MICROENER

Smartline S16 relays
Product Specification

PROTECTA HUNGARY

FDE 24LA0771652 - Rev. A

Version information

Version	Date	Modification	Compiled by
1.0	18.09.2013	Initial creation of EP+S16 relay specification	Dienes/Budenszki
1.1	01.10.2013	Modification of EP+S16 relay specification	Dienes/Budenszki
1.2	15.10.2013	2 independent BI groups and 4 BOs introduced Backplane illustrations updated Block diagram updated	Dienes/Budenszki
2.0	12.2015.	Minor correction	Dienes/Budenszki
A	17/03/24	Minor correction	L.A

CONTENTS

INTRODUCTION

The Smartline S16 series is a member of the MICROENER product line, The Smartline are complex and modular in respect of hardware and software. The modules are assembled and configured according to the requirements, and then the software determines the functions.

The primarily target of the S16 feeder protection relay (S16/F) is the protection of incoming and outgoing feeders in distribution substations. 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 for 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. The Modbus® RTU will be available later. As of now the 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 a specific parametrization PC software running on Microsoft Windows™ operating systems with .NET framework 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.

The S16 series will also provide built-in disturbance recorder in the future.

APPLICATION

Currently the IED S16 is available in five predefined standard configurations to suit the most common feeder protection applications.

Available configurations of the S16 series:

- **S16/F (Variant 1)** is mainly used as main or backup overcurrent protection.
- **S16/M (Variant 2)** provides additional motor protection functions compared to S16/F.
- **S16/U (Variant 3)** is suitable for those application where only voltage and frequency based protection functions are required.
- **S16/DT (Variant 4)** device 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.
- **S16/MDT (Variant 5)** provides motor protection functions above S16/DT.

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

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 of 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	S16/F V1.	S16/M V2.	S16/U V3.	S16/DT V4.	S16/MDT V5.
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				✓	✓
Negative sequence overcurrent protection	I2 >	46	1	✓	✓		✓	✓
Thermal protection	T >	49	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			✓		
Undercurrent protection	3IdB >	37	1		✓			✓
Vector jump protection		78	1			✓		
Startup supervision with restart inhibit		66	1		✓			✓
Frequent start protection		66	1		✓			✓
Transiens earth-fault protection			1				✓	
Restricted earth-fault protection (High-impedance)			1				op.	

op.: optional

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)

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 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		
TOC67N_low	Dir.Residual TOC	Directional residual overcurrent protection function block description
TOC67N_high		
TUC37	UnderCurrent	Undercurrent (loss–of–load) protection function block description
TUV 27_low	Undervoltage	Definite time undervoltage 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

Hardware configuration

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

S16/F and S16/M	
Housing	Panel instrument enclosure (16 HP size)
Current inputs (4th channel can be sensitive)	4 (3 × 1/5 A and 1 × 1/5/0,2 A)
Digital inputs	4
Digital outputs	4
Fast trip outputs	2
IRF contact	1

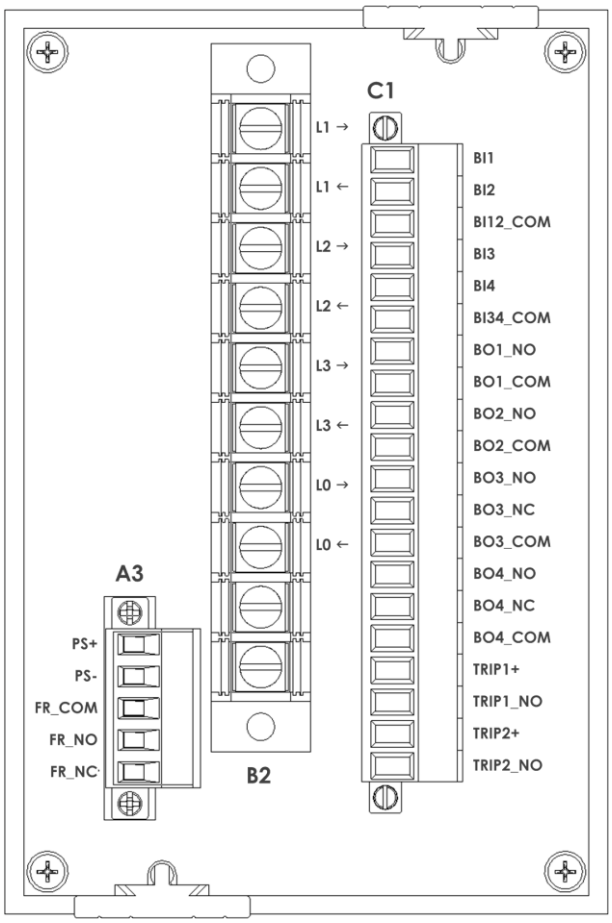


Figure 0-1 S16/F and S16/M backplane with barrier strip connector for ring lug

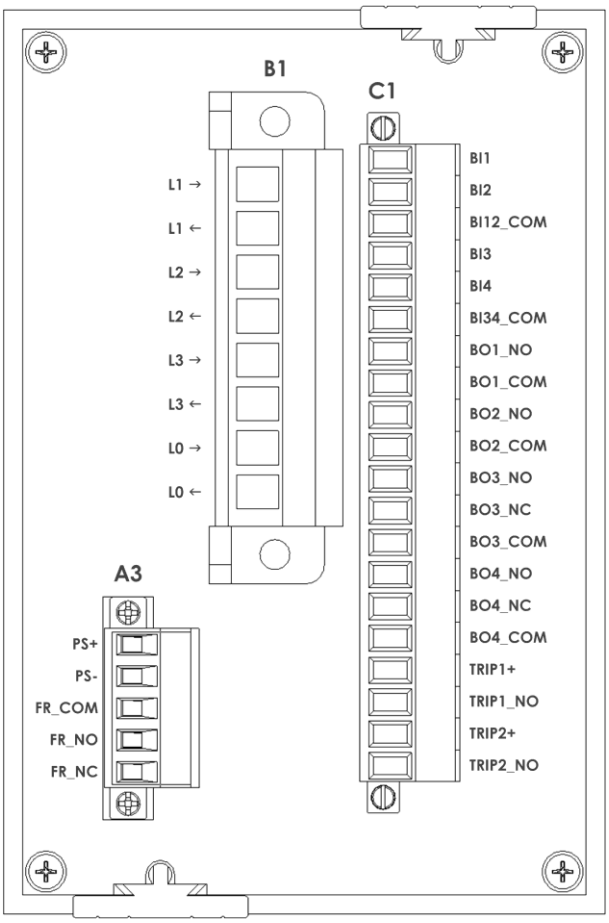


Figure 0-2 S16/F and S16/M backplane with terminal block connector

S16/U	
Housing	Panel instrument enclosure (16 HP size)
Voltage inputs	4
Digital inputs	4
Digital outputs	4
Fast trip outputs	2
IRF contact	1

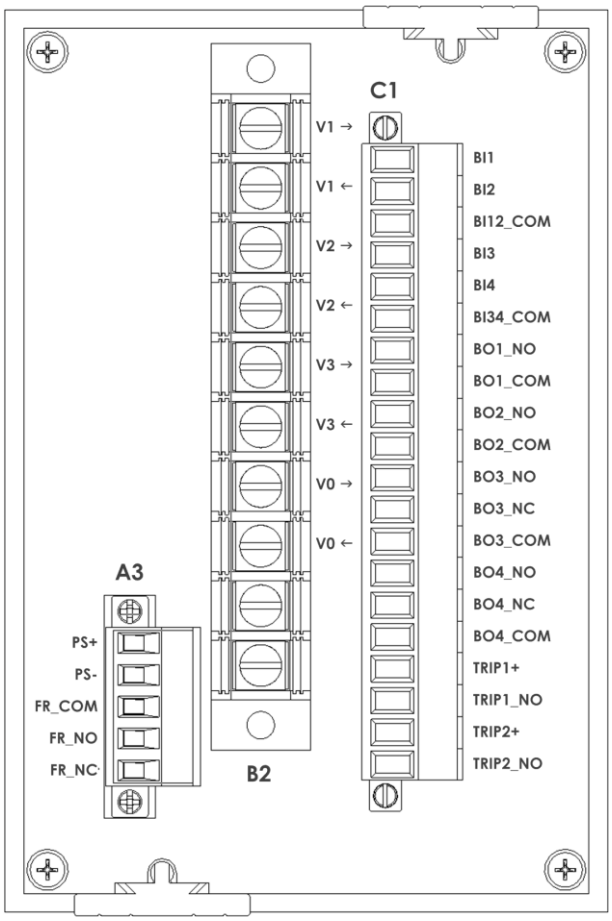


Figure 0-3 S16/U backplane with barrier strip connector for ring lug

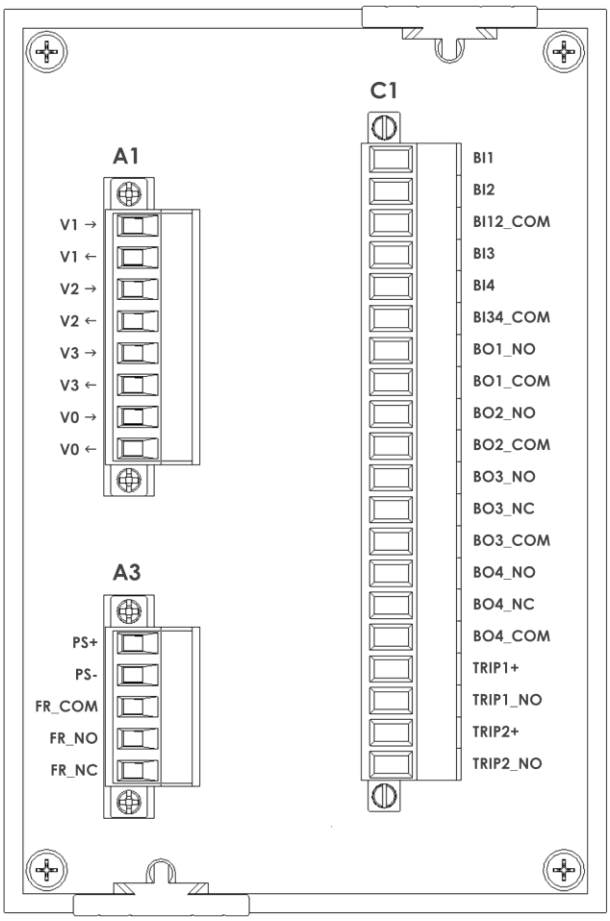


Figure 0-4 S16/U backplane with terminal block connector

S16/DT and S16/MDT	
Housing	Panel instrument enclosure (16 HP size)
Current inputs (4th channel can be sensitive)	4 (3 × 1/5 A and 1 × 1/5/0,2 A)
Voltage inputs	1
Digital inputs	4
Digital outputs	4
Fast trip outputs	2
IRF contact	1

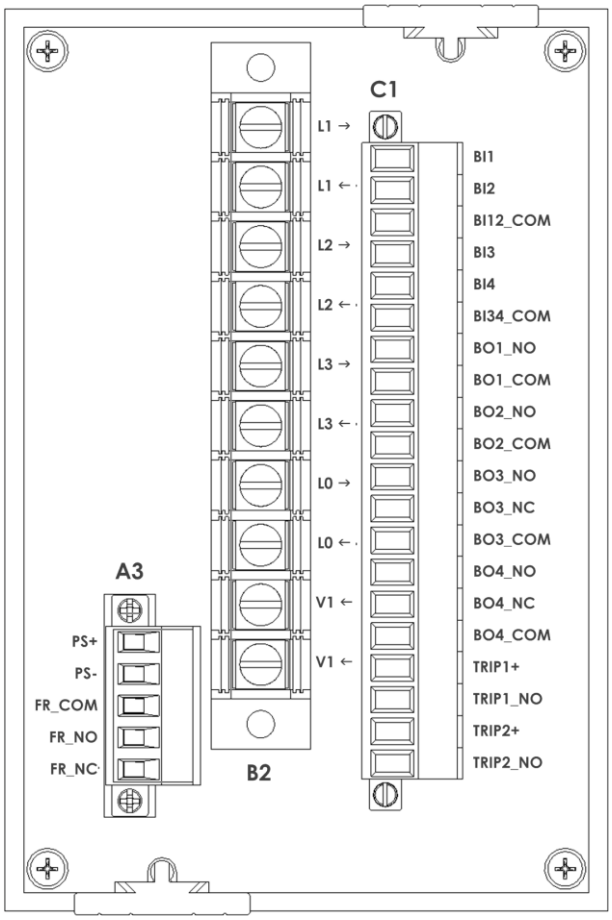


Figure 0-5 S16/DT a,d S16/MDT backplane with barrier strip connector for ring lug

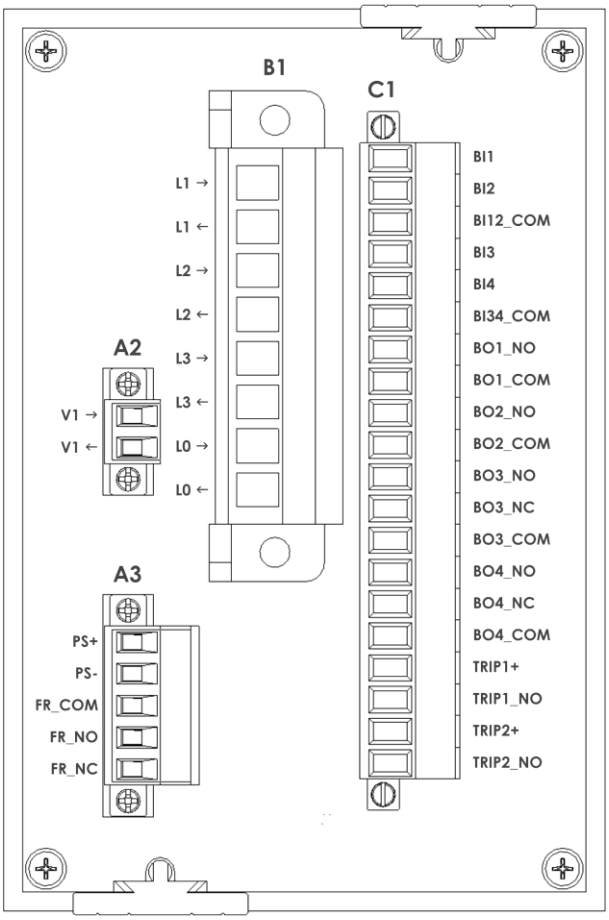


Figure 0-6 S16/DT and S16/MDT backplane with terminal block connectors

IP ratings:

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

The basic hardware shown as follows:

Standard version

Option version

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
Optional available:	
ASIF-O+/S16	Asynchronous communication subunit (legacy serial protocols) and timing input (PPS, IRIG….)
ASIF-G+/S16	Asynchronous communication subunit (legacy serial protocols)

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	

HARDWARE SPECIFICATION

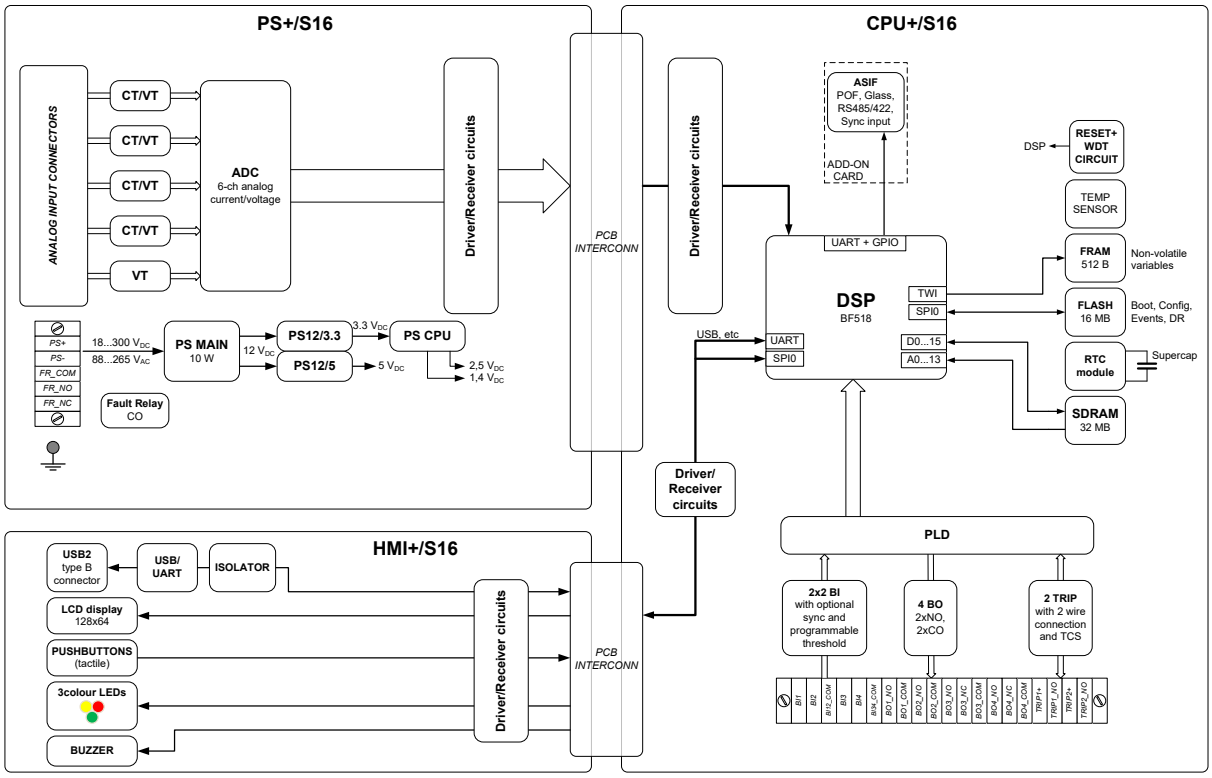


Figure 0-1 S16 Block diagram

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 (USB2 connection)

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, 60 Hz

Subunit name	**CT**				
Channel number	1-3		4		
Selectable rated current, I_n [A]	1	5	0.2	1	5
Max. measured current	50 × I_n		50 × I_n		
Relative accuracy [%] ± 1 digit	± 1 (> 0.5I_n)	± 1 (> 0.4I_n)	± 1 (> 0.5I_n)		
Phase angle accuracy at I_x ≥ 10% ± 1 digit	≤ 1.5 °		≤ 1.5 °		
Power consumption at rated current [VA]	0.002	0.04	0.001-0.04		
Thermal withstand [A]					
continuously	20				
1 s	500				
10 ms	1200				
Recommended application	General protection applications.				

Characteristics of voltage input

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

Subunit name	VT
Channel number	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	0.2 VA at 100 V
Relative accuracy	± 0.5 % (> 0.6Un)
Frequency measurement range	± 0.01 % at Ux ≥ 25 % of rated voltage
Phase angle accuracy	≤ 0.5 ° at Ux ≥ 25 % of rated voltage
Recommended application	General protection applications.

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
Channel number	4
Synchronization input	4
Selectable rated voltage	24 V, 48 V, 110 V, 220 V
Max. withstand voltage	265 V
Clamp voltage	falling 0.6 × U_{rated} rising 0.8 × U_{rated}
Grounding groups	2 x 2 common ground

Main features:

- Digitally filtered per channel
- Current drain: 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.

Signaling relays

There are 3 relay outputs with dry contacts.

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

- 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

Tripping relays

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

Subunit name	TRIP
Channel number	2
Selectable TCS rated voltage*	24 V, 48 V, 110 V, 220 V
Max. withstand voltage	265 V
Continuous carry	6 A
Making capacity	4 A (0.1 s)
Breaking capacity	4 A (L/R = 40 ms, 0.4 s)

** 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 0.1 s: 10 A
- Mechanical endurance: 10×10^6 cycles

TRIP relay wiring

The tripping relay provides tripping circuit supervision function (TCS).
The injected current from the normally open contact (No) is 0.1 mA.

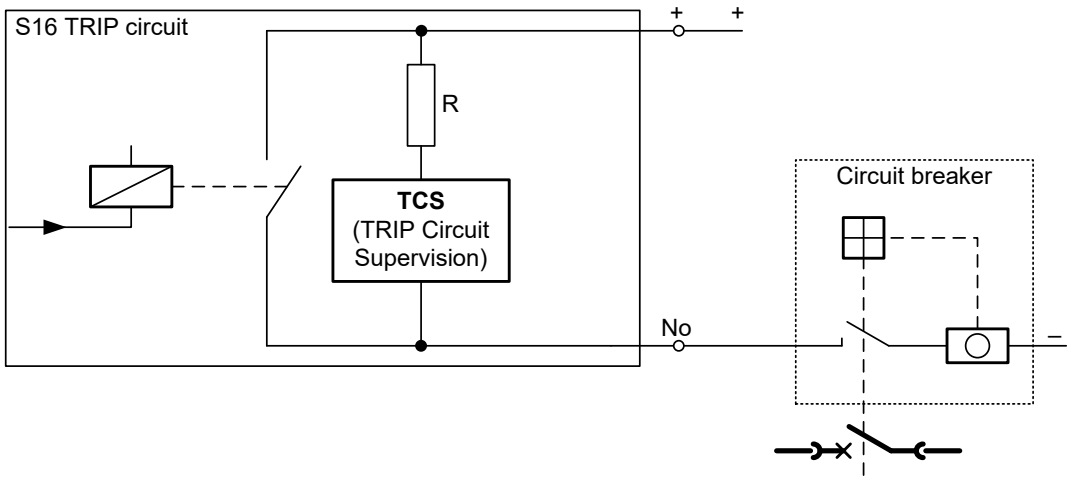


Figure 0-2 TRIP wiring using a single TRIP channel

It is possible to use parallel connected TRIP circuits. The injected current from the “No” contacts is 3 mA.

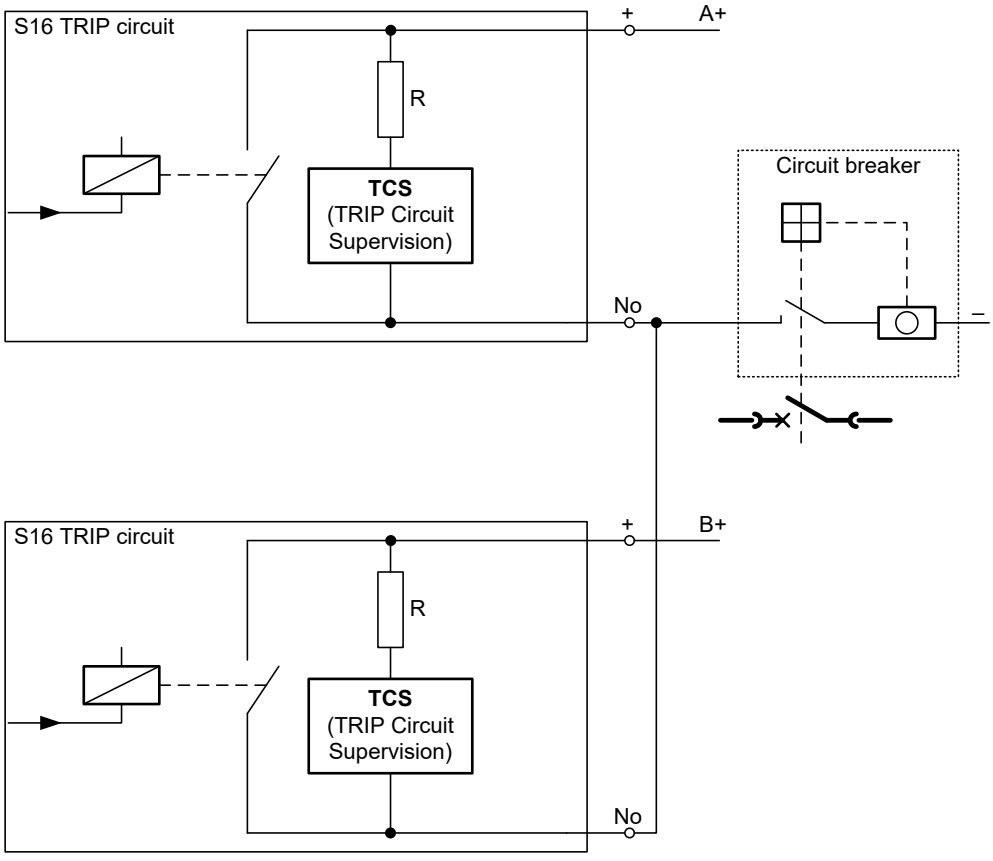


Figure 0-3 TRIP wiring using parallel connected TRIP channels

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

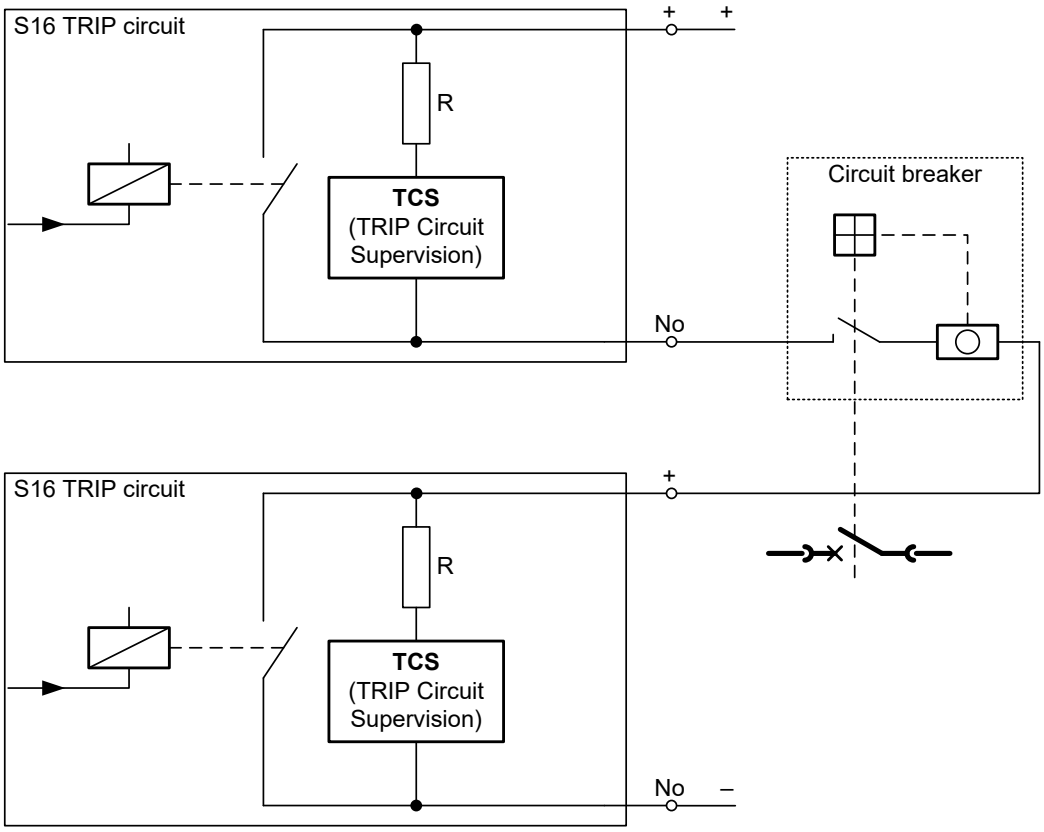


Figure 0-4 TRIP wiring using series connected TRIP channels

Subunit name	TRIP
Value of R resistor (± 10 %)	1 MΩ

Power supply

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

Subunit name	PS
Input voltage	18-300 V DC 80-255 V AC
Nominal voltage	24/48/60/110/220 V DC 230 V AC
Nominal power	10 W
Input voltage interruption time *(at nominal load)*	min. **50 ms** in the specified input voltage range

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

GENERAL DATA

- Storage temperature: -30 °C … +70 °C, extended range: -40 °C to + 85 °C
- Operation temperature: -20 °C … +55 °C,
- Extended (from -40 °C to + 85 °C) temperature range is valid only without LCD on the HMI
- 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
- EMC case protects against electromagnetic environmental influences and protects the environment from radiation from the interior
- IP20 protection from rear side
- Mounting methods:
  - semi flush
  - flush
  - vertical on DIN-rail
- Size:
  - 16 HP, panel instrument case
  - Weight: max. 3 kg

Connector type	Stripping length [mm]	Conductor area [mm²]	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	0.5 – 4	0.8 – 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

** 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.

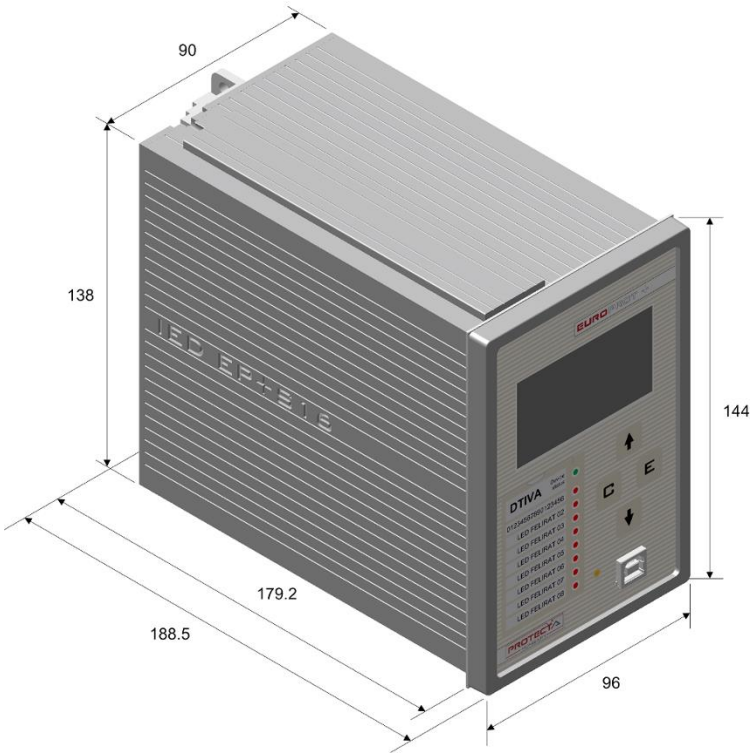
The minimum distance between an S16 device and its wire channel must be at least 3 cm.
The minimum distance between two S16 devices must be at least 10 cm.

Drawings of panel instrument case and recommended panel cut-out

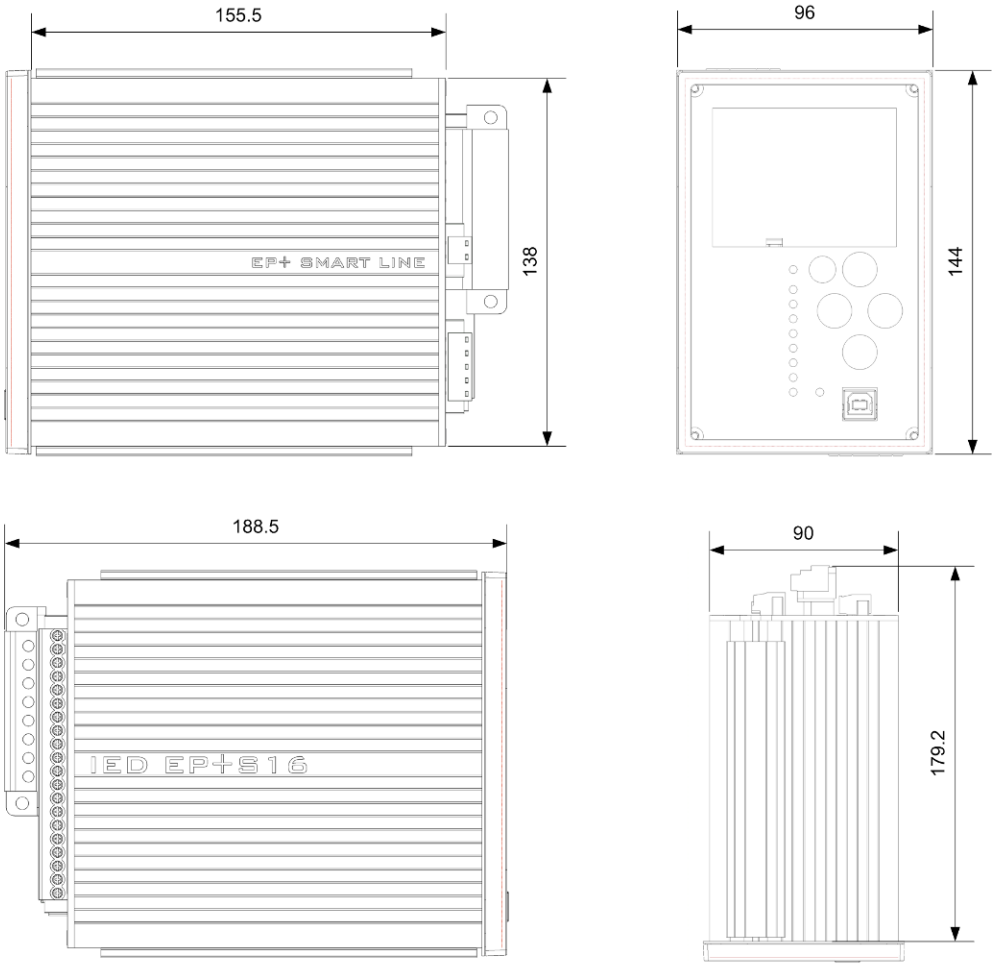
Standard version :

S16 DIN-rail mounting method

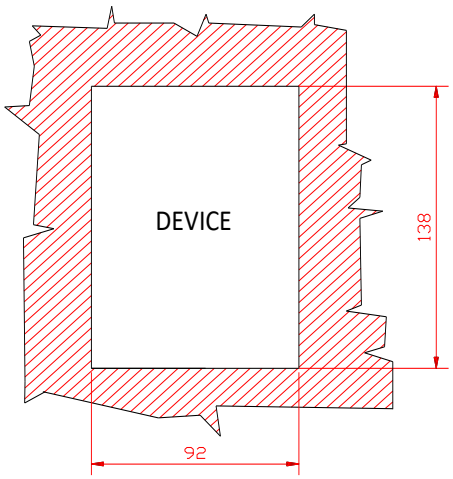
Option



S16 dimensions with STVS CT connector



S16 dimensions with STVS CT connector



S16 panel cut-out for flush and semi-flush mounting

S16 semi-flush mounting method (max. depth = 75mm)

S16 flush mounting method

Connection assignment

Connector ID	Pin number	Signal name
A1	1	V1 ➔
	2	V1 ←
	3	V2 ➔
	4	V2 ←
	5	V3 ➔
	6	V3 ←
	7	V0 ➔
	8	V0 ←

Connector ID	Pin number	Signal name
A2	1	V1 ➔
	2	V1 ←

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	L1 ➔
	2	L1 ←
	3	L2 ➔
	4	L2 ←
	5	L3 ➔
	6	L3 ←
	7	L0 ➔
	8	L0 ←

Connector ID	Pin number	Signal name		
		Var 1 & 2	Var 3	Var 4 & 5
B2	1	L1 ➔	V1 ➔	L1 ➔
	2	L1 ←	V1 ←	L1 ←
	3	L2 ➔	V2 ➔	L2 ➔
	4	L2 ←	V2 ←	L2 ←
	5	L3 ➔	V3 ➔	L3 ➔
	6	L3 ←	V3 ←	L3 ←
	7	L0 ➔	V0 ➔	L0 ➔
	8	L0 ←	V0 ←	L0 ←
	9	NC	NC	V1 ➔
	10	NC	NC	V1 ←

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

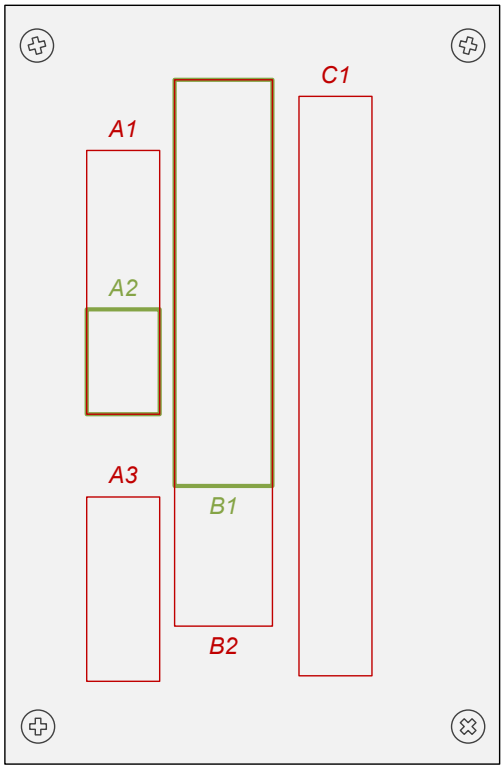


Figure 0-1 S16 backplane connectors marking

COMMUNICATION

The serial communication protocols supported by IED can be selected using the local LCD
- IEC 60870-5-101
- IEC 60870-5-103
- Modbus RTU

Link level parameters: 1200-57600 bps, 8 data bit (fixed), 1 stop bit (fixed), even parity (fixed).

All the device settings and parameters can be set by a specific parametrization PC software running on Microsoft operating systems with .NET framework system. User can connect their PC's USB port to the USB interface of the device, and the software will automatically detect the device. It is also possible to change parameters through the ASIF interface on the back side using a substation engineering computer.
Parameters and events can also be uploaded and stored on the user's computer.

SUBUNIT IDENTIFICATION

PS+/S16_XYZW	Connector				Hardware variant	
	CT		VT			
	Barrier strip	Terminal block	Barrier strip	Terminal block		
1401		x			a	S16/F & S16/M Var 1 & 2 (4CT)
1402	x				b	
1043				x (8 pin)	a	S16/U Var 3 (4VT)
1042			x		b	
1414		x		x (2 pin)	a	S16/DT & S16/MDT Var 4 & 5 (4CT+1VT)
1412	x		x		b	

CPU+/S16_	X					Y			Z	W
	Legacy communication and sync.					Communication			Spare	Version
	ASIF				IRIG	IEC61850				
	NO	POF	GLASS	RS485-422	BNC	NO	MM/ST	RJ45		
	0	3	4	5	6	0	1	2	0	1

HMI+/S16_	X		Y	Z		W
	LCD		Spare	Mounting method		Version
	NO	BW LCD		Flush	DIN rail	
	0	1	6	0	1	1