S24/U (V6)
configuration description

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S24/U RELAY OVERVIEW

The **S24/U** series is member of the ***Smartline*** product line. The ***Smartline*** 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 S24 series is contain a special selection of the PROTECTA modules, bearing in mind the cost effective realization.

The IEDs support a range of communication protocols including the IEC 61850 substation automation standard with horizontal GOOSE communication, IEC 60870-5-101, IEC 60870-5-103 and Modbus® RTU. The IED-EP+ S24 is available in six predefined standard configurations to suit the most common feeder protection and control applications.

The relay is provided with a built-in digital disturbance recorder for up to eight analog signal channels and 32 digital signal channels. The recordings are stored in a non-volatile memory from which data can be uploaded for subsequent fault analysis.

To provide network control and monitoring systems with feeder level event logs, the relay incorporates a non-volatile memory with capacity of storing 1000 event codes including time stamps. The non-volatile memory retains its data also in case the relay temporarily loses its auxiliary supply. The event log facilitates detailed pre- and post-fault analyses of feeder faults and distribution disturbances.

The trip circuit supervision continuously monitors the availability and operability of the trip circuit. It provides open circuit monitoring both when the circuit breaker is in its closed and in its open position.

The relay’s built-in self-supervision system continuously monitors the state of the relay hardware and the operation of the relay software. Any fault or malfunction detected will be used for alerting the operator. When a permanent relay fault is detected the protection functions of the relay will be completely blocked to prevent any incorrect relay operation.

CONFIGURATION DESCRIPTION

S24/U (V6) is dedicated for those application where is only voltage and frequency based protection functions are required. This chapter describes the specific application of the **S24/U (V6)** factory configuration.

Protection functions

The **S24/U (V6)** configuration measures only the three phase voltages and the selected bus voltage, which is dedicated to the synronisation. These measurements allow to the voltage-based protection functions. The main protection functions in this application: is the voltage and frequency protection function.

The configured protection functions are listed in the Table below.

Protection functions	IEC	ANSI	S24/U (V6)
Definite time overvoltage protection	U >, U >>	59	X
Definite time undervoltage protection	U <, U <<	27	X
Residual overvoltage protection	Uo >, Uo >>	59N	X
Overfrequency protection	f >, f >>	81O	X
Underfrequency protection	f <, f <<	81U	X
Rate of change of frequency protection	df/dt	81R	X
Synchro check		*25*	X
Fuse failure (VTS)		60	X

Table 1 The protection functions of the S24/U (V6) configuration

The configured functions are drawn symbolically in the Figure below.

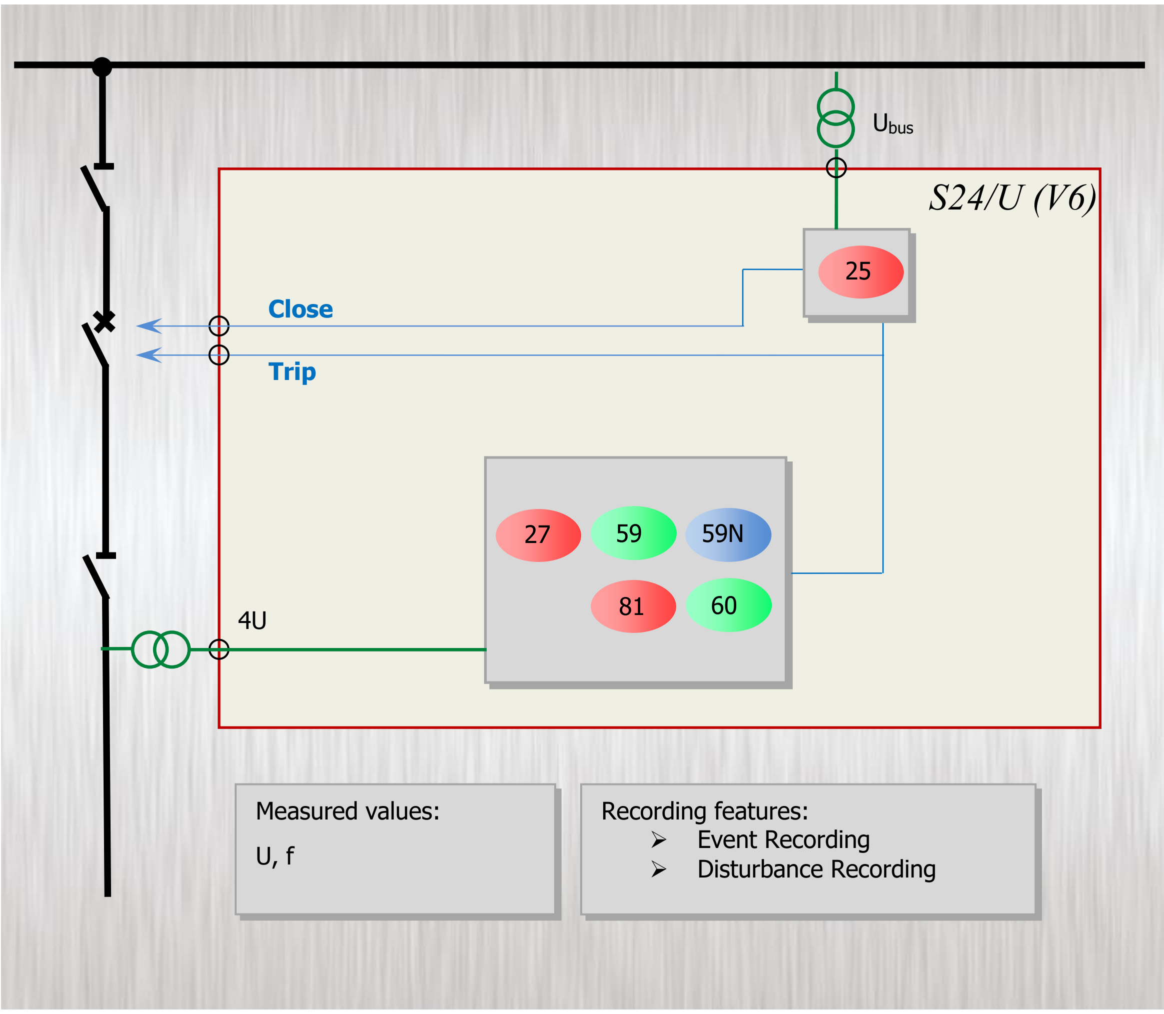


Figure 1 Implemented protection functions

Measurement functions

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

Measurement functions	S24/U (V6)
Voltage (U1, U2, U3, U12, U23, U31, Uo, Useq) and frequency	X
Supervised trip contacts (TCS)	X

Table 2 The measurement functions of the S24/U (V6) configuration

Hardware configuration	S24/U (V6)
Housing	Panel instrument enclosure (24 HP size)
Voltage inputs	4
Digital inputs	6*
Digital outputs	5*
Fast trip outputs	2 (4 A)
IRF contact	1

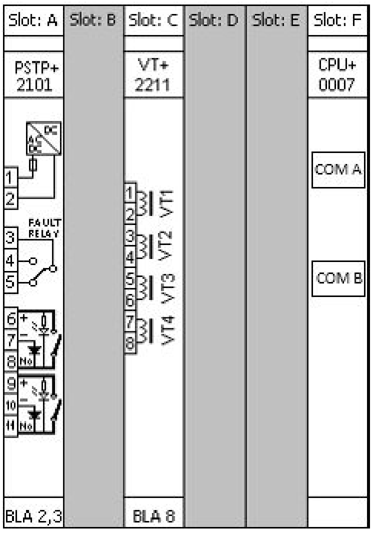
* as standard I/O card hardware configuration.

Table 3 The basic hardware configuration of the S24/U (V6) configuration

IP ratings:

- IP20 protection from rear side
- IP54 protection from front side

The module arrangement of the S24/U (V6) configuration is shown below.



I/O card options for S24/U (V6):

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

Figure 2 Module arrangement of the S24/U (V6) configuration (rear view)

Communication options for S24/U (V6):

Communication ports	No communication	Legacy protocols	IEC 61850	Redundant Ethernet
COM A	Standard	N/A	N/A	Option
COM B	Standard	Option	Option	N/A

The applied hardware modules

The applied modules are listed in **Erreur ! Source du renvoi introuvable.**.
The technical specification of the device and that of the modules are described in the document "***Hardware description***".

Module identifier	Explanation
PSTP+ xx01	Power supply unit with trip contacts
O6R5+ xx01	Binary I/O module
O12+ xx01	Binary input module
O8+ xx01	Binary input module
R8+ 00	Signal relay output module
VT+ 2211	Analog voltage input module
CPU+ xxxx	Processing and communication module

Table 4 The applied modules of the S24/U (V6) configuration

Meeting the device

The basic information for working with the ***Smartline*** devices are described in the document "***Quick start guide to the devices of the PROTECTA product line***".

Figure 3 IED EP+ S24 with B&W HMI front panel ***as standard***

Figure 4 IED EP+S24 with true colour HMI front panel ***as optional***

SOFTWARE CONFIGURATION

Protection and control functions

The implemented protection and control functions are listed in **Erreur ! Source du renvoi introuvable.**. The function blocks are described in details in separate documents. These are referred to also in this table.

The range of the parameter settings of the following function blocks can be modified, if it doesn't correspond to the costumer's request. In this case please, contact to the developer team on the Protecta Support Site: http://buy.protecta.hu/support/

Name	Title	Document
TOV59_high TOV59_low	Overvoltage	***Definite time overvoltage protection function block description***
TUV27_high TUV27_low	Undervoltage	***Definite time undervoltage protection function block description***
TOV59N_high TOV59N_low	Res. Overvoltage	***Residual definite time overvoltage protection function block description***
TOF81_high TOF81_low	Overfrequency	***Overfrequency protection function block description***
TUF81_high TUF81_low	Underfrequency	***Underfrequency protection function block description***
FRC81_high FRC81_low	ROC of frequency	***Rate of change of frequency protection function block description***
SYN25	Syncro Check	***Synchro check***
VTS60	Voltage transformer supervision	***Voltage transformer supervision function block description***
TRC94	Trip Logic	***Trip logic function block description***
VT4		***Voltage input function block description***
MXU_V	Voltage measurement	
MXU_f	Frequency measurement	

Table 1 Implemented protection and control functions

Definite time overvoltage protection function (TOV59)

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 TOV59 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 overvoltaget 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.

Technical data

Function	Value	Accuracy
Pick-up starting accuracy		< ± 0,5 %
Blocking voltage		< ± 1,5 %
Reset time U< → Un U< → 0	 60 ms 50 ms	
Operate time accuracy		< ± 20 ms
Minimum operate time	50 ms	

Table 2 Technical data of the definite time overvoltage protection function

Parameters

Enumerated parameter

Parameter name	Title	Selection range	Default
Enabling or disabling the overvoltage protection function			
TOV59_Oper_EPar_	Operation	Off, On	On

Table 3 The enumerated parameter of the definite time overvoltage protection function

Integer parameter

Parameter name	Title	Unit	Min	Max	Step	Default
Voltage level setting. If the measured voltage is above the setting value, the function generates a start signal.						
TOV59_StVol_IPar_	Start Voltage	%	30	130	1	63

Table 4 The integer parameter of the definite time overvoltage protection function

Boolean parameter

Parameter name	Title	Default
Enabling start signal only:		
TOV59_StOnly_BPar_	Start Signal Only	FALSE

Table 5 The boolean parameter of the definite time overvoltage protection function

Timer parameter

Parameter name	Title	Unit	Min	Max	Step	Default
Time delay of the overvoltage protection function.						
TOV59_Delay_TPar_	Time Delay	ms	0	60000	1	100

Table 6 The timer parameter of the definite time overvoltage protection function

Definite time undervoltage protection function (TUV27)

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.

Technical data

Function	**Value**	**Accuracy**
Pick-up starting accuracy		< ± 0,5 %
Blocking voltage		< ± 1,5 %
Reset time U> → Un U> → 0	 50 ms 40 ms	
Operate time accuracy		< ± 20 ms
Minimum operate time	50 ms	

Table 7 Technical data of the definite time undervoltage protection function

Parameters

Enumerated parameter

Parameter name	**Title**	**Selection range**	**Default**
Parameter for type selection			
TUV27_Oper_EPar_	Operation	Off, 1 out of 3, 2 out of 3, All	1 out of 3

Table 8 The enumerated parameter of the definite time undervoltage protection function

Integer parameters

Parameter name	**Title**	**Unit**	**Min**	**Max**	**Step**	**Default**
Starting voltage level setting						
TUV27_StVol_IPar_	Start Voltage	%	30	130	1	52
Blocking voltage level setting						
TUV27_BlkVol_IPar_	Block Voltage	%	0	20	1	10

Table 9 The integer parameters of the definite time undervoltage protection function

Boolean parameter

Parameter name	**Title**	**Default**
Enabling start signal only:		
TUV27_StOnly_BPar_	Start Signal Only	FALSE

Table 10 The boolean parameter of the definite time undervoltage protection function

Timer parameters

Parameter name	**Title**	**Unit**	**Min**	**Max**	**Step**	**Default**
Time delay of the undervoltage protection function.						
TUV27_Delay_TPar_	Time Delay	ms	0	60000	1	100

Table 11 The timer parameter of the definite time undervoltage protection function

Residual definite time overvoltage protection function (TOV59N)

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.

Technical data

Function	Value	Accuracy
Pick-up starting accuracy	2 – 8 % 8 – 60 %	< ± 2 % < ± 1.5 %
Reset time U> → Un U> → 0	 60 ms 50 ms	
Operate time	50 ms	< ± 20 ms

Table 12 Technical data of the residual definite time overvoltage protection function

Parameters

Enumerated parameter

Parameter name	Title	Selection range	Default
Parameter for enabling/disabling:			
TOV59N_Oper_EPar_	Operation	Off, On	On

Table 13 The enumerated parameter of the residual definite time overvoltage protection function

Integer parameter

Parameter name	Title	Unit	Min	Max	Step	Default
Starting voltage parameter:						
TOV59N_StVol_IPar_	Start Voltage	%	2	60	1	30

Table 14 The integer parameter of the residual definite time overvoltage protection function

Boolean parameter

Parameter name	Title	Default
Enabling start signal only:		
TOV59N_StOnly_BPar_	Start Signal Only	FALSE

Table 15 The boolean parameter of the residual definite time overvoltage protection function

Timer parameter

Parameter name	Title	Unit	Min	Max	Step	Default
Definite time delay:						
TOV59N_Delay_TPar_	Time Delay	ms	0	60000	1	100

Table 16 The time parameter of the residual definite time overvoltage protection function

Over-frequency protection function (TOF81)

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.

Accurate frequency measurement is also the criterion for the synchro-check and synchro-switch functions. The accurate frequency measurement is performed by measuring the time period between two rising edges at zero crossing of a voltage signal. For the acceptance of the measured frequency, at least four subsequent identical measurements are needed. Similarly, four invalid measurements are needed to reset the measured frequency to zero. The basic criterion is that the evaluated voltage should be above 30% of the rated voltage value.

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.

Technical data

Function	Range	Accuracy
Operate range	40 - 70 Hz	30 mHz
Effective range	45 - 55 Hz / 55 - 65 Hz	2 mHz
Operate time		min 140 ms
Time delay	140 – 60000 ms	± 20 ms
Reset ratio		0,99

Table 17 Technical data of the over-frequency protection function

Parameters

Enumerated parameter

Parameter name	Title	Selection range	Default
Selection of the operating mode			
TOF81_Oper_EPar_	Operation	Off,On	On

Table 18 The enumerated parameter of the over-frequency protection function

Boolean parameter

Parameter name	Title	Default
Enabling start signal only:		
TOF81_StOnly_BPar_	Start Signal Only	FALSE

Table 19 The boolean parameter of the over-frequency protection function

Float point parameter

Parameter name	Title	Unit	Min	Max	Step	Default
Setting value of the comparison						
TOF81_St_FPar_	Start Frequency	Hz	40	60	0.01	51

Table 20 The float point parameter of the over-frequency protection function

Timer parameter

Parameter name	Title	Unit	Min	Max	Step	Default
Time delay						
TOF81_Del_TPar_	Time Delay	msec	100	60000	1	200

Table 21 The timer parameter of the over-frequency protection function

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 accurate frequency measurement is performed by measuring the time period between two rising edges at zero crossing of a voltage signal. For the acceptance of the measured frequency, at least four subsequent identical measurements are needed. Similarly, four invalid measurements are needed to reset the measured frequency to zero. The basic criterion is that the evaluated voltage should be above 30% of the rated voltage value.

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.

Technical data

Function	Range	Accuracy
Operate range	40 - 70 Hz	30 mHz
Effective range	45 - 55 Hz / 55 - 65 Hz	2 mHz
Operate time		min 140 ms
Time delay	140 – 60000 ms	± 20 ms
Reset ratio		0,99

Table 22 Technical data of the under-frequency protection function

Parameters

Enumerated parameter

Parameter name	Title	Selection range	Default
Selection of the operating mode			
TUF81_Oper_EPar_	Operation	Off, On	On

Table 23 The enumerated parameter of the under-frequency protection function

Boolean parameter

Parameter name	Title	Default
Enabling start signal only:		
TUF81_StOnly_BPar_	Start Signal Only	FALSE

Table 24 The boolean parameter of the under-frequency protection function

Float point parameter

Parameter name	Title	Unit	Min	Max	Digits	Default
Preset value of the comparison						
TUF81_St_FPar_	Start Frequency	Hz	40	60	0.01	49

Table 25 The float point parameter of the under-frequency protection function

Timer parameter

Parameter name	Title	Unit	Min	Max	Step	Default
Time delay						
TUF81_Del_TPar_	Time Delay	ms	100	60000	1	200

Table 26 The timer parameter of the under-frequency protection function

Rate of change of frequency protection function (FRC81)

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.

Accurate frequency measurement is also the criterion for the synchro-switch function.

The source for the rate of change of frequency calculation is an accurate frequency measurement.

In some applications, the frequency is measured based on the weighted sum of the phase voltages.

The accurate frequency measurement is performed by measuring the time period between two rising edges at zero crossing of a voltage signal. For the acceptance of the measured frequency, at least four subsequent identical measurements are needed. Similarly, four invalid measurements are needed to reset the measured frequency to zero. The basic criterion is that the evaluated voltage should be above 30% of the rated voltage value.

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.

Technical data

Function	Effective range	Accuracy
Operating range	-5 - -0.05 and +0.05 - +5 Hz/sec	
Pick-up accuracy		±20 mHz/sec
Operate time	min 140 ms	
Time delay	140 – 60000 ms	± 20 ms

Table 27 Technical data of the rate of change of frequency protection function

Parameters

Enumerated parameter

Parameter name	Title	Selection range	Default
Selection of the operating mode			
FRC81_Oper_EPar_	Operation	Off,On	On

Table 28 The enumerated parameter of the rate of change of frequency protection function

Boolean parameter

Parameter name	Title	Default
Enabling start signal only:		
FRC81_StOnly_BPar_	Start Signal Only	True

Table 29 The boolean parameter of the rate of change of frequency protection function

Float point parameter

Parameter name	Title	Unit	Min	Max	Step	Default
Setting value of the comparison						
FRC81_St_FPar_	Start df/dt	Hz/sec	-5	5	0.01	0.5

Table 30 The float point parameter of the rate of change of frequency protection function

Timer parameters

Parameter name	Title	Unit	Min	Max	Step	Default
Time delay						
FRC81_Del_TPar_	Time Delay	msec	100	60000	1	200

Table 31 The timer parameter of the rate of change of frequency protection function

Synchro check, synchro switch function

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.

The conditions for safe closing are as follows:

- The difference of the voltage magnitudes is below the declared limit,
- The difference of the frequencies is below the declared limit and
- The angle difference between the voltages on both sides of the circuit breaker is within the declared limit.

The function processes both automatic reclosing and manual close commands.

The limits for automatic reclosing and manual close commands can be set independently of each other.

The function compares the voltage of the line and the voltage of one of the bar sections (Bus1 or Bus2). The bus selection is made automatically based on a binary input signal defined by the user applying the graphic equation editor.

As to voltages: any phase-to-ground or phase-to-phase voltage can be selected.

The function processes the signals of the voltage transformer supervision function and enables the close command only in case of plausible voltages.

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)

If the conditions for "Energizing check" or "Synchro check" are fulfilled, then the function generates the release command, and in case of a manual or automatic close request, the close command is generated.

If the conditions for energizing or synchronous operation are not met when the close request is received, then synchronous switching is attempted within the set time-out. In this case, the rotating vectors must fulfill the conditions for safe switching within the declared waiting time: at the moment the contacts of the circuit breaker are closed, the voltage vectors must match each other with appropriate accuracy. For this mode of operation, the expected operating time of the circuit breaker must be set as a parameter value, to generate the close command in advance taking the relative vector rotation speed into consideration.

The started checking procedure can be interrupted by a cancel command defined by the user in the graphic equation editor.

In "bypass" operation mode, the function generates the release signals and simply transmits the close command.

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.

Technical data

Function	Effective range	Accuracy in the effective range
Rated Voltage Un	100/200V, parameter setting	
Voltage effective range	10-110 % of Un	±1% of Un
Frequency	47.5 – 52.5 Hz	±10 mHz
Phase angle		±3 °
Operate time	Setting value	±3 ms
Reset time	<50 ms	
Reset ratio	0.95 Un	

Parameters

Enumerated parameters

Parameter name	Title	Selection range	Default
Selection of the processed voltage			
SYN25_VoltSel_EPar_	Voltage Select	L1-N,L2-N,L3-N,L1-L2,L2-L3,L3-L1	L1-N
Operation mode for automatic switching			
SYN25_OperA_EPar_	Operation Auto	Off, On, ByPass	On
Enabling/disabling automatic synchro switching			
SYN25_SwOperA_EPar_	SynSW Auto	Off, On	On
Energizing mode for automatic switching			
SYN25_EnOperA_EPar_	Energizing Auto	Off, DeadBus LiveLine, LiveBus DeadLine, Any energ case	DeadBus LiveLine
Operation mode for manual switching			
SYN25_OperM_EPar_	Operation Man	Off, On, ByPass	On
Enabling/disabling manual synchro switching			
SYN25_SwOperM_EPar_	SynSW Man	Off, On	On
Energizing mode for manual switching			
SYN25_EnOperM_EPar_	Energizing Man	Off,DeadBus LiveLine, LiveBus DeadLine, Any energ case	DeadBus LiveLine

Integer parameters

Parameter name	Title	Unit	Min	Max	Step	Default
Voltage limit for "live line" detection						
SYN25_LiveU_IPar_	U Live	%	60	110	1	70
Voltage limit for "dead line" detection						
SYN25_DeadU_IPar_	U Dead	%	10	60	1	30
Voltage difference for automatic synchro checking mode						
SYN25_ChkUdA_IPar_	Udiff SynCheck Auto	%	5	30	1	10
Voltage difference for automatic synchro switching mode						
SYN25_SwUdA_IPar_	Udiff SynSW Auto	%	5	30	1	10
Phase difference for automatic switching						
SYN25_MaxPhDiffA_IPar_	MaxPhaseDiff Auto	deg	5	80	1	20
Voltage difference for manual synchro checking mode						
SYN25_ChkUdM_IPar_	Udiff SynCheck Man	%	5	30	1	10
Voltage difference for manual synchro switching mode						
SYN25_SwUdM_IPar_	Udiff SynSW Man	%	5	30	1	10
Phase difference for manual switching						
SYN25_MaxPhDiffM_IPar_	MaxPhaseDiff Man	deg	5	80	1	20

Floating point parameters

Parameter name	Title	Dim.	Min	Max	Default
Frequency difference for automatic synchro checking mode					
SYN25_ChkFrDA_FPar_	FrDiff SynCheck Auto	Hz	0.02	0.5	0.02
Frequency difference for automatic synchro switching mode					
SYN25_SwFrDA_FPar_	FrDiff SynSW Auto	Hz	0.10	1.00	0.2
Frequency difference for manual synchro checking mode					
SYN25_ChkFrDM_FPar_	FrDiff SynCheck Man	Hz	0.02	0.5	0.02
Frequency difference for manual synchro switching mode					
SYN25_SwFrDM_FPar_	FrDiff SynSW Man	Hz	0.10	1.00	0.2

Timer parameters

Parameter name	Title	Unit	Min	Max	Step	Default
Breaker operating time at closing						
SYN25_CBTrav_TPar_	Breaker Time	msec	0	500	1	80
Impulse duration for close command						
SYN25_SwPu_TPar_	Close Pulse	msec	10	60000	1	1000
Maximum allowed switching time						
SYN25_MaxSw_TPar_	Max Switch Time	msec	100	60000	1	2000

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.

(Another method for detecting voltage disturbances is the supervision of the auxiliary contacts of the miniature circuit breakers in the voltage transformer secondary circuits. This function is not described here.)

The user has to generate graphic equations for the application of the signal of this voltage transformer supervision function.

This function is interconnected with the "dead line detection function". Although the dead line detection function is described fully in a separate document, the explanation necessary to understand the operation of the VT supervision function is repeated also in this document.

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.)

NOTE: For the operation of the voltage transformer supervision function the " Dead line detection function" must be operable as well: it must be enabled by binary parameter setting, and its blocking signal may not be active.

If, in the active state, the conditions for operation are no longer fulfilled, the resetting of the function depends on the mode of operation of the primary circuit:

- If the "Live line" state is valid, then the function resets after approx. 200 ms of time delay. (When evaluating this time delay, the natural operating time of the applied Fourier algorithm must also be considered.)
- If the "Dead line" state is started and the "VTS Failure" signal has been continuous for at least 100 ms, then the "VTS failure" signal does not reset; it is generated continuously even when the line is in a disconnected state. Thus, the "VTS Failure" signal remains active at reclosing.
- If the "Dead line" state is started and the "VTS Failure" signal has not been continuous for at least 100 ms, then the "VTS failure" signal resets.

Technical data

Function	Value	Accuracy
Pick-up voltage Io=0A I2=0A		 <1% <1%
Operation time	<20ms	
Reset ratio	0.95	

Table 32 Technical data of the voltage transformer supervision function

Parameters

Integer parameters

Parameter name	Title	Unit	Min	Max	Step	Default
Integer parameters of the dead line detection function						
DLD_ULev_IPar_	Min Operate Voltage	%	10	100	1	60
DLD_ILev_IPar_	Min Operate Current	%	2	100	1	10
Starting voltage and current parameter for residual and negative sequence detection:						
VTS_Uo_IPar_	Start URes	%	5	50	1	30
VTS_Io_IPar_	Start IRes	%	10	50	1	10
VTS_Uneg_IPar_	Start UNeg	%	5	50	1	10
VTS_Ineg_IPar_	Start INeg	%	10	50	1	10

Table 33 The integer parameters of the voltage transformer supervision function

Enumerated parameter

Parameter name	Title	Selection range	Default
Parameter for type selection			
VTS_Oper_EPar_	Operation	Off, Zero sequence, Neg. sequence, Special	Zero sequence

Table 34 The enumerated parameter of the voltage transformer supervision function

The simple trip logic function operates according to the functionality required by the IEC 61850 standard for the "Trip logic logical node". This simplified software module can be applied if only three-phase trip commands are required, that is, phase selectivity is not applied.

The function receives the trip requirements of the protective functions implemented in the device and combines the binary signals and parameters to the outputs of the device.

The trip requirements are programmed by the user, using the graphic equation editor. The aim of the decision logic is to define a minimal impulse duration even if the protection functions detect a very short-time fault.

Technical data

Function		Accuracy
Impulse time duration	Setting value	<3 ms

Table 35 Technical data of the simple trip logic function

Parameters

Enumerated parameter

Parameter name	Title	Selection range	Default
Selection of the operating mode			
TRC94_Oper_EPar_	Operation	Off, On	On

Tables 36 The enumerated parameter of the decision logic

Timer parameter

Parameter name	Title	Unit	Min	Max	Step	Default
Minimum duration of the generated impulse						
TRC94_TrPu_TPar_	Min Pulse Duration	msec	50	60000	1	150

Table 37 Timer parameter of the decision logic

MEASURING FUNCTIONS

The measured values can be checked on the touch-screen of the device in the "On-line functions" page, or using an Internet browser of a connected computer. The displayed values are secondary voltages and currents, except the block "Voltage measurement". This specific block displays the measured values in primary units, using VT primary value settings.

Analog value	Explanation
VT4 module	
Voltage Ch – U1	RMS value of the Fourier fundamental harmonic voltage component in phase L1
Angle Ch – U1	Phase angle of the Fourier fundamental harmonic voltage component in phase L1*
Voltage Ch – U2	RMS value of the Fourier fundamental harmonic voltage component in phase L2
Angle Ch – U2	Phase angle of the Fourier fundamental harmonic voltage component in phase L2*
Voltage Ch – U3	RMS value of the Fourier fundamental harmonic voltage component in phase L3
Angle Ch – U3	Phase angle of the Fourier fundamental harmonic voltage component in phase L3*
Voltage Ch – U4	RMS value of the Fourier fundamental harmonic voltage component in Channel U4
Angle Ch – U4	Phase angle of the Fourier fundamental harmonic voltage component in Channel U4*
Synchrocheck function (SYN25)	
Voltage Diff	Voltage different value
Frequency Diff	Frequency different value
Angle Diff	Angle different value
Line measurement (MXU_L) (here the displayed information means primary value)	
Voltage L1	True RMS value of the voltage in phase L1
Voltage L2	True RMS value of the voltage in phase L2
Voltage L3	True RMS value of the voltage in phase L3
Voltage L12	True RMS value of the voltage between phases L1 L2
Voltage L23	True RMS value of the voltage between phases L2 L3
Voltage L31	True RMS value of the voltage between phases L3 L1
U4	True RMS value of the voltage in channel 4 (Ubus)
Frequency	Frequency

* *The reference angle is the phase angle of "Voltage Ch - U1"*

Table 1 Measured analog values

VOLTAGE INPUT FUNCTION (VT4)

If the factory configuration includes a voltage transformer hardware module, the voltage input function block is automatically configured among the software function blocks. Separate voltage input function blocks are assigned to each voltage transformer hardware module.

A voltage transformer hardware module is equipped with four special intermediate voltage transformers. As usual, the first three voltage inputs receive the three phase voltages (UL1, UL2, UL3), the fourth input is reserved for zero sequence voltage or for a voltage from the other side of the circuit breaker for synchron switching. All inputs have a common parameter for type selection: 100V or 200V.

Additionally, there is a correction factor available if the rated secondary voltage of the main voltage transformer (e.g. 110V) does not match the rated input of the device.

The role of the voltage input function block is to

- set the required parameters associated to the voltage inputs,
- deliver the sampled voltage values for disturbance recording,
- perform the basic calculations
    - Fourier basic harmonic magnitude and angle,
    - True RMS value;
- provide the pre-calculated voltage values to the subsequent software modules,
- deliver the basic calculated values for on-line displaying.

Operation of the voltage input algorithm

The voltage input function block receives the sampled voltage values from the internal operating system. The scaling (even hardware scaling) depends on parameter setting. See the parameter VT4_Type_EPar_ (Range). The options to choose from are 100V or 200V. This parameter influences the internal number format and, naturally, accuracy. (A small voltage is processed with finer resolution if 100V is selected.)

The connection of the first three VT secondary winding must be set to reflect actual physical connection. The associated parameter is VT4_Ch13Nom_EPar_ (Connection U1-3). The selection can be: Ph-N, Ph-Ph or Ph-N-Isolated.

The Ph-N option is applied in solidly grounded networks, where the measured phase voltage is never above 1.5-Un. In this case the primary rated voltage of the VT must be the value of the rated PHASE-TO-NEUTRAL voltage.

The Ph-N option is applied in compensated or isolated networks, where the measured phase voltage can be above 1.5-Un even in normal operation. In this case the primary rated voltage of the VT must be the value of the rated PHASE-TO-PHASE voltage.

If phase-to-phase voltage is connected to the VT input of the device, then the Ph-Ph option is to be selected. Here, the primary rated voltage of the VT must be the value of the rated PHASE-TO-PHASE voltage. This option must not be selected if the distance protection function is supplied from the VT input.

The fourth input is reserved for zero sequence voltage or for a voltage from the other side of the circuit breaker for synchron switching. Accordingly, the connected voltage must be identified with parameter setting VT4_Ch4Nom_EPar_ (Connection U4). Here, phase-to-neutral or phase-to-phase voltage can be selected: Ph-N,Ph-Ph

If needed, the phase voltages can be inverted by setting the parameter VT4_Ch13Dir_EPar_ (Direction U1-3). This selection applies to each of the channels UL1, UL2 and UL3. The fourth voltage channel can be inverted by setting the parameter VT4_Ch4Dir_EPar_ (Direction U4). This inversion may be needed in protection functions such as distance protection, differential protection or for any functions with directional decision, or for checking the voltage vector positions.

Additionally, there is a correction factor available if the rated secondary voltage of the main voltage transformer (e.g. 110V) does not match the rated input of the device. The related parameter is VT4_CorrFact_IPar_ (VT correction). As an example: if the rated secondary voltage of the main voltage transformer is 110V, then select Type 100 for the parameter "Range" and the required value to set here is 110%.

These sampled values are available for further processing and for disturbance recording.

The performed basic calculation results the Fourier basic harmonic magnitude and angle and the true RMS value of the voltages. These results are processed by subsequent protection function blocks and they are available for on-line displaying as well.

The function block also provides parameters for setting the primary rated voltages of the main voltage transformer. This function block does not need that parameter setting. These values are passed on to function blocks such as displaying primary measured values, primary power calculation, etc. Concerning the rated voltage, see the instructions related to the parameter for the connection of the first three VT secondary winding.

Parameters

Enumerated parameters

Parameter name	Title	Selection range	Default
Rated secondary voltage of the input channels. 100 V or 200V is selected by parameter setting, no hardware modification is needed.			
VT4_Type_EPar_	Range	Type 100,Type 200	Type 100
Connection of the first three voltage inputs (main VT secondary)			
VT4_Ch13Nom_EPar_	Connection U1-3	Ph-N, Ph-Ph, Ph-N-Isolated	Ph-N
Selection of the fourth channel input: phase-to-neutral or phase-to-phase voltage			
VT4_Ch4Nom_EPar_	Connection U4	Ph-N,Ph-Ph	Ph-Ph
Definition of the positive direction of the first three input channels, given as normal or inverted			
VT4_Ch13Dir_EPar_	Direction U1-3	Normal,Inverted	Normal
Definition of the positive direction of the fourth voltage, given as normal or inverted			
VT4_Ch4Dir_EPar_	Direction U4	Normal,Inverted	Normal

Table 1 The enumerated parameters of the voltage input function

Integer parameter

Parameter name	Title	Unit	Min	Max	Step	Default
Voltage correction						
VT4_CorrFact_IPar_	VT correction	%	100	115	1	100

Table 2 The integer parameter of the voltage input function

Floating point parameters

Parameter name	Title	Dim.	Min	Max	Default
Rated primary voltage of channel1					
VT4_PriU1_FPar	Rated Primary U1	kV	1	1000	100
Rated primary voltage of channel2					
VT4_PriU2_FPar	Rated Primary U2	kV	1	1000	100
Rated primary voltage of channel3					
VT4_PriU3_FPar	Rated Primary U3	kV	1	1000	100
Rated primary voltage of channel4					
VT4_PriU4_FPar	Rated Primary U4	kV	1	1000	100

Table 3 The floating point parameters of the voltage input function

NOTE: The rated primary voltage of the channels is not needed for the voltage input function block itself. These values are passed on to the subsequent function blocks.

Function	Range	Accuracy
Voltage accuracy	30% … 130%	< 0.5 %

Table 4 Technical data of the voltage input

Measured values

Measured value	Dim.	Explanation
Voltage Ch - U1	V(secondary)	Fourier basic component of the voltage in channel UL1
Angle Ch - U1	degree	Vector position of the voltage in channel UL1
Voltage Ch – U2	V(secondary)	Fourier basic component of the voltage in channel UL2
Angle Ch – U2	degree	Vector position of the voltage in channel UL2
Voltage Ch – U3	V(secondary)	Fourier basic component of the voltage in channel UL3
Angle Ch – U3	degree	Vector position of the voltage in channel UL3
Voltage Ch – U4	V(secondary)	Fourier basic component of the voltage in channel U4
Angle Ch – U4	degree	Vector position of the voltage in channel U4

Table 5 The measured analogue values of the voltage input function

NOTE1: The scaling of the Fourier basic component is such if pure sinusoid 57V RMS of the rated frequency is injected, the displayed value is 57V. (The displayed value does not depend on the parameter setting values "Rated Secondary".)

NOTE2: The reference vector (vector with angle 0 degree) is the vector calculated for the first voltage input channel of the first applied voltage input module.

The figure below shows an example of how the calculated Fourier components are displayed in the on-line block.

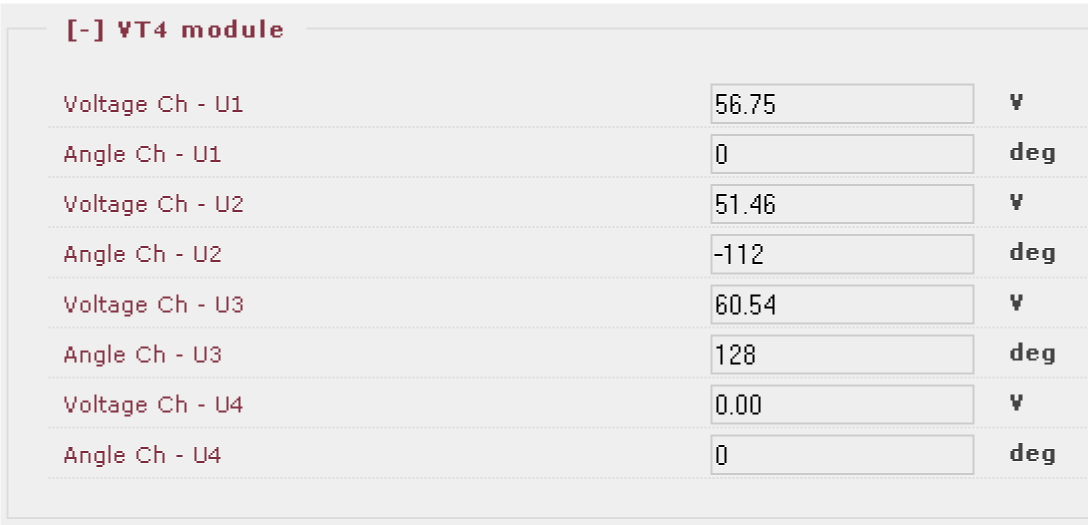


Figure 1 Example: On-line displayed values for the voltage input module

DISTURBANCE RECORDER

The S24/U (V6) configuration contains a disturbance recorder function. The details are described in the document shown in **Erreur ! Source du renvoi introuvable.**.

Name	Title	Document
DRE	Disturbance Rec	***Disturbance recorder function block description***

Table 1 Implemented disturbance recorder function

The recorded analog channels:

Recorded analog signal	Explanation
UL1	Measured voltage of line 1
UL2	Measured voltage of line 2
UL3	Measured voltage of line 3
U4	Measured voltage of the fourth voltage input channel (Ubus)

Table 2 Disturbance recorder, recorded analog channels

The recorded binary channels:

Recorded binary signal	Explanation
Trip	Trip command of the trip logic function
Overfreq. Start Low	Low setting stage start signal of the overfrequency prot. function
Overfreq. Start High	High setting stage start signal of the overfrequency prot. function
Overfreq. Trip Low	Low setting stage trip command of the overfrequency prot. function
Overfreq. Trip High	High setting stage trip command of the overfrequency prot. function
Underfreq. Start Low	Low setting stage start signal of the underfrequency prot. function
Underfreq. Start High	High setting stage start signal of the underfrequency prot. function
Underfreq. Trip Low	Low setting stage trip command of the underfrequency prot. function
Underfreq. Trip High	High setting stage trip command of the underfrequency prot. function
ROC of Freq. Start	Start signal of the rate of change of frequency prot. function
ROC of Freq. Trip	Trip command of the rate of change of frequency prot. function
Overvoltage Start Low	Low setting stage start signal of the definite time overvoltage prot.
Overvoltage Start High	High setting stage start signal of the definite time overvoltage prot.
Overvoltage Trip Low	Low setting stage trip command of the definite time overvoltage prot.
Overvoltage Trip High	High setting stage trip command of the definite time overvoltage prot.
Res OV Start Low	Low setting stage start signal of the residual overvoltage prot.
Res OV Start High	High setting stage start signal of the residual overvoltage prot.
Res OV Trip Low	Low setting stage trip command of the residual overvoltage prot.
Res OV Trip High	High setting stage trip command of the residual overvoltage prot.
Undervoltage Start Low	Low setting stage start signal of the definite time undervoltage prot.
Undervoltage Start High	High setting stage start signal of the def. time undervoltage prot.
Undervoltage Trip Low	Low setting stage trip command of the definite time undervoltage prot.
SYN Release Auto	Release auto signal of the synchrocheck function
SYN Release Manaul	Release manual signal of the synchrocheck function

Table 3 Disturbance recorder, recorded binary channels

Enumerated parameter

Parameter name	Title	Selection range	Default
Parameter for activation			
DRE_Oper_EPar_	Operation	Off, On	Off

Table 4 The enumerated parameter of the disturbance recorder function

Timer parameters

Parameter name	Title	Unit	Min	Max	Step	Default
Pre-fault time:						
DRE_PreFault_TPar_	PreFault	msec	100	1000	1	200
Post-fault time:						
DRE_PostFault_TPar_	PostFault	msec	100	1000	1	200
Overall-fault time limit:						
DRE_MaxFault_TPar_	MaxFault	msec	500	10000	1	1000

Table 5 The timer parameters of the disturbance recorder function

TRIP CONTACT ASSIGNMENT

The procedures of command processing are shown in the following symbolical figure.

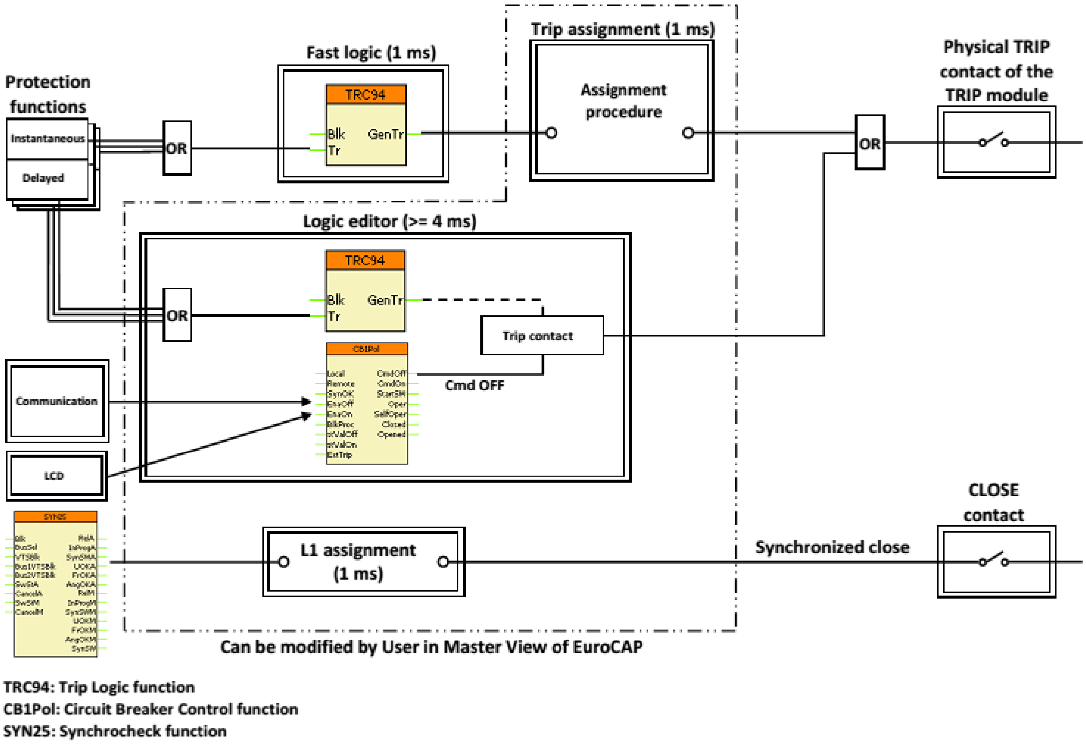


Figure 1 Principle of TRIP command processing

The left side of the Figure shows the available sources of the trip commands:

- The function blocks, configured in the device,
- The communication channels to the SCADA system,
- Commands generated using the front panel LCD of the device,
- Any other binary signals, e.g. signals from the binary inputs of the device.

The right side of the Figure shows one of the TRIP relays symbolically. The Figure provides a survey of the configured trip command processing methods. In the middle of the Figure, the locations indicated by "User" shows the possibilities for the user to modify the procedures. All other parts are factory programmed. The detailed description of the TRIP command processing can be found on the website in the following document: "**Application of high – speed TRIP contacts"**.

The outputs of the "Simplified trip logic function" are connected directly to the contacts of the trip module (PSTP+/2101 module in position "A").

Binary status signal	**Title**	Connected to the contact PSTP+/2101 module in position "A"
TRC94_GenTr_GrI_	General Trip	Trip

Table 1 The connected signals of the phase-selective trip logic function

To the inputs of the "phase-selective trip logic function" some signals are assigned during factory configuration, some signals however depend on the programming by the user**. The conditions are defined by the user applying the graphic equation editor.** The factory defined inputs and the user defined inputs are in "**OR**" relationship.

Input	Binary status signal	Explanation
3Ph Trip	-	-
Block	n.a.	Blocking the outputs of the phase-selective trip logic function

Table 2 The factory defined binary input signals of the trip logic function

The user defined signals are listed in **Erreur ! Source du renvoi introuvable.**.

Input	Binary status signal	Explanation
3ph Trip	TOV59_GenTr_GrI_1 TOV59_GenTr_GrI_2 OR TUV27_GenTr_GrI_1 TUV27_GenTr_GrI_2 OR TOV59N_GenTr_GrI_1 TOV59N_GenTr_GrI_2 OR TOF81_GenSt_GrI_1 TOF81_GenSt_GrI_2 OR TUF81_GenSt_GrI_1 TUF81_GenSt_GrI_2 OR FRC81_GenTr_GrI_	General trip command of the overvoltage protection function stage 1 and stage 2 OR General trip command of the overvoltage protection function stage 1 and 2 OR General trip command of the Res. overvoltage protection function stage 1 and 2 OR General trip command of the overfrequency protection function stage 1 and 2 OR General trip command of the underfrequency protection function stage 1 and 2 OR General trip command of the rate of change of frequency
Block	TRC94_Blk_GrO_	Blocking the outputs of the phase-selective trip logic function

Table 3 The user defined binary input signals of the trip logic function

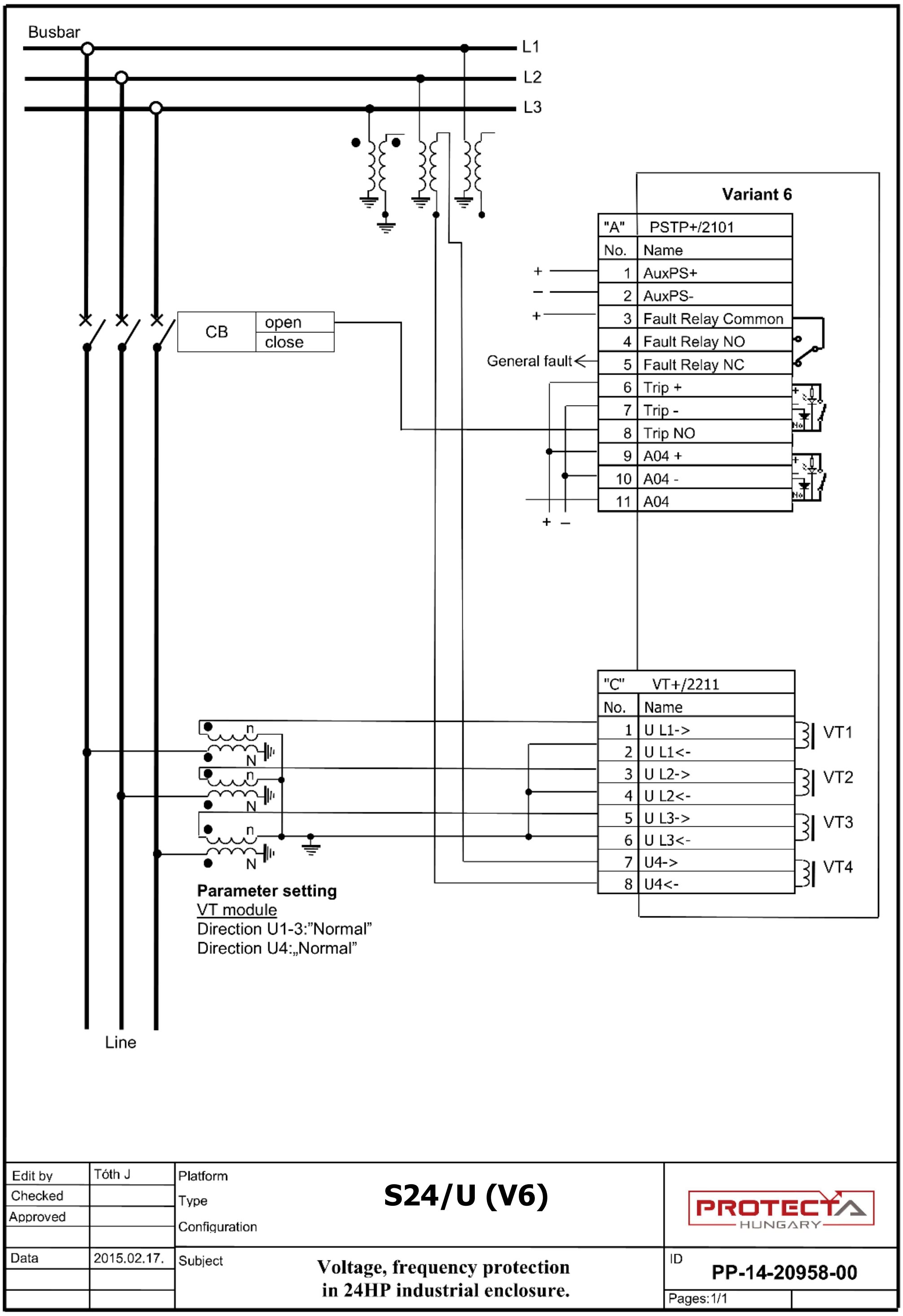
LED ASSIGNMENT

On the front panel of the device there are "User LED"-s with the "Changeable LED description label" (See the document "***Quick start guide to the devices of the PROTECTA product line***"). Some LED-s are factory assigned, some are free to be defined by the user.

LED	Explanation
General Trip	Trip command generated by the trip logic function
Freq. Trip	Trip command of the frequency based protection functions
OV/UV Trip	Trip command of the phase-voltage based protection functions
OVN Trip	Trip command of the residual voltage based protection functions
LED3105	Free LED, it can be configured by the costumer
LED3106	Free LED, it can be configured by the costumer
LED3107	Free LED, it can be configured by the costumer
LED3108	Free LED, it can be configured by the costumer
LED3109	Free LED, it can be configured by the costumer
LED3110	Free LED, it can be configured by the costumer
LED3111	Free LED, it can be configured by the costumer
LED3112	Free LED, it can be configured by the costumer
LED3113	Free LED, it can be configured by the costumer
LED3114	Free LED, it can be configured by the costumer
LED3115	Free LED, it can be configured by the costumer
LED3116	Free LED, it can be configured by the costumer

Table 1 LED assignment

EXTERNAL CONNECTION



HARDWARE SPECIFICATION

System design

The Smartline S24 protection device line is a scalable hardware platform to adapt to different applications. Data exchange is performed via a 16-bit high-speed digital non-multiplexed parallel bus with the help of a backplane module. Each module is identified by its location and there is no difference between module slots in terms of functionality. The only restriction is the position of the CPU module because it is limited to the "CPU" position. The built-in self-supervisory function minimizes the risk of device malfunctions.

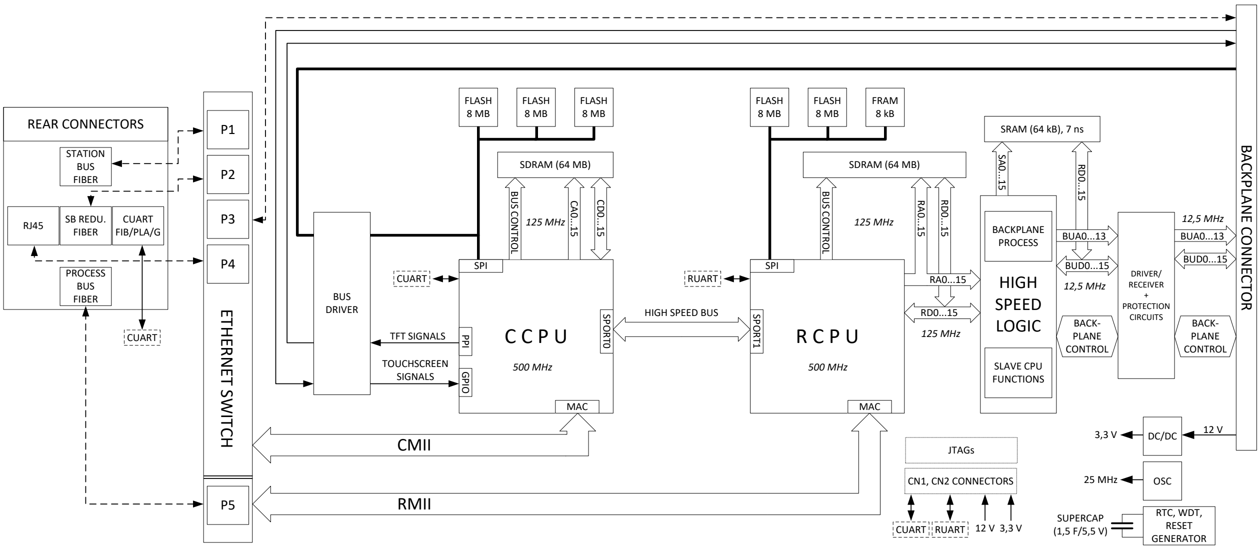


Figure 1 CPU block diagram

CPU module

CPU+ module

The CPU module contains all the protection, control and communication functions of the SmartlineS24 device. Dual 500 MHz high-performance Analog Devices Blackfin processors separate relay functions (RDSP) from communication and HMI functions (CDSP). Reliable communication between processors is performed via high-speed synchronous serial internal bus (SPORT).
Each processor has its own operative memory such as SDRAM and flash memories for configuration, parameter and firmware storage. CDSP's operating system (uClinux) utilizes a robust JFFS flash file system, which enables fail-safe operation and the storage of disturbance record files, configuration and parameters.

Module handling

The RDSP core runs at 500 MHz and its external bus speed is 125 MHz. The backplane data speed is limited to approx. 20 MHz, which is more than enough for module data throughput. An additional logic element (CPLD and SRAM) is used as a bridge between the RDSP and the backplane. The CPLD collects analogue samples from CT/VT modules and also controls signaling outputs and inputs.

Fast startup

After power-up the RDSP processor starts up with the previously saved configuration and parameters. Generally, the power-up procedure for the RDSP and relay functions takes only a few seconds. That is to say, it is ready to trip within this time. CDSP's start-up procedure is longer because its operating system needs time to build its file system, initializing user applications such as HMI functions and the IEC61850 software stack.

HMI and communication tasks

- Embedded WEB-server:
  - Remote or local firmware upgrade possibility
  - Modification of user parameters
  - Events list and disturbance records
  - Password management
  - Online data measurement
  - Commands
  - Administrative tasks
- Front panel
  - TFT display handling: the interactive menu set is available through the TFT and the touchscreen interface
  - Black and white 128x64 pixels display with 4 tactile switches
- User keys:
  - tactile switches in B&W display configuration

The built-in 5-port Ethernet switch allows Smartline S24 to connect to IP/Ethernet-based networks. 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

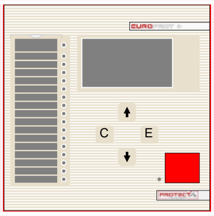
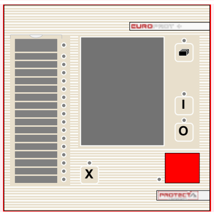
Other communication:

- RS422/RS485 interfaces (galvanic interface to support legacy or other serial protocols, ASIF)
- Plastic or glass fiber interfaces to support legacy protocols, ASIF

Human-Machine Interface (HMI) module

The Smartline S24 device HMI consists of the following two main parts:

- HMI module, which is the front panel of the device,
- HMI functionality is the embedded web server and the intuitive menu system that is accessible through the HMI module. The web server is accessible via station bus or via RJ-45 Ethernet connector.

Module type	Display	User keys	Service port	Rack size	Illustration
HMI+2504	128 x 64 pixels, black and white	4 x tactile	RJ45 10/100Mbit/s	24 HP	
Optional HMI+2404	3,5″ TFT	4 x tactile	RJ45 10/100Mbit/s	24 HP	

Main features of the HMI module

Function	Description
16 pieces user LEDs	Three-color, 3 mm circular LEDs
COM LED	Yellow, 3 mm circular LED indicating RJ-45 (on the front panel) communication link and activity
Device 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
Tactile keys	Four tactile mechanical keys (On, Off, Page, LED acknowledgement)
Buzzer	Audible touch key pressure feedback
LED description	User changeable
3.5” or 128x64 pixels display	• 128 * 64 pixel B&W display • 320 × 240 pixel TFT display with resistive touchscreen interface (optional)
Ethernet service port	**IP56** rated Ethernet 10/100-Base-T interface with RJ-45 type connector

Regarding the other hardware modules detailed descriptions please find it in Smartline S24 Hardware description see the hardware description of PROTECTA range on our web site : www.microener.com

GENERAL DATA

- Storage temperature: -40 °C … +70 °C
- Operation temperature: -20 °C … +55 °C
- Humidity: 10 % - 93 %

- EMC/ESD standard conformance:
    - Electrostatic discharge (ESD) EN 61000-4-2, IEC 60255-22-2, Class 3
    - Electrical fast transients (EFT/B) EN 61000-4-4, IEC 60255-22-4, Class A
    - Surges EN 61000-4-5, IEC 60255-22-5
        - Test voltages: line to earth 4 kV, line to line 1 kV
        - Conducted radio-frequency common mode EN 61000-4-6, IEC 60255-22-6, Level 3
    - 1 MHz damped oscillatory waves IEC 60255-22-1
        - Test voltage: 2.5 kV (for common and differential mode alike)
    - Voltage interruptions IEC 60255-11
        - Duration: 5 s, Criterion for acceptance: C
    - Voltage dips and short interruptions EN 61000-4-11
        - Voltage during dips: 0%, 40%, 70%
    - Power frequency magnetic field EN 61000-4-8, Level 4
    - Power frequency IEC 60255-22-7, Class A
    - Impulse voltage withstand test EN 60255-5, Class III
    - Dielectric test EN 60255-5, Class III
    - Insulation resistance test EN 60255-5
    - Insulation resistance > 15 GΩ

- Radiofrequency interference test (RFI):
    - Radiated disturbance EN 55011, IEC 60255-25
    - Conducted disturbance at mains ports EN 55011, IEC 60255-255
    - Immunity tests according to the test specifications IEC 60255-26 (2004), EN 50263 (1999), EN 61000-6-2 (2001) and IEC TS 61000-6-5 (2001)
    - Radiated radio-frequency electromagnetic field EN 61000-4-3, IEC 60255-22-3

- Vibration, shock, bump and seismic tests on measuring relays and protection equipment:
    - Vibration tests (sinusoidal), Class I, IEC 60255-21-1
    - Shock and bump tests, Class I, IEC 60255-21-2
    - Seismic tests, Class I, IEC 60255-21-3

Mechanical data

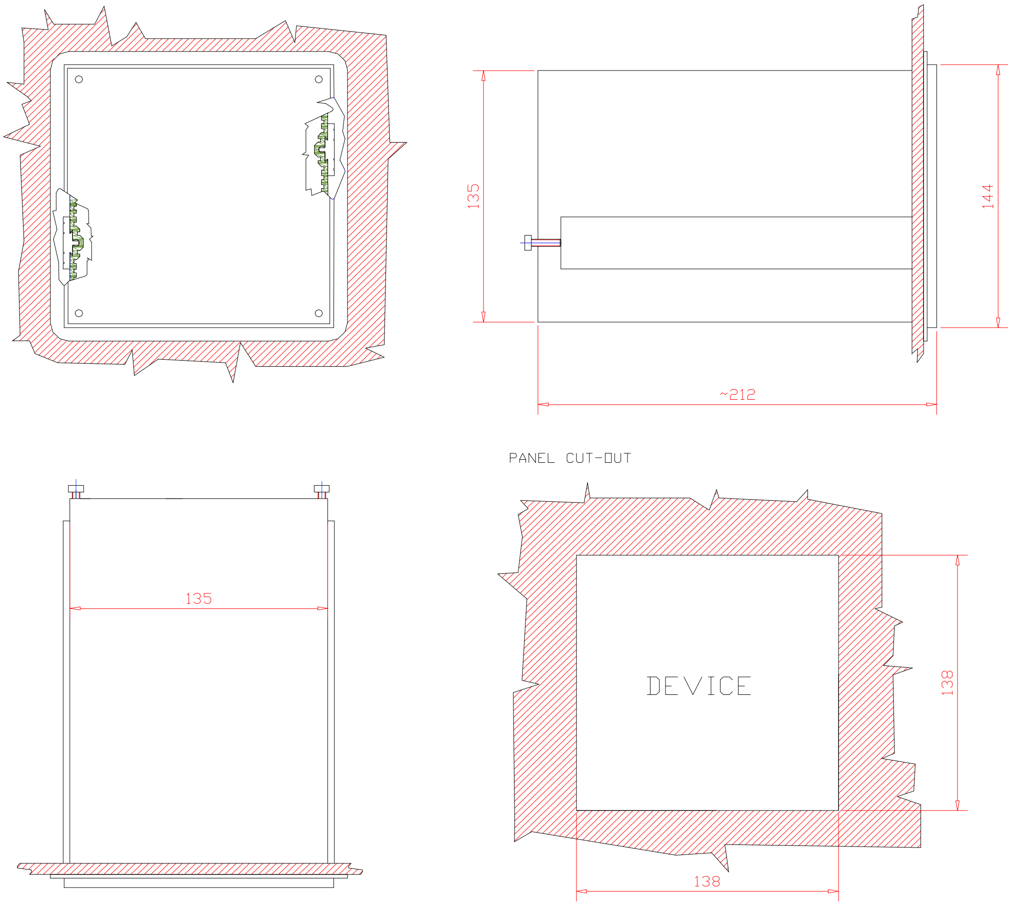
- Construction: anodized aluminum surface in tube
- EMC case protects against electromagnetic environmental influences and protects the environment from radiation from the interior
- IP20 protection from rear side (optional IP3X available)
- Size:
  - 24 HP, panel instrument case
  - Weight: max. 3 kg

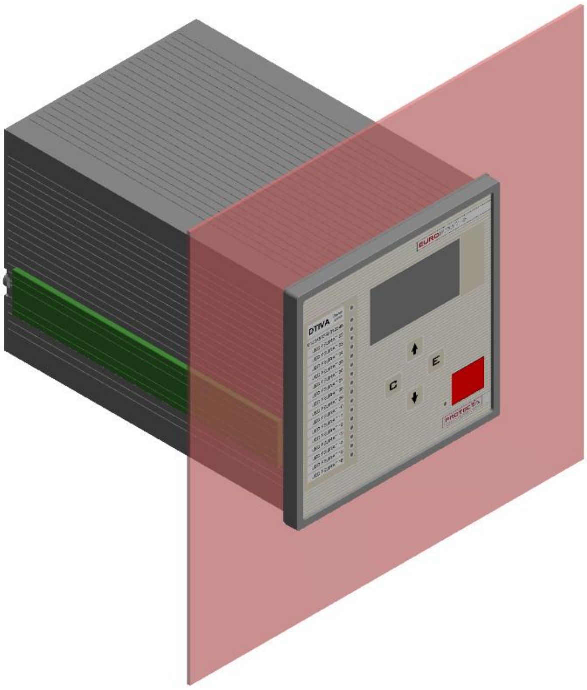
Mounting methods of IED EP+S24

Mounting methods:

- Flush mounting panel instrument case with IP54 (front side), see 0-1. Figure
- Semi-flush mounting panel instrument case with IP54 (front side), see 0-1. Figure
- Din rail mounting with IP40 (front side), see 0-3. Figure

Flush mounting of 24 HP panel instrument case

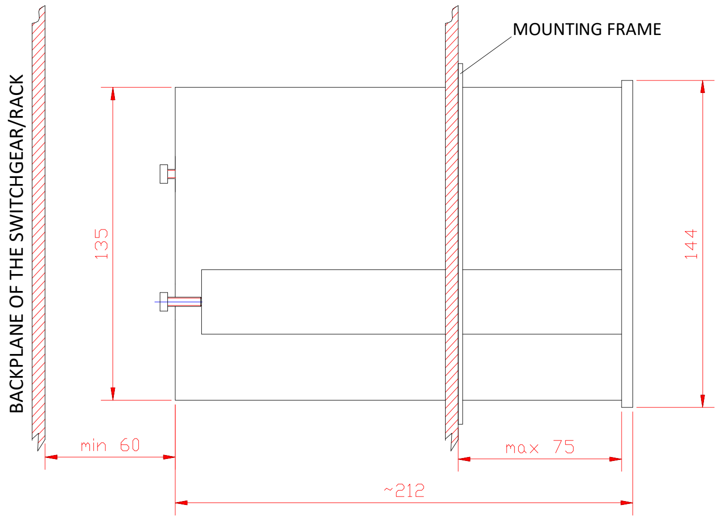


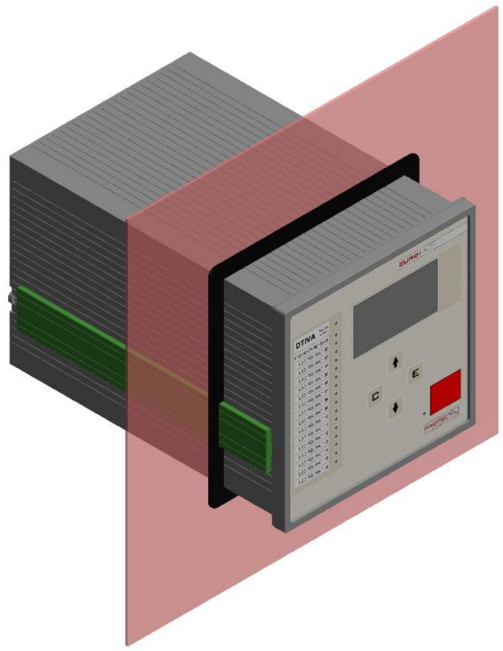


0-1. Figure S24 flush mounting method

Semi-flush mounting of 24 HP panel instrument case

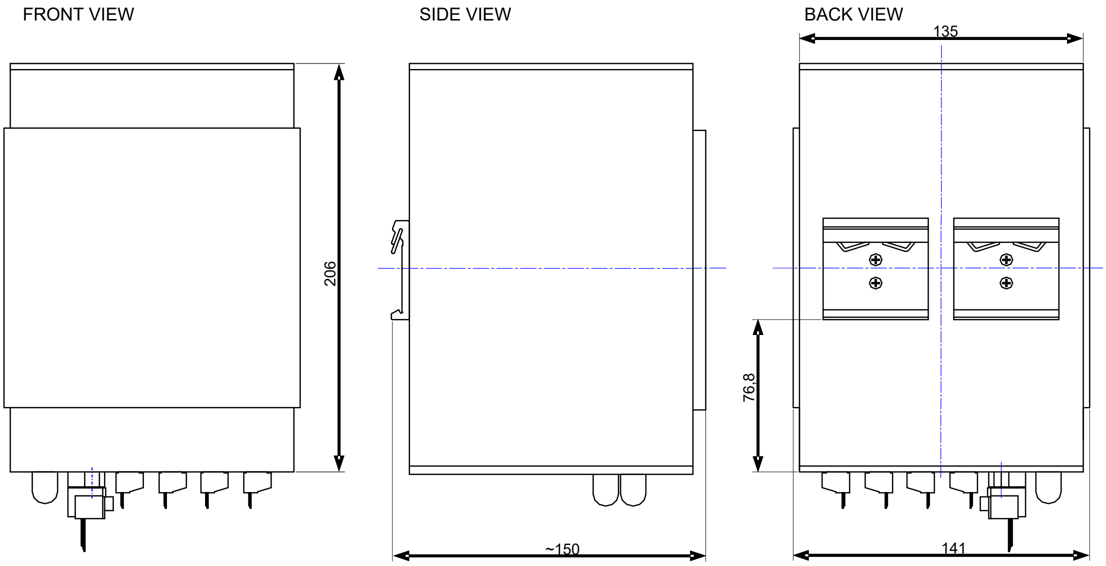
The dimensions of the panel cut-out for this type of mounting method are the same as in case of flush mounting (138 mm × 138 mm). For semi flush mounting you only have to cut in two the fixing elements (with green colour in the 3D illustration below) and make the assembly as you can see in the pictures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





0-2. Figure S24 semi-flush mounting method (max. depth=75mm)

Din rail mounting of 24 HP panel instrument case



0-3. Figure S24 Din rail mounting

If the Smartline IED needs to be connected to legacy communication networks, the available options are

- Serial protocols (IEC 60870-5-101/103, Modbus RTU, DNP3, ABB-SPA)
- Network protocols (IEC 60870-5-104, DNP3, Modbus-TCP)
- Legacy network based protocols via 100Base-FX and 10/100Base-TX (RJ45)

Serial interfaces:

- optical (glass/fiber)
- RS485/RS422

All devices of the Smartline IED product range act on an Ethernet network as servers, exchanging with connected clients all information needed for continuous supervision of the entire power network

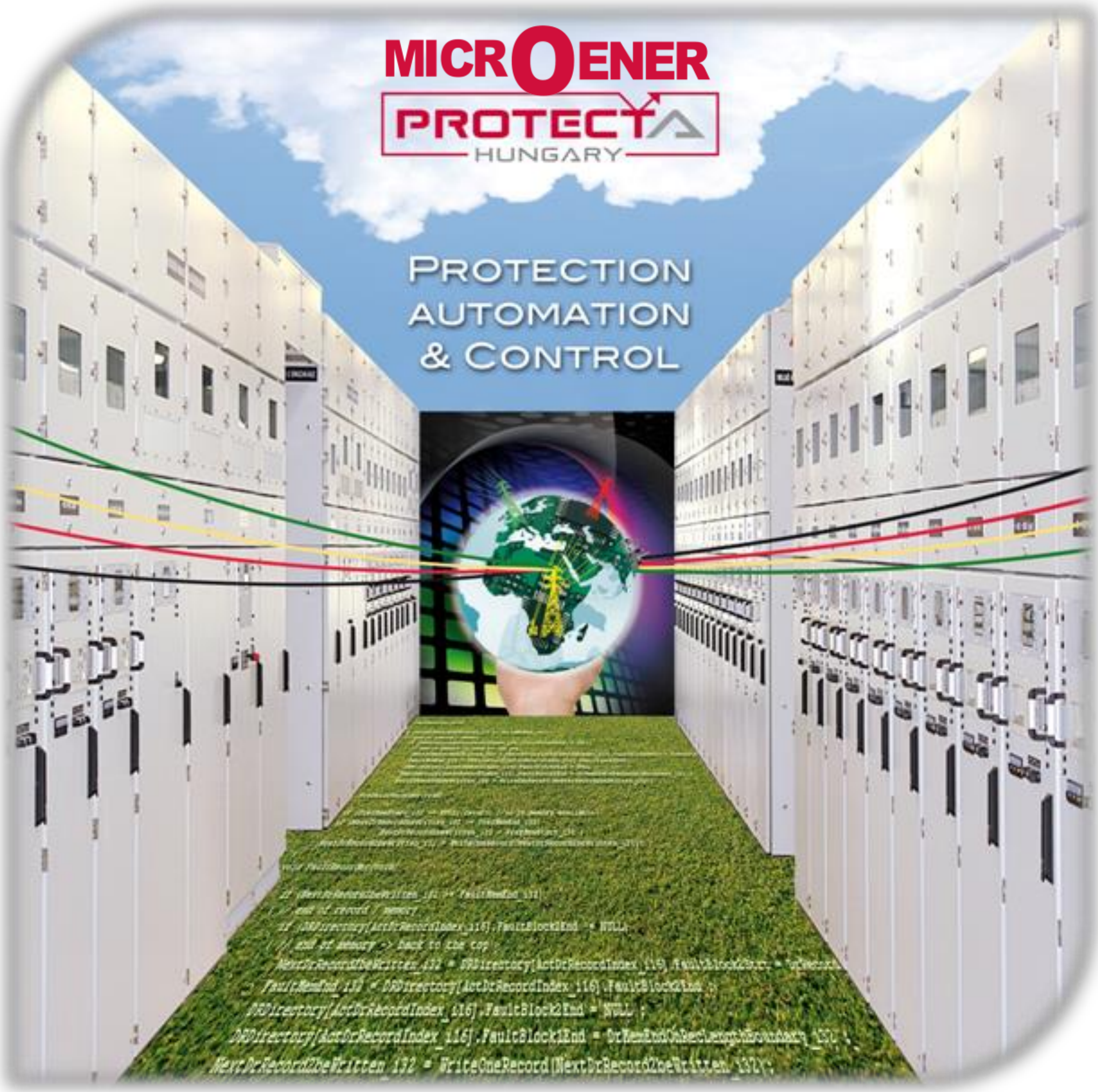
- Local or remote access to the device by widely used browsers (e.g. Internet Explorer, Mozilla Firefox, Opera, Google Chrome, PDAs, smart phones)
- Front panel image and system characteristics
- Parameter setting
- On-line information
- Event log
- Disturbance record download and fast view
- Command screen
- Scanning the connected devices
- Download of device documentation
- Advanced functions such as diagnostic information, password manager, update manager, device test

Application of the IEC61850 based communication assures interoperability of the Smartline IEDs with devices made by other manufacturers

- Native and configurable IEC61850 support for both vertical and horizontal communication
- Full range of devices both for high voltage and medium voltage protection tasks with IEC61850 compatibility

The time synchronization methods offered support easy matching in existing SCADA systems

- Primary and secondary NTP server
- Legacy protocol master
- Minute pulse
- IRIG-B000 or IRIG-B12X



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