MICR**O**ENER

Smartline S24 relays
Product Specification

MICROENER — EUROPROT+

On-line data
Line measurement
Active Power - P
0.00 kW

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C E
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PROTECTA HUNGARY

PROTECTA HUNGARY

FDE 19AA1121500 - Rev. A1

Update Management					
Rev.	**Description**	**Date**	**Written by**	**Checked by**	**Approved by**
A1	Minor Changes	13/12/2019	NLT	LA	LA
A	Diffusion	12/12/2019	NLT	LA	LA
Z	Creation	11/12/2019	AA	LA	LA

CONTENTS

INTRODUCTION

The Smartline S24 line is member of the MICROENER 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 line contains a special selection of the MICROENER modules, bearing in mind the cost-effective realization.

The IED provides main protection for overhead lines and cable feeders in distribution networks. The S24 line is a dedicated transformer protection and control IED (intelligent electronic device) for power transformers, unit and step-up transformers including power generator-transformer blocks in utility and industry power distribution systems. The S24 line is also used as back-up protection for motors, transformers and generators in utility and industry applications, where an independent and redundant protection system is required. Depending on the chosen standard configuration, the IED is adapted for the protection of medium voltage feeders in isolated neutral, resistance earthed, compensated and solidly earthed networks. Once the standard configuration IED has been given the application-specific settings, it can directly be put into service. Application area also covers protection functions for a large variety of applications, e.g. frequency and voltage-based protection, motor protection and thermal overload protection function.

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 S24 line 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.

APPLICATION

The S24 protection device is a member of the MICROENER Smartline product line. The Smartline 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.

As of now, the S24 line is available in six predefined standard configurations to suit the most common feeder protection application.

Available configurations of the S24 line:

- **S24/F (Variant 1)** is mainly used main or backup protection as overcurrent and motor protection.
- **S24/FR (Variant 2)** has additional provide voltage protection above **S24/F**. Especially for those applications where small generators are connected to the network / smart grids.
  Additionally, it can be extended with restricted earth fault protection function for simple protection of small transformer.
- **S24/L (Variant 3)** is used main protection for overhead lines and cable feeders in distribution networks with distance protection function.
- **S24/LD (Variant 4)** application has already included line differential protection function for medium voltage distribution network
- **S24/T (Variant 5)** is dedicated transformer protection and control IED (intelligent electronic device) for power transformers, unit and step-up transformers including power generator-transformer blocks in utility and industry power distribution systems.
- **S24/U (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: www.microener.com

Protection functions

The 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.

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Protection functions	IEC	ANSI	S24/F (Var1.)	S24/FR (Var2.)	S24/L (Var3.)	S24/LD (Var4.)	S24/T (Var 5.)	S24/U (Var 6.)
Three-phase instantaneous overcurrent protection	I >>>	50	✓	✓	✓	✓	✓	
Three-phase time overcurrent protection	I >, I >>	51	✓	✓	✓	✓	✓	
Residual instantaneous overcurrent protection	Io >>>	50N	✓	✓	✓	✓	✓	
Residual time overcurrent protection	Io >, Io >>	51N	✓	✓	✓	✓	✓	
Voltage dependent overcurrent protection	I> U<	51V		✓				
Three-phase directional overcurrent protection	I Dir > >, I Dir >>	67		✓	✓			
Residual directional overcurrent protection	Io Dir > >, Io Dir >>	67N		✓	✓			
Negative sequence overcurrent protection	$I_2 >$	46	✓	✓	✓	✓	✓	
Thermal protection	T >	49	✓	✓	✓	✓	✓	
Inrush detection	I2h >	68	✓	✓	✓	✓	✓	
Definite time overvoltage protection	U >, U >>	59		✓	✓			✓
Definite time undervoltage protection	U <, U <<	27		✓	✓			✓
Residual overvoltage protection	Uo >, Uo >>	59N		✓	✓			✓
Negative sequence overvoltage protection	$U_2 >$	47		✓	✓			
Overfrequency protection	f >, f >>	81O		✓	✓			✓
Underfrequency protection	f <, f <<	81U		✓	✓			✓
Rate of change of frequency protection	df/dt	81R		✓	✓			✓
Undercurrent protection	I <	37	✓					
Vector jump protection		78		✓				
Startup supervision with restart inhibit		66	✓					
Frequent start protection		66	✓					
Line differential protection	3Idl >	87L				✓		
Distance protection	Z<	21			✓			
Syncro check		25			✓			✓
Auto reclosure		79	✓	✓	✓	✓		
Transformer differential protection (2 winding)	3IdT >	87T					✓	
Generator/Motor differential protection	3IdG >	87G/M					op.	
Restricted earth fault	REF	87N		op.				
Breaker failure protection	CBFP	50BF	✓	✓	✓	✓	✓	

op.: optional

Measurement functions

Based on the hardware inputs the measurements listed below can be available.
- Current (I1, I2, I3, Io)
- Voltage (U1, U2, U3, U12, U23, U31, Uo, Useq) and frequency
- Supervised trip contacts (TCS)

Software configuration

The implemented protection functions are listed in table below – the applied functions of each IEDs are depending on the configuration. The function blocks are described in detail 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 customer's request. In this case please, contact to the developer team on the MICROENER Support Site: https://www.microener.com/js-support-ticket-controlpanel

| Name	Title	Document
IOC50	3ph Instant.OC	*Three-phase instantaneous overcurrent protection function block description*
TOC51_low	3ph Overcurr	*Three-phase overcurrent protection function block description*
TOC51_high		
IOC50N	Residual Instant.OC	*Residual instantaneous overcurrent protection function block description*
TOC51N_low	Residual TOC	*Residual overcurrent protection function block description*
TOC51N_high		
VOC51_low	VoltRestr OC	*Voltage dependent overcurrent protection*
VOC51_high		
TOC67_low	3ph Dir .OC	*Three-phase directional overcurrent protection*
TOC67_high		
TOC67N_low	Dir.Residual TOC	*Directional residual overcurrent protection function block description*
TOC67N_high		
DIS21_MV	5 zone distance	*Distance protection function block description*
DIF87_2w	Transformer Differential	*Transformer differential protection function block description*
DIF87N	Restricted EF	*Restricted Earth Fault protection function block description*
DIF87G	Generator Differential	*Generator differential protection function block description*
DIF87L	Line differential	*Line differential protection function block description*
TUC37	UnderCurrent	*Undercurrent (loss – of - load) protection function block description*
TUV 27_low	Undervoltage	*Definite time under voltage protection function block description*
TUV 27_high		

TOV59_high	Overvoltage	*Definite time overvoltage protection function block description*
TOV59_low		
TOV59N_high	Overvoltage	*Definite time residual overvoltage protection function block description*
TOV59N_low		
INR68	Inrush	*Inrush detection and blocking protection function block description*
TOF81_high	Overfrequency	*Overfrequency protection function block description*
TOF81_low		
TUF81_high	Underfrequency	*Underfrequency protection function block description*
TUF81_low		
FRC81	ROC of frequency	*Rate of change of frequency protection function block description*
TTR49L	Thermal overload	*Line thermal protection function block description*
VCB60	Current Unbalance	*Current unbalance function block description*
BRF50	Breaker Failure	*Breaker failure protection for not solidly grounded networks function block description*
REC79	Auto reclosure	*Auto reclosure function block description*
SYN25	Synchro check	*Synchro check function block description*
CT4		*Current input function block description*
VT4		*Voltage input function block description*

The basic hardware shown as follows:
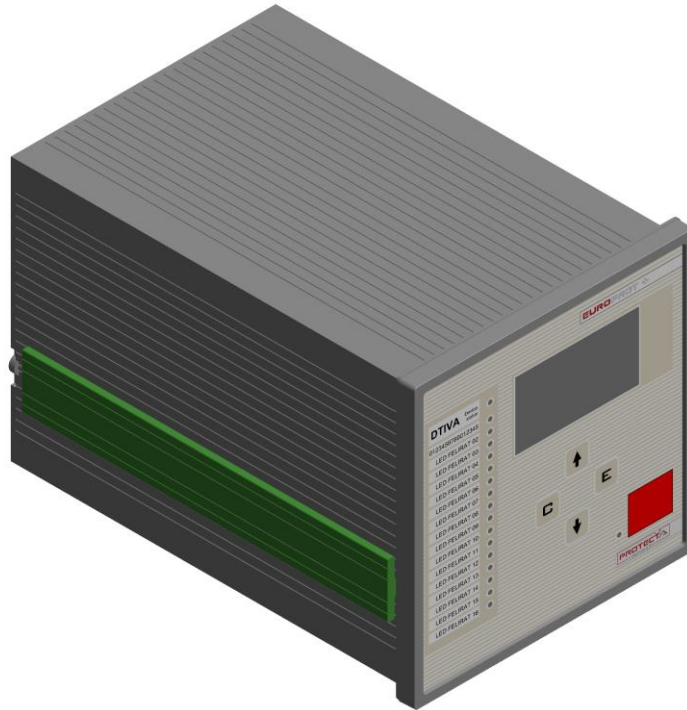
0-1. Figure S24 design with B&W HMI
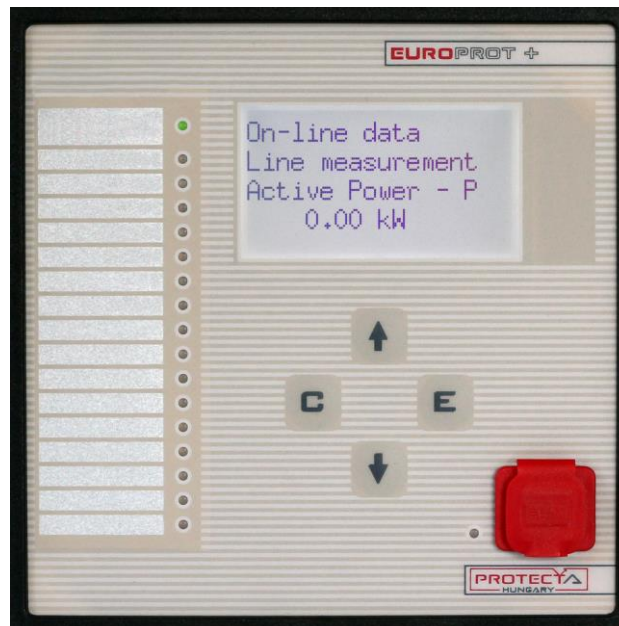
0-2. Figure S24 B&W HMI front panel as standard

*0-3. Figure S24 True colour HMI front panel as optional*

The number of inputs and outputs are listed in the table below.

S24/F & S24/LD (Variant 1 & 4)	
Housing	See Chapter 4.1: Mechanical data
Current inputs (4th channel can be sensitive)	4 (3x 1/5 A and 1x 1/5/0,2A)
Digital inputs	6*
Digital outputs	5*
Fast trip outputs	2 (4 A)
IRF contact	1

S24/FR & S24/L (Variant 2 & 3)	
Housing	See Chapter 4.1: Mechanical data
Current inputs (4th channel can be sensitive)	4 (3x 1/5 A and 1x 1/5/0,2A)
Voltage inputs	4
Digital inputs	6*
Digital outputs	5*
Fast trip outputs	2 (4 A)
IRF contact	1

S24/T (Variant 5)	
Housing	See Chapter 4.1: Mechanical data
Current inputs (4th channel can be sensitive)	8 (3x 1/5 A and 1x 1/5/0,2A)
Digital inputs	6*
Digital outputs	5*
Fast trip outputs	2 (4 A)
IRF contact	1

S24/U (Variant 6)	
Housing	See Chapter 4.1: Mechanical data
Voltage inputs	4
Digital inputs	6*
Digital outputs	5*
Fast trip outputs	2 (4 A)
IRF contact	1

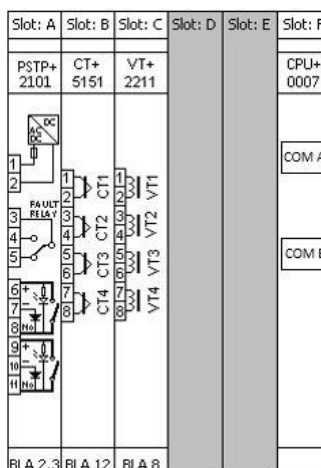* as standard I/O card hardware configuration.

IP ratings:

- IP20 protection from rear side
- IP54 protection from front side
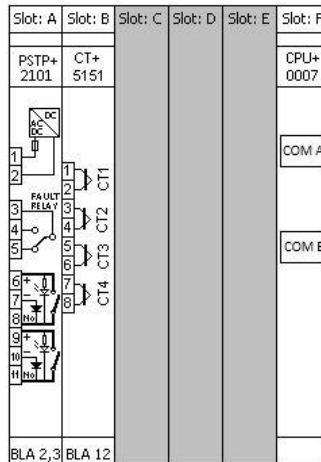
I/O card options for S24/F:

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

0-4. Figure S24/F configuration card layout

I/O card options for S24/FR and S24/L:

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

0-6. Figure S24/FR & S24/L configuration card layout
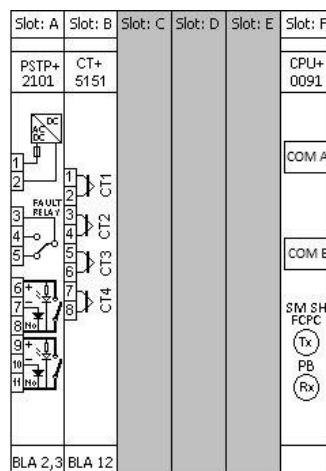
I/O card options for S24/LD:

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

0-7. Figure S24/LD configuration card layout
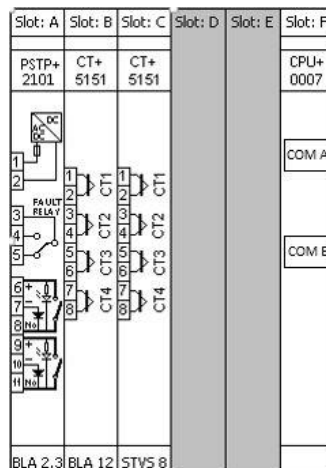
I/O card options for S24/T:

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

0-8. Figure S24/T configuration card layout
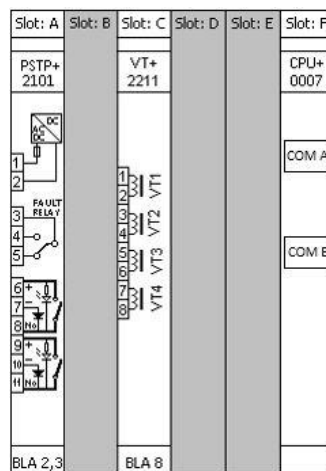
I/O card options for S24/U:

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

0-9. Figure S24/U configuration card layout

Communication options for all variants:

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

HARDWARE SPECIFICATION

System design

The 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.
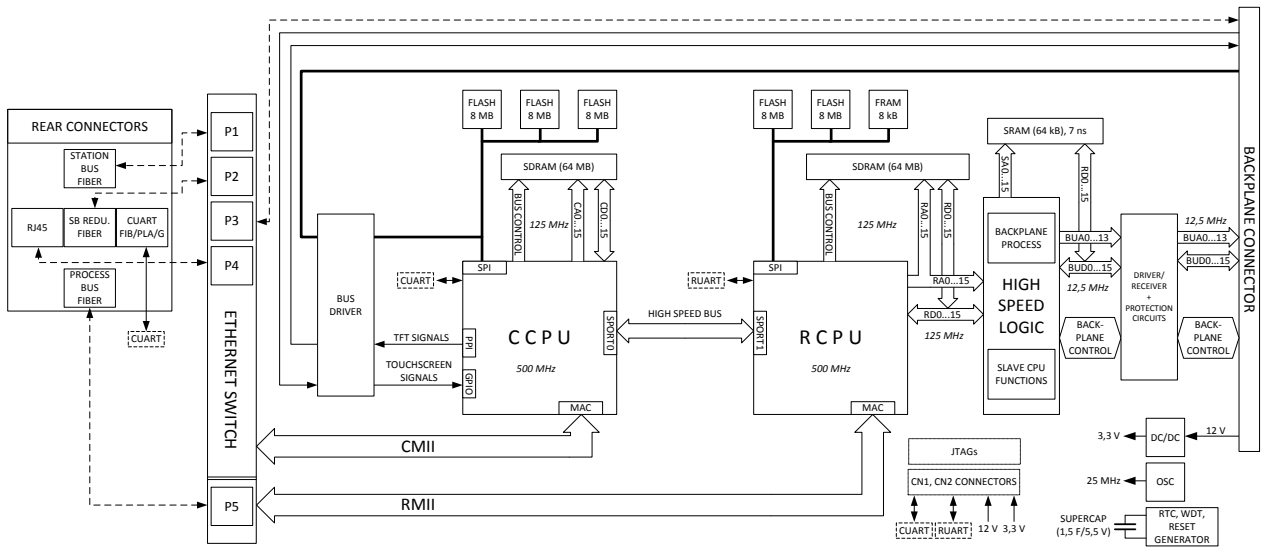
Figure 0-1 CPU block diagram

CPU module

CPU+ Module

The CPU module contains all the protection, control and communication functions of the S24 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:

    - 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 S24 relay 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
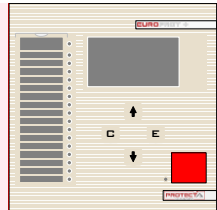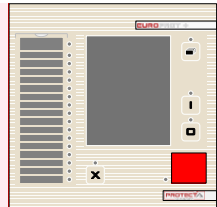   - Optional 10/100Base-T port via RJ-45 connector

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 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

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Regarding the other hardware modules detailed descriptions please find it in PROTECTA Line Hardware description 19AA0991200 rev. A : www.microener.com

Chapter	Module name	Page
5	Current input module	26
6	Voltage input module	31
7	Binary input module (O12+xxxx)	33
8	Signaling module (R8+xxxx)	36
13.1	PSTP+ modules	60
13.2	O6R5+ modules	64

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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 withstands 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)
- 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 0-2. Figure
  - Din rail mounting with IP40 (front side), see 0-3. Figure
- Weight: max. 3 kg

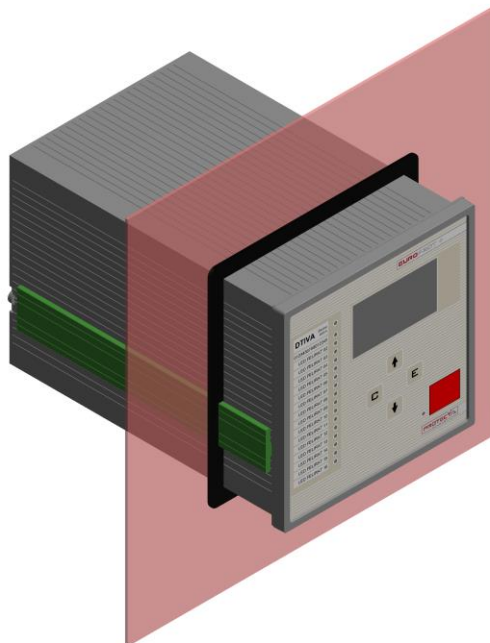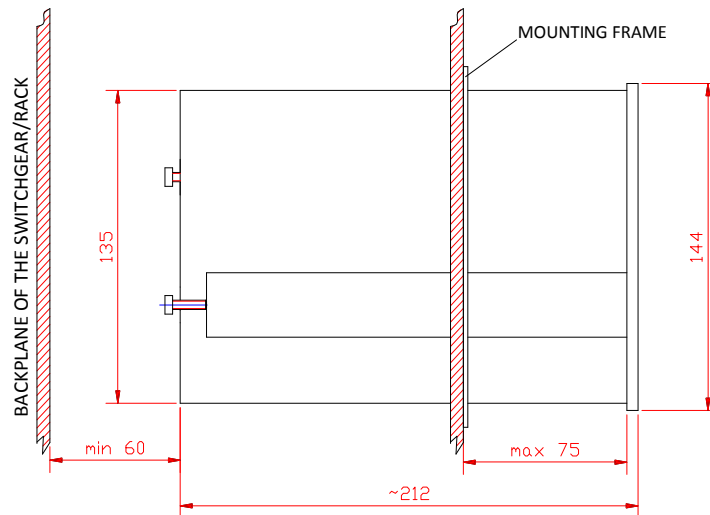**Flush mounting of 24 HP panel instrument case**
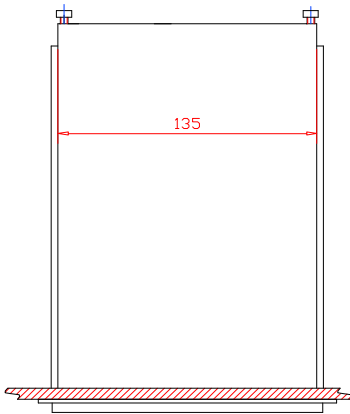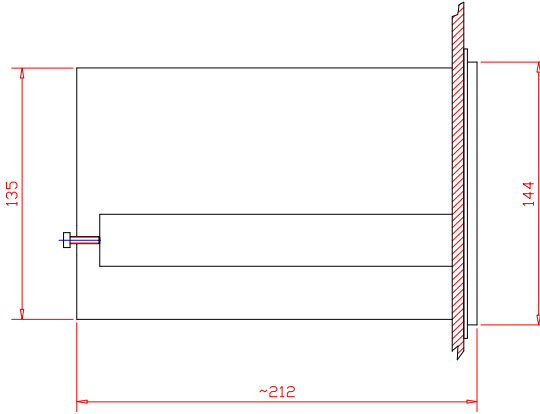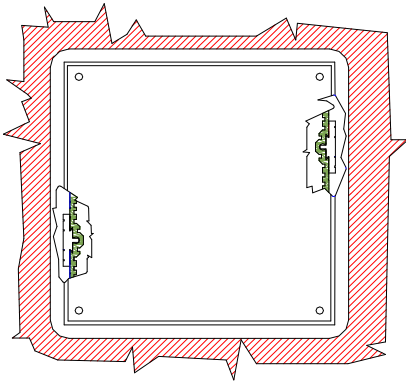
PANEL CUT-OUT
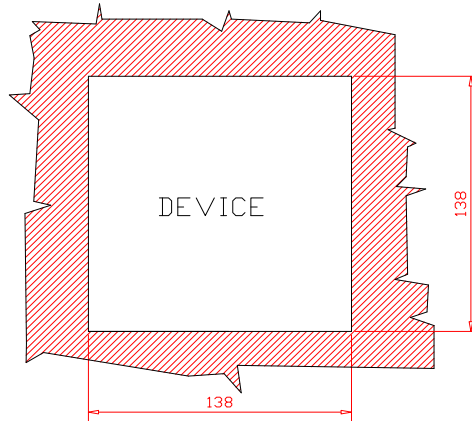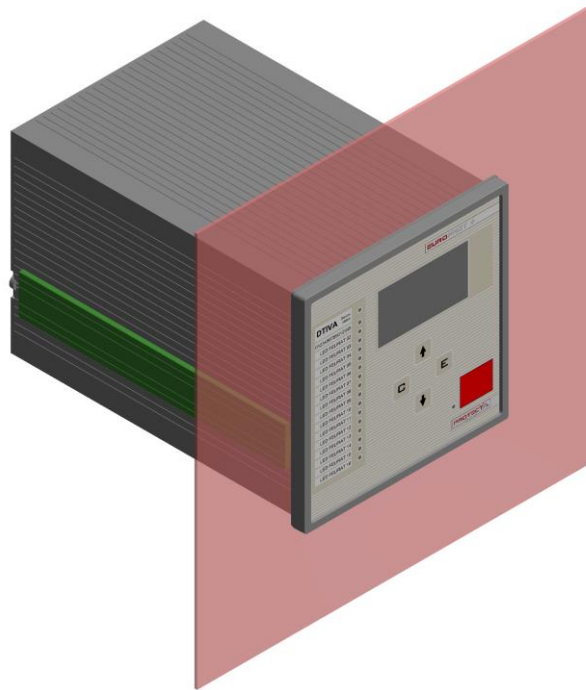
*0-1. Figure S24 flush mounting method*

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

FRONT VIEW   SIDE VIEW   BACK VIEW
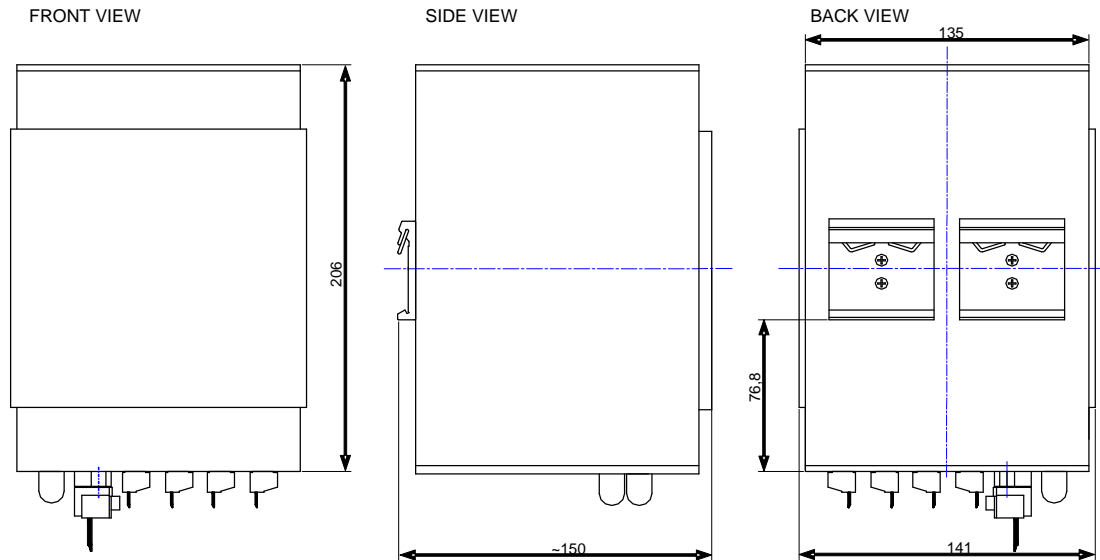
0-3. Figure S24 Din rail mounting

<div style="text-align: right">**Communication**</div>

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