.95
Accuracy in minimum time range	±35 ms
Reset ratio	0.95
Reset time	Approx 50 ms
Reset time accuracy	±35 ms
Transient overreach	< 2 %

Pickup time	±35 ms
Angular accuracy	<3º
Io ≤ 0.1 In	<±10º
Io ≤ 0.1 In	<±5º
Io ≤ 0.1 In	<±2º
Angular reset ratio	
Forward and backward	10º
All other selection	5º
Voltage dependent overcurrent protection (51V)	
Operating accuracy	<2% (when 20 ≤ G_S ≤ 1000)
Operate time accuracy	±5% or ±15 ms, whichever is greater
Reset ratio	0.95
Reset time	
Dependent time char.	Dependent time char.
Definite time char.	Approx 60 ms
Reset time accuracy	< 2% or ±35 ms, whichever is greater
Transient overreach	< 2 %
Pickup time *	< 40 ms
Overshot time	
Dependent time char.	30 ms
Definite time char.	50 ms
Influence of time varying value of the input current (IEC 60255-151)	< 4 %
Negative sequence overcurrent protection (46)	
Operating accuracy	<2% (when 20 ≤ G_S ≤ 1000)
Operate time accuracy	±5% or ±15 ms, whichever is greater
Reset ratio	0.95
Reset time	
Dependent time char.	Dependent time char.
Definite time char.	Approx 60 ms
Reset accuracy time	< 2% or ±35 ms, whichever is greater
Transient overreach	< 2 %
Pickup time *	< 40 ms
Overshot time	
Dependent time char.	25 ms
Definite time char.	45 ms
Influence of time varying value of the input current (IEC 60255-151) accuracy	< 4 %
Inrush detection (68)	
Range	20 – 2000% of In
Current accuracy	±1% of In
Thermal protection (49)	
Operate time at I>1.2*Itrip accuracy	<3 % or <+ 20 ms
Definite time overvoltage protection (59)	
Pick-up starting accuracy	< ± 0,5 %
Reset time	
U> → Un	60 ms

U> → 0 Operate time accuracy Minimum operate time	50 ms < ± 20 ms 50 ms
Definite time undervoltage protection (27)	
Pick-up starting accuracy Reset time U> → Un U> → 0 Operate time accuracy Minimum operate time	< ± 0,5 % 50 ms 40 ms < ± 20 ms 50 ms
Residual overvoltage protection (59N)	
Pick-up starting accuracy 2 – 8 % 8 – 60 % Reset time U> → Un U> → 0 Operate time Operate time accurracy	 < ± 2 % < ± 1.5 % 60 ms 50 ms 50 ms < ± 20 ms
Negative sequence overvoltage protection (47)	
Pick-up starting accuracy Blocking voltage accuracy Reset time U> → Un U> → 0 Operate time accuracy Drop-off ratio accuracy Minimum operate time	< ± 0,5 % < ± 1,5 % 60 ms 50 ms < ± 20 ms ± 0,5 % 50 ms
Overfrequency protection (81O) Undefrequency protection (81U)	
Min. operate voltage Operate range Effective range Accuracy Minimum operate time Minimum operate time accuracy Accuracy when time delay: 140 – 60000 ms <140 ms (50 Hz system) <140 ms (60 Hz system) Reset frequency Reset time Reset time accuracy	0.1 Un 40 - 60 Hz (50 Hz system) 50 - 70 Hz (60 Hz system) 45 - 55 Hz (50 Hz system) 55 - 65 Hz (60 Hz system) ± 3 mHz 93ms (50 Hz system) 73ms Hz (60 Hz system) ± 32 ms (50 Hz system) ± 27 ms (60 Hz system) ± 4 ms ± 32 ms ± 27 ms [Start freq.] – 101 mHz, accuracy: ± 1 mHz 98 ms (50 Hz) 85 ms (60 Hz) ± 6 ms

Rate of change of frequency protection (81R)	
Min. operate voltage	0.1 Un
Operate range	± 10 Hz/s, accuracy: ± 50 mHz/s
Effective range	± 5 Hz/s, accuracy: ± 15 mHz/s
Minimum operate time	191 ms (50 Hz system), accuracy: ± 40 ms 159 ms (60 Hz system), accuracy: ± 39 ms 200 – 60000 ms (50 Hz), accuracy: ± 2 ms
Time delay (at 0.2 Hz/s)	± 1 mHz
Reset ratio (drop/pick in absolute values)	0.92 (>0.5 Hz/s), accuracy: -0.03 0.999 (<0.5 Hz/s), accuracy: -0.072
Reset time	187 ms (50Hz), accuracy: ±44ms 157 ms (60Hz), accuracy: ±38 ms
Vector jump protection (78)	
Pick-up starting accuracy	±5%
Blocking voltage	U>0.2Un, accuracy: <5%
Operate time	
Jump>2*setting	<50 ms
Minimum operate time	40 ms
Pulse duration	150 … 500 ms, accuracy: <10 ms
Auto-reclose (79)	
Operating time accuracy	±1% of setting value or ±30 ms
Synchro check (25)	
Rated Voltage Un	100/200V, parameter setting
Voltage effective range	10-110 % of Un, accuracy: ±1% of Un
Frequency	47.5 – 52.5 Hz, accuracy: ±10 mHz
Phase angle accuracy	±3 °
Operate time	Setting value, accuracy: ±3 ms
Reset time	<50 ms
Reset ratio	0.95 Un
Breaker failure protection (50BF)	
Current accuracy	<2 %
BF Time accuracy	±5 ms
Current reset time	20 ms
Current unbalance protection (60)	
Pick-up starting accuracy at In	Pick-up starting accuracy at In
Reset ratio	0.95
Operate time	70 ms
Switch-onto-fault preparation (SOTF)	
Timer accuracy	±5% or ±15 ms, whichever is greater
Brocken conductor protection (46BC)	
Pick-up starting accuracy	<2 %
Reset ratio	0.95
Min. operate time	70ms

Voltage transformer supervision function (VTS60)	
Pick-up voltage accuracy Operate time Reset ratio	<1% <20 ms 0.95
MEASUREMENT FUNCTION	
Current	
With CT/5151 modules	Range: 0.02-0.05In, accuracy: ±3%, ±1 digit Range: 0.05-20In, accuracy: ±0.5%, ±1 digit
With CT/5115 modules	Range: 0.002-0.01In, accuracy: ±3%, ±1 digit Range: 0.01-0.03In, accuracy: ±1%, ±1 digit Range: 0.03-5In, accuracy: ±0.5%, ±1 digit
With CT/1500 modules	Range: 0.002-0.005In, accuracy: ±1.5%, ±1 digit Range: 0.005-0.02In, accuracy: ±0.5%, ±1 digit Range: 0.02-2In, accuracy: ±0.2%, ±1 digit
Voltage	Range: 0.05-1.5%Un, accuracy: ±0.5%, ±1 digit
Power	
With CT/5151 modules	Range: 0.02-0.05In, accuracy: ±3%, ±1 digit Range: 0.05-20In, accuracy: ±0.5%, ±1 digit
With CT/5115 modules	Range: 0.002-0.01In, accuracy: ±3%, ±1 digit Range: 0.01-0.03In, accuracy: ±1%, ±1 digit Range: 0.03-5In, accuracy: ±0.5%, ±1 digit
With CT/1500 modules	Range: 0.002-0.005In, accuracy: ±1.5%, ±1 digit Range: 0.005-0.02In, accuracy: ±0.5%, ±1 digit Range: 0.02-2In, accuracy: ±0.2%, ±1 digit
Frequency accuracy	Range: 40-60Hz (50 Hz system), accuracy: ±2mHz 50-70Hz (60 Hz system), accuracy: ±2mHz

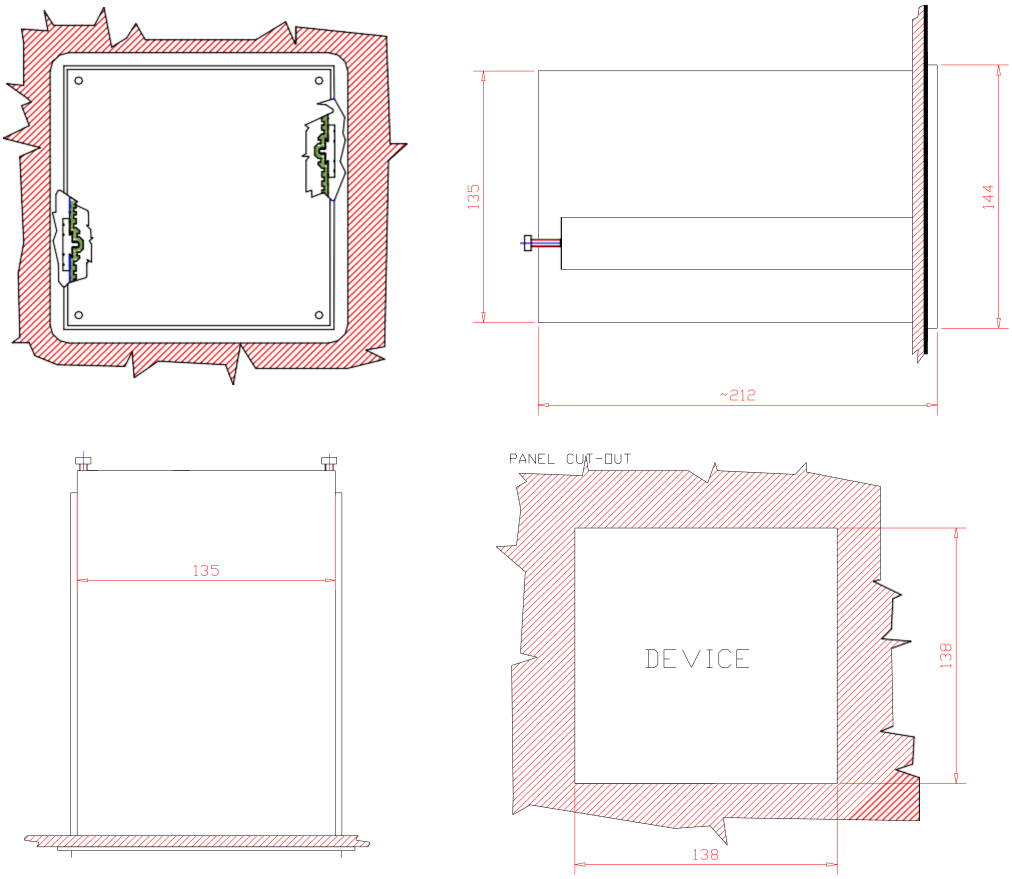
ENVIRONMENTAL PERFORMANCE

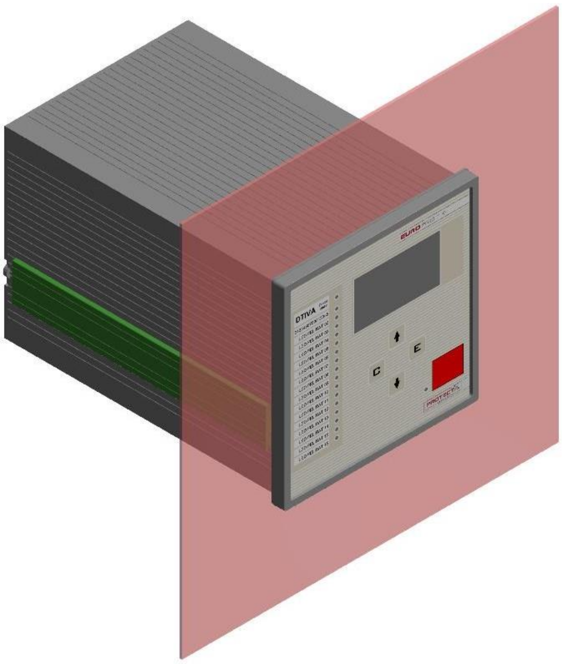
Atmospheric Environment		
Temperature	IEC 60068-2-1 IEC 60068-2-2 IEC 60068-2-14	Storage temperature: - 40 ºC … + 70 ºC Operation temperature: 20 ºC … + 55 ºC
Humidity	IEC 60255-1 IEC 60068-2-78	Humidity: 10 % ... 93 %
Enclosure protection	IEC 60529	IP4x from front side, IP2x from rear side IP54 Rated mounting kit
Mechanical Environment		
Vibration	IEC 60255-21-1	Class I
Shock and bump	IEC 60255-21-2	Class I
Seismic	IEC 60255-21-3	Class I
Electrical Environment		
Dielectric withstand	IEC 60255-27	Test levels: 2 kV AC 50 Hz (0.705 kV DC for transducer inputs)
High voltage impulse	IEC 60255-27	Test levels: 5 kV (1 kV for transducer and temperature measuring inputs)
Insulation resistance	IEC 60255-27	Insulation resistance > 15 GΩ
Voltage dips, interruptions, variations and ripple on dc supply	IEC 60255-26	Voltage dips: 40 % (200 ms), 70 % (500ms), 80 % (5000 ms)
Thermal short time	IEC 60255-27	
Electromagnetic Environment		
Electrostatic discharge	IEC 61000-4-2 IEC 60255-26	Test voltages: 15 kV air discharge, 8 kV contact discharge
Radiated radio frequency electromagnetic field immunity	IEC 61000-4-3 IEC 60255-26	Test field strength: 10 V/m
Electrical fast transient	IEC 61000-4-4 IEC 60255-26	Test voltage: 4 kV, 5kHz
Surge immunity	IEC 61000-4-5 IEC 60255-26	Test voltages: 4 kV line-to-earth, 2 kV line-to-line
Immunity to conducted disturbances, induced by radio-frequency fields	IEC 61000-4-6 IEC 60255-26	Frequency sweep: 150kHz…80 MHz Spot frequencies: 27 MHz, 68 MHz Test voltage: 10 V
Power frequency magnetic field immunity	IEC 61000-4-8 IEC 60255-26	Test field field strength: 100 A/m continuous, 1000 A/m for 3 s

Damped oscillatory wave immunity	IEC 61000-4-18 IEC 60255-26	Test frequency: 100 kHz, 1 MHz Test voltage: 2.5 kV in common mode, 1 kV in differential mode

DIMENSION AND PANEL CUT-OUT

- **Flush mounting of 24HP panel instrument case**

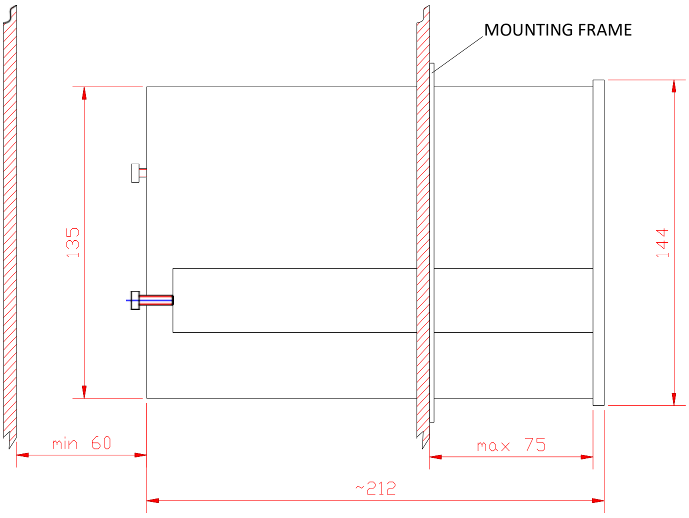


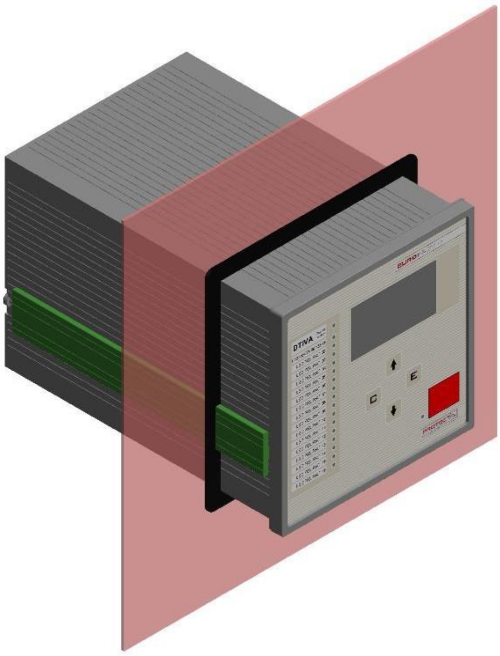


S24 Series flush mounting method

- **Semi-flush mounting of 24HP panel instrument case**

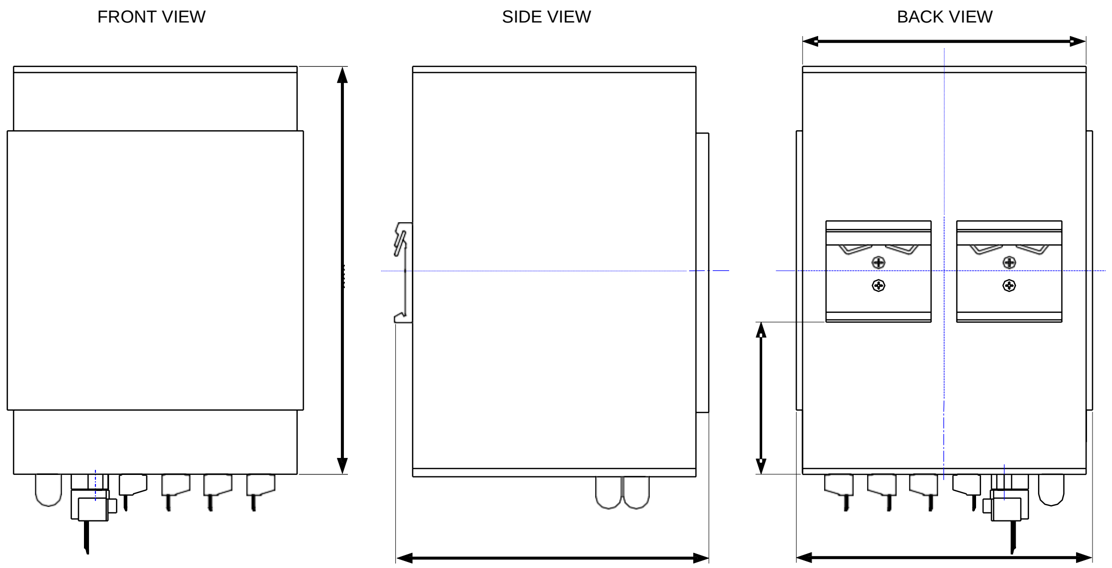
The dimensions of the panel cut-out for this type of mounting method are the same as in case of flush mounting (138 mm × 138 mm). For semi flush mounting you only have to cut in two the fixing elements (with green colour in the 3D illustration below) and make the assembly as you can see in the pictures below





S24 Series Semi-flush mounting method

- **Din rail mounting of 24HP panel instrument case**



S24 Series din rail mounting method

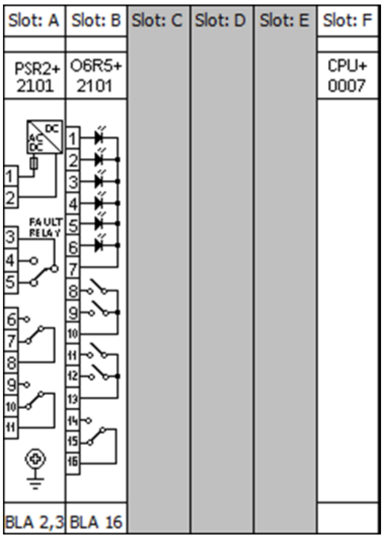
- **I/O configuration**

  The standard number of inputs and outputs of each variant are listed in the table below

Hardware configuration	Variant 0	Variant 1	Variant 2	Variant 6
Current inputs (4th channel can be sensitive)		4	4	
Voltage inputs			4	4
Digital inputs	6*	6*	6*	6*
Digital outputs	7*	5*	5*	5*
Fast trip outputs		2*	2*	2*

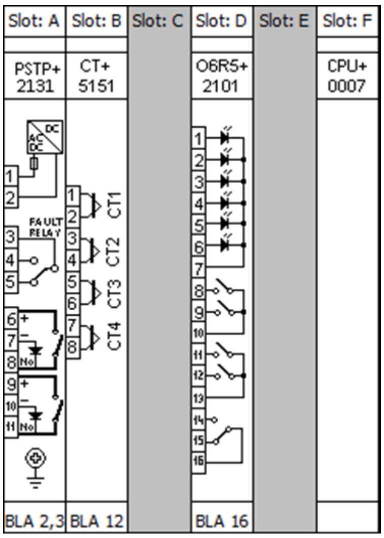
* as standard I/O card hardware configuration. The number of digital input, digital output, fast trip output can be selected as optional (I/O card option)

- **Module arrangement**
  - **S24 – Variant 0**



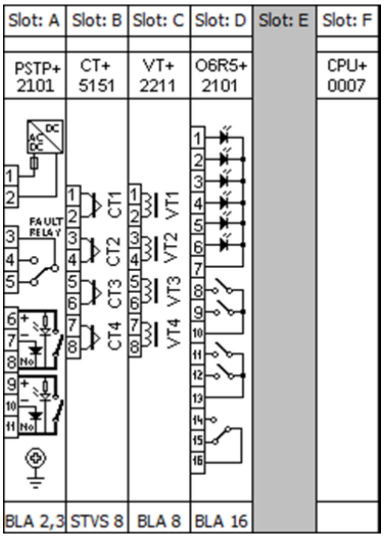
Basic module arrangement of the S24 – Variant 0 configuration (24HP, rear view)

  - **S24 – Variant 1**



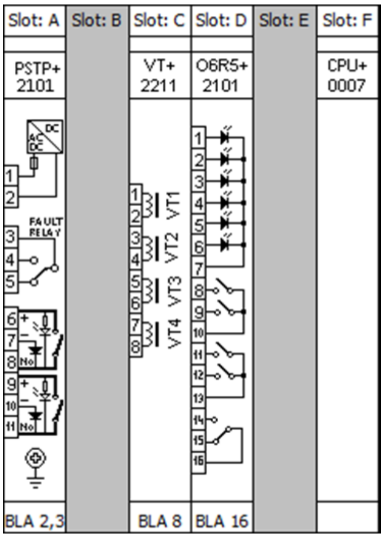
Basic module arrangement of the S24 – Variant 1 configuration (24HP, rear view)

  - **S24 – Variant 2**



Basic module arrangement of the S24 – Variant 2 configuration (24HP, rear view)

- **S24 – Variant 6**



Basic module arrangement of the S24 – Variant 6 configuration (24HP, rear view)

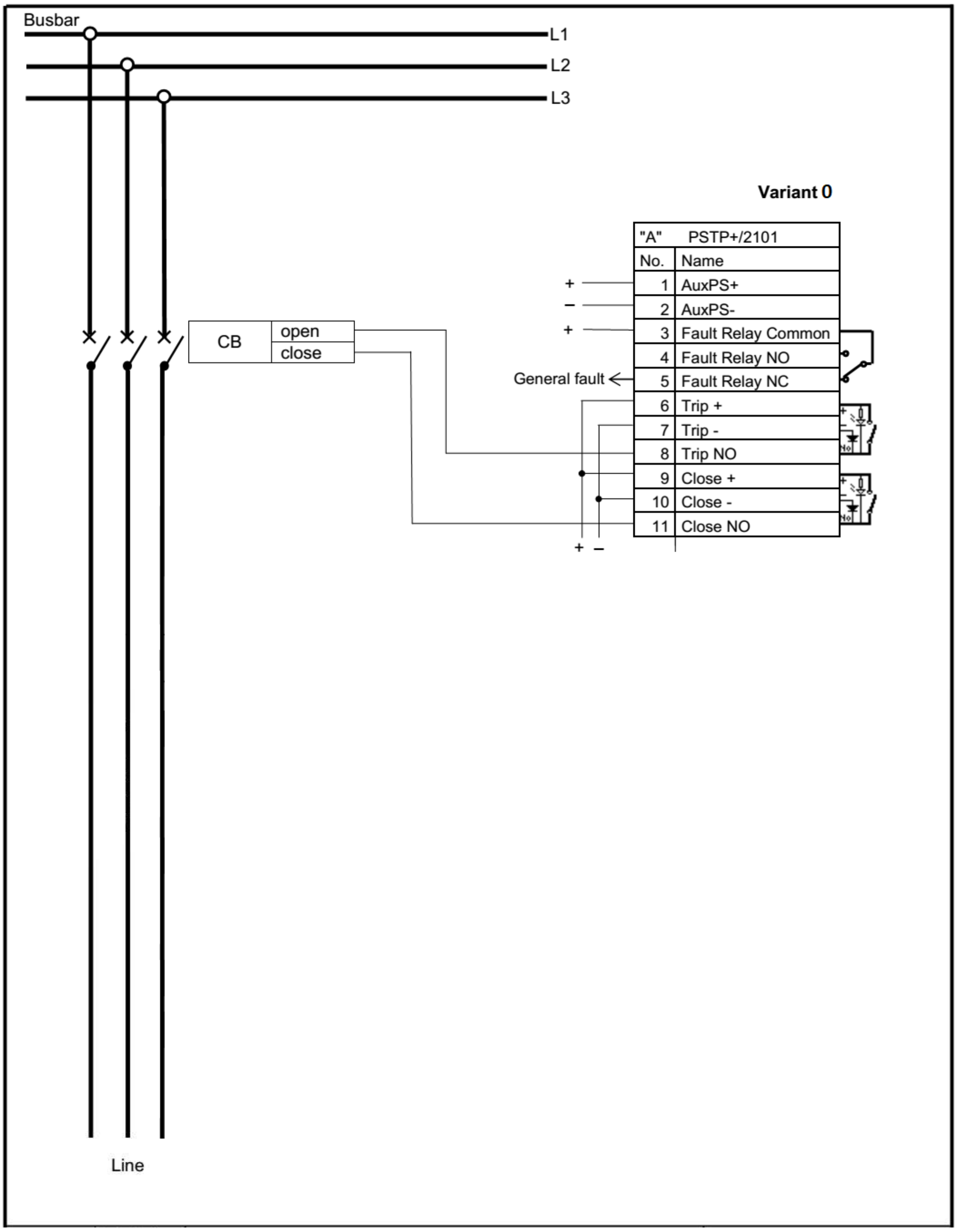
- **I/O card options for slot D and slot E**

IO card type	Slot D	Slot E
O6R5	Standard	N/A
O12	Option	Option
O8	Option	Option
R8	Option	Option

- **I/O card type:**
  - O6R5: I/O Card with 6 digital inputs and 5 digital outputs
  - O12: I/O Card with 12 digital inputs
  - O8: I/O Card with 8 digital inputs
  - R8: I/O Card with 8 digital inputs

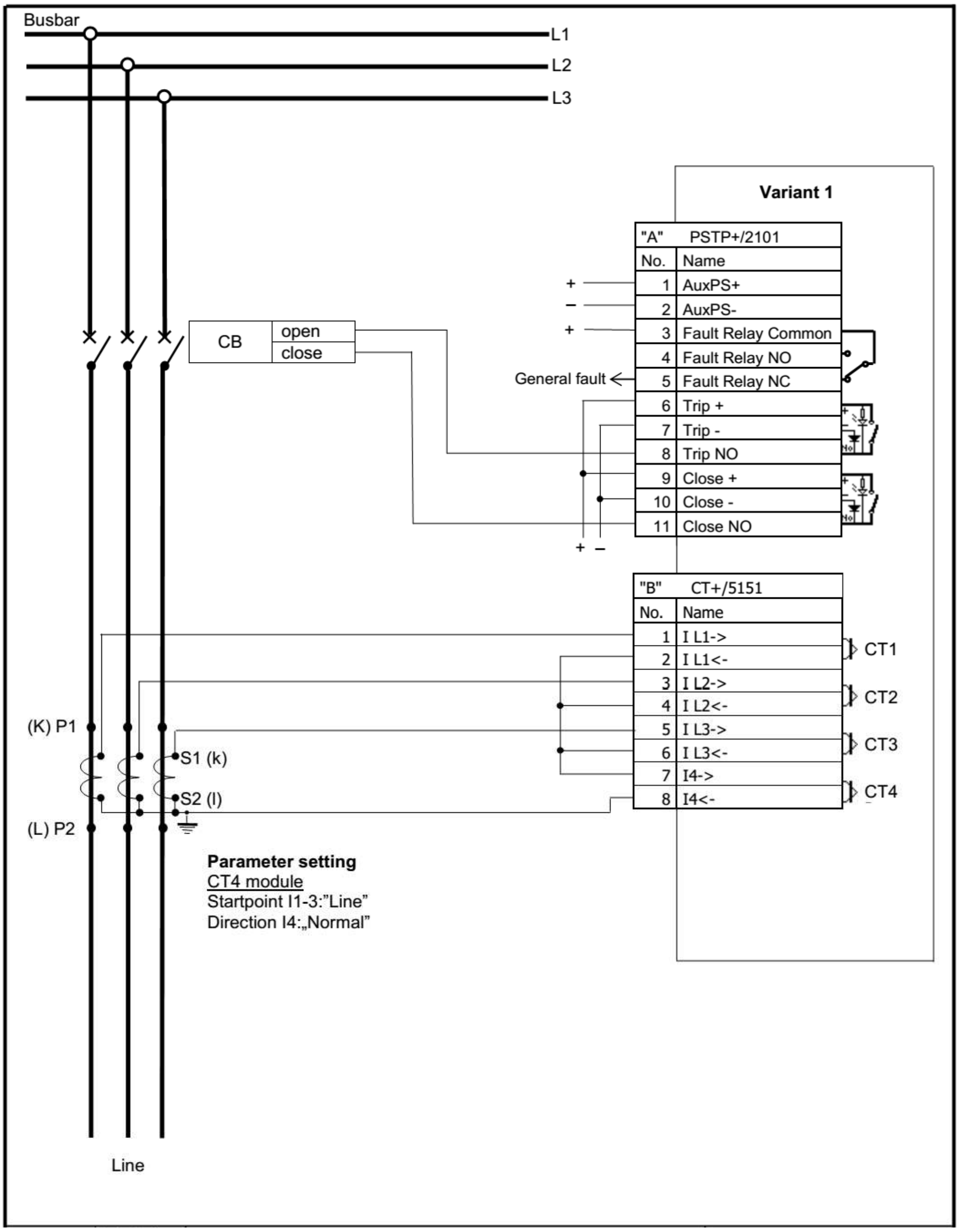
EXTERNAL CONNECTION DIAGRAM

- **S24 – Variant 0**



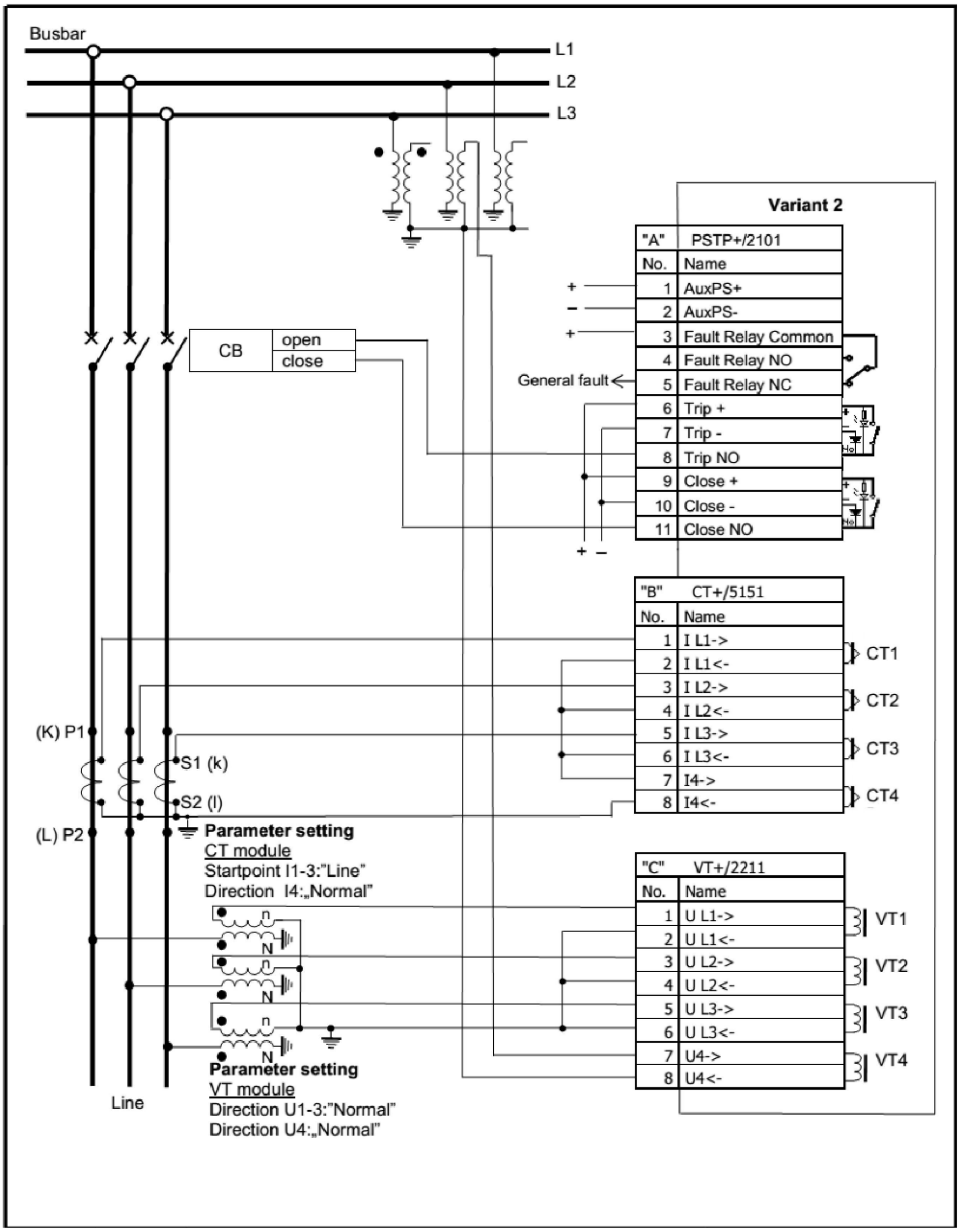
Typical connection diagram for the S24 – Variant 0

- **S24 – Variant 1**



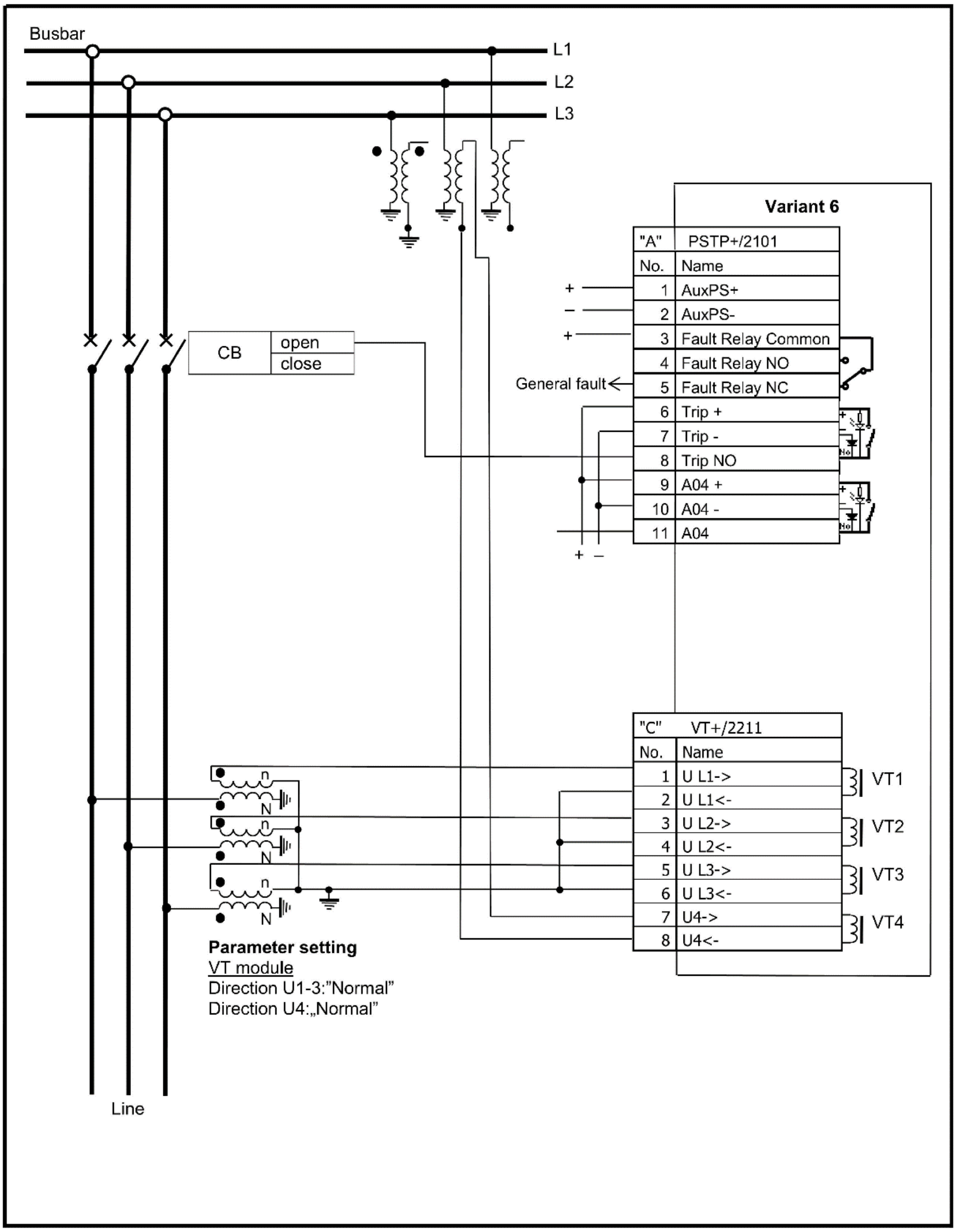
Typical connection diagram for the S24 – Variant 1

- **S24 – Variant 2**



Typical connection diagram for the S24 – Variant 2

- **S24 – Variant 6**



Typical connection diagram for the S24 – Variant 6

CONTACT

For more information, please refer to the **Europrot+ Smart Line S24 Series** configuration description document or contact us:

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