EUROPROT +

Product general description

Smart line IED-EP+ in
16 HP industrial enclosure

PROTECTA HUNGARY

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Version information

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1.0	2016-09-26	First edition	Dienes/Budenszki/ Bidó/Erdős
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1 Introduction

The IED-EP+ S16 series is part of the ***EuroProt+ Smart Line***. Members of the Smart Line also offer a wide range of functions but they do so in a small, compact enclosure so that they can be installed in locations with limited space available for the protection equipment.

The IED-EP+ S16 series contains a special selection of the EuroProt+ modules, bearing in mind the cost effective realization. The low-cost IED-EP+ S16 series was able to be realized with predefined hardware arrangement and fixed standard configurations. (More details about the hardware configurations can be found in Chapter 0)

The primary target of the IED-EP+ S16 feeder protection relay is the protection of incoming and outgoing feeders in distribution substations. IED-EP+ S16 is also used as back-up protection for feeders, motors, transformers and generators in utility and industry applications, where an independent and redundant protection system is required. Depending on the selected standard configuration, the IED is adapted to the protection of medium voltage feeders in isolated neutral, resistance earthed, compensated or solidly earthed networks. Once the standard configuration IED has been given the application-specific settings, it can be directly put into service. Application area also covers protection functions for a large variety of applications, e.g. frequency and voltage based protections, motor protection and thermal overload protection function.

The IEDs support several communication protocols including IEC 60870-5-101, IEC 60870-5-103. As of now the EP+ S16 is available in five predefined standard configurations to suit the most common feeder protection and control applications.

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 alert 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.
All device settings and parameters can be set by specific parametrization PC software running on Microsoft Windows™ operating systems (Windows 7 and above) with .NET framework (4.0 and above) installed. The user's PC can be connected to the device via the USB interface the device will be automatically detected. It is also possible to change parameters through the ASIF interface on the back side of the IED using a substation engineering computer.
Parameters and events can be also uploaded and stored on the user's computer.

2 Application

The IED-EP+ S16 is available in five predefined standard configurations to suit the most common feeder protection applications.

Available configurations of the S16 series:

- **Variant 1** is mainly used as main or backup overcurrent protection.
- **Variant 2** provides additional motor protection functions compared to Variant 1.
- **Variant 3** is suitable for those application where only voltage and frequency based protection functions are required.
- **Variant 4** is extended with one voltage input. It can be used for residual voltage measuring. Consequently the Variant 4 application includes the residual directional overcurrent protection function.
- **Variant 5** provides motor protection functions above Variant 4.

Available detailed protection function for each variant can be found in Table 2-1.

2.1 Protection functions

The different configurations can measure three phase currents, the residual current component and additionally three phase voltages and the residual voltage. These measurements allow in addition to the current- or voltage-based functions directionality extension to the configured phase and residual overcurrent functions. Based on the voltage measurement also the frequency is evaluated to realize frequency-based protection functions.

The configured protection functions of each predefined standard configuration are listed in the table below.

Protection functions	IEC	ANSI	Instance	Var. 1	Var. 2	Var. 3	Var. 4	Var. 5
Three-phase instantaneous overcurrent protection	I >>>	50	1	✓	✓		✓	✓
Three-phase time overcurrent protection	I >, I >>	51	2	✓	✓		✓	✓
Residual instantaneous overcurrent protection	Io >>>	50N	1	✓	✓		✓	✓
Residual time overcurrent protection	Io >, Io >>	51N	2	✓	✓		✓	✓
Residual directional overcurrent protection	Io Dir >, Io Dir >>	67N	2				✓	✓
Inrush detection	I2h >	68	1	✓	✓		✓	
Negative sequence overcurrent protection	I2 >	46	1	✓	✓		✓	✓
Thermal protection (Line/Motor)	T >	49L/ 49M	1	✓	✓		✓	✓
Definite time overvoltage protection	U >, U >>	59	2			✓		
Definite time undervoltage protection	U <, U <<	27	2			✓		
Residual overvoltage protection	Uo >, Uo >>	59N	2			✓	✓	✓
Negative sequence overvoltage protection	U2 >	47	1			✓		
Overfrequency protection	f >, f >>	81O	2			✓		
Underfrequency protection	f <, f <<	81U	2			✓		
Rate of change of frequency protection	df/dt	81R	1			✓		
Breaker failure protection	CBFP	50BF	1	✓	✓	✓	✓	✓
Vector jump protection	ΔφU>	78V	1			✓		
Undercurrent protection	I <	37	1		✓			✓
Startup supervision with restart inhibit	I²start	48	1		✓			✓
Frequent start protection	I²t	66	1		✓			✓

Table 2-1: Protection functions

op.: optional

2.2 Measurement functions

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

- Current (I1, I2, I3, Io)
- Voltage (U1, U2, U3, U12, U23, U31, Uo, Useq) and frequency
- Supervised trip contacts (TCS)

2.3 Software configuration

The implemented protection functions are listed in table below. The function blocks are described in details in separate documents. These are referred to also in this table.

Name	Title	Document
IOC50	3ph Inst Overcurrent	*Three-phase instantaneous overcurrent protection function block description*
TOC51_1	I> Overcurrent / I> Start-up	*Three-phase time overcurrent protection function block description*
TOC51_2	I>> Overcurrent	
IOC50N	Res Inst Overcurrent	*Residual instantaneous overcurrent protection function block description*
TOC51N_1	3Io> Overcurrent	*Residual overcurrent protection function block description*
TOC51N_2	3Io>> Overcurrent	
TOC67N_1	3Io> Dir. Overcurrent	*Directional residual overcurrent protection function block description*
TOC67N_2	3Io>> Dir. Overcurrent	
INR68	Inrush Detection	*Inrush current detection function block description*
TOC46	Neg. Seq. Overcurrent	*Negative sequence overcurrent protection function block description*
TTR49L/M	Line Overload / Motor Overload	*Line thermal protection function block description* / *Motor thermal protection function block description*
TOV59_1	U> Overvoltage	*Definite time overvoltage protection function block description*
TOV59_2	U>> Overvoltage	
TUV27_1	U< Undervoltage	*Definite time undervoltage protection function block description*
TUV27_2	U<< Undervoltage	
TOV59N_1	3Uo> Overvoltage	*Residual definite time overvoltage protection function block description*
TOV59N_2	3Uo>> Overvoltage	
TOV47	Neg. Seq. Overvoltage	*Negative sequence definite time overvoltage protection function block description*
TOF81_1	f> Overfrequency	*Overfrequency protection function block description*
TOF81_2	f>> Overfrequency	
TUF81_1	f< Underfrequency	*Underfrequency protection function block description*
TUF81_2	f<< Underfrequency	
FRC81	ROC of Frequency	*Rate of change of frequency protection function block description*

VectJmp	Vector Jump	*Vector jump protection function block description*
TUC37	I< Undercurrent	*Undercurrent (loss–of–load) protection function block description*
MSS46	Start-up Supervision	*Motor startup supervision function block description*
VCB60	Current Unbalance	*Current unbalance function block description*

Table 2-2: Function blocks

2.4 Hardware configuration

The number of inputs and outputs are listed in the table below. Note that *the voltage input is unused in the Variant 1 & 2 configurations*.

Variant 1 & 2	
Housing	Panel instrument enclosure (16 HP size)
Current inputs (4th channel can be sensitive)	4 sets (3 × 1/5 A and 1 × 0.2/1/5 A)
Voltage inputs	0 (connector not used)
Digital inputs	4 sets (Selectable Rated Voltage)
Digital outputs	4 sets (2 x NO, 2 x CO)
Fast trip outputs	2 sets (1 A, L/R = 40 ms, NO)
IRF contact	1 set (CO)

Table 2-3: Variant 1 & 2 hardware configuration

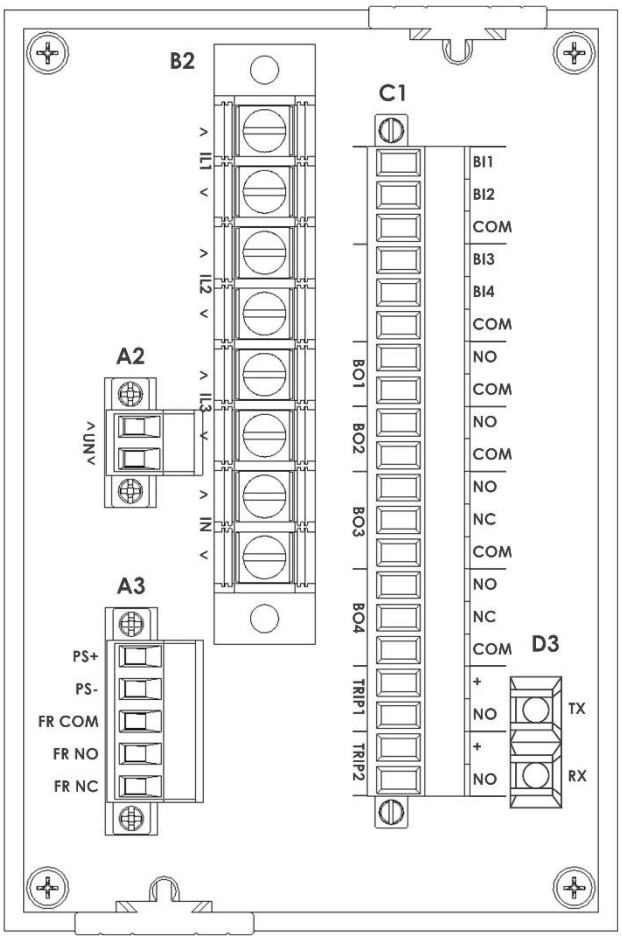

Figure 2-1: Variant 1 & 2 backplane with barrier strip connector for ring lug

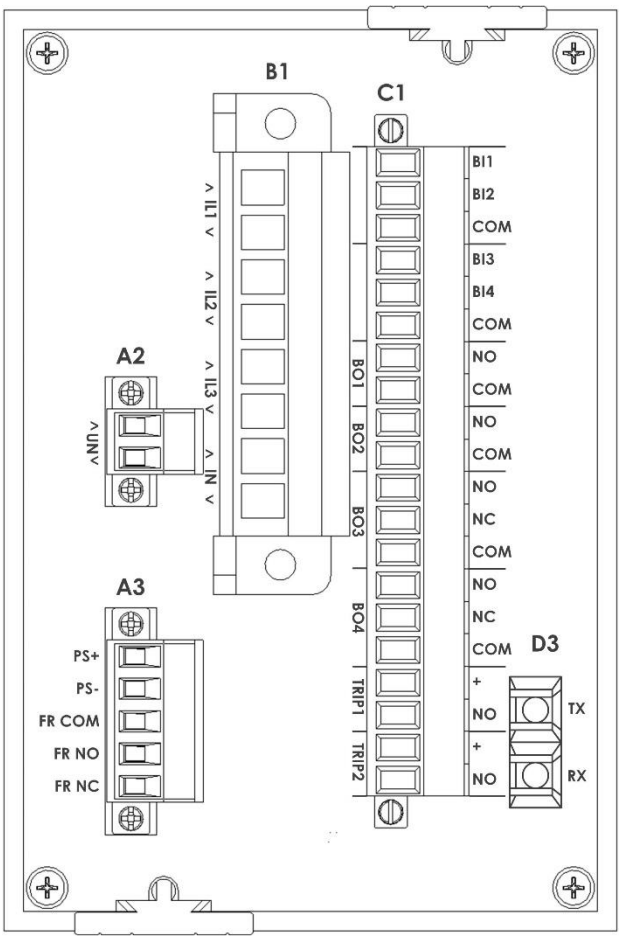

Figure 2-2: Variant 1 & 2 backplane with terminal block connector

Variant 3	
Housing	Panel instrument enclosure (16 HP size)
Voltage inputs	4 sets
Digital inputs	4 sets (Selectable Rated Voltage)
Digital outputs	4 sets (2 x NO, 2 x CO)
Fast trip outputs	2 sets (1 A, L/R = 40 ms, NO)
IRF contact	1 sets (CO)

Table 2-4: Variant 3 hardware configuration

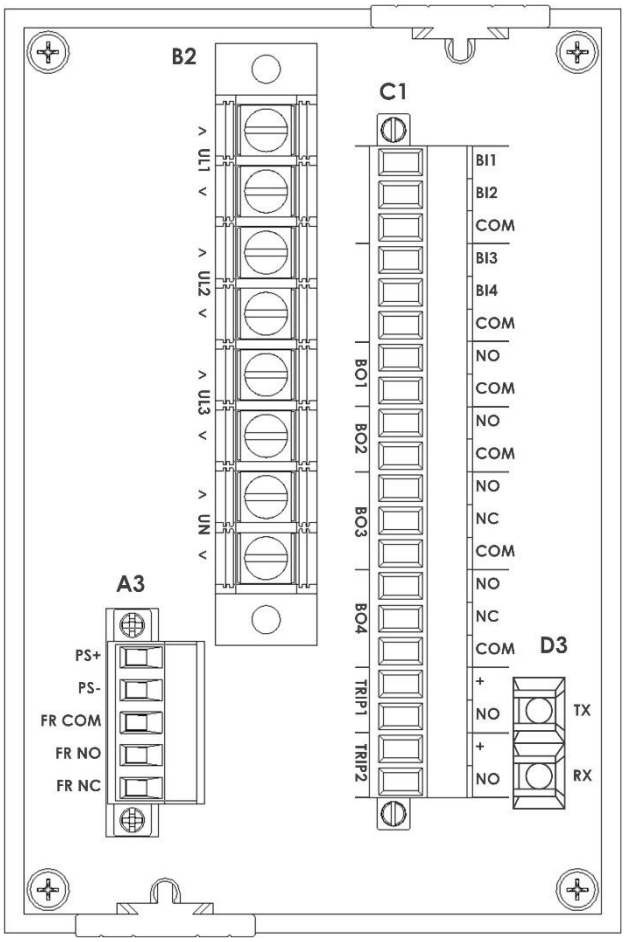

Figure 2-3: Variant 3 backplane with barrier strip connector for ring lug

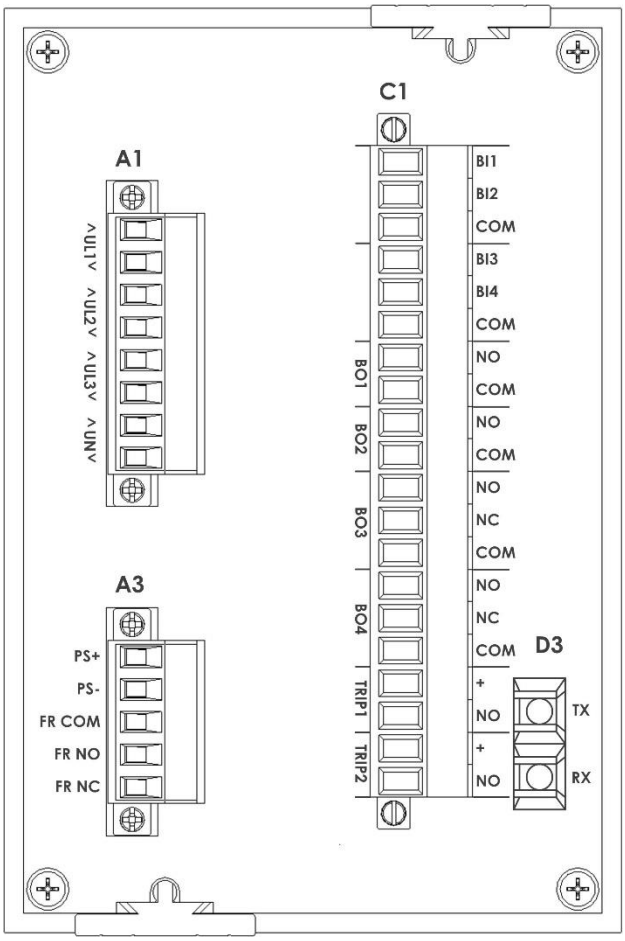

Figure 2-4: Variant 3 backplane with terminal block connector

Variant 4 & 5	
Housing	Panel instrument enclosure (16 HP size)
Current inputs (4th channel can be sensitive)	4 sets (3 × 1/5 A and 1 × 0.2/1/5 A)
Voltage inputs	1 set
Digital inputs	4 sets (Selectable Rated Voltage)
Digital outputs	4 sets (2 x NO, 2 x CO)
Fast trip outputs	2 sets (1 A, L/R = 40 ms, NO)
IRF contact	1 set (CO)

Table 2-5: Variant 4 & 5 hardware configuration

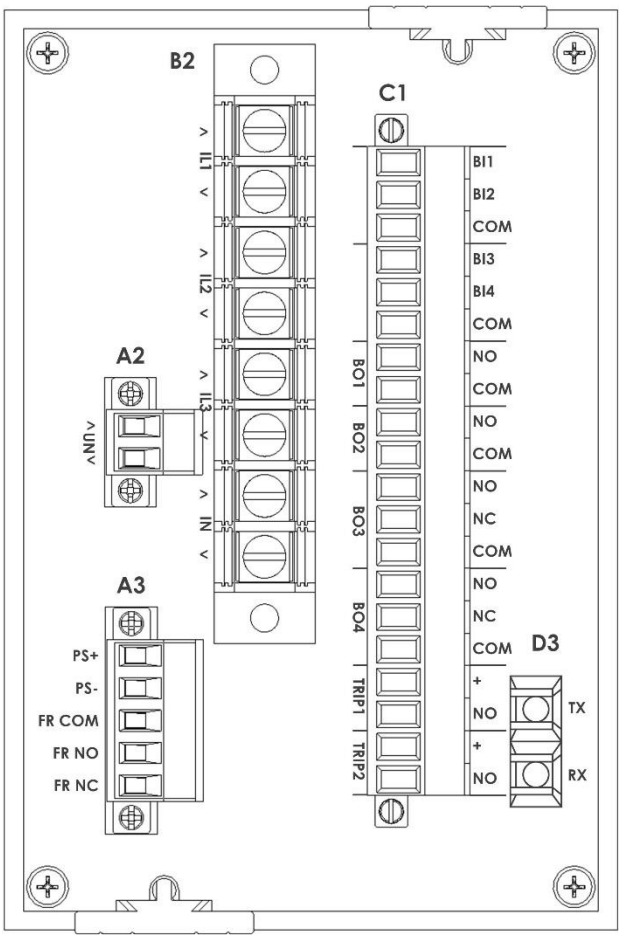

Figure 2-5: Variant 4 & 5 backplane with barrier strip connector for ring lug

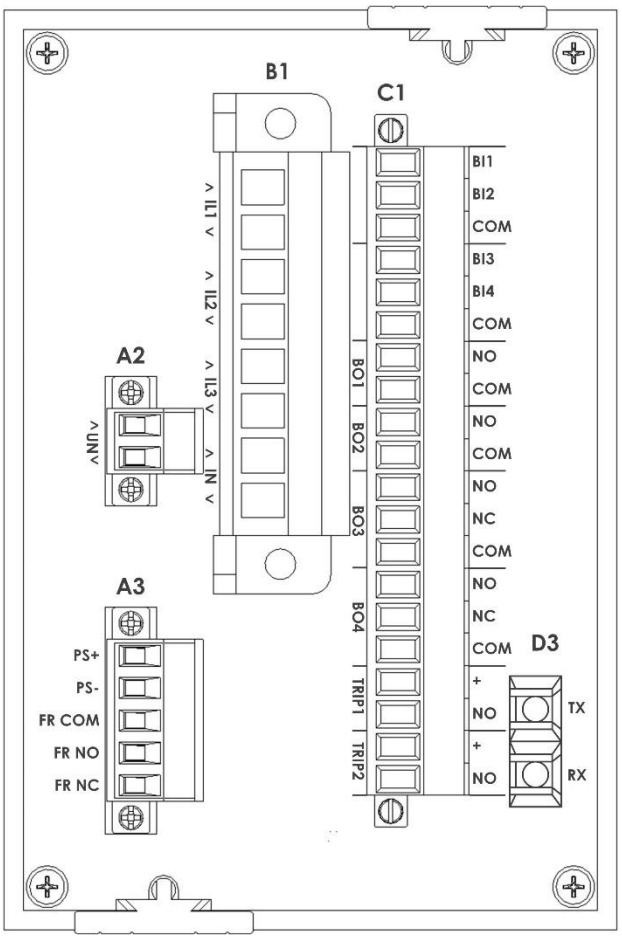

Figure 2-6: Variant 4 & 5 backplane with terminal block connectors

IP ratings:

- IP30 protection from rear side
- IP54 protection from front side

The basic hardware shown as follows:

Figure 2-7: Basic hardware

Subunit identifier	Explanation
CPU+/S16	CPU function, binary inputs, binary outputs and trip circuitry
PS+/S16	4ch CT or 4ch VT or 4ch CT + 1ch VT and power supply
HMI+/S16	Human-Machine Interface
Selectable communication subunit:	
ASIF-O+/S16	Asynchronous communication subunit (legacy serial protocols) and timing input (PPS, IRIG….)
ASIF-G+/S16	Asynchronous communication subunit (legacy serial protocols, future option)

Table 2-6: Subunit identifier

Subunit connectors	Connector type	
CPU+/S16	Receptacle: Weidmüller SL 5.08HC/20/90F 3.2SN OR BX Plug: Weidmüller BLZP 5.08/02/180F SN OR BX	
Power & IFR	Receptacle: Weidmüller SL 5.08HC/05/90F 3.2SN OR BX Plug: Weidmüller BLZP 5.08/05/180F SN OR BX	
	Barrier strip (ring lug)	**Terminal block**
CT	TE Connectivity JC6-Q308-10	Receptacle: Weidmüller STVS8 SS Plug: Weidmüller STVS8 SB
VT	TE Connectivity JC6-Q308-10	Receptacle: Weidmüller SL 5.08HC/08/90F 3.2SN OR BX Plug: Weidmüller BLZP 5.08/08/180F SN OR BX
CT+VT	TE Connectivity JC6-Q308-10	CT Receptacle: Weidmüller STVS8 SS CT Plug: Weidmüller STVS8 SB VT Receptacle: Weidmüller SL 5.08HC/02/90F 3.2SN OR BX VT Plug: Weidmüller BLZP 5.08/02/180F SN OR BX
ASIF_SYNC	Receptacle: Weidmüller Plug: Weidmüller	

Table 2-7: Subunit connectors

3 Hardware specification

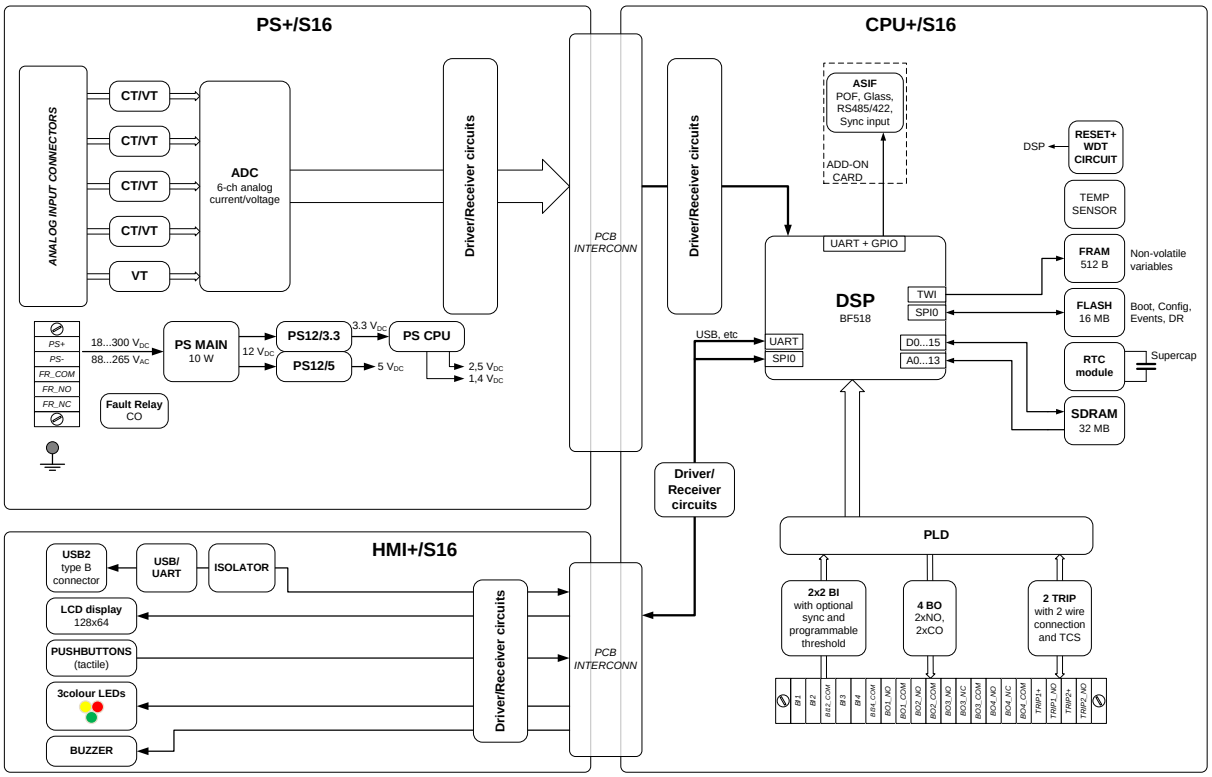

Figure 3-1: EP+S16 Block diagram

3.1 Human-Machine Interface

The HMI of the IED contains the following elements:

- Display (128 x 64 pixel monochrome, with white backlight)
- Mechanical buttons: up, down, enter, cancel (cancel also has LED acknowledge function)
- 3-color matrix programmable alarm LED indicators (8 pieces). The LEDs can be configured with configuration software.
- 3-color status LED
- Communication port (USB 2.0 connection)

3.2 Characteristics of current input

These inputs are equipped with intermediate current transformers to input the phase currents and the zero sequence current. The rated current for the phase current and for the residual current can be selectable by parameter.

- Rated frequency: 50 Hz

Subunit name	**CT**				
Number of CT inputs	1-3		4		
Selectable rated current, I_n [A]	1	5	0.2	1	5
Max. measured current	50 × I_n		50 × I_n		
Power consumption at rated current [VA]	0.05	0.25	0.01-0.25		
Thermal withstand [A]					
continuously	20				
10 s	175				
1 s	500				
10 ms	1200				

Table 3-1: Current input characteristics

3.3 Characteristics of voltage input

If the device realizes voltage related functions (over/undervoltage, directionality), then these inputs are needed.

Subunit name	VT
Number of VT inputs	1-4 / 4
Nominal voltage	100 V
Continuous voltage withstand	250 V
Short time overload (1 s)	275 V AC / 350 V DC
Voltage measuring range	0.05 U_n – 1.5 U_n
Consumption of voltage input	0.3 VA at 100 V

Table 3-2: Voltage input characteristics

3.4 Binary inputs

These inputs are galvanic isolated and it converts high-voltage signals to the voltage level and format of the internal circuits. It can be used as a PPM input, too.

Subunit name	BI
Number of binary inputs	4
Synchronization input	4th CH
Selectable rated voltage	24 V, 48 V, 110 V, 220 V
Max. withstand voltage	265 V
Clamp voltage	Un [V] / Falling [V] / Rising [V]: 220 / 132 - 154 / 158 – 170; 110 / 66 – 77 / 79 – 85; 48 / 29 – 34 / 34 – 37; 42 / 25 – 29 / 30 – 32; 24 / 12.4 – 15.8 / 16.2 – 18.5
Grounding groups	2 x 2 common ground

Table 3-3: Binary inputs characteristics

Main features:

- Digitally filtered per channel
- Burden: approx. 1 mA per channel
- Input voltage type can be either DC or AC voltage. If AC voltage is used make sure that the type and the parameters of the binary inputs are configured properly in S16Tool.

3.5 Signaling relays

There are 4 relay outputs with dry contacts.

Subunit name	BO
Number of binary outputs	4
Max. withstand voltage	250 V AC/DC
Continuous carry	6 A
Contact versions	2 x NO, 2 x CO
Group isolation	Independent

Table 3-4: Binary output characteristics

- Breaking capacity, (L/R = 40 ms) at 220 V DC: 0.05 A, at 110 V DC: 0.1 A
- Initial dielectric strength between open contacts: 1000 Vrms
- Current carrying capacity for 4 sec: 10 A
- Mechanical endurance: 10×10^6 cycles
- Making capacity at inductive load: 10 A
- Making capacity for 4 sec: 10 A
- Maximum breaking capacity AC: 1500 VA
- Maximum making power: 10 A × 250 V AC

3.6 Tripping relays

The tripping relay is proprietary and patented solution that facilitates direct control of a circuit breaker.

Subunit name	TRIP
Number of TRIP outputs	2
Selectable TCS rated voltage*	24 V, 48 V, 110 V, 220 V
Max. withstand voltage	265 V
Continuous carry	6 A
Making capacity	6 A
Breaking capacity	L/R = 40 ms: 1 A DC

Table 3-5: TRIP output characteristics

**same parameter as the binary input has*

Main features:

- High-speed operation
- Trip circuit supervision for each trip contact
- Tripping output can be dry contact type too
- Maximum open contact circuit voltage 1000 Vrms
- Current carrying capacity for 4 s: 10 A
- Mechanical endurance: 10 × 106 cycles

3.6.1 TRIP relay wiring

The tripping relay provides tripping circuit supervision function (TCS).
The injected current from the normally open contact (NO) is 0.5 mA.

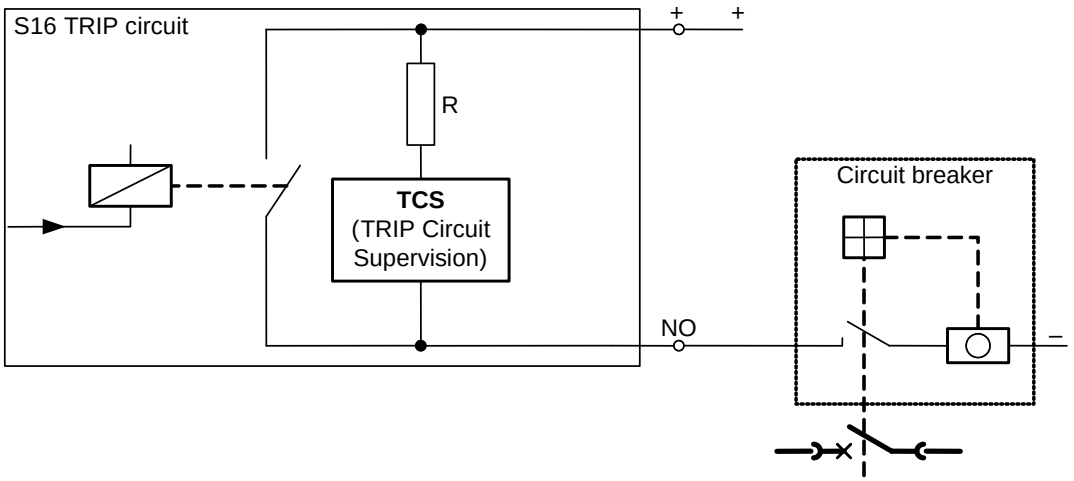

Figure 3-2: TRIP wiring using a single TRIP channel

It is possible to use parallel connected TRIP circuits. The injected current from the normally open contacts (NO) is 1 mA.

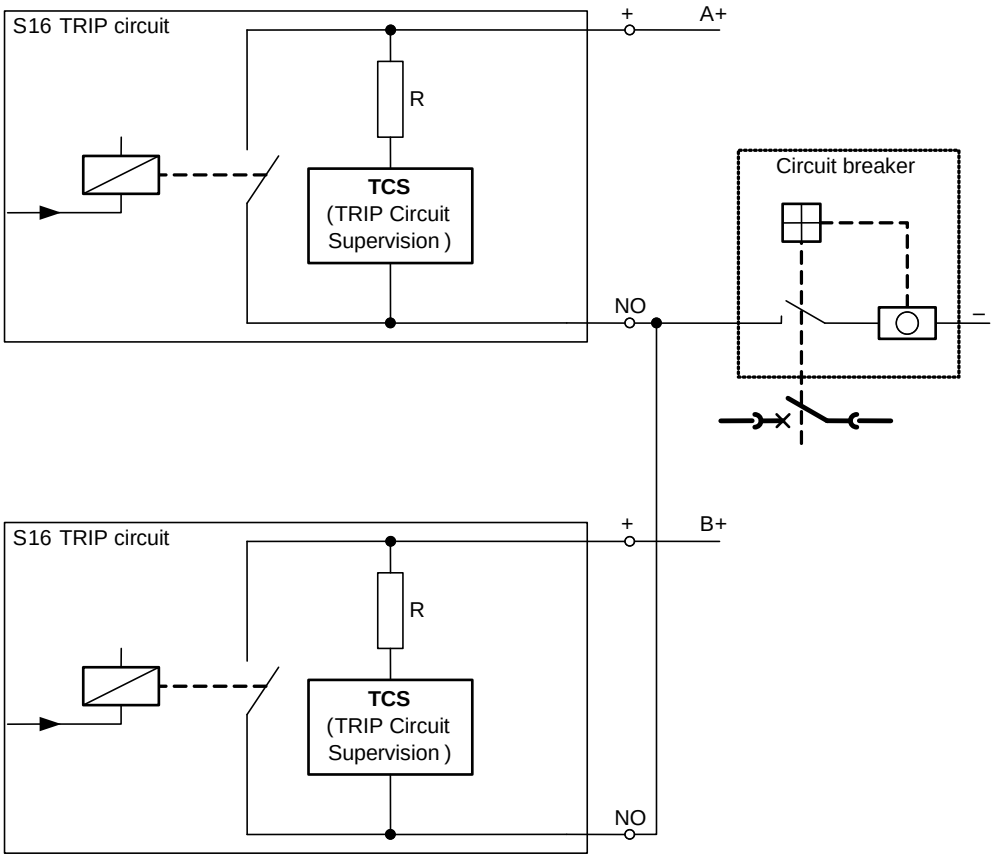

Figure 3-3: TRIP wiring using parallel connected TRIP channels

If the circuit breaker needs two-pole switching TRIP circuits can be connected series.

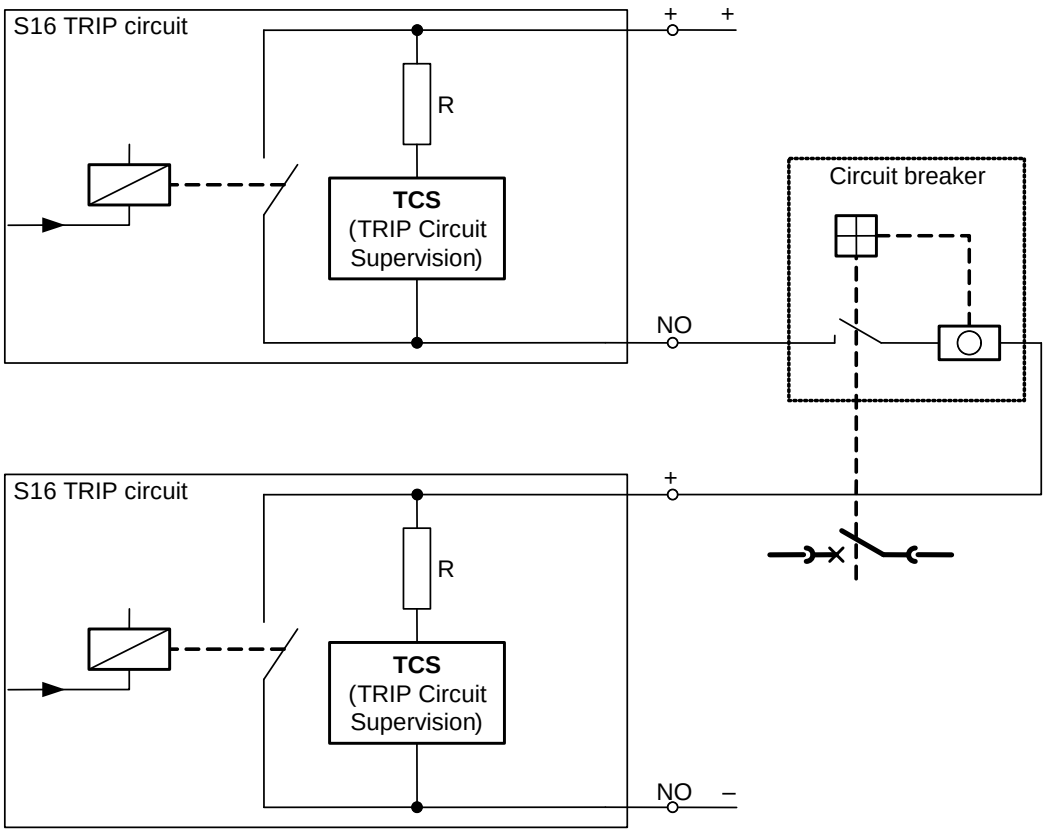

Figure 3-4: TRIP wiring using series connected TRIP channels

Subunit name	TRIP
Value of R resistor (± 10 %)	450 kΩ

Table 3-6: Value of R resistor

3.7 Power supply

The power supply converts primary AC and/or DC voltage to required system voltages.

Subunit name	PS
Input voltage	19.2 - 300 V DC 80 - 255 V AC
Rated voltage	24/48/60/110/220 V DC 110/230 V AC
Rated burden	< 10 W
Maximum inrush current	< 4 A during 0.01 s
Input voltage interruption time	min. **50 ms** in the specified input voltage range (100 V < @ **min. 200 ms**)

Table 3-7: Power supply characteristics

Main features:

- Fault relay contacts (NC and NO): device fault contact. All the three relay contact points (NO, NC, COM) are accessible to users.
- On-board self-supervisory circuits: temperature and voltage monitors
- Short-circuit-protected outputs
- Efficiency: > 70 %, power consumption = nominal power / efficiency
- Passive heatsink
- Early power failure indication signals to the CPU the possibility of power outage, thus the CPU has enough time to save the necessary data to non-volatile memory

4 General data

- Storage temperature range: -30 °C to +70 °C
- Extended storage temperature range (valid only for devices without LCD): -30 °C to +80 °C
- Operation temperature range: -20 °C … +55 °C
- Operation and storage humidity: 10 % - 93 %

- EMC/ESD standard conformance:
  - Electrostatic discharge (ESD) EN 61000-4-2, EN 60255-26
    - Test voltage: 8 kV AD, 6 kV CD
  - Radiated electromagnetic field EN 61000-4-3, EN 60255-26
    - Test field strength: 10 V/m
  - Electrical fast transients (EFT/B) EN 61000-4-4, EN 60255-26, Zone A
    - Test voltage: 4 kV
  - Surges EN 61000-4-5, EN 60255-26, Zone A
    - Test voltages: line-to-earth 4 kV, line-to-line 2 kV
  - Conducted radio-frequency EN 61000-4-6, EN 60255-26
    - Test voltage: 10 V
  - Damped oscillatory waves EN 61000-4-18, EN 60255-26
    - Test voltage: 2.5 kV (for common and differential mode alike)
  - Voltage interruptions EN 6100-4-11, EN 60255-26
    - Duration: 5 s, Criterion for acceptance: C
  - Voltage dips and short interruptions EN 6100-4-11, EN 60255-26
    - Voltage during dips: 0%, 40%, 70%
  - Power frequency magnetic field EN 61000-4-8, EN 60255-26
    - Test field strength: 30 A/m cont, 300 A/m 3 s
  - Power frequency disturbance EN 60255-26, Zone A
    - Test voltage: 150 V DM, 300 V CM
  - Impulse voltage withstand test EN 60255-27
    - Test voltage: 5 kV
  - Dielectric test EN 60255-27
    - Test voltage: 2 kV
  - Insulation resistance test EN 60255-27
    - Insulation resistance > 15 GΩ

- Radiofrequency interference emission test (RFI):
  - Radiated disturbance EN 55011, IEC 60255-26
  - Conducted disturbance at mains ports EN 55011, IEC 60255-26

- 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

4.1 Mechanical data

- Construction: anodized aluminum surface
- EMC case protects against electromagnetic environmental influences and protects the environment from radiation from the interior
- IP30 protection from rear side
- Mounting methods:
  - flush
  - semi flush
  - vertical on DIN-rail
- Size:
  - 16 HP, panel instrument case
  - Weight: max. 1.5 kg

Connector type	Stripping length [mm]	Conductor area [mm^2]	Conductor diameter [mm]	Tightening torque [Nm]	Minimum bend radius*
BL	7	0.2 – 1.5 solid: 0.2 – 2.5	0.5 – 1.4 solid: 0.5 – 1.8	0.4 – 0.5	3 × OD**
STVS	9	2.5 – 4	1.8 – 2.3	0.5 – 0.6	3 × OD**
Barrier strip JC6-Q308-08	-	0.32 – 3.3	0.64 – 2	0.5 – 0.6	3 × OD**
WE Series 3405	7 – 8	0.2 – 3	0.5 – 2	0.56	3 × OD**
ST/FC/LC	-	-	-	-	30 mm

Table 4-1: Installation Connector types and conductor specifications

** Bend radius is measured along the inside curve of the wire or wire bundles.*
*** OD is the outer diameter of the wire or cable, including insulation.*

The tightening torque of the screw for protective earth connection and the wall mounting must be approx. 5 Nm.
The tightening torque of the screw for fastening the STVS connector must be approx. 1 Nm.

The minimum distance between an EP+S16 device and its wire channel must be at least 3 cm.
The minimum distance between two EP+S16 devices must be at least 10 cm.

4.2 Drawings of panel instrument case (16 HP) and recommended panel cut-out

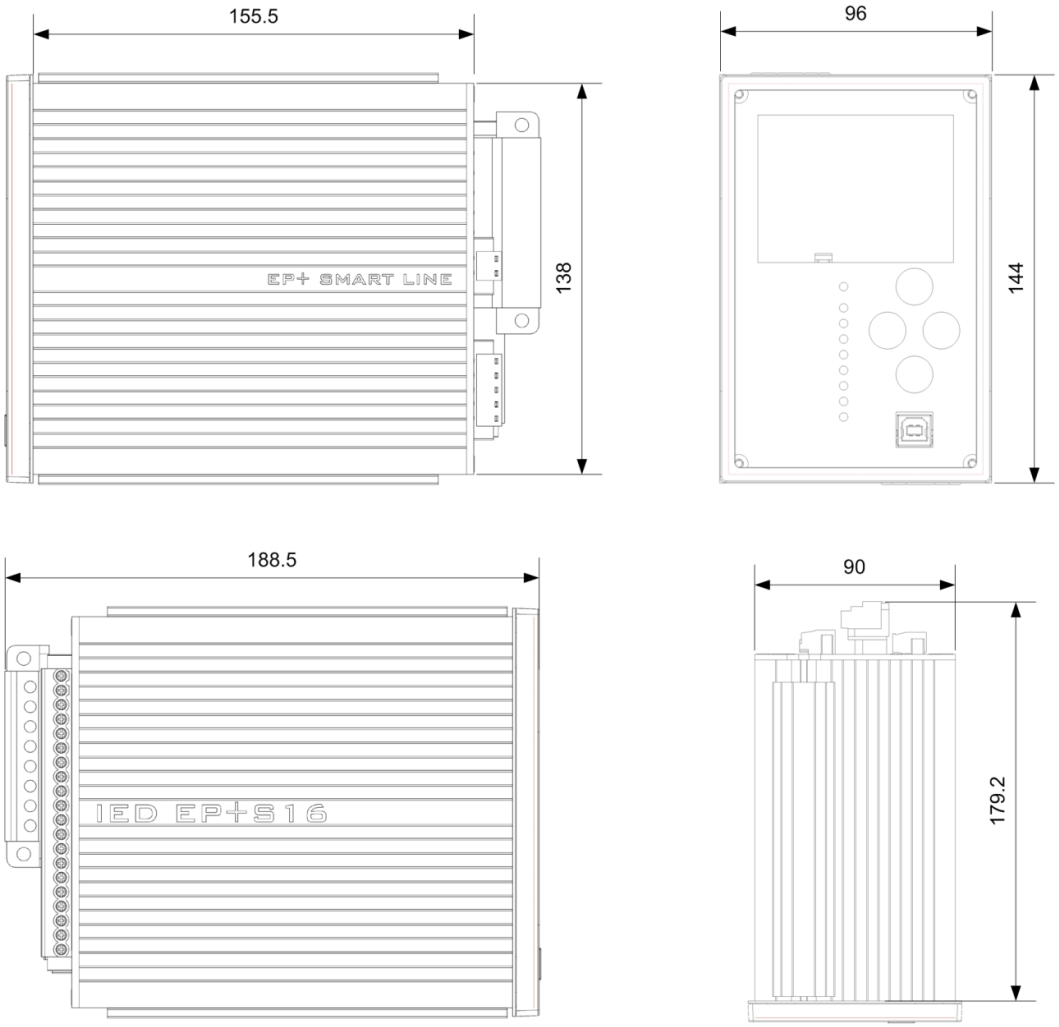

Figure 4-1: S16 dimensions with STVS CT connector

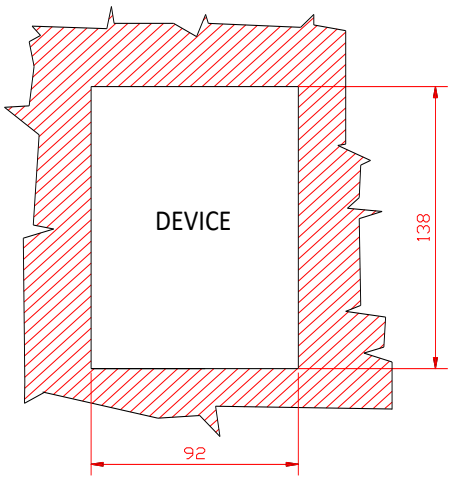

Figure 4-2: S16 panel cut-out for flush and semi-flush mounting

Figure 4-3: S16 semi-flush mounting method (max. depth = 75mm)

Figure 4-4: S16 flush mounting method

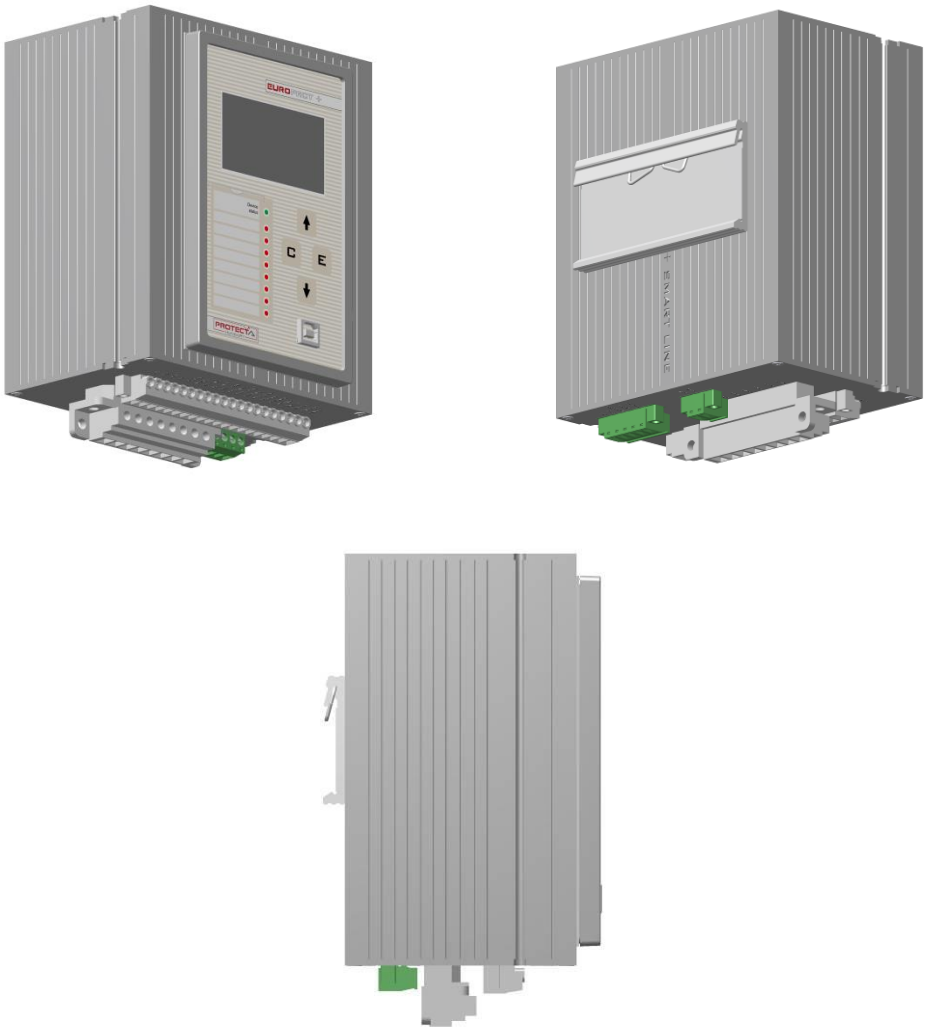

Figure 4-5: S16 DIN-rail mounting method

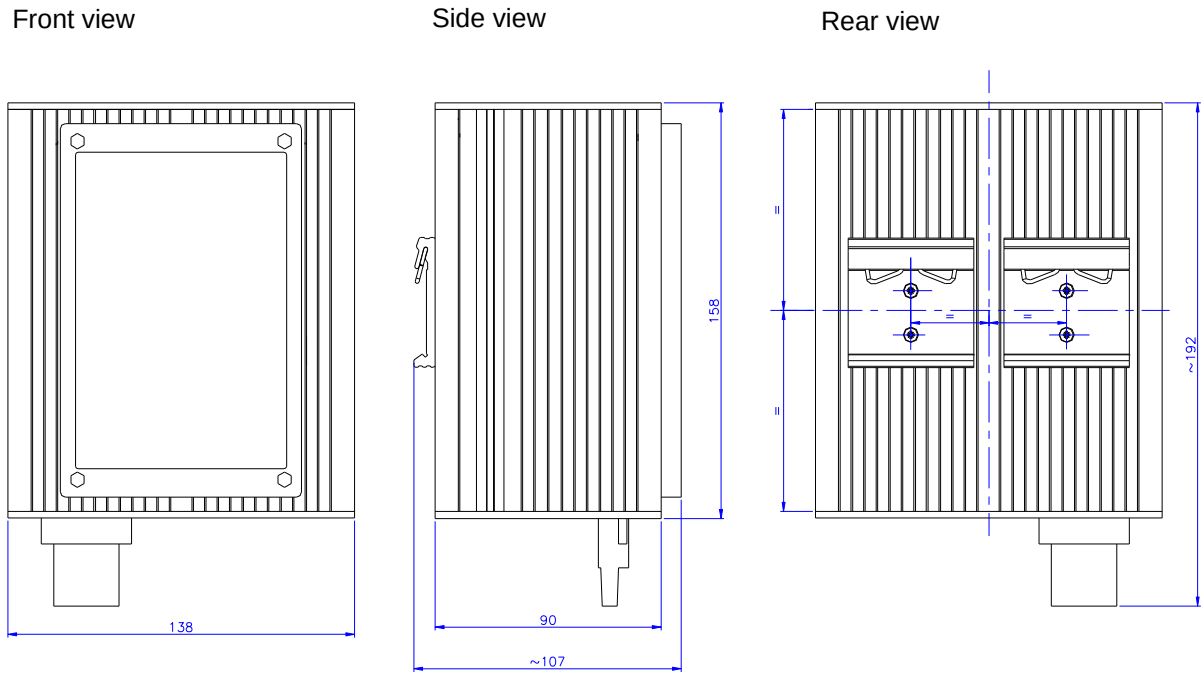

Figure 4-6: S16 DIN-rail dimensions

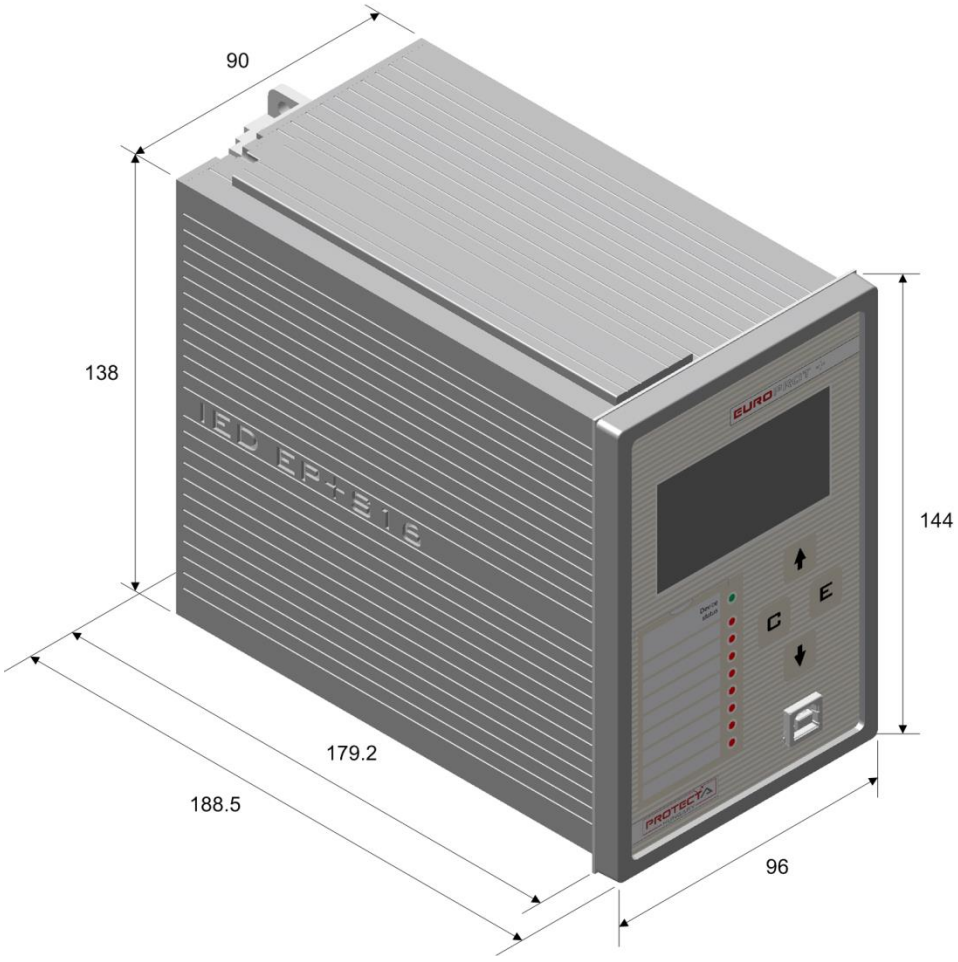

Figure 4-7: S16 dimensions with STVS CT connector

4.3 Connection assignment

Connector ID	Pin number	Signal name
A1	1	UL1 ➔
	2	UL1 ←
	3	UL2 ➔
	4	UL2 ←
	5	UL3 ➔
	6	UL3 ←
	7	UN ➔
	8	UN ←
A2	1	UN ➔
	2	UN ←

Connector ID	Pin number	Signal name
A3	1	PS+
	2	PS-
	3	FR COM
	4	FR NO
	5	FR NC

Connector ID	Pin number	Signal name
B1	1	IL1 ➔
	2	IL1 ←
	3	IL2 ➔
	4	IL2 ←
	5	IL3 ➔
	6	IL3 ←
	7	IN ➔
	8	IN ←

Connector ID	Pin number	Signal name		
		Var 1 & 2	Var 3	Var 4 & 5
B2	1	IL1 ➔	UL1 ➔	IL1 ➔
	2	IL1 ←	UL1 ←	IL1 ←
	3	IL2 ➔	UL2 ➔	IL2 ➔
	4	IL2 ←	UL2 ←	IL2 ←
	5	IL3 ➔	UL3 ➔	IL3 ➔
	6	IL3 ←	UL3 ←	IL3 ←
	7	IN ➔	UN ➔	IN ➔
	8	IN ←	UN ←	IN ←

Connector ID	Pin number	Signal name
C1	1	BI1
	2	BI2
	3	BI12 COM
	4	BI3
	5	BI4
	6	BI34 COM
	7	BO1 NO
	8	BO1 COM
	9	BO2 NO
	10	BO2 COM
	11	BO3 NO
	12	BO3 NC
	13	BO3 COM
	14	BO4 NO
	15	BO4 NC
	16	BO4 COM
	17	TRIP1+
	18	TRIP1 NO
	19	TRIP2+
	20	TRIP2 NO

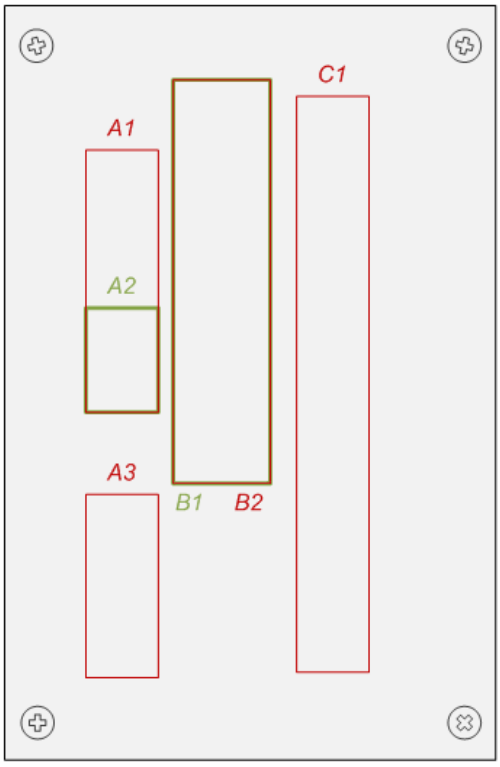

Figure 4-8: S16 backplane connectors marking

5 Communication

The serial communication protocols supported by the IED can be selected using the local LCD
- IEC 60870-5-101
- IEC 60870-5-103
Link level parameters: 1200-57600 bps, 8 data bit (fixed), 1 stop bit (fixed), even parity (fixed).

All device settings and parameters can be set by specific parametrization PC software running on Microsoft Windows™ operating systems (Windows 7 and above) with .NET framework (4.0 and above) installed. The user's PC can be connected to the device via the USB interface the device will be automatically detected. It is also possible to change parameters through the ASIF interface on the back side of the IED using a substation engineering computer.

Parameters and events can also be uploaded and stored on the user's computer.