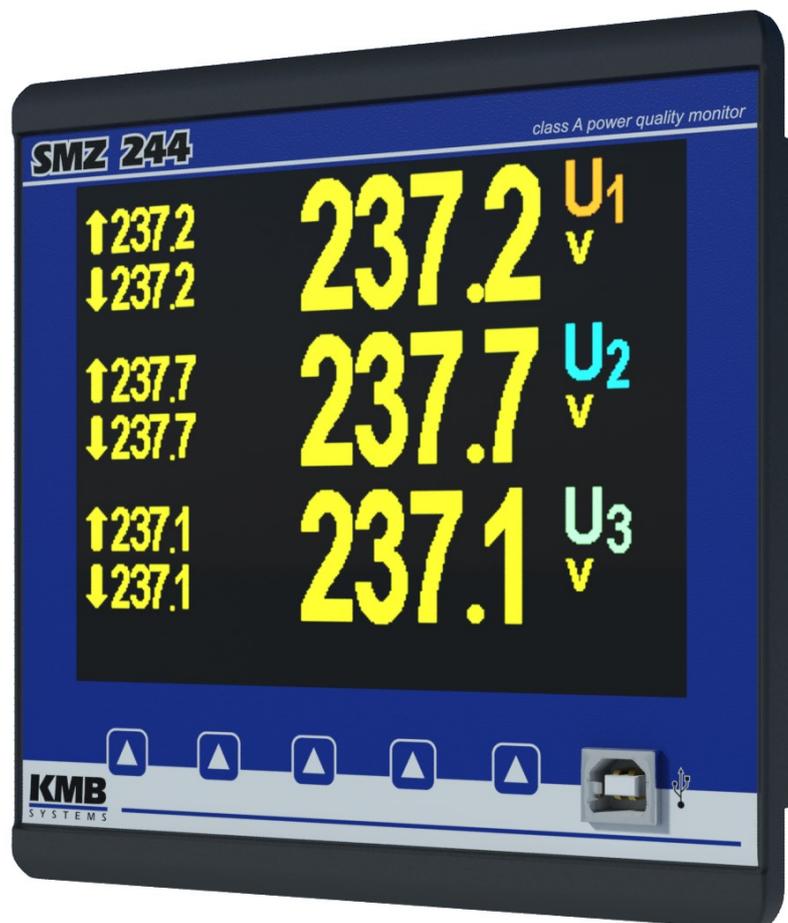


SMZ244

Power Quality Analyzer

Operating Manual

Document revision	Release date	Valid for versions			
		hardware	bootloader	firmware	ENVIS
1.4	28.1.2020	2.6	4.0	3.3	1.9



LIST OF CONTENTS

1. GENERAL.....	6
2. INSTALLATION.....	7
2.1 Meaning of the symbols used on instrument.....	7
2.2 Physical.....	7
2.3 Instrument Connection.....	8
2.3.1 Power Supply.....	8
2.3.2 Measured Voltages.....	9
2.3.3 Measured Currents.....	9
2.3.4 Other Inputs/Outputs.....	9
3. COMMISSIONING.....	10
3.1 Setup.....	10
3.1.1 Measured Electrical Quantities Installation Setup.....	10
3.1.1.1 Setup Example.....	11
4. DETAILED DESCRIPTION.....	13
4.1 Basic Functions.....	13
4.2 Manipulation and Setting.....	13
4.2.1 Data Area – Status Bar - Toolbar.....	13
4.2.2 Main Menu.....	14
4.2.3 Main Data Group.....	14
4.2.4 Actual & Average Data Groups.....	14
4.2.5 Electricity meter.....	15
4.2.6 Oscillograms.....	15
4.2.7 Phasor Diagram.....	15
4.2.8 Harmonics & THDs.....	15
4.2.9 Power Quality & Voltage Events.....	16
4.2.10 Ripple Control Signal.....	16
4.2.11 Instrument Settings (Parameters).....	17
4.2.11.1 Display Setting.....	17
4.2.11.2 Installation Setting.....	17
4.2.11.3 Remote Communication Setting.....	17
4.2.11.4 Clock Setting.....	18
4.2.11.5 Average Values Processing Setting.....	18
4.2.11.6 Embedded Electricity Meter Setting.....	18
4.2.11.7 Power Quality & Input/Output Setting.....	18
4.2.11.8 Ripple Control Signal Setting.....	18
4.2.12 Instrument Lock.....	19
4.2.12.1 Locking from the Instrument Panel.....	19
4.2.12.2 Unlocking from the Instrument Panel.....	19
4.2.12.3 Locking/Unlocking by the User Management.....	20
4.2.13 Instrument Information.....	20
4.3 Description of Operation.....	21

4.3.1 Method of Measurement.....	21
4.3.1.1 Voltage Fundamental Frequency Measurement Method.....	21
4.3.1.2 Voltage and Current Measurement Method.....	21
4.3.1.3 Harmonics and THD Evaluation Method.....	22
4.3.1.4 Power, Power Factor and Unbalance Evaluation Method.....	23
4.3.1.5 Temperature.....	25
4.3.1.6 “ The Fixscan” Mode.....	25
4.3.1.6.1 Function.....	25
4.3.2 Measured Values Evaluation and Aggregation.....	26
4.3.2.1 Actual Values Evaluation and Aggregation.....	26
4.3.2.2 Average Values Evaluation.....	27
4.3.2.2.1 Maximum and Minimum Average Values.....	28
4.3.2.3 Recorded Values Aggregation.....	28
4.3.3 Embedded Electricity Meter.....	29
4.3.3.1 Electric Energy Processing.....	29
4.3.3.1.1 Standard Energy Presentation.....	29
4.3.3.1.2 Customizable Energy Screen.....	30
4.3.3.1.3 Recorded Values of Energy Aggregation.....	31
4.3.3.2 Maximum Demand Processing.....	31
4.3.3.2.1 Fixed Window MD Processing, Last Demand and Estimated Demand.....	32
4.3.3.2.2 Maximum Demand Presentation.....	32

5. RESIDUAL CURRENT MONITORING (RCM).....33

5.1 Measuring Transformers for the RCM.....	33
5.1.1 Electrical Safety.....	33
5.1.2 Standard RCTs with AC-Current Output.....	33
5.1.2.1 Overcurrent Protection.....	33
5.1.3 Special RCTs with DC-Current Output.....	34
5.2 RCM Inputs Connection.....	34
5.3 RCM Setup & Presentation.....	35
5.4 Tips & Hints.....	36

6. INPUTS & OUTPUTS.....37

6.1 Connection of the I/Os.....	38
6.1.1 DI/O1 - DI/O4 Digital Inputs/Outputs Connection.....	39
6.1.2 DI5 Digital Input Connection.....	40
6.1.3 RO5 - RO8 Digital Outputs Connection.....	40
6.1.4 Analog Inputs Connection.....	40
6.1.4.1 AI1 - AI2 Analog Inputs.....	40
6.1.4.2 AI3 - AI4 Analog Inputs.....	40
6.1.5 External Pt100 Temperature (T _E) Sensor Connection.....	41
6.1.6 Embedded 12 VDC Auxiliary Power Supply.....	41
6.2 I/O Setup.....	41
6.2.1 I/O Actions.....	43
6.2.1.1 Digital Output (Standard, DO/RO).....	43
6.2.1.2 Alarm Light (A).....	43
6.2.1.3 Pulse Output (PO).....	43
6.2.1.4 Pulse Switch.....	44
6.2.1.5 Frequency Counter (FC).....	44
6.2.1.5.1 Frequency Mode.....	44
6.2.1.5.2 PWM Mode.....	45

6.2.1.6 Pulse Counter (PC).....	45
6.2.1.7 Analog Input (AI).....	45
6.2.1.8 Analog Output (AO).....	46
6.2.1.9 Send Message.....	46
6.2.1.10 Send Email.....	47
6.2.1.11 Hour Meter (HM).....	47
6.2.1.12 Time Synchronization.....	48
6.2.1.13 Archive Control.....	48
6.2.1.14 General Oscillogram.....	49
6.2.1.15 Variable.....	50
6.2.2 I/O Conditions.....	51
6.2.2.1 Digital Input Condition.....	51
6.2.2.2 Measured Quantity Condition.....	51
6.2.2.3 Device State Condition.....	52
6.2.2.4 RCM Condition.....	52
6.2.2.5 Time Condition.....	53
6.2.2.6 Variable Condition.....	53
6.3 I/O Actual Data Presentation.....	54
6.3.1 Digital and Analog I/O.....	54
6.3.2 Pulse Counters.....	54
6.4 I/O Block Processing.....	55
6.4.1 Digital Inputs.....	55
6.4.1.1 Digital Input Filter.....	55
6.4.1.2 Digital Input as Frequency Counter.....	55
6.4.1.2.1 "Frequency" Mode.....	55
6.4.1.2.2 "PWM" Mode.....	56
6.4.1.3 Digital Input as Pulse Counter.....	56
6.4.2 Digital Outputs.....	56
6.4.2.1 Pulse Outputs.....	56
7. COMPUTER CONTROLLED OPERATION.....	57
7.1 Communication Links.....	57
7.1.1 Local Communication Link.....	57
7.1.2 Remote Communication Links.....	57
7.1.2.1 RS-485 Interface (COM).....	57
7.1.2.1.1 Communication Cable.....	57
7.1.2.1.2 Terminating Resistors.....	58
7.1.2.2 Ethernet (IEEE802.3) Interface.....	58
7.2 Communication Protocols.....	58
7.2.1 KMB Communications Protocol.....	58
7.2.2 Modbus-RTU Communications Protocol.....	58
7.3 Embedded Webserver.....	59
8. FIRMWARE EXTENSION MODULES.....	60
8.1 Power Quality Module.....	60
8.2 Ripple Control Signal Module.....	60
8.3 General Oscillogram Module.....	61
8.4 Modbus Master Module.....	61

8.5 Ethernet-to-Serial Module.....	62
8.6 UDP Push Module.....	62
9. EXAMPLES OF CONNECTIONS.....	63
10. MANUFACTURED MODELS AND MARKING.....	70
11. TECHNICAL SPECIFICATIONS.....	71
12. MAINTENANCE, SERVICE.....	79

1. General

Measurement & Evaluation

- four measurement voltage inputs, star / delta / Aron connection
- four measurement current inputs for CTs nominal secondary output of 5 or 1 A
- 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 128th/108th
- class A voltage measurement according to IEC 61000-4-30 ed. 3
- fixed window / floating window average values of all evaluated quantities with minimum & maximum values registration
- built-in electricity meter :
 - four-quadrant counters for both active and reactive energies at three tariffs
 - single phase and three phase energies
 - maximum of average active power value registration (maximum demand)
- built-in thermometer
- two residual current inputs

Communication

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

Datalogging Capabilities

- battery backed real time circuit (RTC)
- record interval from 0.2 second up to 1 hour
- high memory capacity for programmable recording of aggregated measurement values
- automated electricity meter readings at preselected time intervals

Inputs & Outputs (Depending on Instrument Model)

- digital outputs (relays & solid state)
- digital inputs
- 0 ÷ 20 mA_{DC} analog inputs & outputs
- Pt100 temperature sensor input
- auxiliary 12 VDC power supply pro I/Os

Design

- 144x144 mm plastic box for panel mounting
- TFT-LCD colour 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

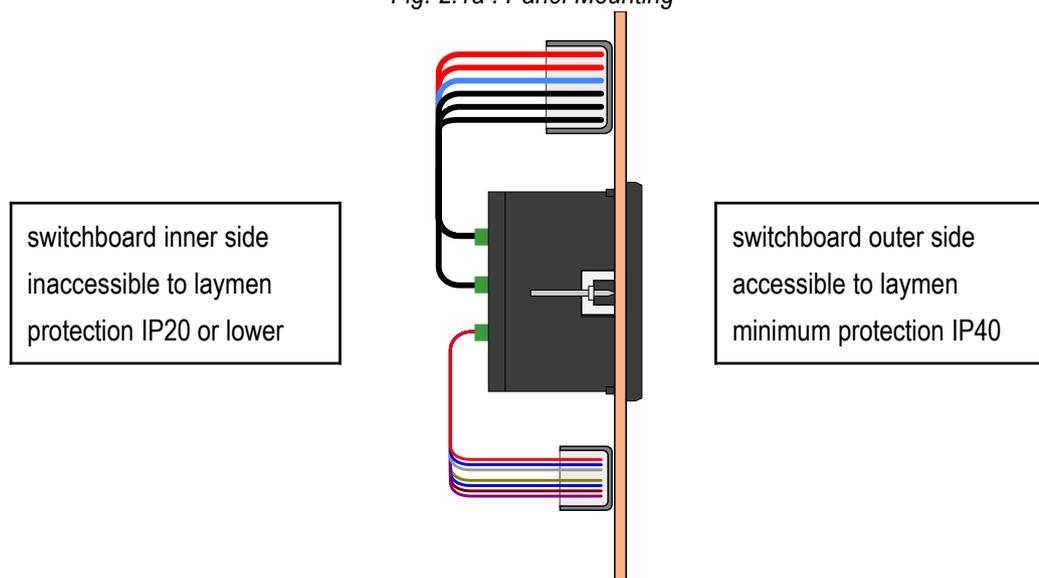


Double or reinforced insulation instrument (protection class II)

2.2 Physical

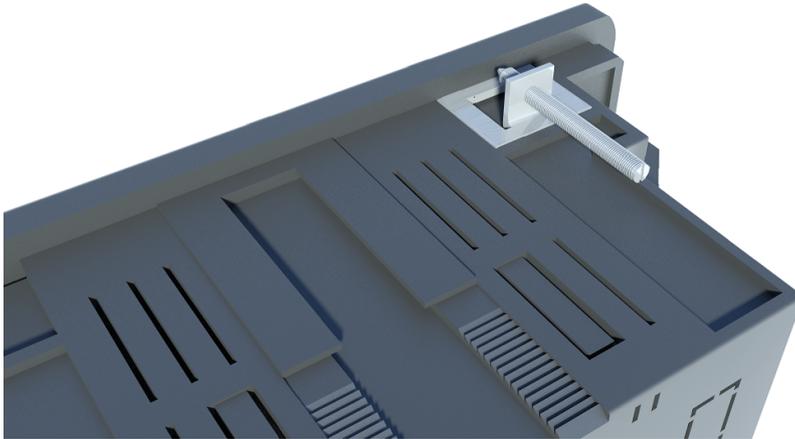
The instrument is built in a plastic box to be installed in a distribution board panel. As a rule, the panel is a part of a switchboard door - then the installation must be such that the switchboard door can be closed under all conditions of use. In any case, it must be ensured that only the front panel 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



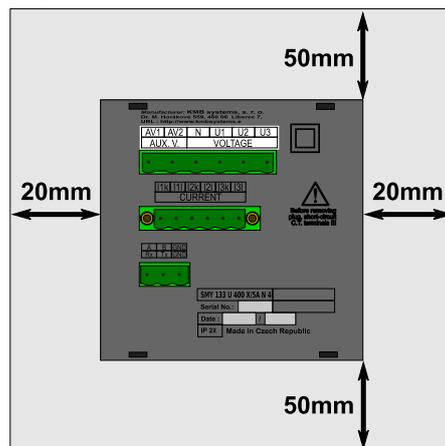
The instrument's position must be fixed with locks.

Fig.2.1b: Fixation with locks detail



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

Fig. 2.1c : 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 supply voltage (in range according technical specifications) connects to terminals **X1** (No. 15) and **X2** (16) via a disconnecting device (switch – see wiring diagram). It must be located at the instrument's proximity and easily accessible by the operator. The disconnecting device must be marked as such. A two-pole circuit breaker with the C-type tripping characteristics rated at 1A makes a suitable disconnecting device. Its function and working positions, however, must be clearly marked.

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 **X2**.

Recommended wire type :	H07V-U (CY)
Recommended minimum conductor cross-section :	1.5 mm ²
Maximum conductor cross-section :	2.5 mm ²

2.3.2 Measured Voltages

The phase voltages measured are connected to terminals **L1** (12), **L2** (13), **L3** (14), the common terminal to connect to the neutral wire is identified as **N** (11; it stays free at delta- (3-D) and Aron- (A) connections).

Optionally, another voltage with separate reference potential can be connected to terminals **L4** (9) and **N4** (10).

It is suitable to protect the voltage lines measured for example with 1A fuses. Measured voltages can also be connected via instrument voltage transformers.

Recommended wire type :	H07V-U (CY)
Recommended minimum conductor cross-section :	1.5 mm ²
Maximum conductor cross-section :	2.5 mm ²

2.3.3 Measured Currents

The instruments are designed for indirect current measurement via external CTs only.

The current signals from 5A or 1A instrument current transformers must be connected to the terminal pairs **I1S1**, **I1S2**, **I2S1**, **I2S2**, **I3S1**, **I3S2** (No. 1-6). Optionally, you can connect the 4th current signal too to the terminals **I4S1**, **I4S2** (No. 7-8).

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

It is necessary to set the CT-ratio – see example below.

Recommended wire type:	H05V-U (CY)
Recommended minimum conductor cross-section :	
• “X/5A” instruments :	2.5 mm ²
• “X/100mA” instruments :	0.75 mm ²
Maximum conductor cross-section :	2.5 mm ²

2.3.4 Other Inputs/Outputs

Connection of residual current inputs, other inputs, outputs and communication links are described in appropriate chapters further below.

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** (CT_N , CT_{RCM}) - ratios must be specified, in case of “**via VT**” connection mode **VT**-ratio too.

The **CT** is valid for currents I_1 , I_2 and I_3 . If an instrument is equipped with four current inputs or residual current inputs, appropriate ratios CT_N / CT_{RCM} must be set too.

CT ratios can be set in form either .../ 5A or .../ 1A.

The **VT**-ratio must be set in form *Nominal primary voltage / Nominal secondary voltage* . For higher primary voltage values *the U-multiplier* must be used too.

- **I- and U-Multipliers** - You can modify any CT- / VT-ratio with this parameters. 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.

The CT_N and CT_{RCM} ratios have their extra I_N - and I_{RCM} -**Multipliers**.

Instead the I_{RCM} -multiplier, the 0/20mA or the 4/20mA RCT- type can be set – see the RCM chapter below.

- **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 , navigate to the **Menu-Settings** with the buttons

and and then choose it with the . 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 .



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

You can set other parameters in the same way.

After all of the parameters of the group correctly set, return back to an actual data screen with the (escape) button and confirm saving of changes with the .

Now you can browse through displayed actual values with the  and  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 four voltage signals, four current signals (for connection of external CTs with 5 or 1 A_{AC} output), two residual current signals 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 backedup 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, RS-485 and Ethernet communication interface is available.

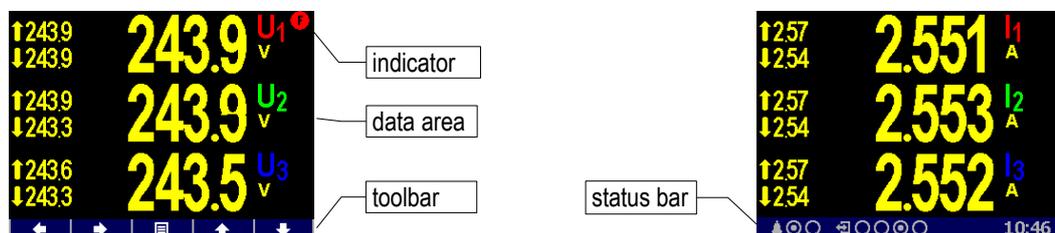
Basic specifications of the instrument can be set up by using the inbuilt keyboard and the display. With the ENVIS program supplied as standard you can, via any of communication link, adjust the instrument and transfer recorded data. In addition to the instrument adjustment, ENVIS program allows you 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 on on the example, the A2 is just switched off. This information appears only when either A1 or A2 function is set in the I/O management setup (see below).

- ... digital I/O state. The instrument on example is equipped with four bidirectional inputs(DI)/outputs(DO) and either the DI3 input or DO3 output is just active.
 Instruments equipped with unidirectional I/Os uses icon for inputs and icon for outputs.
- ... local time (hours : minutes)

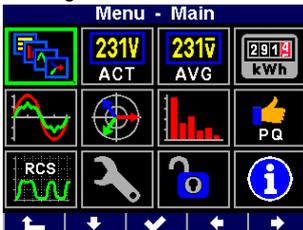
As soon as any button is pressed, a toolbar replaces the status bar. The toolbar determines function of individual buttons and changes dynamically by a context. If no manipulation with buttons for a longer period the toolbar is replaced with *the status bar*.

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

4.2.2 Main Menu

Fig. 4.2: Main Menu



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

All other buttons but the are context dependent and variable, but the is accessible from nearly every window which helps to quick orientation.

Next chapters describe individual main menu options.



4.2.3 Main Data Group

This data group of screens is configurable by user. You can choose data screens you are most interested in and place them in this group for easy access. Use the ENVIS-DAQ program for the setup.



4.2.4 Actual & Average Data Groups



Actual / Average values of measured data in numeric form are displayed in the groups, respectively. For detailed description of the actual values presentation see chapter *Display Actual Values Evaluation and Aggregation* further below.

Fig. 4.3 : Actual Data Summary Window

	L1	L2	L3	3P
ULL	0.00	0.00	0.00	
ULN	239.7	240.2	239.5	
I	1.87	1.85	1.87	
PF	0.65	0.65	0.65	0.65
P	289.3	288.0	288.7	865.9
Q	-190.2	-187.6	-188.9	-566.7
S _k	0.45	0.45	0.45	1.34
THDu	3.91	3.92	3.94	
THDi	81.75	82.10	82.07	
Unb	100.0		f	50.00

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 row, there is actual values of voltage unbalance **u2** [%] and frequency **f** [Hz].

The 2nd exception is the I/O actual data window . For detailed description see the chapter *I/O Actual Data Presentation*.



4.2.5 Electricity meter

In this data group you can check active & reactive energies registered in all quadrants. Next, maximum values of average three-phase active power including time stamps – so called maximum demands. For details see the chapter *Embedded Electricity Meter*.

Furthermore, there is the pulse counters actual state table. For detailed description see the chapter *Actual Data Presentation*.



4.2.6 Oscillograms

At this group there are actual waveshapes of all measured voltages and currents. With the



you can toggle between voltage and current screen.

They are also displayed effective values of the voltages/currents and maximum of their peak values U_p/A_p .

Fig. 4.4 : Voltage Waves

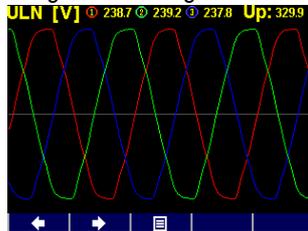


Fig. 4.5 : Current Waves



4.2.7 Phasor Diagram

Fig. 4.6 : Phasor Diagram



Diagram of actual voltage and current fundamental harmonic phasors.

Voltage phasor angles φ are absolute, current phasor angles are relative to appropriate voltage phasor ($\Delta\varphi$).

Phase order can be checked here too (indicated as 1-2-3 or 1-3-2).



4.2.8 Harmonics & THDs

Actual harmonic components of all voltage and current signals in graphic (histogram) format. They are expressed in per cent of fundamental harmonic component.

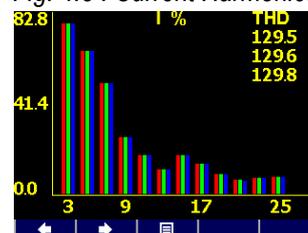
Only odd components from the 3rd to 25th are displayed; for full spectrum of harmonics use ENVIS-DAQ program.

In the upper right corner, there are values of THD of individual phases.

Fig. 4.7 : Voltage Harmonics



Fig. 4.8 : Current Harmonics





4.2.9 Power Quality & Voltage Events

This data group is available when appropriate firmware module is installed only.

On the first screen, there is “calendar” of power quality evaluation according the EN 50160 standard. Each day is marked with either or depending on that if power quality during the day was in compliance with the standard or not.

Next, there is the table of voltage events (VE). The events are sorted according magnitude and duration of each sag/swell/interruption and in the table you can check number of particular events registered since last clear. You can clear the VE-table in the PQ-setup screen.

Fig. 4.9 : Power Quality Calendar



Fig. 4.10 : Voltage Events Table

PQ - Voltage Events					
U<%	0.2	0.5	1	5	60s
90					
80					
70					
40	1				
5			1		
U>%	0.5	5	60s	Clear	
120				30.05.18	
110				15:23:02	

Detailed information of the PQ evaluation and the voltage events can be analyzed after downloaded into the ENVIS program.



4.2.10 Ripple Control Signal

This data group is available when appropriate firmware module is installed only.

At the screen you can check live graph of ripple control signal (mains signalling, U_{RC}) of chosen frequency. At the example there is starting part of a telegram of frequency 183 Hz on the L1 phase (U_{RC1}).

Fig. 4.11 : Ripple Control Signal Graph

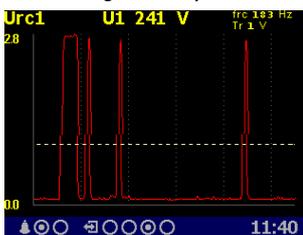


Fig. 4.12 : Ripple Control Signal Data Table

RCS			
Urc [V]	L1	L2	L3
act	3.6	3.6	3.6
avg	0.1	0.1	0.1
Last telegram L1			
avg1	3.7		
max1	3.9		
min1	3.5		
time	15.06.18 07:45:44		
frc=183.3Hz	Trig. Urc=1.0V		

With the and you can pass through all of phases measured. With the and you can toggle into the measured data table. There you can check :

- the upper part : actual and average (3 second floating window) values of the U_{RC1} , U_{RC2} , U_{RC3} ripple control signals
- the bottom part : average, maximum and minimum voltage of detected pulses (= when signal exceeds treshold U_{RCSTR}) registered during the last telegram.

With the and you can scroll through all measured phases.

The f_{RC} frequency and the U_{RCSTR} treshold voltage can be set in the RCS-setup screen.



4.2.11 Instrument Settings (Parameters)

In this group most of presetable parameters can be viewed and edited. Other parameters can be accessed via communication link using the ENVIS-DAQ 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.



4.2.11.1 Display Setting

- **Contrast** ... Can be set in range 0 – 100%
- **Brightness** ... The set level of brightness is activated whenever any button is pushed. If no manipulation with buttons for preset *dim time* (see below), the brightness is automatically decreased to a dimmed level in order to reduce instrument power dissipation and to spare display lifetime.
- **Dimmed Brightness** ... Decreased brightness level.
- **Dim Time** ... Brightness change to dimmed level time.
- **Language** ... In addition to the basic English version, other language versions can also be set.
- **Display refresh cycle** ... Actual values refresh period. For details see chapter *Display Actual Values Evaluation and Aggregation*.
- **Display Resolution** ... Actual & average data groups format be set to 3 or 4 significant figures.



4.2.11.2 Installation Setting

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



4.2.11.3 Remote Communication Setting

COM (RS-485) interface :

- **Communication Address**
- **Communication Rate** ...in Bauds (Bd)
- **Data Bits** ... including parity bits! Set to 8 for KMB-protocol; set to 9 when parity bit is used (Modbus-protocol, for example)
- **Parity** ...none/even/odd
- **Stop Bits** ... set to 1 (usually)

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 (2101 as default)
- **Web-port** ... communication port used for webserver communication (80)
- **Modbus-port** ... communication port used for Modbus protocol communication (502)

Nex information can be found in chapter *Computer Controlled Operation* below.



4.2.11.4 Clock Setting

- **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-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_{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** !



4.2.11.5 Average Values Processing Setting

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



4.2.11.6 Embedded Electricity Meter Setting

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



4.2.11.7 Power Quality & Input/Output Setting

There are only overviews of parameters. To edit them, use the ENVIS-DAQ program.



You can only clear the voltage events table in the power quality setup group.



4.2.11.8 Ripple Control Signal Setting

- **Method** ... Method of the signal evaluation can be set either to *Filter* or in compliance with the *IEC61000-4-30* standard

- f_{RC} ... frequency of the ripple control signal in Hz
- U_{RC} **unit** ... ripple control voltage unit : either V or percent of U_{NOM}
- U_{RC} **threshold** (U_{RCTR}) ... minimum signal level to be recognized as „pulse“. Relevant for telegram detection, signal below the threshold is recognized as „gap“.



4.2.12 Instrument Lock

To be protected against unauthorized changes or access, an instrument can be locked.

You can lock the instrument in two different ways :

- directly from the instrument panel
- via a communication link with the ENVIS-DAQ program using so called *user management setup* (see below)

The actual lock state is symbolized in *the main* menu by its icon :



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



- **Locked** – a *password* (PIN) is required before any configuration change is requested.



Exclusion : You can change the display setting group parameters even if the instrument is locked ! These are the only parameters that are free to change always.

4.2.12.1 Locking from the Instrument Panel

To lock the instrument, simply switch in the **Menu-Lock** window the lock from  to . Then escape from the window with the  and confirm saving of changed state.

4.2.12.2 Unlocking from the Instrument Panel

To unlock the instrument, switch in **Menu -> Lock** the lock state back from  to  by entering a PIN.

When the instrument was locked from the instrument panel, the value of this PIN 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** .

When the instrument was locked by the user management, you need the PIN defined in the management (see below).

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



*Note, that unlocking **the user management locked state** from the instrument panel is **temporary** and the instrument will switch to the locked state automatically approx. 15 minutes after last pressing of any button. To unlock such instrument permanently, use the user management.*

4.2.12.3 Locking/Unlocking by the User Management

Fig. 4.13 : User Management Locked Instrument



With the user management you can use more complex and sophisticated access control to the instrument not only from the instrument panel, but from all of communication interfaces.

You can check if the user management lock is used in the **Menu -> Lock** screen – at least one additional parameter *user* is displayed.

In such case, the PIN described in the previous chapter is inapplicable and the PIN defined in the user management is necessary for unlocking. Furthermore, more users with their private PINs can be defined.

So, when you want to change anything from the instrument panel, you must :

1. choose the user (*Peter* in our example)
2. enter the PIN corresponding this user in the user management setup

For details see the application note No. 004 : *Users, passwords and PINs*.



In case the PIN is lost, ask manufacturer for alternate PIN via manufacturer's website at www.kmbystems.eu.



4.2.13 Instrument Information

- **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-DAQ 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 4.1 : 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

4.3 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. 3 standard. The unitary evaluation interval, *a measurement cycle*, is a ten / twelve (value behind slash is valid for $f_{NOM} = 60 \text{ Hz}$) *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 288 / 240 samples per mains cycle. The sampling rate is adjusted according to the frequency measured on any of the voltage inputs **U1, U2, U3, U4**. 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) :

$$\text{Phase voltage (effective value) : } U_1 = \sqrt{\frac{1}{n} \sum_{i=1}^n U_{1i}^2}$$

$$\text{Line voltage (effective value) : } U_{12} = \sqrt{\frac{1}{n} \sum_{i=1}^n (U_{1i} - U_{2i})^2}$$

$$\text{Current (effective value) : } I_1 = \sqrt{\frac{1}{n} \sum_{i=1}^n I_{1i}^2}$$

where : i sample index

n number of samples per measurement cycle = 2880

U_{1i}, I_{1i} ... 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 / L1** to **L3** towards the terminal **VOLTAGE / N**. The voltage U_4 corresponds to the potential of terminals **VOLTAGE / L4** towards the terminal **VOLTAGE / N4**.



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 !

At the star (wye, 3Y) connection, four current signals - I_1, I_2, I_3, I_4 - are measured. Another currents are calculated from samples of directly measured ones by the Kirchhoff rule :

- I_{NC} as negative vector sum of current vectors I_1, I_2, I_3
- I_{PEC} as negative vector sum of current vectors I_1, I_2, I_3, I_4

At the Aron (3A) connection, the current I_2 is not measured, but it is calculated as negative vector sum of current vectors I_1 and I_3 .

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.3 as harmonic sub-groups (H_{sg}).

Following quantities are evaluated :

Harmonic components of voltage and current up to 128th 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 : $\Delta\varphi_{ih_1}$

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 kth harmonic components of voltage and current (of phase 1)

$\Delta\varphi_{k,1}$... angle between the kth 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 :
$$\cos \Delta\varphi_1 \text{ (or } \tan \Delta\varphi_1, \Delta\varphi_1)$$

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

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

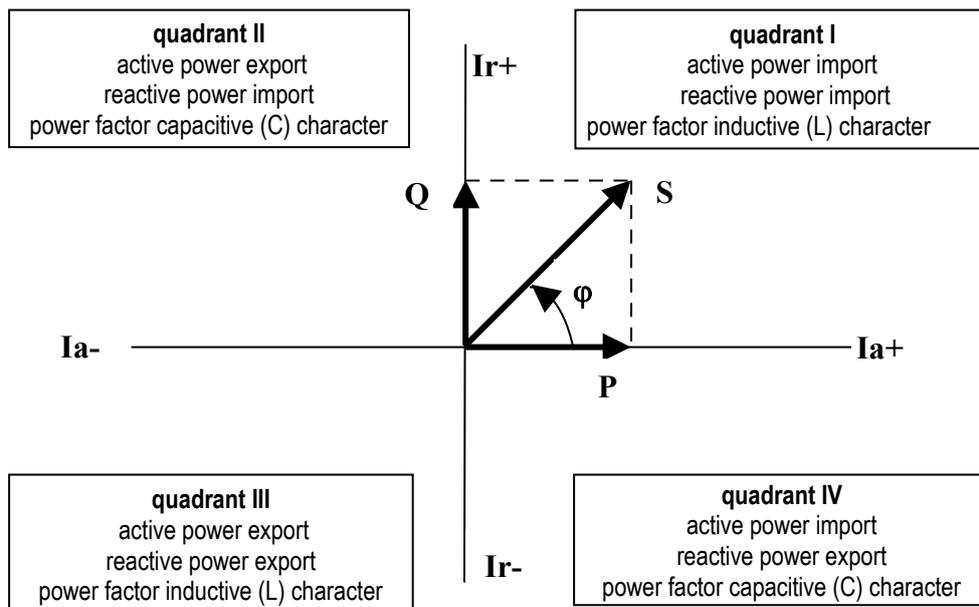
Fundamental harmonic three-phase active power :
$$\sum Pfh = Pfh_1 + Pfh_2 + Pfh_3$$

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 :

Fig. 4.20 : 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 :

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

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

Current negative sequence angle : φ_{nsl}

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

4.3.1.5 Temperature

Both the internal temperature **T_i** and the external temperature **T_e** (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_{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_{NOM}** = 400 Hz
- variable frequency networks, such as output of frequency inverters

The Fixscan mode is used to measure such networks.

4.3.1.6.1 Function

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

- U and I signals sampled at the fixed sampling frequency of 14400 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. 4.2 : 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)	$U1 = \sqrt{\frac{1}{2880} \sum_{i=1}^{2880} U_{i1}^2}$
Udc1	direct phase-to-neutral voltage (direct component of the signal)	$Udc1 = \frac{1}{2880} \sum_{i=1}^{2880} U_{i1}$
U12	phase-to-phase alternating voltage (effective value)	$U12 = \sqrt{\frac{1}{2880} \sum_{i=1}^{2880} (U_{i1} - U_{i2})^2}$
I1	alternating current (effective value)	$I1 = \sqrt{\frac{1}{2880} \sum_{i=1}^{2880} I_{i1}^2}$
P1	active power	$P1 = \frac{1}{2880} \sum_{i=1}^{2880} U_{i1} * I_{i1}$
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.3, 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 presettable 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.

Exceptions :

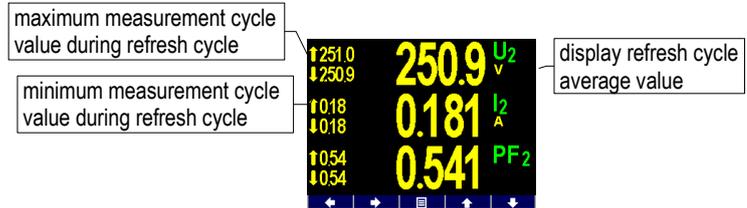
- frequency – the value is refreshed each frequency measurement cycle (see above)

- 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)

Fig. 4.21 : Actual Data Display Refresh Cycle Setting



Fig. 4.22 : Actual Data



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.

4.3.2.2 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 0.2 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 exponential moving average is evaluated.

Average values processing can be set independently for so called **U/I** -group, **P/Q/S** -group and optionally for the **RCM**-group of quantities.. Following table lists processed quantities of all of groups.

Tab. 4.5 : Average Values Groups

Average values group	Averaged quantities
“ U / I ”	U_{LL}, U_{LN}, I, f, T
“ P / Q / S ”	$P, Q, S, PF, P_{fh}, Q_{fh}, \cos\phi$
“ RCM ”	$I\Delta$ (residual currents)



After the average parameters set, evaluation of average values starts from beginning. The average values are temporary not available until the first averaging window expires.



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

4.3.2.2.1 Maximum and Minimum Average Values

Maximum and minimum values of average values are registered into the instrument's memory, including the date & time of their occurrence.

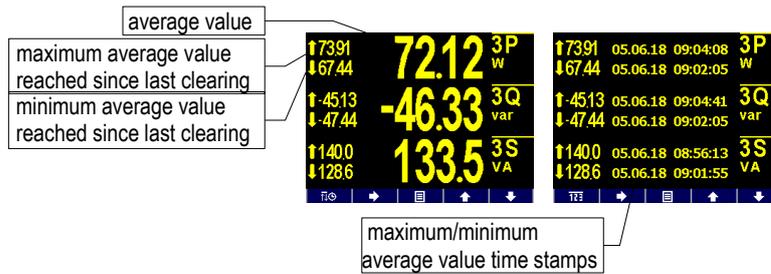
The maximums&minimums are displayed on the left side of average values window - maximum value is identified with the ↑ symbol and minimum value with the ↓ symbol.

To view their time stamps, press the .

Fig. 4.23 : Average Data Processing Setting



Fig. 4.24 : Average Data



The maximum and minimum registered values can be cleared either manually or automatic clearing can be set.

To clear the values manually, navigate to appropriate average group setup screen and use **Clear** option. At this screen last clear date can be checked too.

To activate automatic clearing of maximums/minimums of average values, set the automatic clear period.



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



After clearing of registered average maximums/minimums, evaluation of appropriate average values starts from beginning. After that, both the average values and their registered maximums/minimums are temporary not available until new averaging window expires.

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 presetable 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 aggregation interval below 1 minute is selected then evaluation is aggregated according to cycle count at actual frequency. For intervals longer than one minute the aggregation is carried out 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 (**EP**) consumed (+, import), active energy supplied (-, export), reactive energy (**EQ**) inductive (**L**) and reactive energy capacitive (**C**). Both single-phase and three-phase energies are processed.

In addition, 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.

The 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.



4.3.3.1.1 Standard Energy Presentation

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

As default , so called **2Q** branch is displayed (at the left on the map). The 1st screen shows actual three-phase energies registered since last clearing up to now for all tariff zones (**ΣT**) :

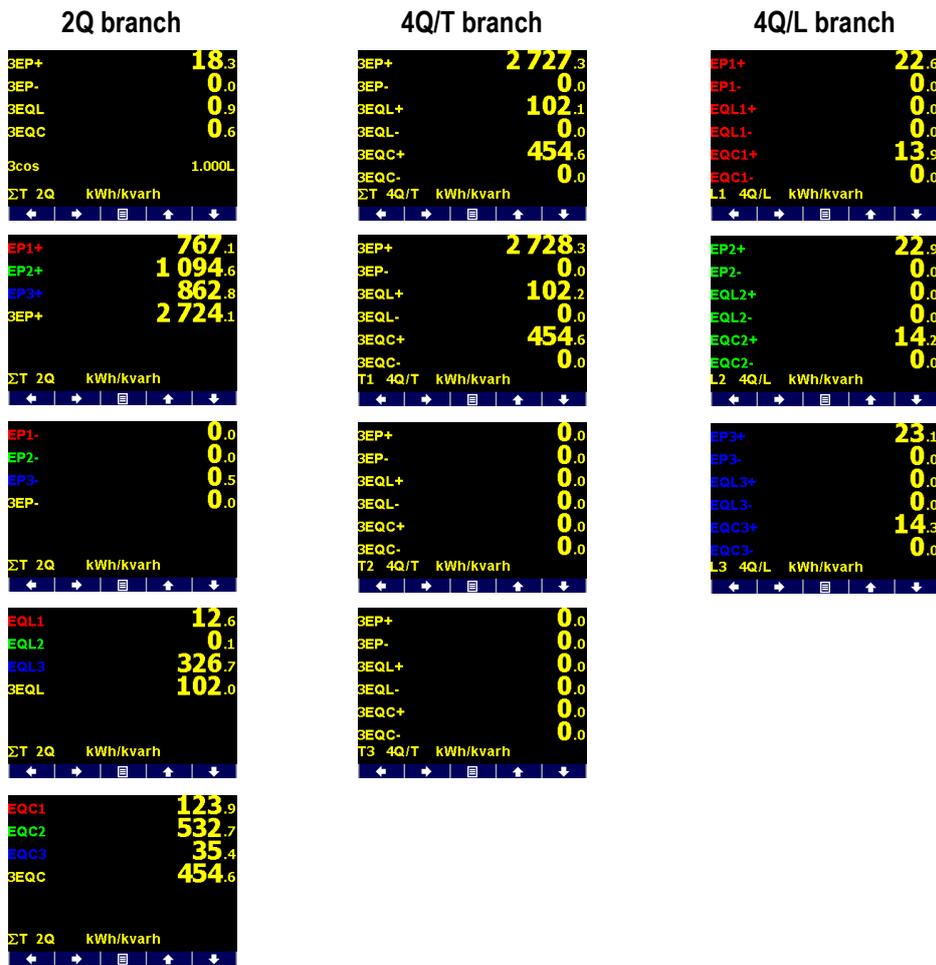
- **3EP+** ... imported active energy
- **3EP-** ... exported active energy
- **3EQL** ... imported reactive energy (inductive, **L**)
- **3EQC** ... exported reactive energy (capacitive, **C**)

Scrolling down, individual phase energies can be checked too.

Navigating to the right you get into the **4Q/T** branch. This presentation brings individual reactive energies registered during active power import and export, that can be useful especially for monitoring of renewable sources. For example :

- **3EQL+** ... registered, when three-phase active power **3P** is positive (+ = import)
- **3EQL-** ... registered, when three-phase active power **3P** is negative (- = export)

Fig. 4.28 : Electricity Meter Screen Map



Scrolling down you can check these energies registered in individual tariff zones **T1**, **T2** and **T3**.

Finally, at the right branch **4Q/L** you can browse through energies of individual phases **L1**, **L2**, **L3** (for all three tariff zones).

Tariff zones can be set via a communication link using the program ENVIS-DAQ.

Energy counters can be cleared either manually or with a remote PC. Manual clearing can be invoked by the **Clear** option in the electricity meter setup screen. There you can check time & date of the previous clearing too.

4.3.3.1.2 Customizable Energy Screen

With the ENVIS-DAQ program you can add special user configurable electricity meter screen into the main data group. In the screen you can choose not only energies you are interested in, but processing period too.

The processing period can be selected from :

- **Actual** ... energies registered since the last clearing
- **This Month/Week** ... energies registered during present month/week
- **Last Month/Week** ... energies registered during last month/week
- **Bookmark** ... energies registered since defined date & time (=bookmark)

For example, when you are interested in imported three-phase active energy registered since 11 o'clock of 5th June 2018, create such custom screen in the ENVIS-DAQ program, choose evaluation period to *bookmark* and set its date & time. Then desired screen appears in the main data group.

Fig. 4.29 : Electricity Meter Setting



Fig. 4.30 : Custom Electricity Meter Screen with Bookmark



When you set the processing period, note that energies evaluated in this screen are calculated according values stored in the electricity meter archive. If such record is not stored in the archive, the evaluated energies can be false. To get correct values, the electricity meter archive recording must be set appropriately and the archive must be filled with sufficient depth of data. Attention must be paid whenever the electricity meter archive is cleared!

4.3.3.1.3 Recorded Values of Energy Aggregation

All of electricity meter readings can be optionally archived into the separate archive. Use the ENVIS-DAQ for the electricity meter archive setup.

You can set *the record period* that defines how often the electricity meter state is stored into the memory. Minimum record period is 1 minute. 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.

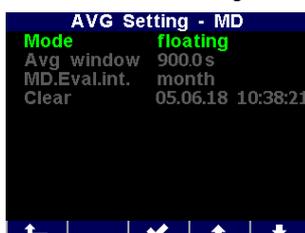
In case of *the digital input* selection, chosen digital input specifies actual tariff – open state means tariff 1, closed state tariff 2. Tariff 3 is not used at this case.

4.3.3.2 Maximum Demand Processing

From the instantaneous measured values of all active powers the instrument evaluates their average values per preset period using preset averaging method. Such quantities are called *actual demands (AD)*. Note that the actual demands are processed individually and their averaging method & period are presettable independently on standard average values (P_{AVG}).

Their maximum values reached since the last clearing or during *the MD evaluation interval*, are called *maximum demands (MD)*.

Fig. 4.31 : Maximum Demand Setting



Parameters determining maximum demand processing can be set in the **Setting – AVG – MD** screen. As default, *the floating window* averaging method is set.

The demand registered since the last clearing is marked simply **MD**. The demands registered during *the MD evaluation interval*, are marked with additional appropriate index X - see below.

The MD evaluation interval can be set in range 1 day up to 1 year.

The maximum demands are stored including their time stamps. They can be cleared independently of standard average maximums & minimums. Time & date of the last clearing can be checked in the MD-setting screen.



After the MD average parameters set or registered MD values cleared, evaluation of demands starts from beginning. The demand values are temporary not available until the first averaging window expires.

4.3.3.2.1 Fixed Window MD Processing, Last Demand and Estimated Demand

If the maximum demand averaging mode is set to the *fixed window* method, evaluation of the **AD** is different from that of floating window. Auxiliary energy buffer is cleared at the beginning of every averaging window and starts to count from zero. So average power that is calculated from energy registered in the buffer divided by averaging window length drops to zero periodically, then raises and reaches true average power at the end of the averaging interval only.

Then other demands can be useful :

- **LD** ... last demand = value of the **AD** (actual demand =average active power) at the end of previous averaging window. The value is displayed including its time stamp, that corresponds to the end of the window
- **ED** ... estimated demand = estimated value of the **AD** (actual demand =average active power) that should be reached at the end of current averaging window



If the maximum demand averaging mode is set to the *floating window* method, the **LD** and **ED** values are irrelevant (contains only copies of the **AD** quantities).

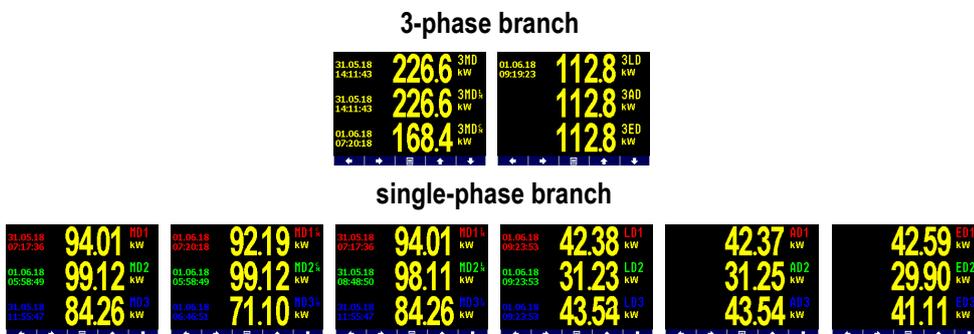
4.3.3.2.2 Maximum Demand Presentation

While in the electricity meter energy window you can switch down to the maximum demand windows.

The first branch has two screens only and comprises three-phase values :

- **3MD** ... maximum demand = maximum of **3AD** reached since the last clearing
- **3MD_{LX}**, **3MD_{CX}** ... maximums of the **3AD** reached during the last (L) and current (C) evaluation interval. The "X"-index depends on *the MD evaluation interval* preset value : D=day, W=week, M=month, Q=quarter, Y=year.
- **3AD**, **3LD**, **3ED** ... actual / last / estimated demand

Fig. 4.32 : Maximum Demand Screen Map



Scrolling down you get into the single-phase branch of the maximum demand values. You can check individual phase demands here.

5. Residual Current Monitoring (RCM)

Instruments equipped with residual current inputs can be used for residual current monitoring (RCM). The RCM can get early warning of measured network failures.

The instruments measure alternating and pulsating direct residual currents according to the A-type RCM specification as defined in the IEC 62020 standard. No directional sensitivity of the residual currents is implemented.

5.1 Measuring Transformers for the RCM

All of the instruments are designed for indirect connection, thus use of a current transformer is necessary. But for the RCM, special residual current transformer (RCT) must be used. The following parameters are essential for a suitable RCT selection :

- **In** ... rated current = maximum primary current of the RCT. The RCT **In** must be greater than the upstream circuit breaker rating (= maximum permanent phase current of monitored network). If not specified, the RCT **Icth** (rated continuous thermal current) can be used instead.
Usually, size of the RCT and its window depends on the **In** value – check it too in order the cable used to match it.
- **RCT-ratio** ... (600/1, for example)
- **IΔn** ... primary residual operating current. It defines range of primary residual currents that can be measured with defined accuracy and used for reliable indication of a residual current threshold exceeding. Then :
 - desired residual current threshold must fit into the RCT **IΔn** range
 - the desired residual current threshold divided by the RCT-ratio must fit into the instrument residual current range
- **RRCMMAX** ... maximum burden = maximum impedance of the shunt connected to the RCT output. It must be higher than the instrument residual current input impedance.

5.1.1 Electrical Safety

The residual current measurement inputs are not insulated from the instrument internal circuitry, therefore signals of safe voltage only can be connected to.



Insulation of used RCT must fulfil IEC61010-1 requirements for the CATIII double insulation for the mains voltage present!

5.1.2 Standard RCTs with AC-Current Output

These RCTs are commonly used. Appropriate **CT_{RCM}**-ratio in form xxx/1 must be set in the *Installation* group of parameters.

But it must be taken in account that in certain cases possible overcurrent on the RCT output could be dangerous for the instrument input.

5.1.2.1 Overcurrent Protection

Unlike standard current inputs, the residual current inputs are designed to measure residual current in range of milliamperes (see technical specifications), i.e. currents that are several orders of magnitude

lower. Due to this, they are generally less resistant against overcurrents than the standard current inputs.

Therefore, check possible worst conditions in the network and calculate maximum possible residual currents on the RCT output, both the permanent and the dynamic ones. Then compare them with maximum allowable static and dynamic currents of the instrument inputs that can be found in technical specifications.

Particular care must be taken during the RCT installation. When, for example, only two power conductors of a three phase cable is installed into the RCT by mistake, the RCT can push from its output false residual current of magnitude corresponding up to rated phase current of the network!

Example :

rated nominal primary phase current :	120 A
RCT-ratio :	600 / 1
false primary residual current (2 phase currents only measured):	120 A
false secondary residual current :	$120 / 600 = 0.2 \text{ A}$



If the RCT is powerful enough to source such false secondary residual current for long time and its value exceeds maximum allowable current of the instrument input, it is strongly recommended to check the RCT output current before connecting it to the instrument!



Never use standard CTs with 5A nominal secondary current for the RCM! Eventual overcurrent could damage the instrument residual current input!

5.1.3 Special RCTs with DC-Current Output

Besides standard RCTs, RCTs with output current loop of 4-20 mA DC can be used too. In such case, instead the CT_{RCM} -ratio set primary residual current values corresponding to 20 mA in the *Installation* group of parameters (see below).

Any current overload of the instrument inputs cannot occur in such case.

5.2 RCM Inputs Connection

Although it is not mandatory, we recommend to connect the S1-signal (or "k") from a standard type RCT to the **IA11 / IA21** terminal and the S2-signal ("l") to the **IA12 / IA22** when standard RCT is used.

When special RCT with DC current loop output used, connect positive (+) pole to the **IA11 / IA21** terminal and negative pole (-) to the **IA12 / IA22**.

recommended wire type :	H05V-U (CY)
recommended minimum cross-section :	0.5 mm^2
maximum cross-section :	1.5 mm^2



Check measured residual currents immediately after the RCT connection - if any is higher than maximum allowable current of the input (defined in the technical specifications), disconnect the RCT immediately, otherwise the instrument can be damaged!!!

Residual currents are marked $I\Delta$ and can be checked on the instrument display. When any of the RCM inputs is overloaded, the indicator  flashes at the display upper right corner.

Then set the CT_{RCM} -ratio in the *Installation Setting* group of parameters.



The RCM inputs are insulated neither from instrument internal circuitry nor mutually! The terminals $I\Delta 12$ and $I\Delta 22$ are connected internally, do not connect signals of different potential to them!



One of outputs of each RCT can be optionally grounded to PE – in such case, always ground the output connected to the $I\Delta 12$ / $I\Delta 22$ terminal(s)!
Take such grounding in account when one of residual current inputs is used for the RCM and simultaneously the other one for a 20 mA DC current loop measurement or when a temperature input is connected too to avoid possible short-circuits!



Maximum length of cable is 3 meters ! Otherwise, EMC-immunity of the instrument can be degraded.

5.3 RCM Setup & Presentation

If a standard RCT with AC-current output is used, set its CT_{RCM} -ratio in the *Installation* group of parameters. Optionally, you can use the I_{RCM} -multiplier too.

Fig. 5.1 : Standard RCT
 CT_{RCM} -Ratio and I_{RCM} -
Multiplier Setting

Setting - Installation	
VT Mode	direct
Connection	3Y
U-Mult.	1.00
CT	500 / 5
I-Mult.	1.00
CTN	300 / 5
IN-Mult.	1.00
RCT Ratio	600 / 1
IRCM-Mult.	1.00

Fig. 5.2 : DC-Current
Output RCT Ratio Setting

Setting - Installation	
VT Mode	direct
Connection	3Y
U-Mult.	1.00
CT	500 / 5
I-Mult.	1.00
CTN	300 / 5
IN-Mult.	1.00
RCT Curr.	300 / 20mA
RCT type	4-20mA

If a RCT with DC-current output loop 4/20 mA or 0/20 mA is used, switch appropriately the **RCT type** first by editing the I_{RCM} -multiplier. Then enter the RCT primary current corresponding to 20 mA DC output (in milliamperes – on the example above conversion ratio of 300 mA / 20 mA is set). The value corresponding to 0 or 4 mA cannot be set – it is supposed zero automatically.

Effective values only of residual currents are available. The residual currents are marked as $I\Delta 1$ and $I\Delta 2$.

The residual current values can be not only monitored and archived, but exceeding a preset level can be signalled using appropriate I/O Setup condition – see appropriate chapter below.



If the **0-20mA** or the **4-20mA** RCT type is set, residual current value is marked as overloaded and the indicator flashes at the display upper right corner as soon as the primary residual current exceeds the value corresponding to secondary current of 20 mA, indicating possible overload of the RCT.



If the **4-20mA** RCT type is set, residual current value is marked as possible wrong and the indicator flashes at the display upper right corner as soon as the RCT secondary current drops below 3.8 mA, indicating wrong connection or possible damaged RCT.



As soon a residual current input is used as analog input (AI) and corresponding action is defined in the I/O block setup (see below), residual current monitoring on appropriate input is suppressed and appropriate $I\Delta$ value is no longer available!

5.4 Tips & Hints

- Never lead the PE conductor through a RCT, only **all live conductors** can be threaded through. The only exception is when residual current is monitored by a single PE conductor measurement – then it must be **the only conductor** threaded through.
- Never lead a shielded cable through the RCT.
- Install the RCT on straight part of a cable, far enough from bends. Center the cable inside the RCT window as precise as possible. Otherwise, false residual currents may appear.
- To reach higher immunity to false residual currents due to asymmetric installation, especially when low residual currents to be measured, use a RCT with a larger window diameter than is necessary.
- Take in account native leakage currents caused by long cables (stray capacitance), capacitive filters, surge arresters, etc., especially when many single-phase appliances connected to the PE-conductor (for safety or other purposes) installed in the monitored network. They can cause nuisance residual current indication.

6. Inputs & Outputs

Instruments can be optionally equipped with a combination of outputs and inputs (see manufactured models marking below). Following I/O types are available :

- electromechanical relay digital output, referenced as **ROx** (x =output number)
- solid state (semiconductor) digital output – **DOx**
- digital signal input (solid state) – **DIx**
- analog input, usually of range 0-20 mA_{DC} – **AIx**
- analog output, usually of range 0-20 mA_{DC} – **AOx**
- temperature input, usually for a Pt100 sensor – **TE**

Depending of instrument model following inputs & outputs are available :

I/O Combination Assortment

model	I/O combination	I/O character
N	4 x DO/DI (bidirectional) 2 x AI	unipolar (DC) 20mA DC loop (shared with RCM)
F	4 x DO/DI (bidirectional) 4 x AI 2 x AO 4 x RO 1 x DI 1 x T _E	unipolar (DC) AI1-2 : 20mA DC loop (AI1/2 shared with RCM) AI3-4 : 20mA DC loop or 10V DC 20mA DC loop bipolar (AC/DC) bipolar (AC/DC) Pt100

Any of 4 bidirectional digital inputs/outputs DI/DO 1-4 can be used as either input or output. The signal polarity must be kept ; it depends on whether particular I/O is used as input or output (see description below).

Both of residual current inputs - if not used for residual current measurement - can be used as 0-20mA DC (or 4-20mA DC) current loop analog inputs AI1, AI2. The inputs are insulated neither from instrument internal circuitry nor mutually !

The “F” models have another two analog inputs AI3 and AI4, that can be used either for 0-20mA DC (or 4-20mA DC) current loop or 0-10V DC signal measurement. Furthermore, two analog outputs (0-20mA DC current loop) AO1, AO2 are available. All of these AI/Os are insulated from instrument internal circuitry.

Next, the “F” models bring four electromechanical relay outputs RO5-8, one AC/DC digital input DI5 and one Pt100 temperature sensor input (insulated) for an external temperature (T_E) measurement.

All of digital inputs/outouts are insulated from instrument internal circuitry.

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.

The behaviour of digital outputs can be programmed according to requirements as :

- *standard output* ... a simple two-position controller or a defined status indicator
- *pulse output* ... transmitting electricity meter (only DO-type outputs)

- *time synchronization output* ... for transmission of second or minute pulses

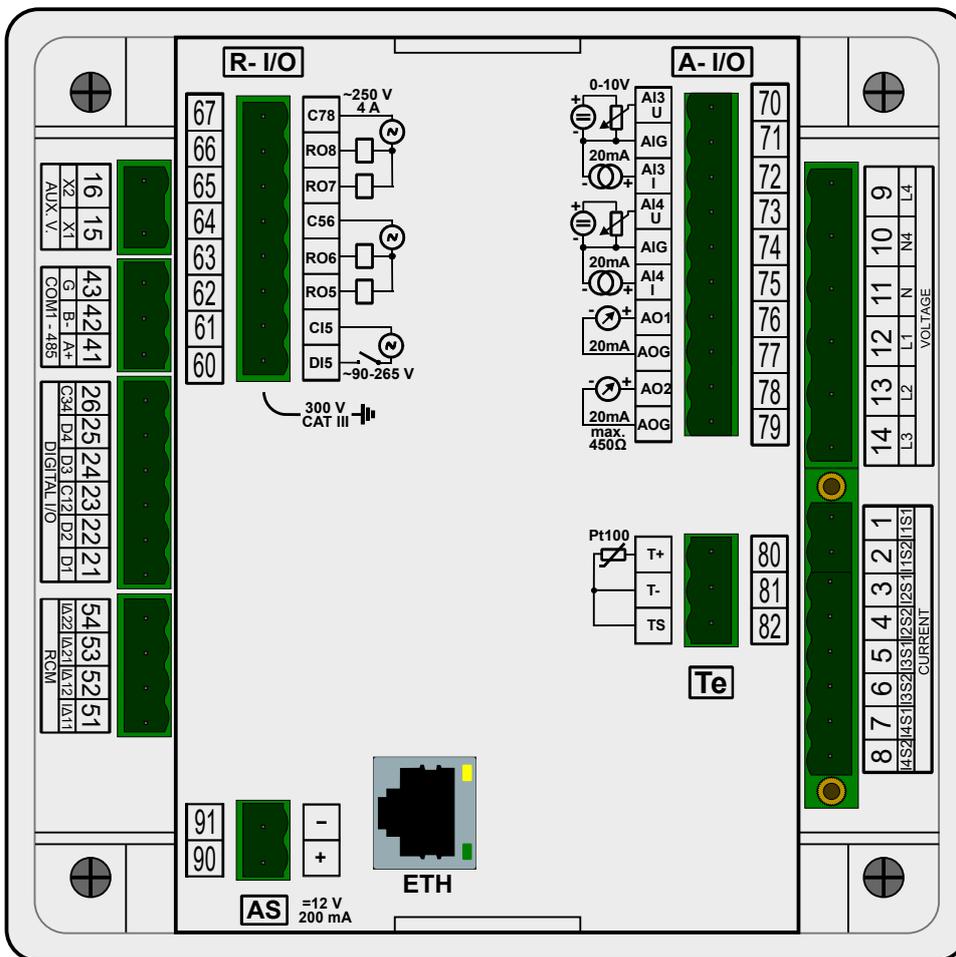
Digital inputs can be used :

- for *state monitoring* (a contact closure etc.)
- as *pulse or frequency counter* (see description below)
- as input quantity of an *I/O setup clause condition* (see description below)

Actual state of both alarm lights and digital I/Os can be checked on the status bar (see above).

6.1 Connection of the I/Os

Fig. 6.1 : SMZ244 – I/O Connectors



Inputs & outputs are connected to terminals on a rear panel of an instrument according to the following table.

- recommended wire type : H05V-U (CY)
- rec. minimum cross-section : 0.75 mm²
- maximum cross-section : 2.5 mm²

I/O Connection

terminal No./name	signal	notes
21 / D1	DO1 digital output or DI1 digital input	- input and outputs are unipolar - common pole of outputs „DO“ is positive (+) - common pole of inputs „DI“ is negative (-) - inputs and outputs are insulated from instrument internal circuitry - DO1/DI1 & DO2/DI2 pair is insulated from DO3/DI3 & DO4/DI4 pair
22 / D2	DO2 digital output or DI2 digital input	
23 / C12	DO1/DI1 & DO2/DI2 common pole	
24 / D3	DO3 digital output or DI3 digital input	
25 / D4	DO4 digital output or DI4 digital input	
26 / C34	DO3/DI3 & DO4/DI4 common pole	
60, 61 / DI5, C15	DI5 digital input	- bipolar, 250 V AC - insulated from both instrument internal circuitry and other I/Os
62 / RO5	RO5 digital output	- electromechanical relays, 250 V AC - insulated from instrument internal circuitry - RO5 & RO6 pair is insulated from RO7 & RO8 pair
63 / RO6	RO6 digital output	
64 / C56	RO5 & RO6 common pole	
65 / RO7	RO7 digital output	
66 / RO8	RO8 digital output	
67 / C78	RO7 & RO8 common pole	
51, 52 / IΔ11, IΔ12	AI1 analog input – current alternatively if residual current is not measured	- for 20mA current loop IΔ11, IΔ21 are positive (+) - inputs are not insulated from instrument internal circuitry !!! - the same signal (voltage level) or potential-free signal can be connected to the terminals IΔ12, IΔ22 only !
53, 54 / IΔ21, IΔ22	AI2 analog input – current alternatively if residual current is not measured	
70 / AI3U	AI3 analog input – voltage, positive	- either voltage or current signal can be connected to each input, not both - common poles AIG of both inputs are connected internally - inputs are insulated from both instrument internal circuitry and other I/Os
71 / AIG	AI3 analog input common pole (negative)	
72 / AI3I	AI3 analog input – current, positive	
73 / AI4U	AI4 analog input – voltage, positive	
74 / AIG	AI4 analog input common pole (negative)	
75 / AI4I	AI4 analog input – current, positive	
76 / AO1	AO1 analog output – current, positive	- common poles AOG of both outputs are connected internally - outputs are insulated from both instrument internal circuitry and other I/Os
77 / AOG	AO1 analog output common pole (negative)	
78 / AO2	AO2 analog output – current, positive	
79 / AOG	AO2 analog output common pole (negative)	
80 / T+	T_E Pt100 temperature sensor input, positive	- input is insulated from both instrument internal circuitry and other I/Os
81 / T-	T_E Pt100 temperature sensor input, negative	
82 / TS	T_E Pt100 temperature sensor supply	

6.1.1 DI/O1 - DI/O4 Digital Inputs/Outputs Connection

Each of digital inputs/outputs No. 1-4 can be used as either input or output. The inputs/outputs are unipolar (DC voltage signals can be connected only) and proper polarity of signal terminal and appropriate common terminal must be kept.

The inputs/outputs are of solid-state type and maximum allowable voltage and load current according technical specifications must be observed.

The inputs/outputs are insulated from instrument internal circuitry. Each of input/output pair has common pole and the pairs are insulated mutually.

6.1.2 DI5 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 **DI5** (No. 60) and **CI5** (61) of the R-I/O connector. The input is insulated from all of other instrument circuitry. For the input activation, voltage of declared level must lead on the input.

6.1.3 RO5 - RO8 Digital Outputs Connection

A SPST-NO (single-pole, single-throw, normally open) electromechanical relays 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 pairs are insulated mutually.

6.1.4 Analog Inputs Connection

6.1.4.1 AI1 - AI2 Analog Inputs

If residual currents are not measured, the residual current inputs can be optionally used as 0-20mA DC (or 4-20mA DC) current loop analog inputs.

Check if the signal source is capable to work with the impedance of the input defined in the technical specifications.

Connect positive signal (+) to the **IA11** / **IA21** terminal and negative signal (-) to the **IA12** / **IA22**.

Then set the input parameters – see the chapter *I/O Setup* below.



The residual current inputs are not insulated neither from instrument internal circuitry nor mutually ! The terminals IA12 and IA22 are connected internally, do not connect signals of different potential to them !



Maximum length of the cable is 3 meters. Otherwise, immunity against electromagnetic disturbances can be affected negative !



As soon an analog input (AI1, AI2) mode is activated in the I/O block setup (see below), residual current monitoring on appropriate input is suppressed and appropriate IA value is no longer available !

6.1.4.2 AI3 - AI4 Analog Inputs

Two other analog inputs - AI3 and AI4 - can be monitored for selected instrument models. Signal character of the inputs can be :

- 0(4) ÷ 20 mAdc
- or 0 ÷ 10 Vdc

The inputs are insulated from instrument internal circuitry and other I/Os, but not mutually – both of the AI3 and AI4 have common pole marked AIG.



You can connect either voltage or current signal to each of the inputs, not both !



The common pole terminals AIG are connected internally, do not connect signals of different potential to them !

6.1.5 External Pt100 Temperature (T_E) Sensor Connection

With selected instrument models, an external temperature T_E can be measured.

The input is designed for three-wire connection to a resistive temperature Pt100-type sensor. Connect the sensor to the terminals No. 80 (**T+**), 81 (**T-**) and 82 (**TS**) according example drawing below.

In case of two-wire connection, connect the sensor to the terminals **T+** and **T-** and short-circuit the **T-** terminal with the **TS** 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).

6.1.6 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 + (No. 90) and negative pole at terminal - (91).

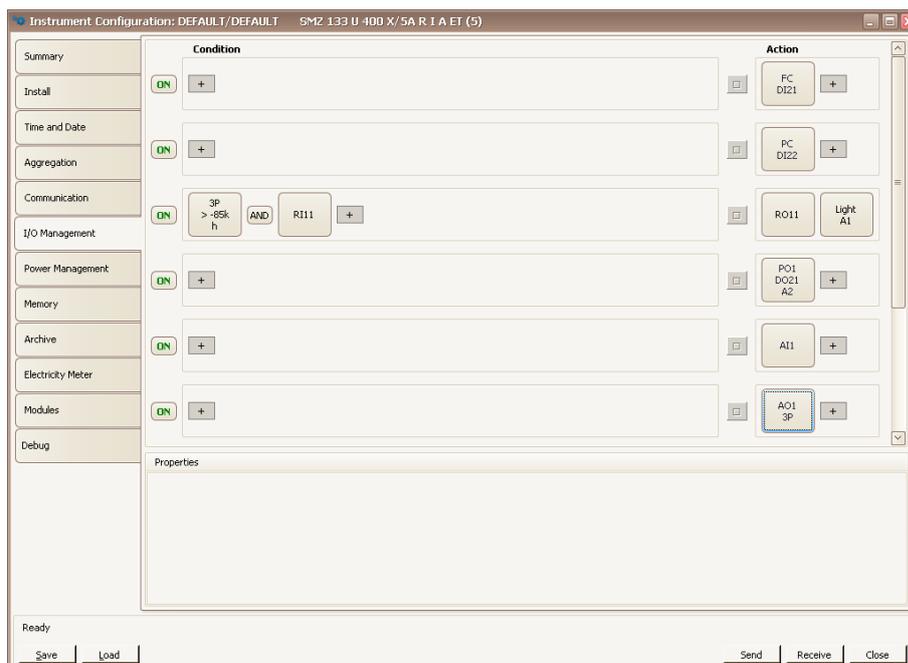
The supply is insulated from instrument internal circuitry and other I/Os.

Maximum load current is given in technical specifications.

6.2 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.

Fig. 6.2 : The I/O Management Setup Example in 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.

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 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.

6.2.1 I/O Actions

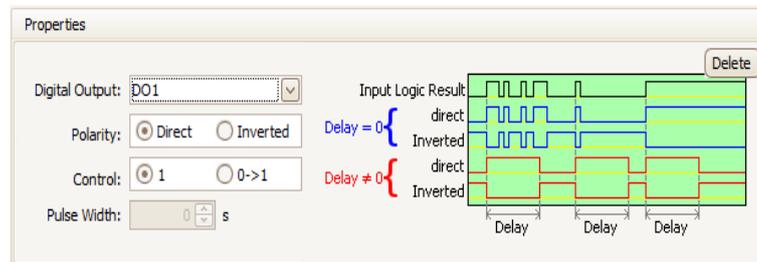
6.2.1.1 Digital Output (Standard, DO/RO)

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. 6.3: 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..

6.2.1.2 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.

6.2.1.3 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.

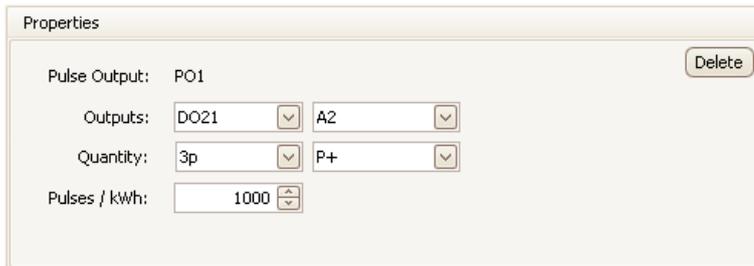


You can set to impulse output mode not only the **I**-type (solid-state) outputs, but the **R**-type (electromechanical relay) outputs too. But note lifetime of electromechanical relays, they have limited number of switching operations.

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. 6.4: 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.

6.2.1.4 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. 6.5: 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

6.2.1.5 Frequency Counter (FC)

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

6.2.1.5.1 Frequency Mode

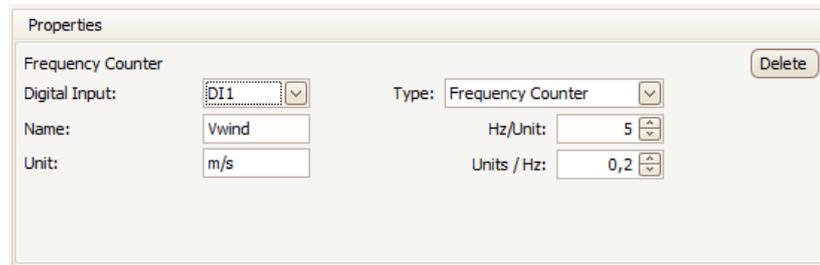
As example, flowmeters or anemometers with pulse output (often the „S0-type“) can be connected and the instrument can measure and record a flow rate or a wind speed. So despite being so called, this quantity is not any counter but a frequency controlled quantity.

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 hertzs 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. 6.6 : 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).

6.2.1.5.2 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).

6.2.1.6 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. 6.7 : I/O Setup – PC Action Properties



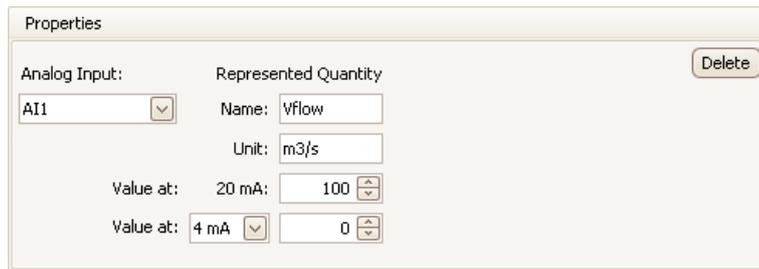
If the name is not defined, the quantity is referenced with its general name *PCxx* (when the *xx* is index corresponding digital input).

6.2.1.7 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. 6.8 : 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.

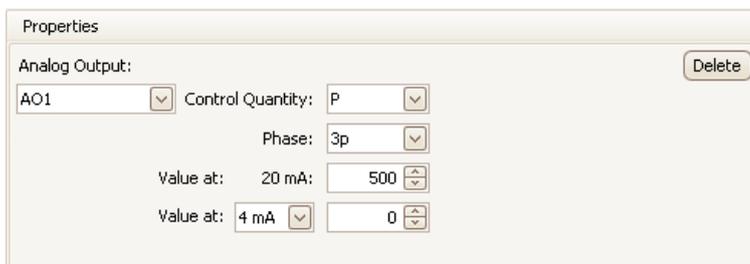
But as soon as the analog input action is defined in the I/O block setup, the residual current monitoring on this input is suppressed and appropriate $I\Delta$ value is no longer available, because the input is used for a 20 mA current loop signal now.

6.2.1.8 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. 6.9 : 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.

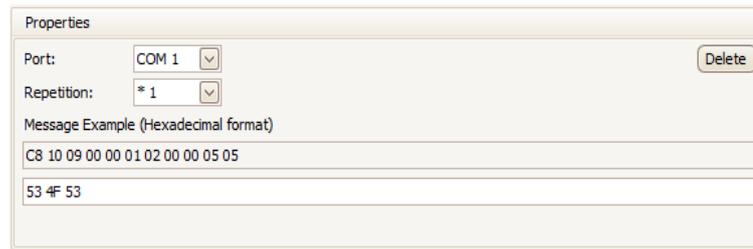
Output current is limited to maximum value of 22 mA.

6.2.1.9 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. 6.10 : I/O Setup – Send Message



Properties

Port: COM 1 Delete

Repetition: * 1

Message Example (Hexadecimal format)

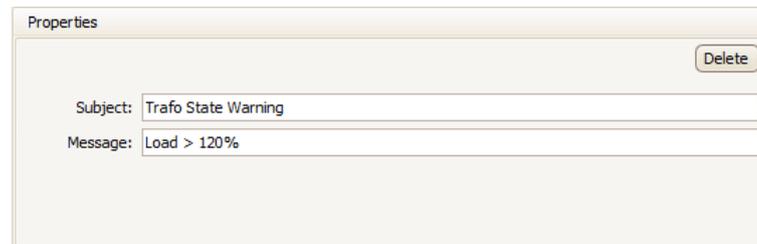
C8 10 09 00 00 01 02 00 00 05 05

53 4F 53

6.2.1.10 Send Email

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

Fig. 6.11 : I/O Setup – Send Email



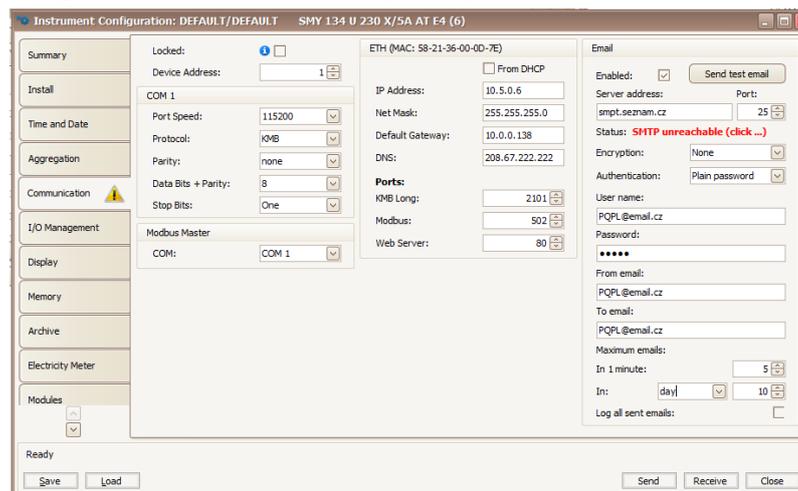
Properties Delete

Subject: Trafo State Warning

Message: Load > 120%

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. 6.12 : Communication Setup Example for the Send Email Action



Instrument Configuration: DEFAULT/DEFAULT SMY 134 U 230 X/5A AT E4 (6)

Summary

Locked:

Device Address: 1

COM 1

Port Speed: 115200

Protocol: QMB

Parity: none

Data Bits + Parity: 8

Stop Bits: One

Modbus Master

COM: COM 1

ETH (MAC: 58-21-36-00-0D-7E)

From DHCP

IP Address: 10.5.0.6

Net Mask: 255.255.255.0

Default Gateway: 10.0.0.138

DNS: 208.67.222.222

Ports:

KMB Long: 2101

Modbus: 502

Web Server: 80

Email

Enabled: Send test email

Server address: smtp.seznam.cz

Port: 25

Status: **SMTP unreachable (click ...)**

Encryption: None

Authentication: Plain password

User name: PQL@emai.cz

To email: PQL@emai.cz

Maximum emails: 5

In 1 minute: 10

In: day

Log all sent emails:

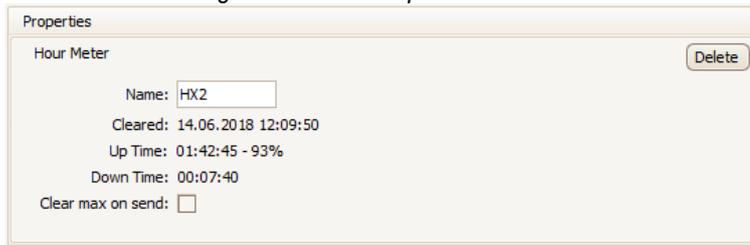
Ready

Save Load Send Receive Close

6.2.1.11 Hour Meter (HM)

With the hour meter it is possible to measure duration of some events. Add the hour meter and enter its name – HX2, for example:

Fig. 6.13 : I/O Setup – Hour Meter



Then add a condition for the event - for example, for checking of time of power overload, add the *Measured Quantity* condition and set a power limit for it (see condition setup below).

After that, the hour meter starts running. It contains three counters :

- **Up** ... the period since the last clearing for which the condition was met (= true)
- **Down** ... the period since the last clearing for which the condition was not met (= false)
- **Cnt** ... number of the condition false to true changes since the last clearing

Fig. 6.14 : Hour Meter

Hour Meters HM			
Up	h:m	Down	Cnt
HX1	22:19	0:35	4
HX2	1:42	0:05	2

Up to 4 hour meters can be defined.

To check state of hour meters on an instrument display, you must add the hour meter screen with the ENVIS-DAQ program into the main data group. Then you can scroll to the screen and check measured data.

On the example you can see two hour meters : HM1 with name HX1 a HM2 with name HX2. Duration of the *Up* and *Down* counters is expressed as *hours:minutes*.



The only method how to clear a hour meter is to select the hour meter setup icon in the ENVIS-DAQ program, check the option **Clear on send** and send the setting into the instrument. The time & date of the clearing is registered simultaneously and can be checked by reading the setting back from the instrument.

6.2.1.12 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. 6.15 : I/O Setup – Time Synchronization Output



6.2.1.13 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. 6.16 : I/O Setup – Archive Control



Fig. 6.16 : I/O Setup – Archive Control



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

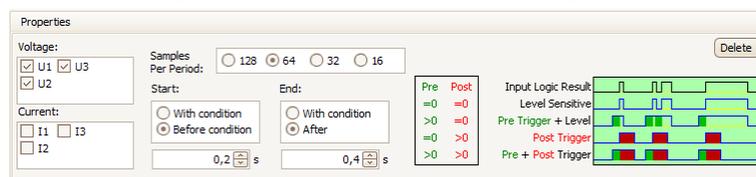
6.2.1.14 General Oscillogram

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. 6.17 : I/O Setup – General Oscillogram



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 Oscillogram 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 !

6.2.1.15 Variable

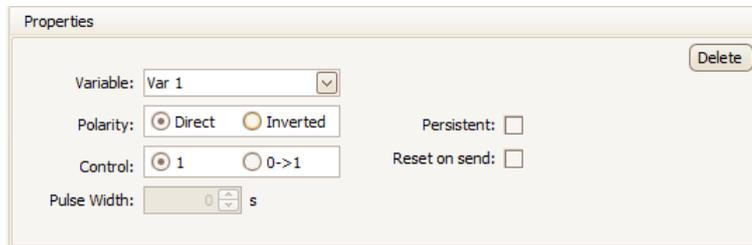
With this action you can design more complex conditions in a clause than can be designed with basic conditions only.

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. 6.18 : I/O Setup – Variable



Now specify condition for this action, for example :

Fig. 6.19 : 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.

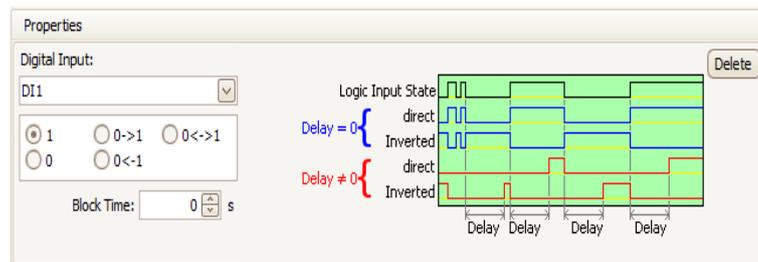
6.2.2 I/O Conditions

6.2.2.1 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*
- $1 / 0 / 0 \leftarrow 1 / 1 \leftarrow 0 / 0 \leftarrow 1$... 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. 6.20 : I/O Setup – Digital Input Condition Properties



6.2.2.2 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. 6.21 : I/O Setup – Measured Quantity Condition Properties



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

6.2.2.3 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. 6.22 : 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.

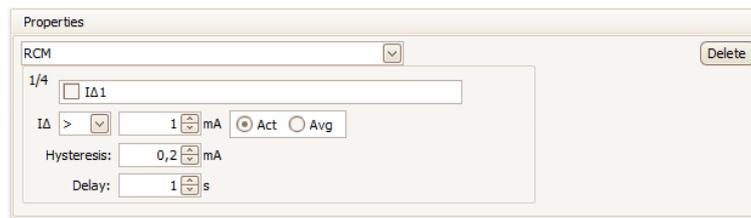
For further details, see the application note *General Oscillogram Firmware Module*.

6.2.2.4 RCM Condition

Instruments equipped with a residual current monitoring (RCM) inputs can be used for indication of network isolation state failures using this condition.

Add the condition and check RCM currents $I_{\Delta x}$ to be monitored. Then set the residual current limit, polarity of deviation, actual/average current value evaluation, hysteresis and delay.

Fig. 6.23 : I/O Setup – RCM Condition Properties



Up to four such different conditions can be created and used.



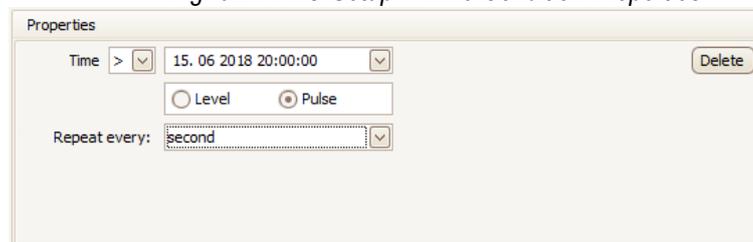
Do not forget to set residual current monitoring ratio CT_{RCM} in the Installation Setting group of parameters !

6.2.2.5 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. 6.24 : I/O Setup – Time Condition Properties

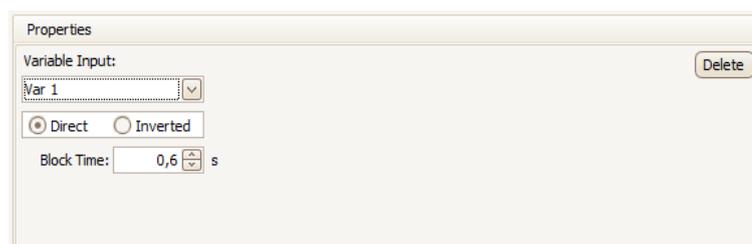


6.2.2.6 Variable Condition

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. 6.25 : I/O Setup – Variable Condition Properties

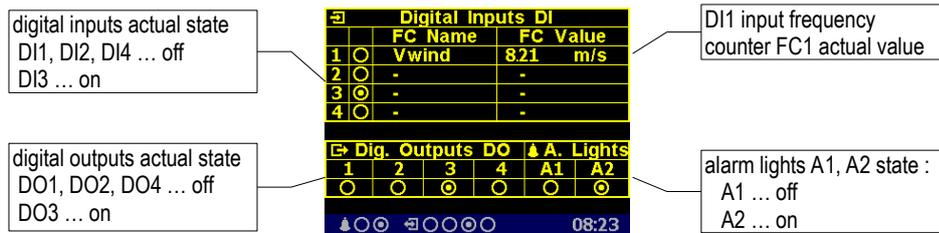


6.3 I/O Actual Data Presentation

6.3.1 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. 6.30 : Digital I/O Actual Data Screen Example



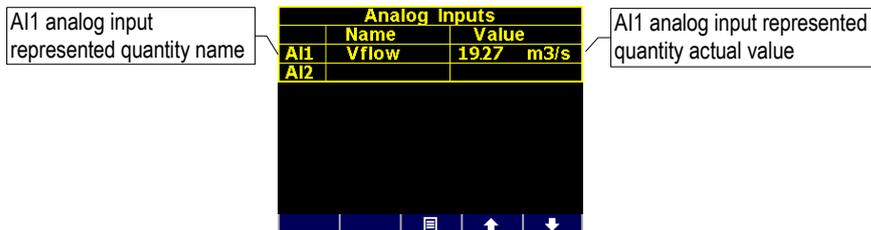
The digital I/O actual data screen shows actual state of all of the inputs and outputs :

- ... 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 (*8.21 m/s*) 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) :

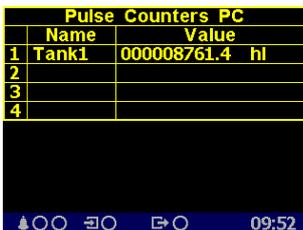
Fig. 6.31 : Analog I/O Actual Data Screen Example



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 $19.27 \text{ m}^3/\text{s}$.

6.3.2 Pulse Counters

Fig. 6.32 : Pulse Counters Screen Example



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.

The table shows set pulse counters PC corresponding to digital inputs DI. Actual pulse counter value recalculated to preset pulse counter quantity units is displayed in appropriate line including its name and unit (shortened to 6/4 characters).

6.4 I/O Block Processing

The I/O block is processed periodically each measurement cycle (i.e. 200 ms @ 50 Hz), so it defines the fastest reaction time of all set actions.

The evaluation order is as follows :

1. **Conditions** of the clauses that are not switched-off are evaluated in the order in which they are listed – from top to bottom.
 As default, individual conditions are evaluated from the left to the right. But expressions bound with the AND-operator are always evaluated first, then that bound with the OR - operator.
 If any variable used in a condition, values from the previous I/O block evaluation cycle are used. In the first evaluation cycle (after the instrument power-up or a restart), value of all the variables is false, excluding that keeping true due to the *Persistent* option.
2. **Variable type actions** (of clauses that are not switched off) are evaluated from top to bottom (the variables get new values).
3. The steps 1 and 2 executed once more with the new variable values (the conditions and variable values are updated).
4. All of the **actions** (of the clauses that are not switched off), excluding the variable type actions, are evaluated and executed from top to bottom, using updated conditions.
5. Updated values of the **variables** are stored for the next I/O block evaluation step.

6.4.1 Digital Inputs

6.4.1.1 Digital Input Filter

Digital inputs are read each measurement cycle (with 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.

6.4.1.2 Digital Input as Frequency Counter

6.4.1.2.1 “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).

6.4.1.2.2 “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%

6.4.1.3 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.

6.4.2 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*.

6.4.2.1 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.

7. 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.

7.1 Communication Links

7.1.1 Local Communication Link

Instruments are 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*.

7.1.2 Remote Communication Links

The instruments are equipped with the remote communication links 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.

RS-485 and Ethernet interfaces are available. 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.

7.1.2.1 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+** (No.41), **B-** (42), **G** (43).

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

A USB/485 level converter must be installed on the computer side. For suitable converters see optional accessory list.

7.1.2.1.1 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 mm², for example Belden 9842 or Unitronic Li2YCY (Lappkabel)

Recommended minimum conductor cross-section : 0.2 mm²

Maximum conductor cross-section : 2.5 mm²

7.1.2.1.2 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.

7.1.2.2 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.

7.2 Communication Protocols

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

7.2.1 KMB Communications Protocol

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

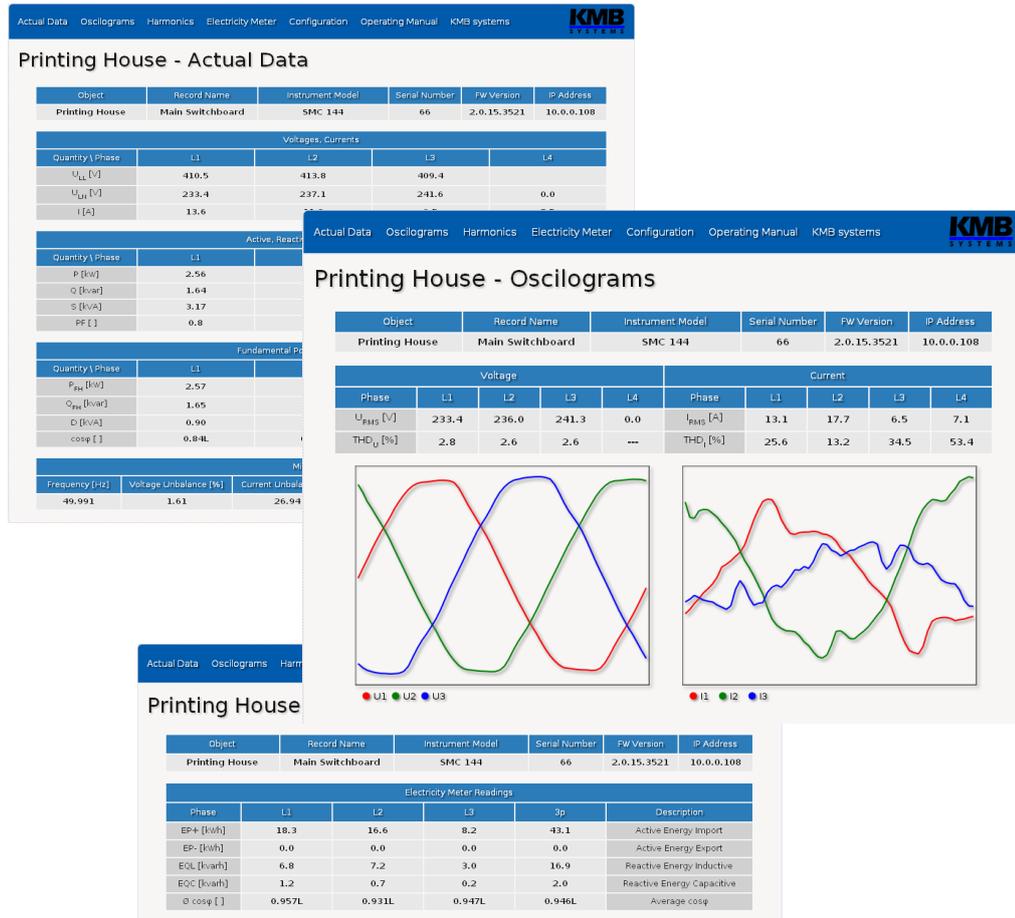
7.2.2 Modbus-RTU Communications Protocol

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.

7.3 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 the figure.

Fig. 7.1 : Webserver

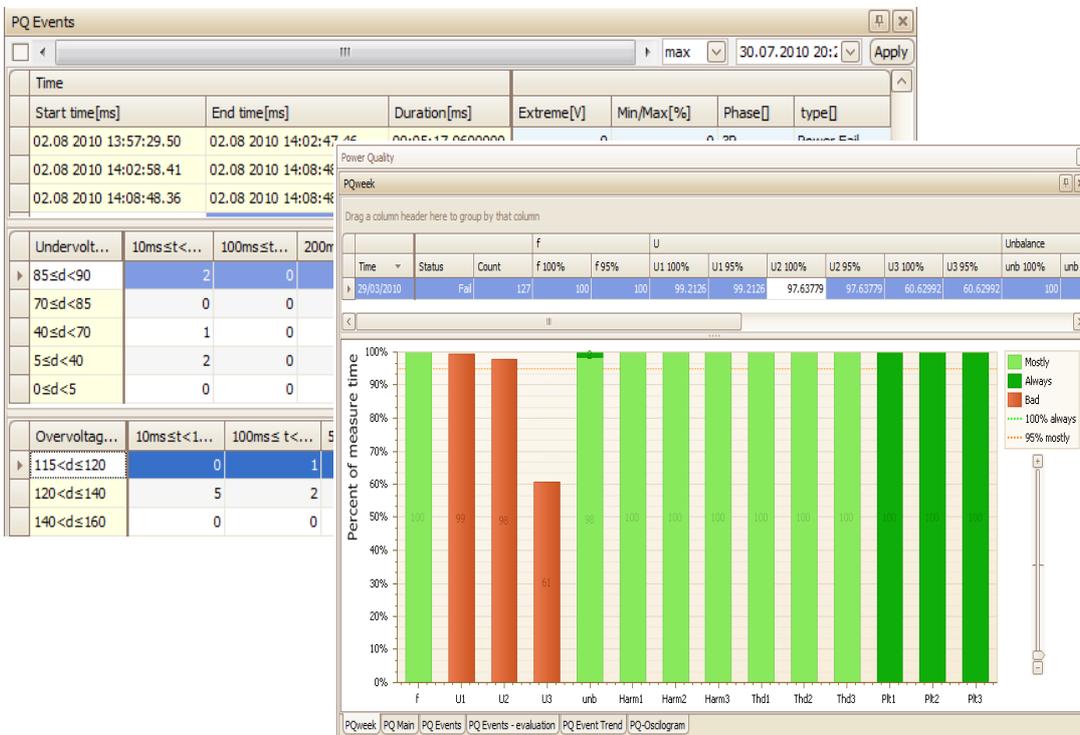


8. Firmware Extension Modules

Standard firmware contains specific modules with additional functionality. To enable the modules they must be activated first. For activation code contact the supplier of your instrument or enquiry directly our sales department.

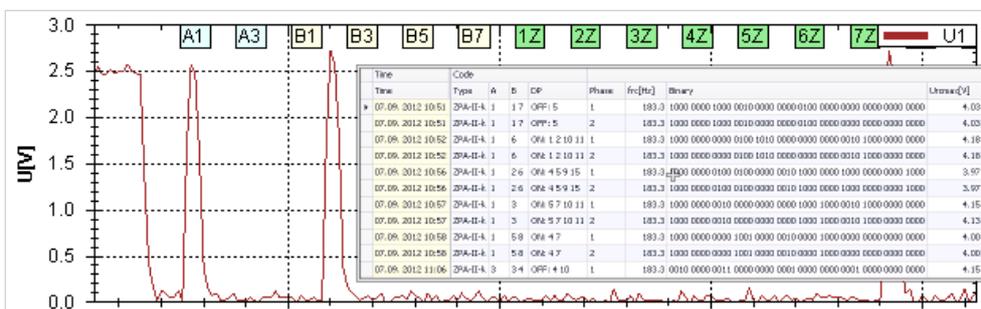
8.1 Power Quality Module

Instruments with PQ module enabled do measure the power quality indices as required by EN 50160. It enables specific features in the power analyser required for the PQ monitoring: Flicker indices, interharmonics and voltage events as defined in EN 50160, IEC EN 61000-4-30, -4-7 and -4-15. This module also activates secondary archive - the PQ Main Archive, which contains aggregated value readings in the required interval. Module also adds an archive of voltage events - the PQ Event Archive - which contains start-/end- time and extremal values of every recorded voltage fluctuation.



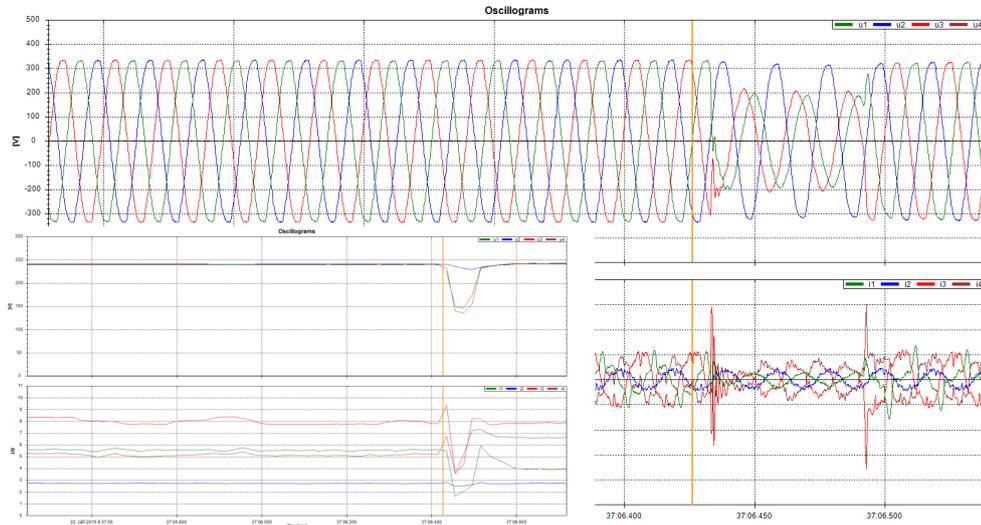
8.2 Ripple Control Signal Module

The RCS module (Ripple Control Signal or mains signalling voltage) activates an ability to detect, evaluate, decode and store various ripple control signals on the monitored power network. Signalling frequency and telegram threshold voltage can be specified. Signals get decoded and archived in the internal memory. On instruments with display the signal level can be also displayed live.



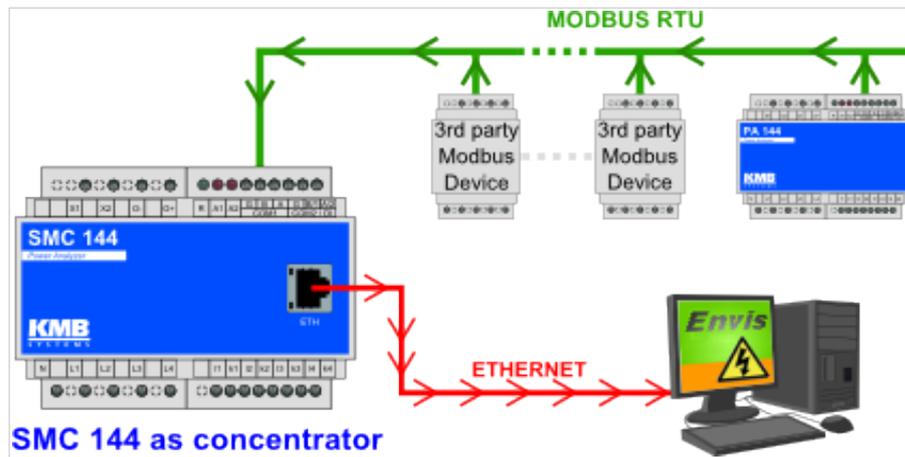
8.3 General Oscillogram Module

This module extends the ability to record detailed oscillographic events into internal memory. For details, see the *General Oscillogram Firmware Module* application note.



8.4 Modbus Master Module

This firmware extension adds capability to read out and record Modbus registers from slave units into the memory. Simply it allows to store locally data from simpler memory less devices connected on the slave RS 485 bus. This module allows creation of complex monitoring and control systems by using small and relatively simple building blocks.



Downloaded values are stored into it's memory including an actual timestamp. Archived readings can be downloaded into a CEA file or to the SQL database with ENVIS.Daq or Online.

Set 2: SML Modbus		MM
U1	238.55 V	
U2	238.57 V	
U3	238.58 V	
I1	0.05 A	
I2	0.05 A	
I3	0.05 A	
EP	183.25 Wh	
Temperature	24.00 °C	
		10:41

The readings can be both viewed on the instrument display (in additional screens in the actual data group) and visualised in the ENVIS program. Users can create graphs, tables, reports and other out of these archive readings.

It's also possible to collect data from electric-, water- and gas-meters, power factor controllers, HVAC, GPS, weather and any other device supporting Modbus.

For details, see the *Modbus Master Firmware Module* application note.

8.5 Ethernet-to-Serial Module

The ES module uses device with multiple communication ports as a remote communication hub between Ethernet and the slave devices connected on one or more RS 485 channels. Data traffic from Ethernet is forwarded to the specific instruments and back in a transparent manner, which simplifies the overall system complexity.

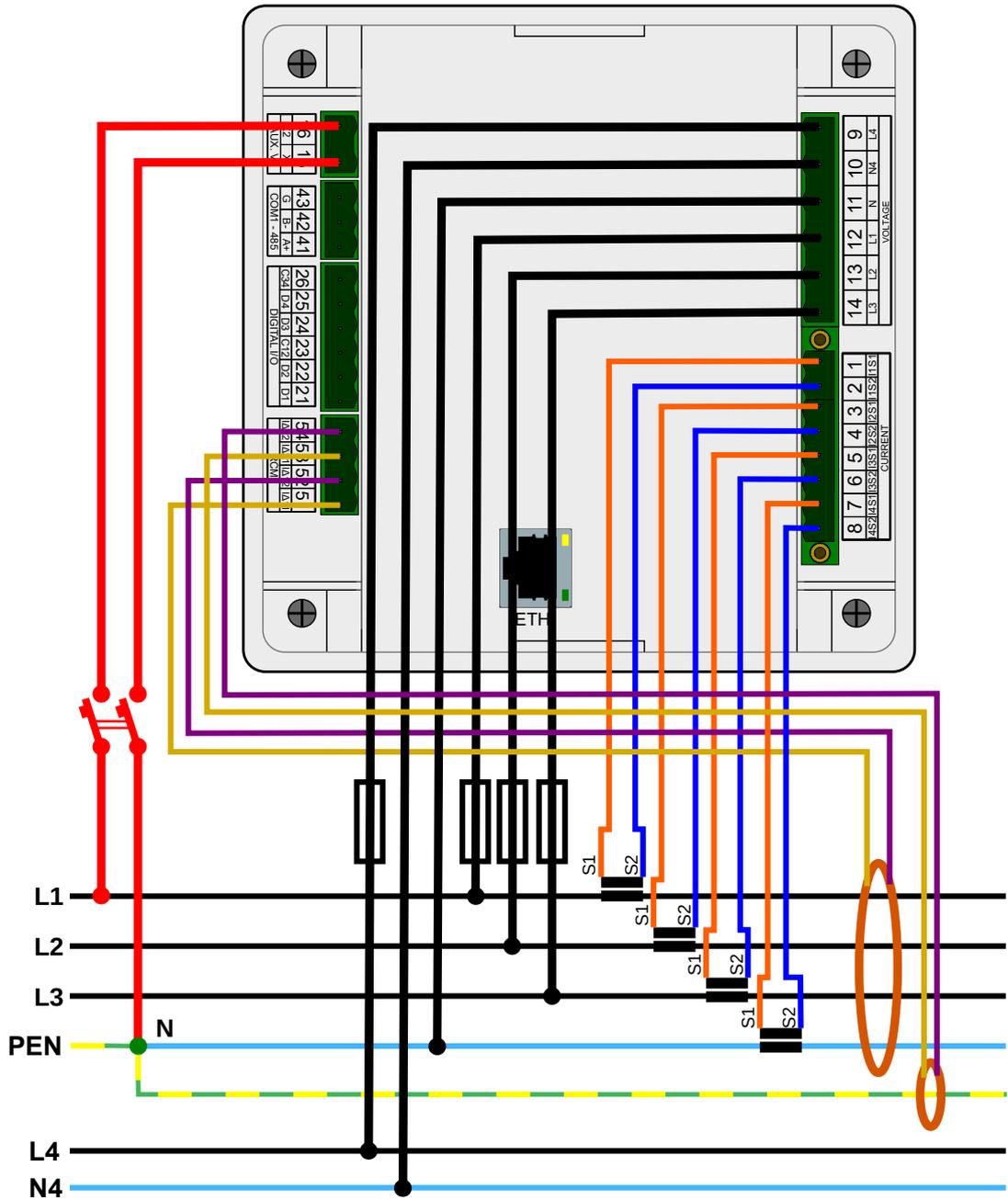
8.6 UDP Push Module

The UDP Push (UP module) pushes a defined interval of values of selected variables through the device's Ethernet interface to the specified server. The data receiver can be an ordinary panel device with a display on the cabinet door to display the current values as well as a publicly available dedicated server. The UP module uses a simple open communication protocol over UDP and does not require any incoming data (queries) on the server side to transmit data.

The UP module also activates user-defined functions for read-out of archive values by Modbus RTU or TCP on selected devices with internal memory.

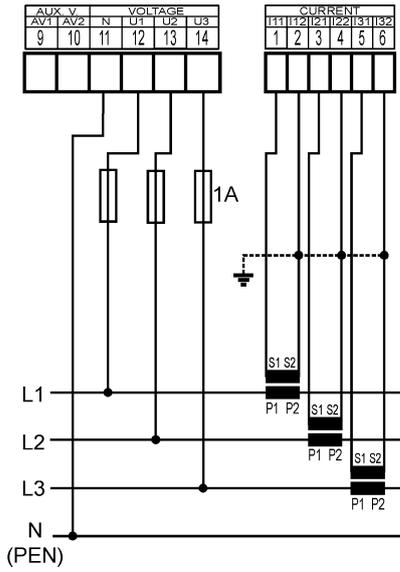
9. Examples of Connections

Direct Star ("3Y") Connection and Residual Current Monitoring Example

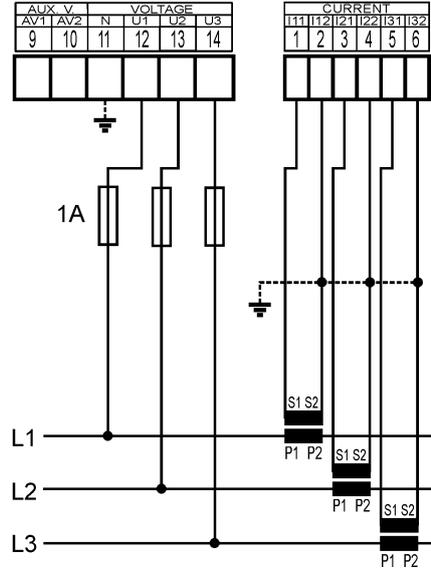


Three Phase Voltage & Current Connection Examples

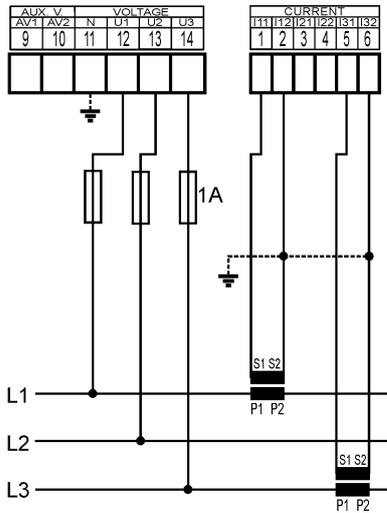
*TN Network
Direct Star ("3Y") Connection*



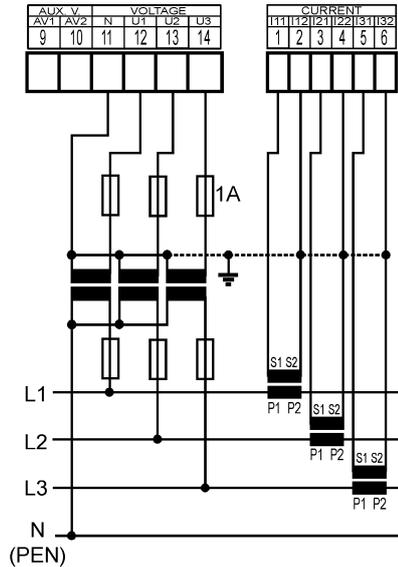
*IT Network
Direct Delta ("3D") Connection*



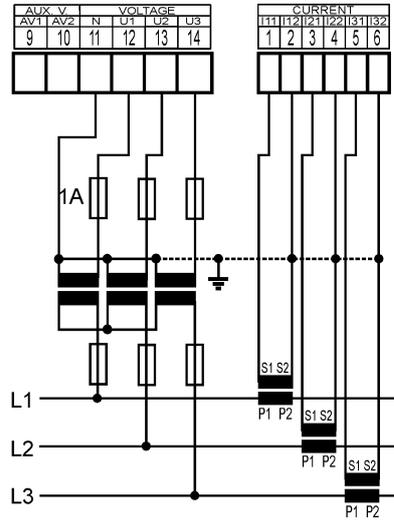
*IT Network
Direct Aron ("3A") Connection*



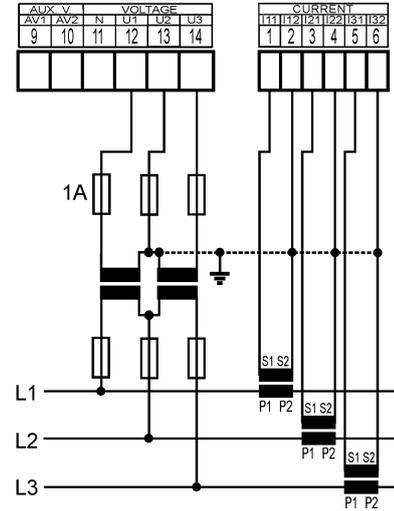
*TN Network
Star ("3Y") Connection via VT*



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

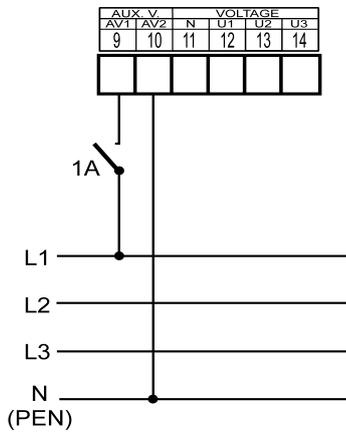


*IT Network
Delta ("3D") Connection via VT
(VT to Line-to-Line Primary Voltage)*

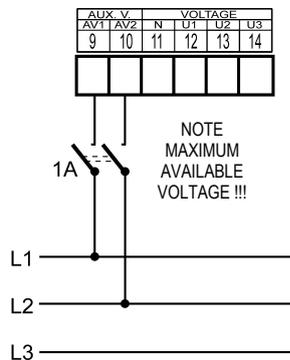


Power Supply Options

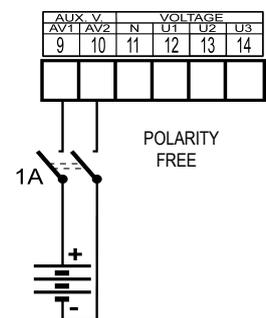
*Line-to-Neutral Voltage
AC Power Supply*



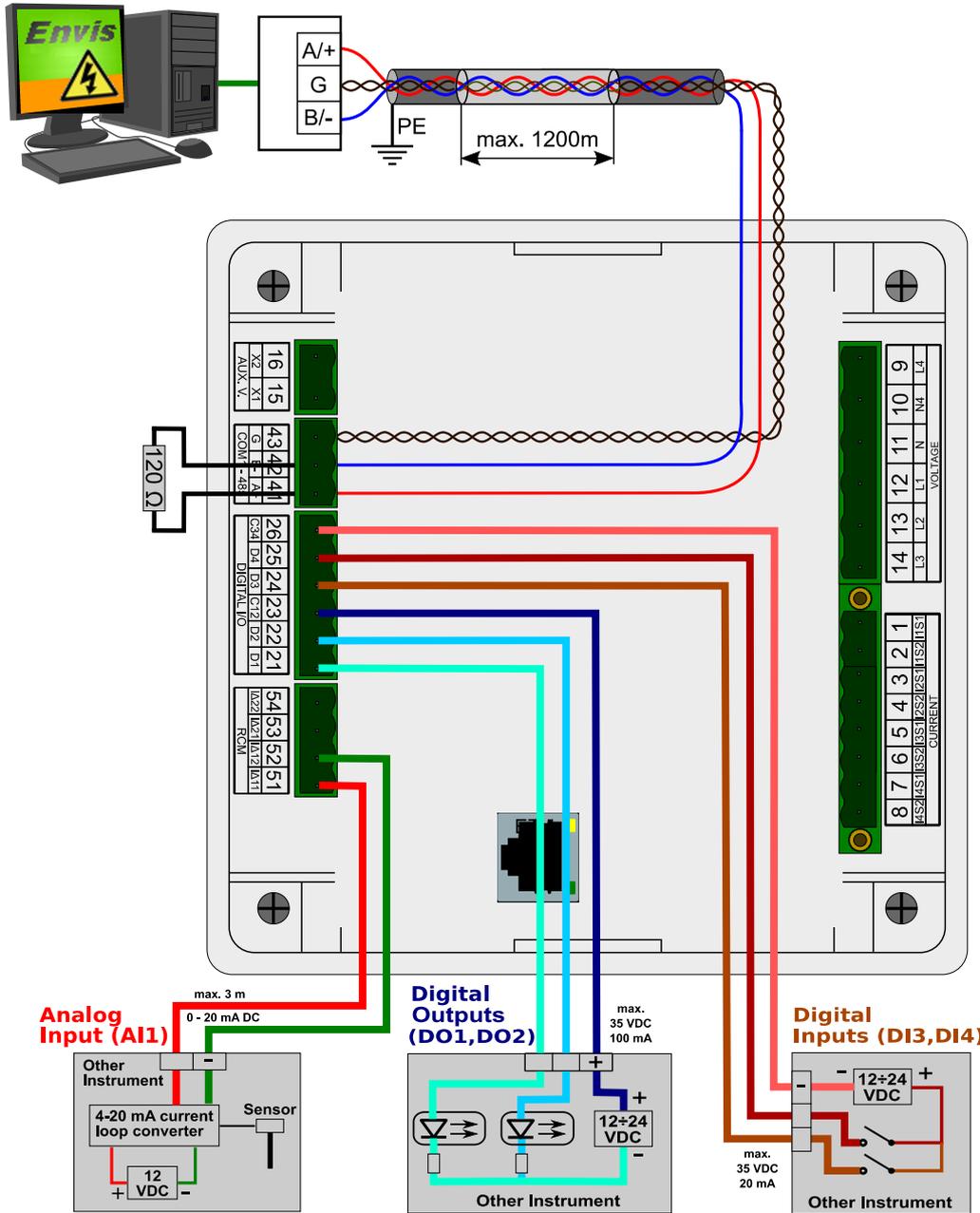
*Line-to-Line Voltage
AC Power Supply*



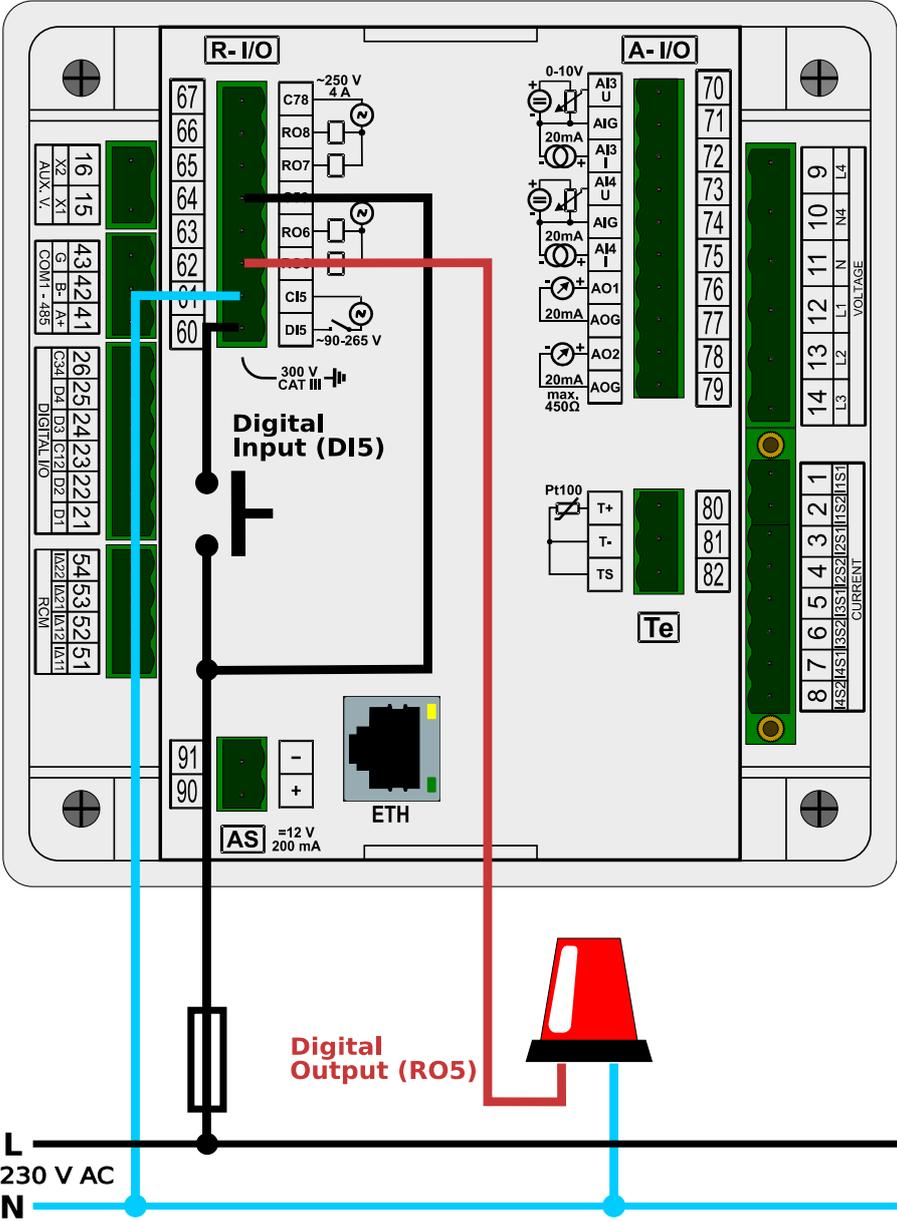
DC Power Supply



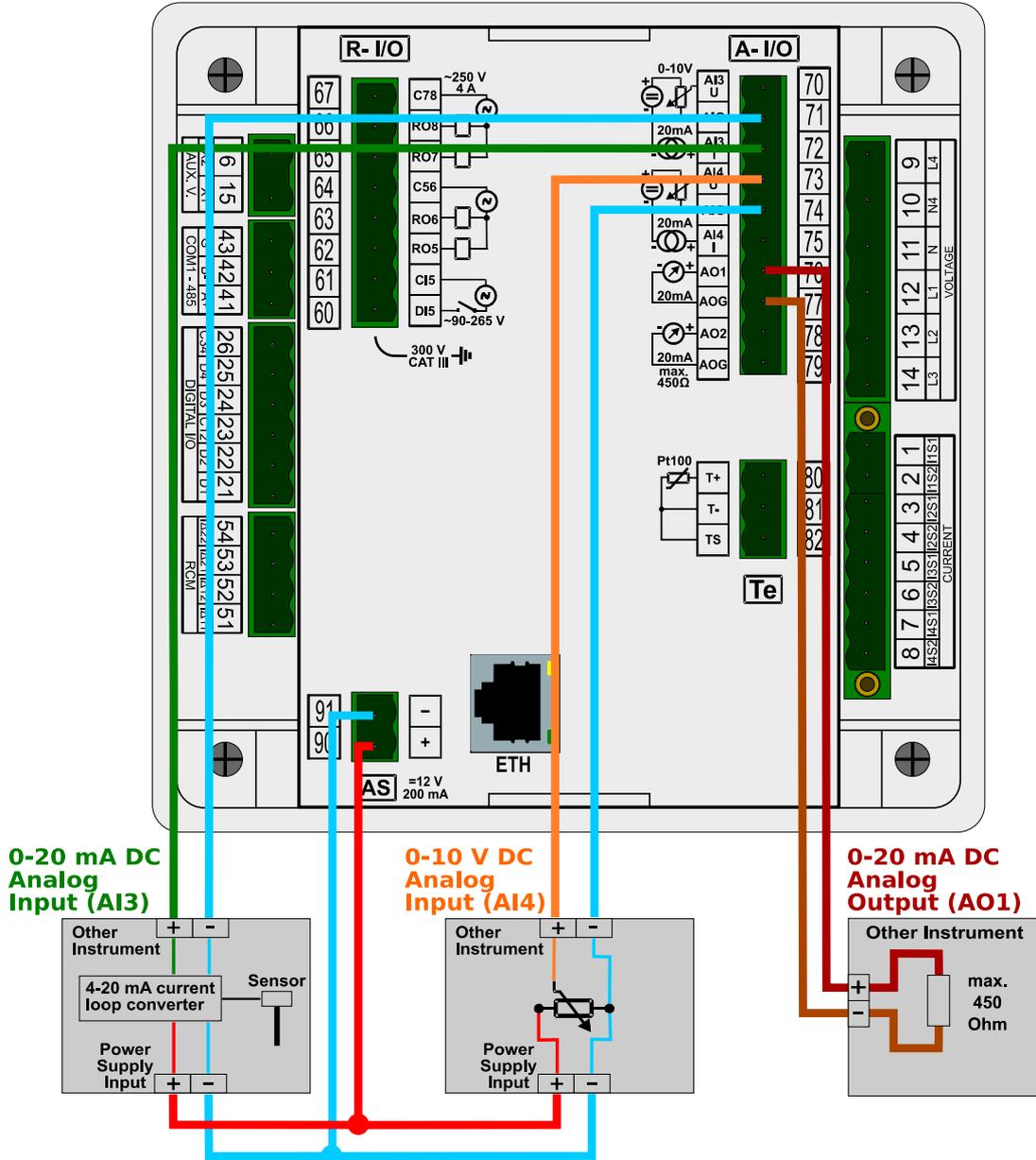
AI1, 24 V DC I/O and RS-485 Communication Link Connection Example



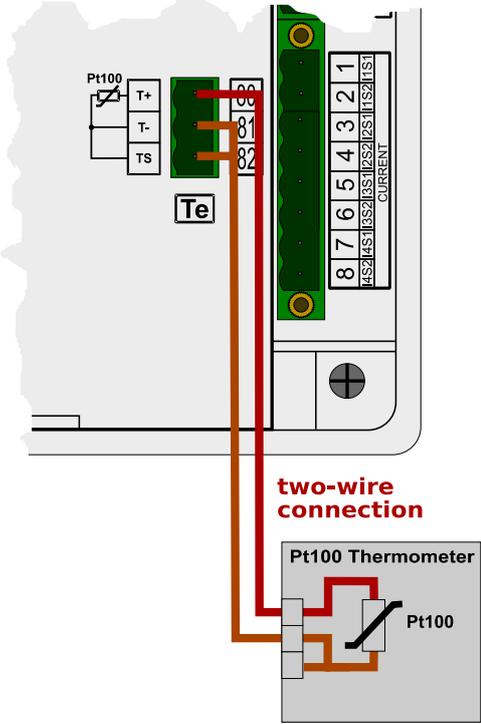
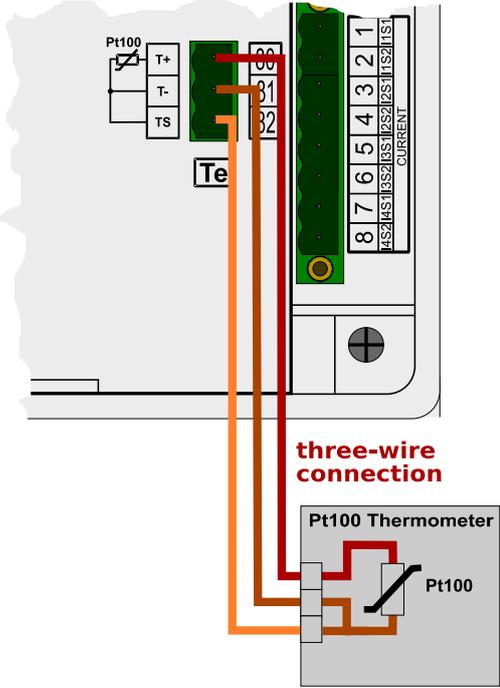
250 V AC Digital I/O Connection Example



Analog Inputs AI3, AI4 and Analog Output AO1 Connection Example



Pt100 Temperature Sensor Connection



10. Manufactured Models and Marking

	SMZ	244	H	400	X/5A	N	E4
Instrument Model SMZ 244 = Power analyser and datalogger, 4U, 4I, 2×RCM, 4DIO							
Auxiliary Power Supply H = 100 V ÷ 415 VAC, 90 V ÷ 600 VDC							
Nominal Measuring Voltage 400 = 50V/86,5V ÷ 400V/690V							
Current Inputs X/5A = 1A - 5A AC (standard indirect measurement) + 2×RCM input							
Optional Peripherals N = no optional peripherals F = 4×RO, 1×DI(230V), 2×AO, 2×AI, 1×Pt100							
Communication Interface E4 = Ethernet, RS-485, USB							

11. Technical Specifications

Function Characteristics according to IEC 61557-12				
Model „230 X/5A“, UNOM = 230 V, INOM = 5 A				
Symbol	Function	Class	Measuring range	Notes
P	total effective power	0.2	0 - 24 kW	
QA, QV	total reactive power	1	0 - 24 kvar	
SA, SV	total apparent power	0.2	0 - 24 kVA	
Ea	total active energy	0.2	0 - 24 kWh	
ErA, ErV	total reactive energy	2	0 - 24 kvarh	
EapA, EapV	total apparent energy	0.2	0 - 24 kVAh	
f	frequency	0.02	40 - 70 Hz	
I	phase current	0.1	0.5 - 10 AAC	
IN	neutral current measured	0.1	0.5 - 10 AAC	
INc	neutral current calculated	0.1	0.5 - 30 AAC	
ULN	line-to-neutral voltage	0.1	40 - 800 VAC	
ULL	line-to-line voltage	0.1	70 - 1400 VAC	
PFA, PFV	power factor	0.5	0 - 1	
Pst, PIt	flicker	2	0.4 - 10	2)
Udip	voltage dips	0.1	10 - 230 VAC	2)
Uswl	voltage swells	0.1	230 - 850 VAC	2)
Utr	transients overvoltage	–	–	
Uint	voltage interruption	0.1	0 - 10 VAC	2)
Unba	voltage unbalance (amp.)	0.2	0 - 10 %	
Unb	voltage unbalance (ph.&amp.)	0.2	0 - 10 %	
Uh	voltage harmonics 50 Hz (60 Hz)	1	up to 128 ^h (108 th) order	1)
THDu	voltage total harm. distortion (rel. to fund.)	1	0 - 20 %	1)
THD-Ru	voltage total harm. distortion (rel. to RMS)	1	0 - 20 %	1)
Ih	current harmonics 50 Hz (60 Hz)	1	up to 128 th (108 th) order	1)
THDi	current total harm. distortion (rel. to fund.)	1	0 - 200 %	1)
THD-Ri	voltage total harm. distortion (rel. to RMS)	1	0 - 200 %	1)
Msv	mains signalling voltage	1	0 - 46 VAC	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“

Instrument Characteristics according to IEC 61557-12	
power quality assessment function	PQI-A
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 < 2000 m
active power/energy function performance class	0.2

Function characteristics according to IEC 61000-4-30 ed.2				
Function	Class	Uncertainty	Measuring range	Notes
frequency	A	± 10 mHz	40 - 70 Hz	
magnitude if supply	A	± 0.1 % U_{din}	10 - 200 % U_{din}	
flicker	A	± 5 % of rdg or $\pm 0,05$	0.2 - 20	2, 4)
dips and swells	A	± 0.1 % U_{din} , ± 1 cycle	5 ÷ 120 % U_{din}	2)
interruptions	A	± 1 cycle	unlimited	2)
unbalance	A	± 0.15 %	0.5 - 10 %	
voltage harmonics & interharmonics	A	the levels of class I acc. IEC 61000-4-7 ed.2	10 - 200 % of class 3, acc. to IEC 61000-2-4 ed.2, up to 128 th order	1)
mains signalling voltage	A	the levels of class I 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

Instrument Auxiliary Power Supply Voltage			
model	„H“	„L“	„S“
nominal aux. voltage range	100 - 415 VAC	23 - 68 VDC	12 - 32 VDC
aux. voltage range AC: $f=40\div 100$ Hz; DC:	75 - 500 VAC 90 - 600 VDC	20 - 50 VAC 20 - 75 VDC	10 - 26 VAC 10 - 36 VDC
power	30 VA / 12 W		
overvoltage cat.	up to 300V : III over 300V : II		
pollution degree	2		
connection	isolated, polarity free		

Measured Quantities – Voltage *)	
Frequency	
f_{NOM} – nominal frequency	50 / 60 Hz
measuring range	40 - 70 Hz
measuring uncertainty	± 5 mHz
Voltage	
model	„400“
U_{NOM} (U_{DIN}) – rated voltage (phase-to-neutral, $U_{\text{L-N}}$)	50 - 440 V _{AC}
crest factor at U_{NOM}	2.8
measuring range $U_{\text{L-N}}$	3 - 880 V _{AC}
measuring range $U_{\text{L-L}}$	5 - 1530 V _{AC}
measuring uncertainty ($t_{\text{A}}=23\pm 2^{\circ}\text{C}$)	± 0.05 % of rdg ± 0.01 % of rng
temperature drift	± 0.03 % of rdg ± 0.01 % of rng / 10 °C
measurement category	300V CAT IV, 600V CATIII
permanent overload	1300 V _{AC}
peak overload ($U_{\text{L-N}}$ / 1 sec.)	2210 V _{AC}
burden power, impedance	< 0.1 VA, $R_i = 2,7$ M Ω
Voltage Unbalance	
measuring range	0 - 10 %
measuring uncertainty	± 0.15
Harmonics & Interharmonics (up to 128th order, or 108th order @ 60 Hz)	
reference conditions	other harmonics up to 200 % of class 3 acc. to IEC 61000–2-4 ed.2
measuring range	10 ÷ 200 % of class 3 acc. to IEC 61000–2-4 ed.2
measuring uncertainty	levels of class I acc. to IEC 61000–4-7 ed.2
THDU	
measuring range	0 - 20 %
measuring uncertainty	± 0.1

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.

Measured Quantities – Current *)	
model	„X/5A“
I_{NOM} (I _B) – rated current	1 / 5 A _{AC}
crest factor at I_{NOM}	2.8
measuring range	0.0025 - 10 A _{AC}
meas. uncertainty ($t_A=23\pm 2^\circ\text{C}$)	+/- 0.05 % of rdg +/- 0.01 % of rng
temperature drift	+/- 0.03 % of rdg +/- 0.01 % of rng / 10 °C
measurement category	150V CAT IV
permanent overload	7.5 A _{AC}
peak overload - for 1 second, max. repetition frequency > 5 minutes	70 A _{AC}
burden power (impedance)	< 0.5 VA ($R_i < 10\ \text{m}\Omega$)
Current Unbalance	
measuring range	0 - 100 %
measuring uncertainty	$\pm 0.15\ %$
Harmonics & Interharmonics (up to 128th order, or 108th order @ 60 Hz)	
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	$I_h \leq 10\% I_{NOM} : \pm 0.1\% I_{NOM}$ $I_h > 10\% I_{NOM} : \pm 0.5\% \text{ of rdg}$
THDI	
measuring range	0 ÷ 200 %
measuring uncertainty	THDI $\leq 100\% : \pm 0.1\%$ THDI $> 100\% : \pm 0.1\% \text{ of rdg}$

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

Measured Quantities - Temperature	
T_I - (internal sensor, measured value affected by the instrument power dissipation)	
measuring range	- 40 ÷ 85 °C
measurement uncertainty	$\pm 3\ ^\circ\text{C}$
T_E – External Pt100 Temperature Sensor Input	
measuring range	- 50 ÷ 150 °
measurement uncertainty	$\pm 2\ ^\circ\text{C}$ (three-wire connection)

Measured Quantities – Power, Power Factor, Energy *)	
Active / Reactive Power, Power Factor (PF), cos φ (P_{NOM} = U_{NOM} x I_{NOM})	
reference conditions "A" : ambient temperature (t _A) U, I for active power, PF, cos φ for reactive power	23 ± 2 °C U = 80 - 120 % U _{NOM} , I = 1 - 120 % I _{NOM} PF = 1.00 PF = 0.00
act. / react. power uncertainty	± 0.1 % of rdg ± 0.005 % P _{NOM}
PF & cos φ uncertainty	± 0.005
reference conditions "B" : ambient temperature (t _A) U, I for active power, PF, cos φ for reactive power	23 ± 2 °C U = 80 - 120 % U _{NOM} , I = 1 - 120 % I _{NOM} PF ≥ 0.5 PF ≤ 0.87
act. / react. power uncertainty	± 0.2 % of rdg ± 0.005 % P _{NOM}
PF & cos φ uncertainty	± 0.005
temperature drift of powers	+/- 0.05 % of rdg +/- 0.02 % P _{NOM} / 10 °C
Energy	
measuring range	corresponds to U & I measuring ranges 4 quadrant energy counters for both active and reactive energies
active energy uncertainty	class 0.2S acc. to EN 62053 – 22
reactive energy uncertainty	class 0.5S acc. to EN 62053 – 24

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

„FIXSCAN“ Mode - Measuring Uncertainties	
f_{NOM} set to „DC-500“	
Frequency Range : 350 ÷ 450 Hz	
Frequency	
measuring uncertainty	± 5 mHz
Voltage	
measuring uncertainty	+/- 0.01 % of rdg +/- 0.05 % of rng
Current	
measuring uncertainty	+/- 0.01 % of rdg +/- 0.05 % of rng
Active / Reactive Power, Power Factor (PF), cos φ (P_{NOM} = U_{NOM} x I_{NOM})	
reference conditions "A" : U, I for active power, PF, cos φ for reactive power	U = 80 ÷ 120 % U _{NOM} , I = 1 ÷ 120 % I _{NOM} PF = 1.00 PF = 0.00
act. / react. power uncertainty	± 0.2 % of rdg ± 0.01 % P _{NOM}
PF & cos φ uncertainty	± 0.01
reference conditions "B" : U, I for active power, PF, cos φ for reactive power	U = 80 ÷ 120 % U _{NOM} , I = 1 ÷ 120 % I _{NOM} PF ≥ 0.5 PF ≤ 0.87
act. / react. power uncertainty	± 0.5 % of rdg ± 0.01 % P _{NOM}
PF & cos φ uncertainty	± 0.01

Residual Currents $I_{\Delta 1}$, $I_{\Delta 2}$ / Analog Inputs AI1, AI2		
mode of operation	RCM	20 mA DC
measuring range	0.01 - 40 mA _{AC}	0.02 - 22 mA _{DC}
residual operating current $I_{\Delta n}$ setup range	0.1 - 30 mA _{AC}	-
intrinsic uncertainty ($t_A=23\pm 2^\circ\text{C}$)	+/- 0.1 % of rdg + +/- 0.02 % of rng	
temperature drift	+/- 0.03 % of rdg + +/- 0.01 % of rng / 10°C	
permanent overload	1 A _{AC}	
peak overload	6 A _{AC} / 200 ms, repetition delay > 5 seconds 60 A _{AC} / 20 ms, repetition delay > 1 minute	
burden power (impedance)	< 0.007 VA ($R_i = 4 \Omega$)	
notes	<p>- Measuring inputs insulated neither from instrument internal circuitry nor mutually not from external temperature input</p> <p>- The terminals $I_{\Delta 1}$ and $I_{\Delta 2}$ are connected internally, do not connect signals of different potential !</p> <p>- Maximum length of connection cable is 3 meters ! Otherwise, EMC-immunity of the instrument can be degraded.</p> <p>RCM mode :</p> <p>- Inputs designed for indirect connection only – suitable residual current transformer (RCT) must be used</p> <p>- Insulation of the RCT must fulfil IEC61010-1 requirements for the CATIII double insulation for the mains voltage present</p> <p>- Alternating and pulsating direct residual currents measurement according the A-type RCM specification as defined in the IEC 62020 standard</p> <p>- No directional sensitivity of the residual currents evaluated</p>	

Residual Current Transformer Examples							
Manu facturer	Type	In [A]	Window Size [mm] Diameter or x/y or Length	RCT_ratio / 20 mA _{DC}	$I_{\Delta n}$ [A]	$R_{RCM\text{MAX}}$ [Ω]	Notes
Bender	W	n.s. *)	D 20 - 210	600 / 1	10	180	fixed core
Bender	WS	n.s. *)	20x30 - 80x120	600 / 1	10	180	split core
Bender	WF	n.s. *)	L 170 - 1800	600 / 1	0.1 - 20	68	Rogowski-type, split core
MBS	DACT	n.s. *)	D 20 - 120	600 / 1	0.02 - 20	180	fixed core
Doepke	DCTRA	200-300	D 35 - 70	20 mA _{DC}	0.3	300	fixed core, 20 mA _{DC} current loop output
IME	TD	65-630	D 28 - 310	700 / 1	0.03 – 1 ($I_{\Delta n}$ min.)	n.s. *)	fixed core
J&D	BCT	100-600	D 30 - 80	127 / 1	10	10	fixed core

n.s. *) not specified

Digital Inputs & Outputs	
DI1 – DI4 Digital Inputs (12 – 24 VDC)	
type	optoisolated, unipolar
maximum voltage	35 V _{DC}
voltage for “logical “ 0 / 1	< 3 V _{DC} / > 10 V _{DC}
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
DO1 – DO4 Digital Outputs (12 – 24 VDC)	
typ	Opto-MOS, unipolar
load rating	35 V _{DC} , 100 mA
dynamic param. (pulse output) : - pulse duration - gap duration - maximum frequency	S0 - compatible 50 ms >= 50 ms 10 Hz
DI5 Digital Input (230 VAC)	
type	optoisolated, bipolar
maximum voltage	265 V _{AC} (460 V _{AC} for overvoltage cat. II)
voltage for “logical “ 0 / 1	<= 30 V _{AC} / >= 90 V _{AC}
burden power (impedance)	< 0.4 VA (Ri = 200 k Ω)
dynamic parameters *) : - pulse/gap duration - maximum frequency	>= 50 / 50 ms 10 Hz
RO5 – RO8 Digital Outputs (230 VAC)	
type	relay, N.O. contact
load rating	250 V _{AC} / 30 V _{DC} , 4 A

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

AI3 - AI4 Analog Inputs	
type	current (20mA) or voltage (10V) isolated from internal circuitry, common pole AIG
„20 mA“ type inputs (terminals AI3I, AI4I) : measuring range impedance	0 ÷ 24 mA 120 Ω
„10 V“ type inputs (terminals AI3U, AI4U) : measuring range impedance	0 ÷ 12 V 20 k Ω
measuring uncertainty	\pm 0.5 % of range

AO1, AO2 Analog Outputs	
type	current (20mA) isolated from internal circuitry, common pole AOG
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
output voltage	11.7 - 12.3 V _{DC}
maximum permanent load	200 mA _{DC}
short-circuit protection	continuous, automatic recovery

Other Specifications	
operational temperature :	- 20 to 60°C
storage temperature	- 40 to 80°C
operational and storage humidity	< 95 % - non-condensable environment
EMC – generic standards	EN 61326-1 ed. 2, EN 61000-6-2 ed. 3, EN 61000-6-4 ed. 2, EN 61000-6-5
EMC – immunity	EN 61000-4-2 (6 kV / 8 kV), EN 61000-4-3 (10 V/m from 80 MHz to 3 GHz), EN 61000-4-4 (4 kV), EN 61000-4-5 (4 kV / 2 kV), EN 61000-4-6 (10 V from 150 kHz to 80 MHz), EN 61000-4-11, EN 61000-4-18
EMC – emissions	EN 55011, class A (not for home use)
protection class (IEC 61140)	II - 
RTC	
accuracy	+/- 0,2 second per day from 0°C to +40°C (+/- 2 ppm) +/- 0,3 second per day from -40°C to +85°C (+/- 3,5 ppm)
backup battery capacity	> 5 years (without supply voltage applied)
communication ports	USB 2.0, RS-485 (2.4 - 460 kBd), Ethernet 100 Base-T
communication protocols	KMB, Ethernet to RS-485 gateway (optional FW-module), Modbus RTU and TCP, Modbus Master (optional FW-module), WEB server, JSON, DHCP, SNTP, SNMP
sampling frequency 50 Hz (60 Hz)	28,8 kHz (28,8 kHz)
display	colour TFT LCD, 320x240 pixels, 5.7"
protection class (IEC 60529)	
front panel	IP 40 (IP 54 with cover sheeting)
back panel	IP 20
dimensions	
front panel	144 x 144 mm
built-in depth	70 mm
installation cutout	138 ⁺¹ x 138 ⁺¹ mm
mass	max. 0.9 kg

12. Maintenance, Service

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.

Built-in CR2450 lithium cell backups 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: kmb@kmb.cz
 Website: www.kmbsystems.eu

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:

Serial number.....

Date of dispatch:

Final quality inspection:

Manufacturer's seal:

Date of purchase:

Supplier's seal: