

# SMZ 133

## Multifunctional Panel Meter

### *Operating Manual*

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		hardware	bootloader	firmware	ENVIS
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# 1. General

## Measurement & Evaluation

- three measurement voltage inputs, star / delta / Aron connection
- three measurement current inputs for CTs nominal secondary output of 5/1 A or 0.1 A
- sampling rate 128/96 samples/period, 10/12 periods evaluation cycle (200 ms at 50/60 Hz)
- continuous ( gap-less) measurement of voltage and current
- evaluation of harmonic components up to 50<sup>th</sup>
- fixed window / floating window / thermal average values of all evaluated quantities with minimum & maximum values registration
- built-in electricity meter :
  - three tariff electricity meter with four-quadrant counters for both active and reactive energies
  - single phase and three phase energies
  - maximum of average active power value ( power demand )
- built-in thermometer

## Communication

- USB 2.0 communication port for fast data acquisition, configuration and firmware upgrades
- optional remote communication interface ( RS 485 / Ethernet )
- proprietary protocol with free data acquisition software ENVIS
- MODBUS RTU and MODBUS TCP protocols for simple integration with third party SCADA software
- embedded webserver ( for instruments with Ethernet interface )

## Datalogging Capabilities

- battery backed real time circuit (RTC)
- selection of aggregation intervals from 0.2 second up to 24 hours
- high memory capacity for programmable recording of aggregated measurement values
- automated electricity meter readings at preselected time intervals

## Inputs & Outputs ( Selected Models Only )

- 1 x 100 ÷ 250 V<sub>AC</sub> digital input
- 4 x 250 V<sub>AC</sub> digital outputs (relays)
- 4 x 12 ÷ 24 V<sub>DC</sub> digital inputs
- 4 x 12 ÷ 24 V<sub>DC</sub> digital outputs (solid state)
- 2 x 0 ÷ 10 V<sub>DC</sub> / 0 ÷ 20 mA<sub>DC</sub> analog inputs
- 2 x 0 ÷ 20 mA<sub>DC</sub> analog outputs
- 1 x Pt100 temperature sensor input (optional)

## Design

- 144x144 mm plastic box for panel mounting
- LCD graphic display, 5 keys

## 2. Installation

### 2.1 Meaning of the symbols used on instrument



Warning – read operating manual !



AC – alternating voltage



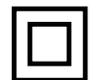
DC – direct voltage



CE marking guarantees compliance with the European directives and regulations



The instrument must not be disposed of in the normal unsorted municipal waste stream

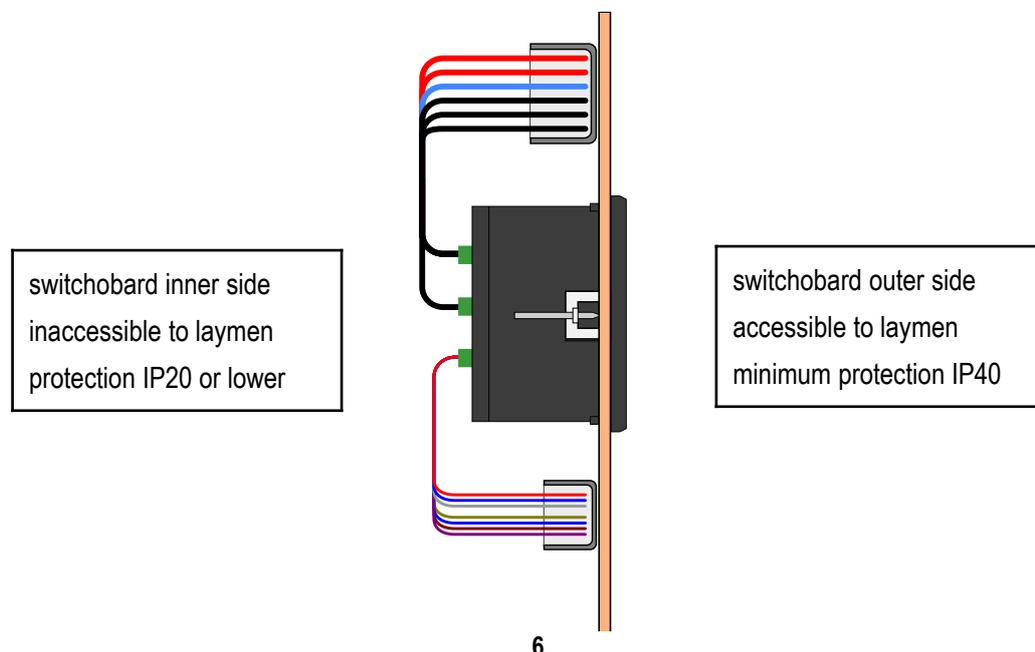


Double or reinforced insulation instrument

### 2.2 Physical

The instrument is built in a plastic box to be installed in a distribution board panel. As a rule, the panel is a part of a switchboard door - then the installation must be such that the switchboard door can be closed under all conditions of use. In any case, it must be ensured that only the front panel of the instrument is accessible to laypersons. Therefore, if the switchgear is located in an area accessible to laypersons, the switchgear door or panel must only be opened by means of a tool, or the door must be locked.

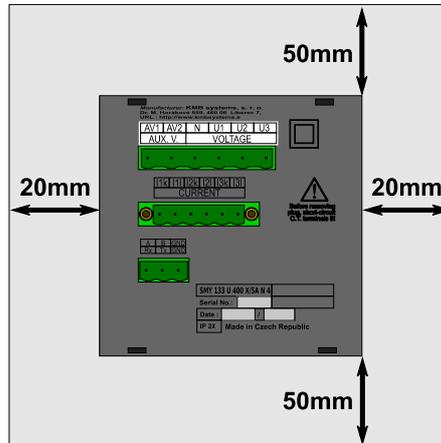
*Fig. 2.1a : Panel Mounting*



The instrument's position must be fixed with locks.

Natural air circulation should be provided inside the distribution board cabinet and in the instrument's neighbourhood no other instrumentation should be installed.

Fig. 2.1b : Space around the Instrument



Especially underneath the instrument, no other instrumentation that is source of heat should be installed or the temperature value measured may be false.

## 2.3 Instrument Connection

### 2.3.1 Power Supply

The instrument requires an AC or DC voltage power supply as specified in technical parameters. The supply inputs are separated from other circuits of the instrument.

It is necessary to connect an auxiliary supply voltage in the range as declared in technical specifications table to the terminals **AV1** ( No. 9, L ) and **AV2** ( No.10, N ). In case of DC supply voltage the polarity of connection is generally free, but for maximum electromagnetic compatibility the grounded pole should be connected to the terminal **AV2**.

The supply voltage must be connected via a disconnecting device ( switch - see installation diagram ). It must be situated directly at the instrument and must be easily accessible by the operator. The disconnecting device must be labelled as the disconnecting device of the equipment. A two-pole circuit breaker with the C-type tripping characteristics rated at 1A makes a suitable disconnecting device; however its function and position must be clearly marked (symbols „O" and „I" according to EN 61010 – 1). If one of the supply signals is neutral wire N (or PEN) usually a single breaker in the line branch is sufficient. If a switch and fuse is used, the T1A (delayed) type is recommended.

Recommended wire type : H07V-U (CY)

Recommended minimum conductor cross-section : 1.5 mm<sup>2</sup>

Maximum conductor cross-section : 2.5 mm<sup>2</sup>

### 2.3.2 Measured Voltages

Connect measured voltages in wye ( star ), delta or Aron configuration to terminals **VOLTAGE / N** (No. 11), **U1** (No. 12), **U2** (No. 13), and **U3** (No. 14). The **N** terminal stays free at delta and Aron connections.

Phase rotating direction is free.

Types of connections are stated in the following table.

Tab. 2.1: Connection of the measured voltages – VOLTAGE group of terminals

Terminal VOLTAGE	Type of connection		
	wye-star (Y)	delta (D)	Aron (A)
U <sub>1</sub>	L1-phase voltage	L1-phase voltage	L1-phase voltage
U <sub>2</sub>	L2-phase voltage	L2-phase voltage	L2-phase voltage
U <sub>3</sub>	L3-phase voltage	L3-phase voltage	L3-phase voltage
U <sub>N</sub>	neutral wire voltage	-	-

It is advisable to protect the supply leads by 1A safety fuses (F1A type, for example).

The type of voltage and currents connection must be entered in *Installation* parameters : the code shows the amount of connected phases, **3Y** means three-phase connection in wye ( star ), **3D** in delta. **3A** means Aron connection. For setup **1Y** the instrument measures phase L1 only and 3-phase values are simulated.

In the case of indirect connection via the measuring voltage transformers, it is necessary to enter this matter ( connection **Mode** ) and the values of the VT ratios during the setup of the instrument.

Recommended wire type : H07V-U (CY)

Recommended minimum conductor cross-section : 1.5 mm<sup>2</sup>

Maximum conductor cross-section : 2.5 mm<sup>2</sup>

## 2.3.3 Measured Currents

The instruments are designed for indirect current measurement via external CTs only. Proper current signal polarity (S1 & S2 terminals) must be observed. You can check the polarity by the sign of phase active powers on the instrument display (in case of energy transfer direction is known, of course).

The CT-ratio must be set. in *the Installation* group of parameters (see below).

The I2 terminals stay free in case of the Aron (A) connection.



*To get better precision when using overweighted CTs, you can apply more windings of measured wire through the transformer. Then you must set the multiplier parameter (see below). For standard connection with 1 winding, the multiplier must be set to 1.*

The current signals from 5A or 1A (or 0.1A for the „X/100mA“ models) instrument current transformers must be connected to the **CURRENT** connector terminal pairs **I11 – I12, I21 – I22, I31 – I32** (No. 1÷6).

A particular connector is provided with a screw lock to prevent an accidental pullout and possible unwanted disconnection of the current circuit.

Recommended wire type: H05V-U (CY)

Recommended minimum conductor cross-section :

- “X/5A” instruments : 2.5 mm<sup>2</sup>
- “X/100mA” instruments : 0.75 mm<sup>2</sup>

Maximum conductor cross-section : 2.5 mm<sup>2</sup>

## 3. Commissioning

### 3.1 Setup

When switching on the power supply, the instrument will display manufacturer's logo for short time and after that, one of actual data screen - for example the line-to-neutral voltages one - is displayed :



At this moment it is necessary to set *instrument parameters* that are essential for proper instrument measurement (so called *Installation* group) :

- mode of connection ( direct measuring or via metering voltage transformers )
- type of connection ( star, delta, Aron )
- ratio of Cts, VTs and their multipliers (if used)
- nominal voltage  $U_{NOM}$  and nominal frequency  $f_{NOM}$
- $I_{NOM}$ ,  $P_{NOM}$  (not mandatory, but recommended)

#### 3.1.1 Measured Electrical Quantities Installation Setup



For the proper data evaluation it is necessary to set all of the *Installation Setting* group parameters.

- **Connection Mode** determines if voltage signals are connected directly or if voltage transformers are used.
- **Connection Type** needs to be set according network configuration – wye (or star, **Y**) or delta (**D**, if neutral voltage potential not connected). Usually, all of three phases are connected so choose **3-Y** or **3-D**. For Aron connection set **3-A**. For single-phase connection, set **1-Y**.
- **CT-ratios** must be specified, in case of “**via VT**” connection mode **VT-ratios** too.  
The VT-ratios must be set in form *Nominal primary voltage / Nominal secondary voltage* . For higher primary voltage values *the U-multiplier* must be used too.  
CT ratios can be set in form either .../ 5A or .../ 1A.
- **I- and U-Multiplier** - You can modify the CT- / VT-ratio with this parameter. For example, to get better precision when using overweighted CTs, you can apply more windings of measured wire through the transformer. Then you must set the multiplier. For example, for 2 windings applied, set the multiplier to  $1/2 = 0.5$  .  
For standard connection with 1 winding, the multiplier must be set to 1.
- **Nominal Frequency  $f_{NOM}$**  - the parameter must be set in compliance with the measurement network nominal frequency to either 50 or 60 Hz, optionally to „DC-500“ (= *Fixscan* mode).
- **Nominal Voltage  $U_{NOM}$ , Nominal Current  $I_{NOM}$ , Nominal Power  $P_{NOM}$**  - For the presentation of quantities in percent of nominal value, alarms operation, voltage events detection and other functions it is necessary to enter also the nominal ( primary ) voltage  $U_{NOM}$ , nominal current  $I_{NOM}$  and nominal apparent three-phase power (input power) of the connected load

$P_{NOM}$  ( in units of kVA ) Although the correct setup has no effect on measuring operation of the instrument, it is strongly recommended to set at least the  $U_{NOM}$  correctly.

Correct setting of the  $I_{NOM}$  and the  $P_{NOM}$  is not critical, it influences percentage representation of powers and currents and statistical processing of measuring in the software only. If measured network node rating is not defined, we recommend to set their values, for example, to the nominal power of source transformer or to the maximum supposed power estimated according current transformers ratio, etc.

The  $U_{NOM}$  is displayed in form of phase/line voltage.

### 3.1.1.1 Setup Example

Following example explains how to adjust the CT ratio :

Assuming that the conversion of used CT for inputs of current L1 to L3 is 750/5 A. To edit the parameters, press the **MENU** button, navigate to the **Menu-Settings** with the buttons **▶** and **◀** and then choose it with the **✓** button. In the **Setting** window choose **Setting-Installation** option. The **Setting-Installation** window appears :



In the window navigate down to the current transformer ratio parameter ( CT ) and choose with the **✓** button.



Now you can type new value of the parameter : with the **▶** button you can move from a digit to another one and to set each digit to target value using the **▲** and **▼** buttons. At the end press the **✓** button and the parameter is set.

You can set other parameters in the same way.

After all of the parameters correctly set, return back to the power factor control screen with the **⏪** (escape) button and confirm saving of changes with the **✓**-button.

Now you can browse through displayed actual values in the right part of the screen with **▲** and **▼** buttons and check if they correspond with reality.



For proper CT connection checking, you can use phasor diagram screen.

After measured quantities checked, other parameters (of RTC, averaging, remote communication etc.) can be set .

## 4. Detailed Description

### 4.1 Basic Functions

The instruments evaluate all of usual electric quantities like line-to-line and phase voltages, currents, active, reactive and apparent powers, power factors, voltage and current THDs and harmonic components, active and reactive energy, average power maximums, frequency etc. Furthermore, temperature is measured with built-in sensor. Optionally, the second temperature can be measured with an external Pt100 sensor at appropriate instrument models.

The instruments are fitted with inputs for connection of three voltage signals, three current signals (for connection of external CTs with either 5/1 A<sub>AC</sub> or 0.1 A<sub>AC</sub> nominal secondary signal) and separate AC/DC power supply input. They can be used in both low and high voltage power grids.

The instruments feature three-rate tariff electricity meter with four-quadrant counters for both active and reactive energies and maximum average active power ( maximum demand ) registration. Advanced models store all results for actual and last month too and a separate archive dedicated for automated meter readings can record actual status in preselected intervals.

The instruments are equipped with battery backed-up real-time circuit (RTC) and high capacity „Flash“ type memory for measured data and events recording.

The USB 2.0 communication link can be used for the instrument adjusting and recorded data transfer. For remote access, optional RS-485 or Ethernet communication interface is available. The instruments with Ethernet interface have embedded webserver.

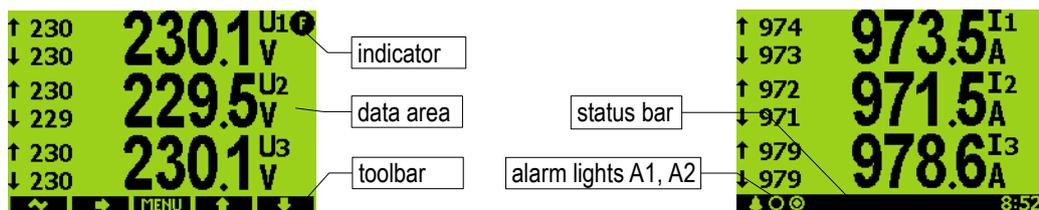
Basic specifications of the instrument can be set up by using the inbuilt keyboard and the display. With the ENVIS program supplied as standard you can, via any of communication link, adjust the instrument and transfer recorded data. In addition to the instrument adjustment, ENVIS program allows you to display, view and archive the measured courses in the graphic form, as well as a number of other features.

### 4.2 Manipulation and Setting

#### 4.2.1 Data Area – Status Bar - Toolbar

Instrument's screen consists of two parts : a *data area* and a *status bar / toolbar area*.

Fig. 4.1: Data Area, Data Area, Status Bar, Toolbar



After instrument's startup the status bar appears below data area as default. The status bar contains following information :

- ... A1 and A2 alarm lights. After the bell icon, two targets represent actual state of the lights; the first one – A1 – is switched off on the example, the A2 is just switched on. This information appears only when either A1 or A2 function is set in the I/O management setup (see below).

- **8:52** ... local time ( hours : minutes)

As soon as any button is pressed, a toolbar replaces the status bar. The toolbar determines function of individual buttons and changes dynamically by a context. If no manipulation with buttons for a longer period the toolbar is replaced with *the status bar*.

In special cases a flashing indicator can appear at upper right corner of the data area. It indicates following cases :

- ... Frequency measurement not yet finished or out of range. In such cases measured signals are scanned according preset nominal frequency  $f_{NOM}$  and measured values can be incorrect. Check  $f_{NOM}$  parameter setting.
- ... At least one of voltage or current input overloaded
- ... Remote communication in progress. This indicator is suppressed approx. 10 seconds after any button pushing.

## 4.2.2 Main Menu

Fig. 4.2: Main Menu



By pressing the **MENU** button, a *Main menu* window appears. With the **▶** and **◀** buttons you can browse through the menu and select a desired action with the **✓** button or return back using the **⏪** (escape) button.

Although all other buttons but the **MENU** button are context dependent and variable, the **MENU** button is accessible from nearly every window which helps to quick orientation. Excluding the PFC block icon, the menu

options consist of :

- Actual data group ( all of measured data in both numeric and graphic form )
- Daily and weekly graphs of main quantities
- Electricity meter data group ( electric energy and maximum demand values )
- Instrument setting ( presetable parameters )
- Instrument lock
- Information ( instrument type & serial number, memory usage state etc. )

### 4.2.2.1 Actual Data Group



*Actual values* in numeric form appear when *Actual data* group is selected as default.

Navigation through the actual values branch is intuitive using the navigation buttons. For detailed description of the actual values presentation see chapter *Display Actual Values Evaluation and Aggregation* further below.

All the values are identified with a quantity name and a quantity unit. An *U/I/P/Q summary* window is an exception – the quantity unit is not displayed (only a **k / M / G** multiplier is). At the last column, which is marked **3p**, values of following quantities are displayed :

Fig. 4.3 : Actual Data Summary Window

	L1	L2	L3	N/3p
U <sub>LL</sub>	415	416	417	0.40
U <sub>LN</sub>	241	236	243	0.28
I	35.2	42.9	37.0	0.00
PF	0.85	0.72	0.75	0.77
P <sub>k</sub>	7.17	7.30	6.71	21.2
Q <sub>k</sub>	4.41	7.01	5.88	17.3

Tab. 4.1: Summary Window 3p Column Quantities

row	3p column quantity
U <sub>LL</sub>	<b>unb<sub>U</sub></b> - voltage unbalance
U <sub>LN</sub>	-
I	<b>ΣI</b> - I1+I2+I3
PF	<b>3PF</b> – three-phase power factor
P	<b>3P</b> – three-phase active power
Q	<b>3Q</b> – three-phase reactive power

Fig. 4.5 : Actual Data Display Mode Switch



The actual data group comprises other actual data presentations that are accessible with the button - so called *actual data display mode switch* . When pressed, a pull up menu rolls over the display temporary. By multiple pressing of the button a desired actual data subgroup can be selected and displayed :

- Actual values – values of all measured quantities in numeric format.
- Average values – average values of main measured quantities including their maximums & minimums. For detailed description see chapter *Display Average Values Evaluation and Aggregation* further below.

- Waveforms – actual wave shapes of all measured voltages and currents.
- Harmonics – actual harmonic components of all voltage and current signals in both numeric and graphic ( histogram ) formats. For detailed description see chapter *Harmonics and THD Presentation*.
- Phasors – diagrams of voltage and current fundamental harmonic phasors. A phase sequence can be checked here too (indicated as **1-2-3** or **1-3-2** ).

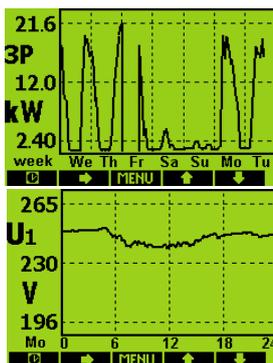
With the last option of the display mode switch – **V,A,W ↔ %** – voltage, current and power quantities expression can be switched between basic units and percent relative to preset nominal voltage **U<sub>NOM</sub>**, current **I<sub>NOM</sub>** and power **P<sub>NOM</sub>**.

### 4.2.2.2 Daily and Weekly Graphs



This option is supported by instrument models equipped with RTC & additional memory only.

Fig. 4.6 : Weekly Graph, Daily Graph



A one-week history of main measured quantities ( such as voltages, currents, powers and power factors ) is registered in the instrument's memory cyclic buffer. Individual courses can be displayed for rough check ( for detailed check at a PC a main archive is intended, see appropriate chapters further below ).

With the button, either whole week or specified day of the passed week can be selected – on the graph, the day is identified with its shortcut ( Mo = Monday, for example ).

With the button desired group of quantities can be selected. For listing through the selected group, use the and buttons.



### 4.2.2.3 Electricity Meter Data Group



The electricity meter group comprises registered electric energy and maximum active power demand values. For detailed explanation see chapter *Energy Data Presentation* further below.

### 4.2.2.4 Instrument Setting



In this group most of presetable parameters can be viewed and edited. Other parameters can be accessed via communication link from a PC using ENVIS program only.

If any of setting window is viewed, an instrument automatically reswitches to actual data display during an approx. 1 minute if no manipulation with buttons is carried out.

Following chapters explain the meaning of particular groups of parameters.



#### 4.2.2.4.1 Display Setting

- **Contrast** ... LCD display contrast in range 0÷100 %
- **Backlight** ... LCD display backlight can be set as permanently on ( **on** ) or to auto-off mode ( **auto** ), in which it is switched off automatically during approx. 2 minutes if no button is pressed to decrease the instrument power dissipation.
- **Language** ... Except the basic English version, other national versions can be selected
- **Display refresh cycle** ... Actual values refresh period. For details see chapter *Display Actual Values Evaluation and Aggregation*.
- **Display Resolution** ... Actual data format can be set to 3 or 4 significant figures ( exception : not applicable for electric energy values ).



#### 4.2.2.4.2 Installation Setting

All parameters of this group are explained in chapter *Measured Electrical Quantities Installation Setup*. above ( *the Commissioning* part ).



#### 4.2.2.4.3 Clock Setting

This setting is relevant for instrument models equipped with a real time circuit ( RTC ).

- **Date & Time** ... Local date and time.
- **Time Zone** ... The time zone should be set according location of an instrument during installation. Correct setting is essential for proper local time interpretation.
- **Daylight Saving** ... This option controls automatic winter/summer local time switching.
- **Time Synchronization** ... As the built-in real time circuit has limited accuracy while free running, with this option it is possible to keep the RTC time in synchronism with an external precise time source. The RTC can be synchronized by :
  - **Pulse Per Second / Minute (PPS / PPM)** ... A digital input is used for time synchronization from an external source at this case. The instrument sets the RTC to the nearest second or minute as soon as a synchronization pulse is detected. Second-, Minute-, quarter-hour- or hour- synchronization pulses are accepted.
  - **NMEA Message** ...If an instrument is equipped with the RS-232 or RS-485 remote communication interface an external ( usually GPS-based ) time receiver can be connected to. The receiver must be set to transmit the "ZDA"- or "RMC"-message

(NMEA 0183 protocol). The communication interface must be set appropriately (usually 4800 Bd, 8 bits, 1 stopbit).

- **NTP Server** ...The option can be used if an instrument is equipped with the Ethernet communication link and a NTP-server is available in the network. Set IP-address of the server. Then time synchronization is performed every hour.
- **Network Frequency** ... For this option, the nominal frequency  $f_{\text{NOM}}$  parameter must be set properly. Otherwise the synchronization will not work.



**Warning** : When editing clock parameters, it must be taken into account that internal data archives are affected : when changing the date or time, **all archives are cleared** !



#### 4.2.2.4.4 Average Values Processing Setting

In this parameter group average values processing for both of *U/I* -group and *P/Q/S* -group of measured quantities can be set. Detailed explanation can be found in the chapter *Average Values Evaluation* further below.



#### 4.2.2.4.5 Remote Communication Setting

Communication parameters for various interface types differ from each other :

**COM (RS-485) interface :**

- **Communication Address**
- **Communication Rate** ...Communication rate in Bauds (Bd).
- **Data Bits** ... Set to 8 for KMB protocol; when parity bit is used (Modbus, usually) set to 9
- **Parity** ... Set to 8 for KMB protocol; for Modbus, usually set to 9
- **Stop Bits** ... Set (usually) to 1

**Ethernet interface :**

- **DHCP** ... activation of dynamic IP-address allocation.
- **IP Address** ...Internet protocol address.
- **Subnet Mask** ...Subnet mask.
- **Default Gateway** ...Default gateway.
- **KMB-port** ... Communication port used for KMB protocol communication.
- **Web-port** ... Communication port used for webserver communication.
- **Modbus-port** ... Communication port used for Modbus protocol communication.



#### 4.2.2.4.6 Embedded Electricity Meter Setting

In this group parameters concerning electric energy registration and maximum active power demand processing can be set. For detailed parameter description see the chapter *Embedded Electricity Meter* further below.



#### 4.2.2.5 Instrument Lock

Three levels of locking to allow protection against unauthorized access are implemented. The active protection level is symbolized in *the main* menu by three different states of the **Lock** icon :



- **Unlocked** – anyone with physical access to the instrument can freely set-up and configure all parameters in the instrument, clear archives and other persistent data or reset counters. In this state anyone can also lock the instrument.



- **User Locked** – fixed *user password* (PIN) is required if the instrument configuration is changed or there is a request to clear any of the data.



- **Admin Locked** – user defined *admin password* (PIN) is required if the instrument configuration is changed or there is a request to clear any of the data.

#### 4.2.2.5.1 Locking

If the instrument is unlocked, you can lock it to either user or admin mode.

To lock the instrument into the user locked mode, simply switch in the **Menu-Lock** window the lock from ✖ to ✔. Then escape from the window with the  button and confirm saving of changed state.

To lock the instrument into the admin locked state, in the **Menu -> Lock** window press the button ▼, keep it pressed and then press the . Then normally hidden admin password option appears. Choose it and type the new admin password code – the value must be different from 0000. Then escape from the **Menu-Lock** window with the  button and confirm saving of changed state. The admin locked state is indicated with the “A”-character inside the lock icon.



**Warning !** Store the admin password code at the secure place to be able to unlock the instrument later in case the code is forgotten !

#### 4.2.2.5.2 Unlocking from the User Locked State

To unlock the instrument, switch in **Menu -> Lock** the lock state back from ✔ to ✖ by entering user password. The value of this password is fixed and equal to the last four digits of the serial number of the instrument. This serial number can be found in device display under **Menu -> Info -> Serial number** .

Then escape from the **Lock** window with the  button and confirm saving of changed state.

#### 4.2.2.5.3 Unlocking from the Admin Locked State

To unlock the instrument, switch in **Menu -> Lock** the lock state back from ✔ to ✖ by entering correct admin password. Then escape from the **Menu-Lock** window with the  button and confirm saving of changed state.

Note, that such unlocking is temporary and the instrument will switch to the admin locked state automatically approx. 15 minutes after last pressing of any button. To avoid this you need to set the admin password code to value 0000 ( in the same way as the locking as described above ). Only after that the instrument state changes to permanently unlocked state.

Note : In case the admin password is lost, ask manufacturer for alternate unlock code via manufacturer's website at [www.kmbystems.eu](http://www.kmbystems.eu) .

### 4.2.2.6 Instrument Information



The instrument identification and actual status are listed in this group. The information are split up to three windows that can be browsed through with the ► button.

#### 4.2.2.6.1 Info – General Window

- **Instrument Model & Serial Number** ... Instrument hardware model & serial No.

- **Instrument Hardware, Firmware & Bootloader Versions** ... Instrument hardware & firmware specification.
- **Object Number** ... Measured node specification ( preset by ENVIS program for data identification ).
- **Vbatt** ... backup battery voltage (if equipped)
- **Error Code** ... Indicates some instrument's hardware or setting problem. At normal state equals to 0. In case of detection of any error it contains a number created as the sum of binary weights of the errors. The following table provides overview of them and recommended action:

Tab 4.2 : Instrument Errors

Error No. (weight)	Error	Action
1	RAM memory error	set the instrument (optimally with the ENVIS program, if possible) to the <i>default setting</i> ; if the error appears again send the instrument to a service organization for repair
2	instrument setup error	set the instrument (optimally with the ENVIS program, if possible) to the <i>default setting</i> ; if the error appears again send the instrument to a service organization for repair
4	calibration error	the instrument must be recalibrated – send to a service organization
8	wireless communication module error (Wifi/Zigbee)	send to a service organization
16	RTC error	in <i>the time setup window</i> (or better with the ENVIS program, if possible), set actual date&time; if the error appears again, check built-in backup battery; otherwise send the instrument to a service organization for repair
128	archive data error	clear all of the archives with the ENVIS program; if the error appears again send the instrument to a service organization for repair
256	FLASH memory error	send to a service organization

#### 4.2.2.6.2 Info – Producer

At this submenu there is producer's logo and website URL-address only.

## 4.3 Description of Operation

### 4.3.1 Method of Measurement

The measurement consists of three processes being performed continuously and simultaneously: frequency measuring, sampling of voltage and current signals and evaluation of the quantities from the sampled signals.

### 4.3.1.1 Voltage Fundamental Frequency Measurement Method

The voltage fundamental frequency is measured at the U1 voltage signal. It is measured continuously and evaluated every 10 seconds.

The fundamental frequency output is the ratio of the number of integral mains cycles counted during the 10 second time clock interval, divided by the cumulative duration of the integer cycles.

If value of frequency is out of measuring range, such state is indicated with flashing indicator  at upper right corner of the actual data window.

### 4.3.1.2 Voltage and Current Measurement Method

Both voltage and current signals are evaluated continuously as required by IEC 61000-4-30, ed. 2 standard. The unitary evaluation interval, a *measurement cycle*, is a ten / twelve ( value behind slash is valid for  $f_{NOM} = 60$  Hz ) *mains cycles* long period ( i.e. 200 ms at frequency equal to preset  $f_{NOM}$  ), which is used as a base for all other calculations.

The sampling of all voltage and current signals is executed together with the frequency of 128 / 96 samples per mains cycle. The sampling rate is adjusted according to the frequency measured on any of the voltage inputs **U1**, **U2**, **U3**. If the measured frequency is in measurable range at least on one of these inputs, then this value is used for subsequent signal sampling. If the measured frequency is out of this range, the preset frequency value (  $f_{NOM}$  ) is used and measured values may be incorrect.

When exceeding the measuring range of any voltage or current, the instrument indicates overload by indicator  at upper right corner of the actual data window.

Effective values of voltages and currents are calculated from sampled signals over the measurement cycle using formulas (examples for phase No. 1) :

$$\text{Phase voltage (effective value) : } U1 = \sqrt{\frac{1}{n} \sum_{i=1}^n U1i^2}$$

$$\text{Line voltage (effective value) : } U12 = \sqrt{\frac{1}{n} \sum_{i=1}^n (U1i - U2i)^2}$$

$$\text{Current (effective value) : } I1 = \sqrt{\frac{1}{n} \sum_{i=1}^n I1i^2}$$

where :  $i$  ..... sample index

$n$  ..... number of samples per measurement cycle ( 1280 / 1152 )

$U_{i1}, I_{i1}$  ... sampled values of voltage and current

$$\text{Phase Current Sum : } \sum I = I_1 + I_2 + I_3$$

The data for the longer measurements are aggregated from these measurement cycles. Long time interval starts after the RTC tick occurrence at the beginning of the next measurement cycle time interval. This principle enables to configure other intervals up to 2 hours for datalogging purposes.

Measured phase voltages  $U_1$  to  $U_3$  correspond to the potential of terminals **VOLTAGE / U1** to **U3** towards the terminal **VOLTAGE / N**.



*Measuring voltage inputs impedance is in range of units of  $M\Omega$ . If no signal connected (for example when protection fuse is blown), due to parasite impedance of power supply input a parasite voltage of up to tens of volts can appear on the measuring voltage inputs. In such case the instrument can show non-zero voltages !*

Three current signals -  $I_1, I_2, I_3$  - are measured. Another current is calculated from samples of directly measured ones as negative vector sum of all measured current vectors (Kirchhoff rule). The calculated current is referenced as  $I_{NC}$ .

### 4.3.1.3 Harmonics and THD Evaluation Method

Entire spectrum of harmonic components and THD is evaluated discontinuously - periodically every second from 10 / 12 mains cycles long signal according to IEC 61000-4-7 ed.2 as harmonic sub-groups ( $H_{sg}$ ).

Following quantities are evaluated :

Harmonic components of voltage and current up to 50<sup>th</sup> order :  $U_{ih_1}, I_{ih_1}$   
(  $i$  .... order of harmonic component )

Absolute angle of voltage harmonic component phasor :  $\varphi_{U_{ih_1}}$

Current harmonic component phasor angle relative to phasor  $U_{fh_1}$  :  $\varphi_{I_{ih_1}}$

Relative angle between correspondent voltage and current phasors :  $\Delta\varphi_{i_1}$

Total harmonic distortion of voltage : 
$$THD_{U_1} = \frac{1}{U_{1h_1}} \sqrt{\sum_{i=2}^{40} U_{ih_1}^2} * 100\%$$

Total harmonic distortion of current : 
$$THD_{I_1} = \frac{1}{I_{1h_1}} \sqrt{\sum_{i=2}^{40} I_{ih_1}^2} * 100\%$$

### 4.3.1.4 Power, Power Factor and Unbalance Evaluation Method

Power and power factor values are calculated continuously from the sampled signals according to formulas mentioned below. The formulas apply to basic type of connection – wye (star).

Active power : 
$$P_1 = \sum_{k=1}^{40} U_{k,1} * I_{k,1} * \cos\Delta\varphi_{k,1}$$

Reactive power : 
$$Q_1 = \sum_{k=1}^{40} U_{k,1} * I_{k,1} * \sin\Delta\varphi_{k,1}$$

where :  $k$  ... harmonic order index, odd components only

$U_{k,1}, I_{k,1}$  ... the  $k^{\text{th}}$  harmonic components of voltage and current ( of phase 1 )

$\Delta\varphi_{k,1}$  ... angle between the  $k^{\text{th}}$  harmonic components  $U_{k,1}, I_{k,1}$  ( of phase 1 )

( these harmonic components of  $U$  and  $I$  are evaluated from each measurement cycle )

Apparent power : 
$$S_1 = U_1 * I_1$$

Distortion power : 
$$D_1 = \sqrt{S_1^2 - P_1^2 - Q_1^2}$$

Power factor : 
$$PF_1 = \frac{|P_1|}{S_1}$$

Three-phase active power : 
$$\sum P = P_1 + P_2 + P_3$$

Three-phase reactive power : 
$$\sum Q = Q_1 + Q_2 + Q_3$$

Three-phase apparent power : 
$$\sum S = S_1 + S_2 + S_3$$

Three-phase distortion power :  $3D = \sqrt{3S^2 - 3P^2 - 3Q^2}$

Three-phase power factor :  $\sum PF = \frac{|\sum P|}{\sum S}$

Fundamental harmonic component quantities :

Fundamental harmonic power factor :  $\cos \Delta\varphi_1$  (or  $\tan \Delta\varphi_1$  ,  $\Delta\varphi_1$ )

Fundamental harmonic active power :  $Pfh_1 = Ufh_1 * Ifh_1 * \cos \Delta\varphi_1$

Fundamental harmonic reactive power :  $Qfh_1 = Ufh_1 * Ifh_1 * \sin \Delta\varphi_1$

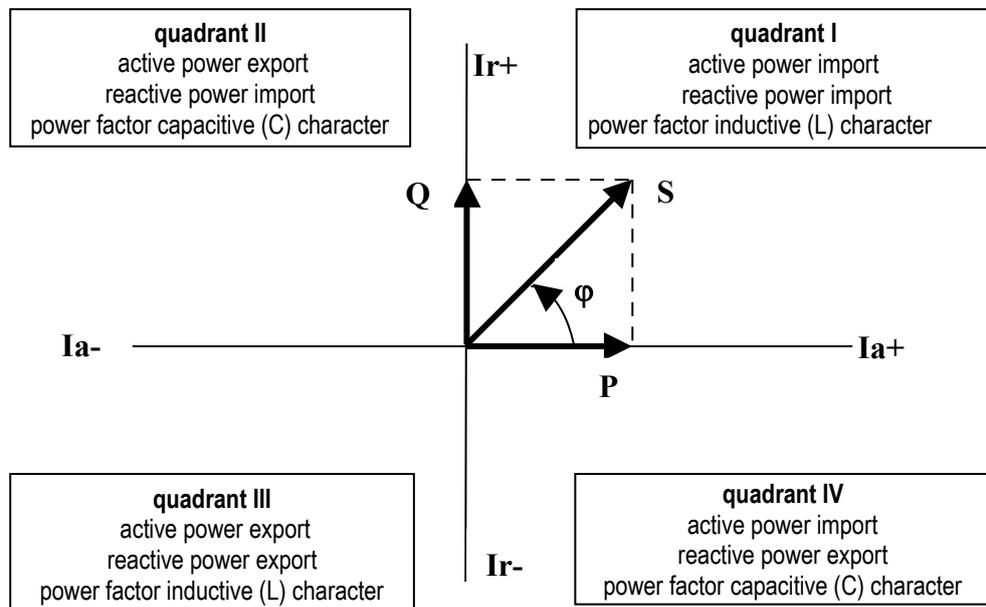
Fundamental harmonic three-phase active power :  $\sum Pfh = Pfh_1 + Pfh_2 + Pfh_3$

Fundamental harmonic three-phase reactive power :  $\sum Qfh = Qfh_1 + Qfh_2 + Qfh_3$

Fundamental harmonic three-phase power factor :  $\sum \cos \Delta\varphi = \cos \left( \arctg \left( \frac{\sum Qfh}{\sum Pfh} \right) \right)$

Powers and power factors of the fundamental harmonic component ( $\cos \varphi$ ) are evaluated in 4 quadrants in compliance with the standard IEC 62053 – 23, appendix C, see Fig. 4.3.

Fig. 4.3: Identification of consumption- supply and the character of reactive power according to phase difference



For outright specification of the quadrant, the power factor of the fundamental harmonic component – **cos φ** – is expressed according to the graph with two attributes :

- a *sign* ( + or - ), which indicates polarity of active power
- a *character* ( **L** or **C** ), which indicates the power factor character ( the polarity of reactive power relative to the active power )

Voltage and current unbalance evaluation is based on negative/positive sequences of voltage and current fundamental harmonic components :

$$\text{Voltage unbalance : } \quad \text{unb}_U = \frac{\text{voltage negative sequence}}{\text{voltage positive sequence}} * 100 \%$$

$$\text{Current unbalance : } \quad \text{unb}_I = \frac{\text{current negative sequence}}{\text{current positive sequence}} * 100 \%$$

Current negative sequence angle :  $\varphi_{nsI}$

All of angle values are expressed in degrees in range [ -180.0 ÷ +179.9 ].

### 4.3.1.5 Temperature

Both the internal temperature **T<sub>i</sub>** and the external temperature **T<sub>e</sub>** (at selected models only) are measured and updated each approx. 10 seconds.

### 4.3.1.6 “ The Fixscan ” Mode

The instrument is primarily designed to measure distribution networks with the nominal frequency of 50 or 60 Hz. Sampling, processing, and aggregation of a measured signal when setting the  $f_{\text{NOM}}$  parameter to one of these two values is described above and corresponds to the standards specified in technical parameters.

However, there are other applications, such as:

- networks with  $f_{\text{NOM}} = 400$  Hz
- variable frequency networks, such as frequency inverters output

The *Fixscan mode* is used to measure such networks.

#### 4.3.1.6.1 Function

The *Fixscan mode* is activated by setting the  $f_{\text{NOM}}$  parameter to "DC-500". The device then works as follows:

- U and I signals sampled at the fixed sampling frequency of 6400 Hz
- fixed evaluation interval of measured quantities every 200ms
- DC component of voltage is also evaluated (DC component of current not measured)
- assortment of measured quantities is limited according to the table below; other variables, such as harmonic components, THDs, unbalances are not measured in this mode
- measurement uncertainties are defined by a separate table (see technical parameters)

The frequency of the measured signal can be in the range of 0 ÷ 500 Hz.



*Due to the fixed evaluation window (200ms), a systematic error of incomplete number of evaluated waves may occur, especially in low frequency signals !*

Temperature and analogue inputs are measured in the same way as in standard mode. Similarly, energy is evaluated standardly by integration of appropriate power.

Tab. 4.4 : The Fixscan Mode Quantities Measured Overview

Mark	Quantity	Evaluation method
f	frequency of voltage	voltage signal digital filtration + zero crossing period measurement
U1	phase-to-neutral alternating voltage (effective value)	$U1 = \sqrt{\frac{1}{1280} \sum_{i=1}^{1280} U_{i1}^2}$
Udc1	direct phase-to-neutral voltage (direct component of the signal)	$U_{dc1} = \frac{1}{1280} \sum_{i=1}^{1280} U_{i1}$
U12	phase-to-phase alternating voltage (effective value)	$U12 = \sqrt{\frac{1}{1280} \sum_{i=1}^{1280} (U_{i1} - U_{i2})^2}$
I1	alternating current (effective value)	$I1 = \sqrt{\frac{1}{1280} \sum_{i=1}^{1280} I_{i1}^2}$
P1	active power	$P1 = \frac{1}{1280} \sum_{i=1}^{1280} U_{i1} * I_{i1}$
Q1	non-active power	$Q1 = \sqrt{S1^2 - P1^2}$
S1	apparent power	$S1 = U1 * I1$
PF1	power factor	$PF1 = \frac{ P1 }{S1}$

Note : marks and evaluation formulas shown for phase No. 1

## 4.3.2 Measured Values Evaluation and Aggregation

As described above, measured values are evaluated according to IEC 61000-4-30 ed.2, based on continuous (gap-less), 10 / 12 mains cycles long intervals ( measurement cycle ) processing.

Further aggregation of the actual values from this evaluation is used to obtain values for displaying and recording.

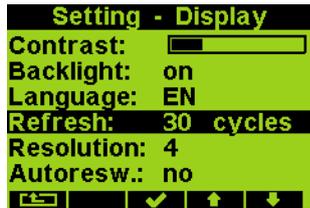
### 4.3.2.1 Actual Values Evaluation and Aggregation

Actual ( instantaneous ) values of measured quantities, that can be viewed on instrument's display, are evaluated as average of integral number of measurement cycle values per *display refresh cycle*.

The display refresh cycle is presetable in range 2 ÷ 20 measurement cycles , corresponding approx. to 0.4 ÷ 4 seconds display refresh cycle duration.

Maximum (marked as ↑ ) and minimum ( ↓ ) measurement cycle values registered during the display refresh cycle interval are displayed too.

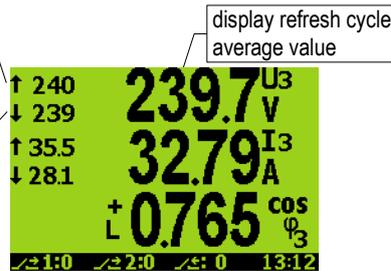
Fig. 4.8: Actual Data Display Refresh Cycle Setting



maximum measurement cycle value during refresh cycle

minimum measurement cycle value during refresh cycle

Fig. 4.9: Actual Data



Exceptions :

- frequency – the value is refreshed each frequency measurement cycle (see above)
- harmonic components, THD and unbalance – the last measurement cycle values are displayed (no averaging)
- temperature – the value is refreshed each temperature measurement cycle (see above)

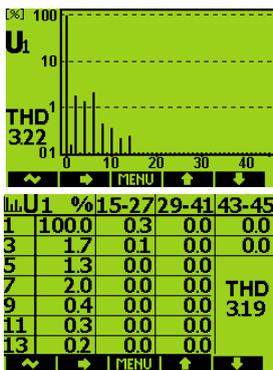
Actual values, read from an instrument via a communication link for monitoring purposes are evaluated from one – the last – measurement cycle only.



Neither maximum nor minimum of  $\cos\phi$  values are evaluated due to special character of the quantity. Similarly, these extreme values are not evaluated at frequency, harmonics & THD and temperature values either due to a specific measurement method.

### 4.3.2.1.1 Harmonics and THD Presentation

Fig. 4.10 : Harmonics



Harmonic components in both numeric and graphic format can be viewed at *Actual data* group. At the numeric format – a table – a value of Total Harmonic Distortion ( THD ) is displayed too. You can list through all measured phase voltage and current signal harmonics with the ▲ and ▼ buttons.

With the ► button you can switch between :

- voltage and current signals using U↔I switch
- absolute ( volts, amps ) or relative (percentual) harmonic values expression using V,A↔% switch
- graphic and numeric representation using ↔123 switch
- odd and event harmonics ( at numeric format only ) using 2-4-6↔1-3-5 switch

If current harmonics are displayed in numeric format and expressed in amperes, their values are extended with a sign. The sign indicates if a current phasor of appropriate harmonic is delayed after its voltage phasor ( positive value ) or if the current phasor foreruns the voltage one ( negative value ). This information can be useful for a harmonic distortion source location.

### 4.3.2.2 Average Values Evaluation

From measurement cycle values, average values of all basic quantities are calculated. Following parameters can be set to control the way of averaging :

- averaging method, which can be set to one of :
  - fixed window
  - floating window
- averaging period in range from 1 second to 1 hour

When **fixed window** averaging is set, values are calculated from fixed block intervals. The values are updated at the end of every interval. Beginnings of the intervals are synchronized to the nearest whole time ( for example, when averaging period is set to 15 minutes, the average values are updated four times per hour in xx:00, xx:15, xx:30 and xx:45 ).

When **floating window** is set, the internal cyclic buffer is used to store auxiliary partial averages. The buffer has depth of 60 values. If preset average period is 1 minute or shorter, partial averages of a quantity are buffered each second and new average values are updated from the preset averaging period each second. If the preset average period is longer than 1 minute, partial averages for longer duration are buffered and the average values are updated less frequently ( for example, if the preset average period is 15 minutes, partial averages are buffered each 15 seconds and average values are updated with this frequency ).

Average values processing can be set independently for two groups of quantities : so called **U/I** -group and **P/Q/S** -group. Following table lists processed quantities of both groups.

Tab. 4.5 : Average Values Groups

Average values group	Averaged quantities
“ U / I ”	U <sub>LL</sub> , U <sub>LN</sub> , I, f, T
“ P / Q / S ”	P, Q, S, PF, Pfh, Qfh, cosφ



Preset averaging parameters noted above are valid for so called standard average values. For the maximum power demand **3MD** in the Electricity Meter group, separate parameter is used (see below).

To display average values, while in actual data window press the button several times until **123.4 avg** - option is selected. Average values are marked with a bar over quantity name ( see below ).

Fig. 4.11 : Average Data Processing Setting

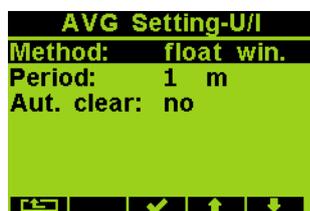
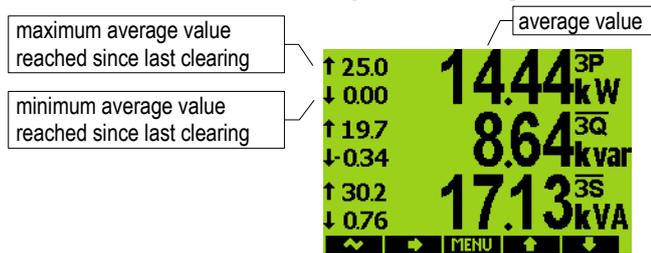


Fig. 4.12 : Average Data



### 4.3.2.2.1 Maximum and Minimum Average Values

Maximum and minimum values of average values are registered into the instrument's memory; in case of appropriate instrument models including the date & time of their occurrence.

Fig. 4.13 : Maximums of Average Values



The maximums&minimums are displayed on the left side of average values window - maximum value is identified with the ↑ symbol and minimum value with the ↓ symbol.

To view their time stamps, press the ► button until, for example **Max** is selected. Maximum average value window appears. On the left of each maximum value, its time stamp is displayed. The symbol ↑ after the time data means that the displayed value is maximum. You can display minimum average values in similar way.

The maximum and minimum registered values can be cleared either manually or -at the instrument models equipped with the RTC - automatic clearing can be set.

To clear the values manually, press the ► button until **Clear** option is selected. Then at the confirmation window press the ✓ button.

To activate automatic clearing of maximums/minimums of average values, set the automatic clear period ( the last option at window on Fig. 5.10 ).



*Only the appropriate group ( U/I or P/Q/S ) of average maxs/mins is affected by single clearing ! Each group must be cleared or set individually*



*If the instrument is locked, resetting is not possible.*

### 4.3.2.3 Recorded Values Aggregation

All of measured and evaluated data can be optionally archived into the instrument's memory. The record period is presettable in a wide range and aggregated data are archived.

The shortest aggregation interval is 0.2 s while the longest configurable interval is 2 hours. If seconds are selected then intervals are aggregated according to cycle count at actual frequency. Intervals longer than one minute are aggregated according to a real time tick.

Where applicable not only the average value but minimum and maximum values over aggregation interval can be stored too.

## 4.3.3 Embedded Electricity Meter

For electric energy measurement, stand-alone unit – *electricity meter* - is implemented inside instruments. Energies are evaluated in compliance of the IEC 62053-24 standard : active energy from full harmonic spectrum and reactive energy from the fundamental harmonic component only.

Except of electric energy, maximum active power demands are registered in the unit.

### 4.3.3.1 Electric Energy Processing

Measured values of electrical energy are recorded separately in four quadrants : active energy consumed (**I**, import), active energy supplied (**E**, export), reactive energy inductive (**L**) and reactive energy capacitive (**C**). Both single-phase and three-phase energies are processed.

In addition at selected models, three-phase energies are evaluated in three preset tariff zones ( time of use ). The actual tariff can be controlled either by an actual RTC time using preset tariff zone table with one hour resolution or by an external signal through a digital input.

Internal energy counters have sufficient capacity in order not to overflow during the whole instrument lifetime. On the instrument's display only 9 digits can be viewed – therefore, after energy value exceeds 999999999 kWh/kvarh, instrument's display format automatically switches to MWh/Mvarh, then to GWh/Gvarh.

At selected models, electricity meter data can be periodically archived with a preset registering interval into the instruments memory and can be analysed later after being downloaded into a PC.

### 4.3.3.2 Maximum Demand Registration

From the instantaneous measured values of all active powers the instrument evaluates their average values per preset period using preset averaging method. In the electricity meter unit, such quantities are called *actual demands* (**AD**). Note that the actual demands are processed individually and their averaging period is presetable independently on standard average values (**P<sub>AVG</sub>**).

Their maximum values reached since the last clearing are called *maximum demands* (**MD**).

The AD values are not displayed on the instrument display – only their registered three-phase maximums **3MD** are.

The total maximums can be cleared independently of standard average maximums/minimums.

### 4.3.3.3 Setting

Main parameters determining electricity meter unit function can be set manually. By selecting appropriate icon a **Setting – Elmeter** window appears.

Fig. 4.14 : Electricity Meter Setting

Setting - E-Meter	
Record per.:	15 min
Tariff cont.:	table
Tariff zones:	...
MD method:	float
MD period:	15 m
MD.Eval.int.:	month

**Record period** is an automated meter reading interval that defines how often the electricity meter state is stored into the memory (at selected models only). The electricity meter history can be later downloaded into a PC and analysed.

Actual tariff can be controlled either by actual local time using the *tariff zones table* or by a digital input. In case of **table** selection, a day long timetable for 3 different tariff selections with hourly resolution can be defined.

In case of **digital input** selection, chosen digital input specifies actual tariff – open state means tariff 1, closed state tariff 2. Tariff 3 is not used at this case.

Tariff zones table can be opened and set by selection of **Tariff zones** option.

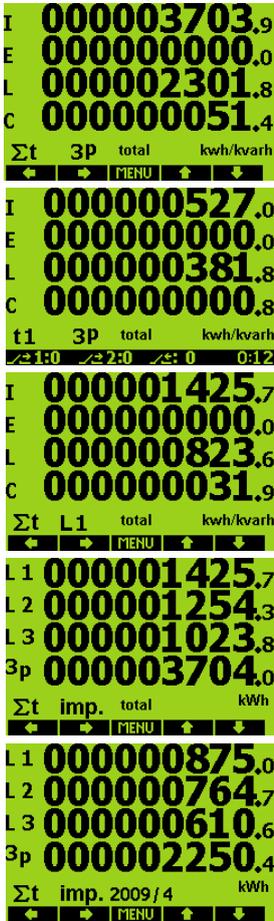
Next, electricity meter group power demand (AD, Actual Demand) **averaging parameters** can be specified. With **the evaluation interval of maximum demand**, the period of maximum demand (MD) registration in range 1 day up to 1 year can be set (see 3MD<sub>CX</sub>, 3MD<sub>LX</sub> presentation below).

### 4.3.3.4 Energy Presentation



Electricity meter energy data are situated in a separated window, which is accessible via the main menu.

Fig. 4.15 : Electricity Meter – Energy Window



As default actual three-phase ( **3p** ) energies registered since last clearing up to now ( **total** ) for all tariff zones (  $\Sigma t$  ) appear : imported active energy **3EP+** ( **I** ), exported active energy **3EP-** ( **E** ), imported reactive energy **3EQL** ( = inductive, **L** ) and exported reactive energy **3EQC** ( capacitive, **C** ), as shown on the uppermost screen at left.

With the ◀ button outline of registered energies for individual tariff zones can be listed ( 2<sup>nd</sup> screen ).

With the ▶ button, single-phase energies can be displayed using **1p** ↔ **3p** toggle switch ( 3<sup>rd</sup> screen ). In this case you can select energies of individual phases L1, L2, L3 with the ◀ button or display overview of both single-phase energies and three-phase energy in specified quadrant, for example imported active energies with **Active-Import** option, as shown on the 4<sup>th</sup> screen.

Besides the total energies (that means energy values registered since last clearing up till now ), state of registered values at the end of previous month can be viewed with **Act.↔ Last Month** toggle switch of the ▶ button ( 5<sup>th</sup> screen ). The last month window is indicated by the month specification, for example **2009/4** , which means March of year 2009.

Finally, registered energies can be recalculated using preset tariff rates to money values in Euros with **kWh↔EUR** toggle switch.

Tariff zones and appropriate Euro tariff rates can be set via a communication link using a PC with ENVIS program.

Energy counters can be cleared either manually or with a remote PC. Manual clearing can be invoked with the ▶ button by **Clear** option and confirmed with the ✓ button.

### 4.3.3.5 Maximum Demand Presentation

While in the electricity meter energy window you can switch to the maximum active power demand window with the ▼ or ▲ button.

Fig. 4.16 : Maximum Demand Window



Only three-phase maximums with their time stamps are displayed. In the first row there is total maximum demand **3MD**, i.e. maximum of the 3AD reached since last maximum clearing. You can check this clearing time with the ▶ button – by **Clear** option selection, the clearing confirmation window appears and last maximum power demand clearing time and current averaging parameters setting can be checked. If you don't want to clear the registered maximums , push the \* button, otherwise the ✓ button.

In the 2<sup>nd</sup> row there is maximum of the 3AD reached during the last evaluation interval – **3MD<sub>Lx</sub>** (L=last). The “X”-index depends on the evaluation interval preset value : D=day, W=week, M=month, Q=quarter, Y=year. In the 3<sup>rd</sup> row there is maximum of the 3AD reached during just passing evaluation interval : **3MD<sub>cx</sub>** (C=current).

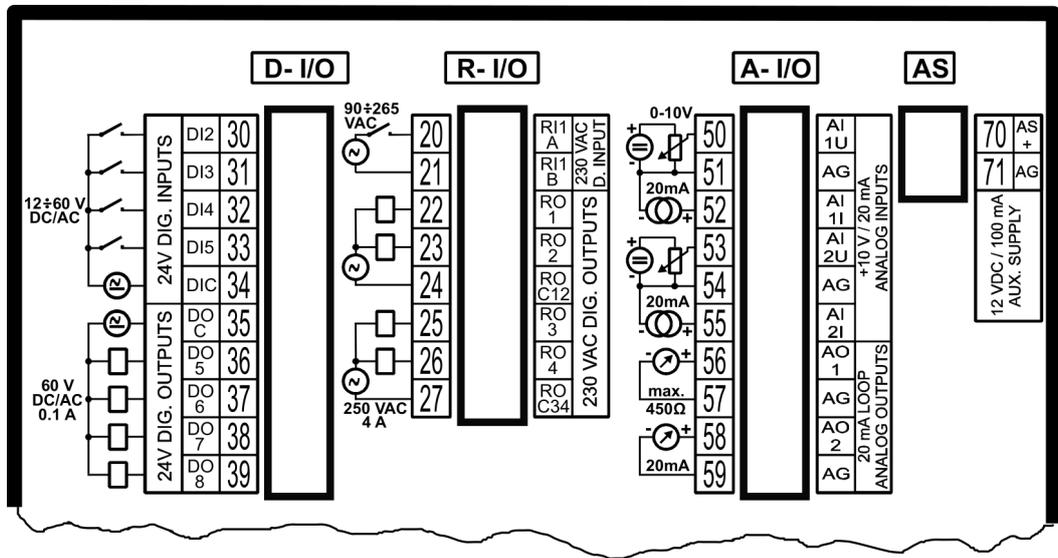
The last two values are available at instrument equipped with an RTC only.

The entire information, including phase values of both AD and MD, can be obtained from a PC with ENVIS program.

## 5. Inputs & Outputs

Instruments can be equipped with various combinations of inputs and outputs (see manufactured models marking below).

Fig. 5.1 : SMZ 133 – I/O Connectors



Assortment of inputs and outputs is :

- 1 100 ÷ 250 VAC digital input – marked as **RI1**
- 4 250 VAC digital outputs (relays) – **RO1 ÷ RO4**
- 4 12 ÷ 24 VDC digital inputs – **DI2 ÷ DI5**
- 4 12 ÷ 24 VDC digital outputs (solid state) – **DO5 ÷ DO8**
- 2 0 ÷ 10 VDC / 0 ÷ 20 mADC analog inputs – **AI1 ÷ AI2**
- 2 0 ÷ 20 mADC analog outputs – **AO1 ÷ AO2**
- 1 Pt100 temperature sensor input (optional) – **TE**

Furthermore, all of instrument models feature two “alarm ” lights **A1** and **A2** for indication of various states, that can be considered as other special digital outputs. Function of these lights can be set in the same way as at standard digital outputs.

All of the inputs and outputs are isolated from the instrument's internal circuitry.

### 5.1 Connection of the I/O

Recommended wire type: H05V-U (CY)

Recommended minimum conductor cross-section : 0.75 mm<sup>2</sup>

Maximum conductor cross-section : 2.5 mm<sup>2</sup>

### 5.1.1 RI1 Digital Input Connection

The input is designed for signal of nominal voltage in range of 100 ÷ 230 VAC („power input“).

Connect the signal to terminals RI1A (No. 20) and RI1B (21, see connection examples in appropriate chapter) of the R-I/O connector. The input is isolated from all of other instrument circuitry. For the input activation, voltage of declared level must lead on the input.

### 5.1.2 RO1 ÷ RO4 Digital Outputs Connection

A SPST-NO ( single-pole, single-throw, normally open ) relays type are used. Maximum allowable voltage and load current (both AC and DC) according technical specifications must be observed.

Each pair of relays shares common pole connected separately to the R-I/O connector terminal. These common poles are isolated each from other.

*Tab. 5.1 : RO1 ÷ RO4 Digital Outputs Connection*

terminal No.	signal
22	RO1 ... RO11 relay NO contact
23	RO2 ... RO12 relay NO contact
24	ROC12 ... RO1 & RO2 relays common pole
25	RO3 ... RO3 relay NO contact
26	RO4 ... RO4 relay NO contact
27	ROC34 ... RO3 & RO4 relays common pole

### 5.1.3 DI2 ÷ DI5 (12 ÷ 24 VDC) Digital Inputs Connection

The inputs are determined for monitoring of 12 ÷ 24 VDC nominal voltage signals („signal inputs“). If you need to connect a voltage signal of magnitude exceeding maximum allowed voltage, external limiting resistor of appropriate rating must be used.

Polarity of input signal is free.

Connect the input signals to the D-I/O connector according the table below. All of the four signals have common pole, that is isolated from all of other instrument circuitry.

*Tab. 5.2 : DI2 ÷ DI5 Digital Inputs Connection*

terminal No.	signal
30	DI2 input
31	DI3 input
32	DI4 input
33	DI5 input
34	DIC ... DI2 ÷ DI5 inputs common pole

### 5.1.4 DO5 ÷ DO8 (12 ÷ 24 VDC) Digital Outputs Connection

These outputs are solid state type. The can switch small voltage signals only, usually of 12 ÷ 24 V nominal voltage.

The outputs are bipolar, thus both DC voltage (of free polarity) and AC voltage signals can be driven.

Connect the output signals to the D-I/O connector according the table below. All of the four signals have common pole, that is isolated from all of other instrument circuitry.

Tab. 5.3 : DO5 ÷ DO8 Digital Outputs Connection

terminal No.	signal
35	DOC ... DO5 ÷ DO8 outputs common pole
36	DO5 output
37	DO6 output
38	DO7 output
39	DO8 output

### 5.1.5 AI1, AI2 Analog Inputs Connection

Two analog signals can be monitored. Character of the signal can be :

- 0 ÷ 20 mA<sub>DC</sub>
- or 0 ÷ 10 V<sub>DC</sub>

The inputs have common pole marked AG. The pole is internally connected with both common pole of analog outputs AO1, AO2 and negative pole of embedded 12 V DC auxiliary power supply .

Connect input signals to the A-I/O connector according its character as described in the table below.

Tab. 5.4 : AI1, AI2 Analog Inputs Connection

terminal No.	signal
50	AI1U ... 0 ÷ 10V character AI1 signal positive pole (if AI1 signal character is 0 ÷ 20mA this terminal must stay free)
51	AG ... AI1, AI2 signals common negative pole
52	AI1I ... 0 ÷ 20mA character AI1 signal positive pole (if AI1 signal character is 0 ÷ 10V this terminal must stay free)
53	AI2U ... 0 ÷ 10V character AI2 signal positive pole (if AI2 signal character is 0 ÷ 20mA this terminal must stay free)
54	AG ... AI1, AI2 signals common negative pole
55	AI2I ... 0 ÷ 20mA character AI2 signal positive pole (if AI2 signal character is 0 ÷ 10V this terminal must stay free)

### 5.1.6 AO1, AO2 Analog Outputs Connection

The AO1 and AO2 analog outputs of 20 mA current loop character can be use for any measured quantity actual value transmission.

The outputs have common pole marked AG. The pole is internally connected with both common pole of analog inputs AI1, AI2 and negative pole of embedded 12 V DC auxiliary power supply .

Connect input signals to the A-I/O as described in the table below.

Tab. 5.5 : AO1, AO2 Analog Outputs Connection

terminal No.	signal
56	AO1 ... AO1 output positive pole
57	AG ... AO1, AO2 signals common negative pole
58	AO2 ... AO2 output positive pole
59	AG ... AO1, AO2 signals common negative pole

The AO1, AO2 output signals are powered by embedded 12 VDC auxiliary power supply. When connected to other instruments maximum allowed input impedance must be observed (see technical specifications).

## 5.1.7 Embedded 12 VDC Auxiliary Power Supply

The supply can be used for connection of passive contacts or sensors. Outputs of the supply are at the AS connector : positive pole at terminal AS+ (No. 70) and negative pole at terminal AG (71). The AG pole is internally connected with common poles of analog inputs AI and outputs AO.

Maximum load current is given in technical specifications.

## 5.1.8 External Temperature Sensor Connection

Some models are equipped with the *EXT. TEMP* external temperature sensor connector for measurement of external temperature.

The input is designed for three-wire connection to a resistive temperature Pt100-type sensor. Connect the sensor to the terminals No. 44 (*TA*), 45 (*TB*) and 46 (*G*) according example drawing below.

In case of two-wire connection, connect the sensor to the terminals *TA* and *TB* and short-circuit the *TB* terminal with the *G* terminal. Note that the sensor cable loop impedance must be as low as possible ( each 0.39 Ohms means additional measurement error of 1 °C).

The *G* signal is internally connected to the *GND* signal of the RS-485 remote communication link.

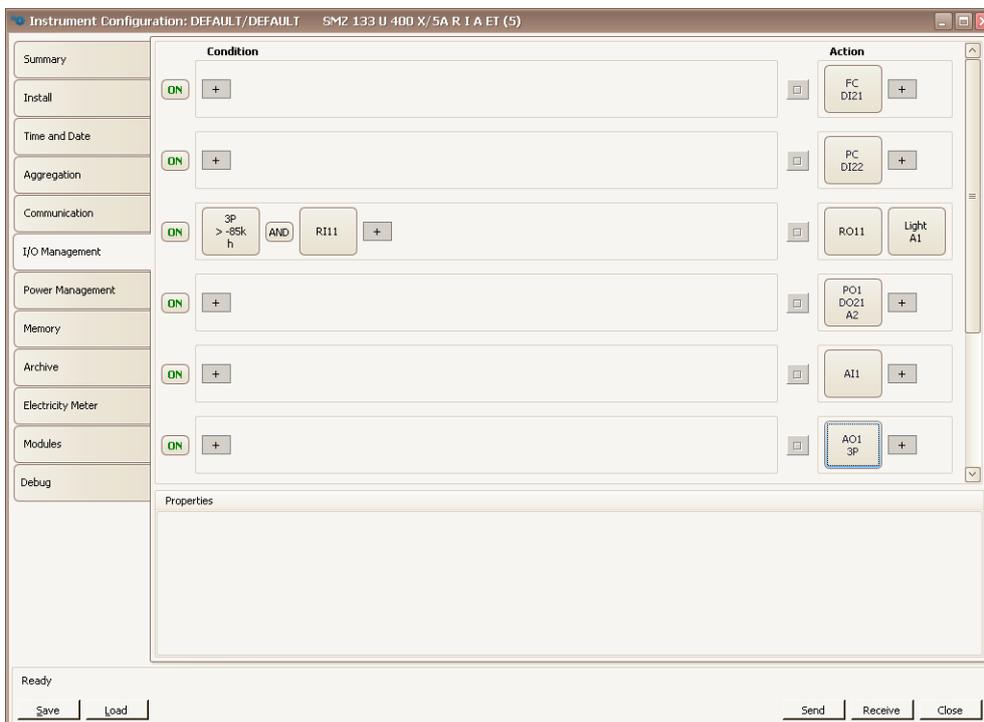
The temperature sensor can be ordered as the instrument's optional accessory.

## 5.2 I/O Setup

The inputs and outputs processing capabilities are very wide and it would be rather complicated to set it using the instrument panel. Therefore, you can set it only on a PC connected with a communication link only using the ENVIS-Daq program.

For the I/O setup, use *Config* → *I/O Management* . Complete I/O setup consist of so called *clauses* . Individual clauses are listed in the I/O management screen.

Fig. 5.2 : The I/O Management Setup Example in the ENVIS-Daq Program



Each clause consists of :

-  ... *The clause switch* - If ON the clause is active, i.e. *the clause condition* (if any set) is evaluated and if it gets true (= logic 1), *the clause action* (or *actions*) are processed. By clicking on the switch you can toggle it to OFF – then the clause processing is suppressed and has no effect.
- *The clause condition* – a logic expression. When result of the expression is true (= logic 1) the clause action is performed. If the result is false (= logic 0), the action is not performed (=suppressed).

The clause condition can :

- be empty – then appropriate clause action is performed permanently (empty condition gets true result)
- be created by one condition item only (for example *the quantity value condition* )
- be formed by combination of two or more *condition items* joined with  and  operators ( see the clause No. 2 in the example above)
- *The clause action* – with the actions you can set various functions concerning usually instrument inputs and outputs. Typical action are, for example, a digital output control or an analog input processing.



The symbol  is neither condition, nor operator nor an action – it is the button with which you can add conditions or actions into the clause.

Even if no I/O action is set the I/O Management folder contains one empty clause “template” with the -buttons prepared for new clause definition.

To add new clause, click on the -button in the action (= right) field of an empty clause template. In the pop-up menu choose required action. You can add either one or up to two actions into the same clause.

Optionally, you can add one or more conditions too with corresponding -button in the condition (=left) field. If more conditions added, you must set the logic operators OR/AND - simply click on it to toggle its value.



When designing the condition expression, note that the AND operator has higher priority - firstly, subexpressions joined with the AND-operators are evaluated and then the rest of the expression with the OR-operators.

To remove an action or a condition from a clause, click on it and press the *Delete* button in the the condition/action properties field (or push the *Delete* key).

For temporary disabling or enabling any of the clauses use the ON / OFF clause switch. When OFF, the clause operation is suppressed, but it stays in the setup prepared for future use.

## 5.2.1 I/O Setup Actions

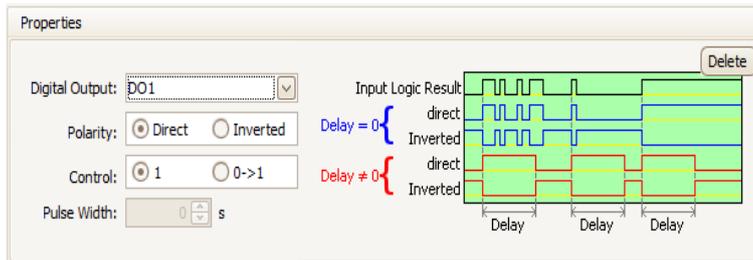
### 5.2.1.1 Digital Output (Standard, DO/RO)

In combination with a suitable condition (see *the quantity value condition* description below) you can create simple two-point controller or indicator with this action. This type of action will be called as *standard output*.

Add the *Digital Output* action and set :

- desired *digital output*
- *polarity* ... choose *Direct* if the output to be switched *on* under true result of corresponding clause condition and vice versa
- *control* ... when set to 1 the output state simply follows the condition result value. If set to  $\uparrow$  the output switches on/off (depending on the polarity setup) temporary for preset *pulse width* only when the condition result changes *from false (0) to true (1)*

Fig. 5.3: I/O Setup – Standard Digital Output Action Properties



For simple „manual“ control of a digital output add the standard digital output action without any condition („empty“ condition gets permanent true (=1) result). Then set desired polarity and send the setup into the instrument..

### 5.2.1.2 Alarm Light (A)

Alarm lights A1, A2 can be set in the same way as digital outputs (see above) and used for indication of various events on the instrument display.

### 5.2.1.3 Pulse Output (PO)

Any of digital outputs or alarm lights can be set as transmitting electricity meter. The frequency of generated impulses can be set depending on values of measured electric energy by the embedded electricity meter unit.

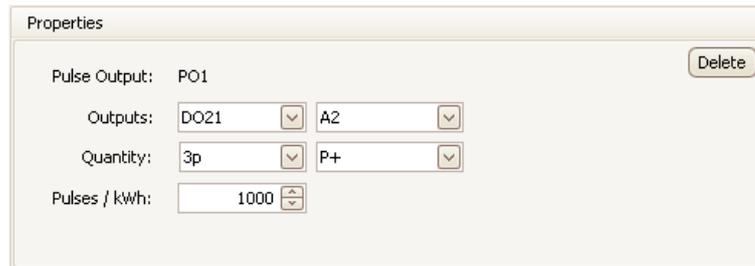


You can set to impulse output mode not only the *I*-type (solid-state) outputs, but the *R*-type (electromechanical relay) outputs too. But note lifetime of electromechanical relays, they have limited number of switching operations.

For pulse output following parameters must be set :

- target *digital output*
- target energy quantity ... the transmitted energy must be chosen here (see the electricity meter description for the energies explanation)
- number of *pulses per kWh/kvarh/kVAh*

Fig. 5.4: I/O Setup – Pulse Output Action Properties




You can set one of alarm lights (A1, A2) as pulse output too and then you can check the pulse function on the instrument display simultaneously.

### 5.2.1.4 Pulse Switch

The pulse switch action is designed to control switches or contactors that require two signals : one for switch-on and the second for switch-off.

Select digital outputs for switch-on and for switch-off and set the switching pulse width. Next add a condition for the pulse switch action.

Fig. 5.5: I/O Setup – Pulse Switch



After the setup, if any change of the condition occurs, pulse of specified duration appears :

- on the output set as *On*, when false-to-true change
- on the output set as *Off*, when true-to-false change

### 5.2.1.5 Frequency Counter (FC)

The digital input can be used for monitoring of a quantity depending on frequency or duty cycle of incoming pulses.

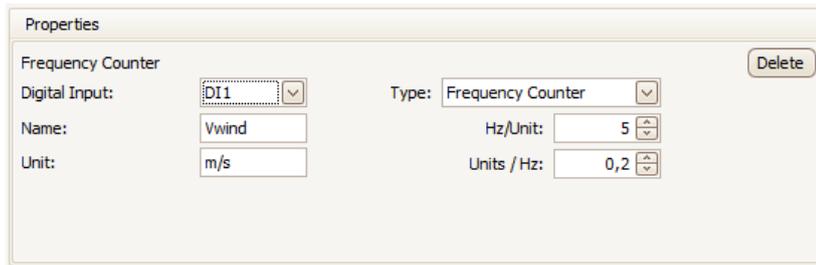
#### 5.2.1.5.1 Frequency Mode

As example, flowmeters or anemometers with pulse output (often the „S0-type“) can be connected and the instrument can measure and record a flow rate or a wind speed. So despite being so called, this quantity is not any counter but a frequency controlled quantity.

Select an empty clause and add the *Frequency Counter* action. In the *Type* field choose *Frequency*. In the *Properties* field below you can set :

- *name* of the quantity (for example *Vwind*)
- *unit* of the quantity (*m/s*)
- transformation ratio in one of two formats :
  - either *Hz / Unit ...* frequency of the input pulses in hertz corresponding to one unit
  - or *Units / Hz ...* value of the quantity (in the set units) in case the input pulse frequency is 1 Hz

Fig. 5.6 : I/O Setup – FC Action Properties



If the name is not defined, the quantity is referenced with its general name *FCxx* (when the *xx* is index of corresponding digital input).

### 5.2.1.5.2 PWM Mode

In this mode the duty cycle of incoming signal controls the counter value. Such signal is often called *PWM* (Pulse With Modulation) too.

In the *Type* field choose *PWM*. The other settings are the same as that of *Frequency* type excluding the transformation ratio – it is specified with limit values for duty of 100% (permanently active input) and 0% (permanently inactive input).

### 5.2.1.6 Pulse Counter (PC)

Similarly, counters of incoming pulses can be checked for all of digital inputs. The counters usually represent amount of a media passing since last counter clearing.

Add the *Pulse Counter* action and set :

- *name* of the counter (for example *Barrel1*)
- *unit* of the quantity (*hl*)
- transformation ratio in one of two formats :
  - either *Pulses / Unit* ... number of the input pulses corresponding to one unit
  - or *Units / Pulse* ... value of the quantity (in the set units) corresponding to one pulse

Fig. 5.7 : I/O Setup – PC Action Properties



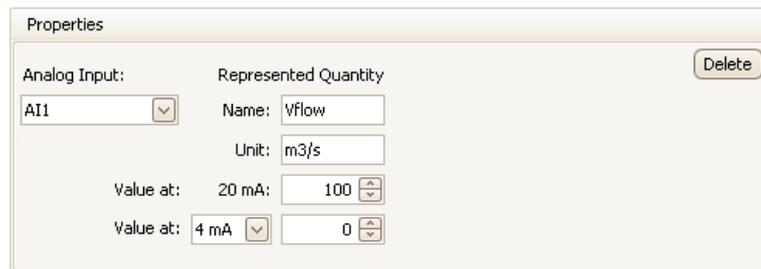
If the name is not defined, the quantity is referenced with its general name *PCxx* (when the *xx* is index corresponding digital input).

### 5.2.1.7 Analog Input (AI)

For each of the analog inputs there must be specified :

- *analog input* number
- represented quantity *name*
- represented quantity *unit*
- input type and *conversion ratio* ... choose either "10V" or „20mA" input type and the values of represented quantity for 10V / 20mA and 0V / 4(0)mA, respectively

Fig. 5.8 : I/O Setup – Analog Input Properties




If an analog input is capable to measure residual current too, appropriate  $I\Delta$  residual current is measured on the input as default, using the  $CT_{RCM}$  ratio specified in the Installation group of parameters.

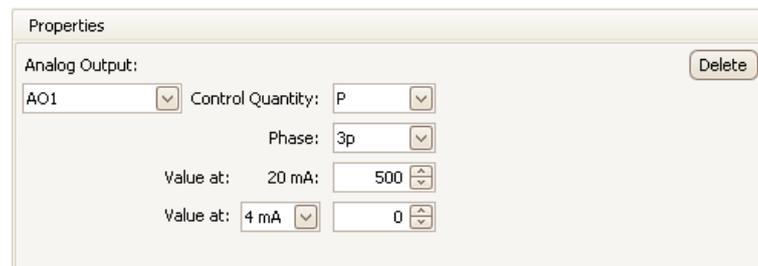
But as soon as the analog input action is defined in the I/O block setup, the residual current monitoring on this input is suppressed and appropriate  $I\Delta$  value is no longer available, because the input is used for a 20 mA current loop signal now.

### 5.2.1.8 Analog Output (AO)

Analog outputs require following parameters to be set :

- *analog output number*
- *control quantity & phase ...* select desired quantity to be transmitted to the output. Both single-phase and three-phase quantities or logical AND/OR of them can be chosen.
- *conversion ratio ...* values of control quantity corresponding to 20mA and 4(0)mA

Fig. 5.9 : I/O Setup – Analog Output Properties




If the conversion ratio is defined with the 4/20 mA form, output current never drops under 4 mA – this minimum output current is kept even if corresponding control quantity is lower in order to supply possible passive receivers connected.

Output current is limited to maximum value of 22 mA.

### 5.2.1.9 Send Message

With this action a simple message can be transmitted to chosen communication interface. The message must be entered in hexadecimal format.

The message is sent as soon as corresponding condition changes from false to true. With the *Repetition* option, you can set multiple transmissions of the message.

Fig. 5.10 : I/O Setup – Send Message

The 'Properties' dialog box contains the following fields:

- Port: COM 1 (dropdown menu)
- Repetition: \* 1 (dropdown menu)
- Message Example (Hexadecimal format):
  - Input field: C8 10 09 00 00 01 02 00 00 05 05
  - Output field: 53 4F 53
- Delete button

### 5.2.1.10 Send Email

Similar function as the previous action. Besides the message you can set the message *subject* too - both in text format.

Fig. 5.11 : I/O Setup – Send Email

The 'Properties' dialog box contains the following fields:

- Subject: Trafo State Warning
- Message: Load > 120%
- Delete button

Furthermore, recipient must be specified in the *Communication* setup folder. Enable the *Email* option and set email parameters according application note No. 003 : *E-mail Usage for Status Notifications* .

Fig. 5.12 : Communication Setup Example for the Send Email Action

The 'Instrument Configuration' window shows the following settings for the 'Email' tab:

- Enabled:  Send test email
- Server address: smpt.seznam.cz
- Port: 25
- Status: **SMTP unreachable (click ...)**
- Encryption: None
- Authentication: Plain password
- User name: PQL@email.cz
- Password: PQL@email.cz
- From email: PQL@email.cz
- To email: PQL@email.cz
- Maximum emails: 5
- In 1 minute: 10
- In: day
- Log all sent emails:

### 5.2.1.11 Time Synchronization

Instruments that have internal real time counter (RTC) can be used for time synchronization of other instruments using this action.

Select digital output where the synchronization pulse to be sent to and choose the transmitting period to PPS or PPM. The synchronization pulse width is fixed : 200 ms.

Fig. 5.13 : I/O Setup – Time Synchronization Output



### 5.2.1.12 Archive Control

With this action you can control recording of measured data into the instrument archive.

You can set one of two operating modes :

- *Continuous* ... data recording runs when corresponding condition is true and stopped when false
- *Duration* ... data recording starts as soon as corresponding condition changes from false to true; after the period defined in the field *Duration* expires, the recording is stopped; then waits for the next false->>true change of the condition

Fig. 5.14 : I/O Setup – Archive Control



If no archive control action is set, the recording runs permanently.

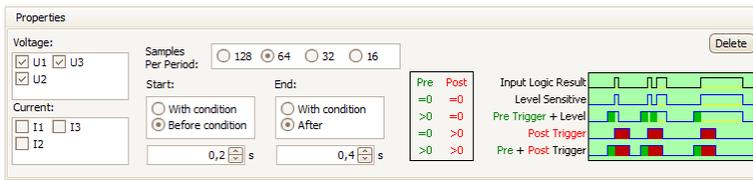
### 5.2.1.13 General Oscillogram

This action is available when appropriate firmware module is installed only. It enables to record courses of measured voltages and currents in graphical form.

In the setup screen you can set :

- voltage and current signals to be recorded
- sampling rate of recording
- duration of record before (pretrigger) and after (posttrigger) the false-to-true triggering condition change

Fig. 5.15 : I/O Setup – General Oscilloscope



Then, the oscillograms are recorded as soon as corresponding condition changes from false to true or the recording can be controlled by the condition value - see the application note *General Oscilloscope Firmware Module*.



Usually, the VE-All device state condition is optimal for the oscillogram record triggering. See the Device State Condition description below.



Check, if sufficient part of memory is allocated for the oscillogram recording in the memory setting folder ! Otherwise no records will be created !

### 5.2.1.14 Variable

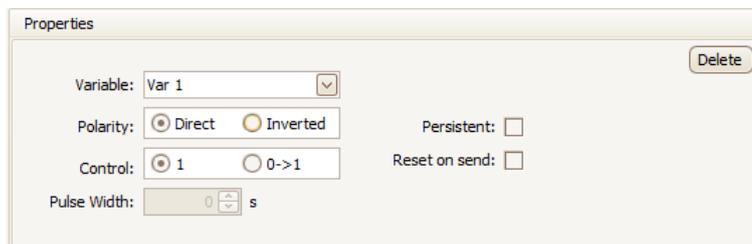
With this action you can design more complex conditions in a clause than can be designed with basic conditions only.

Value of the variable is evaluated from the condition defined in the clause using the parameters below. Then it can be used in logic expressions of conditions in any of other clauses.

Add the action and choose its name *Var x*, where *x* is its serial number from 1 up to 16. Then set :

- *Polarity* ... if direct or inverted result of condition defined in the clause is used for the variable evaluation
- *Control* ... if the variable is the condition value controlled (1, "level-controlled") or the condition value change controlled (0→1, "slope-controlled")
- *Pulse Width* ... if the variable is slope-controlled (control = 0→1), this option defines the time for which the variable keeps true after being set to; then it gets back to false automatically
- *Persistent* ... as soon as the variable gets true this option "glues" the value until being reset back to false manually
- *Reset on send* ... if the variable keeps true due to the *Persistent* option, it is possible to force it back to false by checking this option and sending into the instrument

Fig. 5.16 : I/O Setup – Variable



Now specify condition for this action, for example :

Fig. 5.17 : I/O Setup – Condition Example of the Variable Action

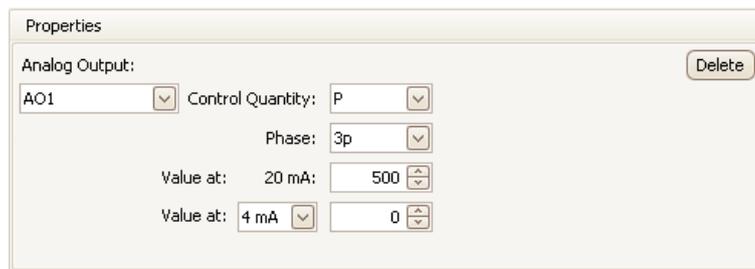


Then the variable is controlled by the condition and can be simply used in other clauses as another condition *Var1* - see the chapter *I/O Conditions* below.



During the I/O block initialization after the instrument power-up or restart, all of the variables (excluding that keeping true due to the Persistent option) are set to false. After each of the I/O block evaluation step, variable values are stored and used in the next step. See the *I/O Block Processing* chapter.

Fig. 5.18: I/O Setup – Analog Output Properties



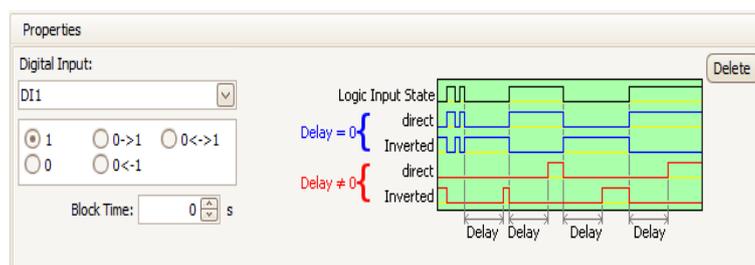
## 5.2.2 I/O Setup Conditions

### 5.2.2.1 Digital Input Condition

Click on the **+**-button in the condition part of target clause and choose the *Digital Input* option. Then you must set :

- desired *Digital Input*
- $1/0/0 \leftrightarrow 1/1 \leftrightarrow 0/0 \leftrightarrow 1$  ... state (=level controlled mode) or state change (=slope controlled mode) of the digital input that gets the condition *true* (logical 1).  
If any of state change set and the digital input keeps the same value as in the previous I/O block evaluation cycle the condition result is false.
- *Block Time* ... minimum duration of stable digital input state (relevant for level-controlled mode only). If not zero, quick changes of the input signal are “filtered” and new state of the condition result occurs only if the signal lasts for at least set block time. This setup is indicated with the “b” character in the condition icon.

Fig. 5.19 : I/O Setup – Digital Input Condition Properties

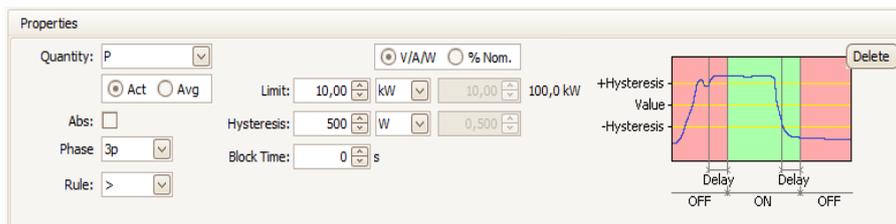


## 5.2.2.2 Measured Quantity Condition

Values of main measured quantities can be used as condition in the I/O setup clauses. Selected quantity size is compared with preset limit and gets either true(1) or false(0) result. For this, the following parameters must be preset :

- *Quantity & Phase* ... desired control quantity (single- or three-phase or AND/OR combination of them)
- *Actual or Average* ... desired value of the control quantity
- *Abs* ... check if absolute value of control quantity to be evaluated (relevant for bipolar quantities only)
- *Rule* ... specifies polarity of deviation between the control quantity and the preset limit value for true result of the condition
- *Limit Value* ... limit value of the control quantity – either in basic units or percent of nominal value ( $U_{NOM}$  /  $I_{NOM}$  /  $P_{NOM}$  )
- *Limit Hysteresis* ... defines the insensibility range of the condition state evaluation
- *Block Time* ... defines minimum continuous duration of appropriate magnitude of control quantity until the condition result changes

Fig. 5.20 : I/O Setup – Measured Quantity Condition Properties




If value of the control quantity is not defined result of the condition is false.

## 5.2.2.3 Device State Condition

The condition can be configured to monitor various events mostly concerning the power quality (voltage events, power failures, rapid voltage changes etc.) or some instrument state changes.

Select desired event and – if applicable – check phases to be evaluated.

With the *Control* option you can set manner of event appearance evaluation :

- **1** ... if any of events **appeared** (i.e. originated during present evaluation cycle or persisted from the previous one) result of the condition gets **true**; otherwise it gets **false**
- **0→1** ... if any of events **originated** during present evaluation cycle (i.e. not persisted), result of the condition gets **true**; if no of events originated (i.e. any did not appear at all or lasted only) it gets **false**

Fig. 5.21 : I/O Setup – Device State Condition Properties




If the „0→1” control is set, all of events at all of set phases are evaluated individually and independently on each other. For example, if an interruption on phase L1 lasted for all the evaluation cycle and simultaneously a swell occurred on phase L2, the result of condition is true.

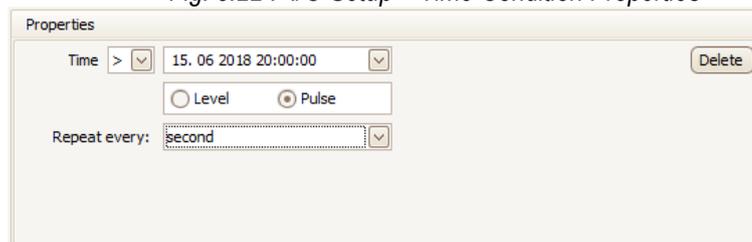
For further details, see the application note *General Oscillogram Firmware Module*.

### 5.2.2.4 Time Condition

This condition can be used as a single timer.

- *Time* ... date & time since the condition result either gets true forever or starts pulsing
- *Fixed / Pulse* ... if *Fixed*, the condition gets true forever after the specified date & time passes; if *Pulse*, the condition gets true periodically (for one I/O block evaluation cycle) with the *Repeat every period*

Fig. 5.22 : I/O Setup – Time Condition Properties

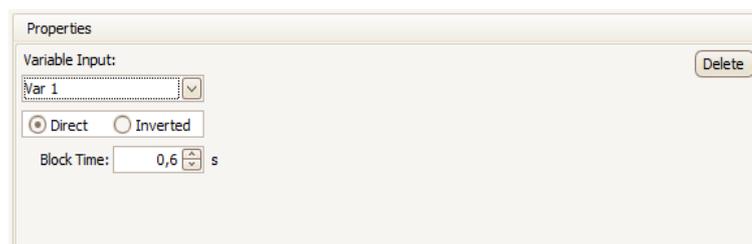


### 5.2.2.5 Variable Condition

If any *Variable* action is defined (see description above), it can be used in the same way as other basic conditions.

The setup is similar as the digital input condition – specify the variable number, polarity and the block time.

Fig. 5.23 : I/O Setup – Variable Condition Properties

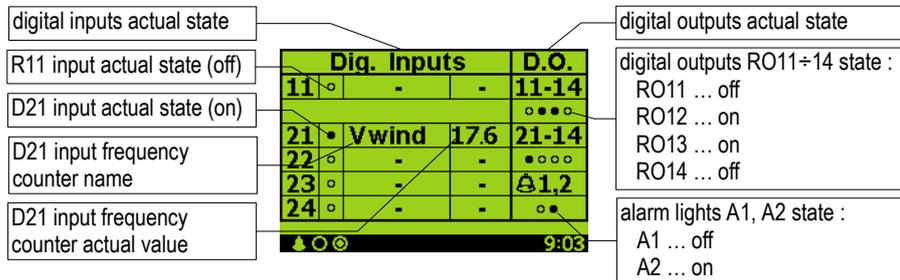


## 5.3 I/O Actual Data Presentation

### 5.3.1 Digital and Analog I/O

At the end of the actual data branch, the digital I/O actual state screen and, if set, the analog I/O state screen can be listed.

Fig. 5.24 : Digital I/O Actual Data Screen Example



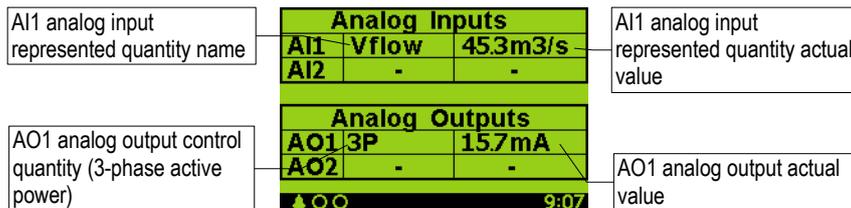
The digital I/O actual data screen shows actual state of all of the inputs and outputs :

- ... off-state (or inactive : the input voltage below defined threshold or open output)
- ... on-state (or active : the input voltage over defined threshold or closed output)

If a digital input frequency counter processing is set, its name (*Vwind* on the example) and actual value (*17.6*) is shown in appropriate line too. Otherwise, a dash is displayed only.

If any of analog quantities processing is set too, the analog I/O actual data screen is shown in the branch (otherwise, it is skipped) :

Fig. 5.25 : Analog I/O Actual Data Screen Example



The analog input represented quantity value corresponds to actual input current or voltage at appropriate analog input according to the set ratio. At the example, the represented quantity *Vflow* has actual value of  $45.3 \text{ m}^3/\text{s}$ .

Similarly, the analog output current value corresponds to the set control quantity value – the *3P* means that three-phase active power actual value is transmitted to the analog output AO1 as  $15.7 \text{ mA}$ .



*Real value of transmitted analog output current correspond to the displayed value only when the device input impedance connected to the output complies to the technical specifications of the analog outputs – see the Technical Specifications chapter below.*

### 5.3.2 Pulse Counters

If at least one pulse counter action is used in the I/O setup the pulse counters screen can be listed in the electricity meter branch.

Fig. 5.26: Pulse Counters Screen Example

Pulse Counters	
-	- -
-	- -
Bar1	000005060.6 hl
-	- -
-	- -
	
16:00	

The table of the pulse counters has separate line for each digital input (DI1, DI21÷DI24). Actual pulse counter value recalculated to preset pulse counter quantity units is displayed in appropriate line including its name and unit (shortened to 4/3 characters).

## 5.4 I/O Processing

Processing of digital input in frequency & pulse counter function is described in separate chapter below.

Outputs are processed each *measurement cycle* that equals to 200 ms at nominal frequency. With this period, the device monitors and evaluates the digital input and controls all of outputs.

### 5.4.1 Digital Inputs

#### 5.4.1.1 Digital Input Filter

Digital inputs are monitored with the period of 0.2 ms. For interference suppression, the signal is filtered digitally (by firmware). Default limit frequency of the filter is preset to 100 Hz.

The filter limit frequency can be set in *Advanced* parameters. *The DI filter minimum pulse width* parameter defines minimum pulse/gap width in milliseconds. When, for example, limit frequency of 100 Hz is desired set the parameter to 50 ms (pulse 50ms + gap 50 ms = 100ms). Pulses and gaps shorter than the set limit will be filtered.



*It is not recommended to increase the limit frequency too much. Otherwise interference spikes can cause false measurement.*

*On contrary, when maximum output frequency of a sensor connected to the instrument is lower than 100Hz, it is suitable to decrease the limit frequency to corresponding value.*

#### 5.4.1.2 Digital Input as Frequency Counter

##### 5.4.1.2.1 “Frequency” Mode

The frequency counter operation is based on measurement of duration between last two pulses. After the instrument startup, the quantity value is set to zero until at least two pulses come. Then the counter value is evaluated periodically each measurement cycle (cca 0,2 s).

##### 5.4.1.2.2 “PWM” Mode

The quantity value is controlled by duty cycle of incoming signal. Evaluation runs as follows :

- after the instrument startup, the quantity value is undefined for 50 measurement cycles (cca 10 s)
- then the value is evaluated periodically each measurement cycle (cca 0,2 s)

- if the duty cycle drops below 0,5%, it is rounded to 0%; if it exceeds 99,5% it is rounded to 100%

### 5.4.1.3 Digital Input as Pulse Counter

The pulse counters have capacity of  $2^{32} - 1$  pulses. Then overflow occurs and the counter starts to count from zero again. Contents of the counters is maintained in case of power failure.

Actual state of the counters can be checked via a communication link only using the ENVIS-Daq program.

## 5.4.2 Digital Outputs

Digital outputs are processed and refreshed after each measurement cycle, i.e. usually every 200 ms.

The only exclusion are the outputs set to *pulse function*.

### 5.4.2.1 Pulse Outputs

After the pulse function mode is set, every 200 milliseconds the instrument executes evaluation of the measured electric energy. If the increment of recorded electric power is higher or equal to the quantity of power per one pulse, the instrument will transmit one or two pulses. The mentioned description shows that the fluency of pulse transmission is +/- 200 ms.

The pulse width and minimum pulse gap are 50 / 50 ms (compliant with so-called S0-output definition), maximum frequency is 10 pulses per second.

## 6. Computer Controlled Operation

Monitoring the currently measured values and the instrument setup can be done not only on the instrument panel but also using a local or remote computer connected to the instrument via a communication link. Such an operation is more comfortable, and it also allows you to use all the options of the instrument, such as adjusting the inputs/outputs or setup and the monitoring of courses recorded into the internal memory of the instrument, which it is not possible from the panel of the instrument.

Following chapters describe instrument communication links from the software point of view and embedded webserver only. The detailed description of ENVIS program can be found in the program manual.

### 6.1 Communication Links

#### 6.1.1 Local Communication Link

Instruments can be equipped with a serial interface USB 2.0, on the front panel. Using this interface, adjusting the parameters of the instrument and the transmission of data into a portable computer can be accomplished. It requires to interconnect the instrument with the PC using the appropriate communication cable (connector type "B", see optional accessory list).

Considering the fact that the instruments can be also equipped with a remote communication link, the described communication link is called *Local*.

#### 6.1.2 Remote Communication Links

The instruments may be optionally equipped with the remote communication link for operation of the instrument via a remote computer. Subsequently, this computer can execute a remote adjusting of the instrument and transmission of current or recorded data.

The type of interface can be either RS-485 or Ethernet. Appropriate connector is situated at the rear panel. It is supposed the cable for remote communication link to be provided by customer.

One or more instruments can be connected to the remote PC via this link. Each instrument must have an adjusted proper remote communication address and protocol. These specifications can be set manually or by the computer via a local communication link in ENVIS program.

The remote communication link is always isolated from the internal circuits of the instrument.

Selected models can be equipped with the second communication link RS-485.

#### 6.1.3 RS-485 Interface (COM)

Up to 32 instruments at a maximum distance of 1,200 metres can be connected to this interface. Used signals : **A** , **B** , **G** , and optionally **A2** , **B2** , **G2** .

Tab. 6.1 : RS-485 Remote Communication Links Wiring

COM1 interface		COM2 interface	
signal	terminal No.	signal	terminal No.
A	41	A2	44
B	42	B2	45
G	43	G2	46

Each instrument must have a different communication address within the range of 1 to 253 preset during the installation.

A 232/485 or USB/485 level converter connected to a standard serial port must be installed on the computer side. The converter must provide an automatic communication flow direction switching function. For suitable converters see optional accessory list.

Both of the links are insulated both from the instrument internal circuitry and mutually too, terminals No. 43 and 46 *are not connected internally!*

### 6.1.3.1 Communication Cable

For common applications (cable length up to 100 metres, communication rate up to 9,600 Bd) the selection of the right cable is not crucial. It is practically possible to use any shielded cable with two pairs of wires and to connect the shielding with the Protective Earth wire in a single point.

With cable lengths over 100 metres or with communication rates over 20 kilobits per second, it is convenient to use a special shielded communication cable with twisted pairs and a defined wave impedance (usually about 100 Ohm). Use one pair for the **A** and **B** signals and the second pair for the **G** signal.

Recommended wire type: shielded double twisted pair 2 x 2 x 0.2 mm<sup>2</sup>, for example Belden 9842 or Unitronic Li2YCY (Lappkabel)

Recommended minimum conductor cross-section : 0.2 mm<sup>2</sup>

Maximum conductor cross-section : 2.5 mm<sup>2</sup>

### 6.1.3.2 Terminating Resistors

The RS-485 interface requires impedance termination of the final nodes by installation of terminating resistors, especially at high communication rates and long distances. Terminating resistors are only installed on the final points of the link (for example one on the PC and another on the remotest instrument). They are connected between terminals **A** and **B**. Typical value of the terminating resistor is 120 Ohm.

### 6.1.4 Ethernet (IEEE802.3) Interface

Using this interface the instruments can be connected directly to the local computer network (LAN). Instruments with this interface are equipped with a corresponding connector RJ-45 with eight signals (in accordance with ISO 8877), a physical layer corresponds to 100 BASE-T.

Type and maximum length of the required cable must respond to IEEE 802.3.

Each instrument must have a different IP- address, preset during the installation. The address can be set from the instrument panel or you can use the ENVIS-DAQ program. For detection of actual IP- address you can use *the Locator* function.

Furthermore, you can set the DHCP function for dynamic IP-address allocation.

## 6.2 Communication Protocols

The remote communication link parameters must be set according chapter *Remote Communication Setting* - see above.

### 6.2.1 KMB Communications Protocol

This manufacturer proprietary protocol is used for communication with ENVIS program.

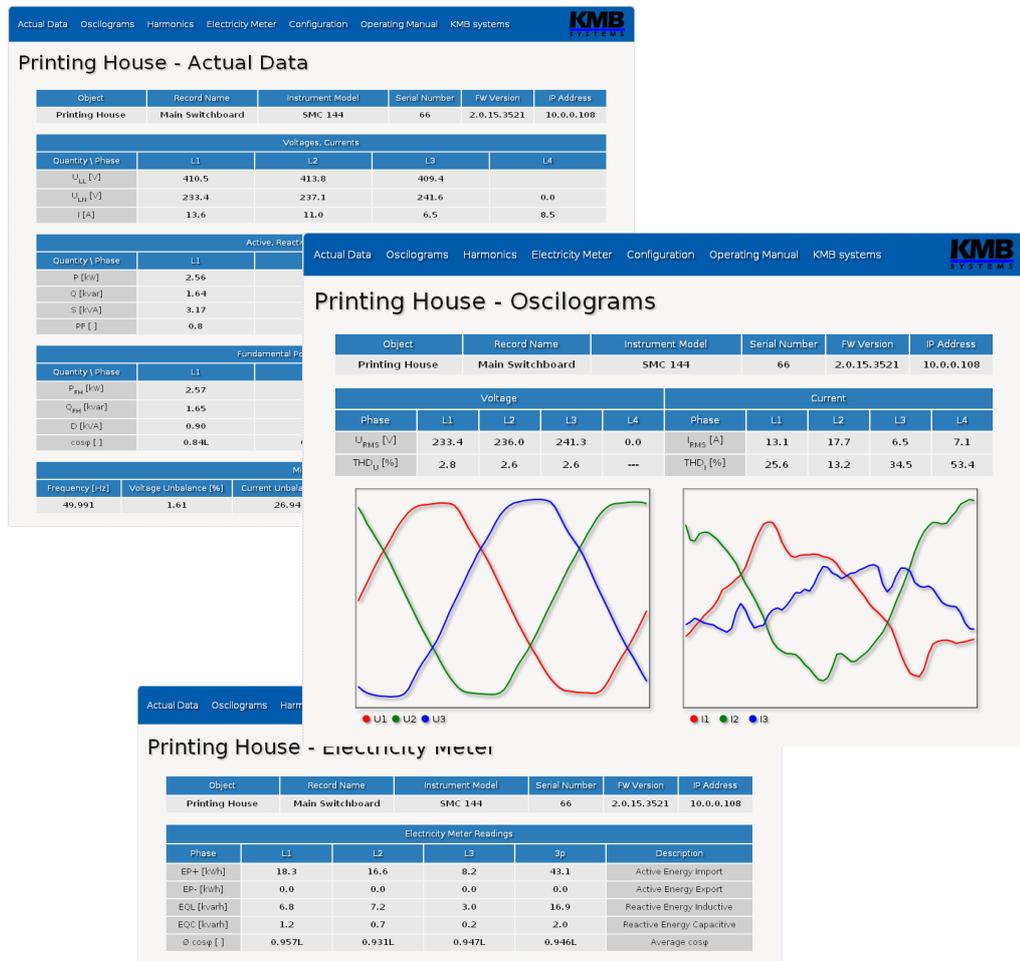
## 6.2.2 Modbus-RTU Communications Protocol

For the chance of easier integration of the instrument to the user's program, the instrument is also equipped with the Modbus - RTU communications protocol. A detailed description of the communications records can be found in an appropriate manual.

## 6.3 Embedded Webserver

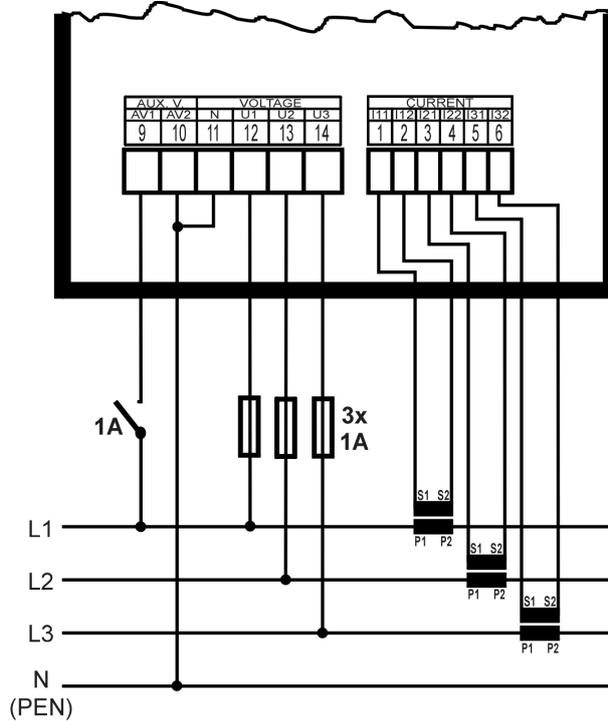
All of instruments with Ethernet remote communication interface are equipped with an embedded webserver, thus both all of main measured values and the instrument setting can be viewed with a standard web browser. It requires to set properly the instrument remote communication parameters and to connect it to the network. Then in the web browser enter appropriate IP-address of the instrument and information from the instrument appears as shown on Fig. 6.1.

Fig. 6.1 : Webserver



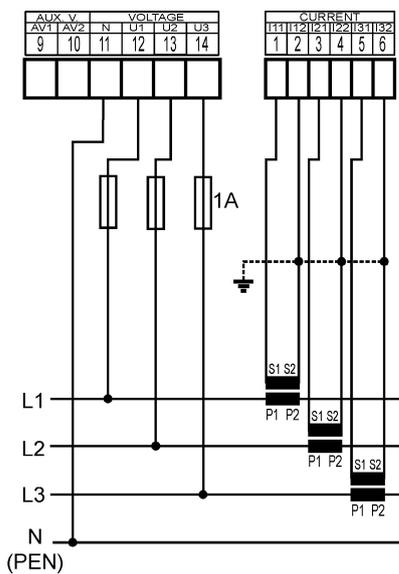
# 7. Examples of Connections

## SMZ 133 H 230 X/5A – CTs with 5A Secondary Nominal Current, TN-Network, Direct Star (“3Y”) Connection

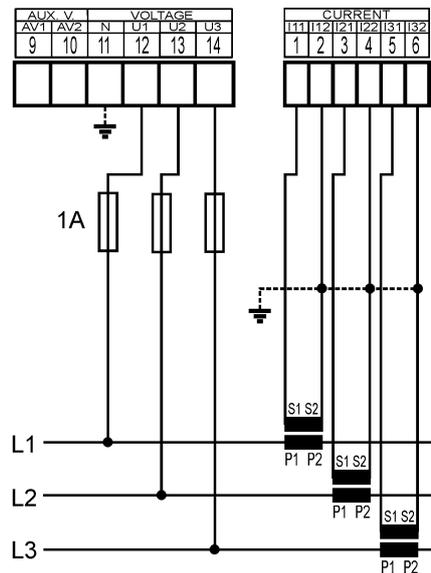


## SMZ 133 ... X/5A – Measured Signals Connection Examples

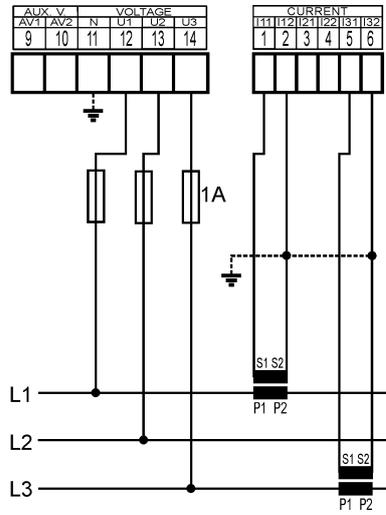
TN Network  
Direct Star (“3Y”) Connection



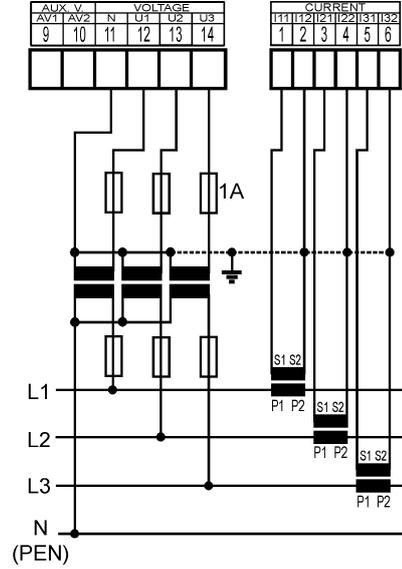
IT Network  
Direct Delta (“3D”) Connection



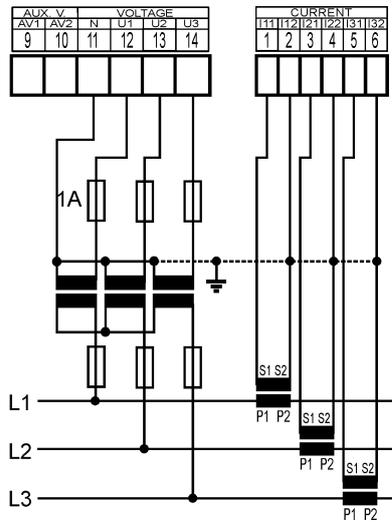
*IT Network  
Direct Aron ("3A") Connection*



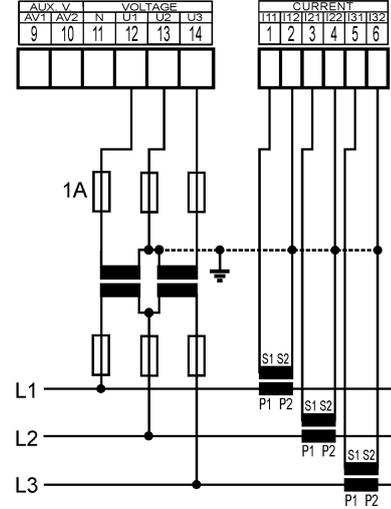
*TN Network  
Star ("3Y") Connection via VT*



*IT Network  
Delta ("3D") Connection via VT  
(VT to Line-to-Neutral Primary Voltage)*

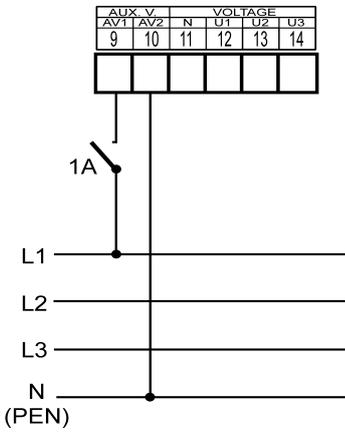


*IT Network  
Delta ("3D") Connection via VT  
(VT to Line-to-Line Primary Voltage)*

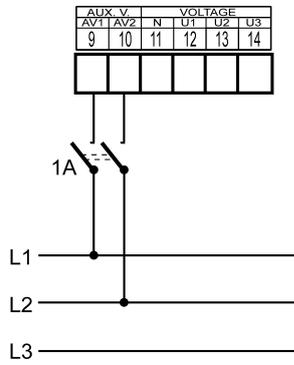


### SMZ 133 ... – Power Supply Options

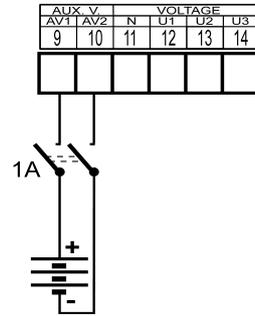
Line-to-Neutral Voltage  
AC Power Supply



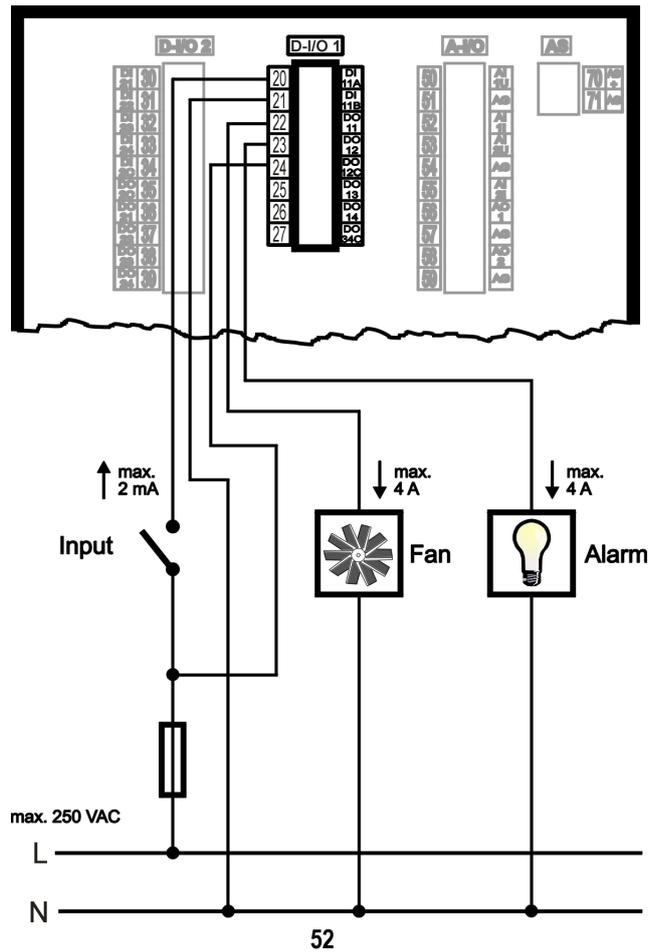
Line-to-Line Voltage  
AC Power Supply



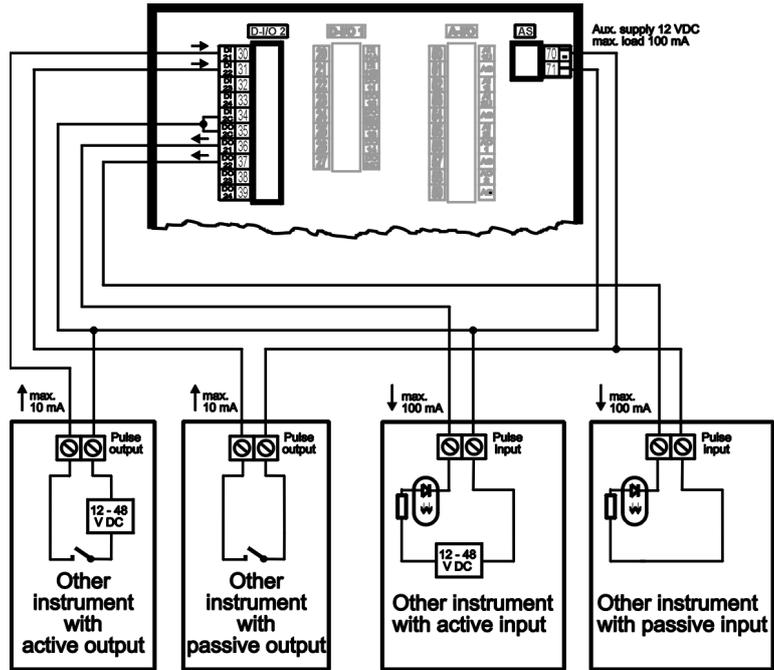
DC Power Supply



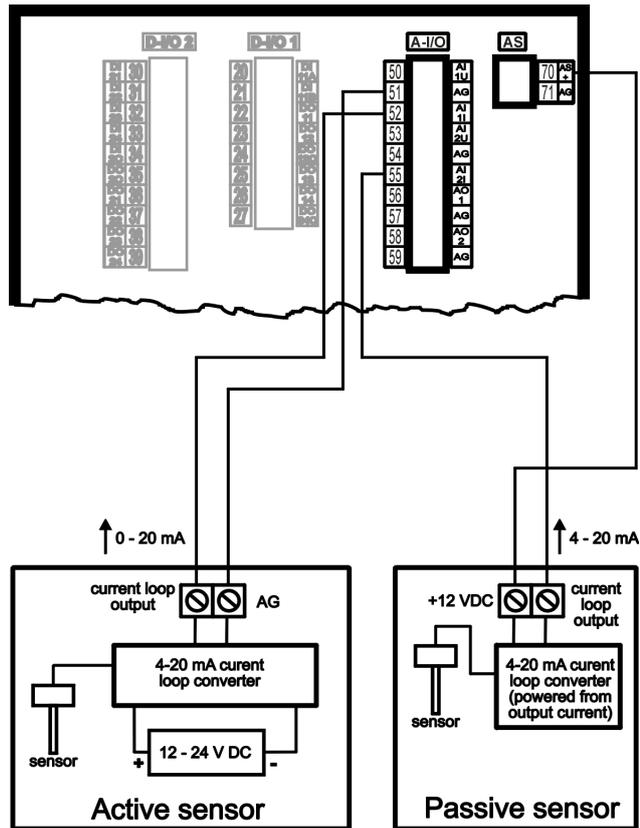
### SMZ 133 ... 230 V AC Type Digital I/O Connection Example



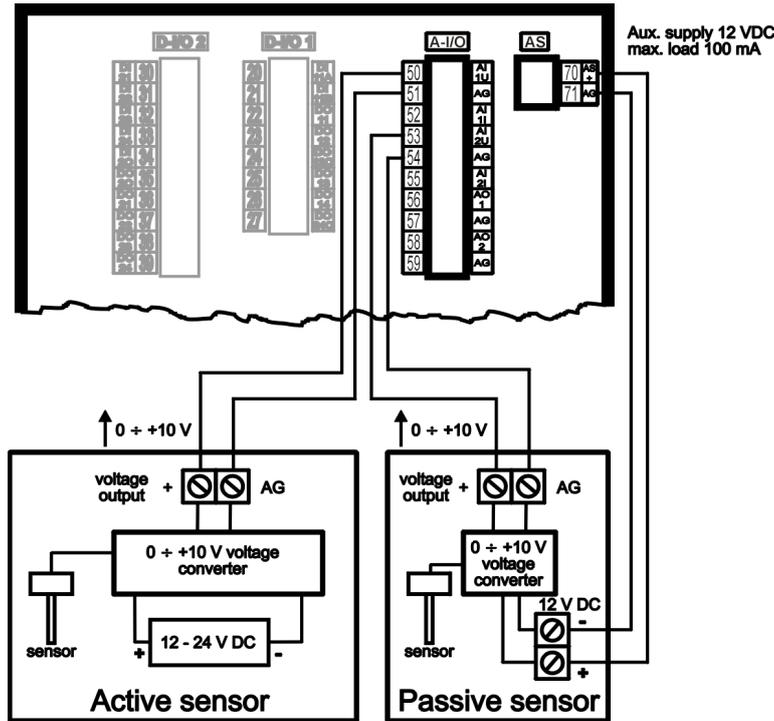
### SMZ 133 ... 12/24 V DC Type Digital I/O Connection Example



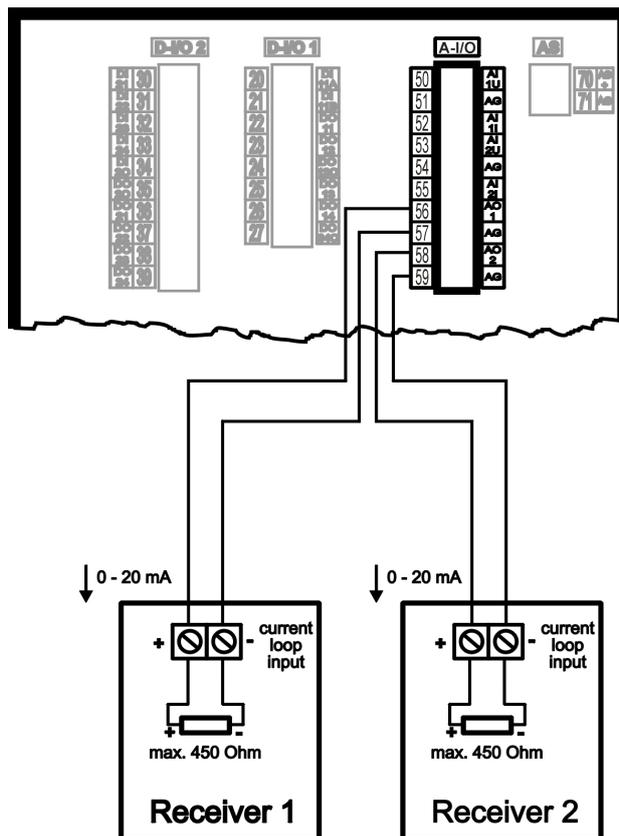
### SMZ 133 ... 0 ÷ 20 mA Analog Inputs Connection Example



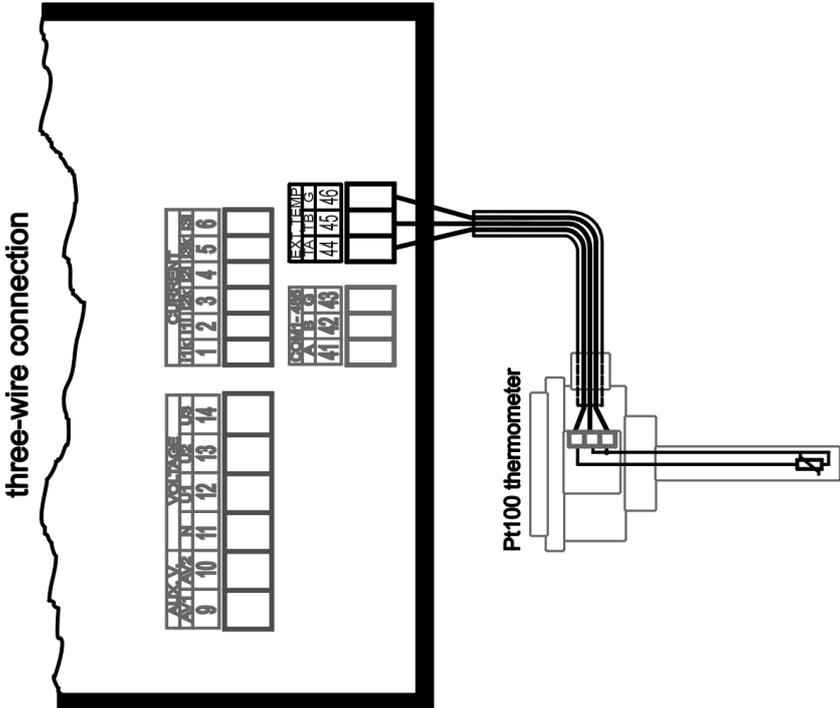
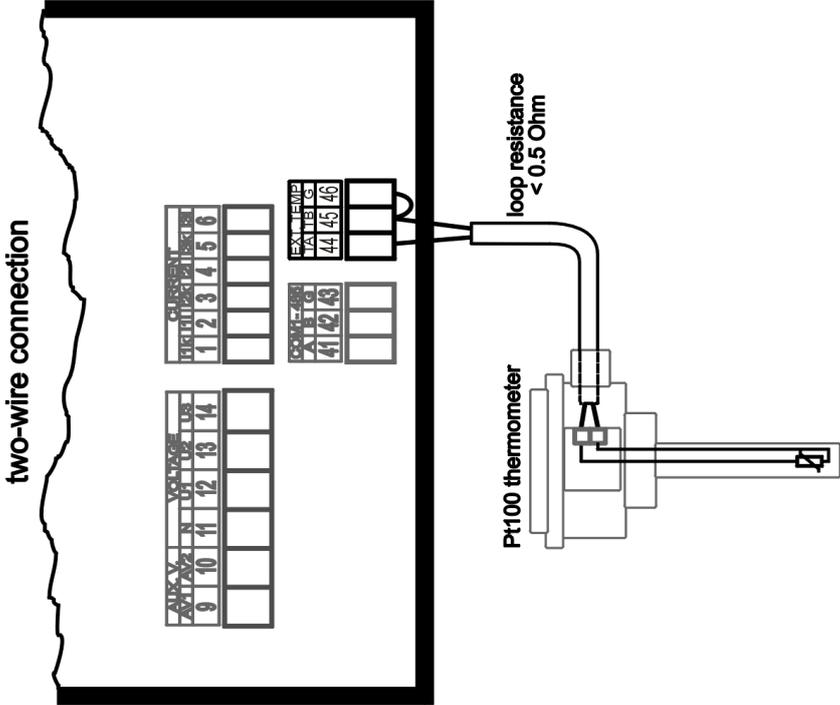
### SMZ 133 ... 0 ÷ 10 V Analog Inputs Connection Example



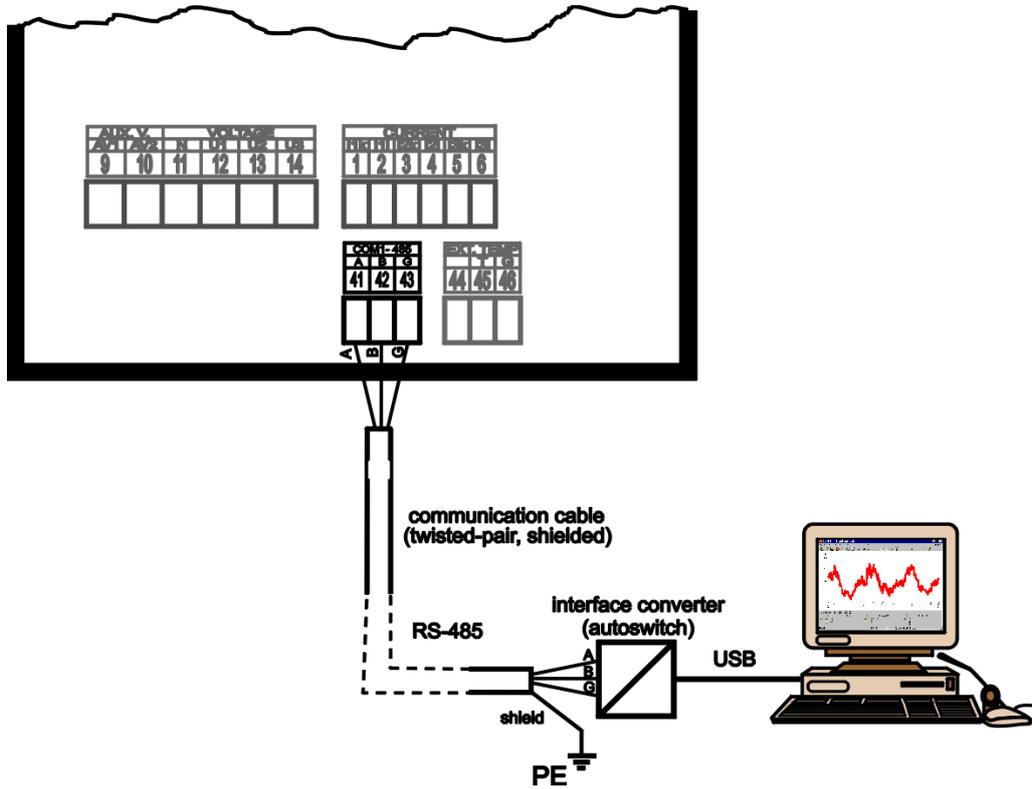
### SMZ 133 ... 0 ÷ 20 mA Analog Outputs Connection Example



### SMZ 133 ... Pt100 Temperature Sensor Connection



### SMZ 133 ... 4 Remote RS485 Communication Link Connection



# 8. Manufactured Models and Marking

	<b>SMZ</b>	<b>133</b>	<b>H</b>	<b>400</b>	<b>X/5A</b>	<b>R</b>	<b>I</b>	<b>A</b>	<b>ET</b>
<b>Instrument Model</b> SMZ 133 = Power analyser with internal memory									
<b>Auxiliary Power Supply</b> H = 75 V ÷ 500 VAC, 90 V ÷ 600 VDC S = 10 V ÷ 26 VAC, 10 V ÷ 36 VDC L = 20 V ÷ 50 VAC, 20 V ÷ 75 VDC									
<b>Nominal Measuring Voltage</b> 400 = 400V/690V 230 = 230V/400V 100 = 57,7V/100V									
<b>Current Inputs</b> X/5A = 5A AC and 1A AC (standard indirect measurement)									
<b>Digital I/O 1</b> R = 4× relay output + 1× logical input 100 ÷ 230VAC									
<b>Digital I/O 2</b> I = 4× pulse output + 4× logical input 24V									
<b>Analog I/O</b> N = No analog I/O A = 2× analog output 0/4÷20mA + 2× analog input 0/4÷20mA + 12VDC aux. supply									
<b>Communication Interface and External Thermometer Input</b> N = USB, without remote communication and thermometer input 4T = USB, RS-485, input for Pt100 thermometer ET = USB, Ethernet, input for Pt100 thermometer E4 = USB, Ethernet, RS-485									

## 9. Technical Specifications

Function Characteristics according to IEC 61557-12				
Model „230 X/5A“, $U_{NOM} = 230\text{ V}$ , $I_{NOM} = 5\text{ A}$				
Symbol	Function	Class	Measuring range	Notes
<b><i>P</i></b>	total effective power	0.5	0 ÷ 5400 W	
<b><i>QA, QV</i></b>	total reactive power	1	0 ÷ 5400 var	
<b><i>SA, SV</i></b>	total apparent power	0.5	0 ÷ 5400 VA	
<b><i>Ea</i></b>	total active energy	0.5	0 ÷ 5400 Wh	
<b><i>ErA, ErV</i></b>	total reactive energy	2	0 ÷ 5400 varh	
<b><i>EapA, EapV</i></b>	total apparent energy	0.5	0 ÷ 5400 VAh	
<b><i>f</i></b>	frequency	0.05	40 ÷ 70 Hz	
<b><i>I</i></b>	phase current	0.5	0.005 ÷ 6 AAC	
<b><i>IN</i></b>	neutral current measured	–	–	
<b><i>INc</i></b>	neutral current calculated	0.5	0.005 ÷ 18 AAC	
<b><i>ULN</i></b>	line-to-neutral voltage	0.5	40 ÷ 280 VAC	
<b><i>ULL</i></b>	line-to-line voltage	0.5	70 ÷ 480 VAC	
<b><i>PFA, PFV</i></b>	power factor	0.5	0 ÷ 1	
<b><i>Pst, PIt</i></b>	flicker	5	0.4 ÷ 10	1, 2)
<b><i>Udip</i></b>	voltage dips	0.5	10 ÷ 230 VAC	2)
<b><i>Uswl</i></b>	voltage swells	0.5	230 ÷ 280 VAC	2)
<b><i>Utr</i></b>	transients overvoltage	–	–	
<b><i>Uint</i></b>	voltage interruption	1	0 ÷ 10 VAC	2)
<b><i>Unba</i></b>	voltage unbalance (amp.)	0.5	0 ÷ 10 %	4)
<b><i>Unb</i></b>	voltage unbalance (ph.&amp;.)	0.5	0 ÷ 10 %	
<b><i>Uh</i></b>	voltage harmonics 50 Hz (60 Hz)	2	up to 50 <sup>th</sup> (40 <sup>th</sup> ) order	1)
<b><i>THDu</i></b>	voltage total harm. distortion (rel. to fund.)	2	0 ÷ 20 %	1)
<b><i>THD-Ru</i></b>	voltage total harm. distortion (rel. to RMS)	2	0 ÷ 20 %	1, 4)
<b><i>Ih</i></b>	current harmonics 50 Hz (60 Hz)	2	up to 50 <sup>th</sup> (40 <sup>th</sup> ) order	1)
<b><i>THDi</i></b>	current total harm. distortion (rel. to fund.)	2	0 ÷ 200 %	1)
<b><i>THD-Ri</i></b>	voltage total harm. distortion (rel. to RMS)	2	0 ÷ 200 %	1,4)
<b><i>Msv</i></b>	mains signalling voltage	2	0 ÷ 46 VAC $f_{Msv} : 100 \div 3000\text{ Hz}$	1, 3)

Notes : 1) ...according to IEC 61000-4-7 ed.2

2) ... with optional firmware module „PQ S“

3) ... with optional firmware module „RCS“

4) ... value available via communication link only, not displayed

Function Characteristics according to IEC 61557-12				
UNOM = 100 / 230 / 400 V for model "100" / "230" / "400"				
Model „X/5A“, INOM = 5 A				
Symbol	Function	Class	Measuring range	Notes
<b>P</b>	total effective power	0.5	0 ÷ (21.6 * UNOM) W	
<b>QA, QV</b>	total reactive power	1	0 ÷ (21.6 * UNOM) var	
<b>SA, SV</b>	total apparent power	0.5	0 ÷ (21.6 * UNOM) VA	
<b>Ea</b>	total active energy	0.5	0 ÷ (21.6 * UNOM) Wh	
<b>ErA, ErV</b>	total reactive energy	2	0 ÷ (21.6 * UNOM) varh	
<b>EapA, EapV</b>	total apparent energy	0.5	0 ÷ (21.6 * UNOM) VAh	
<b>f</b>	frequency	0.05	40 ÷ 70 Hz	
<b>I</b>	phase current	0.5	0.005 ÷ 6 AAC	
<b>IN</b>	neutral current measured	–	–	
<b>INc</b>	neutral current calculated	0.5	0.005 ÷ 18 AAC	
<b>ULN</b>	line-to-neutral voltage	0.5	0.2 ÷ 1.2 * UNOM	
<b>ULL</b>	line-to-line voltage	0.5	0.2 ÷ 1.2 * UNOM * √3	
<b>PFA, PFV</b>	power factor	0.5	0 ÷ 1	
<b>Pst, PIt</b>	flicker	5	0.4 ÷ 10	1, 2)
<b>Udip</b>	voltage dips	0.5	0.05 ÷ 1 * UNOM	2)
<b>Uswl</b>	voltage swells	0.5	1 ÷ 1.2 * UNOM	2)
<b>Utr</b>	transients overvoltage	–	–	
<b>Uint</b>	voltage interruption	1	0 ÷ 0.05 * UNOM	2)
<b>Unba</b>	voltage unbalance (amp.)	0.5	0 ÷ 10 %	4)
<b>Unb</b>	voltage unbalance (ph.&amp;.)	0.5	0 ÷ 10 %	
<b>Uh</b>	voltage harmonics 50 Hz (60 Hz)	2	up to 50 <sup>th</sup> (40 <sup>th</sup> ) order	1)
<b>THDu</b>	voltage total harm. distortion (rel. to fund.)	2	0 ÷ 20 %	1)
<b>THD-Ru</b>	voltage total harm. distortion (rel. to RMS)	2	0 ÷ 20 %	1, 4)
<b>Ih</b>	current harmonics 50 Hz (60 Hz)	2	up to 50 <sup>th</sup> (40 <sup>th</sup> ) order	1)
<b>THDi</b>	current total harm. distortion (rel. to fund.)	2	0 ÷ 200 %	1)
<b>THD-Ri</b>	voltage total harm. distortion (rel. to RMS)	2	0 ÷ 200 %	1, 4)
<b>Msv</b>	mains signalling voltage	2	0 ÷ 0.2 * UNOM fMsv : 100 ÷ 3000 Hz	1, 3)

Notes : 1) ...according to IEC 61000-4-7 ed.2

2) ... with optional firmware module „PQ S“

3) ... with optional firmware module „RCS“

4) ... value available via communication link only, not displayed

Function Characteristics according to IEC 61557-12				
UNOM = 100 / 230 / 400 V for model "100" / "230" / "400"				
Model „X/100mA“, INOM = 0.1 A				
Symbol	Function	Class	Measuring range	Notes
<b>P</b>	total effective power	0.5	0 ÷ (0.43 * UNOM) W	
<b>QA, QV</b>	total reactive power	1	0 ÷ (0.43 * UNOM) var	
<b>SA, SV</b>	total apparent power	0.5	0 ÷ (0.43 * UNOM) VA	
<b>Ea</b>	total active energy	0.5	0 ÷ (0.43 * UNOM) Wh	
<b>ErA, ErV</b>	total reactive energy	2	0 ÷ (0.43 * UNOM) varh	
<b>EapA, EapV</b>	total apparent energy	0.5	0 ÷ (0.43 * UNOM) VAh	
<b>f</b>	frequency	0.05	40 ÷ 70 Hz	
<b>I</b>	phase current	0.5	0.001 ÷ 0.12 AAC	
<b>IN</b>	neutral current measured	–	–	
<b>INc</b>	neutral current calculated	0.5	0.001 ÷ 0.36 AAC	
<b>ULN</b>	line-to-neutral voltage	0.5	0.2 ÷ 1.2 * UNOM	
<b>ULL</b>	line-to-line voltage	0.5	0.2 ÷ 1.2 * UNOM * v3	
<b>PFA, PFV</b>	power factor	0.5	0 ÷ 1	
<b>Pst, PIt</b>	flicker	5	0.4 ÷ 10	1, 2)
<b>Udip</b>	voltage dips	0.5	0.05 ÷ 1 * UNOM	2)
<b>Uswl</b>	voltage swells	0.5	1 ÷ 1.2 * UNOM	2)
<b>Utr</b>	transients overvoltage	–	–	
<b>Uint</b>	voltage interruption	1	0 ÷ 0.05 * UNOM	2)
<b>Unba</b>	voltage unbalance (amp.)	0.5	0 ÷ 10 %	4)
<b>Unb</b>	voltage unbalance (ph.&amp;amp.)	0.5	0 ÷ 10 %	
<b>Uh</b>	voltage harmonics 50 Hz (60 Hz)	2	up to 50 <sup>th</sup> (40 <sup>th</sup> ) order	1)
<b>THDu</b>	voltage total harm. distortion (rel. to fund.)	2	0 ÷ 20 %	1)
<b>THD-Ru</b>	voltage total harm. distortion (rel. to RMS)	2	0 ÷ 20 %	1, 4)
<b>Ih</b>	current harmonics 50 Hz (60 Hz)	2	up to 50 <sup>th</sup> (40 <sup>th</sup> ) order	1)
<b>THDi</b>	current total harm. distortion (rel. to fund.)	2	0 ÷ 200 %	1)
<b>THD-Ri</b>	voltage total harm. distortion (rel. to RMS)	2	0 ÷ 200 %	1, 4)
<b>Msv</b>	mains signalling voltage	2	0 ÷ 0.2 * UNOM fMsv : 100 ÷ 3000 Hz	1, 3)

Notes : 1) ...according to IEC 61000-4-7 ed.2

2) ... with optional firmware module „PQ S“

3) ... with optional firmware module „RCS“

4) ... value available via communication link only, not displayed

Instrument Characteristics according to IEC 61557-12	
power quality assessment function	PQI-S
classification according to par. 4.3 direct voltage connection voltage connection via VT	SD SS
temperature according to par. 4.5.2.2	K55
humidity + altitude according to par. 4.5.2.3	< 95 % - noncondensation conditions < 3000 m
active power/energy function performance class	0.5

Function characteristics according to IEC 61000-4-30 ed.2				
Function	Class	Uncertainty	Measuring range	Notes
frequency	A	$\pm 10$ mHz	40 ÷ 70 Hz	
magnitude if supply	S	$\pm 0.1$ % $U_{din}$	20 ÷ 120 % $U_{din}$	
flicker	S	$\pm 5$ % of rdg or $\pm 0,05$	0.4 ÷ 10	2, 4)
dips and swells	S	$\pm 0.5$ % $U_{din}$ , $\pm 1$ cycle	5 ÷ 120 % $U_{din}$	2)
interruptions	S	$\pm 1$ cycle	unlimited	2)
unbalance	S	$\pm 0.3$ %	0.5 ÷ 10 %	
voltage harmonics & interharmonics	S	twice the levels of class II acc. IEC 61000-4-7 ed.2	10 ÷ 100 % of class 3, acc. to IEC 61000-2-4 ed.2, up to 50 <sup>th</sup> order	1)
mains signalling voltage	S	twice the levels of class II acc. IEC 61000-4-7 ed.2	0 ÷ 20 % $U_{din}$ $f_{Msv}$ : 100 ÷ 3000 Hz	1, 3)

Notes : 1) ...according to IEC 61000-4-7 ed.2

2) ... with optional firmware module „PQ S“

3) ... with optional firmware module „RCS“

4) ... class F3 according to IEC 61000-4-15 ed. 2.0

<b>Measured Quantities – Voltage *)</b>			
<b>Frequency</b>			
$f_{\text{NOM}}$ – nominal frequency	50 / 60 Hz		
measuring range	40 ÷ 70 Hz		
measuring uncertainty	± 10 mHz		
<b>Voltage</b>			
model	„100“	„230“	„400“
$U_{\text{NOM}}$ ( $U_{\text{DIN}}$ ) – rated voltage (phase-to-neutral, $U_{\text{L-N}}$ )	57.7 ÷ 125 V <sub>AC</sub>	180 ÷ 250 V <sub>AC</sub>	300 ÷ 415 V <sub>AC</sub>
crest factor at $U_{\text{NOM}}$	2.1		
measuring range $U_{\text{L-N}}$	3 ÷ 190 V <sub>AC</sub>	6 ÷ 375 V <sub>AC</sub>	10 ÷ 625 V <sub>AC</sub>
measuring range $U_{\text{L-L}}$	5 ÷ 330 V <sub>AC</sub>	8 ÷ 660 V <sub>AC</sub>	20 ÷ 1090 V <sub>AC</sub>
measuring uncertainty ( $t_{\text{A}}=23\pm 2^{\circ}\text{C}$ )	+/- 0.05 % of rdg +/- 0.02 % of rng		
temperature drift	+/- 0.03 % of rdg +/- 0.01 % of rng / 10 °C		
measurement category	150V CAT IV	300V CAT III	300V CAT III 600V CATII
permanent overload	300 V <sub>AC</sub>	600 V <sub>AC</sub>	1000 V <sub>AC</sub>
peak overload ( $U_{\text{L-N}}$ / 1 sec.)	600 V <sub>AC</sub>	1200 V <sub>AC</sub>	2000 V <sub>AC</sub>
burden power, impedance	< 0.013 VA $R_{\text{i}} = 1.8 \text{ M}\Omega$	< 0.025 VA $R_{\text{i}} = 3.6 \text{ M}\Omega$	< 0.05 VA $R_{\text{i}} = 6 \text{ M}\Omega$
<b>Voltage Unbalance</b>			
measuring range	0 ÷ 10 %		
measuring uncertainty	± 0.3		
<b>Harmonics &amp; Interharmonics (up to 50<sup>th</sup> order, or 40<sup>th</sup> order @ 60 Hz)</b>			
reference conditions	other harmonics up to 200 % of class 3 acc. to IEC 61000–2-4 ed.2		
measuring range	10 ÷ 100 % of class 3 acc. to IEC 61000–2-4 ed.2		
measuring uncertainty	twice the levels of class II acc. to IEC 61000–4-7 ed.2		
<b>THDU</b>			
measuring range	0 ÷ 20 %		
measuring uncertainty	± 0.5		

Note \*) : The quantities and their measurement uncertainties are valid for  $f_{\text{NOM}} = 50/60$  Hz. For  $f_{\text{NOM}} = \text{DC} \div 500$  Hz ("The Fixscan" mode), see separate table below.

<b>Measured Quantities - Temperature</b>	
<b>T<sub>I</sub> - (internal sensor, measured value affected by the instrument power dissipation)</b>	
measuring range	- 40 ÷ 80 °C
measurement uncertainty	± 2 °C
<b>T<sub>E</sub> – External Pt100 Temperature Sensor Input (optional, alternatively with communication interface COM2)</b>	
measuring range	- 50 ÷ 150 °
measurement uncertainty	± 2 °C (three-wire connection)

<b>Measured Quantities – Current *)</b>			
model	„X/5A“	„X/100mA“	„X/333mV“
$I_{NOM}$ (I <sub>B</sub> ) – rated current	1 / 5 AAC	0.1 AAC	I @ 333mV
crest factor at $I_{NOM}$	2.0	5.5	2.1
measuring range	0.005 ÷ 7 AAC	0.001 ÷ 0.39 AAC	0.002 ÷ 0.5 VAC
meas. uncertainty ( $t_A=23\pm 2^\circ C$ )	+/- 0.05 % of rdg +/- 0.02 % of rng		
temperature drift	+/- 0.03 % of rdg +/- 0.01 % of rng / 10 °C		
measurement category	150V CAT III	150V CAT III	undefined
permanent overload	7.5 AAC	1 AAC	15 VAC
peak overload - for 1 second, max. repetition frequency > 5 minutes	70 AAC	10 AAC	15 VAC
burden power ( impedance)	< 0.5 VA ( Ri < 10 mΩ)	< 0.01 VA ( Ri < 40 mΩ)	< 3 uVA ( Ri > 100kΩ)
<b>Current Unbalance</b>			
measuring range	0 ÷ 100 %		
measuring uncertainty	± 1 % of rdg or ± 0.5		
<b>Harmonics &amp; Interharmonics (up to 50<sup>th</sup> order, or 40<sup>th</sup> order @ 60 Hz)</b>			
reference conditions	other harm. up to 1000 % of class 3 acc. to IEC 61000–2-4 ed.2		
measuring range	500 % of class 3 acc. to IEC 61000–2-4 ed.2		
measuring uncertainty	I <sub>h</sub> ≤ 10% I <sub>NOM</sub> : ± 1% I <sub>NOM</sub> I <sub>h</sub> > 10% I <sub>NOM</sub> : ± 1% of rdg		
<b>THDI</b>			
measuring range	0 ÷ 200 %		
measuring uncertainty	THDI ≤ 100% : ± 0.6 THDI > 100% : ± 0.6 % of rdg		

Note \*) : The quantities and their measurement uncertainties are valid for  $f_{NOM} = 50/60$  Hz. For  $f_{NOM} = DC \div 500$  Hz ("The Fixscan" mode), see separate table below.

<b>Measured Quantities – Power, Power Factor, Energy *)</b>	
<b>Active / Reactive Power, Power Factor (PF), cos φ ( P<sub>NOM</sub> = U<sub>NOM</sub> x I<sub>NOM</sub> )</b>	
reference conditions "A" : ambient temperature ( t <sub>A</sub> ) U, I for active power, PF, cos φ for reactive power	23 ± 2 °C U = 80 ÷ 120 % U <sub>NOM</sub> , I = 1 ÷ 120 % I <sub>NOM</sub> PF = 1.00 PF = 0.00
act. / react. power uncertainty	± 0.5 % of rdg ± 0.005 % P <sub>NOM</sub>
PF & cos φ uncertainty	± 0.005
reference conditions "B" : ambient temperature ( t <sub>A</sub> ) U, I for active power, PF, cos φ for reactive power	23 ± 2 °C U = 80 ÷ 120 % U <sub>NOM</sub> , I = 1 ÷ 120 % I <sub>NOM</sub> PF ≤ 0.87 PF ≤ 0.87
act. / react. power uncertainty	± 1 % of rdg ± 0.01 % P <sub>NOM</sub>
PF & cos φ uncertainty	± 0.005
temperature drift of powers	+/- 0.05 % of rdg +/- 0.02 % P <sub>NOM</sub> / 10 °C
<b>Energy</b>	
measuring range	corresponds to U & I measuring ranges 4 quadrant energy counters for both active and reactive energies
active energy uncertainty	class 0.5S acc. to EN 62053 – 22
reactive energy uncertainty	class 1S acc. to EN 62053 – 24

Note \*) : The quantities and their measurement uncertainties are valid for f<sub>NOM</sub> = 50/60 Hz. For f<sub>NOM</sub> = DC ÷ 500 Hz ("The Fixscan" mode), see separate table below.

<b>„FIXSCAN“ Mode - Measuring Uncertainties</b>	
<b>f<sub>NOM</sub> set to „DC-500“</b>	
<b>Frequency Range : 350 ÷ 450 Hz</b>	
<b>Frequency</b>	
measuring uncertainty	± 0.1 Hz
<b>Voltage</b>	
measuring uncertainty	+/- 0.2 % of rdg +/- 0.1 % of rng
<b>Current</b>	
measuring uncertainty	+/- 0.2 % of rdg +/- 0.1 % of rng
<b>Active / Reactive Power, Power Factor (PF), cos φ ( P<sub>NOM</sub> = U<sub>NOM</sub> x I<sub>NOM</sub> )</b>	
reference conditions "A" : U, I for active power, PF, cos φ for reactive power	U = 80 ÷ 120 % U <sub>NOM</sub> , I = 1 ÷ 120 % I <sub>NOM</sub> PF = 1.00 PF = 0.00
act. / react. power uncertainty	± 0.5 % of rdg ± 0.01 % P <sub>NOM</sub>
PF & cos φ uncertainty	± 0.01
reference conditions "B" : U, I for active power, PF, cos φ for reactive power	U = 80 ÷ 120 % U <sub>NOM</sub> , I = 1 ÷ 120 % I <sub>NOM</sub> PF ≥ 0.5 PF ≤ 0.87
act. / react. power uncertainty	± 2 % of rdg ± 0.1 % P <sub>NOM</sub>
PF & cos φ uncertainty	± 0.02

Instrument Auxiliary Power Supply Voltage			
model	„H“	„L“	„S“
nominal aux. voltage range	100 ÷ 415 V <sub>AC</sub>	23 ÷ 68 V <sub>DC</sub>	12 ÷ 32 V <sub>DC</sub>
aux. voltage range AC: f=40÷100 Hz; DC:	75 ÷ 500 V <sub>AC</sub> 90 ÷ 600 V <sub>DC</sub>	20 ÷ 50 V <sub>AC</sub> 20 ÷ 75 V <sub>DC</sub>	10 ÷ 26 V <sub>AC</sub> 10 ÷ 36 V <sub>DC</sub>
power	20 VA / 8 W		
overvoltage cat. voltage up to 300 V <sub>AC</sub> voltage over 300 V <sub>AC</sub>	III II		
pollution degree	2		
connection	isolated, polarity free		

„230 VAC“ Digital I/O	
<b>RO11 ÷ 14 Outputs ( relays )</b>	
type	N.O. contact
load rating	250 V <sub>AC</sub> / 30 V <sub>DC</sub> , 4 A
<b>RI11 Input</b>	
type	optoisolated
maximum voltage	265 V <sub>AC</sub> ( 460 V <sub>AC</sub> for overvoltage cat. II )
voltage for “logical 1“	>= 90 V <sub>AC</sub>
voltage for “logical 0“	<= 30 V <sub>AC</sub>
burden power ( impedance )	< 0.4 VA ( Ri = 200 kΩ )
dynamic parameters *) : - pulse/gap duration - maximum frequency	>= 50 / 50 ms 10 Hz

„12 ÷ 24 VDC“ Digital I/O	
<b>DO21 ÷ 24 Outputs (solid state)</b>	
type	Opto-MOS, bipolar
load rating	60 V <sub>AC</sub> / 100 V <sub>DC</sub> , 100 mA
dynamic param. (pulse output) : - pulse duration - gap duration - maximum frequency	S0 - compatible 50 ms >= 50 ms 10 Hz
<b>DI21 ÷ 24 Digital Inputs</b>	
type	optoisolated, bipolar
maximum voltage	35 V <sub>DC</sub>
voltage for “logical 0“ / “logical 1“	< 3 V <sub>DC</sub> / > 10 V <sub>DC</sub>
burden power ( impedance )	< 0.7 VA ( Ri > 1.7 kΩ )
input current	3 mA @ 10V / 13 mA @ 24V / 20 mA @ 35V
dynamic parameters *) : - pulse/gap duration - maximum frequency	>= 0.5 / 0.5 ms 1 kHz

Note \*) : Limit that correspond to the instrument hardware. Real values depend on the firmware filter adjustment - see the chapter *Digital Input Filter*.

AI1, AI2 Analog Inputs	
type	current (20mA) or voltage (10V) isolated from internal circuitry, common pole AG connected internally with the AO1÷2 analog outputs common pole and negative pole of auxiliary 12 VDC power supply
„20 mA“ type inputs (terminals AI1I, AI2I) : measuring range impedance	0 ÷ 24 mA 120 Ω
„10 V“ type inputs (terminals AI1U, AI2U) : measuring range impedance	0 ÷ 12 V 20 kΩ
measuring uncertainty	± 0.5 % of range

AO1, AO2 Analog Outputs	
type	current (20mA) isolated from internal circuitry, common pole AG connected internally with the AI1÷2 analog inputs common pole and negative pole of auxiliary 12 VDC power supply
output current range	0 ÷ 22 mA
maximum load impedance	450 Ω
output signal uncertainty	± 1 % of range

+12 VDC Auxiliary Power Supply for I/O	
connection	isolated (connected with analog I/O common pole)
output voltage	11.5 ÷ 13 VDC
maximum permanent load	100 mA <sub>DC</sub>
short-circuit max. duration	5 seconds

<b>Other Specifications</b>	
operational temperature :	- 20 to 60°C
storage temperature	- 40 to 80°C
operational and storage humidity	< 95 % - non-condensable environment
EMC – immunity	EN 61000 – 4 - 2 ( 4kV / 8kV ) EN 61000 – 4 - 3 ( 10 V/m up to 1 GHz ) EN 61000 – 4 - 4 ( 2 kV ) EN 61000 – 4 - 5 ( 2 kV ) EN 61000 – 4 - 6 ( 3 V ) EN 61000 – 4 - 11 ( 5 periods )
EMC – emissions	EN 55011, class A EN 55022, class A ( not for home use )
RTC accuracy backup battery capacity	+/- 2 seconds per day > 5 years ( without supply voltage applied )
local communication port	USB 2.0
remote comm. port No. 1 (option)	RS-485 / 2400÷460800 Bd / protocols KMB, Modbus-RTU or Ethernet 100 Base-T / DHCP, webserver, Modbus-TCP
remote comm. port No. 2 (option, alternatively with external temperature sensor input)	RS-485 / 2400÷460800 Bd / protocols KMB, Modbus-RTU
display	backlit LCD, graphic, 240 x 160 pixels
protection class front panel back panel	IP 40 ( IP 54 with cover sheeting ) IP 20
dimensions front panel built-in depth installation cutout	144 x 144 mm 80 mm 138 <sup>+1</sup> x 138 <sup>+1</sup> mm
mass	max. 0.8 kg

# 10. Maintenance, Service

The SMZ 133 instruments do not require any maintenance in their operation. For reliable operation it is only necessary to meet the operating conditions specified and not expose the instrument to violent handling and contact with water or chemicals which could cause mechanical damage.

In selected models, the built-in CR2450 lithium cell can backup the memory and real time circuit for more than 5 years without power supply, at average temperature 20°C and load current in the instrument less than 10 µA. If the cell is empty, it is necessary to ship the instrument to the manufacturer for battery replacement.

In the case of failure or a breakdown of the product, you should contact the supplier at their address:

Supplier :	Manufacturer :
	KMB systems, s.r.o.
	Dr. M. Horákové 559
	460 06 LIBEREC 7
	Czech Republic
	Phone+420 485 130 314
	Fax +420 482 736 896
	E-mail: <a href="mailto:kmb@kmb.cz">kmb@kmb.cz</a>
	Website: <a href="http://www.kmbsystems.eu">www.kmbsystems.eu</a>

The product must be in proper packaging to prevent damage during transit. A description of the problem or its symptoms must be delivered together with the product.

If a warranty repair is claimed, the warranty certificate must be sent in. In case of an out-of-warranty repair you have to enclose an order for the repair.

## Warranty Certificate

Warranty period of 24 months from the date of purchase is provided for the instrument, however, no longer than 30 months from the day of dispatch from the manufacturer. Problems in the warranty period, provably because of faulty workmanship, design or inconvenient material, will be repaired free of charge by the manufacturer or an authorized servicing organization.

The warranty ceases even within the warranty period if the user makes unauthorized modifications or changes to the instrument, connects it to out-of-range quantities, if the instrument is damaged due to ineligible or improper handling by the user, or when it is operated in contradiction with the technical specifications presented.

Type of product: **SMZ 133** ..... Serial number.....

Date of dispatch: ..... Final quality inspection: .....

Manufacturer's seal:

Date of purchase: ..... Supplier's seal: