Universal PQ Monitor MEg45DIN

User manual

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Univerzální PQ monitor MEg45DIN

1/ INTRODUCTION

The MEg45DIN universal PQ monitor is designed for measuring and indicating protective functions at the LV level. It transmits measured data and evaluated conditions safely via ETH interface and GSM network even after a power failure of all three phases. It measures three voltages, three currents and two temperatures. It has a two-stage input and a relay output.

For the measured quantities, it functions as a recorder, electric meter and voltage quality analyser simultaneously without interruptions and gaps. The MEg45DIN monitor can also be used for oscillographic recording of all measured AC voltages and currents.

For remote transfer of measured data and measurement parametrization, it has an RS485 and ETH interface and contains a GSM communication module. For time synchronization with a resolution of 1 ms, it contains a GPS time synchronization module.

It measures voltage and current quality parameters using class A methods with class A or S accuracy. It statistically evaluates all voltage quality parameters specified by EN 61000-4-30, ed. 3, including harmonic and interharmonic voltages and currents up to 125 and rapid voltage changes. It records their time courses in individual phases.

It measures energy in four quadrants and records three-phase and single-phase measurements using six-register time series, allowing subsequent evaluation over any selected time range. It also measures phase active energy (supply, consumption) during rapid changes in the directions of the energy flows.

In the recording function, the monitor measures and processes all measured quantities, evaluates powers, energies and harmonics up to the order of 64.

When recording voltage phenomena and events on currents, the monitor, aside from recording the course of $U_{RMS1/2}$ and $I_{RMS1/2}$, also makes oscillographic records of all simultaneously measured voltages and currents, for voltages up to twice and for currents up to ten times the rated value with pre-trigger.

It has protection functions for identification of overvoltage, undervoltage, voltage and current unbalance, reverse current flow signalling and MV fuse blow.

The voltage measuring inputs are designed for direct measurement of three-phase voltages at the LV level even in CAT IV / 300 V environments.

The current inputs are designed for indirect measurements only. The MEg45DIN has two standard current input versions. The first standard version features electronically switched current inputs with ranges of 5 A and 1 A for instrument current transformers and split-core transformers MTPD.51 or flexible sensors AMOSm/1A. The second standard version allows, according to EN 61 869-6, the connection of low-power current sensors LPCT, TORv and TORm toroids with voltages of 225 mV or 150 mV or 22.5 mV.

A special version allows the direct connection of flexible AMOSm sensors.

The MEg45DIN universal monitor has a galvanically isolated two-stage input and a controlled output switching contact relay. The USB interface is intended for local communication. The galvanically isolated RS485 interface, ETH interface and the integrated GSM module allow remote data transfer, remote parametrization of the measurement, on-line reading of the measured data and updating of the control program of the processor's measurement core. The remote data transmission via the ETH interface and GSM network is secured by IKEv2/IPsec and L2TP/IPsec protocols of the LINUX operating system.

AES-256 encrypted measurement data can be transferred from the instrument using an authorized flash drive. This can also be used to transfer the uniform parametrisation values of the measuring campaign and update the measuring FW.

All three voltage inputs of the MEg45DIN monitor have an overvoltage category of CAT IV / 300 V. It can also be powered with an auxiliary DC supply voltage in the range of 10 to 30 V. The power supply of MEg45DIN contains supercapacitors that provide uninterrupted measurement and remote communication even in the case of short power outages with a total duration of up to 30 s.

2/ SW INFORMATION

Local (USB) and remote (IP address) parametrization of the measurements, which includes specifying the recording interval, current transformer conversions and specification of the measured quantities, initiating the measurements and reading the measured data from the MEg45DIN monitor, is handled by the program **PQ_MEg** [1].

The program **DV_MEg** [2] displays the measured data in graphical and tabular form. This program always works with one instrument.

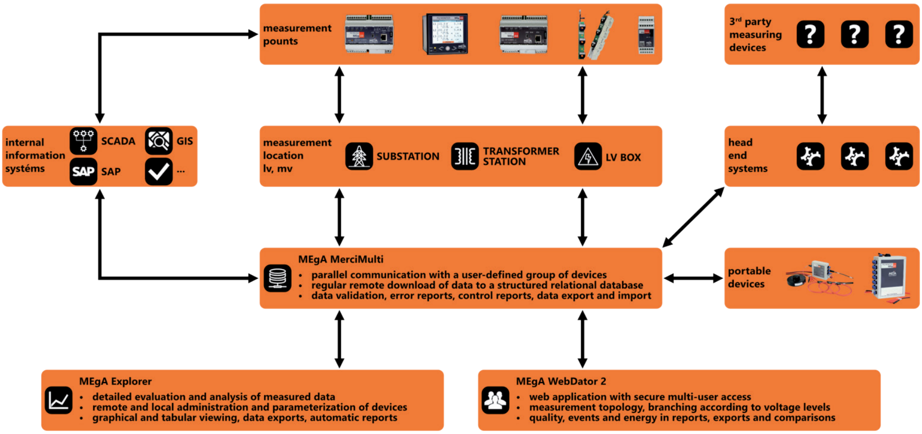
The program **MEgA_Explorer** [3] allows the display and detailed analysis of data from the local SQLite database. It is a Windows application installed on a PC or server. It is mainly focused on the detailed analysis of data from a single measurement, but also supports selected bulk functions (e.g. measurement reports).

The web application **WebDator2** [4] allows multiple access for data display. It is mainly focused on large groups of instruments, for overview and informative evaluations and summary analyses. The application works over a PostgreSQL or Oracle database.

Continuous remote automatic data reading of one, but especially multiple instruments available on the network, including monitoring of input states is performed by the **MEgA_Merci Multi** system [5], which works as a Windows OS service on the server. Periodic data reading is performed at a set interval, usually daily. The system reads newly measured data since the previous reading. The read data is stored in a SQLite, PostgreSQL or ORACLE database. The program also performs automatic exports in CSV format and reports on voltage quality in the form of emails. The program can be used to remotely update the DSP processor core FW after checking the transfer.

With the exception of the WebDator2 program, the mentioned programs, including their manuals, are available at http://www.e-mega.cz/DL/

The MEg45DIN PQ monitor also enables work with third-party SW through the MODBUS RTU protocol, or it can transmit measured data as set via EN 60870-5-104 or DLMS/COSEM protocol. For presentation in other systems, CSV formats can be used, which can be customized. The instrument has web interfaces enabling displaying actual values of selected variables over a web browser



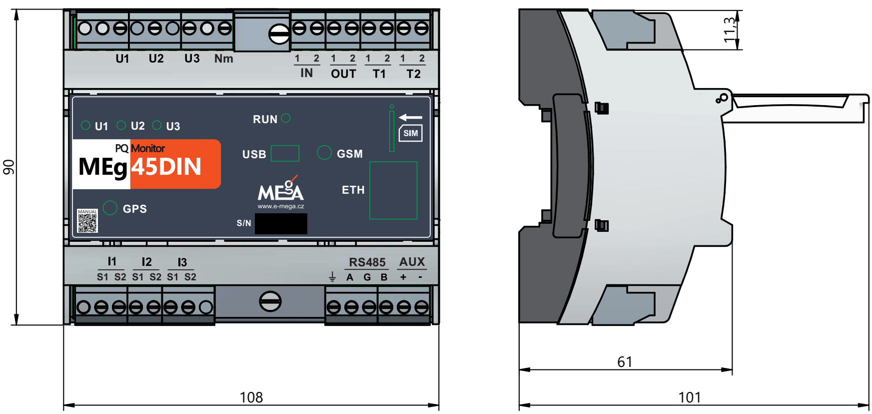
3/ DESCRIPTION OF THE INSTRUMENT

3.1 Design

The MEg45DIN monitor in Fig. 1 is designed for fixed installation on a DIN TS35 rail. It is housed in a polycarbonate self-extinguished box measuring 108 × 90 × 61 mm. The structural elements of the MEg45DIN monitor are shown in Fig. 2. Above the monitor panel is a tilting transparent cover that can be sealed to protect the SIM card inside the monitor panel. In the transparent panel cover near the USB and ETH connectors are holes allowing handling of the corresponding cables. The GPS and GSM antenna cables are fitted with angled connectors and are routed vertically down under the tilting cover. The inlets of measured voltages, currents, temperatures, input and output signal, RS485 interface and auxiliary DC power supply are realized via screw terminals for a wire cross-section of up to 4 mm². The MEg45DIN monitor on a DIN rail can be installed under the panel of the LV cabinet that covers terminals and increases the resistance to mechanical stress.

The measured voltages are fed to the terminal group U1, U2, U3 and N. The three yellow LED indicators under terminals U1, U2 and U3, when illuminated continuously, indicate the presence of input voltages within the pre-set tolerances. If the measured voltage is outside the pre-set tolerances, the corresponding LED flashes. For the description of voltage LED indication, see Table 1. The MEg45DIN universal monitor has three-phase AC supply from measuring inputs, and any measured voltage is sufficient to supply power.

Fig. 1: Dimensions of MEg45DIN with a tilting cover



The first standard version has electronic switching of the rated current of 5 A or 1 A for solid-core current transformers or MTPD.51 split-core transformers or AMOS/1A flexible sensors with a powered converter.

The other standard version with a voltage of 225 mV, 150 mV or 22.5 mV is for low-power current sensors.

A special version of the MEg45DIN monitor is also available with modified current inputs for directly connected loops of AMOSm flexible sensors of rated current from the 30 A / 100 A / 300 A / 1000 A / 3000 A / 5000 A range. The AMOSm sensor loop length can be 200 mm or 400 mm or 600 mm.

On the unit's panel is a green RUN LED indicator signalling the activity of the MEg45DIN monitor. The RUN LED indicator states are described in Table 1.

Auxiliary DC supply voltage rated 12 V_{DC} to 24 V_{DC} is to be connected to AUX terminals, with the positive pole to the + terminal and negative pole to the – terminal.

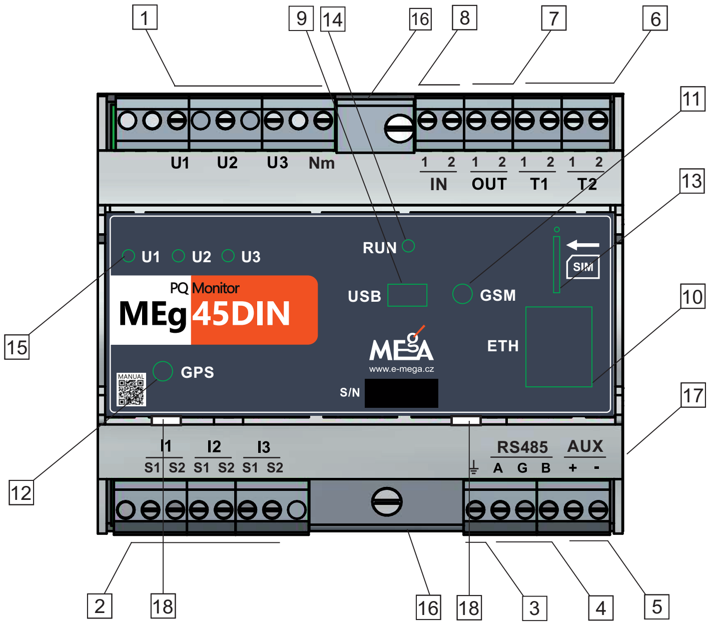
Type Pt1000 resistance temperature sensors are to be connected between two T1 terminals and two T2 terminals.

The OUT output signal is realized via a switching contact of a polarized relay, which thus retains the last state even after a power outage. The IN terminals are to be connected to a galvanically free external contact and its power supply is internal voltage from the monitor. However, it can also be powered from an external power supply up to 30 V.

For local reading of measured data by a computer and measurement parametrization, there is a miniUSB connector on the panel of the instrument. Local parametrization and data reading can also be performed using a flash drive, where measured data are saved in CSV format. Remote communication is realized via an RS485 interface on terminals A, G, B. For remote communication and the built-in Webserver function, it is possible to use the Ethernet interface with an ETH RJ45 connector located on the panel of the monitor. For remote communication via GPRS to LTE data transmission over the GSM network and for time synchronization via GPS, there are screw connectors for GSM and GPS on the front panel of the monitor, which are connected to the corresponding antennas via angled connectors. The size of the SIM card is NANO SIM.

The panel indicates the type of the MEg45DIN monitor, S/N serial number and QR code with a description of the monitor. On the right side of the MEg45DIN monitor is a rating plate specifying the rated values of measured voltages, currents, frequency, supply voltage and input power of the unit and safety pictograms.

Fig. 2: Design elements of the monitor



Tab. 1: Description of MEg45DIN elements

Item	Group name	Description
1	Voltage inputs	Terminals U1, U2, U3 for direct voltage connection of phases L1, L2, L3 and neutral conductor PEN to Nm terminal
2	Current inputs	Pair of terminals I1, I2, I3 for connecting secondary currents or voltages of current transformers or current sensors installed on phases L1, L2, L3. Terminals labelled S1 are input, S2 are output The S1 terminals of the first standard version connect to the common conductor S. The S1 terminals of the second standard version connect to the common conductor S inside the monitor.
3	RF grounding	The terminal ⏚ connects to the PEN conductor or to ground
4	RS485 interface	Terminals for connecting the RS485 data interface, where terminals A and B are communication terminals and the shield connects to the G terminal

Item	Group name	Description
5	DC supply voltage	AUX terminals for connecting auxiliary DC supply voltage with a rated value of 12 – 24 V
6	Temperatures	Terminals for connecting two Pt1000 sensors measuring temperatures T1 and T2
7	Output	OUT terminals of the switching contact of the output bistable relay
8	Input	Terminals IN of the galvanically isolated two-stage input
9	USB 2.0 interface	Mini USB connector for local data transfer
10	ETH interface	RJ45 connector for ETHERNET 100Base-Tx interface for remote data transfer. A wiring example is shown in Figure 16. Meaning of LED indicators: • green LINK; LED indicates the speed of the data line on 100 Mbit/s; off 10 Mbit/s • orange ACTIVITY; LED indicates data transfer by lighting
11	GSM antenna	Angled connector for connecting a GSM antenna
12	GPS antenna	Angled connector for connecting a GPS antenna
13	SIM card	NANO SIM card goes into the indicated slot
14	RUN LED	• Briefly interrupted lighting; the monitor measures according to the programmed parametrisation • Repeated short flashing; the monitor is programmed, it does not measure yet. It is not the default measurement start time yet or the monitor has not been powered at the time of delayed start and could not start measurement • Alternating lighting 1:1 – oscillographic record • Continuously on; indication of a fault condition • Continuously off; indication of a fault or deactivated power supply
15	LEDs U1, U2, U3	State of measured phase voltages on terminals U1, U2 and U3: • continuously on; the voltage is in the pre-set working band (standardized 0.9 U_n to 1.1 U_n) • one flash; voltage is in the pre-set interruption band • two flashes; voltage is in the pre-set drop band • three flashes; voltage is in the pre-set increase band

Item	Group name	Description
16	Lock of the DIN rail	On the upper and lower side of the device base are orange latches that must be unlocked when removing the device from the DIN rail and inserted when installing the device on the DIN rail
17	Rating plate	The rating plate lists information applicable to the monitor
18	Antenna holes	In the indicated areas are holes prepared for antenna cables

Examples of variants of rating plates for individual versions of MEg45DIN monitors are shown in Fig. 3. Voltage, power supply and the design are the same for all versions. Voltage inputs that are also used for three-phase AC power supply have a rated phase voltage value of 230 V. The maximum value of measured and supply voltage in a CAT IV environment is 300 V. The rated value of AC voltage frequency is 50 Hz. DC supply voltage has a rated value of 12 – 24 V. Individual versions have different current inputs.

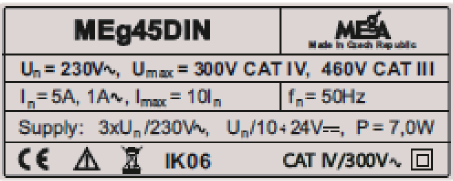
The first standard version has a current input rated for both 5 A and 1 A AC rated values.

The second standard version has a single rated AC voltage value of 225 mV, 150 mV or 22.5 mV. It corresponds to the rated primary current value of the low power sensor.

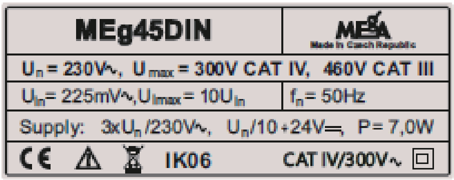
The third, non-standard version is prepared for connecting loops of an AMOSm flexible current sensor, which can be used to measure currents with a rated value of 30 – 5000 A.

Fig. 3: Examples of rating plates of the MEg45DIN monitor

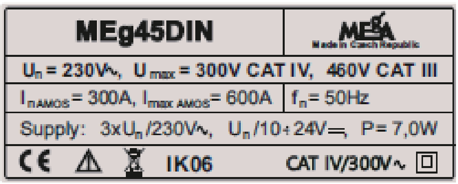
First standard version



Second standard version with a current sensor rated voltage of 225 mV



Special version for flexible AMOSm sensors, for example AMOSm / 300 A



3.2 Functions of the monitor

The MEg45DIN universal monitor is a class A or S instrument whose measurement methods meet the requirements of class A according to EN 61000-4-30, ed.3. The measurement methods and uncertainties of the measured quantities are tested according to EN 62586-2 and the effects of operating conditions according to the procedures specified in EN 62586-1. It measures voltage quality parameters without any interruptions or gaps. The device measures all voltage and current phenomena that have occurred at a measured point during measurement and performs statistical evaluations, including evaluations of extreme values of all measured variables. It measures signal size and records HDO telegrams. It measures energy in all four quadrants. It has protection functions for identifying undervoltage, overvoltage, voltage and current unbalance, signalling interrupted phase of LV distribution, grounding interruption, blown MV fuse and direction protection.

For voltage phenomena, events on currents up to 10 I_n and changes at the two-stage input, it records the courses of RMS½ effective values and oscillographic time courses, both with pre-trigger. The MEg45DIN monitor has a two-stage input with internal supply voltage enabling also external power supply and a switching contact of a relay, the second contact of which is controlled by the processor.

The MEg45DIN universal monitor can be set for the function of recording oscilloscope, in which it records measured voltage and current values for a defined period. During oscillographic recording of details and the recording oscilloscope function, three measured voltages and three measured currents are sampled simultaneously with a rate of 256 samples per period. The oscillographic recording uses a 20-period pre-trigger before the event initialization. Also the number of periods, i.e. the length of the oscillographic record, is SW-adjustable and depends on the extent of allocated memory space. Initiation of the recording can be derived from exceeding the specified limits by any of the six mentioned variables or from the change of the state of the input two-stage signal. The use of automatic remote transmission of measured data can minimise the requirements for memory space in the monitor.

The record of courses of all eight measured quantities in the form of RMS½ defined by the voltage quality standard has a fixed pre-trigger of 1 s length and the possibility of recording up to 400 events with a duration of 300 s.

Currently, the instrument supports the MODBUS protocol at the RS485 interface and the MODBUS RTU and P104 protocols at the Ethernet and GSM interface (according to IEC 60870-5-104). Both protocols can be used to set the device, download data and update the firmware of measuring functions. Measured data are saved in CSV files. The DLMS/COSEM protocol is implemented for data loading. Time synchronization is enabled using the NTP protocol.

To synchronize the function of multiple monitors, the positive zero-crossing of the first phase fundamental harmonic voltage can be used.

The MEg45DIN universal PQ monitor has secure data transmission with IKEv2/IPsec and L2TP/IPsec protocols. The SSH protocol can be used to connect for management of the Linux Debian system, running on the ARM core of the processor and enabling the implementation of advanced communication and other superstructure functions.

3.2.1 Indication on the MEg45DIN panel

After switching on the power supply of the instrument and the delay of the check of the HW and minimum charge of the internal uninterruptible power supply, the correct operation of the device is indicated by intermittent lighting of the RUN LED. The intermittent lighting of the RUN LED has the following meanings:

- Briefly interrupted lighting – the monitor measures according to the programmed parametrisation
- Repeated short flashing – the monitor is programmed but does not measure yet because the pre-set time for the start of measurement has not come yet or the monitor was not powered at this time and could not start measuring.
- Alternating lighting 1 : 1 – oscillographic record
- The RUN indicator continuously on or off signalizes a fault, LED going off can also mean a loss of power supply.

The yellow LED indicators U1, U2 and U3 indicate the states of measured phase voltages on inputs U1, U2 and U3:

- Continuously on – voltage is in the pre-set working band (standardized 0.9 U_n to 1.1 U_n)
- One flash – voltage is in the pre-set interruption band
- Two flashes – the voltage is in the pre-set drop band
- Three flashes – the voltage is in the pre-set increase band.

LEDs in the ETH connector indicate:

- The green LINK_LED indicates the data line speed (on = 100 Mbit/s, off = 10 Mbit/s)
- An illuminated orange ACTIVITY_LED indicates data transmission.

3.2.2 Measuring functions

The scope of measured variables depends on the measurement connection and measurement parametrisation. Measured data can be divided into data of continuous phenomena of voltage quality, data of rapid voltage changes, data during one-off voltage phenomena and events related to currents, recorder data, electric meter function data, data from measurements of active energy during rapid changes of flow direction and data of HDO signals. Measurement methods are specified in EN 61000-4-30, ed.3.

Data of continuous phenomena of three-phase voltage quality at the terminal for an aggregation interval (10 min):

- Number of frequency values in the range of ±1 % f_n and in the range of +4 % to -6 % f_n
- Number of frequency values out of the range of ±1 % f_n and out of the range of +4 % to -6 % f_n
- Frequency f – average, minimum, maximum
- Unbalance of voltage u2 and current i2
- Zero-sequence imbalance of voltage u0 and current i0

Data of continuous phenomena of phase voltage and current quality for each aggregation interval (10 min):

- Voltage – average, minimum, maximum in time and frequency domain
- Current – average, minimum, maximum in time and frequency domain
- Voltage deviations U_{over}, U_{under}
- Flicker P_{st} and P_{lt}
- THD_U voltage harmonic distortion factor
- Direct current component U_{DC}
- Basic to 125th harmonic of voltage with a proportion of adjacent interharmonics
- Centred subgroups of interharmonic voltages up to the order of 125.
- Basic to 125th harmonic of current with a proportion of adjacent interharmonics
- Centred subgroups of interharmonic currents up to the order of 125.
- Voltage of signals in network voltage (HDO) – average, maximum
- Number of 3 s intervals for voltage evaluation of signals in network voltage
- Number of 3 s voltage values of signal in network voltage above set limit.

Data of rapid voltage changes – RVC

- Start time of rapid voltage change
- - Period of duration of a rapid voltage change in ms
- - Average voltage in balanced state before RVC

- Average voltage in balanced state after RVC
- Maximum absolute difference between $U_{RMS1/2}$ during RVC and balanced voltage before RVC
- Maximum absolute difference of ten-period voltage U_{RMS10} at RVC and balanced voltage before RVC
- Curves of voltage $U_{RMS1/2}$ and current $I_{RMS1/2}$ at RVC with time data
- Oscillograms of courses of voltage and current during RVC with time data.

Note: Description of the RVC (rapid voltage change) parameter:

The instrument records rapid voltage changes according to IEC 61000-4-30 ed. 3. The algorithm is based on sliding measurement of 100 values of $U_{RMS1/2}$ in each phase. When parametrizing the device, the user defines a threshold value of voltage $U_{RMS1/2}$ change for starting recording and a size of hysteresis after the rapid change and return to the balanced state. Rapid changes are characterized by the time of beginning, the duration, the difference in voltage between balanced states before a rapid change and after it (ΔU_{ss}) and the maximum difference between voltage $U_{RMS1/2}$ during a rapid change and balanced state voltage before the start of a rapid change (ΔU_{max}).

A record of rapid changes can be extended in user SW by a record of the entire course of $U_{RMS1/2}$ values. When the limits of voltage phenomena ($0.9\,U_n$ and $1.1\,U_n$) are exceeded, the rapid voltage change recording is cancelled and the event is evaluated and stored as a voltage phenomenon.

Data during one-time voltage and current phenomena :

- Time of phenomenon occurrence
- Phenomenon duration
- Moments when the limits for interruption, dip and swell of voltage and current are exceeded
- Residual and maximum values of voltage, maximum values of current
- Courses of voltage $U_{RMS1/2}$ and currents $I_{RMS1/2}$
- Oscillogram of the courses of voltage and current during a one-time phenomenon
- Harmonic voltage and current values during a one-time phenomenon

Recorder data for each aggregation interval and phase (from 1 s to 15 min, according to the parametrisation).

Phase:

- Voltage U_{ef}, – average, minimum, maximum
- THD_U voltage harmonic distortion factor
- Direct-current component of voltage U_{DC},

- Harmonic components of voltage U_{Hn} of order n from 1st to 64th,
- Currents I_{ef}, – average, maximum
- THD_I current harmonic distortion factor
- Current harmonics I_{Hn} of order from 1st to 64th,
- Active power – average, minimum, maximum
- Reactive power – average, minimum, maximum
- Apparent power – average, minimum, maximum
- Deformation power – average, minimum, maximum
- Power factor PF and cos φ
- Active power 1stH – average, minimum, maximum
- Reactive power 1stH – average, minimum, maximum
- Apparent power 1stH – average, minimum, maximum
- Active and reactive energy E_{P+}, E_{P-}, $E_{QC/P+}$, $E_{QL/P+}$, $E_{QC/P-}$, $E_{QL/P-}$

Phase-to-phase:

- Voltage U_{ef} – average, minimum, maximum

Three-phase:

- Active power – average, minimum, maximum
- Reactive power – average, minimum, maximum
- Apparent power – average, minimum, maximum
- Deformation power – average, minimum, maximum
- Unbalance power - average, minimum, maximum
- Power factor PF and cos φ
- Active power 1stH – average, minimum, maximum
- Reactive power 1stH – average, minimum, maximum
- Apparent power 1stH – average, minimum, maximum
- Unbalance power 1stH – average, minimum, maximum

HDO telegram data:

- HDO telegram transmission start time
- HDO telegram phase
- Address and command part of the HDO telegram
- Minimum and maximum voltage of HDO telegram marks
- HDO telegram carrier frequency

Data of electric meter function for output and each phase from the beginning of factory setting and from the start of measurement:

– Active and reactive energy E_{P+}, E_{P-}, $E_{QC/P+}$, $E_{QL/P+}$, $E_{QC/P-}$, $E_{QL/P-}$

Data of the function of active energy measurement during rapid changes of flow direction for the terminal and each phase from the beginning of the measurement according to the measurement parametrization:

– Half-period values of active energy
– Aggregated values of active energy

Measured data can be transferred both by the MODBUS RTU or EN 60870-5-104 protocols, in the CSV format, a description of which is provided in [4] and [5].

3.2.3 Description of the measurement of energy during rapid changes in the direction of its flow

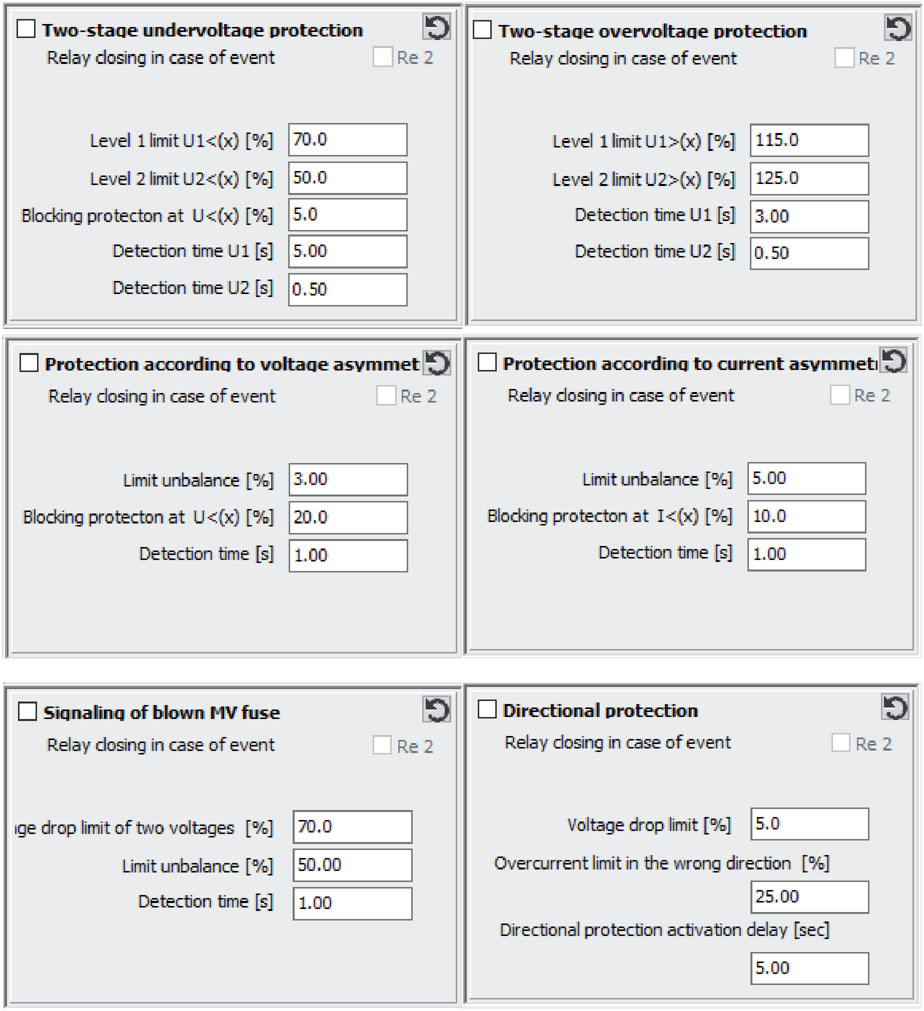
Common instruments for measurement of power and energy work with a basic measuring interval in the order of tens of basic frequency periods. It can, in the case of rapid changes in the flow direction, e.g., at the places of connection of power supplies in a distribution grid, result in inaccurate recording and inaccurate evaluation of energy flows. The basic evaluating interval in the fast energy measurement function is one half-period (10 ms at a frequency of 50 Hz) and thus even such short overflows are written to the corresponding registers. The registers are separate for each phase. Depending on the settings, it is possible to aggregate all half-period values of active energy into one register during the entire measurement period or to set a time interval during which the half-period values are aggregated into the corresponding registers. Higher SW then enables displaying power and energy into a table or graph, or exporting to a .CSV file.

3.2.4 Protection functions

Protection functions are user-adjustable, examples of settings are shown in Fig. 4. Depending on the input, activation of the protection function can close the output relay and send a message via the RS485, ETH or GSM interface. Also, the recording of phase voltage and current courses and voltage and current unbalance into the monitor's memory when the protection functions activate is uniform.

The memory always stores the last 12 events of each type of fault.

Fig. 4: Examples of setting protection and signalling functions



Two-stage undervoltage protection function

In the function input, the user sets the limit of the 1st stage and the lower limit of the 2nd stage of undervoltage in % U_n, the 1st stage detection time and detection time of the 2nd stage in seconds. In addition, the user sets protection blocking at a phase voltage lower than the set value. Optionally, you can set the closing of the output relay and message sending.

With the undervoltage protection function, the instrument continuously evaluates independently for each phase whether all evaluated voltages are under the undervoltage limit within the detection time. If so, the protection function activates. The instrument records the activation time, the affected phase, the undervoltage value at the moment of protection activation as well as the course of RMS½ phase voltages and currents. According to the initial setting, it sends a message and closes the output relay, which remains closed for the duration of the undervoltage.

Each evaluation of voltage above the detection limit of the 1st stage resets the evaluation of the detection time of the given phase.

A voltage drop of any phase under the blocking level blocks the function of the two-stage undervoltage protection in that phase.

Two-stage overvoltage protection function

In the function input, the user sets the limit of the 1st stage and the limit of the higher 2nd stage of overvoltage in % U_n, the 1st stage detection time and detection time of the 2nd stage in seconds. Optionally, you can set the closing of the output relay and message sending.

With the overvoltage protection function, the instrument continuously evaluates independently for each phase whether all voltages evaluated in succession are above the detection limit within the detection time. If so, the protection function activates. The instrument records the activation time, the affected phase, the overvoltage value at the moment of protection activation as well as the course of RMS½ phase voltages and currents. According to the initial setting, it sends a message and closes the output relay, which remains closed for the duration of the overvoltage.

Each evaluation of voltage under the overvoltage limit of the 1st stage resets the evaluation of the detection time of the given phase.

Function of protection according to voltage unbalance

In the function input, the user sets the limit of the u2 unbalance of three-phase voltage in %, the detection time in seconds and protection blocking at phase voltage lower than the set value. Optionally, you can set the closing of the output relay and message sending.

For protection according to voltage unbalance, the instrument continuously evaluates the u2 unbalance. If all unbalance values evaluated within the detection time above the unbalance limit, the protection function according to voltage unbalance activates. The instrument records the moment of action, the value of voltage unbalance at this time, the course of RMS½ phase voltages and currents and, according to the initial setting, sends a message and closes the output relay. The relay remains closed for the duration of the increased voltage unbalance u2.

Each evaluation of voltage unbalance of a value lower than the set limit resets the detection time. A voltage drop of any phase below the blocking limit blocks the protection function.

Function of protection according to current unbalance

In the function input, the user sets the limit of current unbalance of three-phase current i2 in %, the detection time in seconds and protection blocking at phase current lower than the set value. Optionally, you can set the closing of the output relay and message sending. The two-voltage drop limit and the unbalance limit are preset.

For protection according to current unbalance, the instrument continuously evaluates the i2 unbalance. If all unbalance values evaluated within the detection time above the limit, the protection function according to current unbalance activates. The instrument records the moment of action, the value of current unbalance at this time and records the course of RMS½ phase voltages and currents. According to the initial setting, it sends a message and closes the output relay. The relay remains closed for the duration of the increased current unbalance i2.

Each evaluation of current unbalance lower than the set limit resets the detection time.

A current drop of any phase below the blocking limit blocks the protection function.

Function of indication of a blown MV fuse

In the input of the function of indication of a blown MV fuse of a MV/LV transformer, there are different connections Dyn1, Dyn11, Dzn0 and Yzn11. The user sets the detection time in seconds and optionally the output relay closing and message sending.

With the blown MV fuse indication function, the parameters corresponding to a blown MV fuse are continuously evaluated at the LV level. If all parameters evaluated during the detection time correspond to a blown MV fuse, the protection function activates. The instrument records the moment of protection activation, the course of RMS½ phase voltages, currents and voltage unbalance and, according to the initial setting, sends a message and closes the output relay. The relay remains closed for the duration of the evaluation of a blown MV fuse.

Each evaluation that does not correspond to a blown MV fuse resets the detection time.

Direction protection function

In the function input, users set the limit of voltage drop in % of the rated voltage, the limit of overcurrent in the wrong direction in % of the rated current and the protection activation delay time in seconds. Optionally, you can set the closing of the output relay and message sending.

With the direction protection function, the instrument continuously evaluates the current flow direction. If all current values evaluated during the delay time are in the wrong (opposite) direction, the direction protection function activates. The direction protection function immediately activates if the value of current in the wrong direction exceeds the overcurrent limit and, at the same time, voltage dropped below the set limit. The direction protection function evaluates individual phases separately, which means that the fault is signalized even if the incorrect current direction is in one phase only. When the protection activates, the instrument records the activation time, the affected phase and the course of RMS½ voltages and currents with a pre-trigger of 0.5 s and the total duration of 1.0 s. The activation of the direction protection stays recorded even after restoring supply voltage.

The monitor memory holds data of the last twelve records of faults.

4/ MEASURING AND COMMUNICATION CONNECTION, CONNECTION OF INPUTS AND OUTPUTS

The MEg45DIN universal PQ monitor is designed for measuring in power facilities of LV grids and distribution LV grids in the most demanding operating conditions. It has two-way data transfer. It is designed in the measuring category and overvoltage category CAT IV 300 V and in the safety class II. The input and output two-stage signal is ready for connection to external devices. Already operated measuring and information systems can be additionally supplemented with functions provided by the MEg45DIN monitor using the local and remote communication interfaces RS485 and ETH.

Phase voltages are measured to the neutral conductor. Voltage inputs of the instrument are marked **U1**, **U2** and **U3**; connecting to the neutral conductor is via the **Nm** terminal.

Line voltages are evaluated from the difference of instantaneous phase voltage samples.

The high-frequency ground of the instrument on terminal ⏚ is connected to the PE conductor in TN-S networks and to the PEN conductor in TN-C networks.

The MEg45DIN monitor is powered by the voltages of the measuring voltage inputs. It also has an auxiliary (AUX) DC power supply with a rated value of 12 – 24 V connected between terminals **+** and **–**.

The current inputs of MEg45DIN are designed just for indirect current measurement via current transformers or sensors, meeting the requirements for safety at the site of installation. The current inputs of MEg45DIN universal monitors are manufactured with a standardised rated value of current or voltage. They are also produced for the connection of AMOSm flexible current sensors. The rated value of the current input of the monitor or the type of the connected sensor is stated on the rating plate of the monitor. The type and rated value are the same for all three current inputs. Each current input **I1**, **I2** and **I3** of the monitor has input terminal **S1** and output terminal **S2** for the positive current direction. These are to be connected to the outputs of current sensors designated **k** and **l** or **S1** and **S2**. The **S1** input terminals must always be grounded.

The connection of the common terminals in MEg45DIN in safety class II is shown in Fig. 5. The common connection pole **S** is connected to the negative pole of the auxiliary DC power supply. The measuring and supply terminals of the AC voltages and the neutral conductor are connected to it via protective impedances. The terminals of the 2 temperature sensors **T1**, **T2** and, depending on the design of the current inputs, the circuits of the current sensors are connected directly to the common pole. The galvanically isolated power supply of the RS485 interface and the **IN** input contact has a common terminal labelled **G**. The high-frequency shielding of the **ETH** and **USB** interface is connected to the PE grounding conductor. This ground connection is not a safety connection and therefore uses a low-current conductor.

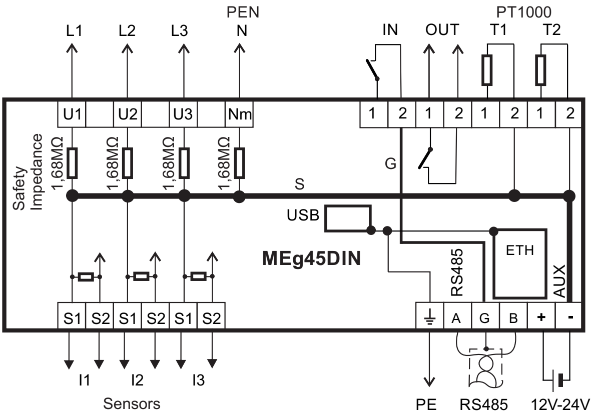
The auxiliary DC power supply is either floating or has a grounded negative pole. When grounding the positive pole of the auxiliary DC power supply, terminals **S1** of current sensors or terminals **2** of temperature sensors must not be connected to ground.

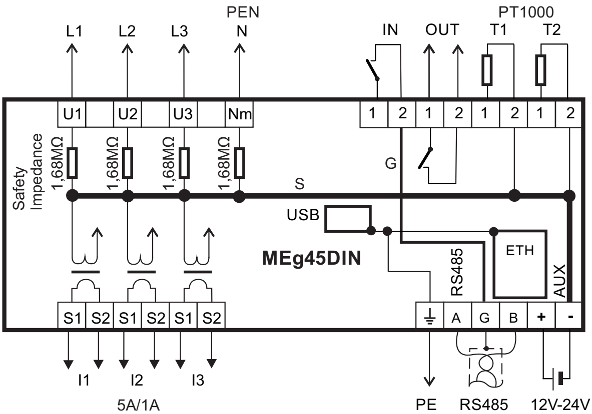
In the basic standard variants of the MEg45DIN monitor, the current inputs **I1**, **I2** and **I3** are designed for standard rated currents of 5 A, 1 A or rated voltage of 225 mV, 150 mV, 22.5 mV. The current inputs of the monitor are connected to secondary circuits of fixed instrument current transformers, split-core transformers and flexible sensors with a standard rated output signal. In the special version, loops of AMOSm flexible sensors can be connected directly to modified current inputs of the MEg45DIN monitor.

Fig. 6 shows the connection with current transformers with the rated secondary current of 5 A or 1 A. If these current transformers are not equipped with the possibility of protection during disconnecting of the secondary circuit or the possibility of short-circuiting on the secondary terminals, their secondary circuits must be connected to short-circuiting terminals enabling the installation of a measuring instrument without the need to switch off the network circuits. MEg45DIN in Fig. 6 is powered from measured voltages.

A split-core current transformer MTPD.51, connected according to Fig. 7 with the rated secondary current of 1 A and electronic protection during disconnecting of the secondary circuit can be used for additional measuring of current in areas with CAT IV 300 V. In the figure, in addition to measured voltages, MEg45DIN is also powered by the AUX auxiliary DC power supply.

Fig. 5: Interconnection of common terminals in MEg45DIN





For measuring currents in structurally complicated types of collecting points (doubled busbar, low distances between busbars, etc.) and in CAT IV 300 V areas, it is advisable to use type AMOS/1A flexible current sensors with a rated current output of 1 A. The flexible AMOS/1A sensors are made with a loop length of 20 cm, 40 cm or 60 cm and with a rated measured current of 30 – 5000 A. The advantage of flexible sensors is the speed of installation, which can be conducted even under voltage without the need for switching off.

When using AMOS/1A sensors, the standard 2 m loop supply cable defines the maximum distance between the installation location of the sensor loop and its converter unit. The distance between the monitor and the converter unit, according to Fig. 8, is determined by the maximum load impedance of 2,5 Ω. In this wiring, it is advisable to ground the negative pole of the auxiliary power supply or the **S1** input terminal of current sensors. When using a trio of AMOS/1A flexible sensors, a power of at least 15 W from a 12 V to 24 V rated power supply is required.

Phase currents of LV installations of buildings can be measured by the MEg45DIN monitor with the use of LCT low-power split-core transformers with the rated primary current of 5 A, 20 A, 60 A, 75 A, 100 A, 120 A, 200 A, 300 A, 400 A, 500 A and 600 A, which have holes for a conductor with measured current with a diameter of 10 mm, 16 mm, 24 mm and 36 mm. The wiring is shown in Figure 9. LCT transformers have a standard output voltage of 225 mV, 150 mV and 22.5 mV. In this case, the MEg45DIN monitor has current inputs with the corresponding voltage values. LCT transformers can only be installed on insulated conductors at air and surface distances from live parts meeting the safety requirements of the installation site.

TORm and TORv toroids should be used if it is possible to disconnect circuits with measured currents. The toroids enable accurate measurements of even small currents. A TORm toroid with a hole for a conductor with a diameter of up to 6 mm can be used for primary current with the rated value of I_n = 1 A or 5 A and a TORv toroid with a hole for a conductor with the diameter of 15 mm for I = 10 A and 50 A. Toroids of both of these types meet the requirements of CAT IV 300 V. The connected MEg45DIN monitor has current inputs with the standard rated voltage. The connected MEg45DIN monitor has current inputs with standard rated voltages corresponding to the output voltages of the toroids. Thanks to their small dimensions, both types of toroids can be used for measurements in LV installations, refer to Fig. 10.

The TORm toroid can also be used for measurement of secondary currents of instrument current transformers. In this way it is possible to galvanically isolate the current circuits of the electric meter and the voltage quality monitor. A wiring example is shown in Figure 11.

The use of the loops of flexible AMOSm sensor with low-voltage direct connection to specially modified current inputs of the MEg45DIN monitor is shown in Fig. 12. The connecting cable is normally 2 m long. The advantage of this special design is that it does not need an external power supply or a converter for a rated current of 1 A. The disadvantage is the need to use the MEg45DIN with special current inputs.

The connection of the **IN** two-stage input and Pt1000 temperature sensors of the MEg45DIN monitor is shown in Fig. 13. The switching contact circuit is powered from the monitor by a galvanically free voltage with a common point **G** on pin 2 of the **IN** input. This galvanically free voltage also supplies the separate RS485 interface circuits. The two-stage **IN** input can also be powered by an external power supply with rated voltages from 12 V to 24 V.

Fig. 14 shows an example of the connection of a load in a LV network to the **OUT** output switching contact of the monitor in CAT IV 300 V environment using the REL IV/DC external isolation relay. Terminals **1** and **2** of the **OUT** switching contact of the output relay switch the excitation circuit of the REL IV/DC electronic relay with inputs **A1**, **A3** powered by an external power supply. The galvanically safely isolated (CAT IV 300 V) output power contact of the REL IV/DC relay in Fig. 14 switches the AC circuit of the motor.

The connection of local communication between the measuring and control system and a group of MEg45DIN monitors using the **RS485** interface is shown in Fig. 15. One RS485 interface with the MODBUS TCP allows communication with up to 30 devices. A 120 Ω terminating resistor must be connected between terminals **A** and **B** of the last device connected in the line with the RS485 interface.

Figure 16 shows the connection of a **GPS** antenna for time synchronization and **GSM** antenna for remote communication to the MEg45DIN monitor. For time synchronisation, the GPS antenna must see at least three satellites. If necessary, use a 10 m long GPS extension cable with additional 2.5 m long insulation at the end with the connector. For GSM communication in CAT IV substation environment, the antenna can be connected through a safe GSM extension cable with a length of 2.524m and, in a safe environment, a GSM extension cable with a length of 10 m. Fig. 16 also shows the connection of the MEg45DIN universal monitor to an Ethernet network through the RJ45 connector. Even in this case, if installed in a hazardous environment, a safe ETH extension cable with a length of 2.5 m can be supplied.

Fig. 17 shows an example of use of the **ETH** interface with the RJ45 connector for remote transmission of data of more than one MEg45DIN universal monitor with the use of a Switch unit.

Figure 18 shows the use of a MEg45DIN universal monitor with an ARM communication core and a transparent channel with secure two-way data transmission using the Linux IPsec function for GSM data transmission between an electric meter concentrator in DTS and the central IT of a distribution company.

The connection of MEg45DIN during single-phase LV measurement is shown in Fig. 19. The measured and supply phase voltage must be connected through a single-pole fuse disconnector to the U1 input of the monitor. The DC uninterruptible power supply of the monitor is not used in the figure.

Fig. 6: Connection of MEg45DIN in a transformer station, CAT IV 300V, current transformers with $I_n = 5\,A$

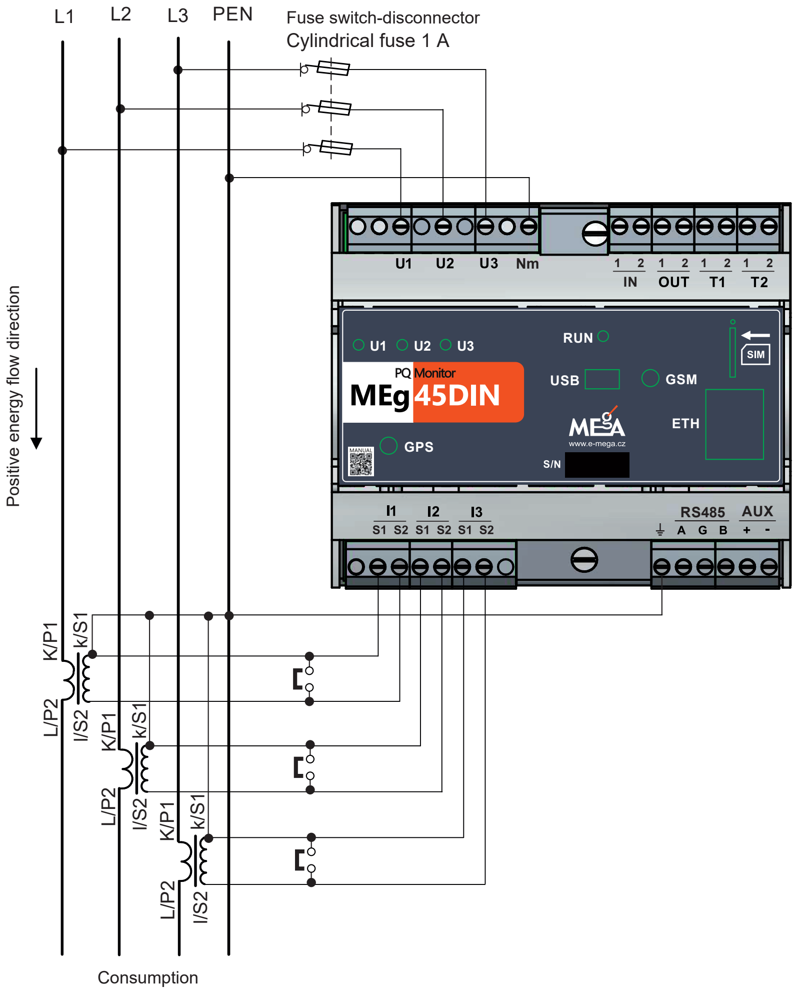


Fig. 7: Connection of MEg45DIN in a LV TN-S type network, with fuse disconnectors in voltage circuits and current transformers MTPD.51 with $I_n = 1$ A

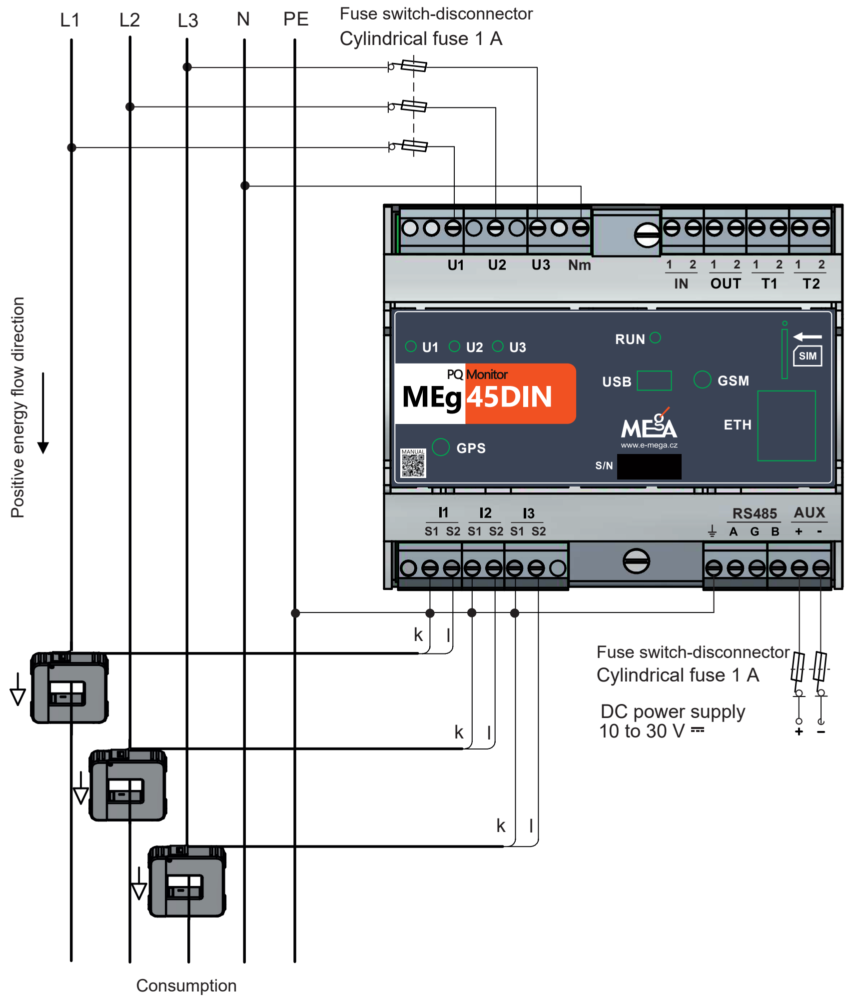


Fig. 8: Connection of MEg45DIN in a LV TN-C type network, with fuse disconnectors in voltage circuits and current measurement by AMOS/1A sensors, category CAT IV 300 V

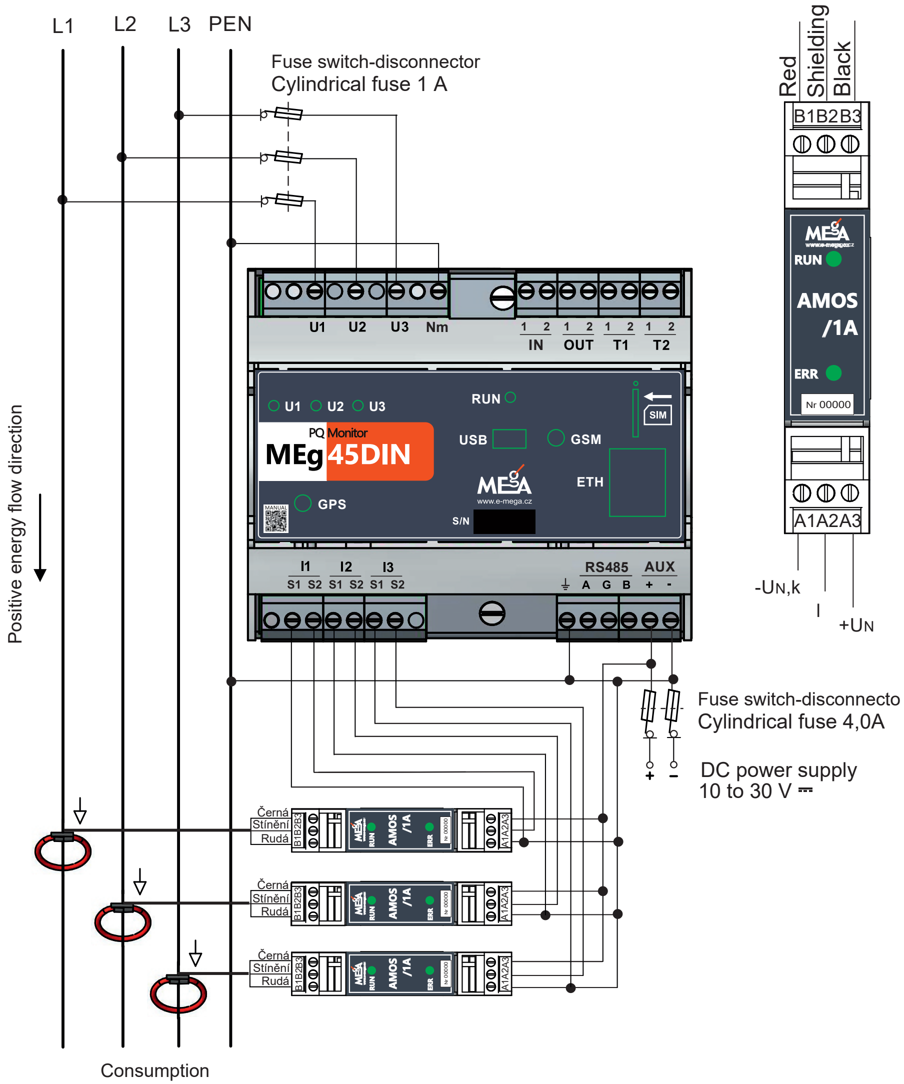


Fig. 9: Connection of MEg45DIN in a LV TN-S type network, current measurement by LCT

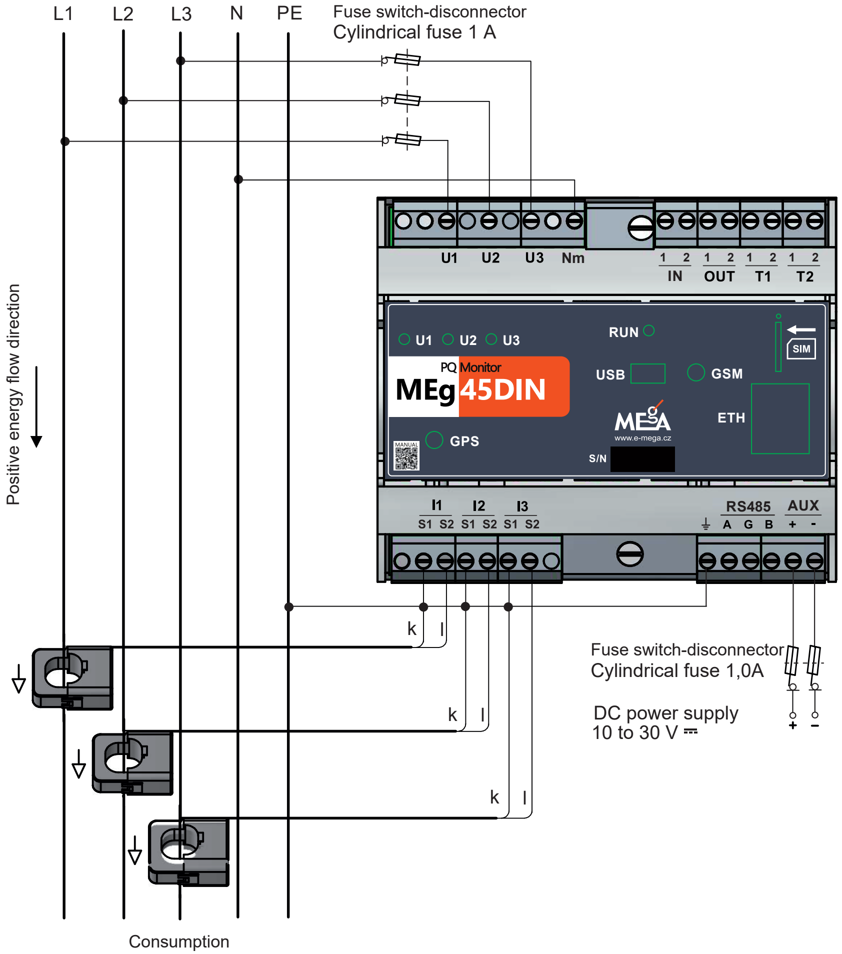


Fig. 10: Connection of MEg45DIN in a LV TN-C type network, current measurement by TORv or TORm toroids, category CAT IV 300 V

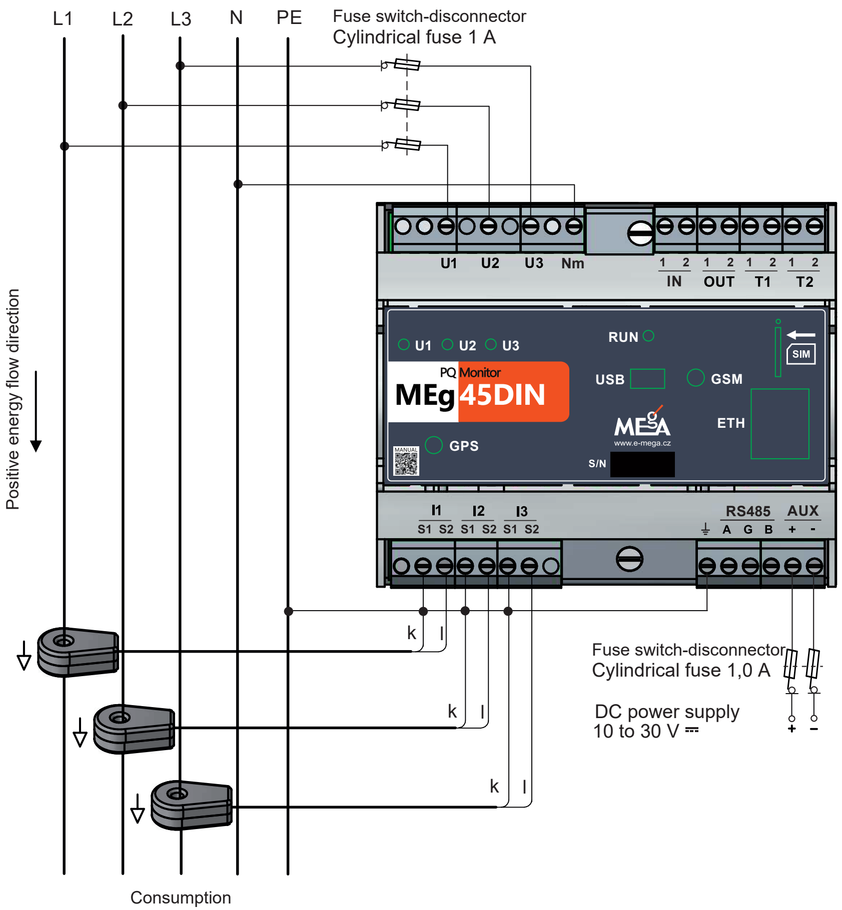


Fig. 11: Connection of MEg45DIN monitor with current measurement by TORm toroids connected in secondary current circuits of current transformers

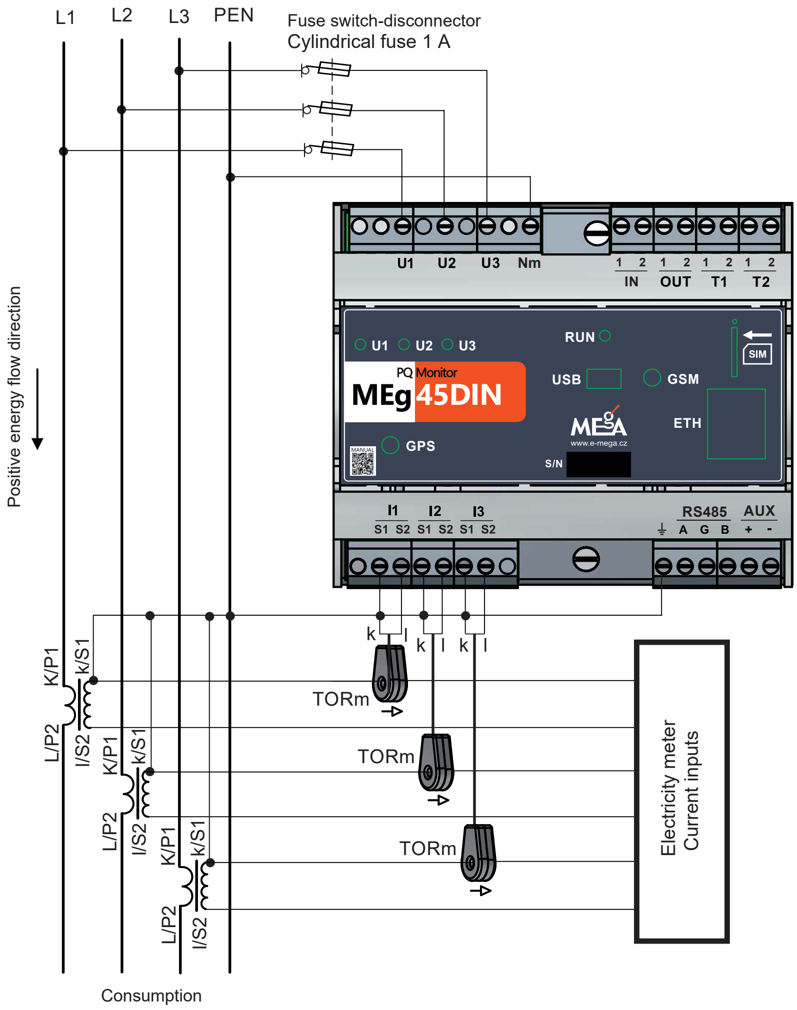


Fig. 12: Connection of MEg45DIN in a LV TN-S type network, current measurement by AMOSm sensors, category CAT IV 300 V

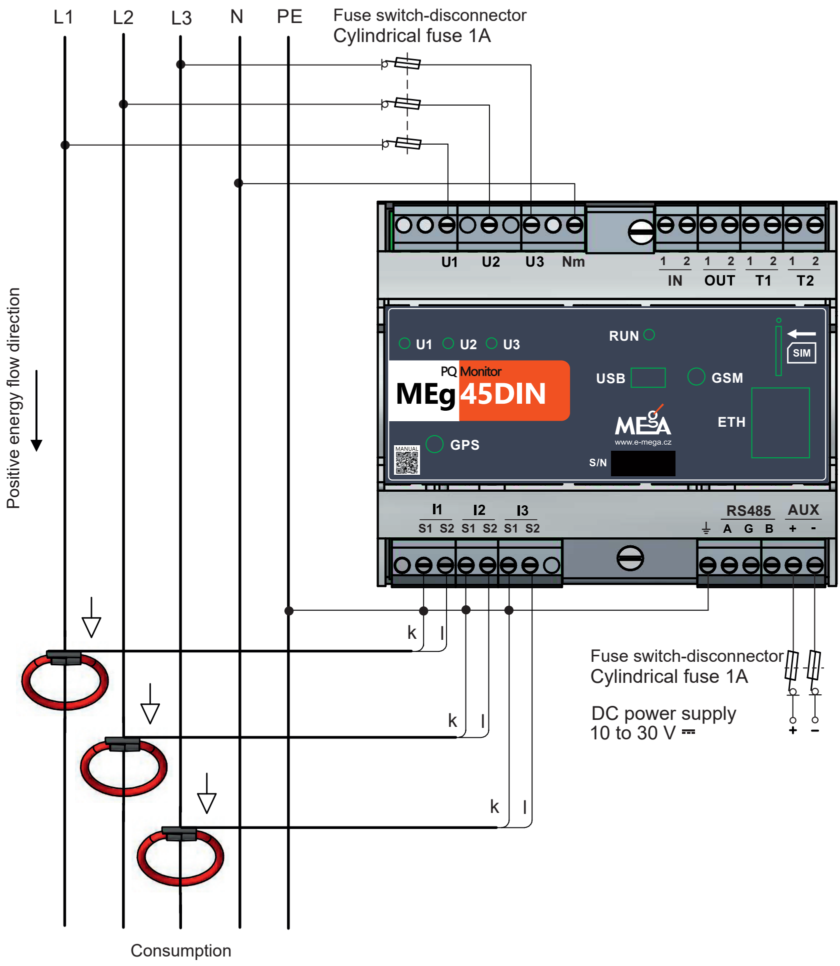


Fig. 13: Connection of MEg45DIN two-stage inputs and temperature sensors

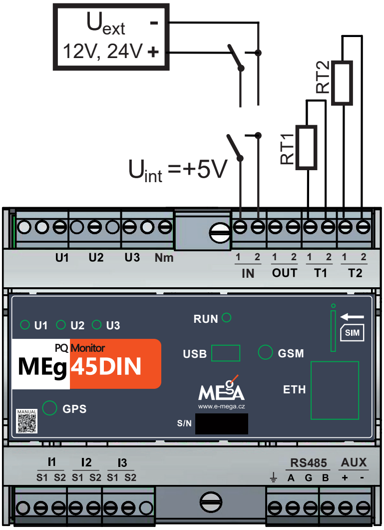


Fig. 14: Connection of load at a LV level in a CAT IV 300 V environment to the OUT output switching contact of the monitor through the REL IV/DC relay

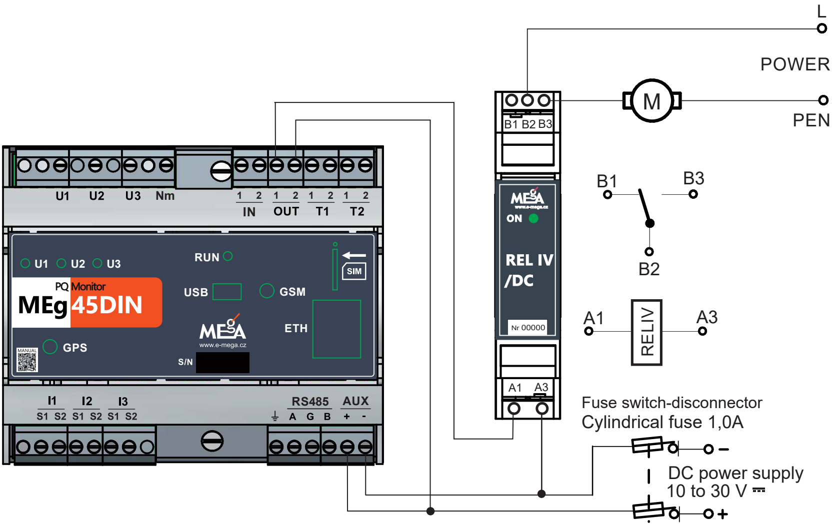


Fig. 15: Communication of MEg45DIN monitors via the RS485 interface

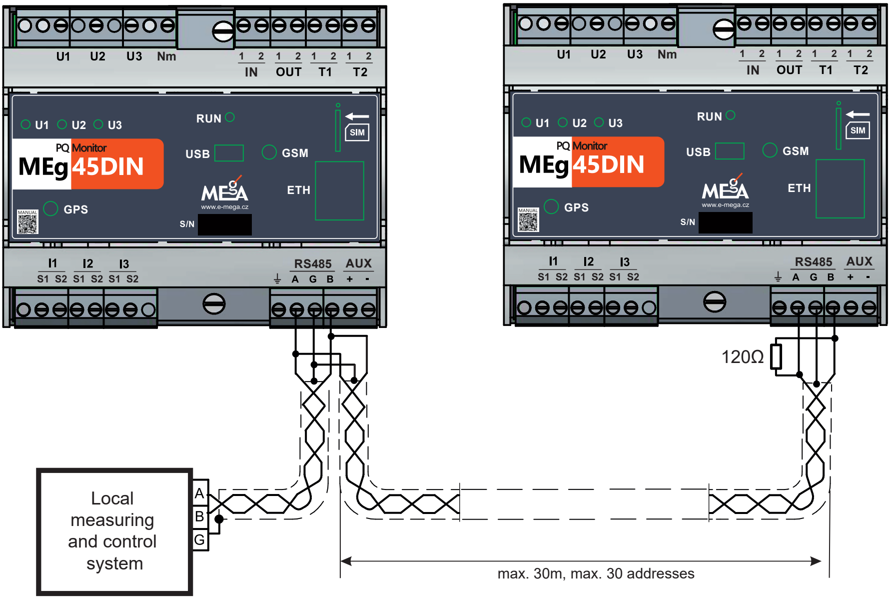
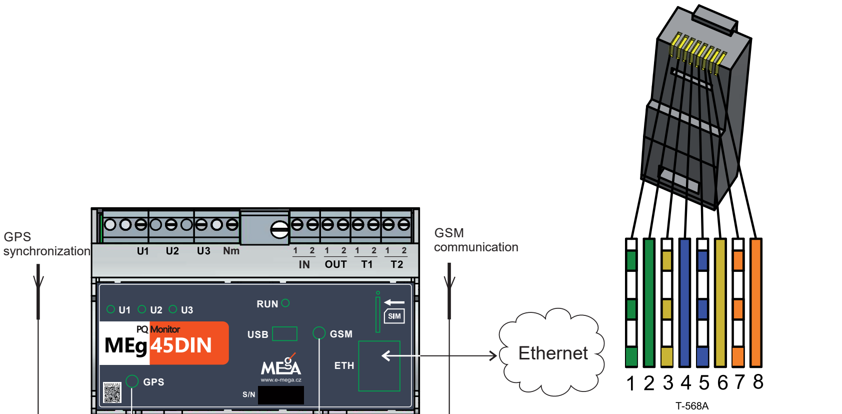


Fig. 16: Connection of GPS and GSM antennas and connection of MEg45DIN to an Ethernet network



RJ45 – ETH connector
Signal TX+ on pin 1
Signal TX- on pin 2
Signal RX+ on pin 3
Signal RX- on pin 6
Pins 4,5,7,8 unused

Fig. 17: Communication of MEg45DIN monitors via the ETH interface and Switch unit

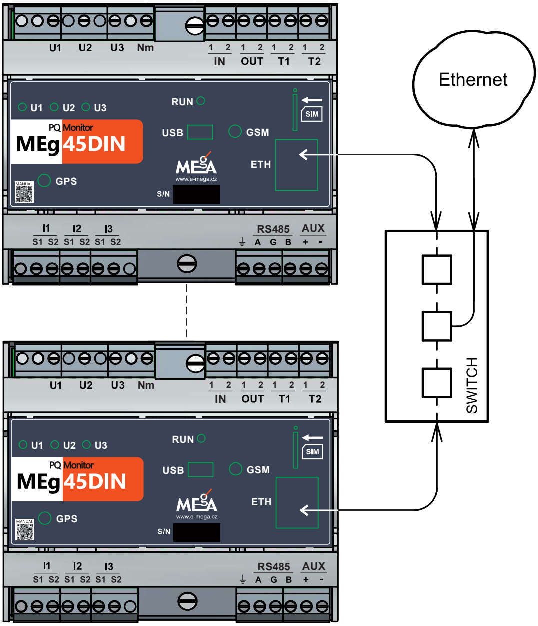


Fig. 18: Data transmission and time synchronization of remote electric meters via a transparent channel of GSM communication of MEg45DIN

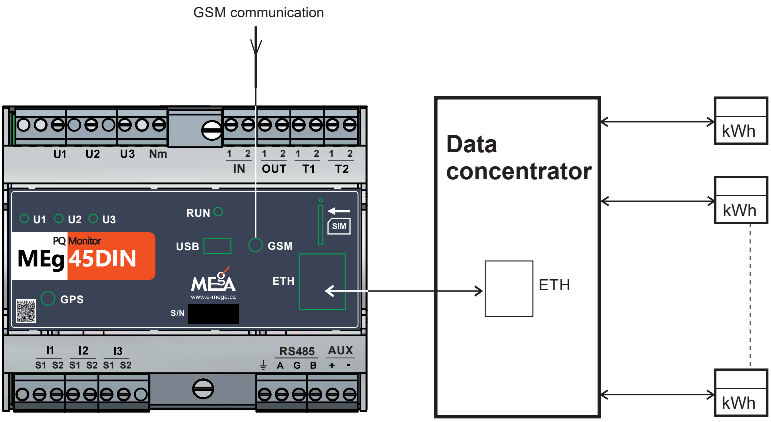
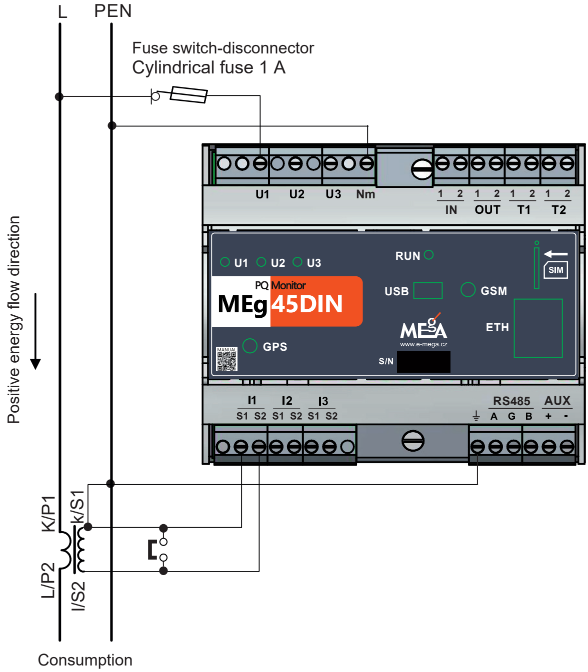


Fig. 19: Single-phase measurement using MEg45DIN



5/ SAFETY INFORMATION

Pay maximum attention to this information.

The warning draws attention to the facts presenting safety risks to the operator.

Cautions indicate conditions and facts that may cause damage to the MEg45DIN monitor.

Warning

- **Be careful, the operator performing the installation of the MEg45DIN universal PQ monitor into circuits and areas with live parts must be equipped with personal protective equipment and additional safety means and use them during the installation.**
- **When the MEg45DIN universal PQ monitor is used in a different way than specified by the manufacturer, the protection provided by MEg45DIN may be impaired.**

- The operator installing the instrument must be qualified for work on or near dangerous voltages. The operator must also be trained in providing first aid.
- The monitor may only be operated by skilled personnel.
- Maintenance and repairs of monitors may only be carried out by the manufacturer or service organizations authorized by the manufacturer.
- It is not permitted to use other accessories than those included in the MEg45DIN monitor set delivery.

⚠ **Caution**

Explanation of symbols used in the user manual and in the specifications of the MEg45DIN universal PQ monitor:

⚠	Note in documentation / Danger, risk of danger
⚡	Danger, risk of electric shock
CAT IV	Overvoltage category, characterizing the state of transient overvoltage. CAT IV 300 V is installation in DTS at the LV level with a voltage of up to 300 V.
⧈	Safety class II, double or increased insulation
IP code	Degree of ingress protection
	The product is intended for recycling and collection points
CE	Declaration of Conformity – European Community
⏚	High-frequency grounding

6/ INSTALLATION OF THE MONITOR

Power supply and measuring voltage circuits shall be connected in a voltage-free state.

Voltage inputs must not be connected to phase voltage exceeding 300 V_{AC} and line-to-line voltage exceeding 510 V_{AC} in CAT IV 300 V measurement category circuits.

Current inputs are not designed for direct measurement of currents. Currents are connected to outputs of current sensors, which must meet the safety requirements applicable at the place of installation. Current circuits shall be connected either in the off state, or with short-circuited secondary windings of instrument current transformers.

The MEg45DIN monitor shall only be installed by qualified personnel equipped with personal protective equipment against electric shock and trained in the provision of first aid.

Warning! In the MEg45DIN monitor with current inputs for low-power sensors with output voltage, the **S1** terminals of the current sensors, the **2** terminals of temperature sensors and the negative terminal for connecting the auxiliary AUX power supply are connected via the common pole **S**, see Figure 5. When installing external components with a grounded pole, this grounded pole must be connected to the above terminals.

In order to suppress hf interference, the contact marked with the ground symbol ⏚ must always be grounded.

Measured voltage must always be brought to the **U1** reference voltage input.

All three current inputs of the MEg45DIN monitor shall be, in accordance with the specification on the rating plate of the monitor, connected to current transformers with the identical rated value of secondary current or voltage or the identical type of non-standard current sensor.

1. Install the MEg45DIN universal monitor on a TS 35 DIN rail, preferably in a horizontal position. Secure its position using locks 16 in Fig. 2.
2. Connect voltage terminals **U1**, **U2**, **U3** through a disconnecting element to phase conductors L1, L2, L3. Use a three-pole disconnector, e.g. OPVP with 1.0 A cylinder fuses with a size of 10 × 38 mm.
3. Connect the **Nm** terminal to the neutral conductor
4. The hf grounding terminal ⏚ always connects to the ground. In a LV TN-C type network to the PEN conductor, and in a LV TN-S network to the PE conductor.
5. If an uninterruptible power supply for the MEg45DIN monitor is required, use a DC power supply with a rated voltage of 12 – 24 V, which connects through a two-

pole fuse disconnector to the **AUX** terminals. Connect the positive pole of the power supply to the + terminal of the monitor and the negative pole of the power supply to the - terminal of the monitor. To power only the MEg45DIN monitor, use 10×38gG cylinder fuses with a rated value of 1.0 A. To power the MEg45DIN unit and three AMOS/1A converters, use fuses with a rated value of 4.0 A.

6. Check the conformity of the marking of the current inputs on the rating plate located on the right side of the unit with the type of connected current sensors.

   The first standard version of MEg45DIN with I_n = 5 A / 1 A connects to secondary circuits of solid-core current transformers or split-core current transformer of type MTPD.51 and AMOS/1A flexible sensors. The choice between 5 A or 1 A rated current is to be made after measurement parametrization.

   The second standard MEg45DIN design has current inputs with rated voltages of 225 mV or 150 mV or 22.5 mV and allows connection of low power LCT transformers or TOR toroids with the same rated output voltage as specified on their rating plates.

   The third, special version of MEg45DIN connects directly to the loops of AMOSm flexible sensors.

   a) Standard instrument solid-core current transformers with a convenient rated value of primary current and with a rated secondary current of 5 A or 1 A are connected to the measured LV phases L1, L2 and L3. Measured current enters the **P1(K)** terminal of the primary winding of the transformer connected in the L1 phase and exits from the **P2(L)** terminal towards the load. The **S1(<u>k</u>)** terminal of their secondary winding is connected to the **S1** terminal of the monitor I1 current and grounded; the **S2(<u>l</u>)** terminal of the secondary winding is connected to the **S2** terminal of the monitor I1 current. The same procedure shall be used for connecting the instrument current transformers in the L2 and L3 phase. Possible disassembling of the MEg45DIN monitor or other measuring instruments connected in the secondary circuit of a current transformer not allowing short-circuiting of its output terminals or without protection for secondary circuit disconnection is enabled by the installation of short-circuiting double-terminals as close as possible to these terminals, which enable short-circuiting of the secondary circuit of the transformer even during operation, see Fig. 6.

   b) A current transformer of the **MTPD.51** type with split core and integrated low-loss protection against disconnecting of the secondary circuit and with a given rated primary current shall be set in the open position on the L1 phase conductor with measured current so that the arrow on the transformer is in the direction of the flow of measured current towards the appliance. Then, engage the turning part of the core in the fixed part of the core and secure it using a colour-contrasting pin inserted in the common hole of both parts of the core. The output cable of the MTPD.51 transformer with marked conductors **S1(k)** and **S2(l)** shall be connected to the corresponding **S1** and **S2** terminals of the I1 current of the MEg45DIN monitor with currents $I_n = 5\,A / 1\,A$, refer to Fig. 7.

To mechanically attach the MTPD.51 transformer at the place of installation on a conductor with measured current, use one or two profiled clamps with holes for cable ties. Mount the clamps on the fixed part of the transformer. Use cable ties threaded through the holes in the clamps to attach the current transformer to the conductor with measured current.

c) A flexible **AMOS/1A** sensor consists of a sensing loop connected to a converter unit by means of a 2 m long shielded cable with a red and black terminal and a shielding terminal. These terminals are connected to terminals **B1** (red), **B2** (shielding) and **B3** (black) of the converter unit during production. The A line terminals on the bottom of the converter are designed for output current and power supply to the unit. The common **A1** terminal of the sensor connected to phase L1 shall be connected to the minus pole of supply voltage with a rated value of 12 – 24 V and to the **S1** terminal of the I1 current input of the monitor, which shall be grounded at the same time. The **A2** terminal shall be connected to the **S2** terminal of the I1 monitor input and the **A3** terminal shall be connected to the plus pole of supply voltage. Connect the circuits of AMOS/1A sensors of phases L2 and L3 in the same way. When installing sensing loops, the arrow direction on the loop must be in the direction of the current flowing to the load.

During three-phase measurement, the three converter units with connected sensing loops can be installed on a DIN TS35 rail with a minimum width of 54 mm (3 × 18 mm), extended by holes for fastening the rail. The DIN rail preferably installs on a panel or walls of a LV cabinet in the horizontal position and the converter unit in such a way that the B line terminals are on top. The place of installation of a converter unit is at the distance of 2 m from the place of installation of the measuring loops. An example of connection of the **A1** (**-U_N,k**), **A2** (**l**), **A3** (**+U_N**) contacts of all three converter units to the input current terminals **S1** and **S2** of the I1, I2 and I3 current inputs of the MEg45DIN monitor, grounding of the **-U_N,k** terminals and connecting of power supply to the converter units is shown in Fig. 8.

Finally, measuring loops of flexible AMOS/1A sensors shall be installed on the L1,L2 and L3 phase conductors with measured currents as follows:

Open the AMOSm measuring loop by turning the lock on its closure and wrap the free end of the loop around the conductor with measured current in such a way that the direction of current flowing towards the load is the same as the direction of the arrow on the pictogram on the loop closure. Insert the free end of the loop in the loop closure deep enough to be locked against accidental extraction by the lock.

When installed on the ribbon steel of a LV busbar, fix the position of the loop on the busbar using a clamp with a clearance of 5 mm or 10 mm. Mount the clamp on the busbar at the site of installation, insert the closed closure of the flexible sensor loop in its cavity so that the closure is guarded against accidental opening and, moreover, the body of the clamp reduces direct electric and thermal contact between the busbar and the loop.

During installation on a round or segment conductor of a LV cable, use a thin securing band that pulls the lock towards the inserted free part of the closure. Attach the closed measuring loop secured against opening and wrapped around the conductor with the measured current using one or two cable ties to the conductor with the measured current. Preferably, attach the measuring loop to the conductor with the measured current at a point farthest from the closure. The closure should not be near another conductor. The conductor at the place of installation of the flexible sensor loop can be without insulation as well.

The cables and loops meet the safety and insulation requirements of CAT IV 300 V and the environment temperature of up to 120 °C.

d) Before installing **LCT** low-power split-core transformers, make sure they are at a safe air and surface distance from live parts at the place of their installation. If necessary, make sure they are safely isolated by using additional insulation.

Before the installation, also make sure that the rated primary current value of all three sensors is the same.

TORm and **TORv** toroids meet the requirements of the CAT IV 300 V measuring category and can therefore be installed in a voltage-free state directly on live conductors.

LCT transformers, like TOR toroids, have a 2 m long shielded output cable with **S1** or **<u>k</u>** and **S2** or **<u>l</u>** terminals, with the cable shield connected to the k terminal.

Connect the **S1** or **<u>k</u>** terminals of the three LCT sensors or TOR toroids to the **S1** terminals of the monitor current inputs. The **S1** terminals shall also be grounded.

Connect the **S2** or **l** terminals of the three LCT sensors or toroids to the **S2** terminals of the monitor current inputs.

When installing the LCT and TOR sensors, make sure the direction of the arrow on the sensor matches the direction of the current flow towards the load.

The LCT low-power current transformers are to be installed on de-energized phase conductors with the cores open, and the sensor connected to the I1 current input of the monitor shall be positioned on the L1 phase and engaged, the sensor connected to the I2 current input of the monitor shall be positioned on the L2 phase, and the sensor connected to the I3 current input of the monitor shall be positioned on the L3 phase. The position of the sensor on the conductor with the measured current must be secured with two cable ties in the LCT holders surrounding the conductor with the measured current.

Slide the TORv or TORm toroids connected to the I1, I2 and I3 current inputs of the monitor over the L1, L2 and L3 disconnected phase conductors in the de-energized state and reconnect the circuits of the phase conductors. The position of the toroid on the phase conductor with the measured current can be secured with a cable tie.

e) Before installing three **AMOSm** sensor loops on phase conductors with measured current according to Fig. 12, check the marking I1, I2 and I3 on the individual sensors and the conformity of the serial numbers of all three AMOSm sensors with the serial number of the MEg45DIN monitor with which they were calibrated by the manufacturer. Then, check the AMOSm marking near the current on the rating plate of the installed MEg45DIN monitor.

Use the procedure stated in article c) to install the measuring loops of AMOSm current sensors on phase conductors with measured currents. The loops of AMOSm sensors have two terminals at the end of the output cable marked **S1** or **k** and **S2** or **l**. The shield of the output cable of the AMOSm sensor is connected in the cable to the k terminal.

Connect the **k** terminal of the AMOSm sensor marked I1 to the **S1** terminal of the I1 current of the MEg45DIN monitor, which shall also be grounded. Connect the **l** terminal of this sensor to the **S2** terminal of the I1 current of the monitor. Similarly, connect the terminals of the AMOSm sensor loop marked I2 to the I2 current terminals of the monitor and connect the terminals of the AMOSm sensor loop marked I3 to the I3 current terminals of the monitor.

7. The MEg45DIN universal monitor can also be used for single-phase measurement, see Fig. 19. In this case, the measured voltage must be connected to the **U1** input and the measured current to the **I1** terminals.
8. The galvanically free switching contact of the external device powered by the internal 5 V voltage of the MEg45DIN monitor in Figure 13 is connected to terminals **1** and **2** of the **IN** input. If the switching contact is grounded at one pole, this pole must be connected to terminal **2** of the **IN** input, which is connected to the RS485 interface shield via the common conductor **G** in the monitor.

   When a higher voltage external source is required to power the external contact circuit (12 V or 24 V), a switching contact must be used and if the external source is not floating, then it must have its negative source grounded and connected to terminal **2** of the **IN** input.

9. The galvanically free output switching contact of the MEg45DIN monitor relay at terminals **1** and **2** on the **OUT** output allows switching of DC and AC circuits with a rated voltage up to 48 V and a current up to 2 A. The function of the monitor output contact is verified by checking the function of the second isolated contact of the output relay.

   Fig. 14 shows an example of switching of an AC LV circuit with external REL IV/DC relay in DIN rail design with CAT IV 300 V overvoltage category between input and output circuits.

10. Fig. 15 to Fig. 18 show the basic connection of MEg45DIN with local and remote communication.

    Figure 15 shows local communication of monitors via the **RS485** interface with a local measuring and control system using a shielded twisted pair. For communication of multiple devices with the RS485 interface, interconnect the **A** terminals of all devices and the **B** terminals of all devices and connect the **G1** terminals of all devices to the shielding of a twisted pair that should not be longer than 30 m in total in a CAT IV 300 V environment. Connect a terminating resistor of 120 Ω between the **A** and **B** terminals of the last communicating device. In MEg45DIN, they can also be connected via a SW command.

    The connection of the **GSM** remote communication antenna and the **GPS** time synchronisation antenna to the MEg45DIN monitor is shown in Fig. 16. The figure also shows an example of MEg45DIN connection to an Ethernet network through a cable inserted in a RJ45 WS 8-8 connector labelled **ETH**. After inserting the antenna cables in connectors, route them down through the hole under the tilting cover.

    If the monitor is to be connected to local and remote communication in a dangerous voltage environment, use a cable meeting the safety requirements for that environment or attach a standard cable so as to meet the safety surface and air distances.

    Multiple MEg45DIN universal monitors can be connected to an Ethernet network through a Switch unit, see Fig. 17. In a LV cabinet, use a safe ETH extension cable with a length of 2.5 m and additional LV insulation.

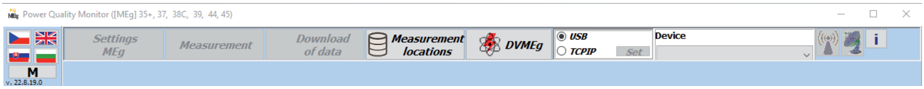
    Figure 18 shows data collection from electric meters in a LV network through a data concentrator (e.g. type PLC) and their further secure transmission via a transparent channel with the IPsec function through a GSM network to the information system of a distribution company.

7/ SWITCHING ON THE MONITOR, PREPARATION FOR MEASUREMENT

1. After switching on any of the measured or supply voltages, the **RUN** LED flashes with a delay of approx. 2 s, necessary to start the power supply and check the correct function of the individual monitor blocks. The flashing pattern is determined by previous programming of the monitor. If the **RUN** LED is continuously on or off, the monitor or power supply is in a fault state.

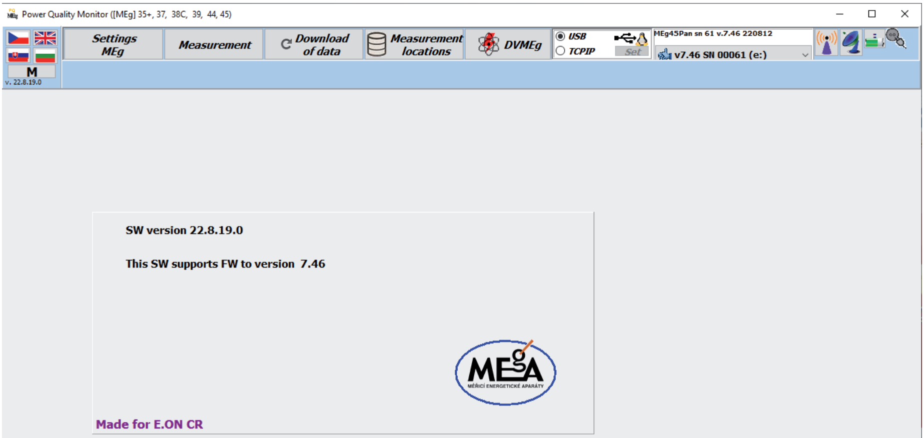
   LINUX starts approximately 2 minutes after connecting supply voltage.
2. The software **PQ_MEg** launches in the inspection computer. If it launches correctly, the main window with a bar according to Fig. 20 is displayed, where USB communication is to be selected. For a detailed description of the PQ_MEg software, visit www.e-mega.cz/DL.

Fig. 20: Start of the PQ_MEg software



3. Use a USBmini communication cable to connect the inspection computer to the MEg45DIN monitor. The main window will display information on the SW and FW version. The bar in the main window displays the type and serial number of the connected monitor, see Figure 21.

Fig. 21: Confirmation of USB communication between MEg45DIN and an inspection computer



4. In the main bar, select “**Měřidlo**” (**Meter**) according to Fig. 22. This shows the values of the connected phase voltages and phase currents in the **Samples** view. To check the correct direction of current connection, correct direction of phase voltage rotation and correct assignment of phase currents to phase voltages, press the **Test** button. An example of a correct test is shown in Figure 23.

Fig. 22: Connection of measured voltages and currents

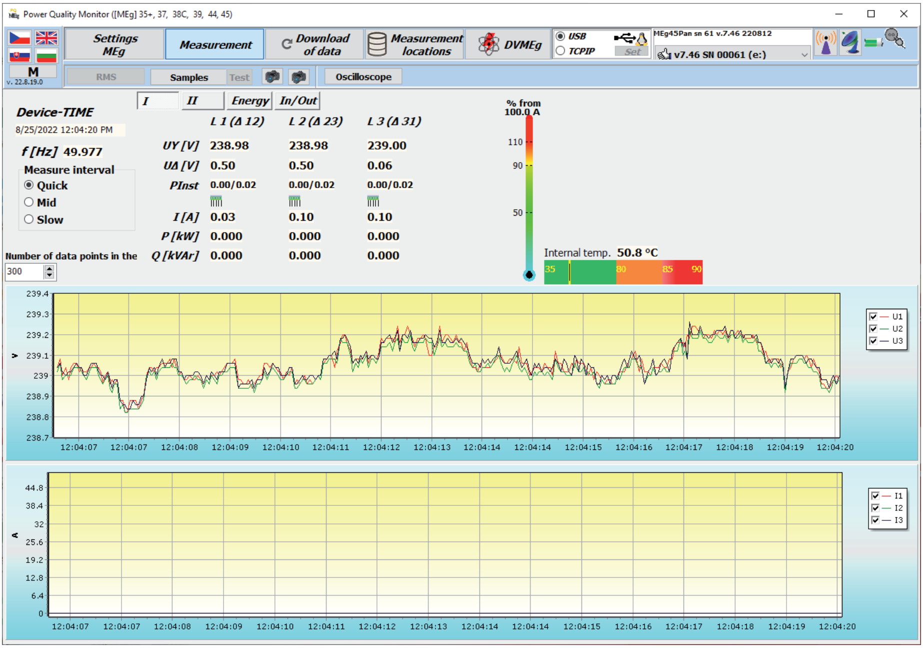
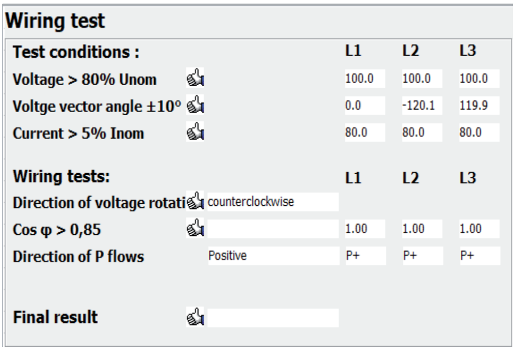


Fig. 23: Check of the correct connection of measured voltages and currents

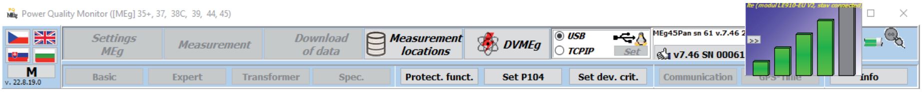


Wiring test

Test conditions :		L1	L2	L3
Voltage > 80% Unom		100.0	100.0	100.0
Voltge vector angle ±10°		0.0	-120.1	119.9
Current > 5% Inom		80.0	80.0	80.0
Wiring tests:		**L1**	**L2**	**L3**
Direction of voltage rotati	counterclockwise			
Cos φ > 0,85		1.00	1.00	1.00
Direction of P flows	Positive	P+	P+	P+
Final result				

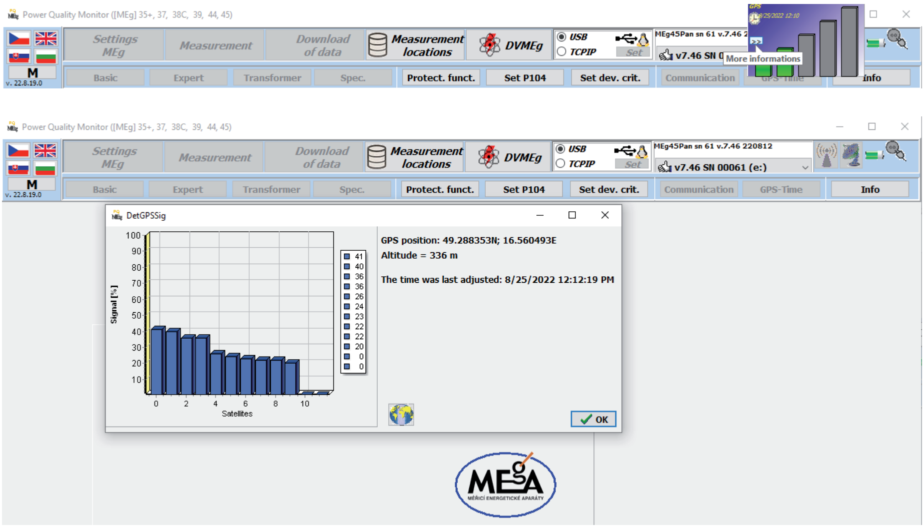
5.  A check of the correct connection of a GSM network antenna with sufficient GSM network signal intensity is indicated by a highlighted GSM network pictogram at the end of the main bar of the program. Click on the pictogram to display information on the GSM network signal intensity at the antenna installation location, see Fig. 24.

Fig. 24: Display of the GSM network signal intensity at the antenna installation location



6.  Approximately 2 minutes after connecting a GSM antenna installed with direct sky visibility, the GPS pictogram will be highlighted. After it is activated, a new window will display the number of received satellites, the monitor installation location and the moment of the last synchronisation of the monitor time.

Fig. 25: Information on the GPS signal reception conditions at the antenna installation location and data in MEg45DIN



8/ MAINTENANCE

Caution

- The repairs of the MEg45DIN universal monitor during the warranty period may only be carried out by the manufacturer's skilled and trained personnel or by the manufacturer's service organizations.
- The monitor may not be exposed to chemicals.
- The monitor must only be transported in original transport packaging supplied by the manufacturer.

The monitor does not require any special maintenance if properly used in compliance with this user manual. Only if dirty should the device be carefully cleaned with a damp cloth without using cleaning agents.

Batteries

The monitor uses the following batteries:

- type CR2032 lithium battery for the clock circuit,
- supercapacitors with a declared lifetime of 10 years.

Fuses

To protect the measuring voltage inputs of the monitor, which also power the monitor, use cylinder fuses 10×38gG 1.0 A.

To protect the AUX auxiliary DC power supply, use cylinder fuses 10×38gG 1.0 A.

To protect the AUX auxiliary DC power supply and the trio of AMOS/1A flexible sensors, use 10×38gG 4.0 A cylinder fuses.

9/ DISPOSAL

When the service life of the MEg45DIN universal monitor is over, it must be recycled at waste disposal sites according to rules for electronic waste disposal.

10/ WARRANTY

The MEg45DIN universal monitor is covered by a 24-month warranty from the date of purchase, however not longer than 30 months from the date of release from the manufacturer's warehouse. Defects originating during this period as a demonstrable result of defective design, manufacturing or using improper material will be repaired free of charge by the manufacturer.

It is not permitted to open the MEg45DIN universal monitor during the warranty period.

The warranty becomes void if the user carries out unauthorized modifications or changes on the MEg45DIN monitor, if the user connects the monitor incorrectly or if the monitor has not been operated in accordance with technical conditions.

Defects on the MEg45DIN monitor originating during the warranty period shall be claimed by the user with the manufacturer. The claimed monitor shall include the warranty certificate.

Under no circumstances the manufacturer is liable for subsequent damage caused by using the MEg45DIN monitor. This warranty does not in any case imply manufacturer's liability exceeding the price of the MEg45DIN monitor.

11/ ORDERS

The basic version of MEg45DIN has:

voltage inputs $U_n = 230\,V$, RS485 and ETH interface, one input and one output signal, two external temperature measurements, three-phase power supply from measured voltages, auxiliary power supply with a rated DC voltage of 12 V to 24 V.

The basic MEg45DIN design includes current inputs with a programmable standard range of 5 A / 1 A or one of 225 mV, 150 mV, 22.5 mV standard voltages or non-standard inputs for AMOSm flexible sensors.

- Function W0, Recorder
- Function W1, Voltage quality
- Function W2, Voltage phenomena and events related to currents
- Function W3, Four-quadrant active and reactive electric meter
- Function W4, Oscillographic measurement
- 1 communication cable USBmini 1.5 m
- 1 socket for a nano SIM card 115S-ACA1

Optional accessories for the MEg45DIN variant:

- Function W5, Evaluation of HDO telegrams
- Function W6, Measurement of fast active energy
- Function W7, Direction protection
- Function W8, Two-stage undervoltage and overvoltage protection
- Function W9, Protection according to voltage and current unbalance
- Function W10, Indication of a blown MV fuse

- Three current transformers MTPD.51, $I_n = 400\,A$, $600\,A$, $1000\,A$[1]
- Three clamps for MTPD.51 transformer with cable ties
- Three LCT current transformers with accessories according to Tab. 2
- Three TORm toroids
- Three TORv toroids
- Three AMOSm/1A flexible sensors, Tab. 3
- Three loops of AMOSm flexible sensors, Tab. 3
- Three AMOSm and AMOS/1A sensor holders on the busbar, clearance 10 mm
- Three AMOSm and AMOS/1A sensor holders on the busbar, clearance 5 mm
- GPS time synchronisation module
- GSM remote communication module
- LTE/GPS PUCK, mounting antenna AO-AKOM-36SS/MEgA[2]
- GPS PUCK, mounting antenna GPS PUCK AP-AGPS-36/MEgA[2]
- LTE rod, rod antenna LTE AO-ALTE-G124S/MEgA[2]
- GPS magnet, GPS magnetic antenna AP-A20C-M5RA/MEgA[2]
- GPS extension cable / 10 m[3] with thicker insulation with a length of 2.5 m
- GSM extension cable / 2.5 m[3]
- ETH extension cable, safe / 2.5 m[3]
- Cable USB OTG AF to mini-BM, 15 cm for flash drive connection

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[1] Can be ordered with $I_n = 100\,A$, $200\,A$
[2] Technical data are provided in Chapter "AGSM and AGPS antennas"
[3] Other lengths are available

Specification of an order of MEg45DIN

MEg45DIN/X/W5 to W10/cl. A or cl. S

X:
- 5A/1A
- 225 mV
- 150 mV
- 22,5 mV
- AMOSm

W5 to W10:
- W5 Evaluation of HDO telegrams
- W6 Measurement of active energy at rapid changes of flow direction
- W7 Direction protection function
- W8 Two-stage undervoltage and overvoltage protection
- W9 Protection according to voltage and current unbalance
- W10 Indication of a blown MV fuse

cl. A means class A and cl. S means class S according to EN 61000-4-30, ed. 3

Tab. 2: Current ranges of LCT split-core transformers (× = yes, ⁄ = no)

Diameter [mm]	Primary current											
	5 A	10 A	20 A	60 A	75 A	100 A	120 A	200 A	300 A	400 A	500 A	600 A
10	×	⁄	×	×	×	⁄	⁄	⁄	⁄	⁄	⁄	⁄
16	⁄	⁄	⁄	⁄	⁄	×	×	×	⁄	⁄	⁄	⁄
24	⁄	⁄	⁄	⁄	⁄	×	⁄	×	⁄	×	⁄	⁄
36	⁄	⁄	⁄	⁄	⁄	⁄	⁄	⁄	×	×	×	×

Tab. 3: Current ranges of AMOS/1A flexible sensors and AMOSm loops (× = yes, ⁄ = no)

Loop length	Primary current					
	30 A	100 A	300 A	1000 A	3000 A	5000 A
short	×	×	×	×	⁄	⁄
standard	×	×	×	×	×	⁄
long	⁄	⁄	⁄	×	×	×

12/ TECHNICAL PARAMETERS

General information

The MEg45DIN universal monitor meets, according to EN 61010-2-30, the measuring category and the overvoltage category of CAT IV 300 V.

The MEg45DIN universal monitor is classified, according to EN 62586-1, as PQI-A-FI1-H or PQI-S-FI1-H.

The development and production of the monitor is in conformity with ISO 9001, ISO 14001:2005, OHSAS 18001:2008, ISO/IEC 27001:2014.

Operating conditions

Operating temperature:	-10 °C to +45 °C, guaranteed measurement uncertainty
Threshold operating temperature:	-25 °C to +55 °C
Stabilisation period:	10 minutes after start-up
Relative humidity:	5 % to 95 %, non-condensing
Altitude:	up to 2000 m

Design data

Dimensions:	108 × 90 × 63 mm
Weight:	0.5 kg
Measuring category:	CAT IV 300 V according to EN 61010-2-030:2011
Safety class:	II, reinforced insulation
Protection:	IP20
Use:	interior
Pollution degree:	2

Power supply	**Inputs**	**AUX**
Phase voltage range:	160 V_{AC} to 300 V_{AC}	10 V_{DC} to 30 V_{DC}
Input power:	18 VA	6 W
Frequency:	50 Hz ± 15 %	
Internal uninterruptible power supply:	35 s with charged supercapacitors, charge time 5 min.	

Protection

U_n = 160 V_{AC} to 300 V_{AC}, inputs:	3 cylinder fuses 10 × 38gG 1.0 A fuse disconnector OPVP-3
U_n = 12 V_{DC} to 24 V_{DC}, AUX:	2 cylinder fuses 10 × 38gG 1.6 A fuse disconnector OPVP-2
	2 cylinder fuses 10 × 38gG 4.0 A fuse disconnector OPVP-2

Measuring characteristics

A/D converter:	16 bit
Sampling frequency:	256 samples per period
Antialiasing filter:	digital filter, type FIR
Phase-locked loop:	controlled by the passage of the fundamental harmonic voltage U1 through zero
Aggregation intervals:	quality function – according to EN 61000-4-30, ed. 3 recorder function – from 1 s to ¼ h
Synchronisation of aggregation:	according to EN 61000-4-30, ed. 3, class A
Time base:	±1 s in 24 h at the operating temperature without external synchronisation ±1 ms at the operating temperature with GPS
Data memory capacity:	512MB, circular organization for each function

Voltage inputs U1, U2 and U3

Rated phase voltages U_n, P-N:	230 V_{AC}
Rated line voltages U_n, P-P:	400 V_{AC}
Maximum voltage, P-N:	300 V_{AC} for CAT IV
Voltage measuring range, P-N, tř. S:	0.2 V_{AC} to 350 V_{AC}
Voltage measurement uncertainty, P-N, cl. S:	±0.2 % M.V. ± 0.025 % U_n, f = 50 Hz
Voltage measuring range, P-N, cl. A:	0.2 V_{AC} to 460 V_{AC}
Voltage measurement uncertainty P-N, cl. A:	±0.05 % M.V. ± 0.025 % U_n, f = 50 Hz
Change of value with temperature:	0.05 % U_n /10 K
Input resistance of voltage inputs:	1.68 MΩ

Voltage inputs with a common center conductor are separated by a high resistance.

Current inputs I1, I2 and I3

Rated value of current I_n:	5 A_{AC}/ 1 A_{AC}, electronically switched, CAT II / 300 V
Current measuring range:	1 % I_n up to 200 % I_n
Current measuring uncertainty [2]:	±0.2 % M.V. ± 0.025 % I_n (45 Hz to 60 Hz)
Overcurrent measuring range:	200 % I_n up to 1000 % I_n
Overcurrent measuring uncertainty [2]:	±0.5 % M.H. (45 Hz to 60 Hz)
Change of value with temperature:	0.05 % I_n/10 K
Permanent overload:	10 A_{AC}
Maximum current, 1 s:	50 A_{AC}, 1 × per 1 min
Input resistance of current inputs:	≤ 50 mΩ
Current inputs are galvanically free.	

Rated voltage U_n at I_n [1]:	225 mV_{AC}, 150 mV_{AC}, 22.5 mV_{AC}
Current measuring range:	5 % I_n up to 200 % I_n
Current measuring uncertainty [2]:	±0.2 % M.V. ± 0.025 % I_n (45 Hz to 60 Hz)
Overcurrent measuring uncertainty [2]:	±0.5 % M.V. (45 Hz to 60 Hz)
Change of value with temperature:	0.05 % I_n/10 K
Permanent overload:	10 × U_n at I_n
Maximum current, 1 s:	50 × U_n at I_n, 1 × per 1 min
Input impedance of current inputs:	2 MΩ / 47pF

The current measurement parameters of the AMOSm + MEg45DIN set are listed in the technical data of Chapter "Current sensors of the MEg45DIN universal PQ monitor".

Active power, reactive power, PF, energy

Active power [2]:	±0.5 % M.V. ± 0.2 % P_n	at U ≥ 80 % U_n, I ≥ 5 % I_n, PF ≥0.5
Reactive power [2]:	±0.5 % M.V. ± 0.2 % Q_n	at U ≥ 80 % U_n, I ≥ 5 % I_n, PF ≤ 0.866
PF:	±0.01	at U ≥ 80 % U_n, I ≥ 5 % I_n
Active energy:	class B	EN 50470-1
Reactive energy:	class 1	TPM 2440-08, ČMI 2008

Note: [1] one of the values
[2] at I_n = 1 A, 5 A and I_n = 225 mV, 150 mV
M.V. – measured value

IN input contacts

Number:	1 galvanically free
Internal supply voltage:	5 V_{DC}
Rated external supply voltage:	12 V_{DC} to 24 V_{DC}
Max. resistance of contact external circuit:	100 Ω

OUT output contacts

Number:	1, galvanically free switching contact
Rated switched voltage:	12 V or 24 V, DC or AC
Maximum switched current:	2 A
Maximum switched voltage:	48 V

USB interface

Type:	USB2.0
Communication speed:	5.4 Mbit/s
Connector:	USBmini B
Flash drive:	maximum supply current 100 mA

RS485 interface

Default settings:	115.2 kbit/s, 8 bit, no parity, one stop bit
MODBUS RTU protocol:	Application Protocol Specification V1.1b3

ETH communication

Speed:	10/100 Mbps Ethernet,
Standard:	Ethernet version 2.0/IEEE 802.3
Protocols for data reading:	MODBUS TCP, IEC 60870-5-104, DLMS/COSEM
VPN protocols:	L2TP/IPsec, IKEv2/IPsec
Management:	SSH (including central management of user access by means of the RADIUS or TACACS+ protocol), SNMP, SYSLOG
Other properties:	Firewall, static routing, dynamic routing protocols
Connector:	RJ45 type WS 8-8

GSM communication

SIM card type:	nano SIM in a 115S-AC1 slot	
Technology:	LTE Cat. 4, HSPA+, EDGE, GPRS (class B, CS1 to CS4)	
Frequency bands [MHz]:	4G	B1 (2100), B3 (1800), B7 (2600), B8 (900), B20 (800)
	3G	B1 (2100), B8 (900)
	2G	B3 (1800), B8 (900)

Watchdog for modem restart in case of communication loss

Protocols, management and other properties are the same as for ETH communication

ETH time synchronization

Protocols: NTP, IEC 60870-5-104, MODBUS TCP

GPS time synchronization

Uncertainty: ± 1 ms

Standards: NMEA, RTCM104

Frequency band: GPS(L1)

Classification of MEg45DIN according to EN 62586-1

Universal monitor MEg45DIN Cl. A is classified **PQI-A-FI1-H**,
Universal monitor MEg45DIN Cl. S is classified **PQI-S-FI1-H**,
f = 50 Hz, CAT IV 300 V according to EN 61010-2-030.

Table of the MEg45DIN functions according to IEC 61000-4-30, ed. 3

Function and measured data	Method of measurement	Measurement uncertainty, measuring range	
		MEg45DIN Cl. S	MEg45DIN Cl. A
Network frequency; 10 s data	Class A	Class S	Class A
Voltage value 150 periods, 10 min, 2 hours	Class A	Class S	Class A
Flicker; 10 min P_{st}, 2 hours P_{lt}	Class A	Class S	Class A
Voltage drops and increases, residual and max. U, duration T	Class A	Class S	Class A
Supply voltage interruption, residual and maximum U, T time	Class A	Class S	Class A
Voltage unbalance 150 periods, 10 min, 2 hours	Class A	Class S	Class A
Harmonic voltages 150 periods, 10 min, 2 hours	Class A	Class S	Class A
Interharmonic voltages 150 periods, 10 min, 2 hours	Class A	Class S	Class A
Voltage of signals in the supply voltage, voltage value	Class A	Class S	Class A
Positive and negative voltage deviations 150 periods, 10 min, 2 hours	Class A	Class S	Class A
Rapid voltage changes – RVC, $U_{RMS1/2}$	Class A	Class S	Class A

Note: According to EN 61557-12, the MEg45DIN universal monitor is a measuring device of the PMD SD class (performance measuring and monitoring device) with current measurement by means of sensors and direct voltage measurement.

It integrates the functions of recording, electric energy measurement, voltage quality measurement, recording of HDO telegrams.

Measurement uncertainty and measuring ranges of voltage quality parameters during test conditions 1, 2 and 3 according to standard EN 61000-4-30 ed. 3

Parameter	MEg45DIN Class S		MEg45DIN Class A	
	Uncertainty	Measuring range	Uncertainty	Measuring range
Frequency	± 2 mHz	42.5 Hz – 57.5 Hz	± 2 mHz	42.5 Hz – 57.5 Hz
Voltage deviation	± 0.2 % U_n	10 % U_n – 120 % U_n	± 0.1 % U_n	10 % U_n – 150 % U_n
Flicker P_{st}, P_{lt}	± 7.5 % P_{st}, P_{lt} IEC 61000-4-15, ed. 2	P_{st}, P_{lt} (0.4 – 4.0) 1–4000 changes/min	± 5.0 % P_{st}, P_{lt} IEC 61000-4-15, ed. 2	P_{st}, P_{lt} (0.2 – 10.0) 1–4000 changes/min
Flicker $P_{inst, max}$	8 % $P_{inst, max}$	$P_{inst, max}$ (0 – 4) sinus, right angle	8 % $P_{inst, max}$	$P_{inst, max}$ (0 – 10) sine, rectangular
Voltage phenomena	Amplitude: ± 0.5 % U_n Duration: ± 1 period	5 % U_n – 150 % U_n 0.02 s – 1.0 s [1]	Amplitude: ± 0.2 % U_n Duration: ± 1 period	5 % U_n – 200 % U_n 0.02 s – 1.0 s [1]
Interruption	Duration: ± 1 period	0.02 s – 1.0 s [1]	Duration: ± 1 period	0.02 s – 1.0 s [1]
Unbalance	± 0.2 %	1.0 % u_2 – 5 % u_2 1.0 % u_0 – 5 % u_0	± 0.15 %	0.5 % u_2 – 5 % u_2 0.5 % u_0 – 5 % u_0
Harmonic voltages	± 5 % U_{harm}, $U_{harm} \geq 3$ % U_n ± 0.15 % U_n, $U_{harm} < 3$ % U_n	10 % – 100 % cl. 3 IEC 61000-2-4	± 5 % U_{harm}, $U_{harm} \geq 1$ % U_n ± 0.05 % U_n, $U_{harm} < 1$ % U_n	10 % – 200 % cl. 3 IEC 61000-2-4
Inter-harmonic voltages	± 5 % U_{harm}, $U_{harm} \geq 3$ % U_n ± 0.15 % U_n, $U_{harm} < 3$ % U_n	10 % – 100 % cl. 3 IEC 61000-2-4	± 5 % U_{harm}, $U_{harm} \geq 1$ % U_n ± 0.05 % U_n, $U_{harm} < 1$ % U_n	10 % – 200 % cl. 3 IEC 61000-2-4
Signals in voltage	± 10 % U_{sig} for 3 % $U_n \leq U_{sig} \leq 15$ % U_n, ± 0.3 % U_n for 1 % $U_n \leq U_{sig} \leq 3$ % U_n	0 % U_n – 15 % U_n	± 5 % U_{sig} for 3 % $U_n \leq U_{sig} \leq 15$ % U_n, ± 0.15 % U_n for 1 % $U_n \leq U_{sig} \leq 3$ % U_n	0 % U_n – 15 % U_n
Rapid voltage changes – RVC, $U_{RMS1/2}$	Amplitude: ± 0.5 % U_n Duration: ± 1 period	Treshold 1.0 – 10 % U_n Hysteresis 50 % tresh.	Amplitude: ± 0.2 % U_n Duration: ± 1 period	Treshold 1.0 – 10 % U_n Hysteresis 50 % tresh.
Current	± 2 % $I_{measured}$	10% – 100 % I_{max}	± 1 % $I_{measured}$	10% – 100 % I_{max}
Time base	± 1 s per 24 h, ± 10 ms with GPS function	–	± 1 s per 24 h, ± 10 ms with GPS function	–

[1] With uninterruptible power supply, duration depends on the external power supply

Overview of evaluated quantities in recorder function

Quantity	Symbol	For each phase	For the three-phase terminal	Average/sum per interval [1)]	200 ms minimum in interval	200 ms maximum in interval
Effective voltage	U_{ef}	F, S		F, S	F	F
Voltage harmonics – 1st to 64th harmonic	$U_{1.h}$ to $U_{64.h}$	F, S		F, S		
Overall harmonic distortion of voltage	THD_U	F, S		F, S		
Effective current	I_{ef}	F, S		F, S		F
Current harmonics – 1st to 64th harmonic	$I_{1.h}$ to $I_{64.h}$	F, S		F, S		
Overall harmonic distortion of current	THD_I	F, S		F, S		
Power factor	$\cos\varphi$	F	F, S	F, S		
Power factor	PF	F	F, S	F, S		
Active power	P	F	F, S	F, S		
Reactive power	Q	F	F, S	F, S		
Apparent power	S	F	F, S	F, S		
Deformation power	D	F	F	F		
Unbalance power [2)]	N		F, S	F, S		

Quantity	Symbol	For each phase	For the three-phase terminal	Average/sum per interval [1)]	200 ms minimum in interval	200 ms maximum in interval
Active power (1st harmonic)	$P_{1.h}$	F	F, S	F, S		
Reactive power (1st harmonic)	$Q_{1.h}$	F	F, S	F, S		
Apparent power (1st harmonic)	$S_{1.h}$	F	F, S	F, S		
Unbalance power (1st harmonic)	$N_{1.h}$		F, S	F, S		
Active energy – consumption	EP+	F	F, S	F, S		
Active energy – supply	EP-	F	F, S	F, S		
Reactive inductive energy during active consumption	EQL/EP+	F	F, S	F, S		
Reactive capacitive energy during active consumption	EQC/EP+	F	F, S	F, S		
Reactive inductive energy during active supply	EQL/EP-	F	F, S	F, S		
Reactive capacitive energy during active supply	EQC/EP-	F	F, S	F, S		
Active energy – consumption (1st harmonic)	$EP+_{1.h}$	F	F, S	F, S		
Active energy – supply (1st harmonic)	$EP-_{1.h}$	F	F, S	F, S		
Reactive inductive energy during active consumption (1st harm)	$EQL/EP+_{1.h}$	F	F, S	F, S		
Reactive capacitive energy during active consumption (1st harm)	$EQC/EP+_{1.h}$	F	F, S	F, S		

Quantity	Symbol	For each phase	For the three-phase terminal	Average/sum per interval [1]	200 ms minimum in interval	200 ms maximum in interval
Reactive inductive energy during active supply (1st harm)	EQL/ $EP-_{1.h}$	F	F, S	F, S		
Reactive capacitive energy during active supply (1st harm)	EQC/ $EP-_{1.h}$	F	F, S	F, S		

[1] Record interval adjustable from 1 s to 15 minutes. Energy represented by total value per interval, other quantities are average values per interval.

[2] In the line-to-line voltage measuring mode, unbalance power also includes the effect of deformation.

F evaluated values during measurement of phase voltage

S evaluated values during measurement of line voltage

13/ LITERATURE

[1] User Description of PQ - MEg, www.e-mega.cz/DL

[2] User Description of MEgA Explorer, www.e-mega.cz/DL

[3] User Description of MEgA Merci Multi, www.e-mega cz/DL

[4] User Description of the MODBUS TCP of MEgA Instruments, www.e-mega.cz/DL

[5] User Description of the EN 60870-5-104 Protocol of Instruments Upon Request

[6] User description of WebDatOr2, on request

14/ MANUFACTURER

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AGSM AND AGPS ANTENNAS OF THE MEg45DIN UNIVERSAL MONITOR

Antennas	**AO-AKOM-36SS/MEgA**	**AO-ALTE-G214S/MEgA**
Use	GSM/UMTS/LTE/GPS	GSM/UMTS/LTE
Frequency bands MHz	800 / 900 / 1700 / 1800 1900 / 2100 / 2600 2700 /1757.42	700 / 800 / 900 / 1700 1800 / 1900 / 2100 / 2600
Gain	0 / 30 dBi	6 dBi
VSWR	< 2.0 : 1	< 3.0 : 1
Impedance	50 Ω	50 Ω
Direction	omnidirectional	omnidirectional
HPBW	H 360° V 30°	H 360° V 30°
Polarisation	linear / R.H.C.P.	vertical
Maximum output power	10 W	10 W
Supply voltage	2.7 - 5.5 V_{DC}	-
Dimensions	ø 54.4 × 24.6 mm	315 × ø 29.5 mm
Weight	165 g	55.99 g
Operating temperature	-30 °C to +90 °C	-40 °C to +85 °C
Design	PUCK	whip
Mounting method	installation	magnetic
Cable type	2 × RG174/U	R174/U
Cable length	2 × 3 m	3 m
Connector type	MMCX(m) / MMCX(m)	MMCX(m)
Overvoltage category	CAT IV 2.5 m	CAT IV
Safety class	II 2.5 m	II 2.5 m

Antennas	**AP-AGPS-36/MEgA**	**AP-A20C-M5RA/MEgA**
Use	GPS	GPS
Frequency bands MHz	1575.42	1575.24
Gain	30 dBi	32 dBi
VSWR	< 2.0 : 1	< 2.0 : 1
Impedance	50 Ω	50 Ω
Direction	omnidirectional	omnidirectional
HPBW	H 360° V 30°	H 360° V 30°
Polarization	R.H.C.P.	R.H.C.P.
Maximum output power	10 W	10 W
Supply voltage	2.7 - 5.0 V	2.7 - 5.0 V
Dimensions	ø 54.7 × 23 mm	38.5 × 34.5 × 12.3 mm
Weight	190 g	88.38 g
Operating temperature	-30 °C to +90 °C	-40 °C to +90 °C
Design	PUCK	external
Mounting method	installation	magnetic
Cable type	R174/U	R174/U
Cable length	10 m	5 m
Connector type	MMCX(m)	MMCX(m)
Overvoltage category	CAT IV 2.5 m	CAT IV 2.5 m
Safety class	II 2.5 m	II

CURRENT SENSORS OF THE MEg45DIN UNIVERSAL PQ MONITOR

Technical data of the MTPD.51 split-core current transformer [1)]

Rated primary current I_n [2)]:	400 A, 600 A, 1000 A
Rated secondary current:	1 A
Rated frequency:	50 Hz
Frequency range:	42.5 Hz to 69 Hz [3)]
Rated load:	2.5 VA
Rated load resistance:	2.5 Ω
Precision class:	0.5 % according to EN 61869-2
FS safety factor:	5
Rated short-term thermal current I_{tn}:	$10 \times I_n$
Rated dynamic current I_{dyn}:	$2.5 \times I_{tn}$
Operating temperature range:	-25 °C to +60 °C
Temperature range with non-destructive effects:	-40 °C to +70 °C
Insulation temperature class:	+120 °C
Maximum temperature of conductor with measured current:	+120 °C
Average relative humidity:	≤ 90 % RH, non-condensing
Ingress protection:	IP20
Impact protection:	IK08
Pollution degree:	2
Altitude:	up to 2000 m
Rated phase voltage of measured conductor:	$230\,V_{AC}$
Maximum phase voltage of measured conductor:	$300\,V_{AC}$
Measuring category:	CAT IV / 300 V
Impulse withstand voltage:	6 kV
Testing voltage:	5.4 kV / 5 s

Safety class:	II
Weight:	0.5 kg
Outer dimensions:	100 × 95 × 29 mm
Dimensions of transformer window:	52 × 33 mm

Supply cable (optional):

Maximum length of supply cable:	10.0 m
Supply cable diameter:	7.0 mm
Supply cable wire cross-section:	1.5 mm^2
Colour-coding of conductors:	S1(K) – brown, S2(L) – blue

Note: 1) Under the reference conditions: T ambient = 20 °C, humidity 40 to 60 % RH
2) A single value only
3) It shall not be used for currents with a rated frequency value outside the stated frequency range

The MTPD.51 transformer can only be installed in inaccessible areas due to its mechanical strength and high temperature.

Technical data of AMOS/1A flexible sensors

The flexible AMOS/1A sensor consists of an AMOSm sensor with the specified length of measuring loop with shielded cable and of a converter unit with the output voltage of 1 A.

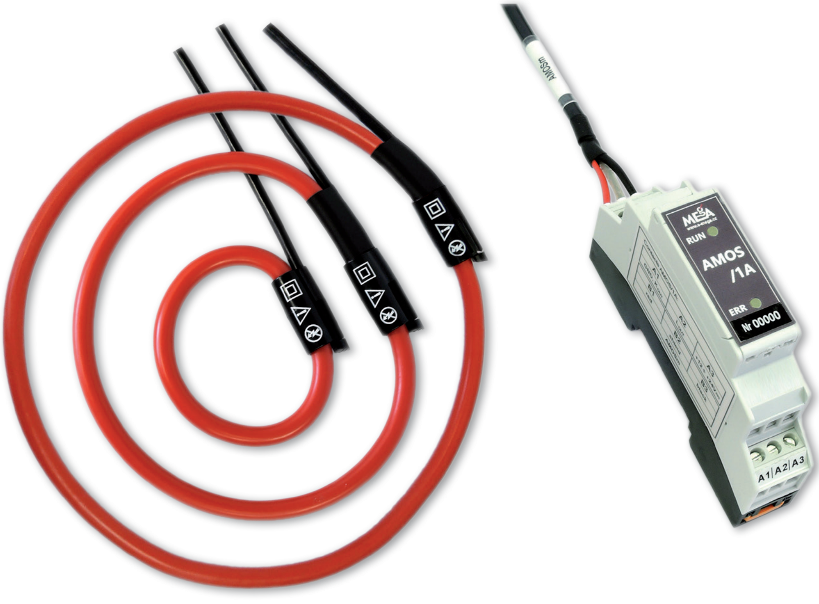
Rated input alternating current I_n [1) 2)]:	100 A, 160 A, 250 A
Rated output alternating current $I_{n\,OUT}$:	1 A
Measuring range:	max. 1.25 I_n
Load impedance range:	R_L = 0 to 2.5 Ω
Band width:	2.5 kHz at R_L = 1 Ω
Maximum rated load S_{max}:	2.5 VA
Load resistance R_L:	≤ 2.5 Ω, to the common terminal
Internal impedance of current output:	> 1 kΩ
Amplitude error:	≤ 0.5 % I_n for the range from 5 % to 120 % I_n
Phase error:	≤ 1 ° for the range from 5 % to 120 % I_n
Measuring section length – standard, long, short:	400 mm / 600 mm / 200 mm
Sensing part diameter:	8 mm
Diameter of inserted section of the closure:	10 mm
Permitted radius of bend of the sensing part:	≥ 20 mm
Supply cable length [3)]:	2 m
Supply cable diameter:	4.8 mm
Maximum alternating voltage of the measured conductor:	CAT IV/300 V … T III/600 V
Sensor safety class:	II, measuring … AMOS/1A III, c… MOS/1A
IP rating:	IP20
Converter unit dimensions:	90 × 6… 18
Converter unit installation:	DIN ra…
Operating temperature:	-20 °C to +…
DC supply voltage U_{supply}:	10 V_{DC} to …8 V

Consumption at I_n and $R_L = 2.5\,\Omega$:	≤ 5 W
Idle consumption:	70 mA at $U_N = 12$ V 50 mA at $U_N = 24$ V
Total efficiency at I_n and $R_L = 1.0\,\Omega$:	42 %
Total efficiency at I_n and $R_L = 2.5\,\Omega$:	60 %

The negative pole of the power supply is connected to the common terminal of the converter.

Note: [1] A single value only
[2] Possible rated value 30 A to 3 000 A
[3] A maximum of 5 m can be ordered

AMOS/1A flexible sensor with loop length short, standard and long.



Technical data of TORv and TORm toroids

	TORv	TORm
Rated input current I_n:	10 A, 50 A	1 A, 5 A
Output voltage [1]:	$225\,mV_{AC}$, $150\,mV_{AC}$, $22.5\,mV_{AC}$	
Measuring range:	5 % to 120 % I_n	
Measurement error at f = 50 Hz [2]:	0.5 % from the range	
Harmonic measurement uncertainty up to the order of 50: [2] [3] [4]	$\pm 5\,\%\,I_{harm}$ at $I_{harm} \geq 3\,\%\,I_n$ $\pm 0.15\,\%\,I_n$ at $I_{harm} < 3\,\%\,I_n$	$\pm 10\,\%\,I_{harm}$ at $I_{harm} \geq 3\,\%\,I_n$ $\pm 0.3\,\%\,I_n$ at $I_{harm} < 3\,\%\,I_n$
Measuring category:	CAT IV / 300 V	
Safety class:	II	
Ingress protection:	IP40	
Operating temperature:	-10 °C to +55 °C	
Temperature coefficient:	0.2 % / 10 K	
Relative humidity:	≤ 85 %	
Cable length:	2 m	
Dimensions:	40 × 15 × 55 (80) mm	30 × 16 × 45 (70) mm
Max. diameter of measured conductor:	15 mm	6 mm
Weight:	0.1 kg	0.1 kg

Note:
1) Only one of the values
2) In the range of 5 % I_n to 120 % I_n
3) Up to the order of 25 the maximum peak factor 2
4) Class 1 according to EN 61000-4-7, ed. 2

TORm toroid

TORm

CATIV/300V~

MEgA S/N 00000

TORv toroid

TORv

CATIV/300V~

MEgA S/N 00000

Technical data of LCT split-core current transformers

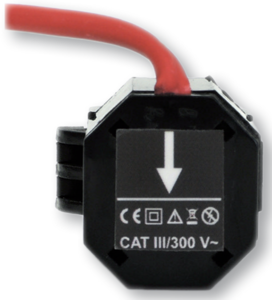
Rated primary current I_n[1]:	LCT-10	5 A, 20 A, 60 A, 75 A
	LCT-16	100 A, 120 A, 200 A
	LCT-24	100 A, 200 A, 400 A
	LCT-36	300 A, 400 A, 500 A, 600 A
Rated secondary voltage[1]:	225 mV, 150 mV, 22.5 mV	
Precision class:	0.5 according to EN 61689-2	
Rated frequency:	50 Hz	
Frequency range:	33 Hz to 1 kHz	
Rated load:	2 MΩ / 50 pF	
Operating temperature range:	-25 °C to +50 °C	
Storage temperature:	-30 °C to +70 °C	
Relative humidity:	≤ 85 % RH, non-condensing	
Operating position:	any	
Altitude:	up to 2,000 m	
Rated phase voltage:	230 V	
Maximum phase voltage:	300 V	
Measuring category:	CAT III / 300 V	
Supply cable length:	2 m ± 5 cm	
Designation of output conductors:	k, l	
Cable ties:	WT - 200MC, length 203 mm, width 2,5 mm	

	LCT-10	LCT-16	LCT-24	LCT-36
Weight [dkg]:	6	9	16	27
Outer dimensions, h × w × d [mm]:	41,5 × 27 × 30	46 × 32 × 42	67 × 47 × 42	82 × 62 × 46
Window dimensions [mm]:	10 × 10	16 × 16	24 × 24	36 × 36

Insulation tape SCOTCh 3M22 for installation on and near LV conductors.

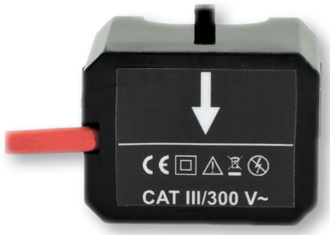
1) Only one of the values

LCT-10 split-core transformer, hole diameter 10 mm



LCT-16 split-core transformer, hole diameter 16 mm

LCT-24 split-core transformer, hole diameter 24 mm



LCT-36 split-core transformer, hole diameter 36 mm

Technical data of the loops of flexible sensors AMOSm / short, AMOSm / standard a AMOSm / long in a measuring set with the MEg45DIN universal PQ monitor

SW setting of the rated value.

Rated alternating current I_n

AMOSm/short:	30 A, 100 A, 300 A
AMOSm/standard:	30 A, 100 A, 300 A, 1000 A, 3000 A
AMOSm/long:	1000 A, 3000 A, 5000 A
Current measuring range:	5 % I_n to 120 % I_n
Frequency range:	40 Hz to 7.2 kHz
Current measuring uncertainty: [1]	
I_n = 30 A, 5000 A:	1.0 % M.V. ± 0.1 % I_n (45 Hz to 60 Hz)
I_n = 100 A, 300 A, 1000 A, 3000 A:	0.5 % M.V. ± 0.1 % I_n (45 Hz to 60 Hz)
Change of value with position:	± 1.0 % M.V.
Change of data due to external fields:	± 1.0 % M.V. ± 0.2 % I_n

(external field of a conductor with 0.3 I_n/50 Hz positioned 35 mm from the closure)

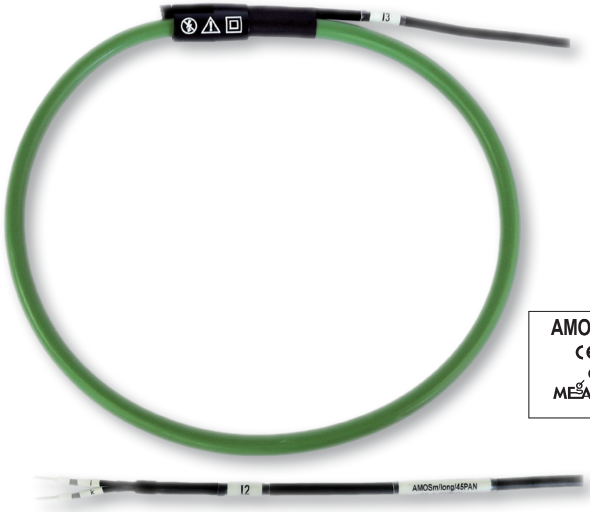
Harmonic measurement uncertainties up to the order of 50. [1), 2), 3)]

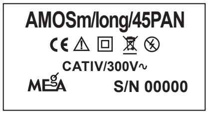
I_n = 100 A, 300 A, 1000 A:	± 5 % I_{harm} at 3 % $I_n \le I_{harm} \le$ 10 % I_n and ± 0.15 % I_n at $I_{harm} <$ 3 % I_n
I_n = 30 A a 3000 A:	± 10 % I_{harm} at 3 % $I_n \le I_{harm} \le$ 10 % I_n and ± 0.3 % I_n at $I_{harm} <$ 3 % I_n
Phase error, (45 Hz to 60 Hz): [1]	2,0 °
Working temperature:	-20 °C to + 55 °C
Temperature coefficient:	0.2 % I_n / 10 K
Relative humidity:	≤ 95 % RH
Ingress protection:	IP65
Measuring category:	CAT IV / 300 V
Safety class:	II
Loop length:	40 cm (standard), 60 cm (long), 20 cm (short)

Note: 1) In the range of 5 % I_n to 120 % I_n
2) Up to the order of 25, the maximum peak factor 2
3) Class 1 according to EN 61000-4-7, ed. 2
M.V. = measured value

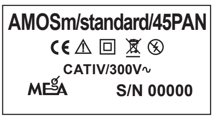
Loop diameter:	8 mm
Enclosure free end diameter:	10 mm
Permissible loop bending radius:	> 20 mm
Cable length:	2 m

Flexible sensor AMOSm/long (loop length 60 cm)

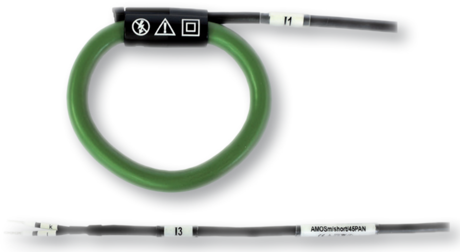


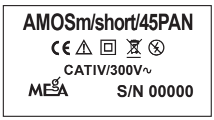


Flexible sensor AMOSm/standard (loop length 40 cm)



Flexible sensor AMOSm/short (loop length 20 cm)





Technical data of CAT IV / 300 V relay

Input circuit; terminals A1, A3

REL IV DC

Maximum and minimum control voltage:	$30\,V_{DC}$ / $10\,V_{DC}$				
Minimum withstand voltage:	$6\,V_{DC}$				
Control DC voltage [1]:	10 V	12 V	15 V	24 V	30 V
Control DC current :	55 mA	65 mA	60 mA	45 mA	40 mA

REL IV AC

Maximum and minimum control voltage:	$24\,V_{AC}$ / $10\,V_{AC}$		
Minimum withstand voltage:	$10\,V_{AC}$		
Control AC voltage:	10 V	12 V	15 V
Control alternating current:	55 mA	65 mA	60 mA

Output circuit; terminals B1, B2, B3

Contact configuration:	1 P, 1 CO (SPDT)
Switched current rated / maximum:	$6\,A_{ef}$ / $10\,A_{ef}$
Switched voltage rated / maximum:	$250\,V_{ef}$ / $300\,V_{ef}$
Rated load AC1 (resistance load):	1500 VA
Rated load AC15 (230 V, electromagnetic load):	300 VA
Rated load by singl… motor ($230\,V_{ef}$):	0.185 kW
Interrupting c… DC1 (resistar… 30 / 110 / 220 V_{ss}:	6…
Minimum int… load:	50…
Contact mate…	Ag/…

[1] The polarity of c… voltage does not matter.

General data

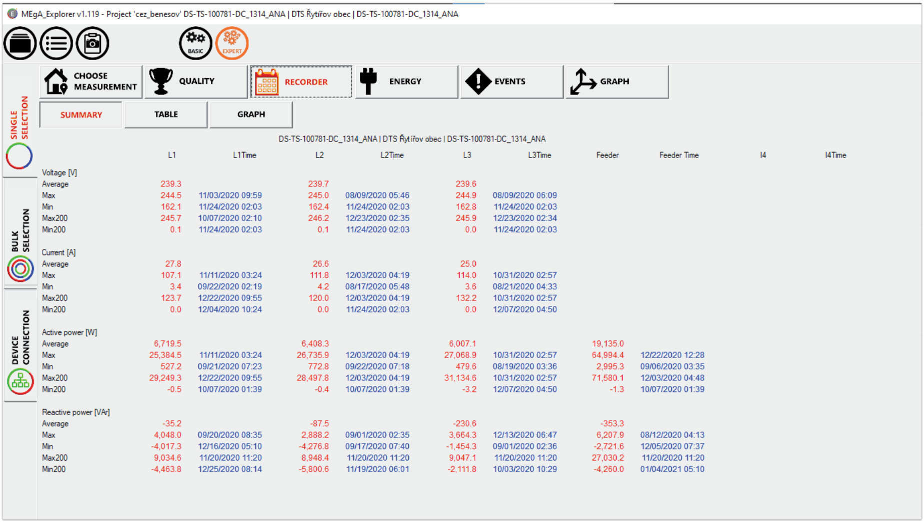
Dimensions:	90 × 60 × 18 mm
Relay installation:	TS35 DIN rail
Number of cycles:	$10 \cdot 10^6$
Switch on/opening time of REL IV DC:	8 ms / 5 ms
Switch on/opening time of REL IV AC:	10 ms / 15 ms
Consumption:	≤ 1.2 W
Overvoltage category (EN 61010-1, ed. 2):	CAT IV 300 V
Ingress protection:	IP20
Protection class	II, reinforced insulation
Operating temperature:	-20 °C to +70 °C
Altitude:	up to 2000 m
Weight:	70 g

ANNEX

Examples of the evaluation of data measured by the MEg45DIN program MEgA Explorer

Measuring function Záznamník (Recorder)

Average and extreme values with time data, voltage, currents, active and reactive power



	L1	L1Time	L2	L2Time	L3	L3Time	Feeder	Feeder Time	I4	I4Time
Voltage [V]										
Average	239.3		239.7		239.6					
Max	244.5	11/03/2020 09:59	245.0	08/09/2020 05:46	244.9	08/09/2020 06:09				
Min	162.1	11/24/2020 02:03	162.4	11/24/2020 02:03	162.8	11/24/2020 02:03				
Max200	245.7	10/07/2020 02:10	246.2	12/23/2020 02:35	245.9	12/23/2020 02:34				
Min200	0.1	11/24/2020 02:03	0.1	11/24/2020 02:03	0.0	11/24/2020 02:03				
Current [A]										
Average	27.8		26.6		25.0					
Max	107.1	11/11/2020 03:24	111.8	12/03/2020 04:19	114.0	10/31/2020 02:57				
Min	3.4	09/22/2020 02:19	4.2	08/17/2020 05:48	3.6	08/21/2020 04:33				
Max200	123.7	12/22/2020 09:55	120.0	12/03/2020 04:19	132.2	10/31/2020 02:57				
Min200	0.0	12/04/2020 10:24	0.0	11/24/2020 02:03	0.0	12/07/2020 04:50				
Active power [W]										
Average	6,719.5		6,408.3		6,007.1		19,135.0			
Max	25,384.5	11/11/2020 03:24	26,735.9	12/03/2020 04:19	27,068.9	10/31/2020 02:57	64,994.4	12/22/2020 12:28		
Min	527.2	09/21/2020 07:23	772.8	09/22/2020 07:18	479.6	08/19/2020 03:36	2,995.3	09/06/2020 03:35		
Max200	29,249.3	12/22/2020 09:55	28,497.8	12/03/2020 04:19	31,134.6	10/31/2020 02:57	71,580.1	12/03/2020 04:48		
Min200	-0.5	10/07/2020 01:39	-0.4	10/07/2020 01:39	-3.2	12/07/2020 04:50	-1.3	10/07/2020 01:39		
Reactive power [VAr]										
Average	-35.2		-87.5		-230.6		-353.3			
Max	4,048.0	09/20/2020 08:35	2,888.2	09/01/2020 02:35	3,664.3	12/13/2020 06:47	6,207.9	08/12/2020 04:13		
Min	-4,017.3	12/16/2020 05:10	-4,276.8	09/17/2020 07:40	-1,454.3	09/01/2020 02:36	-2,721.6	12/05/2020 07:37		
Max200	9,034.6	11/20/2020 11:20	8,948.4	11/20/2020 11:20	9,047.1	11/20/2020 11:20	27,030.2	11/20/2020 11:20		
Min200	-4,463.8	12/25/2020 08:14	-5,800.6	11/19/2020 06:01	-2,111.8	10/03/2020 10:29	-4,260.0	01/04/2021 05:10		

Time course of average, minimum and maximum voltage, average and maximum currents

Measuring function Napěťové jevy (Voltage phenomena)

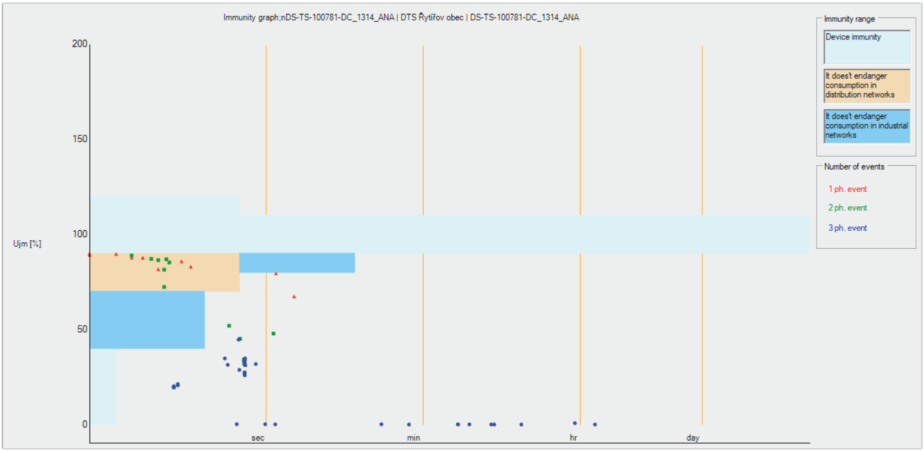
Standard parameters of voltage phenomena

Id	Event beginning	Duration	U1 max/min [%]	U2 max/min [%]	U3 max/min [%]
1	09/09/2020 06:25:42,941 PM	00:00,080	91.97/85.18	93.64/86.67	104.00/101.35
2	09/11/2020 06:37:58,146 AM	00:00,070	101.87/98.58	91.29/81.43	92.24/83.48
3	09/18/2020 12:33:50,450 PM	00:00,030	89.61/88.90	92.07/89.75	102.02/100.39
4	09/30/2020 02:40:15,596 AM	00:00,060	90.01/86.43	101.56/98.86	92.56/88.54
5	10/07/2020 01:38:57,582 PM	52:07,418	100.00/0.72	100.00/0.75	78.41/0.77
6	10/12/2020 10:17:19,957 AM	00:00,074	102.70/100.57	93.26/86.87	91.35/86.97
7	10/14/2020 12:03:06,376 PM	06:21,624	100.00/0.01	100.00/0.00	86.36/0.00
8	10/14/2020 12:09:33,219 PM	00:00,140	91.97/82.99	97.95/94.57	97.82/94.39
9	10/14/2020 12:12:00,523 PM	00:00,110	95.76/90.99	91.68/85.84	97.56/92.44
10	10/21/2020 07:22:28,620 AM	00:41,380	100.00/0.00	100.00/0.00	88.70/0.01
11	10/31/2020 10:28:08,802 AM	00:00,340	101.48/56.29	97.30/34.74	90.21/58.91
12	10/31/2020 10:28:13,691 AM	00:00,573	98.15/35.27	97.05/34.14	104.72/34.88
13	10/31/2020 10:28:35,710 AM	00:00,569	97.77/88.42	69.17/33.30	102.09/93.09
14	11/01/2020 08:27:55,245 AM	00:01,209	102.83/95.77	95.27/83.69	88.94/47.88
15	11/01/2020 08:28:17,312 AM	00:01,290	88.37/79.47	107.35/103.82	97.99/93.44
16	11/01/2020 08:31:49,328 AM	00:02,070	89.10/67.40	106.19/101.03	96.57/90.30

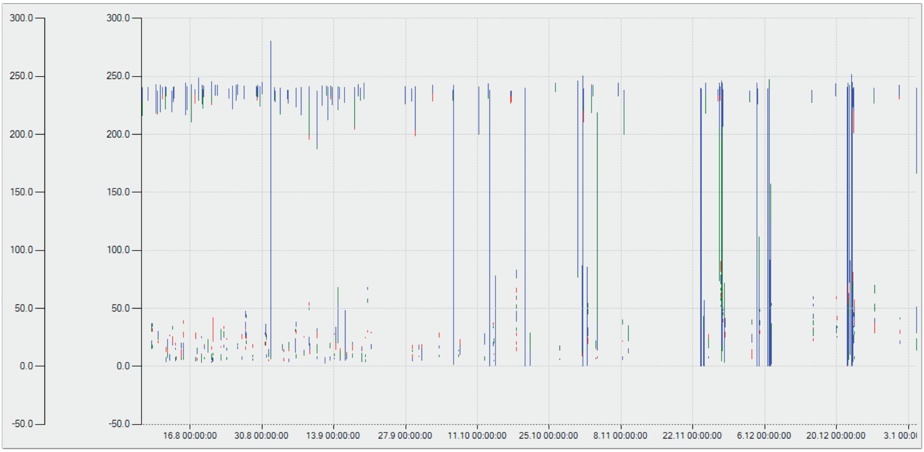
Contingency table of voltage drops

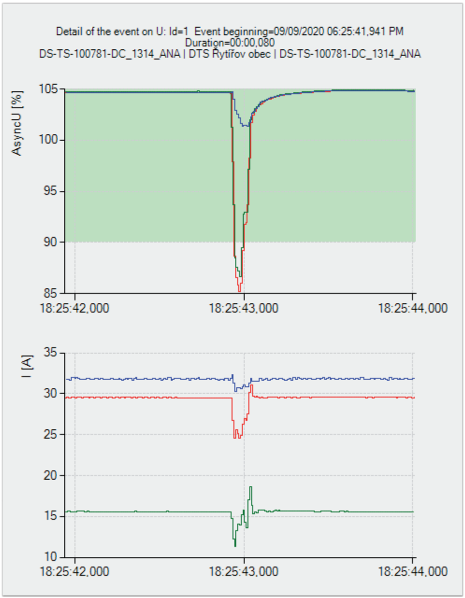
Ujm[%] / t[ms]	10<t <=200	200<t <=500	500<t <=1000	1000<t <=5000	5000<t <=60000
90 > U >= 80	7	0	0	0	0
80 > U >= 70	0	0	0	0	0
70 > U >= 40	0	0	0	0	0
40 > U >= 5	0	0	0	0	0
5 > U >= 0	0	0	0	0	0

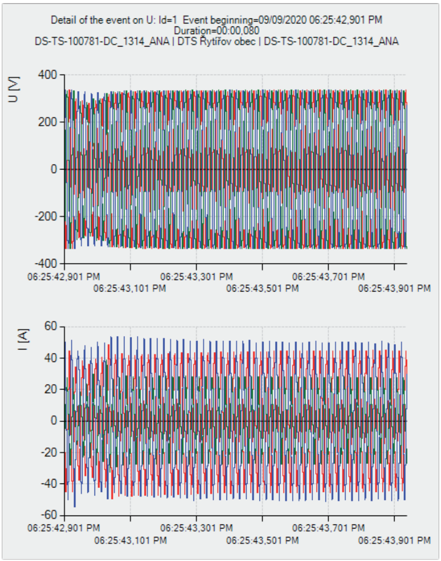
Graph of the appliance resistance against voltage phenomena

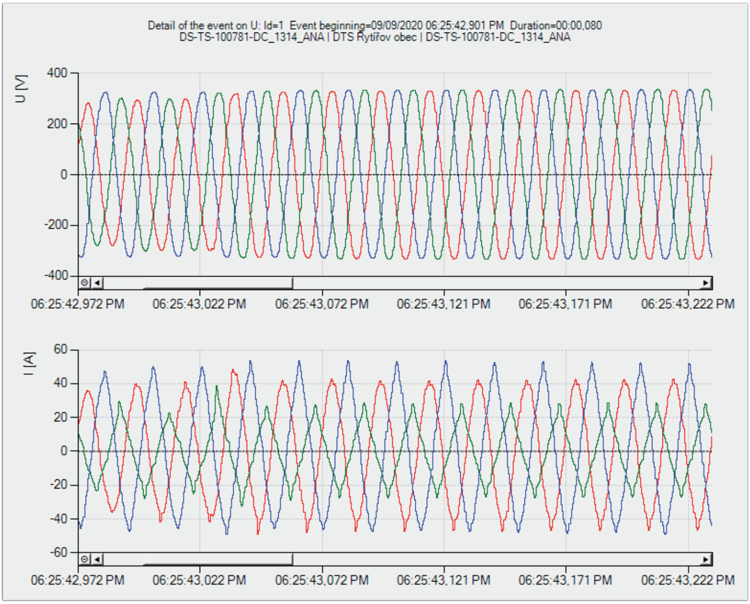


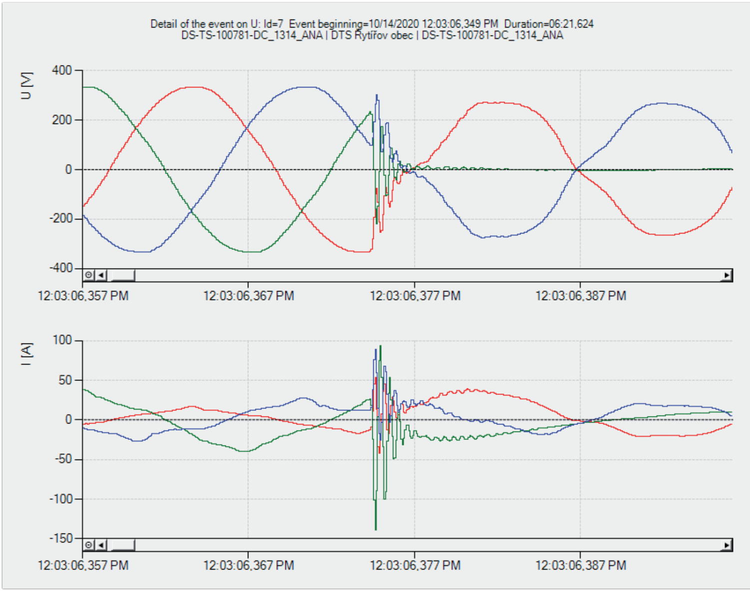
Record of phenomena, example of RMS1/2 courses and oscillographic records of phase voltages and currents








Detail of the event on U: Id=1 Event beginning=09/09/2020 06:25:42,901 PM Duration=00:00,080
DS-TS-100781-DC_1314_ANA | DTS Rytířov obec | DS-TS-100781-DC_1314_ANA
U [V]
400
200
0
-200
-400
06:25:42,972 PM
06:25:43,022 PM
06:25:43,072 PM
06:25:43,121 PM
06:25:43,171 PM
06:25:43,222 PM
I [A]
60
40
20
0
-20
-40
-60

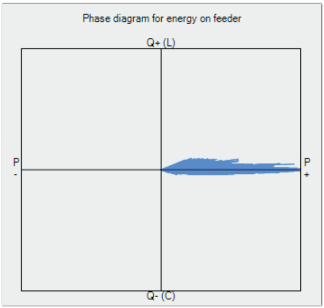

Detail of the event on U: Id=7 Event beginning=10/14/2020 12:03:06,349 PM Duration=06:21,624
DS-TS-100781-DC_1314_ANA | DTS Rytířov obec | DS-TS-100781-DC_1314_ANA
U [V]
400
200
0
-200
-400
12:03:06,357 PM
12:03:06,367 PM
12:03:06,377 PM
12:03:06,387 PM
I [A]
100
50
0
-50
-100
-150

Measuring function Elektroměr (Electric meter)

Total energy of three phases and individual phases with a phasor diagram

08/06/2020 01:10:00,000 PM - 01/08/2021 12:14:00,000 AM

	Feeder	L1	L2	L3
EP+ [kWh]	70,304.585	24,688.012	23,547.219	22,069.355
EP- [kWh]	0.000	0.000	0.000	0.000
EQC_EP+ [kVArh]	2,542.071	650.420	818.816	1,072.831
EQL_EP+ [kVArh]	1,242.766	520.565	496.679	225.522
EQC_EP- [kVArh]	0.000	0.000	0.000	0.000
EQL_EP- [kVArh]	0.000	0.000	0.000	0.000



Quarter-hour, hourly, daily, weekly and monthly table of phase active energy

Datum	EP+ L1 [kWh]	EP+ L2 [kWh]	EP+ L3 [kWh]
08/06/2020 02:10:00 PM-08/06/2020 02:15:00 PM	0.5	0.3	0.4
08/06/2020 02:15:00 PM-08/06/2020 02:30:00 PM	1.5	0.7	1.6
08/06/2020 02:30:00 PM-08/06/2020 02:45:00 PM	2.4	0.5	1.3
08/06/2020 02:45:00 PM-08/06/2020 03:00:00 PM	2.1	1.0	1.6
08/06/2020 03:00:00 PM-08/06/2020 03:15:00 PM	2.7	1.4	1.1
08/06/2020 03:15:00 PM-08/06/2020 03:30:00 PM	2.5	0.9	1.1
08/06/2020 03:30:00 PM-08/06/2020 03:45:00 PM	2.9	0.7	1.3
08/06/2020 03:45:00 PM-08/06/2020 04:00:00 PM	2.6	0.6	1.5
08/06/2020 04:00:00 PM-08/06/2020 04:15:00 PM	2.2	0.5	1.0
08/06/2020 04:15:00 PM-08/06/2020 04:30:00 PM	2.3	0.7	1.0
08/06/2020 04:30:00 PM-08/06/2020 04:45:00 PM	3.4	0.6	1.3
08/06/2020 04:45:00 PM-08/06/2020 05:00:00 PM	2.4	0.9	1.9
08/06/2020 05:00:00 PM-08/06/2020 05:15:00 PM	1.1	1.2	1.2
08/06/2020 05:15:00 PM-08/06/2020 05:30:00 PM	1.1	1.3	0.9
08/06/2020 05:30:00 PM-08/06/2020 05:45:00 PM	1.5	0.9	0.8
08/06/2020 05:45:00 PM-08/06/2020 06:00:00 PM	2.0	1.5	0.6
08/06/2020 06:00:00 PM-08/06/2020 06:15:00 PM	1.5	1.2	1.1
08/06/2020 06:15:00 PM-08/06/2020 06:30:00 PM	1.2	1.3	1.0
08/06/2020 06:30:00 PM-08/06/2020 06:45:00 PM	1.5	1.1	1.1

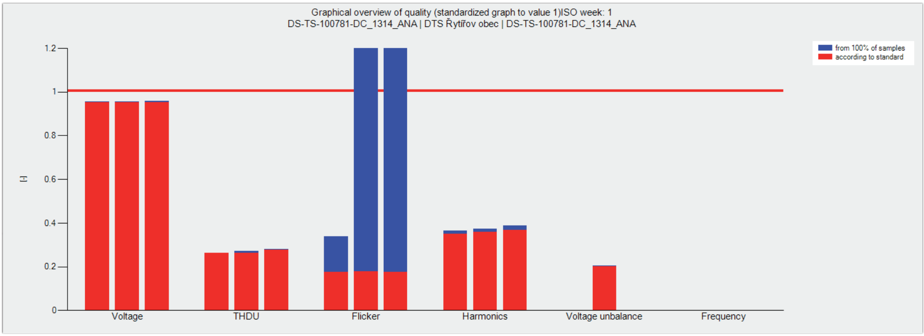
Datum	EP+ L1 [kWh]	EP+ L2 [kWh]	EP+ L3 [kWh]
08/06/2020 02:10:00 PM-08/06/2020 03:00:00 PM	6.4	2.4	4.9
08/06/2020 03:00:00 PM-08/06/2020 04:00:00 PM	10.7	3.6	4.9
08/06/2020 04:00:00 PM-08/06/2020 05:00:00 PM	10.2	2.7	5.2
08/06/2020 05:00:00 PM-08/06/2020 06:00:00 PM	5.7	5.0	3.4
08/06/2020 06:00:00 PM-08/06/2020 07:00:00 PM	5.3	4.3	4.9
08/06/2020 07:00:00 PM-08/06/2020 08:00:00 PM	5.2	3.5	6.2
08/06/2020 08:00:00 PM-08/06/2020 09:00:00 PM	6.1	4.6	6.0
08/06/2020 09:00:00 PM-08/06/2020 10:00:00 PM	6.7	4.3	5.2
08/06/2020 10:00:00 PM-08/06/2020 11:00:00 PM	5.6	3.5	4.3
08/06/2020 11:00:00 PM-08/07/2020 12:00:00 AM	3.6	5.4	4.4
08/07/2020 12:00:00 AM-08/07/2020 01:00:00 AM	7.0	3.4	3.1
08/07/2020 01:00:00 AM-08/07/2020 02:00:00 AM	7.7	1.6	1.7
08/07/2020 02:00:00 AM-08/07/2020 03:00:00 AM	4.7	1.6	1.8
08/07/2020 03:00:00 AM-08/07/2020 04:00:00 AM	3.5	1.9	1.3
08/07/2020 04:00:00 AM-08/07/2020 05:00:00 AM	3.2	1.7	1.4
08/07/2020 05:00:00 AM-08/07/2020 06:00:00 AM	3.3	1.9	1.7
08/07/2020 06:00:00 AM-08/07/2020 07:00:00 AM	3.8	3.7	2.5
08/07/2020 07:00:00 AM-08/07/2020 08:00:00 AM	2.5	2.3	2.3
08/07/2020 08:00:00 AM-08/07/2020 09:00:00 AM	2.6	3.4	3.7

Datum	EP+ L1 [kWh]	EP+ L2 [kWh]	EP+ L3 [kWh]
08/06/2020 02:10:00 PM-08/07/2020 12:00:00 AM	65.5	39.3	49.4
08/07/2020 12:00:00 AM-08/08/2020 12:00:00 AM	100.1	89.4	99.2
08/08/2020 12:00:00 AM-08/09/2020 12:00:00 AM	109.3	91.2	121.6
08/09/2020 12:00:00 AM-08/10/2020 12:00:00 AM	118.3	94.1	116.0
08/10/2020 12:00:00 AM-08/11/2020 12:00:00 AM	89.3	72.7	88.1
08/11/2020 12:00:00 AM-08/12/2020 12:00:00 AM	90.3	78.1	73.6
08/12/2020 12:00:00 AM-08/13/2020 12:00:00 AM	110.1	83.4	96.0
08/13/2020 12:00:00 AM-08/14/2020 12:00:00 AM	96.7	75.8	75.4
08/14/2020 12:00:00 AM-08/15/2020 12:00:00 AM	103.6	79.2	100.7
08/15/2020 12:00:00 AM-08/16/2020 12:00:00 AM	129.9	111.5	89.6
08/16/2020 12:00:00 AM-08/17/2020 12:00:00 AM	114.2	94.1	102.5
08/17/2020 12:00:00 AM-08/18/2020 12:00:00 AM	88.7	80.7	85.4
08/18/2020 12:00:00 AM-08/19/2020 12:00:00 AM	91.5	73.7	83.4
08/19/2020 12:00:00 AM-08/20/2020 12:00:00 AM	91.8	87.9	76.4
08/20/2020 12:00:00 AM-08/21/2020 12:00:00 AM	94.2	76.9	68.8
08/21/2020 12:00:00 AM-08/22/2020 12:00:00 AM	108.7	98.8	98.2
08/22/2020 12:00:00 AM-08/23/2020 12:00:00 AM	127.7	103.6	125.1
08/23/2020 12:00:00 AM-08/24/2020 12:00:00 AM	114.3	97.8	121.4
08/24/2020 12:00:00 AM-08/25/2020 12:00:00 AM	105.9	97.4	111.0

Datum	EP+ L1 [kWh]	EP+ L2 [kWh]	EP+ L3 [kWh]
08/06/2020 02:10:00 PM-08/09/2020 12:00:00 AM	275.0	219.9	270.1
08/09/2020 12:00:00 AM-08/16/2020 12:00:00 AM	738.1	594.8	639.4
08/16/2020 12:00:00 AM-08/23/2020 12:00:00 AM	716.9	615.9	639.8
08/23/2020 12:00:00 AM-08/30/2020 12:00:00 AM	818.7	683.5	798.7
08/30/2020 12:00:00 AM-09/06/2020 12:00:00 AM	744.4	687.6	656.6
09/06/2020 12:00:00 AM-09/13/2020 12:00:00 AM	749.7	670.6	645.1
09/13/2020 12:00:00 AM-09/20/2020 12:00:00 AM	716.5	647.7	687.1
09/20/2020 12:00:00 AM-09/27/2020 12:00:00 AM	837.4	755.1	790.2
09/27/2020 12:00:00 AM-10/04/2020 12:00:00 AM	966.7	928.0	712.8
10/04/2020 12:00:00 AM-10/11/2020 12:00:00 AM	1,008.7	900.7	824.9
10/11/2020 12:00:00 AM-10/18/2020 12:00:00 AM	1,108.1	1,083.0	1,060.8
10/18/2020 12:00:00 AM-10/25/2020 12:00:00 AM	1,251.1	1,090.9	1,094.5
10/25/2020 12:00:00 AM-11/01/2020 12:00:00 AM	1,136.3	1,100.6	1,111.5
11/01/2020 12:00:00 AM-11/08/2020 12:00:00 AM	1,256.2	1,096.3	1,137.2
11/08/2020 12:00:00 AM-11/15/2020 12:00:00 AM	1,336.4	1,246.6	1,197.9
11/15/2020 12:00:00 AM-11/22/2020 12:00:00 AM	1,381.6	1,221.6	1,213.2
11/22/2020 12:00:00 AM-11/29/2020 12:00:00 AM	1,493.1	1,663.1	1,371.4
11/29/2020 12:00:00 AM-12/06/2020 12:00:00 AM	1,459.3	1,638.7	1,280.5
12/06/2020 12:00:00 AM-12/13/2020 12:00:00 AM	1,406.4	1,388.9	1,189.2

Measuring function Kvalita napětí (Voltage quality), selected examples

Graphic overview of continuous voltage quality parameters throughout the entire period of measurement



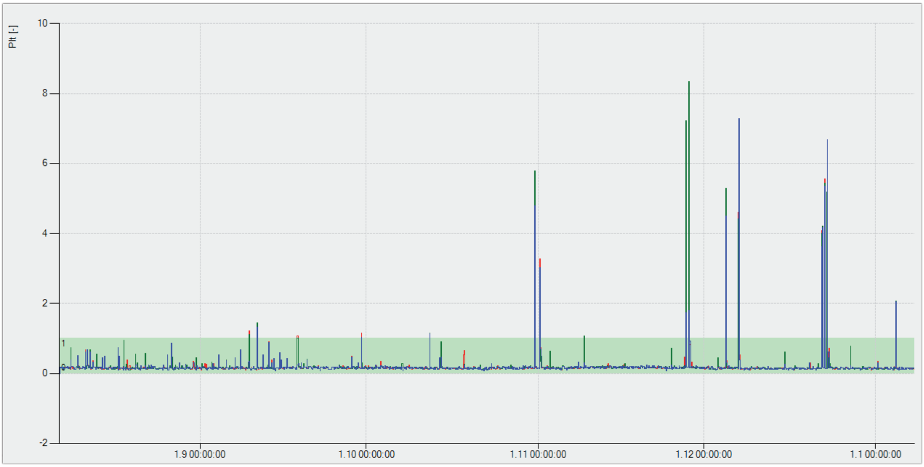
Weekly evaluation of voltage quality

1. quarter													
2. quarter													
3. quarter						32	33	34	35	36	37	38	39
4. quarter	40	41	42	43	44	45	46	47	48	49	50	51	52
53. week	53												

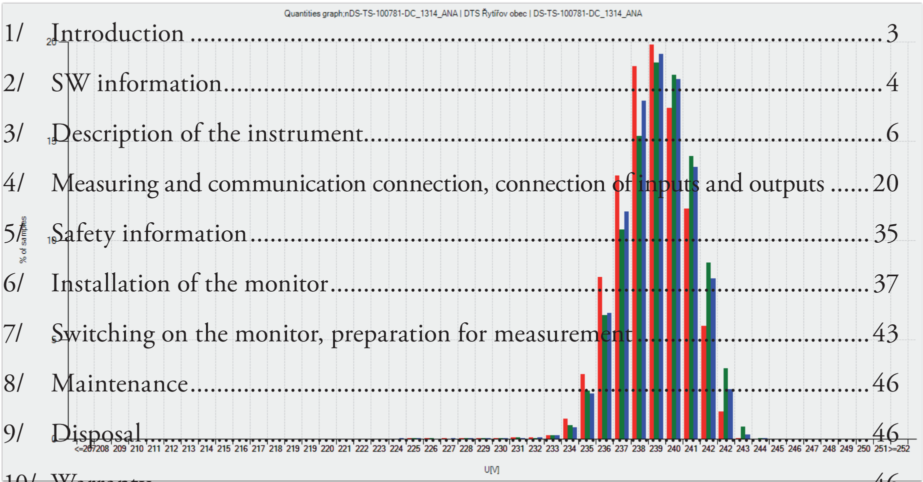
Values are in the form A - B / C (A - minimal value from 95% samples, B - maximal value from 95% samples, C - compliant samples in % from all samples)

Sense of background color:
green - complete count of samples, quality compliant
orange - incomplete count of samples, quality compliant
red - quality not compliant

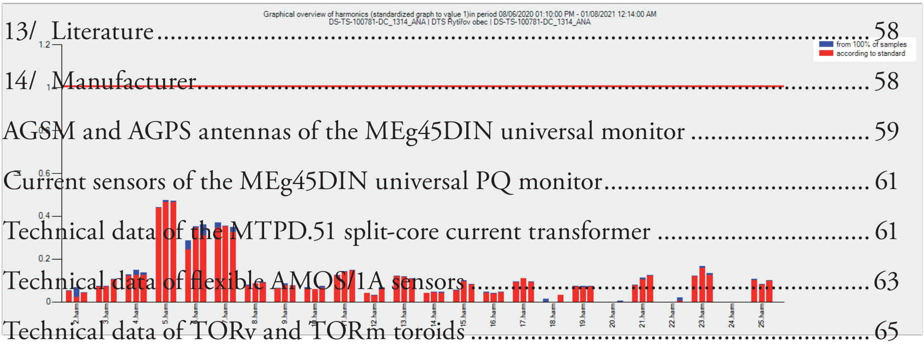
Courses of phase voltage quality Plt flickers



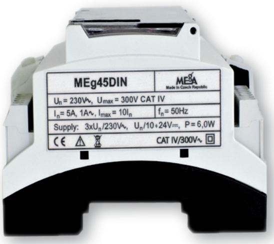
CONTENTS OF THE MANUAL

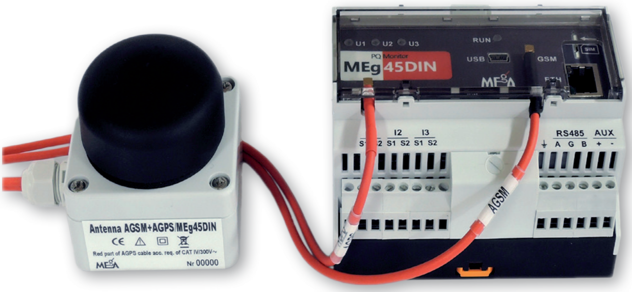


Standardized spectrum of harmonic phase voltages



Universal PQ Monitor
MEg45DIN
User manual





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