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SIMON-341 FLEX2

Mains Monitor

User Manual

Firmware v. 6.x

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1. Basic Features

The SIMON-341 FLEX2 (further only as SIMON) is a programmable recorder to measure parameters in low voltage power distribution networks. The instrument can measure up to three voltages (230/400 V_{ef}), four currents (via current probes with voltage outputs) and a temperature via a Pt100 thermocouple probe, at a time. It furthermore allows measuring power and power factor via three current inputs, total harmonic distortion (THD), voltage and current harmonic components, and frequency.

Together with a SIMON-Z Load Simulator (optional accessory) the instrument allows measuring voltage that corresponds to a real load of 5 or 10 kW and it thus evaluates supply loop impedance.

SIMON has a real time circuit and a memory that are both backed up with an inbuilt battery to save data for typically 8 years.

The instrument is built in a plastic enclosure 115 x 200 x 60 mm and its mass is about 0.8 kg. The dimensions and enclosure material allow installation in confined space of a switch box without the threat of short circuiting.

Connection to quantities measured is provided using cables with non-interchangeable connectors, supplied with the instrument.

SIMON's firmware mainly allows:

- identify a measurement data file with a number and measurement location name (transformer station, switch box, consumer, etc.)
- select the Stop mode where recording stops on full memory, which conditions is shown with a LED, or the Continuous mode where the oldest data are overwritten with the latest data on full memory
- preset the record start time
- select the mode of measurement to record maximum, minimum or average value or plain samples
- select the record interval in a range from 1 second to 60 minutes
- select the input configuration; if some of the quantities are not measured, the record length increases proportionally
- specify the metering current transformer ratio
- save additional information in record files

SIMON's maximum memory capacity is 1 MB, which allows recording data for over a month while measuring via all input channels and at record interval set to 1 minute.

The input configuration, record interval, and data transfer can be carried out via a standard serial line, RS-232C, using a Personal Computer. Software is supplied with the instrument that allows viewing and comparing the measurement data in a graphic format and has a host of other features. A priority in developing the software was its user friendliness to respect a user with minimum knowledge of computers.

1.1 Safety Requirements

While operating the instrument, connecting to parts under hazardous voltage takes place. The instrument must be operated by a person complying formally with qualifications required for such work and the person must get familiar with the principles of operating the instrument as described within this document!

2. OPERATION

The instrument is designed for measuring electrical quantities in transformer stations, low voltage power distribution switch boxes or at points of consumption.

Before using a SIMON, the operator must get familiar in detail with the principles of the instrument operation as described in this document and observe them consistently. Failure to observe these principles may result in electrical accident!

2.1 Unpacking an Inspecting Product

Inspect the product for integrity and completeness, including standard accessories, immediately on receiving it. If the product consignment is not all right, follow the instructions in Chapter 3.

A standard SIMON package contains at least the following principal components:

- SIMON Mains Monitor
- Power Cable
- Communication Cable
- CETIS32 Installation Compact Disc

Other accessories, such as voltage or current measuring cables, current probes, thermocouple probes, and the like, are supplied as specified in a purchase order. Optional accessories available are shown on a separate list which is updated continually.

2.2 Software Installation

Software for support of instrument operation is a standard part of the product. It is CETIS32, version 2.X, for Personal Computer running under Microsoft Windows 98SE or higher.

CETIS32 needs to be installed on your computer. Detailed installation instructions are shown in the relevant chapter of the CETIS32 User Manual.

2.3 Preparation of Measurement

SIMON must be set up to the right mode of operation before each measurement task. This is carried out using CETIS32 installed on a Personal Computer.

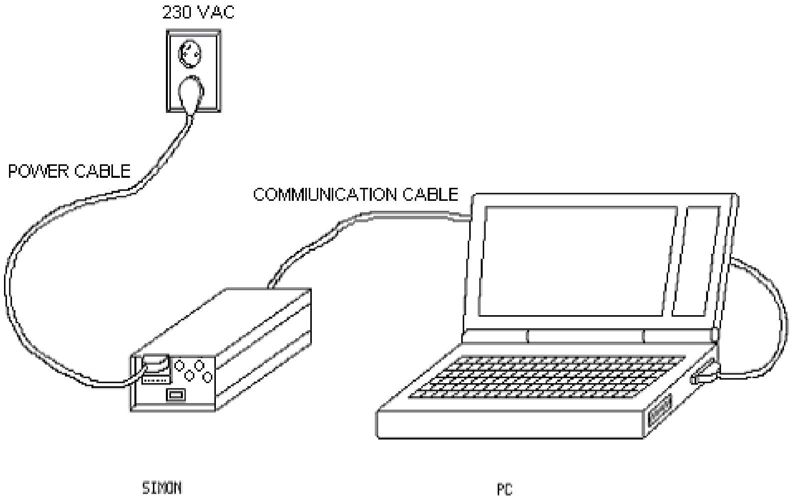
2.3.1 Setting Up SIMON Using PC

The measurement wiring is shown in Figure 2.1. Connect the Communication Cable to a serial port (typically COM1 or COM2) of the Personal Computer to set up the instrument from. The other end of the cable goes to the connector in the back of the instrument, identified as RS-232.

Next connect the Power Cable to the connector identified as U in SIMON's front panel. Toggle the record switch to the REC OFF position. Plug the Power Cable in a 230 Volt outlet. A green pilot LED should start flashing in SIMON's front panel at about 1 Hz. The red LED should be dark.

Note: Observation of the above connection procedure is highly recommended! In order to secure instrument safe operation, especially in an environment with high risk of static electricity, disconnection of the instrument from power while connecting the Communication Cable is essential, unlike while disconnecting it when observing this precaution is not necessary.

Figure 2.1: Connection of SIMON to computer



Now start CETIS32 and set up your SIMON in accordance with the measurement to be carried out (see relevant chapters in the software's user manual). It should be noted that by setting the instrument up, the data from previous measurement, stored in SIMON's memory, are lost. It is therefore important to transfer the last measurement data to the computer before setting up the instrument (as described in the software's user manual).

When the instrument has been set up, unplug the power cable from the mains outlet. Then disconnect the power cable from your SIMON and after that disconnect the Communication Cable from your SIMON too. You can leave the Communication Cable connected to your computer.

Your SIMON is now ready to be connected to the points of measurement.

2.4 Measuring in 3-Phase Systems

The SIMON line of instruments is designed mostly for measuring in low voltage, 230/400 V, power distribution systems in the star configuration. Phase one voltage measured is usually also used to supply power for the instrument.

The model SIMON-341FLEX2/DC has a separate power supply input and it allows indirect voltage measurement via metering voltage transformers of nominal output voltage 57.7/100 V and measuring in delta configuration systems (see description in the relevant chapter).

2.4.1 Connecting to Points of Measurement

Use the Voltage Measurement Cable to connect to points of measurement. The flexible current probes, which are standard part of an instrument's supply, feature round connectors to connect directly to the instrument. If using a split core current transformer, a special adapter connector is required.

The Voltage Measurement Cable has safety banana plugs at its one end to connect crocodile clips to, that in turn connect to points of measurement under hazardous voltage. For example, in transformer stations the crocodile clips connect to the secondary side terminal strip upstream of protective devices and that is why this cable's conductors are protected with 6.3 A fuse links with capability of breaking currents up to 1,500 A that are located in the box housing the noise suppression devices, which is part of the cable.

Wearing insulation gloves is recommended while connecting the cable to the points of measurement. The following procedure must be followed!

1. First make sure the record switch is in the REC OFF position (recording disabled).
2. If you want to measure temperature, connect the thermocouple probe's plug into the connector identified with letter T. Install the thermocouple probe where you want the temperature to be sensed.
3. Connect the Voltage Measurement Cable to the connector identified with letter U.
4. If you want to measure current as well, or power or power factor, connect current probe plugs terminals into the connectors identified with letter I. Do not connect the current probes to the points of measurement yet.
5. Now connect the Voltage Measurement Cable to the points of measurement using the crocodile clips as follows: get ready all the crocodile clips in one hand and in the order you are going to connect them to the points of measurement. Take and hold them in a manner avoiding body contact with their conductive parts.

   The first connection to be made is to the Neutral point of measurement. Take the crocodile clip identified with letter N using your free hand and connect it to the transformer's or line's neutral wire. Correct connection of this point is crucial and you must not confuse it with a phase line else the instrument could get overloaded and broken down.

   Subsequently connect the other crocodile clips, one by one, avoiding to touch conductive parts of any of them. You must connect each voltage input to the relevant point of voltage measurement in accordance with Table 2.1, that is crocodile clip 1 (red conductor) to live wire 1, crocodile clip 2 (white conductor) to live wire 2, and crocodile clip 3 (black conductor) to live wire 3. The connection conductors have, besides the color coding, sleeves showing the conductor number on them.

   You can only connect to as many points of measurement as the number of voltages you want to measure, voltage input 1 must, however, always be connected as this one supplies power to SIMON.

   The green LED on SIMON's front panel starts flashing on connecting the power supply inputs.
6. Connect the current measurement probes. You must connect each current input to the relevant point of current measurement, that is the current probe connected to current input 1 (red mark) must go to live wire 1, current input 2 (white mark) to live wire 2, and current input 3 (black mark) to live wire 3. The current input identified with letter N (blue mark) is there mainly for current measurements in neutral wire.

   The current probe terminals are color coded for this purpose. Correct polarity must be observed while connecting current probes. The arrow on the current probe case must show the direction of the nominal power flow, that is from the power source to point of consumption.

   Then turn the switch on each current probe box to the appropriate current range thus enabling it. The probes' LEDs indicate probe power supply voltage which checks their correct connection to the instrument.
7. Finally toggle the switch in SIMON's front panel to the REC ON position.

At this moment SIMON starts measuring and recording the quantities connected. Correct operation can be checked using the red LED, which indicates measurement in progress; it should turn on once every three seconds and the length of a flash depends on the number of quantities measured.

Tables 2.1 through 2.3 show instrument measurement connectors' pinout.

Table 2.1: The U, Voltage, connector pinout

pin #	assignment	color code
1	voltage 1	red
2	-	-
3	voltage 2	white
4	-	-
5	voltage 3	black
6	-	-
7	neutral wire	blue
8	-	-

Table 2.2: The I, Current, connectors' pinout

pin #	assignment
1	auxiliary voltage -8V
2	auxiliary voltage +8V
3	measurement signal
4	common potential

Table 2.3: The T, Temperature, connector pinout

pin #	assignment
1	source of measurement current -
2	measurement input -
3	source of measurement current +
4	measurement input +

2.4.2 Disconnecting from Points of Measurement

After recording of measurement for the desired period of time has been completed, it is necessary to disconnect SIMON from the points of measurement and transfer the data recorded to a computer. When disconnecting SIMON, the same precautions must be observed as those for connecting it and carry out all the steps in reversed order:

1. First toggle the switch in SIMON's front panel to the REC OFF position. This stops measuring and recording.
2. Disconnect current transformers or probes from the points of measurement.
3. Now disconnect the Voltage Measurement Cable. First disconnect the crocodile clips from line wires. Be careful to avoid touching conductive parts of any of them. Disconnect the neutral wire crocodile clip last.
4. Finally disconnect from SIMON all other cables connected.

2.5 Measuring in Single Phase Outlet Systems

2.5.1 Connecting to Points of Measurement

Use the Power Cable to connect SIMON to a power outlet. The procedure is as follows:

1. First make sure the switch in SIMON's front panel is in the REC OFF (recording disabled) position.
2. If you want to measure temperature, connect the thermocouple probe's plug into the connector identified with letter T. Install the thermocouple probe where you want the temperature to be sensed.
3. Connect the Power Cable to the connector in SIMON's front panel identified with letter U.
4. Plug the Power Cable in a power outlet. The green pilot LED in SIMON's front panel should start flashing on connecting power.
5. Finally toggle the switch in SIMON's front panel to the REC ON position.

At this moment SIMON starts measuring and recording the quantities connected. Correct operation can be checked using the red LED, which indicates measurement in progress; it should turn on once every three seconds.

2.5.2 Disconnecting from Points of Measurement

To disconnect SIMON, carry out the above steps in reversed order:

1. First toggle the switch in SIMON's front panel to the REC OFF position. This stops measuring and recording.
2. Unplug the Power Cable from the power outlet.
3. Last disconnect from SIMON all other cables connected.

2.6 Measuring Voltage Drop on Load Simulated by SIMON-Z

2.6.1 Method of Measuring Voltage Drop

The SIMON-Z Load Simulator can be used to measure a voltage drop corresponding to a real load of 5 or 10 kW.

The principle of measuring with a SIMON-Z Load Simulator lies in loading the system under measurement with an additional load of 10 or 5 kW and measuring voltage under this load. The load, however, is only applied to the system for a period of one half cycle (nominally 10 ms) so the protective devices are too slow to respond. In the event of measuring in systems protected with only a 6A circuit breaker or in systems under an extreme load, using a SIMON-Z/10 (10 kW) Load Simulator may however cause a response from the circuit breaker. A SIMON-Z/5 (5 kW) needs to be used for such situations.

It can be concluded from the above described method that it makes virtually no sense to record values of voltage under load in intervals under 1 minute.

At the moment of Load Simulator actuation, a resistor about 5 ohms connects in parallel to the circuit measured resulting in additional current about 45 A (with 10 kW load). When evaluating the curve of voltage values measured you have to consider the power cord resistance and plug contact resistance causing additional drop of several volts (drop of 1 V across resistance about 20 mΩ).

For the Load Simulator to operate correctly, the moment of actuation, which is derived from the voltage curve, is crucial. Since the switching device is a thyristor, the current phase in circuit under measurement must not be shifted. Power factor in circuit under measurement below about 0.95 may result in incorrect Load Simulator operation.

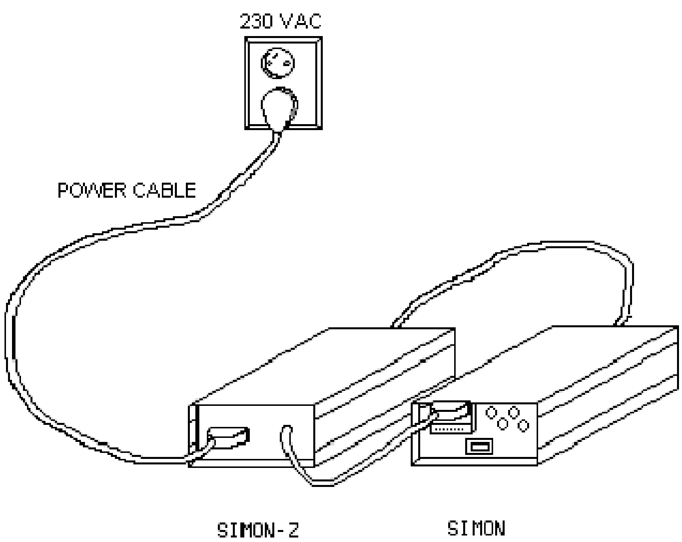
2.6.2 Connecting to Power Outlet

Use the Power Cable to connect SIMON to a power outlet. The procedure is as follows:

1. First make sure the switch in SIMON's front panel is in the REC OFF (recording disabled) position.
2. Connect SIMON-Z Load Simulator to SIMON Mains Monitor, plugging the larger, power, cable coming out of the Load Simulator in the Mains Monitor's front panel connector identified with letter U and plugging the smaller, communication, cable connector in the connector identified as RS-232 in the Main Monitor's back panel.
3. Connect the Power Cable to the connector identified with letter U in the Load Simulator's front panel.
4. Plug the other end of the Power Cable in a power outlet (see Figure 2.2). The green pilot LED in SIMON's front panel should start flashing on powerup.
5. Finally toggle the switch in SIMON's front panel to the REC ON position.

At this moment SIMON Mains Monitor starts measuring and recording the quantities connected. Correct operation can be checked using the red LED, which indicates measurement in progress; it should turn on once every three seconds.

Figure 2.2: Measuring voltage in conjunction with SIMON-Z Load Simulator within a power outlet system.



2.6.3 Disconnection

To disconnect SIMON, carry out the above steps in reversed order:

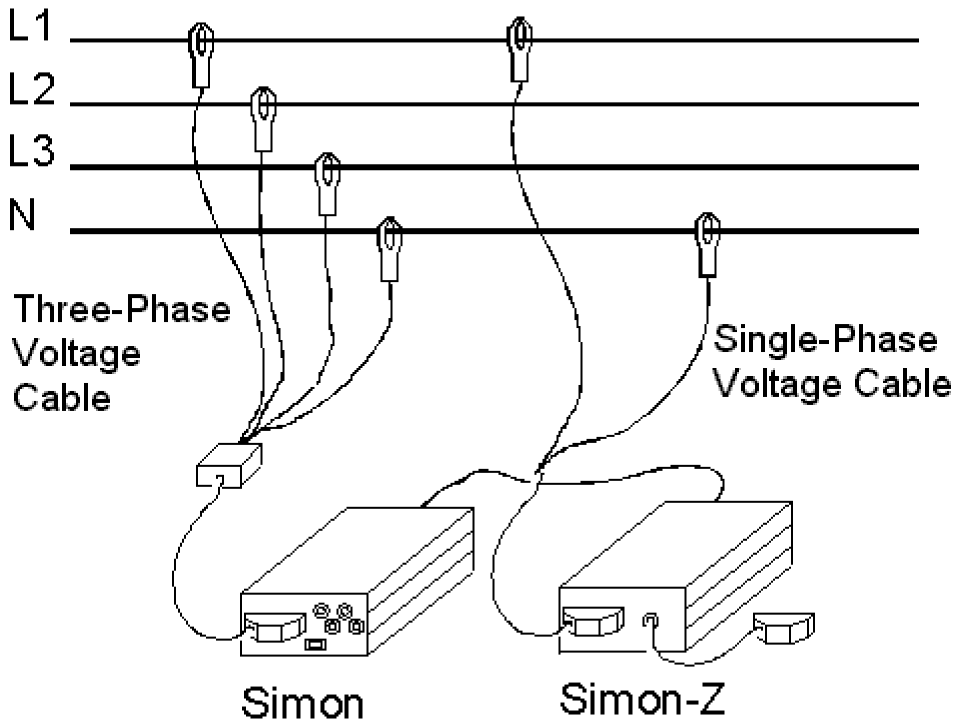
1. First toggle the switch in SIMON's front panel to the REC OFF position. This stops measuring and recording.
2. Unplug the Power Cable from the power outlet.
3. Last disconnect the power cable and SIMON-Z Load Monitor from SIMON Mains Monitor.

2.6.4 Connecting to Three-Phase System

Two voltage cables need to be used to connect to a three-phase system: the Three-Phase Voltage Cable to connect SIMON Mains Monitor and Single-Phase Voltage Cable to connect SIMON-Z Load Simulator. The procedure is as follows:

1. First make sure the switch in SIMON's front panel is in the REC OFF (recording disabled) position.
2. Connect SIMON-Z Load Simulator and SIMON Mains Monitor to each other, plugging the smaller, communication, cable connector in the connector identified as RS-232 in the Main Monitor's back panel. The Load Simulator's larger, power, cable connector is left unconnected.
3. Connect the Three-Phase Voltage Cable to the connector in SIMON Mains Monitor's front panel identified with letter U and the Single-Phase Voltage Cable to SIMON-Z Load Simulator.
4. Using crocodile clips, connect the Three-Phase Voltage Cable to the system under measurement in a fashion similar to that of standard measurement. The green pilot LED in SIMON's front panel should start flashing then.

Figure 2.3: Measuring voltage in conjunction with SIMON-Z Load Simulator within a three-phase system



5. Afterwards connect SIMON-Z Load Simulator using the Single-Phase Voltage Cable's crocodile clips too. Make sure to connect SIMON-Z Load Simulator to live wire L1 (that is the phase which SIMON Mains Monitor's U1 crocodile clips is connected to) and secure reliable contact with minimum contact resistance between the crocodile clips and actual points of measurement.
6. Finally toggle the switch in SIMON's front panel to the REC ON position.

At this moment SIMON Mains Monitor starts measuring and recording the quantities connected. Correct operation can be checked using the red LED, which indicates measurement in progress; it should turn on once every three seconds.

2.6.5 Disconnection

To disconnect SIMON, carry out the above steps in reversed order:

1. First toggle the switch in SIMON's front panel to the REC OFF position. This stops measuring and recording.
2. Disconnect the Single-Phase Voltage Cable, which connects the Load Simulator to the points of measurement, and then disconnect the Three-Phase Voltage Cable, which connects the Mains Monitor to the points of measurement.

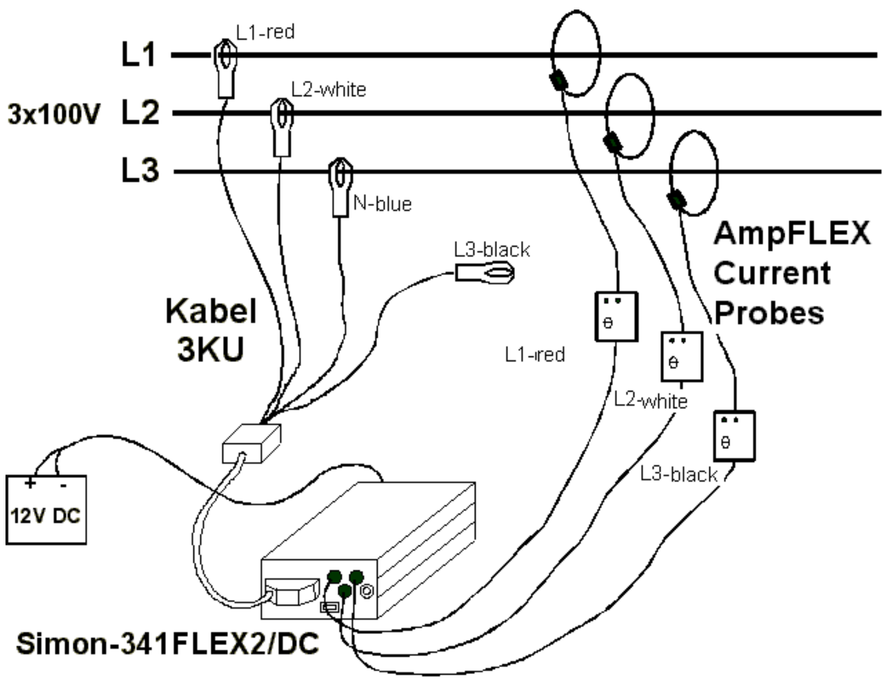
2.7 Direct and Indirect Measurement of Voltage with SIMON-341FLEX2/DC

The basic model of SIMON-341FLEX2 only allows direct measurement of voltages in a 3 x 230/400 VAC system in the star configuration. This instrument, like the other models, draws power from the U1 voltage measurement input line.

A special modification of the instrument referred to as SIMON-341FLEX2/DC also allows indirect measurement of voltages via metering voltage transformers with a standard nominal output range 3 x 57.7/100 V in the star configuration or delta configuration using Aron Connection.

With 3 x 57.7 V star configured systems, the voltages measured are connected in the same way as for direct measurement using the Voltage Measurement Cable via the U connector.

Figure 2.4: Measuring in three-phase systems in delta configuration – Aron Connection



If the measurement takes place in a 3 x 100 V system in the delta configuration where no neutral wire is present, the instrument has to be connected as shown in Figure 2.4. It is the Aron Connection. Live wires L1 and L2, respectively, connect to their corresponding voltage measurement inputs of the instrument. Live wire L3, however, connects to the common, neutral, voltage input of the instrument and voltage measurement input 3 is left unconnected. The current measurement inputs connect in the usual manner – you can measure maximum 3 currents at a time; in order to figure out three-phase power and power factor, it is sufficient to only connect current measurement inputs of live wires L1 and L2. Two phase-to-phase voltages, two or three currents, and three-phase power and power factor are rendered in the measurement process.

Warning! The Aron Connection can only be utilized for indirect voltage measurement of nominal input value 3 x 100 V. If connected to a 3 x 400 V system, the instrument's L1 input limit voltage is exceeded that may result in damage to the instrument!

If direct measurement takes place, the instrument draws power from the U1 measurement voltage line. If indirect measurement takes place, the instrument has to draw power from an external 12 to 24 VDC power supply (battery, power adaptor – see list of accessories available). This power supply voltage needs to go to the power supply connector identified as EXT. PWR in the instrument's back panel. The DC power supply can also be connected for direct measurement of voltages 3 x 230/400 V; in that case the instrument primarily draws power from the U1 measurement voltage line and if this fails, the instrument automatically switches to drawing power from the auxiliary DC power supply.

2.8 Transferring Measurement Data to Computer

Connect SIMON containing the measurement data to a computer using the procedure described in the above chapter on setting up the instrument with a PC. Running CETIS32, transfer data from the Mains Monitor to the computer (as described in the CETIS32 User Manual).

2.9 Methods of Measuring and Rendering Quantities

This chapter describes principles of measuring selected quantities. Knowledge of these principles is important for correct interpretation and post processing of measurement data.

The principles of measuring frequency and temperature, respectively, are well-known, so they do not require additional comments.

2.9.1 Rate of Measurements, Recording Average Values

After you enable recording by toggling the record switch in the instrument's front panel to the REC ON position, the instrument makes a single measurement of all quantities set up every 3 seconds. If the record interval is set to below 5 seconds, the measurement takes place every second (the record interval can only be selected to below 5 seconds if recording of maximum three voltages and three currents in the first input is set up – the other quantities must be disabled).

The instrument processes each instantaneous value measured in accordance with recording setup; it averages the value within the record interval or it records the maximum value or minimum value or the last value measured. It saves the resulting value at the end of the record interval.

If average value recording is set up, you need to realize that the instrument only renders and records the average value for the entire period of time set (record interval) if the instrument is on for this period of time and the record switch is in the REC ON position, that is the position when it measures, processes and records the quantities selected (this condition is indicated by flashing red LED). If there is a power (voltage input 1) failure within a record interval, or measurement and recording are disabled for a time, for example because of setting the instrument up or transferring data, the instrument does not carry out measurement for this time and the group of quantities measured for the time may thus not be included in calculating the average value. This applies to each quantity that is set up to be recorded at the average values as well as to recording average power values.

There are two modes of what happens when the instrument's memory gets full of recording data. Either mode can be selected within the instrument setup procedure. In the Stop mode, the instrument stops recording data on full memory until another instrument setup. This condition is shown by a fast (about 3 Hz) flashing red LED in the instrument's front panel.

In the other, Continuous, mode, the instrument keeps recording data, overwriting the oldest data with the newest data. The instrument thus contains the latest record of values measured, the length of which corresponds to the instrument's memory capacity.

2.9.2 Frequency Factor in Measuring AC Voltages and Currents

Frequency measurement at the U1 voltage input takes place before each measurement of the quantities selected (that is about every 3 seconds). This measurement's value is used to calculate the instantaneous wavelength of the signal under measurement which is applied to measuring and rendering all alternating current (AC) signals, that is to all voltages and currents. This means that all the voltages and currents measured must be of the same frequency. It is further assumed that this frequency does not alter within the single measurement of all quantities selected, that is within an interval of about 2 seconds, otherwise additional inaccuracy is caused.

2.9.3 Measurement Process

2.9.3.1 Measuring Voltage

The instrument renders the true root mean square (TRMS) value. Measuring a signal with dominant basic harmonic component at 42 to 80 Hz is assumed.

The instrument measures signal of four consecutive cycles (4 x 20 = 80 ms) while it samples each of the cycles in 64 points. It calculates simple average from the four cycles sensed, and in turn it calculates the true root mean square value from the average calculated using the formula:

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

U_{eff}… voltage true root mean square value

U_i… voltage sample sensed

2.9.3.2 Measuring Current

The same as above for voltage applies to measuring current.

2.9.3.3 Measuring Power Factor

The instrument renders the true power factor (λ – lambda; for simplicity's sake, letters PF are used for easier identification) from the ratio of active power and apparent power (for measurement method see further below) using the formula:

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

PF… true power factor

P… true power

S… apparent power

The true power factor value is further indexed with attribute L or C, depending on the phase shift between the basic harmonic components of voltage and current, respectively, thus expressing either inductive (L) or capacitive (C) character of the apparent power.

The instrument only renders the total three-phase power factor, 3PF, if measuring in the Aron Connection, using the formula:

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

3PF… active three-phase power factor

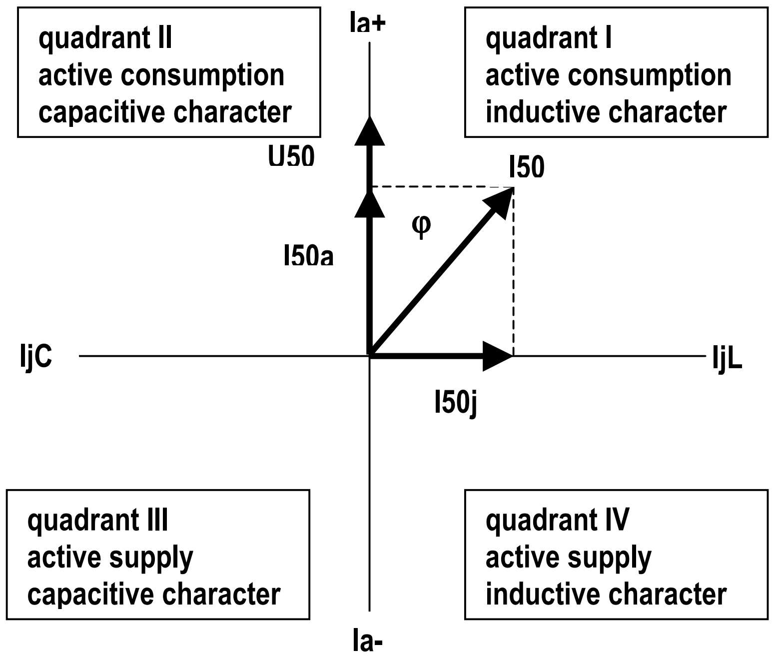
P… active three-phase power

S… apparent three-phase power

The 3PF value is again further indexed with attribute L or C, depending on the apparent three-phase power being of either inductive (L) or capacitive (C) character.

If the instrument is set to record average power factor values, it renders the average from the group of inductive values and that of capacitive values separately. When storing into the memory, the instrument then saves the average value of the group that was predominant within the record interval (it took a longer time).

Figure 2.5: Determining consumption or supply and inductive or capacitive character of apparent power from phase shift angle



2.9.3.4 Measuring Power

The instrument measures and renders the true active power as in the definition equation:

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

P… active power

U_i… voltage sample sensed

I_i… current sample sensed

64 samples of voltage and 64 samples of current sensed per cycle are included in the rendition. If the final result is a positive value, the condition is considered ***consumption*** of active power. If the final result is a negative value, it means the flow of power is reversed in relation to the instrument's connection (polarity of current terminals k and l) and such a condition is considered ***supply*** of power.

The apparent power is rendered using the formula:

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

S… apparent power

U_{eff}… voltage true root mean square value

I_{eff}… current true root mean square value

The reactive power is rendered from active power and apparent power using the formula:

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

Q… reactive power

S… apparent power

P… active power

Like power factor, the reactive power value is indexed with attribute either L or C depending on the phase shift between the basic harmonic components of voltage and current, respectively, thus expressing either inductive (L) or capacitive (C) character of the reactive power.

2.9.3.5 Rendering Three-Phase Power

The instrument renders three-phase power from each phase power.

The active three-phase power is a simple sum as in the equation:

$$3P = P_1 + P_2 + P_3 \qquad [\,W\,] \qquad [\,7\,]$$

3P… active three-phase power

P_1, P_2, P_3… active single-phase power of each phase

The sum takes in each phase power with its polarity (the plus sign is a consumption, the minus sign is a supply). Correct polarity of current probe connection is therefore essential for evaluation of active three-phase power!

Reactive three-phase power is rendered in a similar way:

$$3Q = Q_1 + Q_2 + Q_3 \qquad [\,var\,] \qquad [\,8\,]$$

3Q… reactive three-phase power

Q_1, Q_2, Q_3… reactive single-phase power of each phase

The inductive or capacitive character of reactive power shows as + or – sign and opposite values of single-phase power are subtracted from each other.

Note: With content of high-order harmonic components, the reactive power of each phase is not only caused by phase shift between fundamental harmonics of voltage and current, but there is also some contribution from distortion power of high-order harmonic components. Reactive power of each phase is, however, rendered as a total (content of the distortion power in the total reactive power in a phase is not evaluated by the instrument) and a mathematical sign is assigned to it in accordance with phase shift between fundamental harmonics of voltage and current. If measuring in an unbalanced system (different character, inductive or capacitive, of reactive power in different phase lines) or in the Aron Connection a condition may thus occur in which the sum of reactive power with different character, inductive or capacitive, in different phases, also parts of reactive power, corresponding to distortion power, offset against each other. Under such a scenario, the absolute reactive three-phase power value rendered is lower than actual producing additional inaccuracy of measurement.

The apparent three-phase power, 3S, is rendered using the equation:

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

3S… apparent three-phase power

3P… active three-phase power

3Q… reactive three-phase power

The apparent power, single-phase or three-phase does not bear a mathematical sign, plus or minus.

If measurement of average power is set, the instrument measures and renders instantaneous power at each relevant input in the way described above. It calculates average power from these instantaneous values within a measurement interval and saves the average value calculated in the memory at the end of the recording interval.

2.9.3.6 Rendering Total Harmonic Distortion and High-Order Harmonic Components

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

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

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

THD_U… voltage THD

h_{Ui}……..i-indexed relative voltage harmonic component (relating to the value of fundamental harmonic component H_{U1}; i = the order of harmonic)

THD_I… current THD

h_{Ii}…….. i-indexed relative current harmonic component

Since rendering harmonic components takes a lot of computing power, it is only carried out for one of the quantities of U1, I1, U2, I2, U3, I3 after the measuring cycle and in this order. The harmonic component values are thus only updated 6 times more slowly than the other values measured, about every 20 seconds. The instrument is not thus capable of detecting fluctuations in these values of shorter durations than that.

2.9.4 Rendering Power

SIMON can be set up to measure and record average power. If the instrument was not set up to record average power, CETIS32 can calculate active, reactive, and apparent power from the values of voltage, current, and power factor measured.

The calculation uses the formulae:

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

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

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

P… active power

Q… reactive power

S… apparent power

U… root mean square value of voltage

I… root mean square value of current

cosφ… power factor (for SIMON-341FLEX2 replaced with PF... true power factor)

The following facts, however, need to be considered in calculating power from the values of voltage, current, power factor or true power factor measured:

2.9.4.1 Rendering Instantaneous Power

It is a practical requirement to detect maximum power in a live line within a period of time monitored. The instrument does not, however, measure maximum power directly – it measures voltage, current, and power factor.

There is an issue in detecting precise maximum power, which lies in the fact that when recording for example maximum voltage and maximum power factor, the two values are not arranged to be measured at the same moment – a value of power calculated from values that were not measured at the same moment does not make a sense. An example of such a situation is shown in Figure 2.6.

In this example recording of maximum voltage, maximum current, maximum power factor, and record interval 15 minutes are set. The value of voltage measured at 15:26, value of current measured at 15:20 and value power factor measured at 15:21 are saved at 15:30. If active power is calculated from these values, the result is useless.

CETIS32 allows to set a sampling mode for each phase's quantities (voltage, current, power factor) to evaluate power correctly in such situations.

2.9.4.1.1 Sampling on Setting

This is the default sampling mode in which each quantity is rendered separately and independently of each other, it means that for example recording maximum voltage, minimum current or average power factor values for the record period can be set. Calculation of power does not make a sense in this mode though as the results do not express the actual condition.

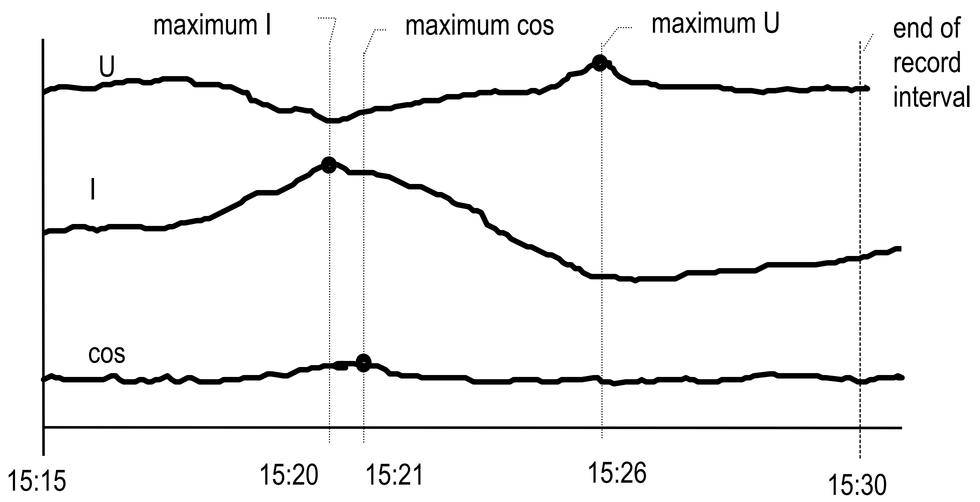
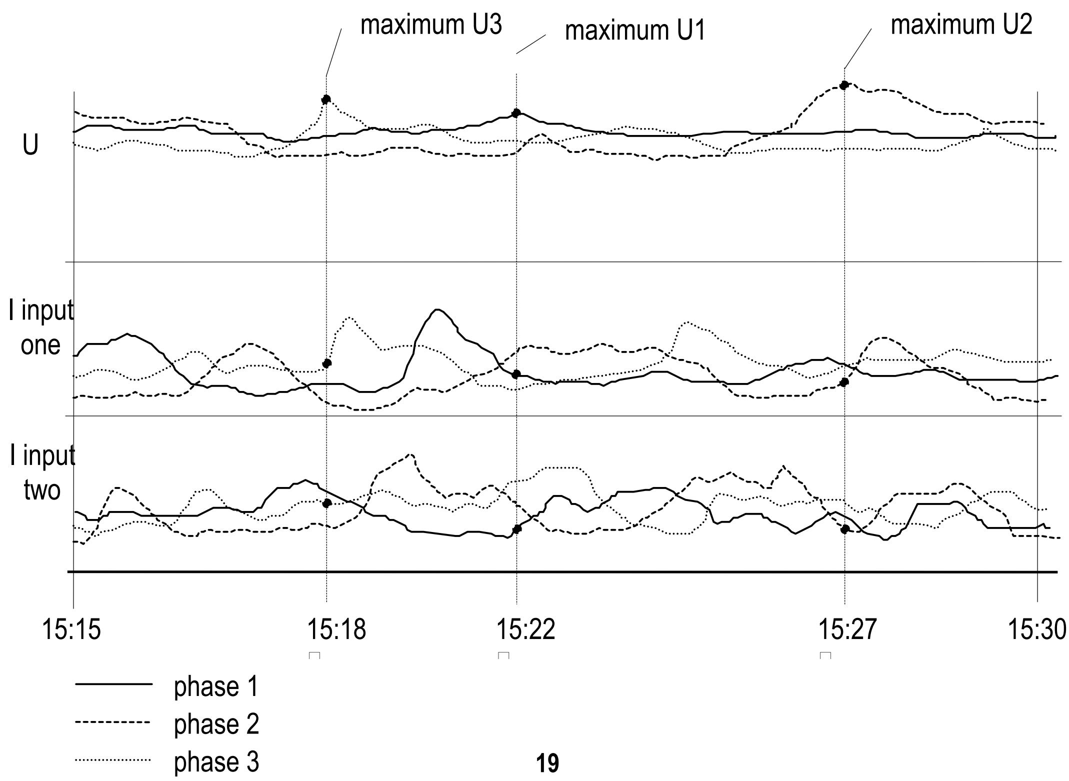


Figure 2.6: Sampling on setting

2.9.4.1.2 Sectional Sampling

In this mode the trigger variable is selected. The sectional trigger variable selected may be set to an extreme value, maximum or minimum, and sample of the other quantities is then taken at the moment such an extreme occurs in the phase line specified (see Figure 2.7).

Figure 2.7: Sampling triggered by maximum voltage



One of the following quantities can be selected as a trigger variable:

- voltage
- current
- power factor
- active single-phase power (input one only)
- active three-phase power (input one only)

If voltage, current or power factor is the sectional trigger variable, maximum or minimum value can be set as the record trigger event. If power is the trigger variable, only the moment of detecting maximum power value triggers sampling and recording the quantities.

Figure 2.7 shows an example of monitoring two three-phase inputs concurrently (power factor values are not shown). If the sectional sampling mode and maximum voltage trigger variable are set, the following values are recorded at the end of record interval (15:30):

1. maximum U1 value within the entire record interval, detected at 15:22, and I1 and cos1 values in inputs 1 and 2 at the same moment
2. maximum U2 value within the entire record interval, detected at 15:27, and I2 and cos2 values in inputs 1 and 2 at the same moment
3. maximum U3 value within the entire record interval, detected at 15:18, and I3 and cos3 values in inputs 1 and 2 at the same moment

The sectional sampling mode provides sampling of all quantities in each phase line (each input) at the same moment. Power in each single live line can thus be calculated from them. The moment of sampling may be different in each phase line, so the three-phase power may not be calculated.

If three-phase power is the trigger variable, all phase-specific quantities in each phase line (in all inputs) are sampled at the same moment and three-phase power can be calculated.

The phase-independent quantities, such as frequency, temperature or zero current, are not affected by the setting of sectional sampling and they are recorded independently, depending on their own settings. Neither is recording of average power affected by the setting of sectional sampling.

2.9.4.2 Rendering Average Power

If recording of average voltage, current, and power factor values is set, the instrument records average values of each quantity as expressed in the following formulae:

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

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

$$\cos\varphi_s = \frac{1}{n}\sum_{i=1}^{n} \cos\varphi i \qquad [-] \qquad [17]$$

where n is the number of samples taken within a record interval.

CETIS32 subsequently renders active power from the average values recorded in the way explained above, using the formula:

$$P_s = U_s \times I_s \times \cos\varphi_s = \left(\frac{1}{n}\sum_{i=1}^{n} Ui\right) \times \left(\frac{1}{n}\sum_{i=1}^{n} Ii\right) \times \left(\frac{1}{n}\sum_{i=1}^{n} \cos\varphi i\right) \qquad [18]$$

Mean active power is defined as follows:

$$P_s = \frac{1}{n}\sum_{i=1}^{n} Pi = \frac{1}{n}\sum_{i=1}^{n} (Ui * Ii * \cos\varphi i) \qquad [19]$$

It is obvious from the above shown formulae that equations [18] and [19] do not yield identical results; the difference increases in proportion to fluctuations in each value, U_i, I_i, $\cos\varphi_i$, measured. Identical result is only achieved if the U_i, I_i, $\cos\varphi_i$ values do not alter within a record interval.

Calculation of mean active power from mean values of voltage, current, and power factor can thus only be utilized to render informative values of power, provided each of the values, U_i, I_i, $\cos\varphi_i$, does not fluctuate with a record interval significantly. In order to evaluate mean power you have to set up the instrument to measure mean power, in which mode the above described error does not occur.

2.10 Troubleshooting

This chapter mentions some of the possible problems in instrument operation, their causes and remedies.

The instrument features a memory backed up with a battery. The memory stores mainly measurement data. System information required for proper operation is stored in the memory too. Although an advanced memory backup technology is used, corruption of data stored in the memory cannot be completely ruled out in exceptional events, with respect to difficult conditions in typical applications (enormous electromagnetic interference, lightning that hits line under measurement, etc.). Such a condition usually results in displaying error message “Memory Failure” on data download.
A condition may arise though, in which the instrument does not detect corrupted data and which results in unpredictable instrument behavior although there is no hardware problem. If you suspect your instrument is in this condition, you need to hard reset the instrument as described in a chapter further below.

1. Problem: The green LED does not start flashing on connecting power supply voltage.

   If neither LED turns on:

   - check power cable connection
   - check the fuse link inside the instrument (after disconnecting instrument and removing the bottom cover)

   If LEDs are on all the time:

   - check the power supply voltage value (you need at least 180 V AC)
   - if the problem persists even after disconnecting and reconnecting power supply voltage, hard reset the instrument (see further below)

2. Problem: The software shows the error message **No Response** on attempting to set up the instrument or to download the measurement data:

- check communication parameter settings (correct COM port, baud rate 9,600 Bd)
- check communication cable connection (correct COM port on PC) and instrument power supply connection
- check if a program is running on the PC that uses the COM port to communicate with the instrument (such as a modem) and eliminate it if necessary

3. Problem: The software shows the error message **Memory Failure xx, Please Reset** on downloading data from the instrument to PC:
   - set up the instrument and carry out a test (one-off) measurement – if the problem persists (or it reoccurs within one year), carry out the following:
     - disconnect the instrument, remove the top cover and check the memory backup battery voltage – if the voltage drops below about 2.5 V, the battery has to be replaced (see chapter Servicing)
4. Problem: The software shows the error message **No Records** on downloading data from the instrument to PC:
   - data recording was not enabled after setting up the instrument (the switch in front panel was not in REC ON position) for the time of at least two record intervals set
   - data recording timer was enabled in the instrument setup and the timer start time has not been yet reached (you can check this by reading in instrument setting)
5. Problem: The red LED is not flashing on enabling data recording (the switch in front panel in REC ON position) to indicate monitoring in progress:
   - After powering up the instrument, or enabling data recording (REC ON), the instrument first checks if some measurement data has been recorded. If so, it checks the time for which measurement data recording was disabled (or instrument was disconnected from power supply). It subsequently fills the memory space corresponding to such a time with the PWOff attribute, which means no data measured. The instrument stops measuring while checking the memory and the red LED is off. This operation may take just a few seconds, but up to several minutes, depending on the record interval setting and the time for which the measurement data recording was broken.
6. Problem: The green LED is flashing, but the red LED is on all the time, even when data recording is off:
   - The source of auxiliary voltage for current probes inside the instrument is overloaded. Identify the defective current probe by disconnecting the current probes connected one by one.
7. Problem: The power factor chart includes PWOff values although neither values of voltage nor values of current are PWOff concurrently:
   - the values of current, corresponding to the power factor values at issue, are below 5% of the nominal range (50 A with a metering current transformer of range 1,000 A), so the power factor can not be measured
   - the metering current transformers have not been connected to the live wires in the correct order, so the values of voltage do not correspond to the values of current correctly

2.10.1 Hard Reset

The instrument sets all system parameters to their default values on reset. All measurement data stored are deleted in this operation.

The instrument can be reset as follows:

1. Disconnect the instrument from power supply – for example by unplugging the power cord from power outlet.
2. Using a convenient sharp tool (such as the tip of a mechanical pencil or measurement cable) press and hold the INIT button. It is located in the instrument's back panel.
3. While holding down the INIT button, connect the instrument to power supply – for example by plugging the power cord in power outlet. The instrument tests whether the button is pressed for the duration of check interval about 2 seconds long indicating this operation with fast alternating flashing of both LEDs. When the check interval has elapsed, the instrument initializes itself and resumes regular operation. Warning: if the button is not pressed down properly for the entire check interval duration, the instrument stops testing itself and the initialization does not take place!

The instrument needs to be set up after initialization.

3. MAINTENANCE, SERVICING

3.1 Maintenance

SIMON Mains Monitor does not require any maintenance while in use. Only the specifications of its operating conditions need to be complied with and the instrument must not be exposed to harsh handling or water or chemicals that could cause mechanical damage to it.

SIMON features a T0.1A fuse, F1, that cuts out power to the instrument on incorrect connection of the U1 power supply input or other faulty condition. A spare fuse link is supplied with the product. It can be easily replaced after removing the instrument cover. Prior to removing the instrument cover, power must be disconnected from the instrument unconditionally!

The same applies to SIMON-Z Load Simulator. Its fuse is 6.3A.

There is further a T1.0A fuse, F2, in a SIMON-342FLEX2/DC. It disconnects the instrument on incorrect connection of the EXT PWR power supply input.

The Voltage Cable conductors are protected with 6.3A fuses that are capable of breaking currents up to 1,500 A and that are located within the enclosure housing the noise filter, which is part of the cable. These fuses should only break on emergencies. To replace them, the enclosure cover has to be removed by unscrewing it, of course with no voltage present.

The lithium battery installed, a VARTA 2/3 AA SLF, lasts about 8 years at average temperature 20 degrees centigrade and typical load current for a SIMON (under 10 μA). However, with respect to presumed severe operating conditions, battery replacement about every five years is recommended. If battery is low, you can send the instrument wiring board to the manufacturer with an order for battery replacement or solder the battery out and a new one (the same or compatible type) back in yourselves.

If battery or fuse link replacement is required, you have to open the instrument cover using a screwdriver. Prior to that, the instrument must be disconnected from power unconditionally!

To solder the old battery out and a new one in, you have to use a soldering iron with a tip replaceable independently of the heating element (not a soldering gun whose soldering tip is directly connected to its transformer secondary side) and observe rules for handling devices sensitive to electrostatic discharge while soldering.

3.2 Servicing

If the instrument shows malfunction, you need to return it to the manufacturer at the following address:

KMB systems , s.r.o.
Tř. dr. M. Horákové 559
460 06 LIBEREC 7
Czech Republic
phone +420 485 130 314, fax +420 482 739 957
e-mail: kmb@kmb.cz
website: www.kmb.cz

The product must be sent in proper package to prevent damage in transit. Description of the problem or its symptoms has to be enclosed.

If warranty repair is claimed, the warranty certificate must be sent in too. If out of warranty repair is required, a repair order must be attached.

4. TECHNICAL SPECIFICATIONS

General Parameters

power supply voltage	230V AC +15/-20%, 42÷80 Hz 10.5 to 30V DC *)
input power	maximum 5 VA
enclosure rating	IP 4X
operating temperature	0 to 45 °C
operating humidity	maximum 80% at 30 °C
class of overvoltage in installation	III in compliance with ČSN EN 61010-1
EMC – radiation	EN 55011 , class B EN 55022 , class A (product not suitable for residential environment)
EMC – resistance	EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-11
dimensions W x L x H [mm]	about 115 x 200 x 60
mass	about 0.8 kg

*) Note 1: applies to model SIMON-341FLEX2/DC with power supply via EXT PWR input

Measurement Ranges and Accuracies

Quantity	Range	Accuracy [% of range maximum]
voltage	175 to 265 Vef 10 to 115Vef **)	1.0
current	0 to 3 V or 0 to 0.1 V	1.0 *)
power factor	0.5 to 1 (C or L) 0 to 0.5 (C or L)	1.5 *) 4 *)
frequency	42 to 55 Hz 55 to 80 Hz	0,2 1.0
temperature	–20 to +40 °C –40 to +100 °C	± 1° ± 3°

*) Note 1: final measurement accuracy depends on converter used
**) Note 2: applies to model SIMON-341FLEX2/DC
Note 3: accuracies shown hold true after 20 minutes from powerup

5. CETIS32 Software for SIMON Mains Monitor

CETIS32, which runs under Microsoft Windows operating systems, allows to set all key parameters in a SIMON Mains Monitor and archive such settings. It further allows to record, visualize, and archive measurement data provided by the instrument.

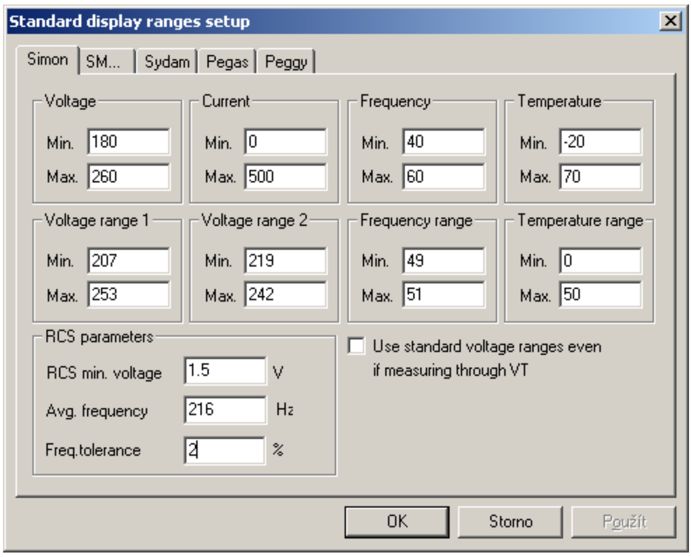
The following chapters explain how you carry that out. General principles of using CETIS32 are laid out in the software's user manual in the General Description section.

5.1 Setting up Program Parameters

You can standardize measurement ranges for each category of instrument in the software. Other items, especially those associated with printing of reports, can be specified besides the standard ranges.

Open the Standard Range Setup window by clicking *on Setup – Standard Ranges – Simon*. A window like in Figure 1 will open.

Figure 1: Range Setup



Specify default values for scale ranges in the Voltage, Current, Frequency, and Temperature groups. When transferring measurement data from the instrument to a Personal Computer, the scale ranges are adapted to these values and at the same time the setting is saved together with the graph created onto computer disk. These ranges are saved for good even if the graph is displayed repeatedly and the standard ranges have been changed.

When processing data from indirect measurement of voltage via a metering voltage transformer, the voltage axis scale is determined dynamically in accordance with maximum and minimum voltage values within the record processed. If a fixed voltage scale range is required for this measurement method, you have to check the *Use standard voltage ranges even if measuring through VT* option.

Zone limits can further be specified in this window. Zones are used for statistic evaluations in measurement reports (see chapter *Measurement Report*). Besides that, *Voltage Range 1* can be displayed using the appropriate button and thus utilized for quick visual examination of measurement data values from the point of view of compliance.

Limits to distinguish between proper and faulty ripple control telegrams can be specified in the Ripple Control Parameters group (see description of displaying ripple control telegrams).

The settings are saved onto disk on pressing the *OK* button and they remain in effect until changed again using the procedures described in this chapter.

5.2 Communication with Instrument

Generally speaking, the software can communicate with an instrument via different interfaces (RS-232 or RS-485 serial link, modem, PC card). Only an RS-232 interface can be used to communicate with a SIMON though. Type of interface and its parameters have to be set up prior to any communication with an instrument using the *Communication* item in the *Instrument Setup* window (detailed description in the CETIS32 user manual, the General Description section).

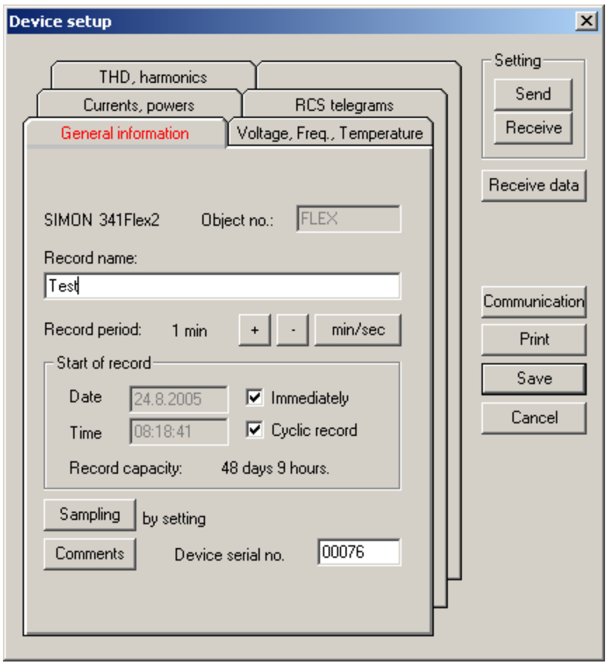
5.2.1 Communication with Instrument via Serial Link

To communicate via the RS-232 serial link, you need to connect the instrument to the computer using the Communication Cable supplied. The communication takes place through the COMx serial port selected in the *Communication* window at Baud rate 9,600 .

5.3 Instrument Setup

The instrument setting last saved on disk is displayed when opening the *Instrument Setup* window (Figure 2). If you want to view the current setting of the instrument connected, select *Receive Setting*.

Figure 2: Instrument Setup



The instrument parameters that can be changed are arranged in cards within the *Instrument Setup* window and if the window is open, parameters can be received from the instrument connected, edited, saved onto disk, and sent back to the instrument.

5.3.1 General Information

The *General Information* card (see Figure 2) shows:

- instrument model and serial number
- object reference number or name of the installation
- name of record (such as identification of transformer within the installation; a string of characters)
- record period
- memory operation settings
- length of record corresponding to measurement configuration and instrument memory capacity
- sampling mode
- comments to measurement data

You can enter the name of the transformer or power network node in the *Record Name* box. This name identifies measurement record together with the measurement beginning time stamp in a database on the evaluation computer's disk.

Record period can be specified in the range from 5 seconds to 60 minutes using the +, –, and *min/sec* buttons. If recording of maximum 3 voltages and 3 currents in input 1, while the other quantities are deselected, the record period can be set as short as 1 second.

If the *Immediately* checkbox is checked, the instrument will commence recording immediately on power up at REC ON switch position. If unchecked, recording will start on reaching the record start time set. The record start time can be specified in the appropriate box.

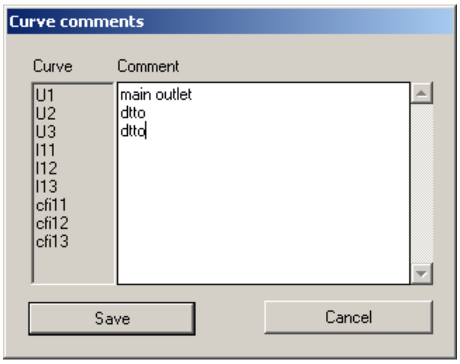
If the *Cyclic Record* checkbox is checked, the newest measurement values will overwrite the oldest measurement values in the instrument's memory on using up all its capacity. The instrument thus stores the latest measurement values of quantities selected and the length of record depends on the memory capacity. If unchecked, the instrument will stop recording on filling the memory with measurement data until the instrument is set up again.

The *Sampling* button selects the sampling mode out of the following choice:

- On Setting
- On Extreme Voltage
- On Extreme Current
- On Extreme Cosine
- On Maximum Active Single-Phase Power in Input 1
- On Maximum Active Three-Phase Power in Input 1

You can further open a window within this list where you can enter Comments to the measurement records (Figure 3). A comment up to 31 characters long can be entered for each quantity recorded. Using these comments, you can identify each record easily while viewing the screen or in printed reports.

Figure 3: Record comments

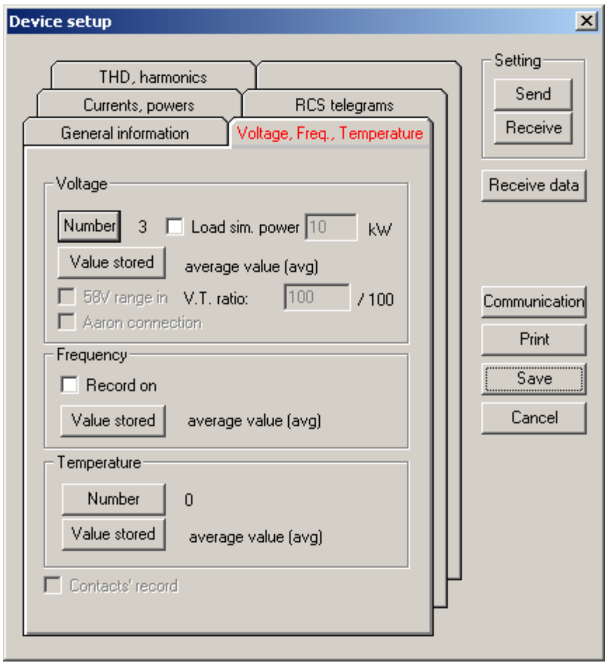


5.3.2 Voltage, Frequency, Temperature

In this card, you can specify the number and measurement method of the quantities shown above.

You can set the number of voltage signals desired in the *Voltage* group and select one of the modes of saving the measurement values with the *Value Stored* button. By checking the *Load Simulator* checkbox, you can set measuring the first voltage input selected with a SIMON-Z Load Simulator connected. The simulated power value has then be specified in kW within the *Load Simulator Power* box. You need to realize that the maximum rate of measuring voltage under simulated load is once a minute, so it does not make a sense to specify a shorter record period than one minute at this arrangement.

Figure 4: Setting up voltage, frequency, and temperature measurement



If you carry out measurement with an instrument that can switch voltage inputs, you have to use the *58V Range* checkbox to select measuring voltage either directly at 230/400 V_{eff} level by unchecking it or indirectly at high voltage level via a metering voltage transformer of nominal secondary voltage

57.7/100 V_{eff} by checking it. If checked for indirect measurement you have to also specify the metering voltage transformer ratio in the box next to the checkbox.

In the indirect measurement mode, a SIMON-341FLEX2/DC can also operate using the Aron Connection. In this configuration, recording of only up to two phase-to-phase voltages can be set up.

In the *Frequency* and *Temperature* groups, you can analogically specify measuring of these quantities.

You can specify recording contact positions with the *Contacts' Record* checkbox if the instrument has this feature.

5.3.3 Current, Power

In this card, you can set up measurement of currents, power factors and average power values in a way analogous to that for the previous card.

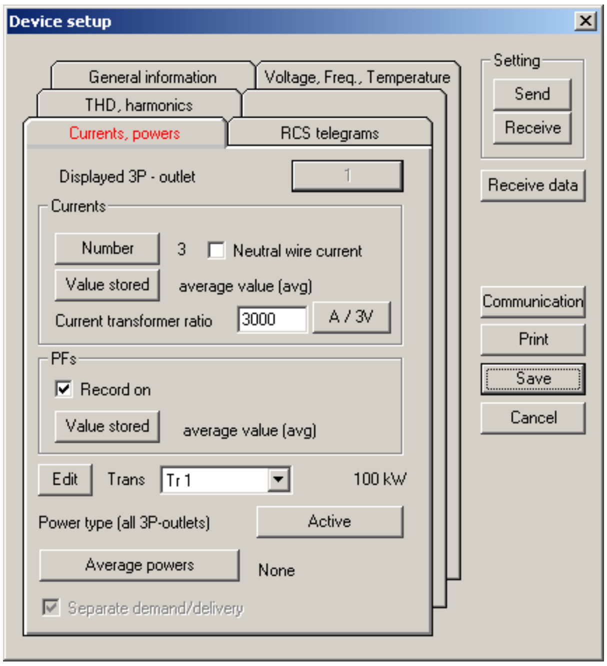
The instrument allows specifying the nominal input range to measure current. It should correspond to the output range of the current probe used, either 0.1V_{eff} or 3V_{eff}, and it is shared by all the phases in a current input. The nominal range selected also determines the maximum current value that the instrument will measure at specified accuracy. The instrument starts limiting the input signal on exceeding the maximum value by about 15%.

The 0.1 V range is to measure small currents, for example using a metering voltage transformer, such as Minipince 1 from Chauvin-Arnoux, which has transformation ratio 1A/1mV. Using one like this, the metering current transformer ratio has to be set to 100A/0.1V within the instrument setup procedure.

The 3V_{eff} range is mainly to measure currents using flexible current probes, such as LEMFlex/AmpFLEX. For instance, the AmpFLEX 0.2÷2K current probes have two switchable ranges, 1A/10mV and 1A/1mV. If measuring at the former range, you have to specify the metering current transformer ratio value 300A/3V within instrument setup. If measuring at the latter range (less sensitive), set the 3000A/3V ratio.

The other parameters to be set are identical to those of instruments in standard design.

Figure 5: Setting up currents and power



If Aron Connection is selected to measure with a SIMON-341FLEX2/DC, measuring of maximum three phase currents can be set up. It is not possible to measure each phase power either, so only recording average three-phase power of the entire input can be set up.

5.3.4 Ripple Control Telegrams

The SIMON-341 FLEX2 instrument are not enabled to receive ripple control messages.

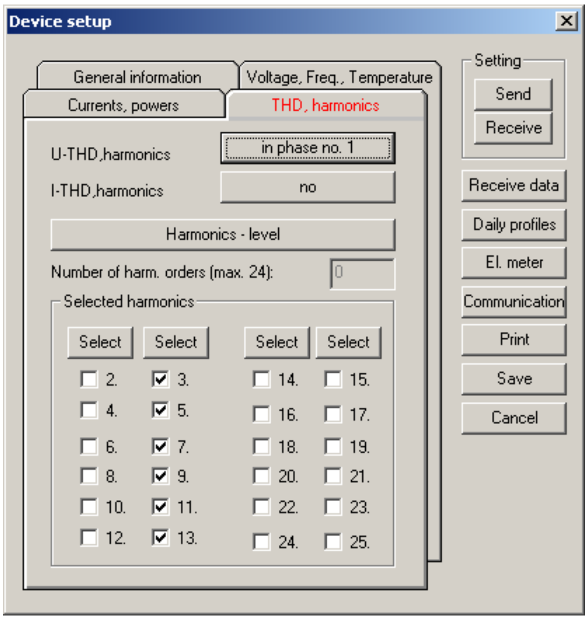
5.3.5 THD, Harmonics

In this card, you can set up recording total harmonic distortion and selected high-order harmonic components, separately for voltage and current signals. In either case, you can choose if you want to record THD and harmonic component values in the first live wire or all three live wires.

If you set to record THD and harmonic components, you can further specify how the harmonic components are to be recorded. One of the following modes can be selected.

- If *High-order Harmonic – Level* is selected, high-order harmonic components' levels are recorded as percentages of the basic harmonic component level; each harmonic component to be recorded is to be selected in the *Selected Harmonic Components* group (jointly for voltage and current).
- If *Maximum High-order Harmonic – Spectrum* is selected, the **orders** of the highest order harmonic components are recorded, sorted by their levels (level is not recorded); at the same time you need to specify how many highest order harmonic components (or their orders) are to be processed in the *Number of Harmonic Orders* box.

Figure 6: Setting up THD and high-order harmonic components



Levels of THD and harmonic components are always recorded as average values within record intervals set. With respect to the rate of evaluating THD and harmonic components (see the appropriate chapter above), it only makes a sense to set recording these values at intervals 20 seconds or longer.

5.4 Transferring Recorded Values to Computer

Start transfer of measurement data recorded in the instrument by selecting *Receive Data*. The data transferred are saved on disk and a new item is created in the record database. Each record is identified with the time of record beginning and name of record appended with a serial number.

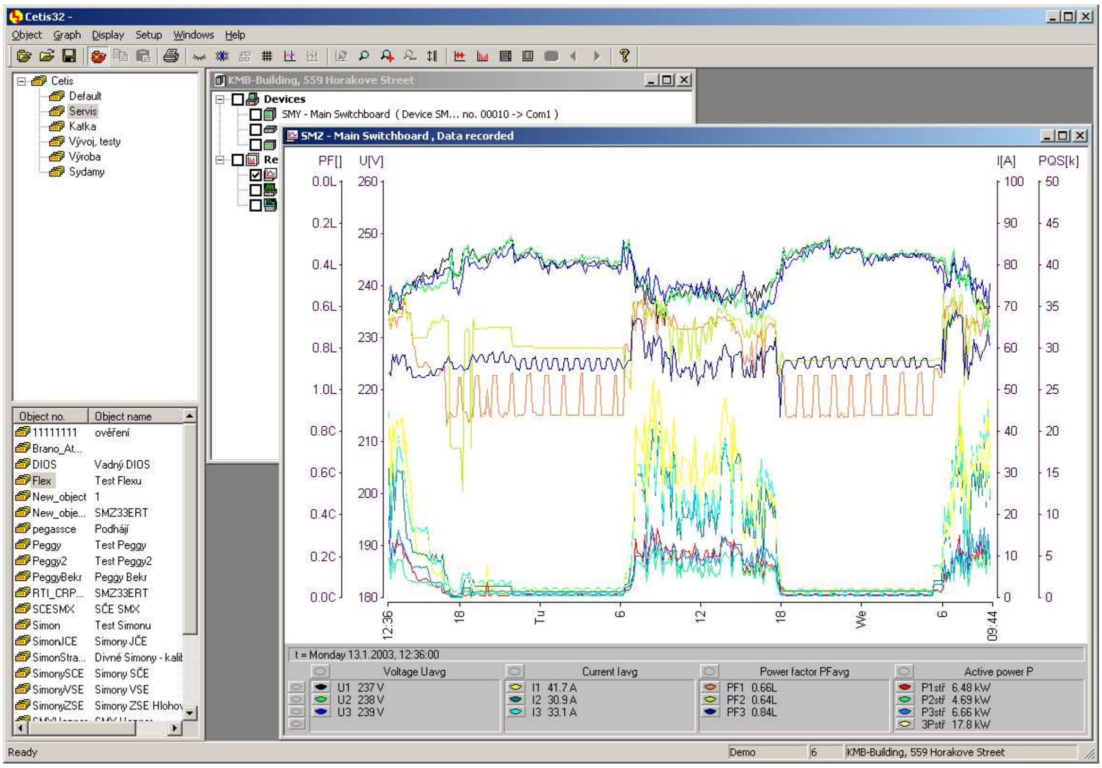
5.5 Using Records

Each record, saved in the corresponding installation's folder, can be viewed by double clicking on the record. A *Graph Window* pops up (see CETIS32 manual – General Description).

The graph proper takes up most of the window. Measurement data records of quantities selected are displayed in the graph as curves.

Each curve can be selected using a curve button in the panel of variables and hide or display them as required. Use the cursor to read values of each variable at specific points. The cursor is displayed in the graph window on pressing the appropriate button. You can move the cursor back and forth using your mouse or left and right arrow keys. The time displayed at the bottom of the graph window shows the current cursor position. The numeric information displayed in the panel of variables shows corresponding value of each variable shown in the graph at the current cursor position. The units of measurement for these variables can be found in the scales displayed to the left and right of the graph window.

Figure 7: Graph window – displaying measurement data



You can see how quantities within a panel of variables were sampled and recorded in the name of each panel of variables. These are identified using the following indices:

- avg - average value within a record interval
- max - maximum value within a record interval

- min - minimum value within a record interval
- o - instantaneous value at the end of a record
- (t) - instantaneous value at the moment of sectional extreme trigger variable (see description of sampling modes)

Tools at the top can be used with the curves displayed. Their meanings are expressed by graphic symbols and they are explained in CETIS32 User Manual – General Description section.

5.5.1 Measurement Report

Besides the graphic chart you can also view or print a measurement report. The report contains the most important statistic information about the measurement in the numeric form. Minimum, maximum, and average values of voltage in each phase over the measurement period, the time outside zone limits set under the *Setup – Standard Ranges* menu item, as a percentage, information about transformer load with respect to nominal current, etc., are shown in the report. The column identified as Total shows average value of each phase quantity (this information is not used for some of the variables, such as Uz).

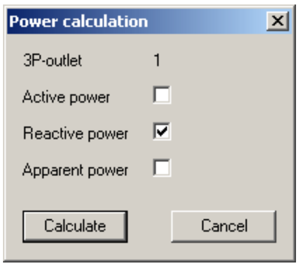
5.5.2 Export of Values to DBF File

Export of values displayed to a DBF file converts each value into its corresponding numeric representation. Inductive character power factor values are converted into positive numbers, capacitive character power factor values are converted into negative numbers.

5.5.3 Rendering Power

If the measurement data include voltage, current, and power factor, the active, reactive, and apparent single-phase or three-phase power in each input measured can be rendered. On selecting this operation, the *Power Calculation* window is displayed; see Figure 8.

Figure 8: Rendering power



Depending on which power you want to have rendered, check the appropriate checkboxes. Afterwards press the *Calculate* button. When the calculation has been completed, the power values rendered show up in the graph together with a power scale (in kW, kVAr or kVA). If power values are not displayed in the graph, 4 other panels are probably already displayed which prevents more curves from being included. Therefore first clear some of the panels displayed and then add a panel with the power values rendered (see CETIS32 User Manual – General Description).

While using the power values rendered, you need to realize which values of voltage, current, and power factor the power values have been calculated from to interpret them correctly (see chapter *Methods of Measuring and Rendering Quantities – Rendering Power*).

5.5.4 Using Values Measured Under Load (with SIMON-Z Load Simulator)

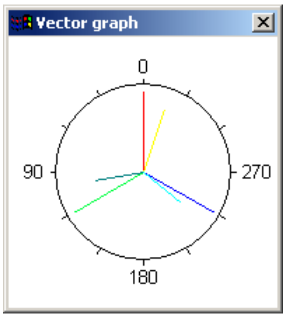
If the graph has a Uz voltage curve from a SIMON-Z Load Simulator measurement, you can convert the Uz measurement data values to a load other than 5 or 10 kW from the measurement. The *Graph –*

Powers – Recalculate Load operation is available for this. On selecting it, the *Load Value Change* window pops up where you need to enter the load value to which you want to have the load data converted. The range of values that can be entered is from 1 to 250 kW. The default load value displayed on opening the window is that of the load corresponding to the data displayed in the graph at the moment of opening the window. You can thus use this operation also to find out about the theoretical load value in effect for the data shown currently in the graph.

5.5.5 Phasor Diagrams

To assess characteristics of load in a three-phase power system, a graphic representation of current phasors for each phase current and corresponding (rendered) zero current in polar coordinates can be useful. On selecting this item, the *Vector Graph* window opens; see Figure 9.

Figure 9: Phasor diagram



While moving the cursor along the time axis, you can view the current phasor position for each phase current shown in yellow and the phasor for the zero current rendered shown in red. The numeric value of the zero current render and its angle against the U1 voltage phasor are shown in the window as well. The angle value is shown in the interval between –180 and +180 degrees.

The *Vector Graph* window can be hidden using the same procedure – the command item has a toggle action.