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SMY 33+

Panel Mounted Measuring Instrument and Recorder

User Manual

firmware v. 8.x

09/2013

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1. Brief Description

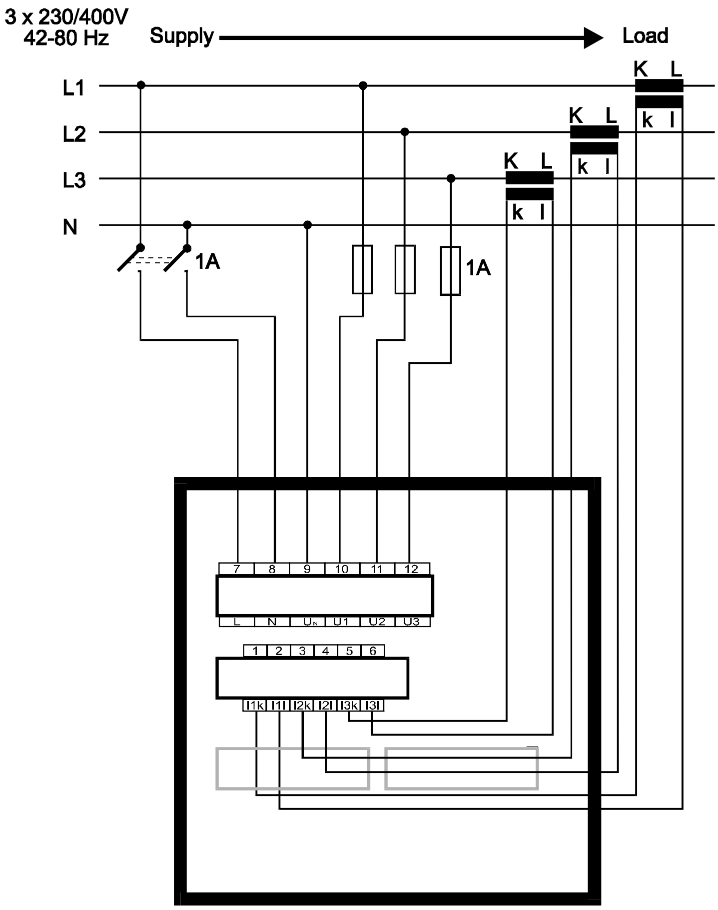
This chapter provides a brief description of connection and basic operation of the instrument in a typical installation. A detailed instrument description of all its features and connection possibilities follows.

1.1 Instrument Connection

Device supply voltage in range of 80 ÷ 275 V AC (or DC) is connected to the L (7) and N (8) terminals via a disconnecting device (switch - see installation diagram); it must be located right at the instrument and easily accessible by the operator. The disconnecting device must be marked as such. A circuit breaker for nominal current of 1 amp makes a suitable disconnecting device, its function and positions, however, must be clearly marked (marks “0” and “I” in accordance with EN 610 10–1).

Single–phase voltages measured connect to terminals U1, U2, U3 (10, 11, 12), the common terminal for the neutral wire is identified as U_N (9). It is convenient to protect the leads of voltages measured with, for example, 1 amp fuses.

Figure 1 :Instrument connection

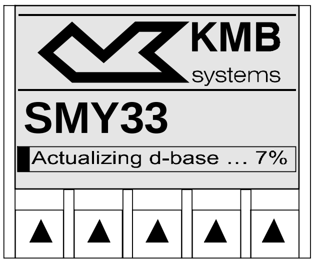


The metering current transformers’ signals, of the nominal value 5 or 1 A AC, need to get to pairs of terminals I1k, I1l, I2k, I2l, I3k, I3l (# 1-2, 3-4, 5-6) while observing their orientation (k, l terminals).

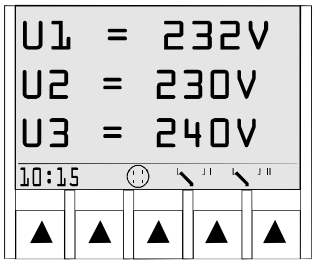
Maximum cross section of the connection wires is 2.5 square millimeters.

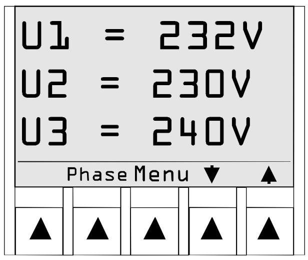
1.2 Setting Up

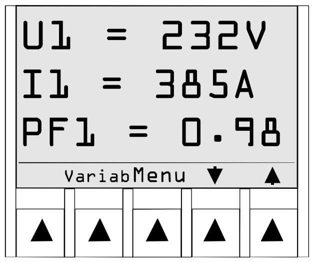
When switching on the power, the instruments runs an inbuilt diagnostic test and updates an internal database of measured data. Doing that, it shows the following messages on the display:



When the powerup operations are complete, the values last shown before power failure are displayed. An example of displayed information follows (if phase voltages or currents are connected):

1) 

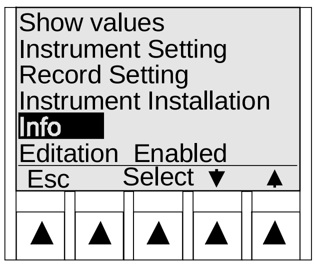
2) 

3) 

ad 1) The status line is currently shown at the bottom of the display. It indicates some of the instrument's conditions. From the left there is instrument time, indication of communication cable being connected to the COM connector, relay 1 status, and relay 2 status.

ad 2), 3) On pressing any key, the status line changes; a line with operation functions currently assigned to the keys below the display appears. Toggling between the two screens is through pressing the **Phase** or **Variab** key. Using the middle key, a menu with more display and instrument setting options can be shown. Using the two right-hand side keys, you can view screens with more measurement variables.

An example of the menu:



The selected item is shown in inverse colours.

To show actual values of voltages, currents, other variables, and the instrument output devices' functions correctly, the instrument must be "installed". Instrument installation means setting parameters, such as type of connected voltage (direct connection or via voltage transformers , the VTs' conversions), method of connection of voltages and currents (Star, Delta or Aron), current transformers' , the CTs' conversions, possibly parameters of each relay and the communication link.

Each parameter can be accessed via the **Instrument Installation** . In the **Instrument Setting** menu other instrument parameters such as time and date of the internal clock circuit, display contrast and language version can be set.

Table 1 shows a list of all **Instrument Installation** parameters, a list of all **Instrument Setting** parameters is shown in Table 2.

Tab. 1 : List of Instrument Installation parameters

<table>
<tr><th>par. #</th><th>description</th><th>range of settings</th><th>comment</th></tr>
<tr><td>1</td><td>type of voltage / current conn.</td><td>Star / Delta / Aron</td><td></td></tr>
<tr><td>2</td><td>VT conversion</td><td>115/ 127/ 230/ 254 V or 0.1 ÷ 400 kV / 0.1 V</td><td>without VT,the value represents nominal phase voltage value</td></tr>
<tr><td>3</td><td>CT conversion</td><td>5 ÷ 4,000 A, 5 / 1 A</td><td></td></tr>
<tr><td>4</td><td>measurement point nominal input power [kVA]</td><td>1 ÷ 1,000 kVA</td><td></td></tr>
<tr><td>5</td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">6</td><td>baud rate (remote communication)</td><td>0.6 ÷ 9.6 kBd</td><td rowspan="2"></td></tr>
<tr><td>communication link address</td><td>1 ÷ 253</td></tr>
<tr><td>communication protocol</td><td>KMB-Modbus N/E/O</td><td></td></tr>
<tr><td rowspan="6">7</td><td colspan="3">relay 1</td></tr>
<tr><td>trelay 1 command variable</td><td>U ÷ THDI</td><td></td></tr>
<tr><td>switching threshold</td><td>1 ÷ 150 %</td><td>if no value is specified, the relay’s operation is disabled</td></tr>
<tr><td>relay 1 c. variable hysteresis</td><td>0 ÷ 50 %</td><td></td></tr>
<tr><td>relay 1 lockout time [mins.secs]</td><td>5 secs ÷ 60 mins</td><td></td></tr>
<tr><td>control intervention</td><td>over on, over off, under on, under off</td><td></td></tr>
<tr><td>8</td><td colspan="3">analogous param’s for relay 2</td></tr>
</table>

Tab. 2 : List of Instrument Setting parameters

parameter	description	comment
1	time	
2	display contrast	
3	language	English / Czech

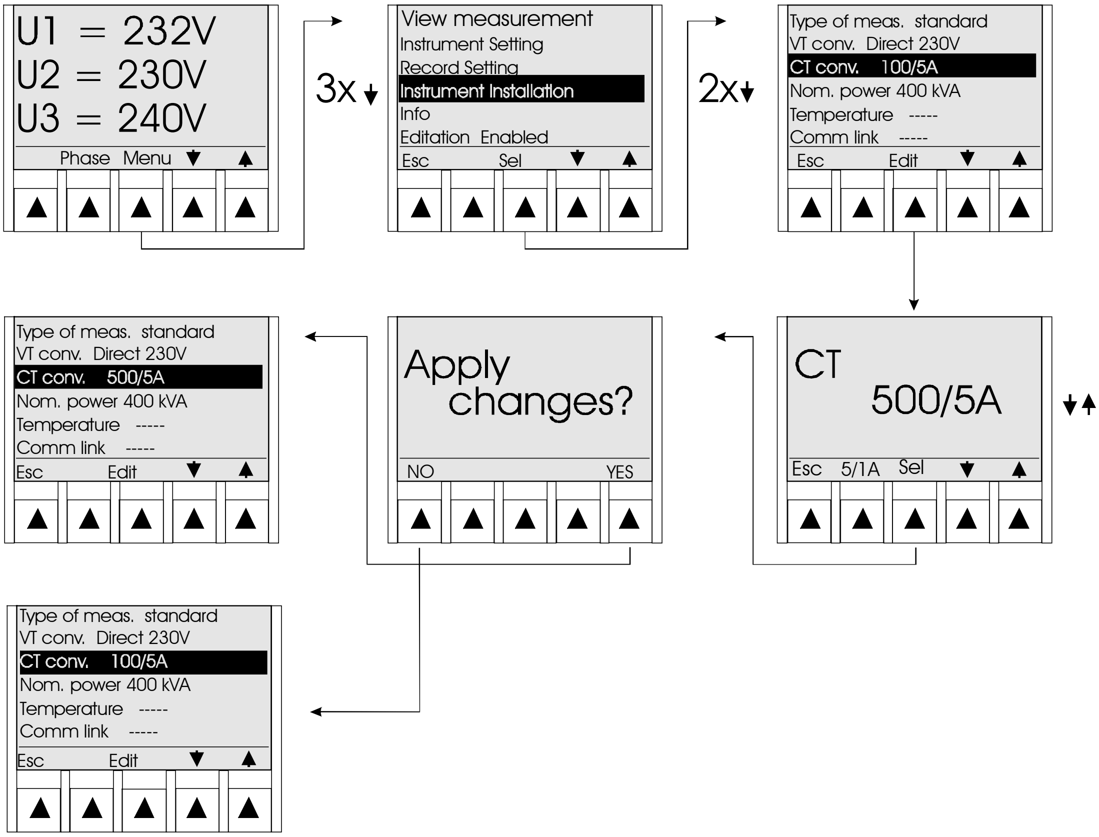
In a typical configuration you usually only need to specify the CTs’ conversion. The following example illustrates how you set the instrument:

Example:

The current signal is connected via a CT with conversion 150 / 5 A. The setting procedure has several steps:

1) display menu;
2) scroll to the item Instrument Installation and go to its lower level by pressing the middle key;
3) scroll to the CT Conversion parameter and go to the edit screen by pressing the middle key;
4) edit the parameter using the up and down keys, the 5 / 1 A key selects the CT’s secondary winding;

5) confirm or cancel the selection.



The other parameters can be edited in an analogous way.

Parameter Edit Enable / Disable

The instrument is shipped in the enabled mode, that means you can edit the parameters applying the above described procedure. After setting the instrument up, you can disable the parameter edit feature and thus protect it against unauthorized handling. To see whether editing is enabled or disabled, check the **Editation** line in the menu.

Enabling or disabling the parameter edit feature is carried out by editing the *Editation* parameter:

1) display the menu;

2) scroll to the Editation item, pressing the middle key displays a screen allowing edit enable or disable by entering the passcode; now we suppose, that number ***1234*** appeared on display;

3) the passcode to enable the parameter edit feature is carried out by pressing keys in the following sequence: ▼ , ▲ , ▲ , ▼ ; the numeric information will change successively from ***1234*** to ***1233*** to ***1234*** to ***1235*** and to ***1234***, so the same as original value is shown at the end of the sequence; to disable the parameter edit feature just press any combination of keys;

4) confirm the changes as in paragraph 3 above by pressing the middle key;

5) enable or disable status is indicated in the menu, the **Editation** line.

The number displayed while entering the passcode is random generated by the instrument and it is not important for the operation (it is only to confuse an intruder). Only the correct sequence of pressing the keys is important.

The parameter edit feature is enabled on correct passcode entry and this condition is preserved at a power failure. The parameter edit feature gets disabled on (intentional) pressing the keys in any sequence that is different from the correct passcode combination while in passcode edit mode.

1.3 Viewing Measurement Variables

Using the keys you can scroll through all measurement variables as in Figure 2. Besides numerical windows you can further view graphic ones such like a daily graph of some of the variables. The graph shows average values of the variable monitored in intervals roughly 15 minutes long. Graphs can be viewed by selecting ***Menu -> Show Values -> Daily Graphs***. Other features are displaying a histogram of the transformer's power load by selecting ***Menu -> Show Values -> Histograms***, or actual wave shapes of voltage and current signals with ***Menu -> Show Values -> Waves.***

1.3.1 Star (wye) Connection

The basic phase variables, such as voltage (U), current, (I), real power factor (PF) and each phase power (P – active, Q – reactive, S – apparent) can be viewed by phase (U-I-PF, P-Q-S) or by variable (U-U-U, etc., P-P-P etc.); to switch between the views you use a key assigned the function ***Phase*** / ***Var***. This setting also affects how the power values are displayed. Line voltages U12, U23, U31 and voltage unbalance **unb** can be displayed in appropriate window too.

Both true power factor (PF) and power factor of fundamental harmonic component (**cos**) including voltage-to-current phase angle (***φ***) are evaluated and displayed in appropriate windows.

In the power values screen you can switch the viewing mode between absolute units of measure and percentage of the measurement point nominal power value by pressing the key assigned the ***% / kW*** function. By pressing the ***1/4hP*** key you can furthermore view a screen of quarter-an-hour maximum active power values with the time of occurrence or with the last reset time for the three-phase maximum value screen.

The THD screens show total harmonic distortion values. By pressing the ***Har*** key a screen is displayed with graphic representation of levels of all odd harmonic components as percentages. Scrolling through can display each harmonic component of all measurement phases up to the 25th order. Using the ***Num*** key you can switch to viewing the values in their numeric representation.

1.3.2 Delta Connection

In this mode of connection, line voltages U12, U23 a U31 are displayed as primary voltage values. As neutral wire is not connected, phase voltages (U1, U2, U3) and other phase quantities (powers, PF, cos) are referenced to geometric centre of phasors of voltages connected.

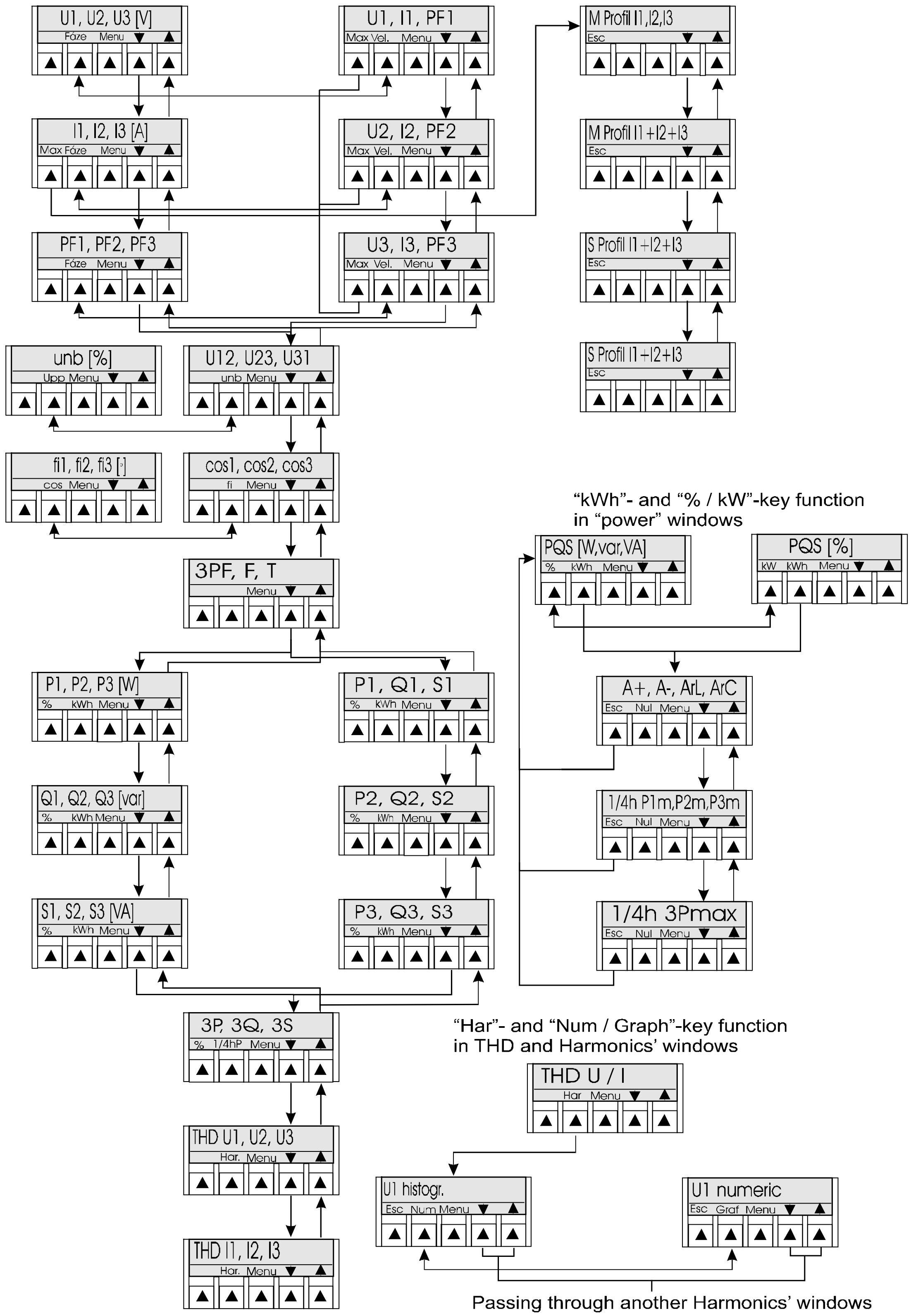
1.3.3 Aron Connection

In this mode of connection the instrument measures and displays only two line voltages: U12 (in field L1) and U32 (in field L3). The same applies to total harmonic distortion and harmonic components in voltage signals.

The currents are measured and visualized in all phases whose signals are connected.

The phase power factors have no significance in this configuration of connection and therefore are not displayed.

Figure 2 : Review of displayed variables



2. Detailed Description

2.1 Basic Features

The instrument has been designed to monitor a record voltage, current, power factor, frequency, power, work, harmonic components and total harmonic distortion in voltage and current in three–phase low voltage, high voltage and very high voltage grids. It replaces older SMY 33 instrument, whose production was stopped.

The instrument features inputs for three voltage signals of nominal voltage up to 3 x 440 V AC (both direct connection and through voltage metering transformers) and three fully isolated current inputs 1 A / 5 A AC (from current metering transformers' outputs). Power supply is required by voltage of 80 ÷ 275 V AC/DC.

The instrument measures the true root mean square value of voltages and currents. It further evaluates both actual power factor (PF, lambda) for each phase separately or all phases together and phase power factor of fundamental harmonic components (cos φ). Measurement of the level of total harmonic distortion (THD) of voltages and currents as well as of each harmonic component separately takes place up to the 25th order.

The function of two inbuilt relays with reverse switching contacts can be programmed to follow the values measured.

1MB memory and a real time circuit backed up with an inbuilt cell allow recording of the measurement data. These can be, using a local RS–232 communication link or, if the instrument has it, a remote communication link (RS–232, RS–485) transmitted, visualized and further processed on a Personal Computer. The accompanying ENVIS / RETIS software allows downloading data recorded by the instrument, their archiving, viewing, and it has a number of other different features. The instrument can also be connected via the communication link to online systems that show actual measurement data. The communication with such online systems is possible using the KMB or MODBUS RTU communication protocol.

The instrument's basic parameters can be set using an integrated keyboard and display. The instrument can also be used as a multifunctional panel meter without using a computer.

2.2 Design

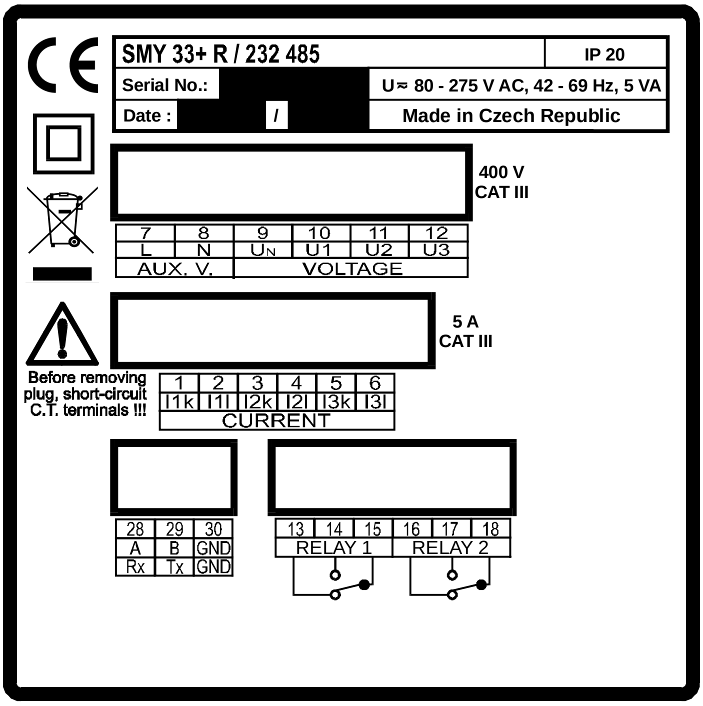
SMY instruments are built in plastic boxes in compliance with DIN 43700 for installation in switchboard panel. The installation opening needs to be 92 x 92 mm. After putting it in the opening the instrument can be attached with brackets that are included.

There is a backlit graphic Liquid Crystal Display, LCD, that provides legibility at even unfavorable light conditions from a distance of a few meters. The five-key keypad is used to move around different display screens and to set up the instrument's basic parameters. To adjust and transmit the measurement data, the instrument features a local communication interface, RS-232, designated **COM** (see this manual's cover).

The back panel has up to four connectors (depending on the model) for connection of measurement signals, relay outputs, temperature sensor input and the remote communication link (see Figure 3).

Maximum cross section area of the wires connected is 1.5 square millimeters.

Figure 3 : SMY 33+ instrument back panel



2.3 Description of Operation

2.3.1 Measuring Electrical Quantities

2.3.1.1 Connection

Example connections are described in the appendix.

2.3.1.1.1 Power Supply Voltage

The instrument requires power supply voltage in range 80 ÷ 260 V (AC, 40÷80 Hz or DC) for its operation with input power maximum 5 VA. The power supply voltage is connected to terminals 7 (**L**) and 8 (**N**). There is an internal single fuse T3.15L to provide circuitry protection.

Since the instrument does not have its own main switch, it is necessary to include a disconnecting device in the power supply circuit (power switch — see installation wiring diagram in the appendix). It must be located right at the instrument and easy to reach by the operator. The equipment disconnecting device must be marked as such. A circuit breaker for nominal current of 1 amp makes a suitable disconnecting device, its function and positions, however, must be clearly marked (marks “0” and “I”, respectively, in accordance with EN 610 10–1).

2.3.1.1.2 Measurement Voltages

The star–connected measurement voltages go to terminals 10 (**U1**), 11 (**U2**), 12 (**U3**) and 9 (**U_N**, neutral). The measurement voltage inputs are galvanically isolated from power supply inputs.

If measuring indirectly via voltage metering transformers, it is necessary to enter the voltage metering transformer ratio when setting up the instrument (the **VT** parameter).

In delta connection terminal 9 is usually not connected – the potential of geometrical centre of voltage phasors connected will appear on it.

In Aron connection the phase 2 voltage is connected to terminal 9 (**U_N**) and terminal 11 (**U2**) is not connected.

It is suitable to protect the leads with fuses 1 A.

The connection is overviewed in the following table.

Table 3: Connection of measurement voltages

terminal #	name	connection method		
		star (wye)	delta	Aron
10	U1	phase 1 voltage	phase 1 voltage	phase 1 voltage
11	U2	phase 2 voltage	phase 2 voltage	-
12	U3	phase 3 voltage	phase 3 voltage	phase 3 voltage
9	U_N	neutral wire	-	phase 2 voltage

2.3.1.1.3 Measurement Currents

Current metering transformer outputs are connected to terminal pairs 1–2 (**I1k - I1l**), 3–4 (**I2k – I2l**), and 5–6 (**I3k – I3l**). You can use a current metering transformer of the nominal output current 5 A or 1 A. The current metering transformer ratio needs to be entered when setting up the instrument (**CT conversion** parameters).

It is necessary to observe connection orientation of the current metering transformer else power factor, power and electric work values will not be evaluated correctly.

In Aron connection, it is sufficient to only measure currents I1 and I3 to evaluate three–phase power factor, three–phase power and electric work. The phase 2 current can be connected and measured optionally; it has no effect on measuring and evaluating the values mentioned.

The relevant connector features a screw lock to prevent accidental pullout and unwanted break in the current circuit.

2.3.1.2 Instrument Setup

To set up the instrument you select ***Instrument Setup*** in the menu and the ***Type of Connection***, ***VT Conversion*** and ***CT Conversion*** parameters. Each parameter is shown on the menu screen's left and its actual setting opposite on the right.

In the choice of options for the ***Type of Connection*** parameter you can select ***STAR*** (wye), ***DELTA*** and ***ARON*** connection. It is further necessary to select the type of voltage connected (**VT**) in the ***VT Conversion*** parameter. If the measurement takes place with no VT, you select the phase voltage nominal value from the choice of values.

Set the current circuit conversion value in the ***CT Conversion*** parameter. You can set the ***CT*** secondary nominal value with the ***5/1A*** key. Confirm the change. It is important for correct measurement, displayed values, and output relay operation to set VT and CT properly.

You can set the measurement point nominal power, such as supply transformer power, in the ***Trf Nom P*** (Transformer Nominal Power) parameter; the unit is kVA. This value just needs setting if you want to monitor the load (power) in not only absolute values, but also as percentages of the nominal power or if you want to choose a power as a relay command variable, otherwise you do not have to set this parameter.

In star connection three phase voltages and three phase currents are measured. Three line voltages are measured too as additional information.

In delta connection three line voltages are measured and registered as main network voltages. Phase voltages and other phase quantities (power, PF, cos) are evaluated too as additional information – these values are referenced to the potential of geometrical centre of voltages connected.

In Aron connection only two line voltages U12 (shown in field L1) and U32 (field L3) and to currents, I1 and I3, are measured.

Besides manual setup you can also set the instrument up using a Personal Computer with ENVIS or RETIS software. The setup procedure is described in the chapter "Computer-Controlled Operation".

2.3.1.3 Method of Measurement and Recording

This chapter describes the principles of measuring and evaluating electric quantities. Knowing these principles is useful for correct interpretation and further processing of measurement data.

2.3.1.3.1 Frequency of Measuring, Record of Average Values

The instrument carries out a single measurement of all inputs connected about every 3 seconds (except total harmonic distortion and harmonic components, see description further below).

Each currently measured input value is displayed and processed in accordance with record setting: the input value is averaged during the record interval or maximum or minimum value is recorded or the last value measured. Such a value is stored at the end of the record interval.

When the instrument memory is full of curves measured, the behavior depends on the settings. If the **Keep Measuring** mode is not selected, the instrument stops recording on full memory until it is reset. If it is selected, recording goes on and new measured values overwrite the oldest recorded values. The instrument thus remembers the latest curve of quantities that are set, the length of which corresponds to the instrument memory capacity.

2.3.1.3.2 Preparing to Measure Voltages and Currents

Before each measurement of all measured inputs (that is about each 3 seconds) first frequency measurement at the U1 voltage input takes place. This measurement gives the instantaneous wavelength of the signal measured which is utilized in measuring and evaluating all alternating current signals, that all such voltages and currents. From that is ensues that all voltages and currents measured need to be of the same frequency (or the same frequency of the dominant harmonic component). It is further assumed that such a frequency does not change within the single measurement of all quantities measured, that is within an interval of about 2 seconds. In the opposite case, an additional error is generated.

2.3.1.3.3 Voltage Measurement

The instrument measures true root mean square value. Measurement of signal with dominant fundamental harmonic of 42 ÷ 80 Hz is assumed.

The instrument measures signal of four consecutive cycles (usually 4 x 20 = 80 ms) while each of the cycles is sampled in 64 points. It calculates the arithmetic average of the four recorded cycles and an effective value is calculated from the average cycle using the following formula:

$$U_{eff} = \sqrt{\frac{1}{n}\sum_{i=1}^{n} Ui^2} \quad [\,V\,] \qquad [\,1\,]$$

U_{eff}…voltage effective value

U_i… voltage sample measured

2.3.1.3.4 Current Measurement

The same applies to current measurement as to voltage measurement.

2.3.1.3.5 Power Factor Evaluation

The instrument evaluates the actual power factor (λ – lambda, for easier displaying called PF = Power Factor) and fundamental harmonic component power factor of each phase, cos φ (suitable, for instance, for checking a compensator).

The actual power factor is evaluated from the ratio of active and apparent power (for method of measurement see further below) using the following formula:

$$PF = \frac{|P|}{S} \qquad [-] \qquad [2]$$

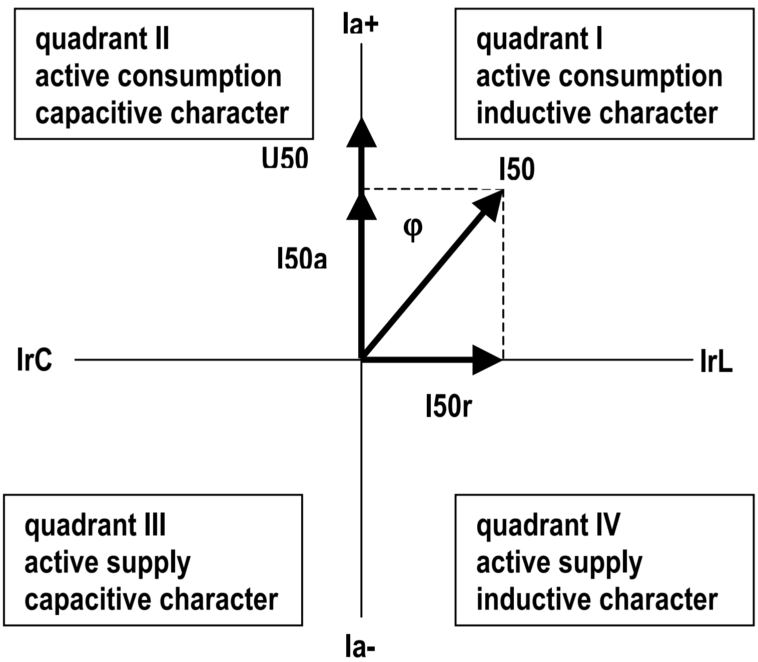
PF… actual power factor

P… active power

S… apparent power

in dependence on the phase difference between fundamental harmonic components of voltage and current and thus expresses inductive or capacitive character of the reactive power.

Figure 4: Identification of consumption–supply and character of reactive current in dependence on phase difference



The instrument further evaluates the total three–phase power factor using the formula:

$$3PF = \frac{|3P|}{3S} \qquad [-] \qquad [3]$$

3PF… actual three–phase power factor

P… three–phase active power

S… three–phase apparent power

Notes:

In Aron connection only total three–phase power factor is evaluated, single phase power factors are not evaluated.

For the use by RETIS / RETIS-OFF software the power factor and three–phase power factor value have an attribute L or C depending on the polarity of the cos φ fundamental harmonic component power factor evaluated. The instrument's display does not show this additional information with power factor values.

Besides the actual power factor for each phase (not in Aron connection) also cos φ fundamental harmonic component power factor using Fourier transformation is evaluated. The cos φ value contains the L or C attribute depending on the apparent power character measured (inductive or capacitive character as in figure 4).

If average power factor value recording is set, the instrument evaluates the average value from both groups of power factor values measured, that is inductive and capacitive, separately. When storing in the memory it then stores the average value of the group that dominated during the record interval (it took a longer time).

2.3.1.3.6 Single–Phase Power Evaluation

The instrument measures and evaluates the actual active power in accordance with the defining equation

$$P = \frac{1}{n}\sum_{i=1}^{n} U_i \times I_i \qquad [\,\mathrm{W}\,] \qquad [\,4\,]$$

P… active power

U_i… voltage sample measured

I_i… current sample measured

In the evaluation 64 measured samples of voltage and current per cycle are included. With positive result value the condition is considered **consumption** (import) of active power. If the result value is negative, it means the energy is flowing in reverse direction to the instrument's connection (orientation of k, l current terminals) and such a condition is considered **supply** (export).

Apparent power is evaluated in the formula

$$S = U_{eff} \times I_{eff} \qquad [\mathrm{VA}] \qquad [\,5\,]$$

S… apparent power

U_{eff}… voltage effective value

I_{eff}… current effective value

Reactive power is evaluated from active and apparent power using the formula

$$Q = \sqrt{S^2 - P^2} \qquad [\,\mathrm{var}\,] \qquad [\,6\,]$$

Q… reactive power

S… apparent power

P… active power

Analogously to power factor the reactive power value is completed with an attribute L or C depending on phase difference of fundamental harmonic components of voltage and current thus expressing inductive or capacitive character of the reactive power.

2.3.1.3.7 Three–phase Power Evaluation

Three–phase power is evaluated by the instrument in calculation from each phase power.

Three–phase active power is yielded from simple addition as in the equation

$$3P = P_1 + P_2 + P_3 \quad [\mathrm{W}] \qquad [7]$$

3P… three–phase active power

P_1, P_2, P_3… single–phase active power

This sum includes each phase power with polarity (positive for consumption, negative for supply). That is why correct orientation of current sensor connection is essential in three–phase active power evaluation.

In a similar fashion three–phase apparent power is evaluated:

$$3Q = Q_1 + Q_2 + Q_3 \quad [\mathrm{var}] \qquad [8]$$

3Q… three–phase apparent power

Q_1, Q_2, Q_3… single–phase active power

Inductive / capacitive character is expressed by +/– sign with apparent power and opposite values of single–phase power gets deducted from each other.

Note: With contents of higher harmonic components, each phase reactive power is consisted not only of phase shift between fundamental harmonics of voltage and current, but partially also of distortion power of higher harmonic components. Phase reactive power is, however, evaluated as a whole (the contribution of distortion power to the total phase reactive power is not evaluated by the instrument) and they are assigned a polarity sign depending on shift of fundamental harmonic voltage and current. With an unbalanced system (reactive power has different L/C characters in each phase) or when measuring in Aron connection a condition can develop in which the sum of phase reactive power of opposite L/C characters, parts of reactive power corresponding to distortion power are deducted from each other. In such a case the absolute three–phase reactive power value evaluated is lower than actual and there is an additional measurement error.

Three–phase apparent power is evaluated using the formula

$$3S = \sqrt{3P^2 + 3Q^2} \quad [\mathrm{VA}] \qquad [9]$$

3S… three–phase apparent power

3P… three–phase active power

3Q… three–phase reactive power

Apparent power, single–phase and three–phase, have no polarity signs.

If average power measurement is set, the instrument measures and evaluates instantaneous power at relevant inputs in a way described above. It calculates average power from the instantaneous power values within a measurement interval and the average value is stored in the memory at the end of the recording interval.

2.3.1.3.8 Electric Energy Evaluatin – Four-Quadrant Electricity meter

Integrating of active (3P) and reactive (3Q) three-phase powers, imported and exported energy are evaluated. Energies are registered into four independent counters according their polarity : active power consumed (**A+**, import), active power supplied (**A–**, export), reactive power consumed (**ArL**, inductive) and reactive power supplied (**ArC**, capacitive).

As the measurement is not continuous, systematic measurement error occurs. The error size depends on actual power fluctuations – the greater and more frequent power changes, the greater the error. Therefore, evaluated energies should be considered approximate.

The electricity meter reading can be reset at the beginning of the period monitored by **Clr** option. The time of reset is stored and it can be checked in the **¼h 3Pmax** window.

Warning !!! By resetting this value you also reset the maximum quarter–an–hour active powers **!!!**

2.3.1.3.9 Total Harmonic Distortion and Higher Harmonic Components Evaluation

The instrument evaluates each relative harmonic component up to the order of 25 from the voltage and current curves measured using Fourier transformation (h_{Ui}, h_{Ii}, evaluated from absolute amplitudes of harmonic components H_{Ui}, H_{Ii} as H_{Ui}/H_{U1}, H_{Ii}/H_{I1}). It calculates the harmonic distortion value from the components evaluated using the formulas:

$$THD_{U} = \sqrt{\sum_{i=2}^{25} h_{Ui}^{2}} \quad [\%] \qquad [10]$$

$$THD_{I} = \sqrt{\sum_{i=2}^{25} h_{Ii}^{2}} \quad [\%] \qquad [11]$$

THD_U… voltage total harmonic distortion

h_{Ui}…..... i^{th} relative voltage harmonic component (relative to fundamental harmonic component value H_{U1} , i = harmonic order)

THD_I… current total harmonic distortion

h_{Ii}…..... i^{th} relative current harmonic component

Since calculation of harmonic components is very time–consuming, it is carried out after each measurement cycle always only for one of curves U1, I1, U2, I2, U3, I3, in this order. The harmonic component and total harmonic distortion current values are thus updated six times more slowly than other measured values, approximately every 20 seconds. The instrument is not able to record fluctuations in these values of a shorter period.

2.3.1.3.10 Evaluation of Maximum Quarter–an–Hour Average Active Power

The instrument continuously measures average active power values and it carries out evaluation every quarter of an hour following its internal real time clock circuit. Actual values of the average powers (**¼hP1**, **¼hP2**, **¼hP3** and **¼h3P**) are displayed in the **¼h3Pmax** window. If the last evaluation average active power is greater than the previously stored maximum value, the latter is replaced with the former. The stored value measurement date and time is also stored. The maximum values are displayed in the **¼hPnmax** , **¼h3Pmax** windows(see Fig..2).

The maximum power values can be reset at the beginning of the period monitored by **Clr** option. The time of reset is stored and it can be checked in the **¼h 3Pmax** window.

Warning !!! By resetting this value you also reset the electricity meter reading**!!!**

2.3.1.3.11 Daily profiles evaluation

In some cases, for example when checking load at distribution network node, there is not necessary to process complete continuous record of period measured, but only so-called *Daily profiles* can be sufficient.

Daily profile is day-long record of voltages, currents and power factors with 1 minute recording interval. Average values of the quantities are recorded. Setting of daily profile (such as number and type of quantities, recording interval etc.) is fixed and cannot be changed by user.

Instrument can record two types of daily profiles :

- selected daily profile (S-profile, or *selected profile*)
- maximum current daily profile (M-profile, or *maximum profile*)

Both of profiles have the same structure, they differs from each other in recording day setting only.

Selected profile recording day can be freely specified by user. After setting the date and sending it to the instrument with *Send record date* button, previous daily profile record in instrument's memory is deleted. When preset day passes, new selected daily profile is created and can be read to the PC.

Maximum profile record is updated when maximum of quarter–an–hour moving average of sum of one-minute average current values I1+I2+I3 occurs. Evaluation principle is as follows :

> With *Maximum profile reset* button, new maximum profile evaluation is started. Every minute average values of voltages, currents and power factors are evaluated and stored to auxiliary memory. At the same time, moving average of sum of minute average current values I1+I2+I3 is calculated. If this value exceeds previous maximum value, new maximum value with time stamp is stored to auxiliary memory and when the day passes, new maximum profile is updated. After that the maximum profile can be downloaded to the PC.

Not only quarter–an–hour moving average of current sum, but quarter–an–hour moving averages of each current I1, I2 and I3 with their time stamps are registered too and can be checked with *Receive actual state* button in *Daily profiles* window.

2.3.1.3.12 Daily Graph

The instrument allows viewing a graph of the variables U, I, PF, P, 3P over the last 24 hours. Time axis resolution of the graph is 15 minutes. The variable value in a particular quarter of an hour is calculated as an average of values measured over the fifteen minutes. The graph can be viewed by selecting ***Menu -> Show values -> Daily Graphs***.

2.3.1.3.13 Histograms

The instrument also shows measurement point power load histogram. The values evaluated in daily graphs, see previous chapter, are used to create a histogram. To view a histogram select ***Menu -> Show values -> Histograms***.

2.3.1.4 Measurement Data Recording and Processing Setup in RETIS / RETIS-OFF Software on a Personal Computer

2.3.1.4.1 Calculation of Power

The SMY33 instruments can be set to measure and record average power. If the instrument has not been set to record average power, additional calculation of active, reactive and apparent power from the voltage, current and power factor values measured is possible.

The calculation follows these formulas:

$$P = U \times I \times PF \qquad [\,W\,] \qquad [\,12\,]$$

$$Q = U \times I \times \sqrt{1 - PF^2} \qquad [\,var\,] \qquad [\,13\,]$$

$$S = U \times I \qquad [\,VA\,] \qquad [\,14\,]$$

P… active power

Q… reactive power

S… apparent power

U… voltage effective value

I… current effective value

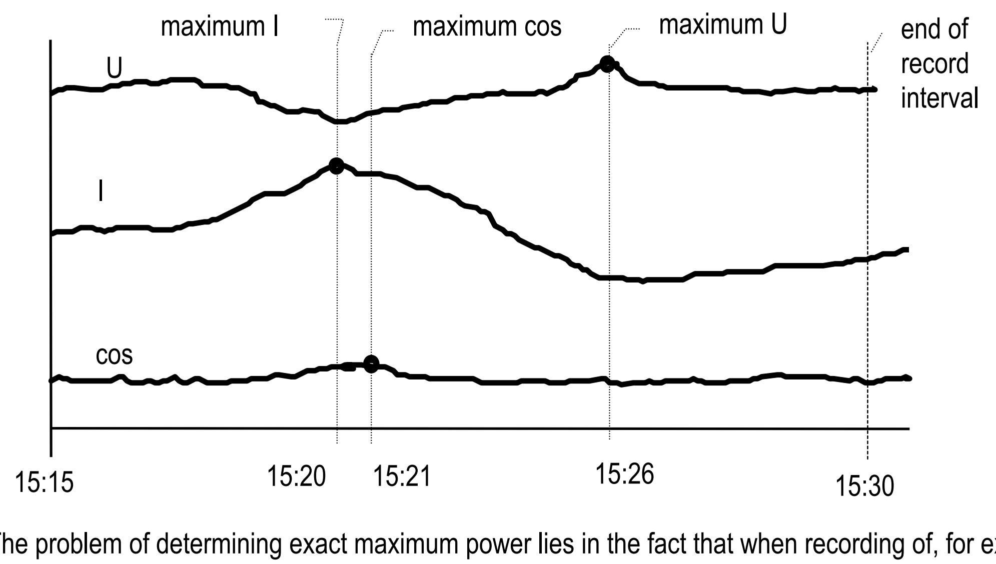
PF… power factor (or cos φ)

If calculating power from U, I, PF (or cos φ) curves measured, it is, however, necessary to take the following facts into account.

2.3.1.4.2 Instantaneous Power Calculation

It is usually required to establish maximum power in a phase over a period of time monitored. The instrument does, however, not measure maximum power directly — it measures U, I, and power factor, separately.

Figure 5: Sampling in accordance with setting



The problem of determining exact maximum power lies in the fact that when recording of, for example, maximum current and maximum power factor are set, it is not guaranteed that both values measured took place in the same point of time — the power value calculated from values that were not measured at the same moment makes no sense.

Figure 5 shows an example of such a situation.

If recording of maximum voltage, maximum current, maximum power factor and 15–minute record interval are set, the voltage value measured, in this example, at 15:26, the current value measured at 15:20, and the power factor value measured at 15:21 are stored at the end of the record interval, that is at 15:30. The calculation of active power yields unreal value.

To evaluate power correctly in such situations the RETIS / RETIS-OFF software allows to set a preferred method of sampling each phase quantity (voltage, current and power factor).

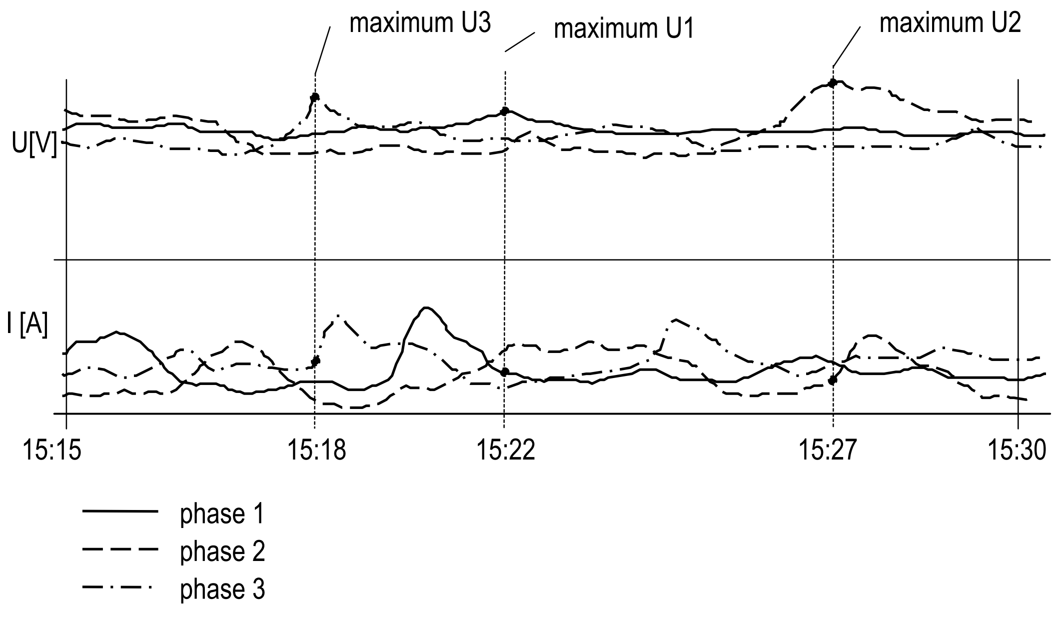
2.3.1.4.3 Sampling in Accordance with Setting

In this basic sampling method, each quantity is evaluated separately and independently, that you can set recording of, for example, maximum voltage, minimum current and average power factor values at the end of the record interval. Calculation of power in this situation, however, does not make sense since it yields unreal values.

2.3.1.4.4 Slice Sampling

If this sampling method is set, a slice command variable is selected. The slice command variable selected can be set to either extreme, that is maximum or minimum, and sampling of the other phase quantities is then triggered by occurrence of the extreme set for the command variable selected in the phase given (see figure 6).

Figure 6 : Sampling by maximum U



You can select the following quantities to be slice command variables:

- voltage
- current
- power factor
- active single–phase power
- active three–phase power

If the slice command variable is voltage, current or power factor, you can select recording by maximum or minimum of the quantity. If the command variable is power, recording of quantities takes place at the moment of detecting the power's maximum.

Figure 6 shows an example of measuring a three–phase outlet (power factor curves are not shown). If sampling by voltage extreme is set and maximum of this quantity is selected, the following values are recorded at the end of the record interval (at 15:30):

- U1 maximum voltage value within the whole record interval, measured at 15:22, and I1 and cos1 values measured at the same moment
- U2 maximum voltage value within the whole record interval, measured at 15:27, and I2 and cos2 values measured at the same moment
- U3 maximum voltage value within the whole record interval, measured at 15:18, and I3 and cos3 values measured at the same moment

In slice recording it is then guaranteed that all quantities of one phase are sampled at the same moment. So single–phase power can be calculated from them. The moment of sampling can be different in different phases so three–phase power can not be calculated.

If the command variable is three–phase power, all phase quantities in all phases are sampled at the same moment and calculation of three–phase power can be carried out.

Non–phase quantities, such as frequency and temperature, are not affected by slice sampling setting in any ways and they are recorded independently and in accordance with their setting. Recording of average power is not affected by the slice sampling setting in any ways either.

2.3.1.5 Calculation of Average Power from Recorded Average Voltage, Current, and Power Factor Values

With the setting to record average values of voltage, current and power factor, the instrument records the average values of each such input as expressed by the formulas:

$$U_s = \frac{1}{n}\sum_{i=1}^{n} Ui \qquad [\,V\,] \qquad [\,15\,]$$

$$I_s = \frac{1}{n}\sum_{i=1}^{n} Ii \qquad [\,A\,] \qquad [\,16\,]$$

$$PF_s = \frac{1}{n}\sum_{i=1}^{n} PFi \qquad [\,-\,] \qquad [\,17\,]$$

Us… arithmetic mean effective voltage value within a record interval
Ui… instantaneous effective voltage value
Is… arithmetic mean effective current value within a record interval
Ii… instantaneous effective current value
PFs… arithmetic mean effective power factor value within a record interval
PFi… instantaneous effective power factor value
n… number of measurements taken within a record interval

In an additional calculation of active power from such average values recorded is carried out using the formula:

$$P_s = U_s \times I_s \times PF_s = \left(\frac{1}{n}\sum_{i=1}^{n} Ui\right) \times \left(\frac{1}{n}\sum_{i=1}^{n} Ii\right) \times \left(\frac{1}{n}\sum_{i=1}^{n} PFi\right) \qquad [\,W\,] \qquad [\,14\,]$$

Arithmetic mean active power is generally defined as

$$P_s = \frac{1}{n}\sum_{i=1}^{n} Pi = \frac{1}{n}\sum_{i=1}^{n}(Ui \times Ii \times PFi) \qquad [\,W\,] \qquad [\,15\,]$$

It ensues from the above formula that the equations [14] and [15] do not generally yield the same results; the difference increases with rising fluctuation of each U_i, I_i, PF_i value measured. We only receive the same results if the U_i, I_i, PF_i values do not change with a record interval.

Arithmetic mean active power calculation from arithmetic mean values of voltage, current and power factor can then only be used for determining informative power value and in the case of not much fluctuation of each of the U_i, I_i, PF_i values within a record interval. To average power it is thus necessary to set the instrument to measure arithmetic mean power in which mode the error described above does not affect the results.

2.3.2 Output Relays

The R models feature two relays with reverse switching contacts, the operation of which can be preprogrammed as desired by the user (see further in the Description of Parameters).

2.3.2.1 Connection

The relays' contacts go to terminals listed in table 4. They can be loaded with current 4 A at 250 V AC.

Table 4: Output relays

relay	# 1	relay	# 2
terminal #	contact	terminal #	contact
13	break	16	break
14	operating	17	operating
15	middle	18	middle

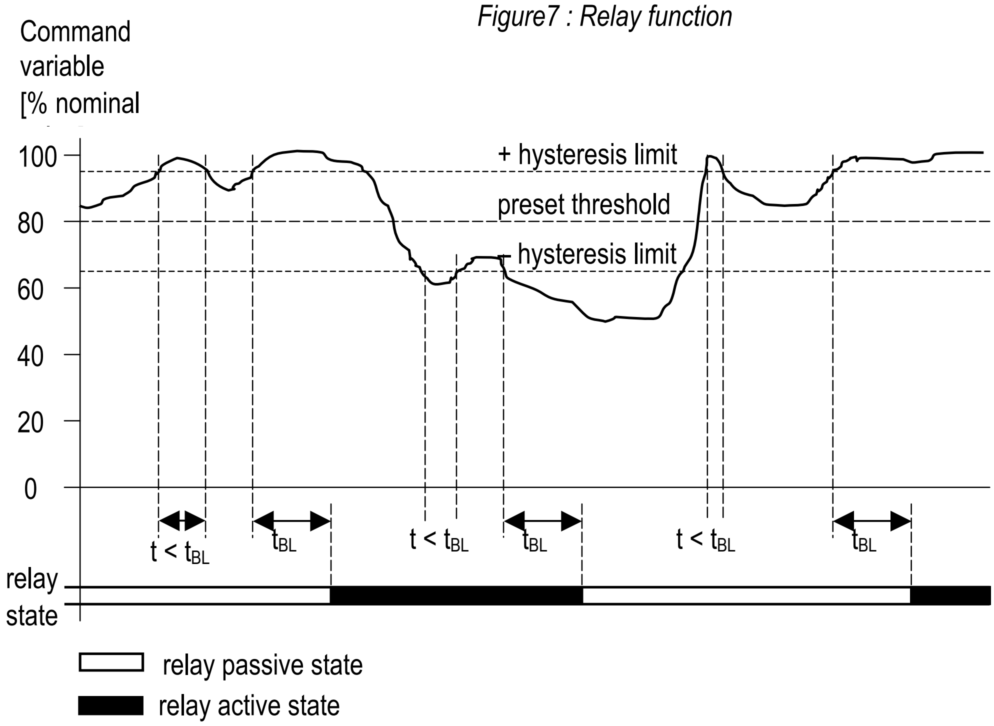
2.3.2.2 Function

The output relay can be used as a single two–position switch controller or for indication of a defined condition. The function is illustrated in a graph in figure 7.

The variable that controls a relay (**Command Variable**), can be selected using Table 5. The **Response** parameter specifies a relay's behavior on the command variable's being above or below the preset threshold.

The parameter can be set to one of the values: **Over On**, **Over Off**, **Under On**, **Under Off**. If you, for example, want to indicate an overload condition of the appliance under measurement using a relay, set the relay 1 **Command Variable** to the **3 *P***, three-phase, active power value, the **Response** parameter to **Over On** (so that the relay *closes* if the command variable is *over* the preset threshold). When subsequently the command variable exceeds the preset threshold, relay 1 will get activated and go to the *closed* position.

Figure7 : Relay function



2.3.2.3 Setup

The relays' behaviors can be set up independently of each other. The ***Instrument Installation -> Relay1***, ***Relay2*** selection in the menu and the *Relay Setting* screen, where you can navigate using the ► key and change parameters with the ▼ and ▲ keys, are used to set them up.

You can also set the relays up using a computer – see relevant chapter below. Closed relay position is indicated in the display's status line.

Table 4: Relay function command variable summary

command variable	name	nominal value to define threshold and hysteresis
single–phase voltage specified	U1 / U2 / U3	direct measurement: - star ... **Unom** [V] - delta/Aron .... **Unom** $x\sqrt{3}$ [V] measurement via voltage metering transformer: - star.... ..VT primary side / $\sqrt{3}$ [V] - delta/Aron ..VT primary side [V]
single–phase voltage any	U123	
single–phase current specified	I1 / I2 / I3	**(Pnom / Unom) / 3** [A]
single–phase current any	I123	
actual power factor singe–phase — specified	PF1/ PF2/ PF3	1.00
actual power factor three–phase	3PF	
frequency (phase L1)	f	threshold and hysteresis specified in absolute value [Hz]
temperature	T	0 % ...**T04**, 100 % ...**T20** [°C]
active power single–phase — specified	P1 / P2 / P3	single–phase quantity.... **Pnom / 3** [VA] 3–phase quantity........... **Pnom** [VA]
active power three–phase	3P	
reactive power single–phase — specified	Q1 / Q2 / Q3	
reactive power three–phase	3Q	
apparent power single–phase — specified	S1 / S2 / S3	
apparent power three–phase	3S	
1st harmonic power factor single–phase — specified	cos1/ cos2/ cos3	1.00
single–phase voltage total harmonic distortion specified	THDU1 / THDU2/ THDU3	100 %
single–phase voltage total harmonic distortion any	THDU123	
single–phase current total harmonic distortion specified	THDI1 / THDI2/ THDI3	100 %
single–phase current total harmonic distortion any	THDI123	

3. Computer–Controlled Operation

You can monitor actual measurement values and change instrument's settings not only on the instrument's front panel, but also using a local or remote computer connected to the instrument via a communication link. You can also adjust and monitor curves stored in the instrument's inbuilt memory using a computer, which is not possible via the instrument's front panel.

3.1 Communication Links

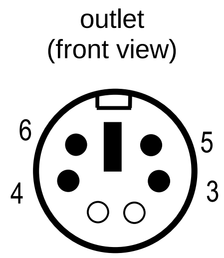
3.1.1 Local Communication Link

The instrument's standard feature is a serial communication interface with levels as defined by V.24 (RS–232) and a connector on the front panel. Using this interface instrument parameter setting and data transmission to a portable computer can be carried out.

With regard to the fact that the instrument can feature a remote communication interface as well, the communication link in this chapter's description is called local. The interface has a MiniDIN connector on the control panel labeled ***COM***. Signal assignment to pins is shown in table 6 .

Table 5: Local communication interface connector configuration

signal	MiniDIN outlet contact (female)
RxD, read data	4
TxD, transmission data	3
/LOCAL, local communication request	5
GND, communication link ground	6



If data transmission via the local communication link is required, the operator has to connect the instrument to a Personal Computer (PC) with a communication cable, which is a listed optional accessory. This cable's MINIDIN connector has its pins 5 and 6 short-circuited. Plugging in the connector thus results in logical 0 appearing on the /LOCAL signal and the instrument redirects communication to this local interface, which is indicated in the display's status line, and, at the same time, it disconnects from the remote communication line (if it has one).

When connected via the local communication line, the communication parameters in ENVIS / RETIS have to be set to COM, 9600 Bd, and the address has to be set to 1 (independently of the address specified in the instrument while setting it up since that is only significant for the main communication line).

The instrument redirects communication back to the remote line on unplugging the connector.

3.1.2 Remote Communication Link

The instrument's optional feature is a remote communication line via which the instrument can be controlled from a remote computer. Using such a computer, you can then change the instrument's settings and transmit actual or stored data remotely. The communication protocol implemented is in-house KMB or standard MODBUS.

The remote communication interface is galvanically isolated from internal circuitry and it can be compliant with RS–232 (instrument model SMY33+ R/232) or RS–485) (... /485).

One or more instruments can be connected to a remote Personal Computer via such a link. Each instrument must have a different communication address and the same communication rate set. These parameters can be preset using a computer via the local communication link through the activity called Installation in ENVIS / RETIS or manually in parameter group 4.

3.1.2.1 RS–232 Interface

Only one instrument can be connected to this interface. The communication cable length should not be more than a few tens of meters. The instrument can also be connected via this interface using a modem. Then the communication distance and number of connected instruments are not limited.

Table 7: RS–232 remote communication interface connector configuration

terminal	signal
28	RxD
29	TxD
30	GND

3.1.2.2 RS–485 Interface

Up to 32 instruments at a distance maximum 1,200 meters can be connected to this interface. Each instrument must have a different communication address from the range 1 through 253 set within installation.

Table 8 : RS–485 remote communication interface connector configuration

terminal	signal
28	DATA A
29	DATA B
30	GND

A communication card with a corresponding interface or an external 232/485 level converter connected to a standard serial port must be installed on the computer side. The converter must feature an automatic communication flow direction switching function.

3.1.2.3 Communication Cable

For common applications (cable length up to 100 meters, communication rate up to 9,600 Bd) choosing the right cable is not crucial. It is practically possible to use any shielded cable with two pairs of wires (such as MK 4 x 0.15) and to connect the shielding with the Protective Earth wire in a single point.

With cable lengths over 100 meters or with communication rates over 20 kilobit per second it is convenient to use a special shielded communication cable with twisted pairs with defined wave impedance, usually around 100 Ohm.

3.1.2.4 Terminating Resistors

The RS–485 interface requires, especially at high communication rates and long distances, impedance termination of the final nodes through installation of terminating resistors (usually 330 Ω). Terminating resistors are only installed at the link's final points (for example one at the Personal Computer and another at the remotest instrument). They are connected between terminals 28 (**A**) and 29 (**B**).

3.1.2.5 Remote Communication Link Protocol

3.1.2.5.1 KMB Communication Protocol

This protocol is used in remote communication via RS–232 or RS–485 when the instrument is connected to a computer through a standard serial communication port (COM). The protocol is preset as default and is indicated as ***KMB.*** Data transmission the takes place at communication rate set in the range from 600 to 19,200 Baud (8 bits, no parity, 1 stop bit).

3.1.2.5.2 Modbus RTU Communication protocol

For easy integration into user information systems the Modbus-RTU protocol is implemented too. The protocol can be set with no parity / even parity / odd parity. Detailed description of communication protocols implementation will be sent on request.

3.1.2.5.3 Communication via Modem

The instruments with an RS–232 interface can be remotely connected via telephone modem.

In installation it is necessary to select, besides the communication address, communication rate in accordance with maximum speed of modem used. It is further necessary to select modem communication by setting an initialization string for the modem. Using this string the instrument sets up the modem for it to be able to establish communication and transmit data successfully when called by a remote computer.

The modem must be compatible with a basic set of AT commands (Hayes). Practically all modern modems meet this requirement so this communication should not pose any problems. From our practical experience's point of view we can recommend using Microcom modems. The following initialization string has proved suitable with them:

ATB0&D0E0&K0&L0Q0V0X1 S0=1 S10=100

If the string does not work with a modem in use, it is necessary to check application of all AT commands in the initialization string following modem documentation and modify the initialization string if required. If there are insisting problems, please contact KMB systems.

3.2 ENVIS and RETIS Programs

ENVIS-ONLINE and RETIS are computer programs developed especially for on-line monitoring of one or more instrument's current condition and archive the measurement data.

For applications where on-line mode is not used, ENVIS or RETIS-OFF is better choice. It doesn't support on-line mode, but it has hierarchical structured database of measured records. This feature is very suitable for processing many records measured at different network nodes.

3.3 *RETIS Program – General*

RETIS is a computer program developed to monitor the instrument's current condition and archive the measurement data. The software can monitor status of a number of instruments concurrently and it allows setting them up.

There are two editions of the program. The basic edition is included in the instrument package on an enclosed compact disk and the latest version can be downloaded via the Internet. This edition has all visualization features in the instrument online mode and allows one-day data archiving. The full edition allows no-limit data archiving as well as operation while the instrument is offline.

A demo mode, in which the software can be tested without a connected instrument, is part of the program.

The general program operation principles are explained in its helptext. Unless otherwise stated, the features described are contained in the program's both basic and full editions.

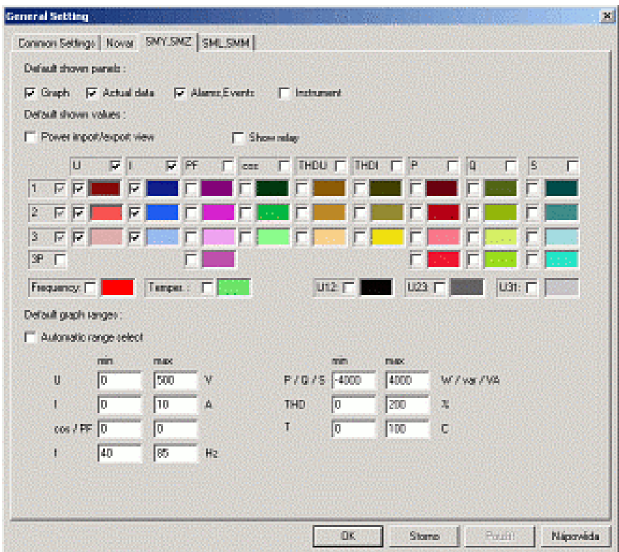
3.3.1 Default Settings

The program can save default settings for each class of instruments. A new instrument automatically takes over the default settings in accordance with the instrument's class. The instrument's settings can be edited at any time or restored to the default values. The following groups of default settings can be saved for instruments of the SMZ and SMY classes:

- panels
- graphs
- ranges

Open the default settings window by selecting *Setup* > *General Settings* > *SMZ, SMY* in the menu. A window as the one shown in Figure 8 will be displayed.

Figure 8 : Default Settings

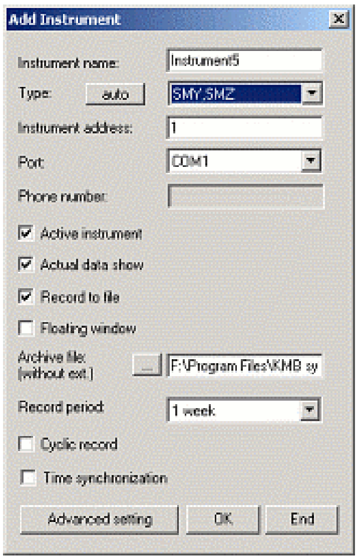


Measuring range is selected automatically in accordance with the current and voltage conversion settings or it can be selected manually in fundamental units.

3.3.2 Connecting Instrument to Computer and Entering into Database

The instrument is to be connected using the appropriate cable to a PC via the local communication interface (COM port) or via the remote communication interface (if available). The instrument is entered into the software's database via the menu *Instrument* > *Add Instrument* (Figure 9).

Figure 9 : Adding Instrument into Database



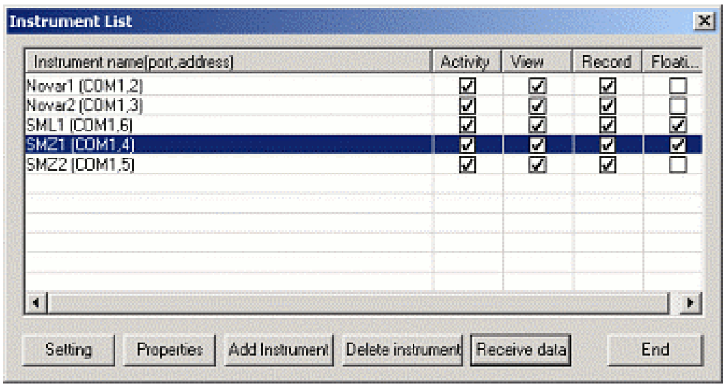
Specify the address and communication port, for example COM1,in the Add Instrument dialog box. Make sure that the communication parameter settings, accessed via *Setup* > *General Settings* in the General Settings dialog box, match the instrument's settings. Then communication can be checked by clicking on *auto*. If communication works correctly, the type of instrument, SMY or SMZ, will show up. The type of instrument can alternatively be selected in the list.

3.3.3 Instrument Database

The instruments entered in the database are shown in a list of instruments (Figure 10). You can do the following in the dialog box:

- Enable or disable instruments
- View or hide active instrument
- View or hide active instrument's floating window
- Enable or disable data archiving from active instrument
- View instrument setup and properties dialog box
- Add or remove instrument
- Download data from instrument memory if you use full edition of software

Figure 10 : List of Instruments

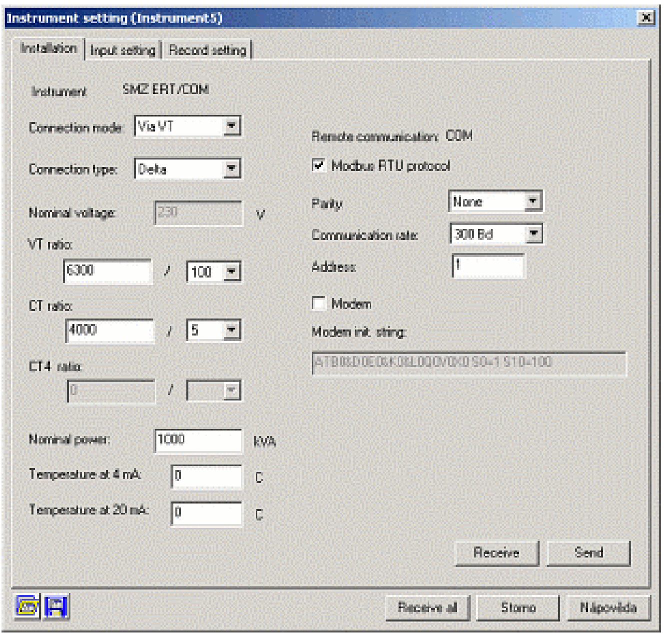


3.3.4 Instrument Setup

Through instrument parameters, specify character and operation of input signals connected to the instrument. There are main parameters and additional parameters.

View parameter settings by selecting *Settings* in the *List of Instruments* dialog box (Figure 11).

Figure 11 : Instrument Settings



3.3.4.1 Main Parameters

You can view instrument's main parameters by selecting the *Installation* card within the *Instrument Settings* dialog box (Figure 11).

The main parameters are as follows:

1. type of voltage (direct or indirect via voltage metering transformer)
2. connection configuration (wye/star, delta, Aaron connection)
3. nominal voltage (if measuring via a voltage metering transformer, this is the transformer's primary voltage value)

4. voltage metering transformer conversion value
5. current metering transformer conversion value
6. transformer's nominal power (if applicable)
7. temperature sensor range (if connected)
8. remote communication line parameters (rate, address, protocol)

These main parameters are usually to be set once for good on having connected the instrument to the power system node under measurement or they are occasionally edited, for example after modifications to the system measured or in order to change the principal communication link parameters or suchlike.

The program attempts to read data from the instrument on viewing the *Instrument Settings* dialog box. If this fails, you can read the settings from a file or close the dialog box. The parameters shown in the *Installation* card can be transferred to the instrument with the *Send* button or from the instrument with the *Receive* button.

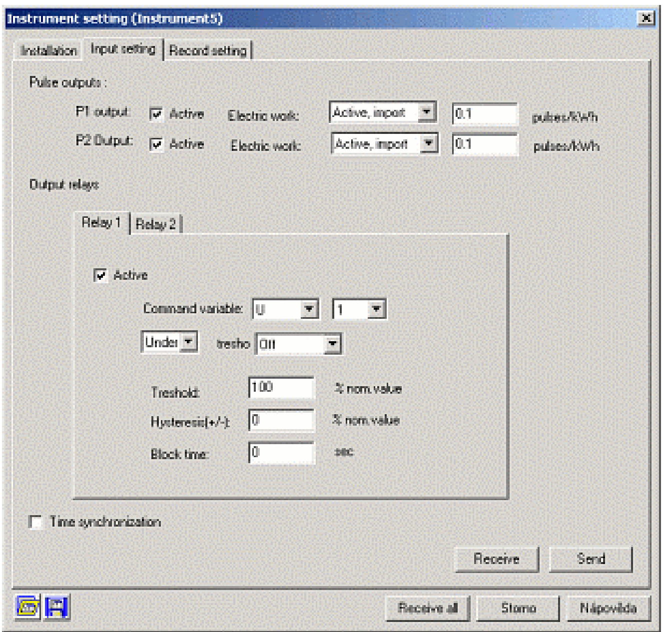
All of the settings (installation, output parameters, recording parameters) can be saved in a single file and retrieved from a file using icons at the bottom left.

WARNING!!! When you send the main parameters into the instrument, all the data stored in the instrument's memory will be deleted and the instrument's energy meter will be reset**!!!**

3.3.4.2 Additional Parameters

If the instrument features output relays, such outputs' operation can be set up using additional parameters. You can view the additional parameters by selecting *Settings* in the *List of Instruments* dialog box's *Output Settings* card (Figure 12). The additional parameters specify output relays' setting only.

Figure 12 : Additional Parameter Settings



The program attempts to read data from the instrument on viewing the *Instrument Settings* dialog box. If this fails, you can read the settings from a file or close the dialog box. The parameters shown in the

Output Settings card can be transferred to the instrument with the *Send* button or from the instrument with the *Receive* button.

All of the settings (installation, output parameters, recording parameters) can be saved in a single file and retrieved from a file using icons at the bottom left. When sending additional parameters to the instrument, the instrument data and energy meter values are maintained.

3.3.5 Recording Parameters

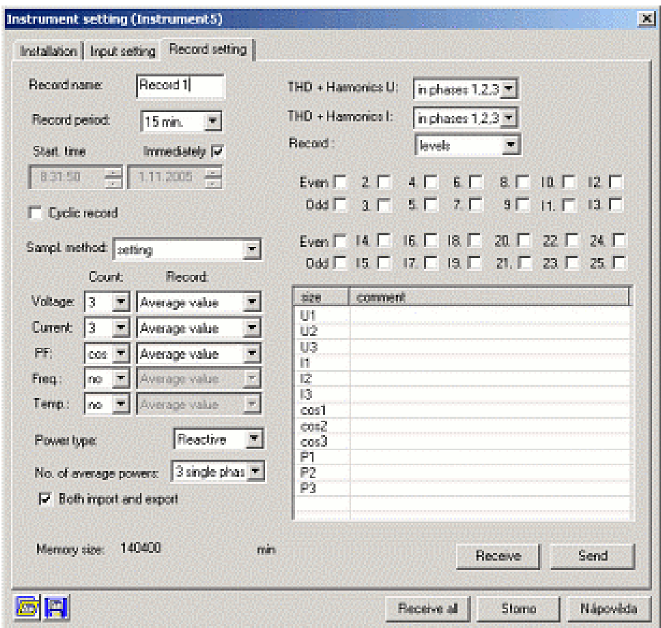
In the online mode, Retis receives, displays and subsequently saves all the measurement data from an instrument, independently of the data storage settings in the instrument. The full edition further allows downloading of internal memory data (offline data) and archiving them separately or using them to patch online data, which may be convenient after communication or computer failure.

If you want the instrument to record data into its memory, you have to set up the recording parameters. The recording parameters specify the quantities and the way to be recorded. View the recording parameters by selecting *Settings* in the *List of Instruments* dialog box's *Recording Parameters* card (Figure 13).

The program attempts to read data from the instrument on viewing the *Instrument Settings* dialog box. If this fails, you can read the settings from a file or close the dialog box. The parameters shown in the *Recording Parameters* card can be transferred to the instrument with the *Send* button or from the instrument with the *Receive* button.

All of the settings (installation, output parameters, recording parameters) can be saved in a single file and retrieved from a file using icons at the bottom left. When sending additional parameters to the instrument, all of the instrument data are deleted, but the instrument energy meter values are maintained.

Figure 13 : Recording Parameters



You can enter the name of a power system node or transformer in the *Record Name* item. This name is for record identification within the RETIS / RETIS-OFF program.

Recording cycle from 5 seconds to 60 minutes can be specified in the *Record Period* box.

Checking the *Immediately* checkbox makes the instrument start data recording immediately after the setup is complete, unchecking it causes that recording starts on reaching the record start time. The start time is to be specified in the boxes provided.

The *Cyclic Record* checkbox decides about what happens when the instrument memory gets full. If unchecked, data recording stops until the instrument is set up again. If checked, data recording continues and the new values overwrite the oldest values, so the instrument stores the latest measurement data and the record length corresponds to the instrument memory capacity.

One of the following quantity sampling methods can be selected in the following box:

- on setting
- on voltage extreme
- on current extreme
- on cos extreme
- on one-phase active power maximum
- on three-phase active power maximum

You can specify the number of signals to be recorded in the *Voltage*, *Current*, *Power Factor*, *Frequency*, and *Temperature* boxes and select one of the methods of storing the values measured from dropdown menus. If measurement voltage is star-connected, only phase voltage values are stored. If it is delta-connected or Aaron-connected, only line voltage values are stored.

You can specify measuring and recording of average power in the *Number of Average Power Values*. You can select recording of one to three average single-phase power values or average three-phase power of the entire outlet. You can select active, reactive or apparent average power in the *Type of Power* dropdown menu.

You can further specify whether consumption and supply power values, or inductive and capacitive reactive power values, are to be recorded separately.

Separate recording of voltage and current signals can be specified in the group of harmonic distortion and selected high-order harmonic components. Both voltage and current harmonic measurements allow recording total harmonic distortion values and signal harmonic components in phase 1 or all three phases.

If recording of total harmonic distortion and harmonic components is enabled, you can further specify which harmonic values are to be recorded. You can select one of two methods:

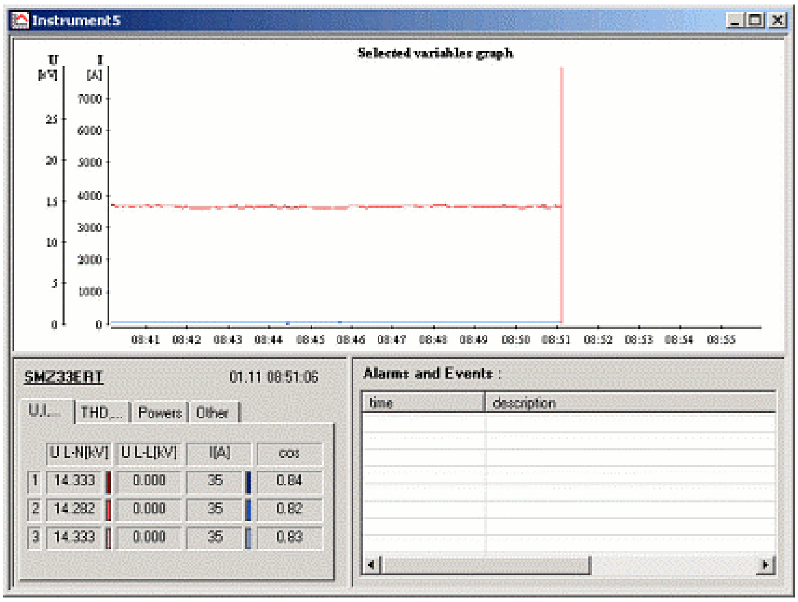
- If you select *Level*, high-order harmonic levels will be stored as percentages in relation to the fundamental harmonic component; you check each harmonic component to be recorded using its checkbox (for voltage and current together).
- If you select *Spectrum*, the order of the highest-order harmonic components will be stored in the order of their levels (not the levels themselves though); you need to further specify how many highest-order harmonic components (or its orders) are to be processed in the *Number of Harmonics* box.

The total harmonic distortion and harmonic component levels are always recorded as average values over the record period specified. With respect to the frequency of rendering total harmonic distortion and harmonic components (see relevant chapter above), it makes sense to store such values at periods 20 seconds or longer.

3.3.6 Current Data Operation

If an instrument is enabled as active in the *List of Instruments* dialog box and viewing is selected (see Chapter 3.3.3), the following instrument window will be displayed (Figure 14):

Figure 14: Instrument Window



You can view the measurement data in a table and a graph within the window. You can also view the latest events that took place within the time displayed in the graph.

You can view archive data in a similar fashion. More details are in the program's helptext.

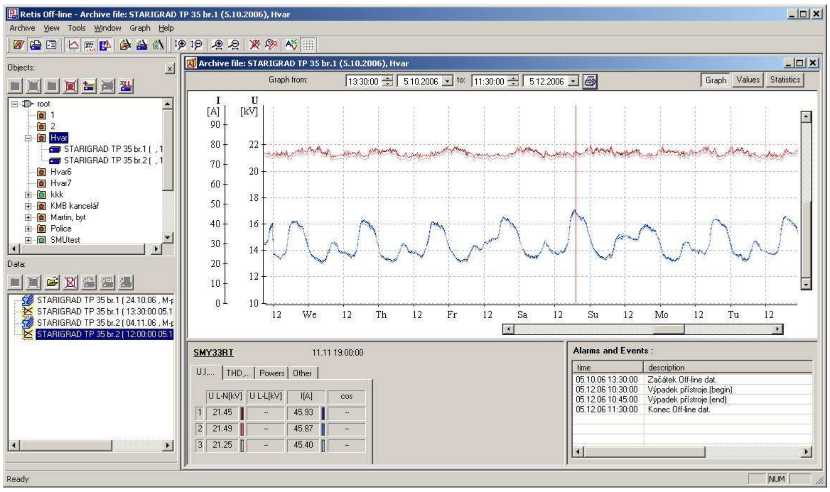
3.4 *RETIS-OFF Program*

RETIS-OFF program is based on the RETIS program and it shares most of functions with it. Main differences are as follows :

- RETIS-OFF doesn't support on-line mode (instrument's current condition monitoring)
- RETIS-OFF has hierarchically structured measurement record database

Therefore, the RETIS-OFF is more suitable especially for processing of great amount of records from many different network nodes that are transferred off-line to a PC.

Figure 15 : RETIS-OFF Program



Basic instructions for operation with the RETIS-OFF can be found in its context help.

3.4.1 CETIS32 to RETIS / RETIS-OFF Measurement Records Format Conversion

RETIS-OFF program replaces older CETIS32 program, development of which was cancelled. To enable processing of records created by CETIS32, the records must be converted to the RETIS format first.

For each converted *object*, new *object* must be created in the RETIS-OFF *Object List*. After selecting new *object* choose *Tools* > *Object* > *Import Object* and then browse and choose source *object* from the CETIS32 database. After that new converted records in the new RETIS-OFF *object* are created. Old records in the CETIS32 database stay unchanged.

3.5 Instrument Computer Control Problems, Possible Causes and Troubleshooting

Problem: While setting the instrument or downloading data to the Personal Computer, the program shows a message *Instrument Does Not Respond*:

- with communication via the local link, check communication cable for correct connection (the instrument must display local communication icon on plugging in the cable), further check communication parameter settings in the program (setting of appropriate COM port, communication arte at 9600 Bd, address 1)
- with communication via the remote link, check communication cable or communication converter for correct connection, further check communication parameter settings in the program (communication rate, address) and in the instrument (manually in the parameter group 4 settings or using a computer via the local link in *Instrument Installation*)

Problem: while downloading data from the instrument to a Personal Computer the program shows a message *Memory Error xx, Reinitialize*:

- setup the instrument and make a test (short–time) record — if the error insists, the instrument needs repairing by the manufacturer
- if the instrument has been disconnected from the power for an extended period of time, leave it connected to power supply for a few days (to charge the backup accumulator) and then make the short–time test record mentioned above

Problem: while downloading data from the instrument to a Personal Computer the program shows a message *No Records in Equipment*:

- when setting up the instrument, data recording from a point in time was set which has not occurred yet (you can check this by downloading instrument settings)

Problem: The graph of power factor, total harmonic distortion or harmonic components contains some PWOff values although neither voltage nor current values are PWOff as well:

- the values of current or voltage are too low so the quantity at issue can not be measured by the instrument

4. MAINTENANCE, SERVICE

Maintenance

The SMY 33+ instruments do not require any maintenance in their operation. For reliable operation it is only necessary to meet operating conditions specified and not expose the instrument to violent handling and activity of water or chemicals which could cause mechanical damage.

The instrument has a T3.15L mains fuse to disconnect it on incorrect power supply voltage connection or on a breakdown. The fuse is not accessible for a user, the instrument needs to be sent to the dealer that will arrange its replacement.

The built–in CR2450 lithium cell can backup the memory and real time circuit for more than 5 years without power supply, at average temperature 20°C and load current in the instrument less than 10 μA.

If the cell is empty, it is necessary to ship the instrument to the manufacturer for battery replacement.

Service

If the product has a breakdown, you need to complain to the supplier at their address:

Supplier :

Manufacturer :

KMB systems, s.r.o.

Dr. M. Horákové 559

460 06 LIBEREC 7

Czech Republic

telephone +420 485 130 314

fax +420 482 739 957

e–mail : kmb@kmb.cz

website : www.kmb.cz

The product must be in proper package to prevent damage in transit. 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 must enclose an order for the repair.

5. TECHNICAL SPECIFICATIONS

Measured quantities

voltage	20.0 to 99.9V, +/- 0.5% of rdg +/- 0.3V 100 to 399V, +/- 0.5% of rdg +/- 1V 400 to 500V, +/- 0.5% of rdg +/- 2V
current (I_{nom} = 5 A_{eff})	0.01A to 0.99A, +/- 0.5% of rdg +/- 0.01A 1.00 to 6.00A, +/- 0.5% of rdg +/- 0.03A
permanent overload (IEC 258)	voltage 800 V_{eff}, current 10 A_{eff}
frequency	42 ÷ 80 Hz (0.2 %)
power factor (PF, cos fi)	0.00 ÷ 1.00 (+/-2 %, for current load 10 % plus)
harmonic components / total harmonic distortion	from 25th order, 0 ÷ 200 % / 0 ÷ 800 % (+/-10 %, for U value or from 10 % up of measurement range)
power (active/reactive/apparent)	0 ÷ 3 kW/kvar/kVA (+/- 2% of rdg +/- 3W)
temperature	as converter range used (temperature/current 4÷20mA) (1 %)

Other parameters

voltage input impedance	> 1 MΩ
current input serial impedance	< 10 mΩ
power supply	80 - 230 V AC, max. 5 VA 100 - 350 V DC, max. 5 W
relay output (2x)	switching contacts max. 230V AC / 4A
operating environment	class C1 in compliance with IEC 654-1
operating temperature	–25 to 50 °C
operating humidity	5 to 100 %
storage temperature	–40 to 70 °C
installation overvoltage category	III in compliance with EN 61010–1
EMC – radiation	EN 55011, class A (not for homes) EN 55022, class A
EMC – resistance	in compliance with EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-11
measurement cycle	about 3 seconds
record interval	5 seconds ÷ 60 minutes
memory	maximum 1024 kB
record of value measured	time, date, minimum, maximum, average, sample
remote communication interface	RS–232 or RS–485, KMB or Modbus-RTU protocol

Design

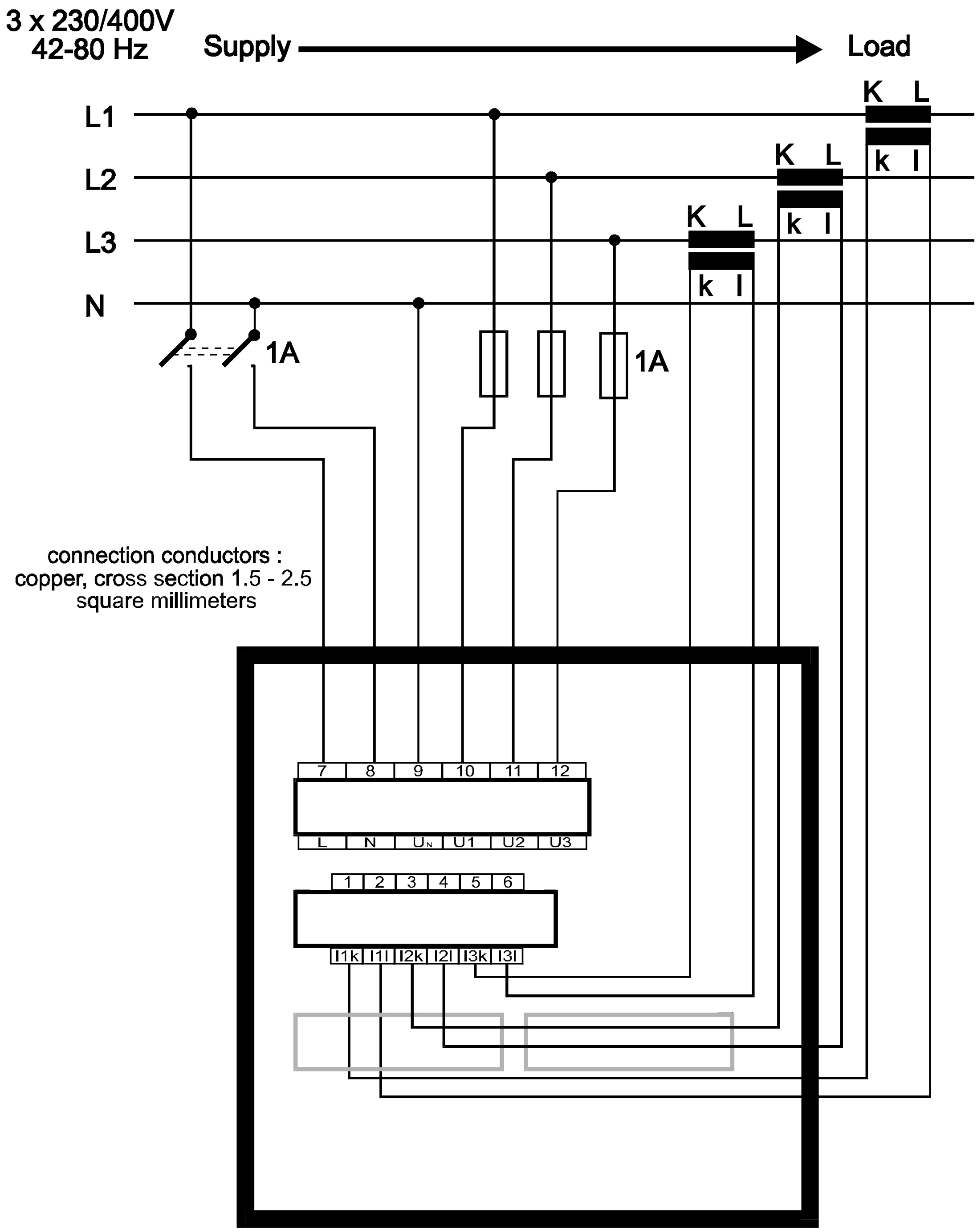
case	plastic box DIN 43700
display	graphic LCD with backlight
protection	IP 4x, back panel IP 2x
dimensions	96 x 96 mm, built depth 150 mm
panel cutout	92 x 92 mm, tolerance –0/+1 mm
mass	about 0.5 kg

6. Example Connections

SMY-33 Instrument

standard connection 3 x 230/400V

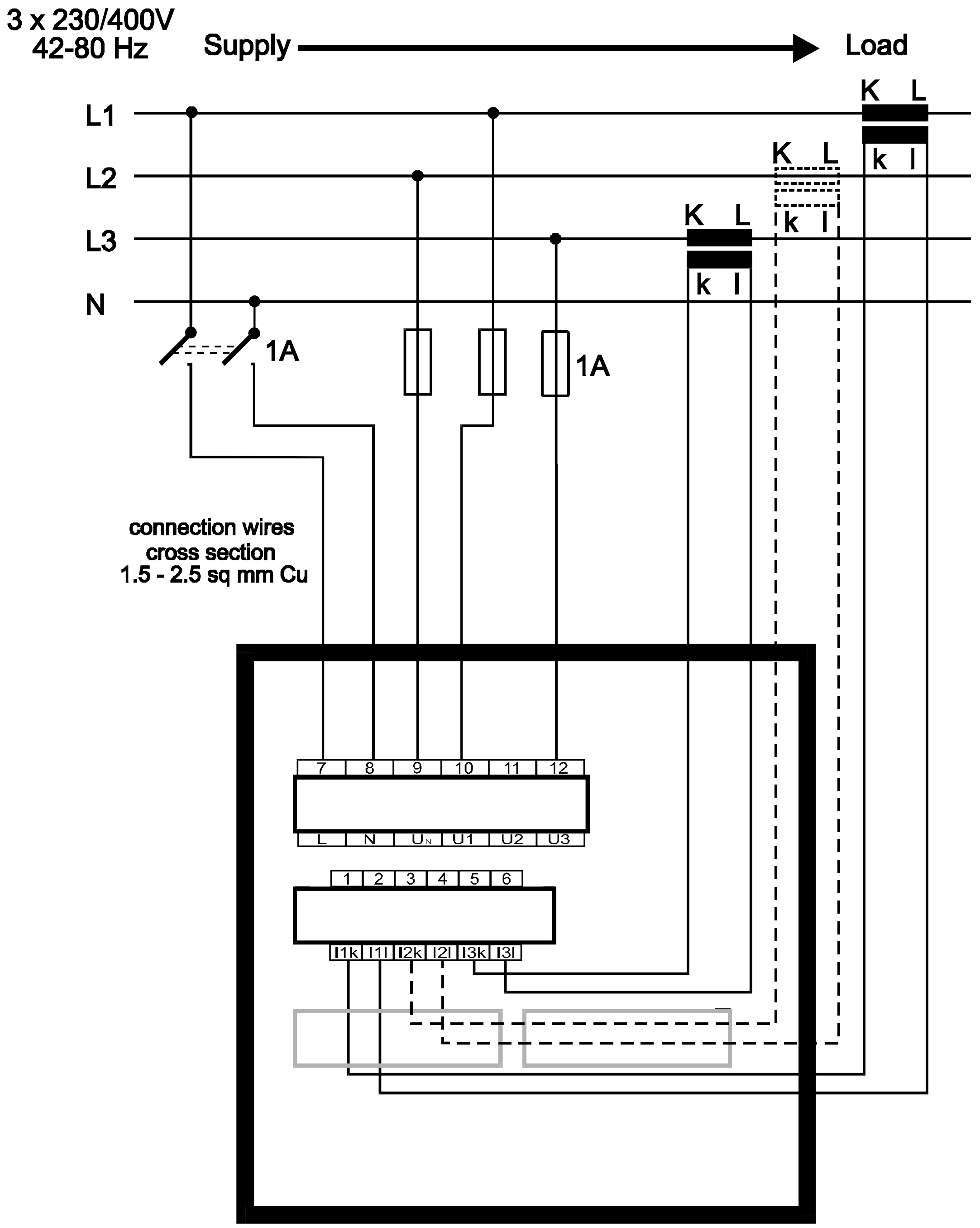
installation - connection of measurement signals and power supply



SMY-33 Instrument

Aron connection 3 x 230/400V

installation - connection of measurement signals and power supply



SMY-33 Instrument

Voltage delta connection, measurement at high voltage installation - connection of measurement signals and power supply