GIS*monitor*

On-line Partial Discharge Monitoring on GIS Systems

Technical Description

Rev. e5.11

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Content

I System Description

The new design of the GIS*monitor* builds on over 20 years of experience in online PD monitoring on rotating machines, transformers, cables, and especially GIS systems. It combines proven technology of the ICM*monitor,* as it is installed now on more than 400 objects, with new processor technology and embedded hardware capabilities. The hardware core of the system has been fully redesigned and optimized for parallel, real time PD acquisition on multiple channels. Any UHF signal can be detected and digitized within micro seconds. A separation of PD events from external disturbances or internal switching pulses is provided by the advanced GIS*monitor* software.

Each acquisition unit operates fully stand alone to monitor all PD sensors in one GIS PD monitoring system in parallel. A remote computer reads all data of the instruments via the high speed fiber optic LAN.

The key features of this GIS*monitor* concept are:

- Real time parallel PD acquisition on all channels
- Parallel reading of PD peak values, PD scope amplitudes, and PD patterns
- Parallel 8x8x16bit colored PD pattern acquisition
- Automatic noise separation techniques via intelligent software analysis
- Noise antenna gating capabilities
- Automatic alarm detection system via software
- PD trending and PD pattern information available with the remote computer includes the entire (continuous) measurement data of all sensors
- User friendly software panel including a customized GIS overview diagram indicating all sensors and its current activities
- Additional analysis and trending panel displaying Qp, NQS, scope, and pattern information of each channel at every time stamp
- Alarm event list indicating peak levels, PD patterns
- Direct access to all historic measurements and to current readings
- Typical PD failure database provided (ICM*expert* software)
- System redundancy in storage and LAN
- Wide temperature operation range
- External interfaces to IEC61850 or other overall monitoring systems available on request
- Low maintenance and user friendly monitoring system
- Extensible and scalable up to over 1000 channels

This online PD monitoring system has been designed to fit to all currently known UHF sensors available on the market for GIS systems. Strong transients will be blocked by a special input protection unit (IPU). All other common UHF signals are converted into lower frequencies by a special pre-processing matching unit (FCU – frequency converter unit). Further information regarding sensors and pre-processing units are given with section I.3 of this spec sheet. The next chapter shows the general signal flow and explains briefly the connection diagram of the system.

I.1 Connection Diagram & Signal Flow

This overview shows all mandatory and also all optional components of one full PD monitoring system. The number of sensors to be monitored depends on the type of GIS, and the individual specification of the customer. Sensors are typically preinstalled by the manufacturer of the GIS. Retrofit external UHF sensors for old switch panels are available and can be used as well. Up to 56/120 sensor signals (indoor cabinet) or up to 40 sensor signals (outdoor cabinet) are fed to a Partial Discharge Monitoring Acquisition Rack (PDMAR). This rack is available for indoor and outdoor use, providing the needed protection class and air condition equipment. The acquisition racks are connected via a redundant fiber network ring to communicate with the Partial Discharge Monitoring Control Rack (PDMCR). The communication can be encrypted via TLS. The control rack accommodates the industrial PC, a touchscreen, a laser printer and further peripheral devices.

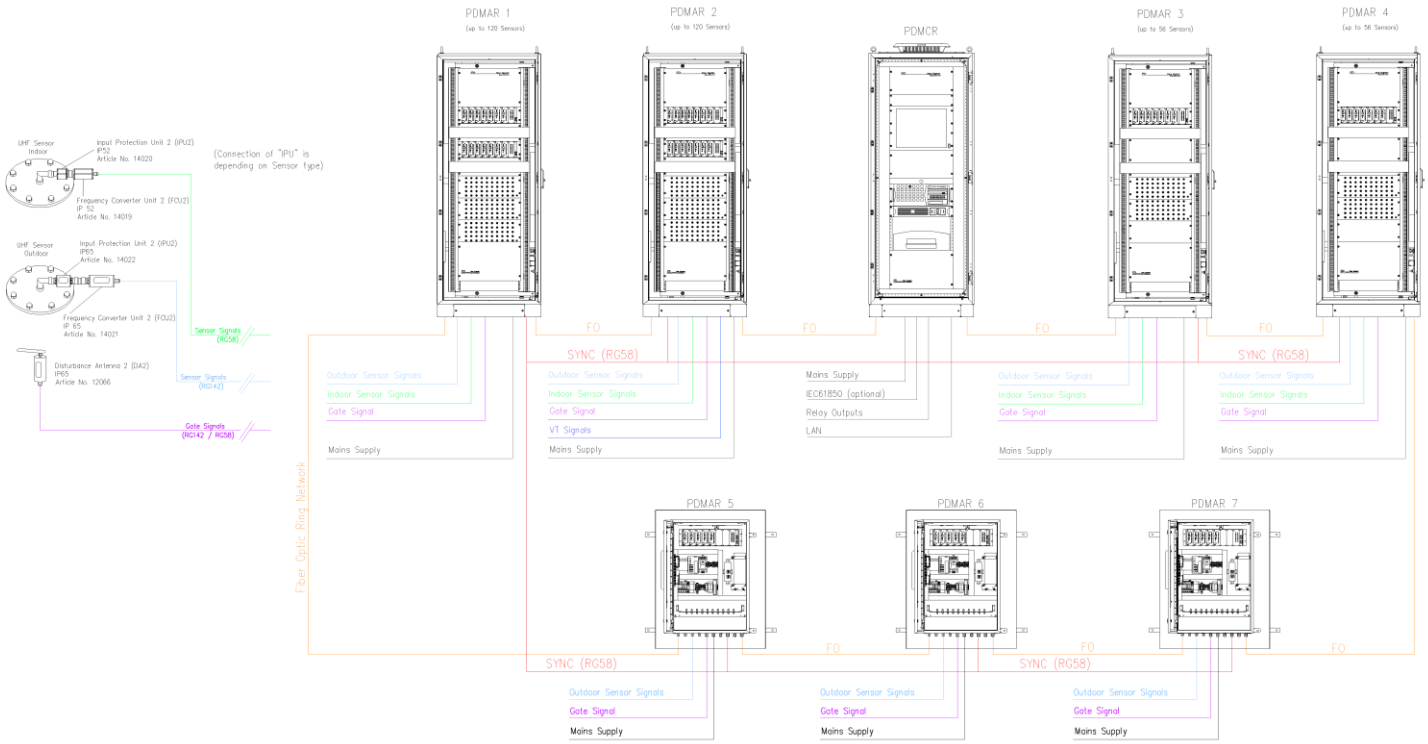


Fig. 1: Typical connection diagram

Because of the modular design, the system is very flexible and scalable. System from a small amount of sensors up to systems with several hundred sensors can be covered.

An optional remote access via VPN gives direct access to all local data stored on the PC and provides analysis and evaluation possibilities given by the GIS*monitor* software.

All racks are powered via an uninterruptable power supply (UPS) that continues operation in case of an electrical power outage and are protected against overvoltage.

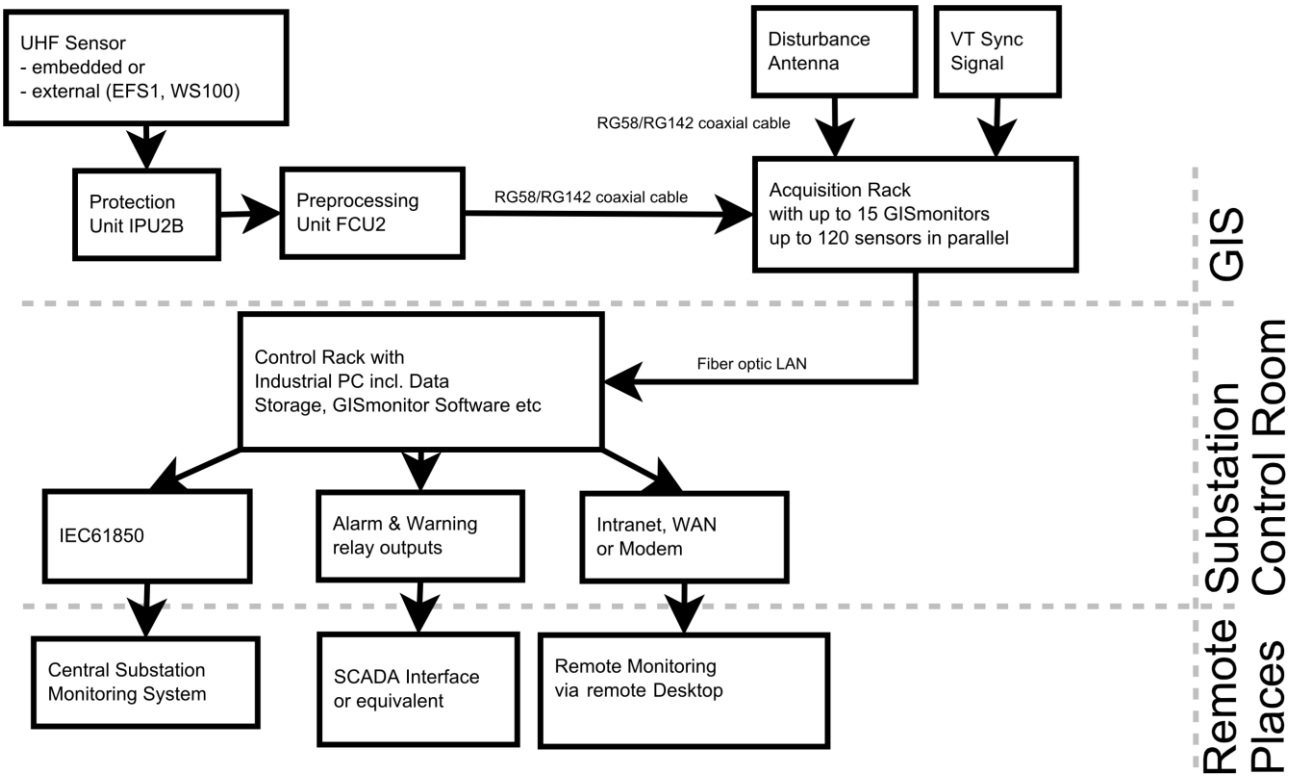


Fig. 2: Typical signal flow

Fig. 2 shows the signal flow in a PDM System. The sensor signals are picked up by the IPU/FCU units and converted into a lower frequency band. They can then be transferred to the acquisition rack via normal RG58/RG142 coaxial cable.

In the acquisition rack, the pulses are digitized by the GIS*monitor* plug-in board and sent over the fiber optic network ring to the control rack, which is located in the substation control room. The GIS*monitor* software analyzes the data and indicates alarms and their location on the screen and via several interfaces like relay outputs or IEC 61850. External access to the monitoring computer can be built up over a second LAN interface or by modem dial-up connection.

I.2 Applicable UHF Partial Discharge Sensors

Due to the dielectric properties of the SF_6 gas, partial discharge activity in gas insulated switchgear covers a bandwidth of well beyond 2 GHz. The mechanical properties of the components of gas insulated switchgear further allow transmission of such signals over a distance of a couple of meters. Thus, the partial discharge monitoring of GIS equipment is done preferably in the UHF range.

Different sensor principles apply to effectively couple to the UHF partial discharge signal travelling internally of the GIS. The most efficient sensor is an embedded sensor or field probe, which is usually installed at a spare flange. Figure 4 shows an example of such internal sensors for small flanges (Hitachi). Other internal sensors using metal shields or embedded electrodes for the control of the electrical field, for instance, offer similar sensitivity. Various GIS manufacturer offer retrofit sensors to upgrade existing gas insulated switchgear. Power Diagnostix may assist in assessing the UHF properties of a GIS and determining the position and the needed properties of the embedded sensors. The installation of internal sensors requires opening of the GIS. Any such opening of a GIS poses the risk of contamination with particles. Thus, the installation of internal sensors shall preferably be done as a task of a refurbishment or general overhaul of a service-aged GIS.

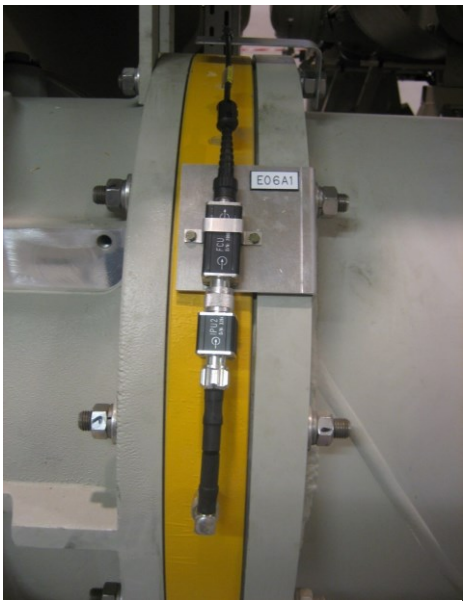


Fig. 3: Embedded electrode, so called "bed spring" sensor

External sensors are used to avoid the ambiguities of the installation of internal sensors. They are further used to enhance the overall coverage of the partial discharge activities in case the internal sensors are located too far apart. With unshielded isolated spacers, ring antennas offer capturing the radiated UHF field (Figure 5, center). Although the bolts tightly connect the two flanges at such spacer in terms of power frequency, a mayor portion of the UHF field is radiated between the bolts and thus captured by the shielded ring antenna of the external sensor. Alternatively, inspection windows are used to externally place sensors similar to the internal, flange-type sensor. Power Diagnostix provides optimized external sensors to upgrade existing GIS. Various different models are available to adapt to the different window sizes. Figure 5 shows at the left the window sensors WS80, WS95, and WS140. In case well matched, such external window sensors offer a sensitivity of few pC.

Furthermore, it's possible to retrofit a GIS with PD sensors by modifying internal components, such as metal shields, earthing switches, or embedded electrodes for the control of the electrical field.

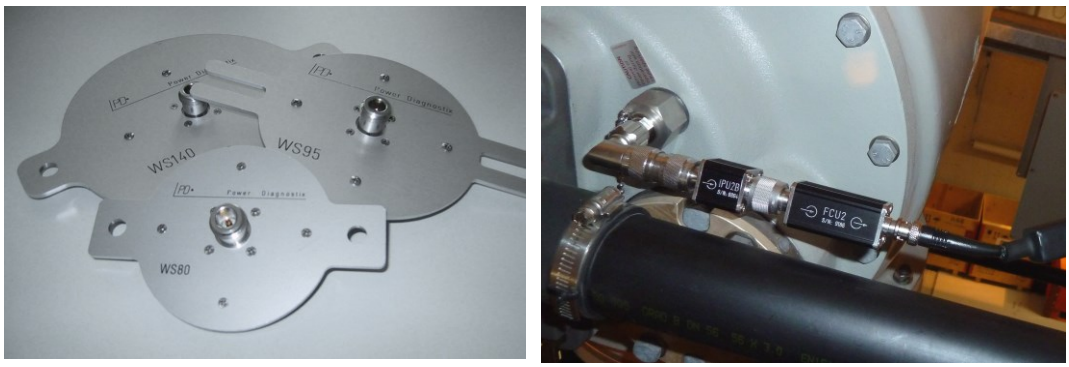


Fig. 4: External retrofit window sensors (left) and embedded sensor with IPU2B and FCU2 (right)

I.3 Signal Conditioning & Preprocessing

The frequency converter unit FCU is a UHF matching and preprocessing unit. The output of this module is the envelope of the UHF signal down-converted into the HF range. The matching unit FCU is placed directly at the output connector of the input protection unit IPU in order to avoid long and lossy UHF cables. Mounting the FCU closely to the sensor's terminal generally ensures the highest sensitivity. Simple and inexpensive RG58/RG142 type coaxial cable connects the FCU to the input of the GIS*monitor*, as the FCU's output signal contains signals only of a frequency, which is not suffering from strong cable attenuation.

The FCU is available in two different housings offering different grades of environmental protection. The protection class IP65 offers extended protection for outdoor use, while the standard IP52 version is for indoor use, only.

Fig. 5: Input protection units (IPU2B) and frequency converter units (FCU2) - IP52 and IP65 type

The FCU comes together with a separate input protection unit IPU with efficient measures to protect the input against the fast transients usually found with GIS sensors. Special high frequency common mode filters are installed on the cables connecting the FCUs with the input terminals of the GIS*monitor* to suppress fast surges on the signal cables and their sheaths.

Different versions of IPU and FCU are available for special frequency ranges based on permanent external noise or customer specification.

I.4 Central PD Monitoring & Acquisition Unit

As one GIS*monitor* can handle up to eight sensors equipped with an FCU, one GIS*monitor* acquisition unit covers one or two bays, depending on the complexity of the GIS. Each acquisition unit builds on the following block diagram.

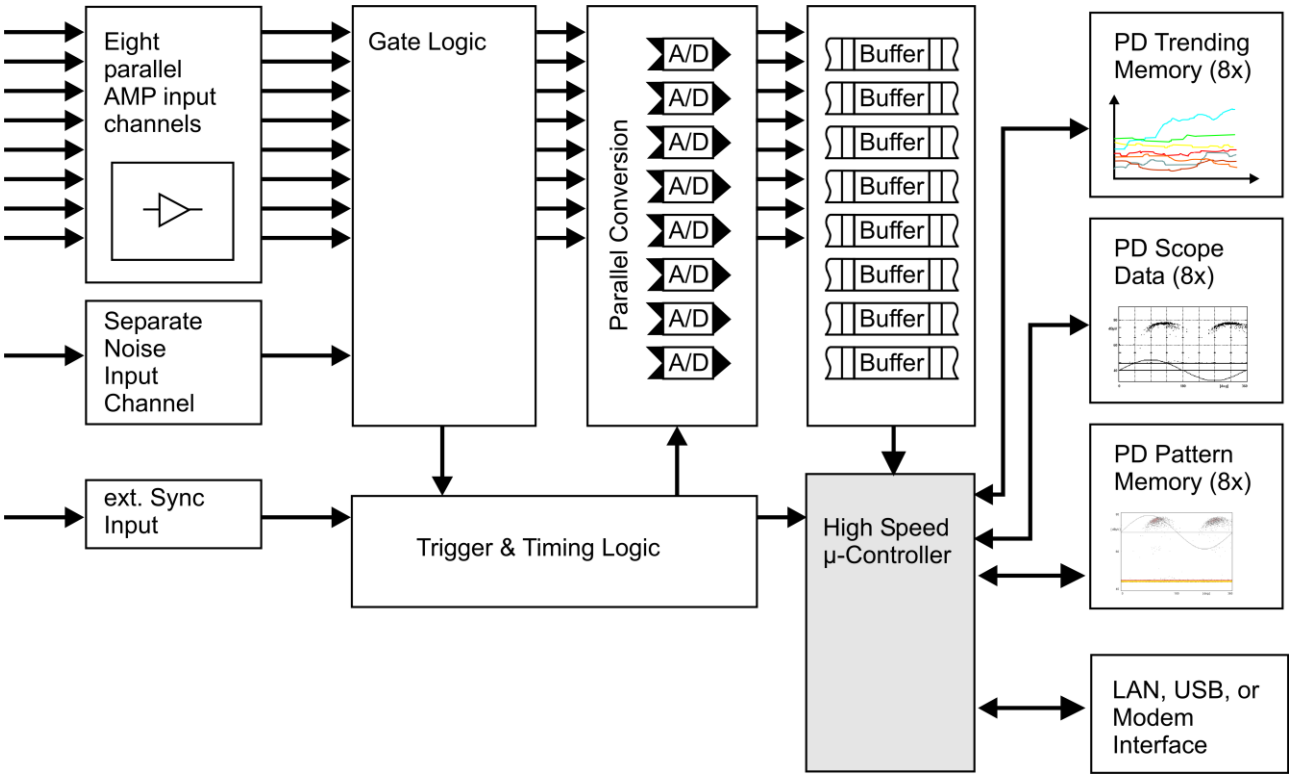


Fig. 6: Block diagram of the GIS*monitor* acquisition unit

Due to the parallel reading on the inputs, it is possible to cancel external noise generated by radar stations, or simultaneous signals caused by internal switching activities. The gating logic takes care of filtering such signals steadily. All "real" PD pulses from all channels are converted in parallel into digital values and buffered temporarily. A high speed µ-controller handles the memory access and the real time data processing. Trending data, phase resolved PD scope data, and PD pattern data measurement is possible in real time without losing any PD pulse.

The remote software of the system runs independently. High speed data transfer via the GIS*monitor* network enables subsequent alarm detection by the overall monitoring system.

The software based alarm detection system recognizes PD patterns automatically on alarm occurrence and stores it with a time stamp into an alarm event list on the industrial PC. Alarm conditions are indicated via relay outputs. All measured values, alarm set points for each sensor and alarm conditions can be read via IEC 61850.

Fig. 7: GIS*monitor* acquisition frame with seven plugin boards

I.5 Partial Discharge Monitoring Control Rack (PDMCR)

The cabinet of size 2000 x 800 x 800 mm³ plus 100 mm socket is used to accommodate the industrial PC, the touchscreen, the printer and further peripherals. Each rack comes with a standard 19” frame, non-interruptible power supply, overvoltage protection, network switch, door operated light, and temperature controlled fans. All cables from external are fed through the bottom side into the rack. A hat rail offers all connections for LAN interface, IEC 61850 interface, relay outputs and power supply.

The 'Windows' based industrial PC comes with a RAID hard disc controller to prevent unwanted losses of data and a redundant power supply unit. The hard disc capacity allows storage of trending and PD patterns up to several years. A built-in printer can be used to print single measurements, screen-shots, or reports. An antivirus solution is provided on request.

Fig. 8: PDMCR

I.6 Partial Discharge Monitoring Acquisition Rack (PDMAR) for Indoor Use

The cabinet of size 2000x800x800 mm³ plus 100 mm socket is used to accommodate the GIS*monitors* and several patch panels. Each rack comes with a standard 19” frame, non-interruptible power supply, humidity controlled air drying heater, overvoltage protection, network switch and door operated light.

Status information of every rack is observed at any time, such as heating status, overvoltage protection status, network ring status, and MCB status.

All measurement signal cables from external are feed through the bottom side into the rack to the back side of the BNC patch boards. From this BNC patch boards all cables are linked directly to the appropriate channel of the GIS*monitor* plug-in boards.

The PDMAR is available in two versions, one for the acquisition of up to 56 sensors (left), one for the acquisition of up to 120 sensors (right) in parallel.

Fig. 9: Partial Discharge Acquisition Racks (PDMAR)

I.7 Partial Discharge Monitoring Acquisition Rack (PDMAR/IP65) for Outdoor Use

The cabinet of size 800 x 600 x 350 mm³ (H x W x D) is used to accommodate the GIS*monitor* and one patch panel. Each rack comes with a non-interruptible power supply, Peltier cooler and heater, overvoltage protection, network switch, and door operated light. The rack is of protection class IP65 and will be equipped with a sun protection for area with a high radiation level.

Status information of every rack are observed at any time, such as heating/cooling status, overvoltage protection status, network ring status, and MCB status.

The rack is capable of handling up to 40 sensors in parallel. All measurement signal cables from external are feed through the bottom side into the rack to the BNC patch board. From this BNC patch boards all cables are linked directly to the appropriate channel of the GIS*monitor* plug-in boards.

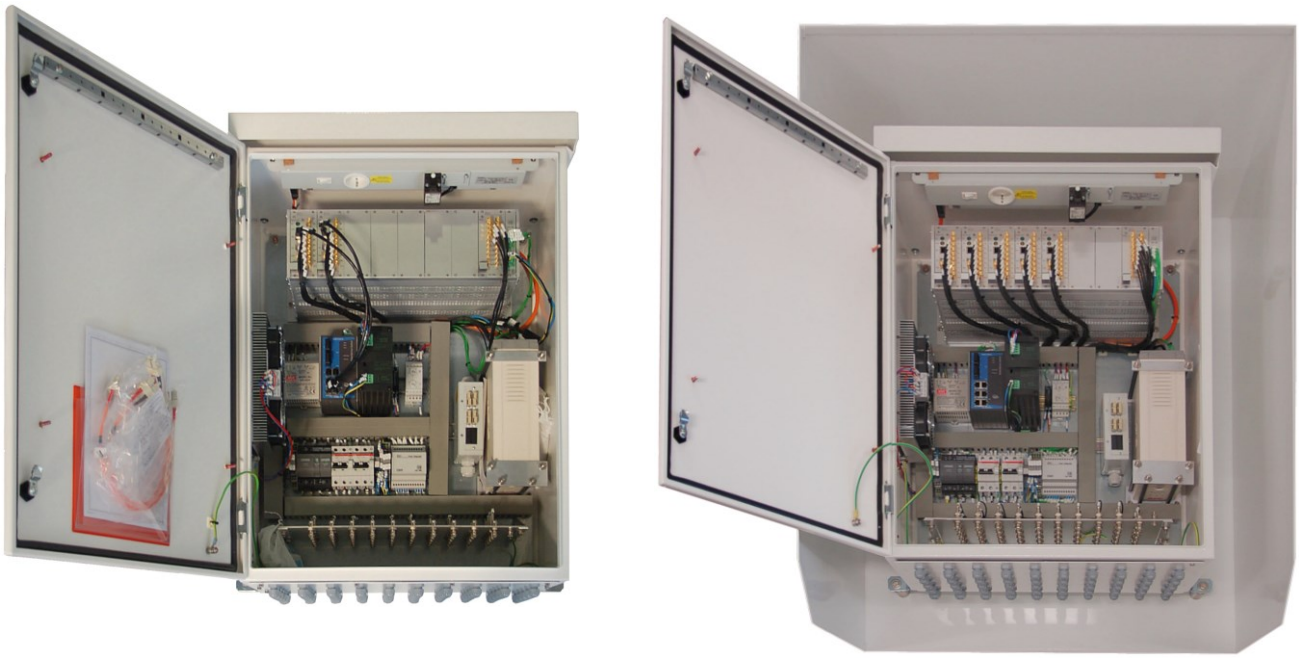


Fig. 10: PDMAR models for outdoor use

II Computer and Software

The user interface software panel of the GIS*monitor* monitoring system is installed on the local industrial PC (IPC) and can be installed additionally on any remote computer for data evaluation and diagnosis. Using an administrative setup allows configuring the system.

Figure 12 shows the main display of the GIS*monitor* software. The diagram of the GIS can be imported as graphic file whereas the position and the labels for each sensor are set manually during configuration of the system. Each sensor can be assigned to a specific input channel of one instrument.

Alarm conditions are visualized by red markers above the sensor position. Current readings, like Qp, NQS, trending, and a PD pattern will show up in a separate popup window by double clicking on the sensor position.

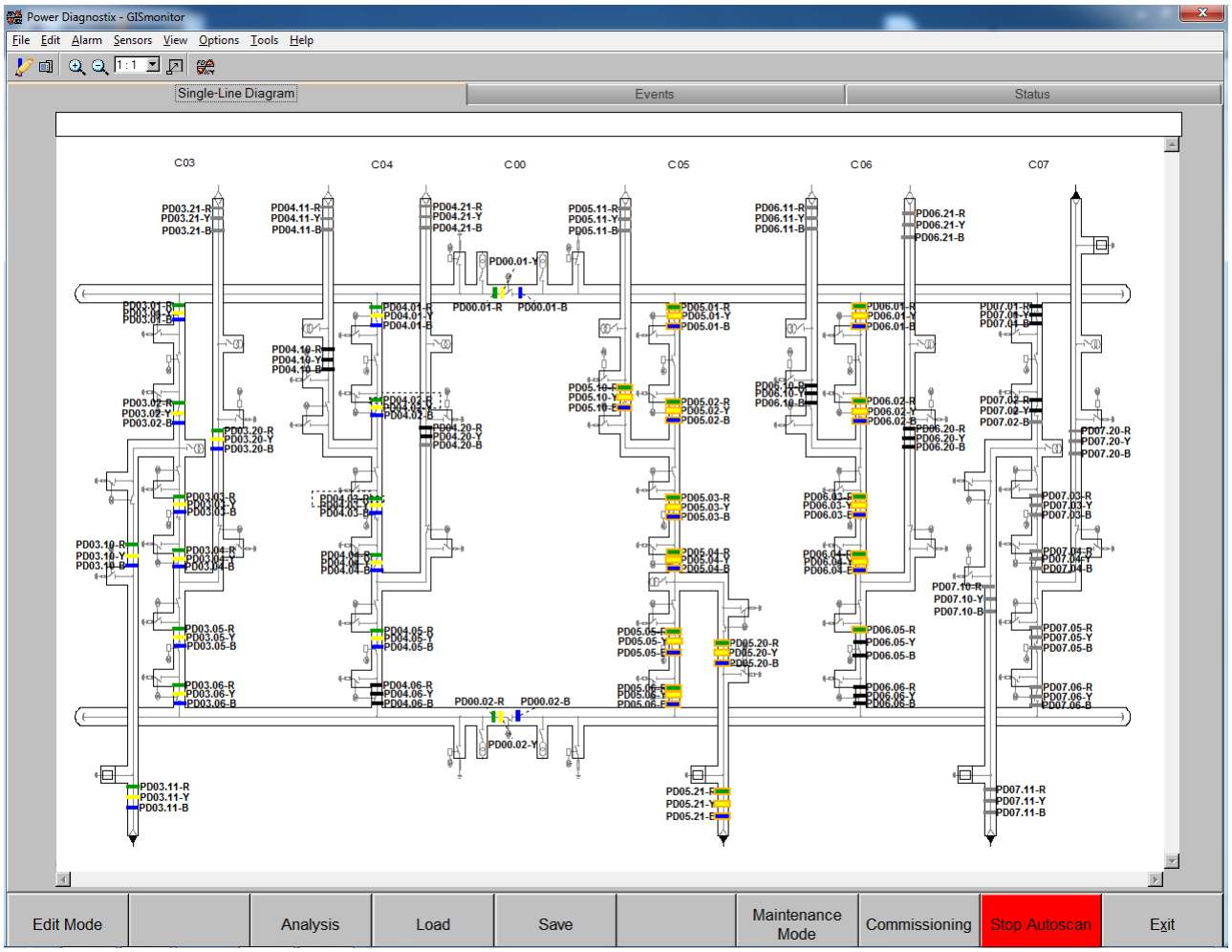


Fig. 11: Main panel of the GIS*monitor* software

The control software is designed for unmanned and autonomous operation. The measurement data from each acquisition unit is gathered by the control software for real time analysis. The software analyzes all measurement data and compares it to the set alarm criteria. The alarm criteria allows to set thresholds along a count rate that needs to be exceeded in an adjustable period of time. The adjustable alarm criteria allow to avoid short term interruptions from external disturbances. The adjustment can be made for each sensor individually or for entire groups of sensors at a time. In case a measurement exceeds the set alarm criteria, a PD event is generated. The system distinguishes between high level and low level PD events. All events are displayed in the PD Alarm Event List along date, time, sensor location and along the measured PRPD. The PD events are further indicated

in the trending diagram of each sensor. The operator can acknowledge all events, stamping them with the date and time of the acknowledgement to track the operators work on the system.

A watchdog functionality ensure that the software is operating at all time.

The major task of this software is the automatic identification of PD failures and to trigger further actions. First, an alarm and warning event list is generated in case of exceeding predefined trigger levels. Secondly, further output signals on embedded I/O boards can be switched to forward such alarm flags to an overall monitoring system. Typically this interface is configured for SCADA (Supervisory Control and Data Acquisition) systems. Optionally, protocol converters for IEC 61850 for instance can be ordered and added to expand the exchangeability of data with higher monitoring control systems.

All trend and history information will be stored locally on a mirrored hard disc system. To evaluate these data a special analysis panel as shown in figure 13 is provided. Multiple channels can be selected and displayed in parallel to compare data and PD activities. A special PD pattern database allows direct comparison of PD patterns from known failures on GIS systems with current measurements.

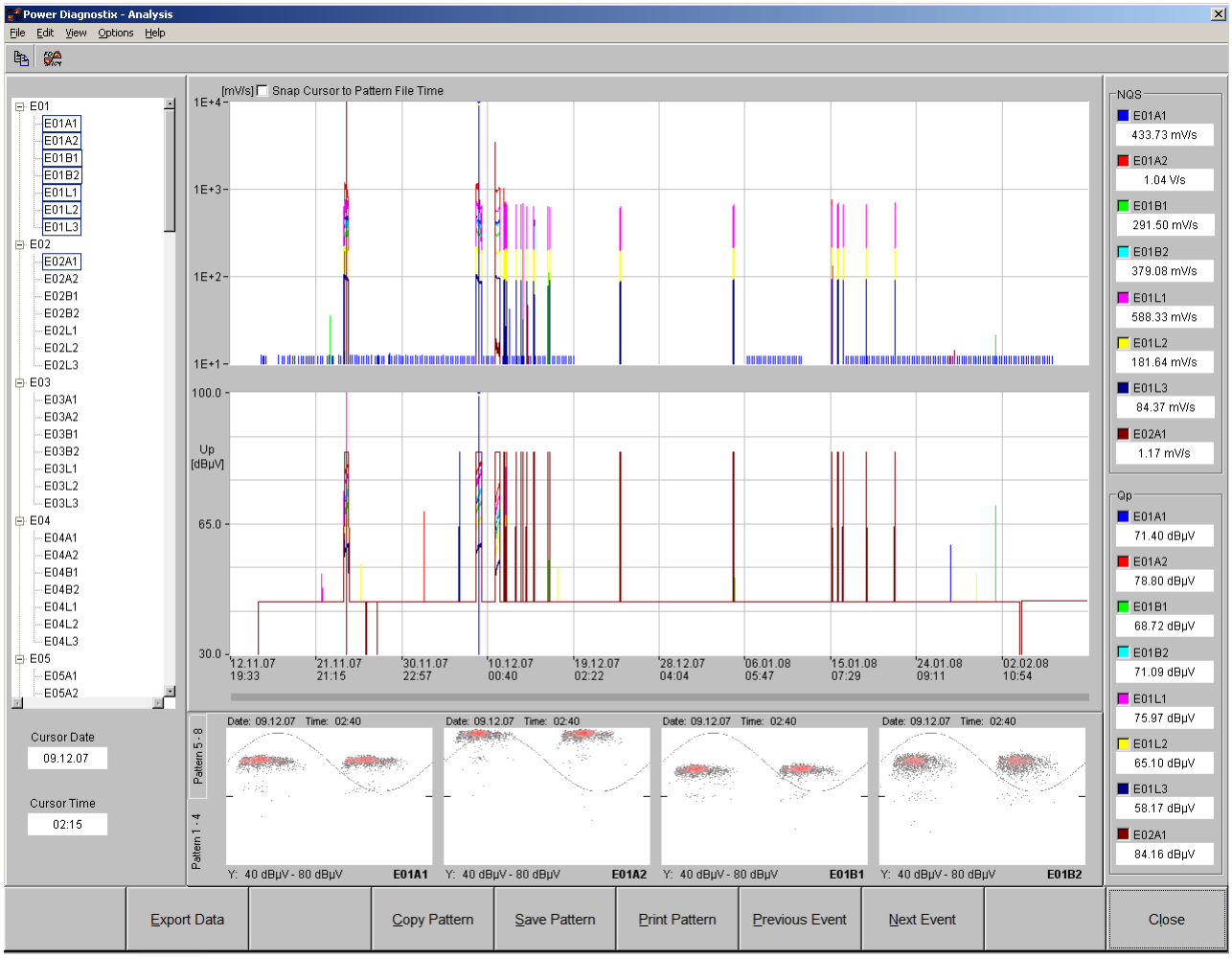


Fig. 12: Trending and analysis panel

Beside the continuous and automatic monitoring mode this software provides an advanced manual mode for commissioning of GIS PD monitoring systems, HV testing of the GIS and investigative measurements. During the manual operation mode, the operator can display the live scope view of up to 24 sensors in parallel, with a update period of ~200ms, to get an instant feedback about PD activity in the GIS. PRPDs can be recorded manually for further analysis. The dedicated HV test mode allows to record all measurement data during the HV test along the HV voltage values to check the PD inception & extinction voltage. The measurement data can be replayed for later review and comparison.

During a commissioning all UHF sensors should be tested and the sensitivity level needs to be recorded. This procedure follows the typical applied method as specified with CIGRE document TF 15/33.03.05 1998 - *Partial Discharge Detection System for GIS, Sensitivity verification for UHF method*.

Figure 14 shows the special panel for the sensitivity check and noise level tests on up to eight channels. A special report provides all data recorded during this procedure.

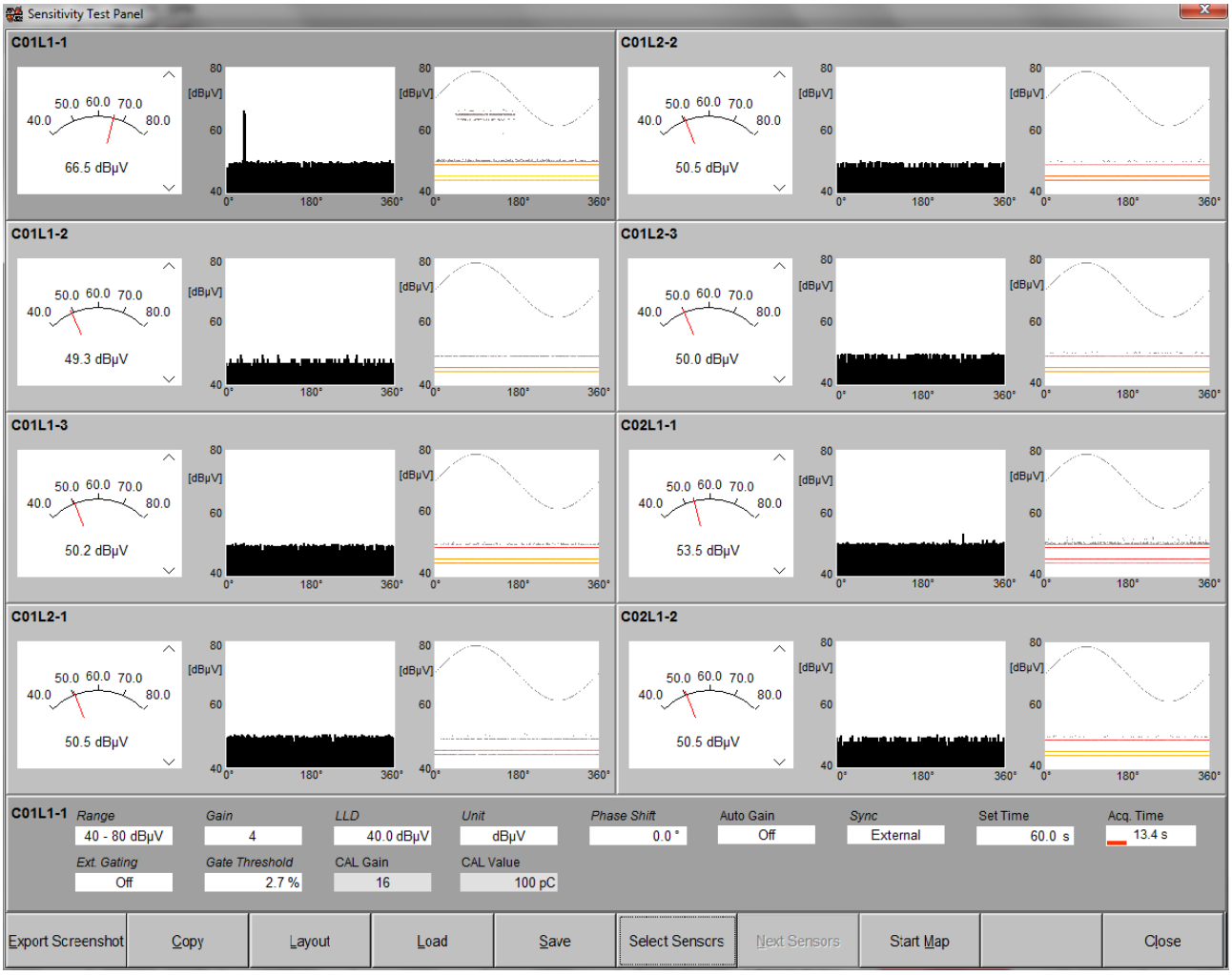


Fig. 13: Scope panel for commissioning and sensitivity check

III Technical Data

III.1 GIS*monitor*

Mains Supply:	220–240 V_{AC}, 47–63Hz (automatic)
Synchronization:	VT input, with automatic change to active phase or line 50 Hz–60 Hz
Interfaces:	LAN (TCP/IP), USB
Operation Temperature:	-10 to 60°C (non-condensing)
Overall Size:	19“rack size, 3 HE
Signal Input:	Eight SMA connectors on each acquisition board
Gate Input:	One SMA connector on each acquisition board
Sync Input:	One SMA connector on each acquisition board

III.2 FCU2 (Frequency Converter & Matching Unit)

Frequency range:	typical 100 MHz–2000 MHz
Input connector:	N-plug
Output connector:	BNC-plug (IP52 case)
	TNC-Plug (IP65 case)
Operation temperature:	-10°C to 60°C (non-condensing)
Overall size:	26 x 26 x 86 mm^3 (IP52 case)
(H x W x D)	36 x 36 x 106 mm^3 (IP65 case)
Weight:	Approx. 80 g (IP52 case)
	Approx. 160 g (IP65 case)
Power requirements:	11-15 V_{DC}, 0.31 W
Enclosure:	IP52: aluminum; HF sealed IP65: aluminum; water proofed and HF sealed

III.3 IPU2B

Transient overvoltage protection.

Input connector:	N-Plug
Output connector:	N-Jack (IP52 case) N-Plug (IP65 case)
Operation temperature:	-10°C to 60°C (non-condensing)
Overall size:	26 x 26 x 64 mm^3 (IP52 case)
(H x W x D)	36 x 36 x 83 mm^3 (IP65 case)
Weight:	Approx. 80 g (IP52 case) Approx. 145 g (IP65 case)
Enclosure:	IP52: aluminum; HF sealed IP65: aluminum; water proofed and HF sealed

III.4 Standard Indoor Cabinets – PDMCR – Control Cabinet

Overall size:	2100 x 800 x 800 mm³ (H x W x D)
Front door:	Sheet steel with glazed door (4 mm single-pane safety glass) 180° hinge
Ingress protection class:	IP54
Fan plate:	Pfannenberg PTF 60.500
Fan plate flow rate:	242 m³/h
Overvoltage protection:	Class I + II + III
Illumination:	Automatically switched on when door is open
Internal thermostat:	Bi-metal sensor
Cabinet surveillance:	Via software

III.5 Standard Indoor Cabinets – PDMAR – Acquisition Cabinet

Overall size:	2100 x 800 x 800 mm³ (H x W x D)
Front door:	Sheet steel with glazed door (4 mm single-pane safety glass) 180° hinge
Ingress protection class:	IP54
Fan plate:	-
Fan plate flow rate:	-
Overvoltage protection:	Class I + II + III
Illumination:	Automatically switched on when door is open
Internal thermostat:	Bi-metal sensor
Cabinet surveillance:	Via software

III.6 Standard Outdoor Cabinets

Overall size:	800 x 600 x 350 mm³ (H x W x D)
Material:	Sheet steel
Front door:	160° hinge
Cooling:	Via thermoelectric Peltier element
Heating:	Via thermoelectric Peltier element
Cooling/Heating power:	150 W
Overvoltage protection:	Class I + II + III
Illumination:	Automatically switched on when door is open
Internal thermostat:	Bi-metal sensor
Cabinet surveillance:	Via software

III.7 Disturbance Antenna DA2

Detection frequency:	100 MHz–2 GHz	
Input connector:	SMA	
Output connector:	TNC-Plug (IP65 case)	
Operation temperature:	-10°C to 60°C	(non-condensing)
Overall size (H x W x D):	36 x 36 x 106 mm^3	(IP65 case)
Weight:	Approx. 160 g	(IP65 case)
Power requirements:	11-15 VDC, 0.31 W	
Enclosure:	IP65, aluminum; water proofed and HF sealed	

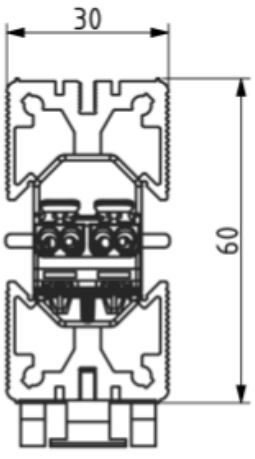
III.8 Splice-Box

Manufacturer:	Fiber Optic Solution
Type of connectors:	SC; pig-tails
Number of connectors:	Eight

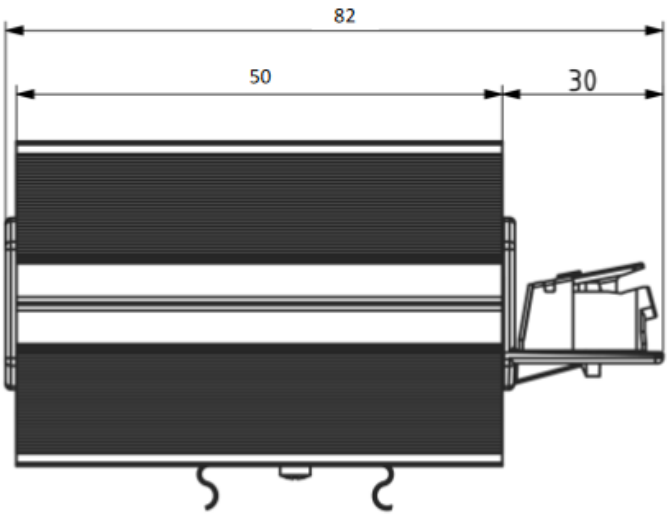
III.9 Heater

Manufacturer:	Elmeko
Type:	SH75
Rating:	75 W, 110–240 VAC

DIMENSIONS

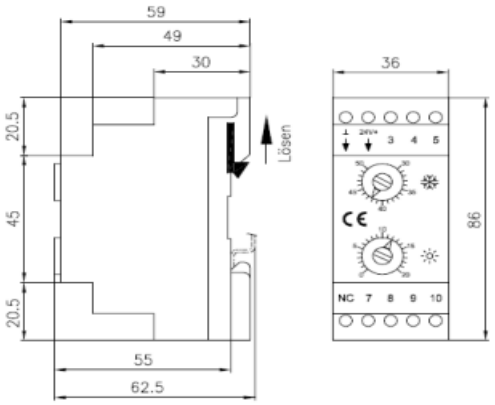


All dimensions in mm



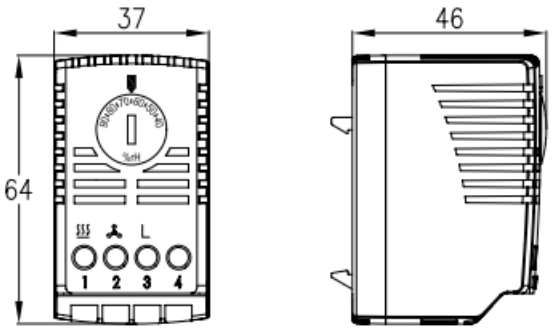
III.10 Thermostat

Manufacturer:	Elemeko
Supply voltage:	24 VDC
Operating temperature:	-20–+80°C
Dimension (H x W x D):	-10–+70°C



III.11 Hygrostat

Manufacturer:	Elemko
Supply voltage:	24 VDC
Operating temperature:	-20–+80°C



III.12 Uninterruptable Power Supply (UPS)

Type for PDMCR:

Manufacturer:	APC by Schneider Electric
Type:	SMT1000RMI2U
Capacity (VA/Watts):	1000
Dimensions (H x W x D):	88 x 432 x 457 mm³
Output voltage:	Sinewave at 230 VAC

Type for PDMAR120/56S:

Control Unit:

Manufacturer:	Phoenix Contact
Type:	UPS-BAT/VRLA/24DC/12AH
Dimensions (H x W x D):	202x 202 x 110 mm³
Supply voltage:	24V DC
Charging voltage:	24V DC
Charging current:	5 A

Battery:

Manufacturer:	Phoenix Contact
Type:	UPS-BAT/VRLA/24DC/12AH
Dimensions (H x W x D):	202x 202 x 110 mm³
Output voltage:	24V DC
Battery capacity:	12 AH

III.13 Ethernet Switch EDS-508A-MM-SC

Manufacturer:	Moxa
Type:	EDS-508A-MM-SC
Input voltage:	24 VDC
Connection:	Two removable 6-contact terminal blocks
Dimensions:	80.2 x 135 x 105 mm^3
Redundancy protocols:	STP, MSTP, RSTP, LACP, Link Aggregation, Turbo Chain, Turbo Ring v1/v2
Mounting:	DIN-rail mounting

III.14 Ethernet Switch EDS-316A

Manufacturer:	Moxa
Type:	EDS-516A
Input voltage:	24 VDC
Connection:	Two removable 6-contact terminal blocks
Dimensions:	94 x 135 x 142.7 mm^3

III.15 Overvoltage Protection

Type 1+2:

Manufacturer:	Phoenix Contact
Type:	SEC-T1+T2-1S-350/25-FM
Dimension:	95.2 x 71.2 x 74.5 mm³
Supply voltage:	up to 230 VAC, up to 125 VDC

Type 3:

Manufacturer:	Phoenix Contact
Type:	PLT-SEC-T3-24-FM-PT
Dimension:	74.5 x 17.7 x 101 mm³
Supply voltage:	up to 230 VAC, up to 125 VDC

Type 1+2 - DC:

Manufacturer:	Phoenix Contact
Type:	VAL-MS-T1/T2 600DC-PV/2+V-FM
Dimension:	98.7 x 53.4 x 65.7 mm³
Rated voltage:	up to 700 VDC

Type 3 – for Any Object Running:

Manufacturer:	Phoenix Contact
Type:	TTC-6P-1x2-24DC-PT-I
Dimension:	105.8 x 6.2 x 100 mm³
Rated voltage:	24 VDC

III.16 Fiber Optic Cables

Product group	Fibre optic cable	
Series	Fibre optic cable Multi mode	
Type	CTC LSZH 1,2kN	
Description	4x MM 50 OM2	
Net weight	50	kg/Km
Marking	ACE-TKF CTC LSZH 4 x MM 50 OM2 (1x4) A/I-DQ(ZN)BH 74748	

III.17 RG142 Coaxial Cable

Coax

Flame retardant	IEC 60332-1-2
	UL 1581 VW-1
Smoke generation	IEC 61034-2
Toxicity	IEC 60754-2
Frequency range	Up to 2,5 GHz
Screening efficiency	-40dB (single braid)
	-70dB (double braid)
Velocity propagation	70%

Construction

Conductor	Silver Plated Copper (SPC) Silver Plated High Strength Copper Alloy (HSA)	Dielectric	PTFE
Shield	Braid of Silver Plated Copper (S)	Sheath	FEP

Identification

Dielectric	Natural
Sheath	Brown-transparent
Marking	

Description	Construction						Electrical			MBR	Order reference
	conductor material	conductor Ø	dielectric Ø	shield (s) Ø	sheath (s) Ø	weight g/m	V rms V DC	imp. Ω	cap. pF/m	static dynamic	
RG 142	SPC solid	0,94	2,95	S: 3,50 S: 4,10	4,80	80	1400 2800	50	95	25 50	30000-142-50

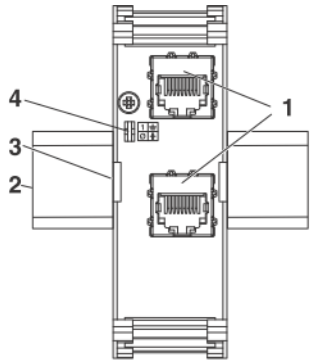
III.18 RG58 Coaxial Cable

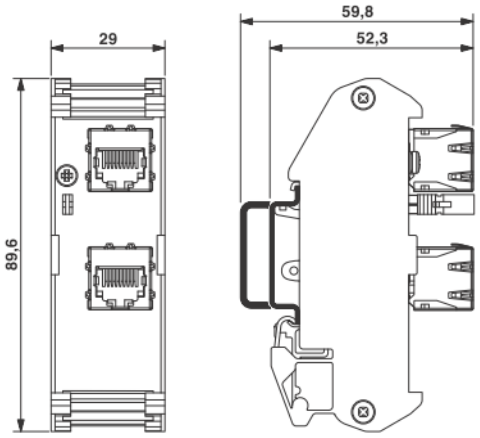
Inner conductor:	Tinned copper wire 19 x 0.18
Outer conductor .	Woven copper wire
Connectors:	BNC, TNC, or N-Plug
Impedance:	50 Ω

III.19 FL-PP-RJ45 Mini Patch Panel

Ports: Two

Type of ports: RJ45





1. RJ45 female connector (TP port)
2. EN DIN rail
3. Universal snap-on foot for EN DIN rails
4. Plug-in bridge for selecting shield grounding

III.20 Power Supply

12V DC Power Supply:

Manufacturer:	Meanwell
Type:	DR-75-12
Output:	12 VDC, 6.3 A
Input voltage:	85–264 VAC, 50/60 Hz

or

Manufacturer:	Meanwell
Type:	NDR-75-12
Output:	12 VDC, 6.3 A
Input voltage:	85–264 VAC, 50/60 Hz

24V DC Power Supply – 2,5A:

Manufacturer:	Meanwell
Type:	HDR-60-24
Output:	24 VDC, 2.5 A
Input voltage:	85–264 VAC, 50/60 Hz

24V DC Power Supply – 10A:

Manufacturer:	PULS
Type:	CP10.242
Output:	24 VDC, 10 A
Input voltage:	100-240 VAC, 50/60 Hz
	110-300 VDC

or

Manufacturer:	Weidmüller
Type:	PRO ECO 240W
Output:	24 VDC, 10 A
Input voltage:	80-264 VAC, 50/60 Hz
	80-370 VDC

24V DC Power Supply – 20A:

Manufacturer:	PULS
Type:	CP20.242
Output:	24 VDC, 20 A
Input voltage:	100-240 VAC, 50/60 Hz
	110-300 VDC

or

Manufacturer:	Weidmüller
Type:	PRO ECO 480W
Output:	24 VDC, 20 A
Input voltage:	80-264 VAC, 50/60 Hz
	80-370 VDC

III.21 Touchscreen

Manufacturer:	Iiyama
Type:	TF2234MC-B6X
Display size:	22"
Display type:	LCD touchscreen
Resolution:	Full HD

III.22 Sync Switching Box (SSB)

Manufacturer:	Power Diagnostix
Number of inputs:	Four
Input voltage:	5–250 VAC
Input frequency:	20–300 Hz
Number of outputs:	Four
Output connector:	BNC

III.23 Relay 230 VAC

Manufacturer:	Finder
Type:	40.51
Rated voltage:	250/400 VAC
Contact configuration:	1 CO (SPDT)
Coil rating:	230 VAC

III.24 Relay 24 VDC

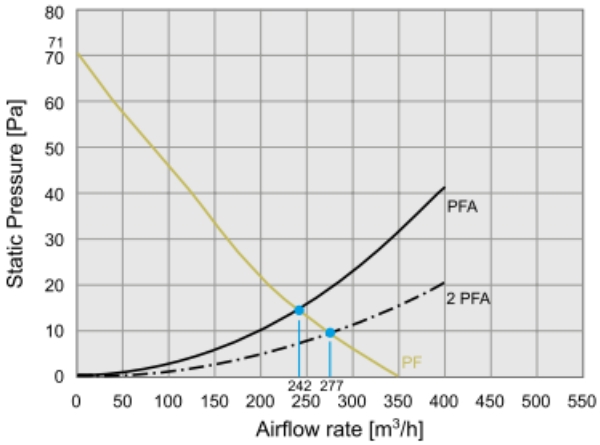
Manufacturer:	Finder
Type:	40.52
Rated voltage:	250/400 VAC
Contact configuration:	2 CO (DPDT)
Coil rating:	24 VDC

III.25 Industrial PC (IPC) - typical

Manufacturer:	DATEC GmbH
Mainboard:	Industry mainboard Supermicro X11SAE
CPU	Intel Core i7-6700K 4-Cores, 4 GHz, 8-threads, 8 MB cache, LGA1151, Turbo-4.2 GHz, HD530
RAM	Two KINGSTON 4 GB/2133 DDR4, CL15, PC4-17000
Hard disc	Three HD SATA3 1TB WD Gold Datacenter, 3.5", 7200 rpm, 128 MB cache, SATA-600, RE WD1005FBYZ
Optical drive	DVD+/-RW burner LG 22xSATA, bulk

III.26 Filter Fan for Roof Mounting

Manufacturer:	Pfannenberg
Type:	PTF 60.500
Input:	230 VAC
Dimensions (H x W):	291 x 291 mm²
Protection class:	IP54



III.27 USB HUB

Manufacturer:	EXSYS
Type:	EX-1177

III.28 Printer

Manufacturer:	HP
Type:	HP Color Laser 150a
Printer type:	Color, laser
Max paper size:	A4
Dimensions (W x D x H):	382 x 397,8 x 274,4 mm^3
Weight:	10,04 kg
Print speed:	Up to 18 pages per minute

III.29 Miniature Circuit Breaker 16 A

Manufacturer:	ABB
Type:	S202MB16
Rated voltage:	440 VAC
Breaking capacity:	10 kA

or

Manufacturer:	ABB
Type:	S202M-B16UC
Rated voltage:	440 VAC, 440VDC
Breaking capacity:	10 kA

III.30 Cabinet Light

Manufacturer:	IBV
Type:	IBV 982106-102
Input voltage:	230 V, 50/60 HZ

or

Manufacturer:	Elmeko
Type:	LE-300-SL
Input voltage:	24 VDC

III.31 Ethernet Remote IO

Manufacturer:	MOXA
Type:	ioLogik E1212
Supply input:	12–36 VDC, max. 400 mA
Digital inputs/outputs:	Eight channels
RJ-45 interfaces:	Two