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Operating Manual for

POWER ANALYSER & METER
SMY 133

Complete version 2.0

The complete and most actual version of this manual is available online at http://www.KMB.cz/

Contents

1 General Description

The SMY 133 is specially designed for monitoring of energy and power quality in advanced power systems and smart grids. The instrument is designed for installation to the panel. Its graphical display presents advanced information locally without the necessity to use PC. It is suitable for a wide spectrum of automation tasks in modern buildings and industrial plants as well as for power generation and transmission systems. For advanced protection, the configuration of SMY 133 can be locked by a pin.

It is equipped with three voltage inputs and three current inputs. The default option X/5A uses common X/5A or X/1A current transformers.

Warning ! The X/100mA, X/333 mV options is specially designed to be used only in combination with provided external through-hole or clamp-on current sensors.

1.1 Version 2.0 improvements

- advanced calibration and higher precision
- optional six-quadrant meter - differentiates reactive energy through the direction of active power flow.
- improved, more precise and continuous measurement of harmonic phasors (amplitude, phase)
- advanced time synchronization options: NMEA, PPS, PPM, power frequency lock
- special rugged current inputs X/100 mA
- new option for current transformers and flex probes with 333 mV output
- modular firmware - Power Quality, ModBus Master, Ethernet-Serial (only for instruments, which have booth interfaces) and General Oscillogram modules
- *PQ module*: power quality analysis according to EN 50160 ed. 3.
  - voltage and current measurement class S according to IEC 61000-4-30 ed. 3
  - inter-harmonics (IEC 61000-4-30 ed. 3, 61000-4-7 ed. 2)
  - flicker severity indices (P_{inst}, P_{st} a P_{lt} class F3 as defined in IEC 61000-4-15 ed. 2)
  - voltage interruptions, dips and swells
- *RCS module*: measurement, analysis and recording of the mains signaling voltage signals

1.2 Characteristic features

Connection and Measurement

- three measuring voltage inputs (L_1, L_2, L_3) towards input N
- three inputs current sensors (I_1, I_2, I_3)
- current input options
  - X/5A and X/1A: standard CT with secondary nominal 5 A resp. 1A.
  -

- option X/100mA for indirect measurement with special curerent transformers (nominal secondary current up to 100 mA)
- optional X/333mV current inputs for split core CTs or flex-probes (RCTs) with nominal output 0.333 V. Aux. supply 5 V for RCT also available.
- option NOCT measures only voltages, does not have any current inputs. It is possible to use it as a smart transducer and relay, with memory, to analyse frequency, voltage, harmonics, unbalance and voltage quality (with PQ module).

- one digital input 24V
- 2x relay or impulse output (option RR, RI or II)
- features can be upgraded via external I/O modules (with ModBus Master module)
- power supply:
  - option U: $75 \div 275\, V_{AC}$ or $85 \div 350\, V_{DC}$
  - option L: $24 \div 48\, V_{AC}$ or $20 \div 75\, V_{DC}$
  - option S: $12 \div 24\, V_{AC}$ or $9 \div 36\, V_{DC}$
- 128 samples per period, voltage and current inputs are read continuously without any gaps
- 50 voltage and current harmonics
- evaluation of all usual three-phase and single-phase quantities such as powers (active, reactive, apparent, distortion, fundamental), power factors, harmonics and THD of voltages and currents etc.

Registration of Measured Data

- built-in real-time clock with battery backup
- flash memory to record the measured data with a capacity of 512 MB
- aggregation interval from 200 milliseconds to 24 hours
- records voltage outages

Transfer and Evaluation of Recorded Data

- ENVIS software suite available free of charge for configuration and data analysis
- system service ENVIS.Online for live data recording.
- USB interface for data transmission, device configuration and firmware upgrade
- can be equipped with Ethernet (option E), RS-485 serial line (option 4), USB.

Supported Firmware Modules

- Power Quality (PQ) — extends the measured quantities for inter-harmonics, flicker and selective voltmeter, archive options for PQ main and PQ events archive, so as that the instrument can serve as a fully compatible PQI-S - class S power quality analyzer.
- General Oscillogram (GO) — Adds a feature that allows recording of raw signal samples.
- Ripple Control Signal (RCS) — Allows archiving of ripple control signals (RCS, HDO) data-grams and theirs voltage levels.

1.3 Types and accessories

The SMY 133 is available in several configurations according to the customer requirements[1]. See the ordering scheme on figure 1.

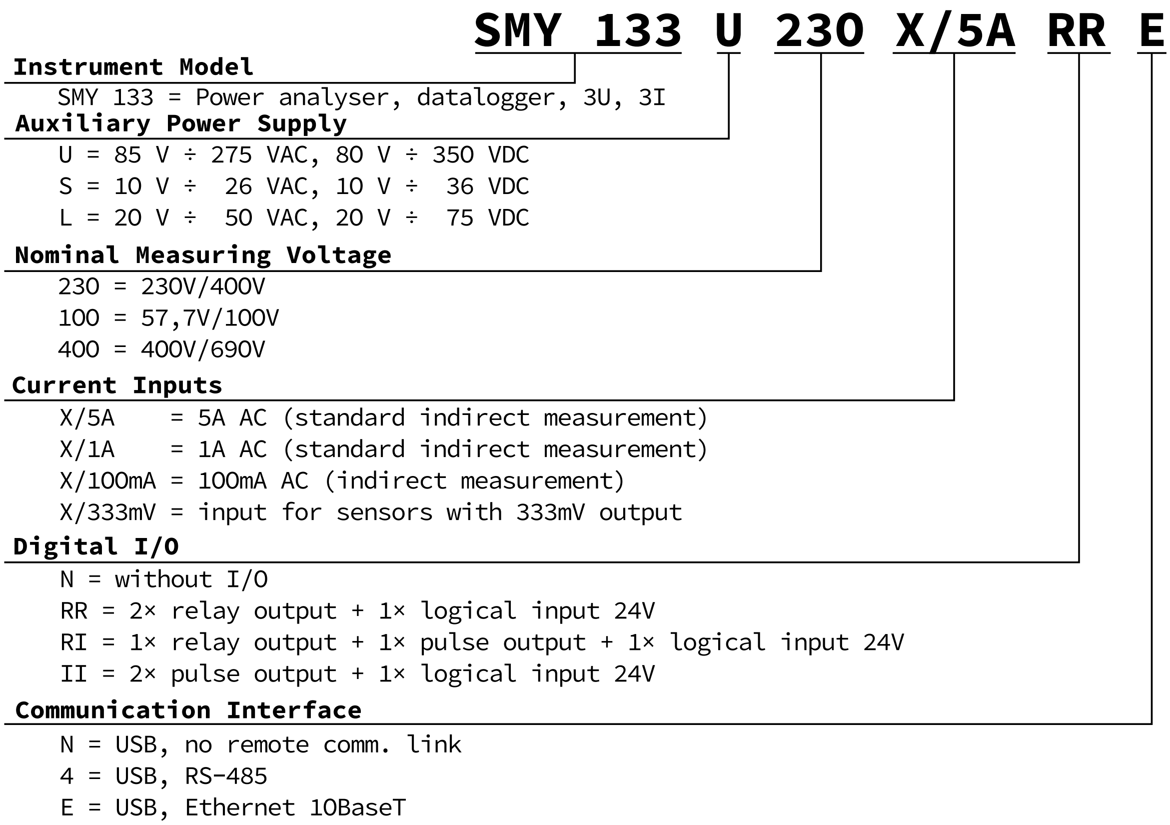


Figure 1: Schematics of the SMY 133 ordering options and variants. It includes special codes for proper current and voltage rating options.

[1] Complete and most up to date list of optional and other accessories are available on request from the device vendor.

Table 1: Selected parameters for **option X/100mA** for indirect measurement with special types of supplied 100mA CTs. See chapter 2.2.3.

Split-Core Model	Inom [A]	d [mm]	Connection	Dimmension [mm]	Overvoltage Category
JS17F – Inom/100mA	050, 100 125, 150	17	Terminal	64×33×34	600V CAT III
JS17S – Inom/100mA	200	17	Terminal	64×33×34	600V CAT III
JS24F – Inom/100mA	200	24	Terminal	75×45×34	600V CAT III
JS24S – Inom/100mA	250, 300	24	Terminal	75×45×34	600V CAT III
JS36S – Inom/100mA	300, 400 500, 600	36	Terminal	91×57×40	600V CAT III
JSC-01 – Inom/100mA	250, 400	38×32	Wire	93×92×39	600V CAT III
JSC-02 – Inom/100mA	400, 600, 800 1000, 1200	73×62	Wire	128×124×39	600V CAT III
JSC-03 – Inom/100mA	800, 1000, 1200 1600, 2000, 2400	141×62	Wire	196×124×39	600V CAT III

Table 2: Selected parameters for **option X/333 mV** for indirect measurement with special types of supplied CTs with nominal output voltage 0.333 V. See chapter 2.2.3.

Split-Core Model	Inom [A]	d [mm]	Connection	Dimmension [mm]	Overvoltage Category
JS17F – Inom/333mV	050, 100 125, 150	17	Terminal	64×33×34	600V CAT III
JS17S – Inom/333mV	200	17	Terminal	64×33×34	600V CAT III
JS24F – Inom/333mV	200	24	Terminal	75×45×34	600V CAT III
JS24S – Inom/333mV	250, 300	24	Terminal	75×45×34	600V CAT III
JS36S – Inom/333mV	300, 400 500, 600	36	Terminal	91×57×40	600V CAT III
JSC-01 – Inom/333mV	250, 400	38×32	Wire	93×92×39	600V CAT III
JSC-02 – Inom/333mV	400, 600, 800 1000, 1200	73×62	Wire	128×124×39	600V CAT III
JSC-03 – Inom/333mV	800, 1000, 1200 1600, 2000, 2400	141×62	Wire	196×124×39	600V CAT III

Table 3: Parameters for **option X/333 mV** for indirect measurement with special types of supplied flexible probes (RCT) with nominal output voltage 0.333 V. See chapter 2.2.3.

Rogowski Coil Model	Inom [A]	d [mm]	Connection	Aux. Supply	Overvoltage Category
JRF MOI 333M-40 Inom	100, 150, 200, 250 300, 400, 500, 600 800, 1000, 1200 1500, 2000, 2400	40	Wire	5VDC 15mA max	600V CAT IV
JRF MOI 333M-80 Inom		80	Wire		600V CAT IV
JRF MOI 333M-115 Inom		115	Wire		600V CAT IV

2 Operating the Meter

2.1 Safety requirements when using SMY 133

Warning ! When working with the instrument it is necessary to perform all necessary measures for the protection of persons and property against injury and electric shock.

- The device must be operated by a person with all required qualifications for such work and this person must know in detail the operation principles of the equipment listed in this description!
- When the device is being connected to the parts which are under dangerous voltage it is necessary to comply with all the necessary measures to protect users and equipment against injury with electrical shock.
- Person, performing the installation or maintenance of the instrument must be equipped with and must use personal protective clothing and tools.
- If the analyzer is used in a manner not specified by the manufacturer, the protection provided by the analyzer may be impaired.
- If the analyzer or its accessories appear to be impaired or not functioning properly, do not use it and send it in for repair.

2.2 Installation of the instrument

The SMY 133 instrument is built in a plastic box to be installed in a distribution board panel. It's position must be fixed with the provided locks. Natural air circulation should be provided inside the distribution board cabinet, and in the instrument's neighborhood, especially underneath the instrument. No other instrumentation that is source of heat should be installed or the temperature value measured may be false.

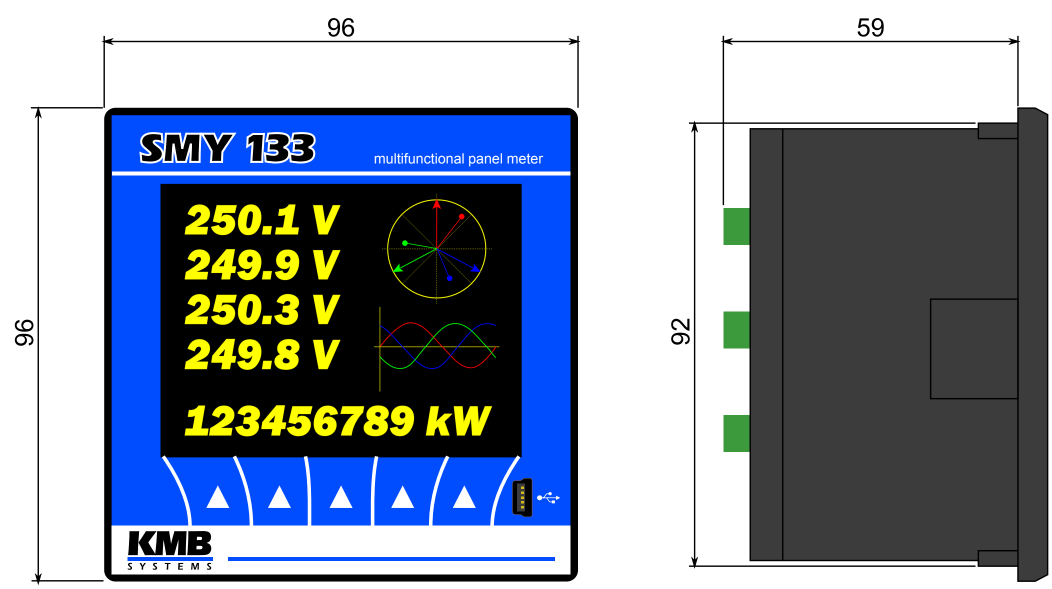
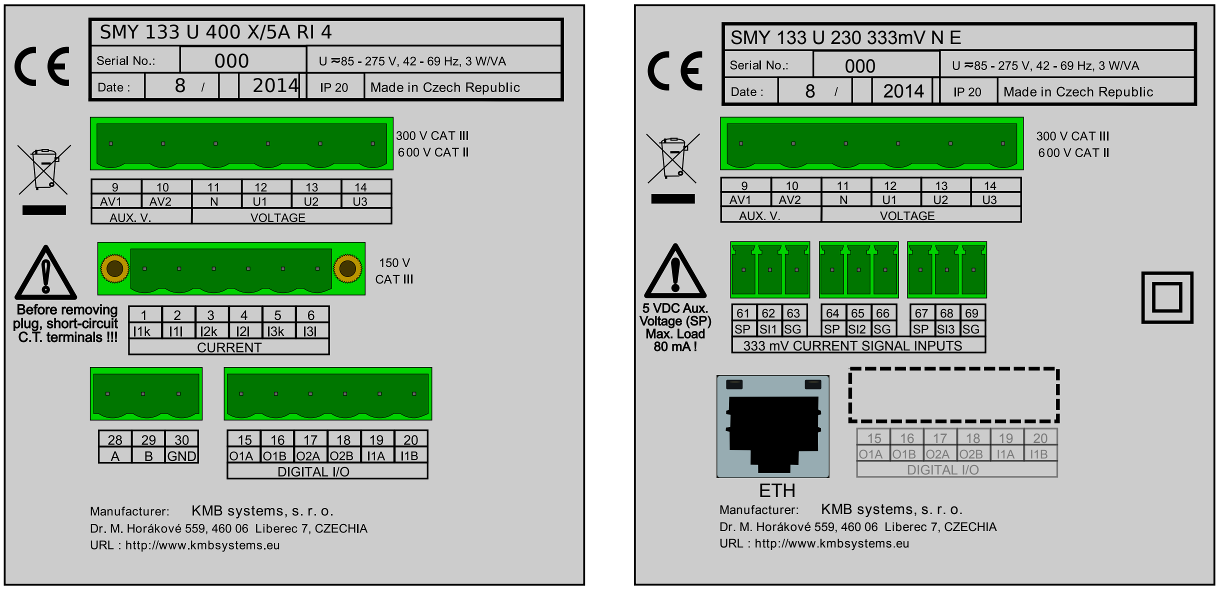


Figure 2: Dimensions of the SMY 133 .



(a) terminals for RS485 serial line communication (option 4) and a digital input with two relay or solid state outputs (options RR, RI or II).

(b) option for current CTs or flexible probes with X/333 mV output, RJ-45 connector for Ethernet (option E), without inputs and outputs (option N in I/O).

Obrázek 3: Back side of the SMY 133 with terminals for serial line, I/O and Ethernet options.

2.2.1 Supply voltage

The supply voltage (according to the technical specifications and the instrument type) connects to terminals AV1 (no. 9) and AV2 (no. 10) via a disconnecting device (switch – see the wiring diagram fig. 16b, fig. 16c). It must be located at the instrument's proximity and easily accessible by the operator. The disconnecting device must be marked as such. A circuit breaker for nominal current of 1 Amp of the required rating makes a suitable disconnecting device. Its function and working positions must be clearly marked (symbols 'O' and 'I' according to IEC EN 61010-1).

2.2.2 Measured voltage

The measured phase voltages are connected to terminals U1 (no. 12), U2 (no. 13), U3 (no. 14). The common terminal to connect the neutral wire is identified as N (no. 11; it remains unused with delta and Aron connections).

It is suitable to protect the voltage lines measured for example with 1A fuses of the required rating. Measured voltages can also be connected via instrument voltage transformers. A connection cable maximum cross section area is $2.5\,mm^2$.

2.2.3 Measured currents

The instruments are designed for indirect current measurement via external CT only. Proper current signal polarity (k, l terminals) must be observed. You can check the polarity by the sign of phase active powers on the instrument display (in case of energy transfer direction is known, of course). Terminals I2k, I2l are not used in case of the Aron connection.

X/5A current input option The current signals from 5A or 1A instrument current transformers must be connected to the terminal pairs I1k, I1l, I2k, I2l, I3k, I3l (No. 1 ÷ 6). A connection cable maximum cross section area is $2.5\,mm^2$.

X/100mA current input option The supplied current transformers (which are standard accessory) must be clamped on measured wires and interconnected with corresponding terminal pairs I1k, I1l, I2k, I2l, I3k, I3l (no. 41 ÷ 46) using a twisted-pair cable of maximum length of 3 m.

Warning !: Connection of other current to an instrument is strictly forbidden !!! The instrument can be seriously damaged by using unsupported 3rd party CTs!

The secondary winding of the split-core transformers is led to the screw terminals. The „K“/„L“ and „k“/„l“ orientation is marked on the CT guide groove. A connection cable maximum cross section area is $1.5\,mm^2$.

X/333 mV current input option (333mV CT or RCT only) these instruments are supplied with separate terminal connector for each current input. The current transformers with nominal output voltage 333 mV must be clamped on measured wires and interconnected with corresponding terminal pairs using a twisted-pair cable of maximum length of 3 m. Again, proper current signal polarity (k and l terminals) must be observed.

Connection of the current inputs with X/333mV option is shown in fig. 5: terminals SI1, SI2 and SI3 (nr. 62, 65 and 68) are input signals corresponding to currents I1, I2 and I3 (terminal "k" of the measuring CT or white wire of the RCT). SG terminals (nr. 63, 66 and 69) are a common pole for signals I1, I2 and I3 (terminal "l" of the measuring CT or black wire of the RCT) and also a negative pole of the internal 5V auxiliary voltage supply. These terminals are internally interconnected. SP terminals (nr. 61, 64 and 67) are the positive pole of the internal 5V auxiliary voltage supply for the connected RCT sensors.

Warning !: Connection of unsupported type of current transformer such as the common type with 5A or 1A secondary to an 333mV option instrument is strictly forbidden! The instrument can be seriously damaged!

Warning !: Do not connect the current input signals of the 333mV option with neither ground nor other potential ! Otherwise, measurement accuracy can be affected or the instrument can be damaged!

The flexible current sensors with embedded integrator usually require a power supply. For such purpose the instruments are equipped with auxiliary power supply 5V. Maximum load of each sensor connected is 20 mA.

2.2.4 Communication peripherals

USB communication port for USB slave is located on the front panel in its bottom-right corner. This communication port is intended for easy local configuration and fast download of archived data to the local PC. Use the supplied USB cable only. SMY 133 is a USB slave device. For correct operation it needs a driver installed in your operating system (see the ENVIS user guide for more info).

Ethernet interface (optional) 10Base-T Ethernet interface with RJ-45 connector described *ETH* is situated on a back side (terminal panel) of the device. Ethernet interface can be used as substitution for the primary RS-485 for connection of the device to LAN and for easy connection of remote control PC.

RS-485 Serial Line serves usually as a remote communication for reading of actual data, archive downloading and device configuration. Serial RS-485 line uses terminals A, B and GND (no. 28, 29 and 30 on fig. 3a and 8). The final points of the communication line must be properly terminated with resistance.

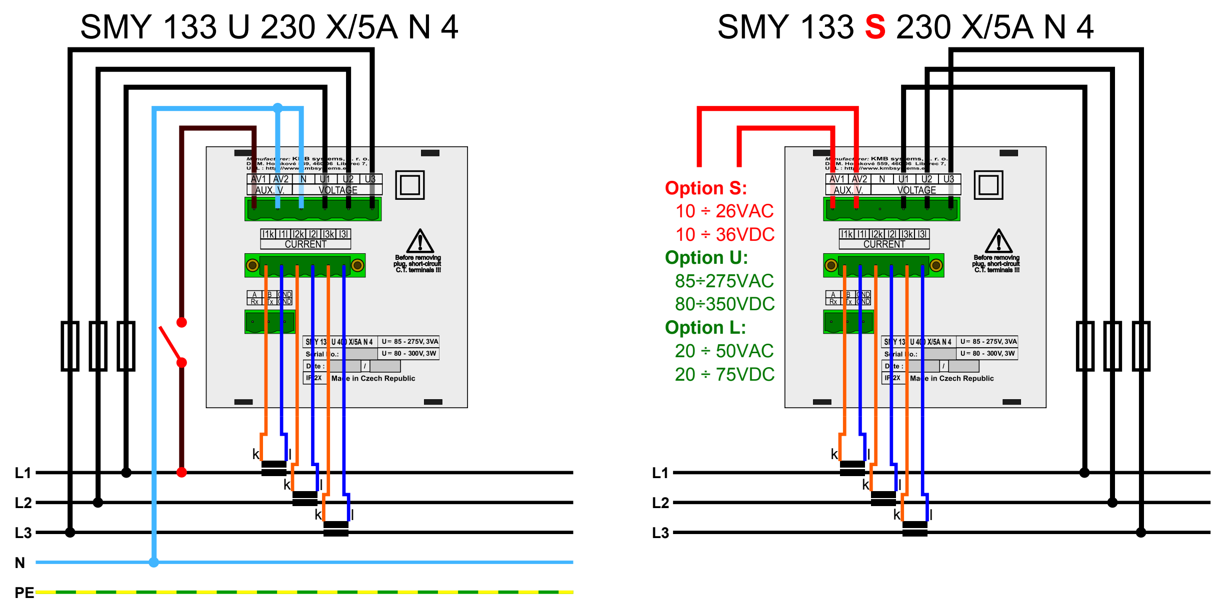


Figure 4: An example of typical installation of SMY 133 instrument in a low voltage network — option U (left) with power supplied from the measured channel in a star connection and option S (right) with low voltage DC power supply, measurement connected as delta connection — based on the power supply option various AC and DC power supplies can be used including battery backed UPC etc.

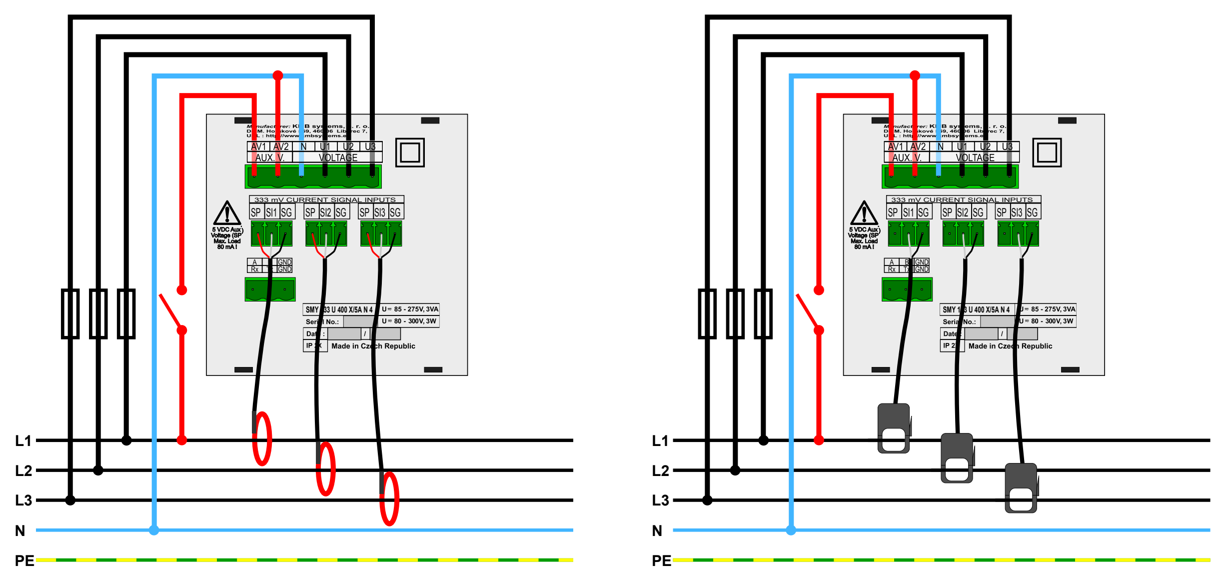


Figure 5: Typical installation of a X/333mV option of SMY 133 instrument in a low voltage network with power supplied independently. Three RCTs (flexible rogowski probes) powered from the instruments internal power supply (left) or split core current transformers with secondary output 333mV (right).

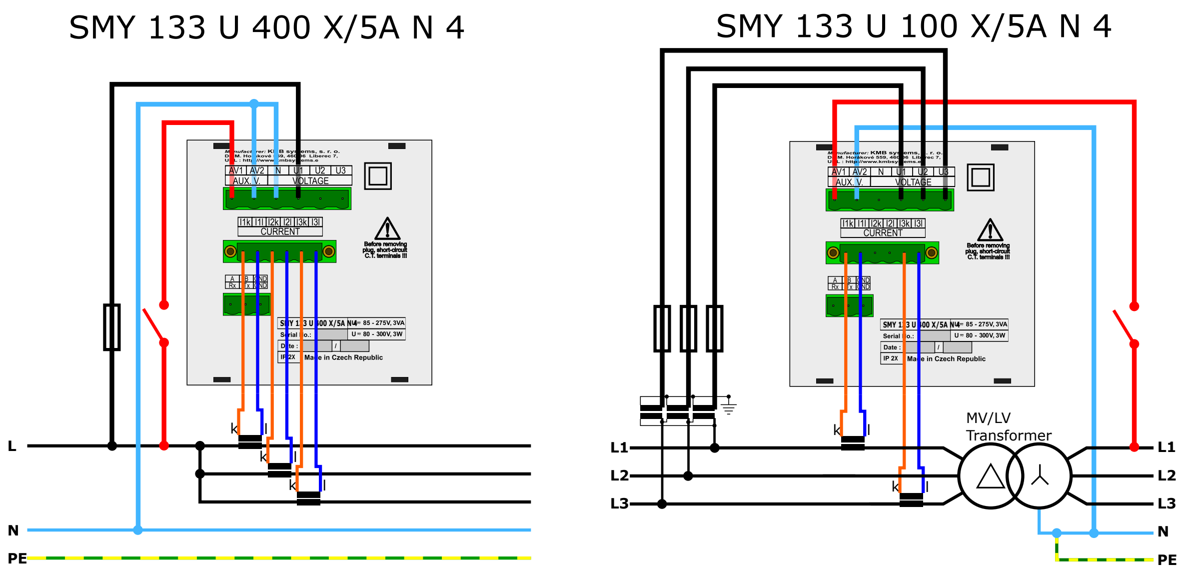


Figure 6: Special cases of connection for SMY 133 instrument: single phase three wire connection in LV network and Aron connection commonly used in MV and HV network. .

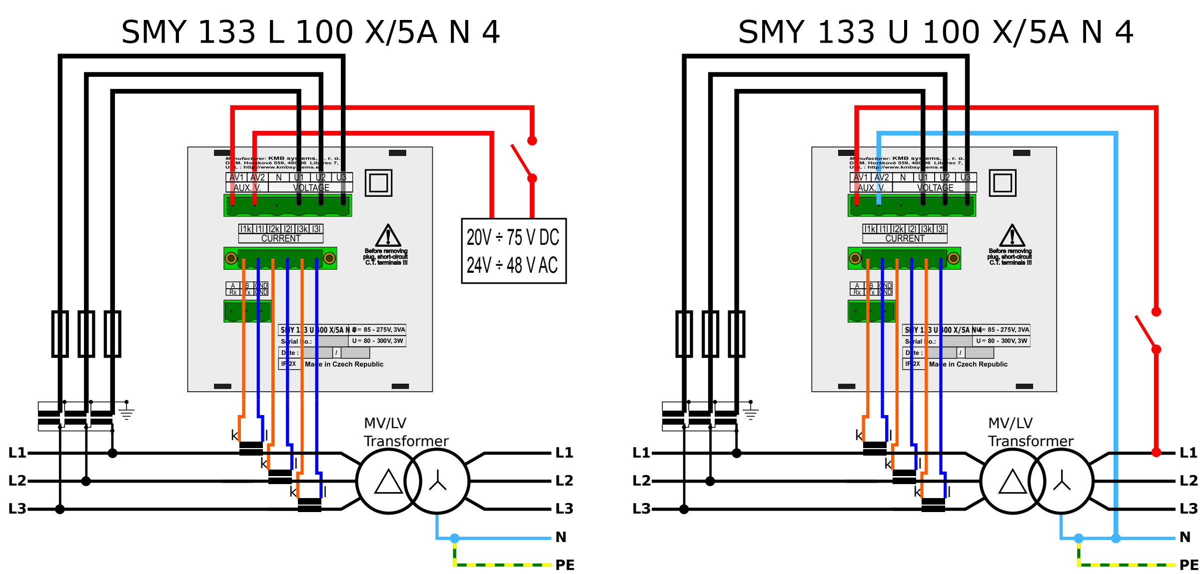


Figure 7: Example of typical connection of SMY 133 in MV or HV network with indirect measurement via voltage transformers. Option L on left side is supplied from a backup power supply. Option U on the right side is supplied from L1 of the LV network.

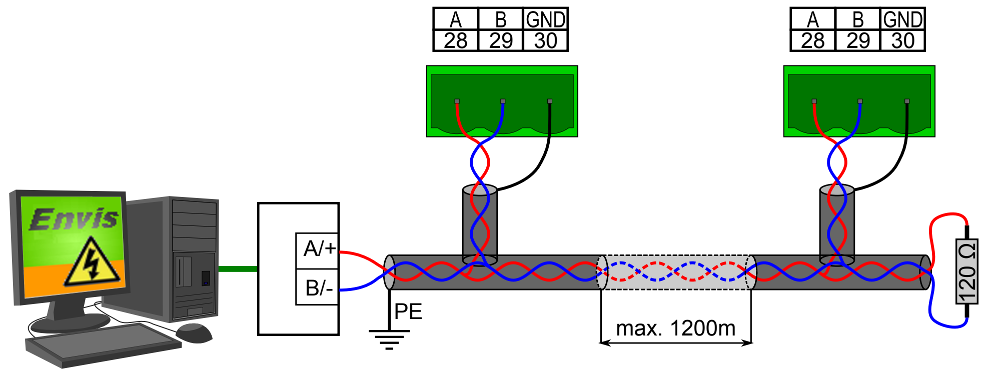


Figure 8: Typical wiring of the RS-485 communication line terminals in SMY 133 .

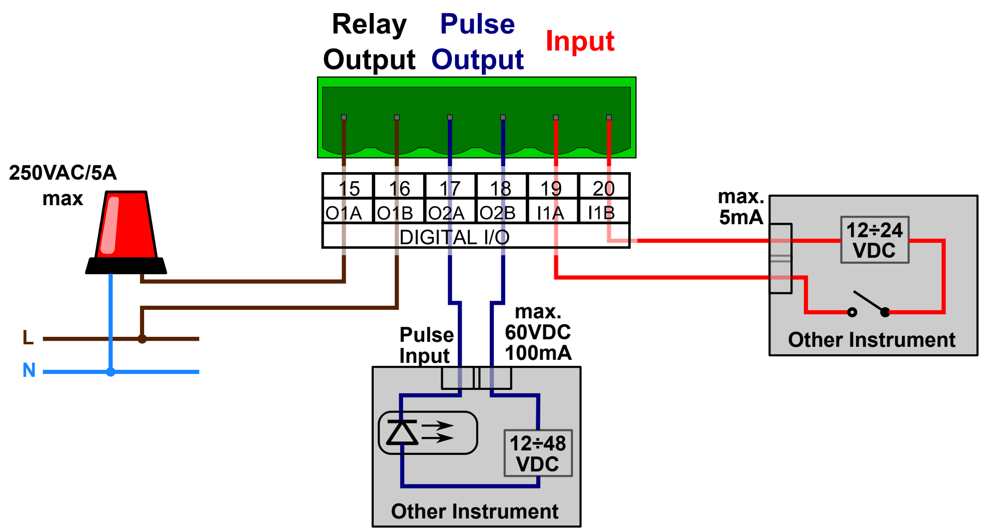


Figure 9: An example of wiring connection for inputs and outputs in SMY 133 .

2.2.5 Outputs and inputs

Instruments can be equipped with optional outputs and inputs. Two digital outputs DO1, DO2 (electromechanical relay or solid-state according to the option), one digital input DI1 and two virtual programmable alarms A1 and A2 are available in the instrument. Outputs are connected to the terminal no. 15 to 18 on the rear panel of an instrument. Input signal can be connected to terminal nr. 19 and 20. A cable maximum cross section area is 2.5 mm^2. Both inputs and outputs are isolated from the instrument internal circuits as well as between each other.

Digital outputs DO1 and DO2 (optional with RR, RI and II) can be configured to generate pulses from an electricity meter or other quantity, as a simple programmable two-position controller or as a remote application controlled output.

Relay output (R) (SPST-NO: single-pole, single-throw, normally open relay) is used. Maximum allowable voltage and load current according to the technical specifications must be fulfilled.

Impulse output (I) is accomplished by a semiconductor switching device. It is assumed that the input opto-couplers of the external recording or control system will be connected to these outputs via proper current–limiting resistors. The signal polarity is not significant to the device.

Digital Input DI1 (optional with RR, RI and II) state is indicated on display and in remote software. Connect a voltage signal of appropriate magnitude to the the DI1 terminals. The signal polarity is not significant to the device. If the voltage exceeds declared level, the input is activated and the symbol is displayed. Usual 12 or 24 V DC/AC signals can be connected directly. If you need to connect a voltage signal of magnitude exceeding maximum digital input voltage, an external limiting resistor of appropriate rating must be used.

2.3 Lock/unlock the instrument

From the manufacturer the instrument is shipped in an unlocked state. It is however possible to lock the instrument so as to prevent any unwanted modifications of its configuration by aliens.

2.3.1 Locking the instrument

1. press the button ③ in the default start screen
2. choose lock/unlock symbol with buttons ④ and ⑤. Unlocked instrument presents open lock symbol.
3. press button ③ and enter the locking/unlocking sub-menu of the instrument. It displays *Unlocked:* ✖
4. press ③ and choose lock option. Symbols ✔ and ✖ will be displayed
5. chose requested new state (✔...locked) by pressing ④ and ⑤
6. confirm your selection with pressing button ③
7. leave the locking screen by pressing button ①
8. press button ② and confirm locking of the instrument. Your SMY 133 is now locked and all local modifications of configuration are not allowed.

2.3.2 Unlocking the instrument

1. press button ③ in the default start screen
2. choose lock/unlock symbol with buttons ④ and ⑤. Locked instrument presents closed lock symbol
3. press button ③ and enter the locking/unlocking sub-menu of the instrument. It displays *Locked:* ✔
4. press ③ and choose lock option. PIN code entry field will be displayed on locked instruments
5. enter the PIN code (instrument serial number) by pressing buttons ②, ④ and ⑤
6. press button ③ to confirm the choice
7. leave the locking menu with button ①
8. press button ② and confirm locking of the instrument. Your SMY 133 is now unlocked and all local modifications are allowed.

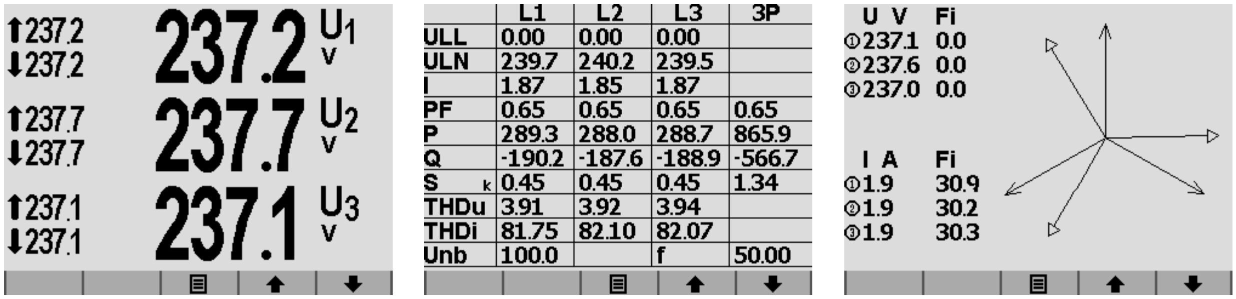
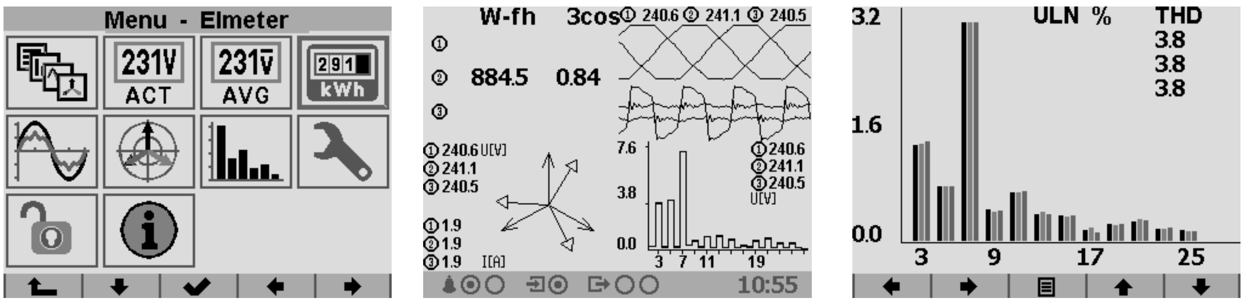


Figure 10: Screen of the SMY 133 : button ① - without function, ② - without function, ③ - menu, ④ - up arrow rotates displayed screens, ⑤ - down arrow rotates displayed screen. Default start-up screen is on the left.



(a) Main menu of the instrument.

(b) Special user defined split screen displays data compacted.

(c) Graphical display of the measured harmonics (here phase voltage).

Figure 11: Examples of different actual data displayed on screen of the SMY 133 instrument.

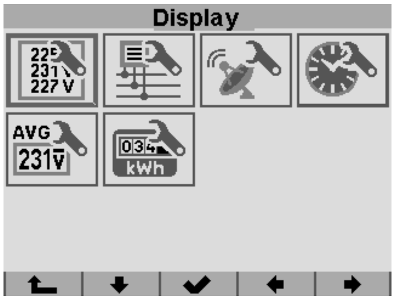
2.4 Basic instrument setup (on screen)

To navigate the screen and to configure the SMY 133 instrument locally there is 5 multifunction buttons located under the display area. its actual function is dynamic and is symbolized by a pictogram on the lower edge of the screen above each button (fig. 10). For intention of use in this manual we are referring to these buttons as button ① to ⑤ from left to right.

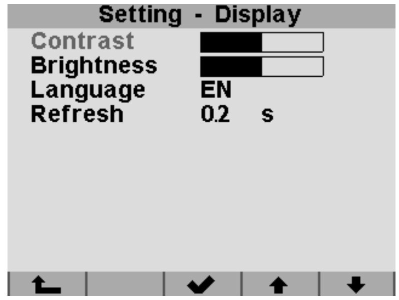
In general buttons ④ and ⑤ are navigational buttons. Button ③ is alternating *Confirm* function and *Return to main menu* function. Buttons ① and ② are either without function or they provide navigation and other functions in the context of each screen.

2.4.1 Installation type and options

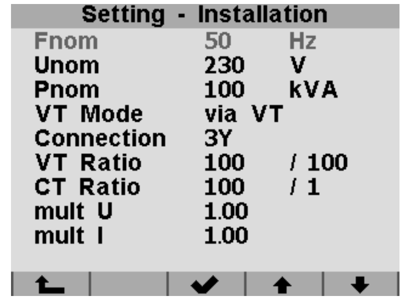
1. turn on the instrument and wait until it boots up. Start-up screen will be displayed (fig. 10).
2. press button ③ - main menu is displayed (fig. 11a). Buttons ②, ④ a ⑤ navigate selection cursor in this screen. Button ③ picks the highlighted menu item. Button ① returns back in the menu level.
3. press multiple times button ⑤ and choose settings symbol - green french key.
4. press button ③. Configuration screen will be displayed (fig. 12a)
5. press multiple times button ⑤ and select *Install Config* item.
6. press button ③. *Install Config* screen is displayed.



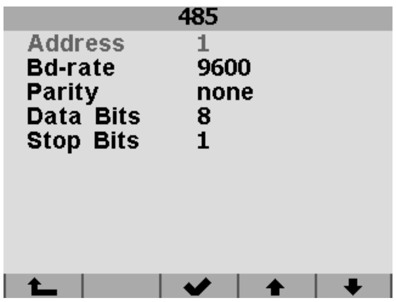
(a) Configuration menu of the SMY 133 analyzer.



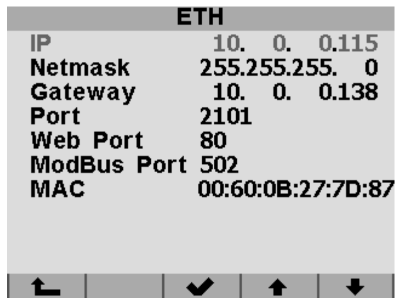
(b) Setting up the display options.



(c) Setting up the basic installation parameters of an instrument.



(d) Setting up the RS485 serial communication option.



(e) Setting up the Ethernet communication option.

(f) Setting up the time, date and time synchronization options.

Figure 12: Set up screens of the SMY 133 analyzer.

7. select *Connection Type* according to the physical connection of the instrument.
8. insert correct value of voltage and current transformer ratio according to the used VT and CT.
9. press button ① and accept the settings modifications on a displayed screen.
10. press button ② to confirm the change or button ④ to cancel the previous modifications.

2.4.2 Communication options

1. select the *Communication* item in menu
2. confirm ETH or RS-485 configuration according to the instrument option
   (a) ETH: enter IP address, network mask and gateway. Leave values of protocol port assignments in its default.
   (b) RS-485: enter communication line parameters according to your setup

2.4.3 Time and date options

1. select the *Time and Date* item in menu
2. enter time and date value, valid at the time of end of editing.
3. select if instrument uses *Summer Time* option.
4. choose the valid *Time Zone*

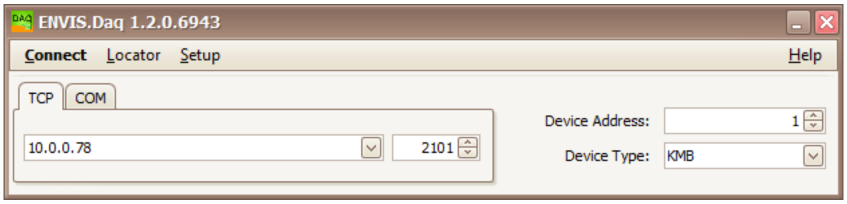


Figure 13: Main window of the ENVIS.Daq application - enter communication type, choose its parameters and click *Connect* to continue.

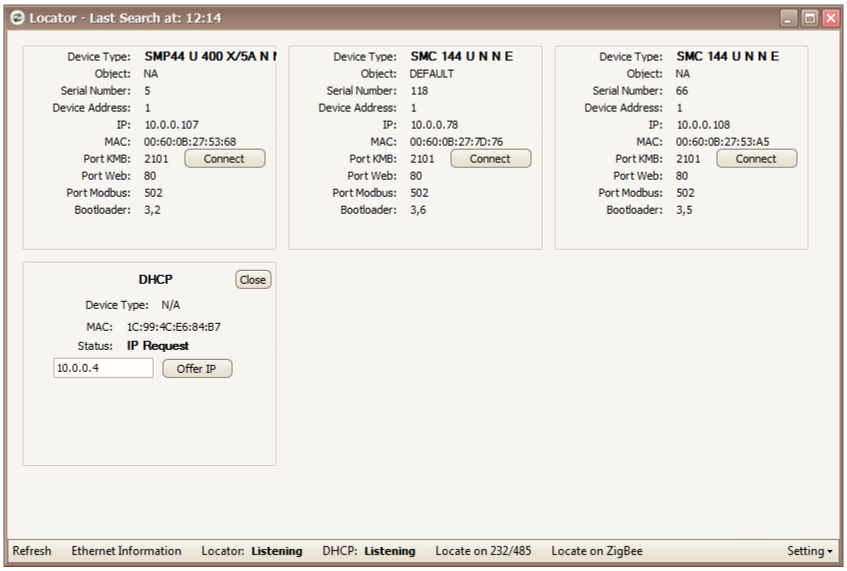


Figure 14: Window of *Locator* tool - provides automatic discovery of the supported instruments in a local network.

5. *Time Synchronization* is usually not required.

Now the instrument is configured and is ready to be used in typical application. Advanced configuration options are described in detail in chapter 2.5.

2.5 Detailed configuration of SMY 133 on a PC

To begin a measurement it is recommended to configure the SMY 133 instrument appropriately. This setting is done by PC with an ENVIS.Daq[2] application.

Warning! This setting will erase all previously archived data in memory of the instrument. Before writing new configuration to the device make sure to backup the last measured archive.

1. Turn on the instrument. Under normal conditions the unit will boot up and display its predefined initial screen.

2. Connect the SMY 133 to a computer via USB[3], RS-485 or Ethernet interface. Now the unit is ready to

[2]The ENVIS.Daq application is used for configuration of the instrument. This software is available for download form WWW.KMB.CZ as a part of ENVIS installation package or as a standalone application. Detailed description can be found in The ENVIS User Guide.

[3]If a USB instrument is connected to the PC for the first time it is necessary to install its driver in Windows. You can find the actual driver for our instruments online on the the WWW.KMB.CZ website. It is also located in the driver folder of ENVIS software installation folder, for example in: *'C:\Program Files (x86)\KMB systems\ENVIS 1.2\driver'*

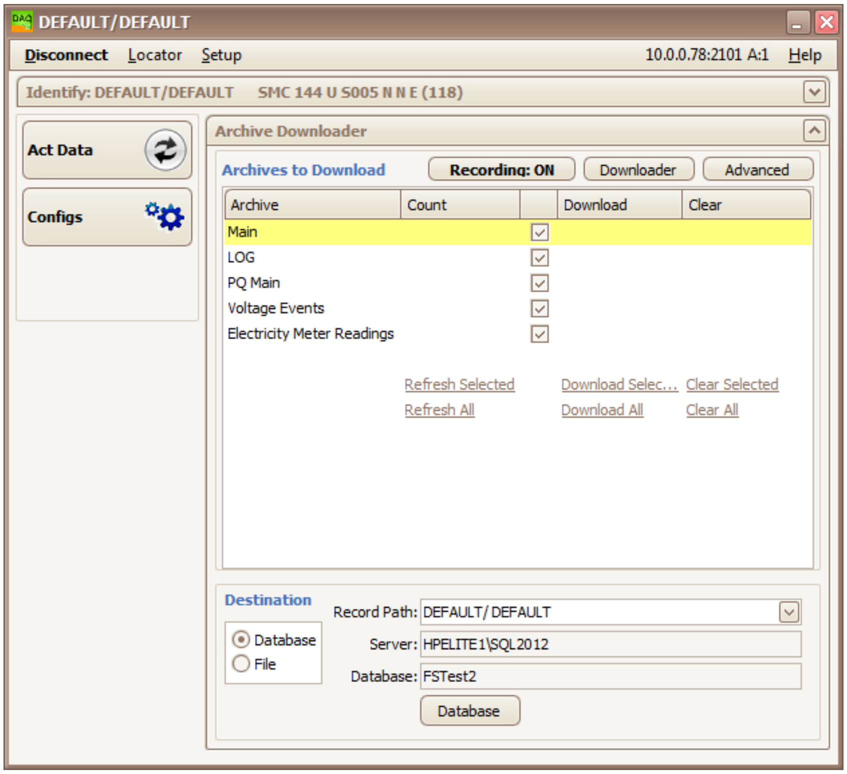


Figure 15: ENVIS.Daq application connected to the instrument.

be configured.

3. Run ENVIS.Daq application and pick the appropriate tab for the given communication line.
4. Fill in communication line parameters. A connection form with typical parameters is shown in figure 13.
   (a) USB: choose the correct virtual communication port from the list
   (b) RS485: Select the correct serial port from a list and set up communication line baud rate.
   (c) Ethernet: enter correct IP address and port (default: 2101). If you do not know the right values you can use *Locator*[4] (fig. 14).
   (d) Edit an address of the instrument (Default: 1)
   (e) Enter the device type: KMB
5. Press the *Connect* button or the *ENTER* key. application will attempt to connect to the instrument. In case of successful connection it reads the configuration from the instrument and displays new window with summary information (figure 15).
6. Press the *Settings* button in left column. New window with actual instrument settings will be opened.

Category *Instrument Settings* includes sub-categories, sorted and grouped in various tabs. Changes in configuration are only performed in the windows application. To the instrument they are sent with a *Send* button. With

[4]Locator is a tool for automatic look-up of the instruments in a local network or on a serial line. Caution: it contains special functions such as an embedded DHCP server, which can severely interfere with the normal operation of Ethernet network. It also might need a customization of your PC firewall to work correctly.

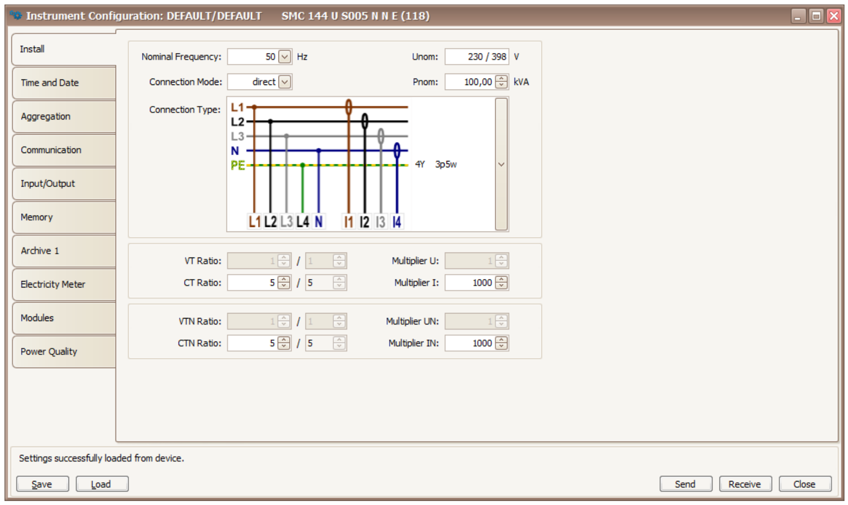
button *Receive* user can re-read the stored configuration from a device. This will effectively cancel all the local modification in the application. Unwritten changes in configuration on each tab is signalized by an exclamation sign. Buttons *Save* and *Load* provide a possibility to archive the actual settings to a file.

For correct operation an appropriate configuration of at least *Installation* and *Time and Date* tab is crucial.

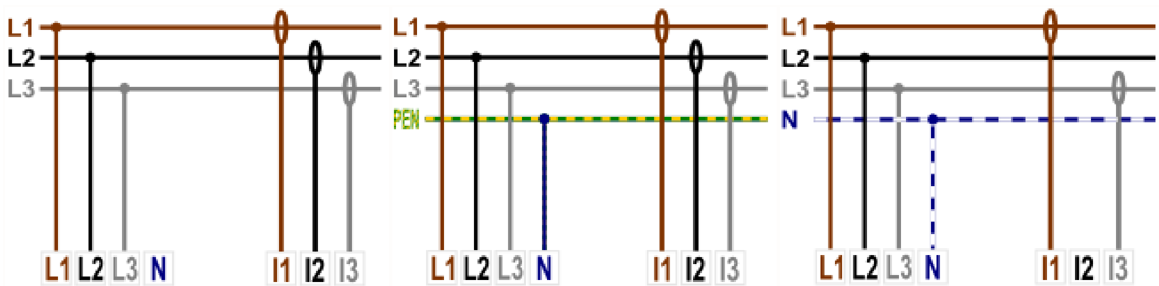
2.5.1 Installation (fig.16)

- *Nominal Frequency* - defines the nominal network frequency measured at 50 or 60 Hz. It also influences, how power quality indice are evaluated.
- *Connection Mode* - the way of connection of the instrument to the measured voltage — either direct voltage measurement or via voltage transformers (usually in a HV network).
- *Connection Type* - type of measured network according to the actual connection - three-phase star, three-phase delta or Aron connection. Supported connections schema are in fig. 16b and 16c for illustration.
- U_{NOM}, P_{NOM} (rated voltage and power) — correct configuration of these values influences relative values used on display and in condition evaluation (alarms, PQ evaluation, IO, ENVIS data processing).
  - U_{NOM} is a nominal (primary) voltage of the measured network
  - P_{NOM} is a nominal power given by the system transformer or used protection device.
- *VT Ratio, VTN Ratio* - sets the conversion ratio of voltage inputs for *Connection Mode: via VT* measurement. Must be set accordingly to the primary and secondary rating of the measuring voltage transformer (transfer ratio). 'VTN' designates the optional fourth voltage input, available with some *Connection Types.*
  - nominal primary voltage: default value for 'via VT' option is 22 000 V.
  - nominal secondary voltage: default value is 100 V (other common values are 110, 120, 230V)
- *CT Ratio, CTN Ratio* - sets the conversion ratio of current input. 'CTN' designates the fourth input, usually a neutral wire.
  - For standard instruments with X/5A and X/1A is specified as a ratio between primary and secondary current. Default value is 100 A/5A resp. 1 A.
  - For SMY 133 options X/100mA and X/20mA a nominal primary and nominal secondary current of the supplied transformer is used. Default value is 100 A/100 mA resp. 20 mA.
  -
- *Multiplier U*: this parameter is usually not necessary. Default value is 1. In special cases it can be used to correct the ratio of measured voltage.
- *Multiplier I* - this parameter is usually not nescessry. Default value is 1.
  - in case of direct current measurement (fig. 4) leave the *Multiplier I* in its default value:1.
  - in case of indirect current measurements with nonstandard conversion ratio (multiple loops of measured wire through the measuring transformer etc) specify the new ratio as a fraction[5] to which you need to multiply the original conversion ratio to get the real measured value of current.

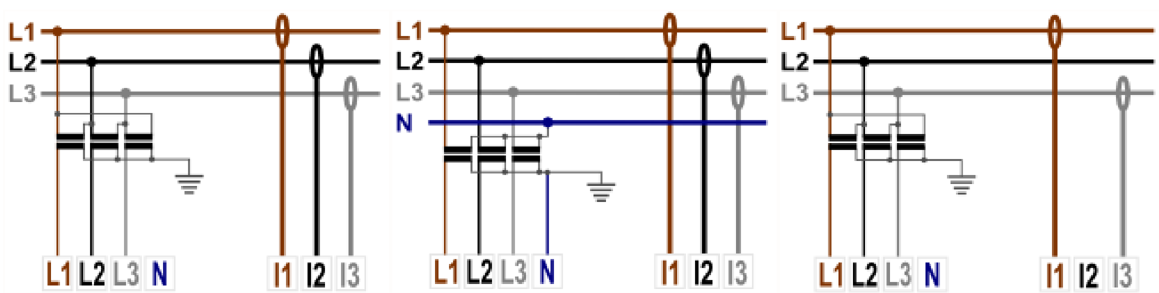
[5] If, for example, primary CT with ratio 100/5 is used, set multiplier to $\frac{100}{5} = 20$. Another example, when *Multiplier I* can be used, is winding more than one loop of measured conductor through current transformer for sensitivity extension (and range reduction). For example for 4 loops *Multiplier I* should be set to $\frac{1}{4} = 0.25$.



(a) Configuration of basic installation parameters in ENVIS.Daq.



(b) Instrument connection types for direct measurement (in LV networks).



(c) Instrument connection types for indirect measurement — to be connected via VT (in HV networks).

Figure 16: ENVIS.Daq - configuration of the device installation.

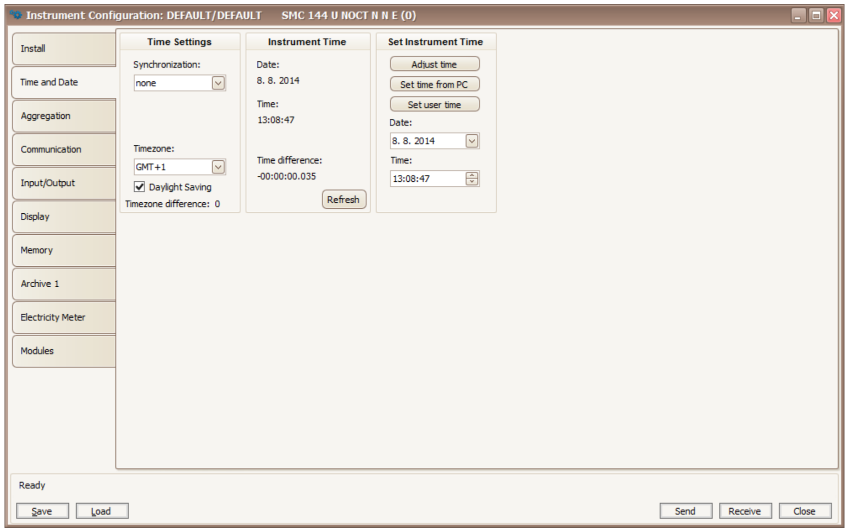


Figure 17: ENVIS.Daq - configuration of date and time options.

2.5.2 Date and time (fig. 17)

This tab contains configurations related to the instrument internal time and date settings.

Warning ! manipulation with the time configuration erases all instrument archives and related registers.

Instrument Time panel displays actual time and date in the instrument and an absolute difference to the actual time in PC. When this tab is opened for the first time the instrument time is immediately read and is periodically actualized. Button *Refresh* rereads the instrument time again.

Time Setup panel provides controls for actual modification of the time in instrument.

- *Set Time from PC* — sets the instrument time according to the clock in PC
- *Set user Time* — sets the instrument time to the manually given value
- *Adjust Time* — aligns the instrument time to the PC time without erasing instrument memory. Adjustment to the desired value is achieved in a way that:
  - to move time forwards it skips required number of archives
  - to move time backwards it waits with the creation of next archive until the instrument reaches the time given in setup.

Calendar Configuration defines ways of interpretation and display of time tags in instrument and in its archives:

- *Synchronization* — defines how each instrument synchronizes its time. Methods supported include:
  - pulse per second and pulse per minute (PPS, PPM) on a digital input,
  - NMEA protocol on a communication line - the comm port must be configured,
  - NTP protocol over Ethernet - IP address of the time server must be filled
  - and a network frequency lock.
  - It is also possible to disable this function.

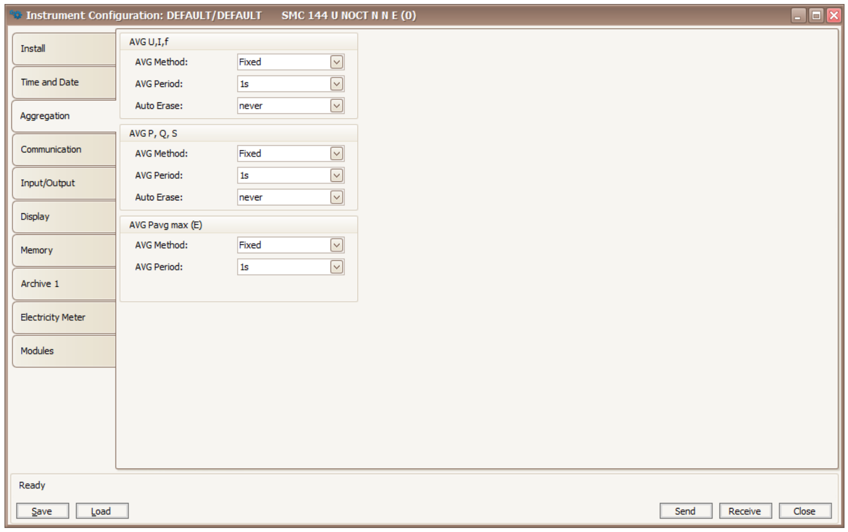


Figure 18: ENVIS.Daq - aggregation configuration defines how instrument evaluates average, minimum and maximum actual values for display and communication.

- *Time Zone* — must be set according to the local requirements. The configuration is important for correct interpretation of the local time for tariff, for remote communication etc.
- *Summer Time* — if set the calendar automatically adjusts itself to the change of the local time according to the season.

2.5.3 Aggregation (averaging, fig. 18)

This configuration influences algorithms used for calculation of special ModBus registers of the aggregated values. In instruments with graphical display it also influences how aggregated (AVG) values are displayed. Parameters are defined separately for primary quantities - voltages, currents and frequency, for derived quantities and specially for PavgMax. Correctly configured aggregation in an istrument allows in connection with ENVIS software to evaluate quarter-hour or hour maximal demand (power).

2.5.4 Communication (fig. 19)

Device is always equipped with an USB slave port for parametrization and data acquisition. Optionally it can be equipped with RS485 or Ethernet interface.

- *Instrument Address* - assign unique address to each instrument on the same serial line.

COM1

- *Communication Speed* — speed (baud rate) of the communication line. Default value is 9600 bps.
- *Communication Protocol* — to be chosen between KMB protocol and ModBus RTU.
- *Parity* — odd, even or none. Defines behavior of the parity bit control settings.
- *Data bits* — defines number of data bits.
- *Stop bits* — defines number of re-synchronization bits after each sent character.

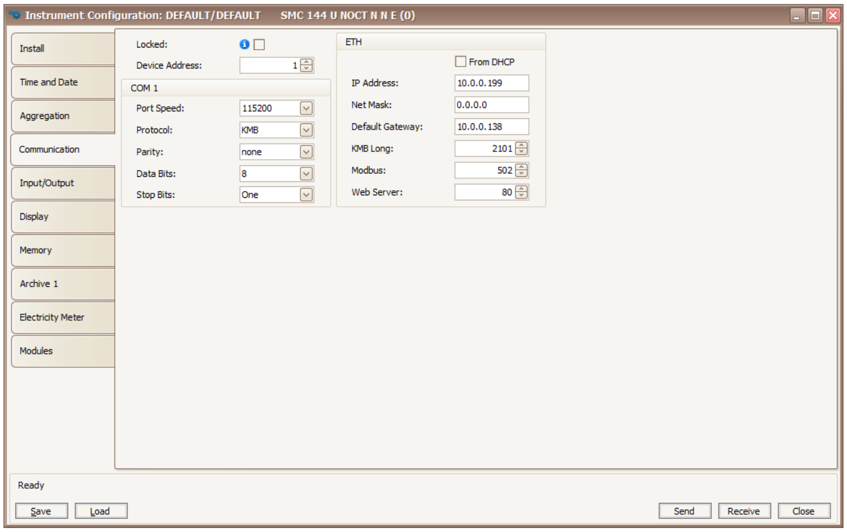


Figure 19: ENVIS.Daq - setting up communication line options.

ETH

- *IP address* — to be specified by user or assigned via the local DHCP server.
- *Network Mask* — setting of the network mask.
- *Gateway* — setting of network gateway.
- TCP Ports — each port can be individually assigned a special TCP port. Default values are:
  - *KMB Long protocol:* 2101,
  - *ModBus TCP protocol:* 502,
  - *Web server:* 80.

2.5.5 Inputs & Outputs (fig. 20)

SMY 133 could be optionally assembled with 2 relay or SSR outputs and one logical input (RR, RI, II).

- output controll logic can be programmed into the instrument
- any output can be configured to provide meter pulse output. In such cases the control quantity can be either active or reactive energy in each quadrant. It is nescessary to correctly configure number of pulses per kWh or kvarh.

2.5.6 Memory Assignments (fig. 21)

In this config tab it is possible to partition the internal memory among different archives with the slider control or by editing the apropriate value. The capacity of the new allocations is displayed right to the slider control. Sizes of some archives are fixed and can not be modified. Allocation for the main archive is automatically adjusted according to the remaining space and user requirements for another data such as meter readings, voltage events, oscillograms etc.

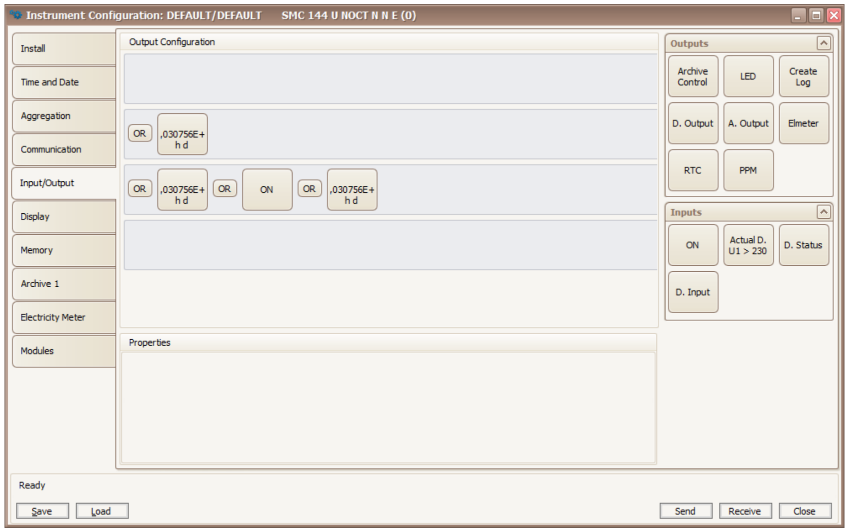


Figure 20: ENVIS.Daq - nastavení chování programovatelných vstupů a výstupů.

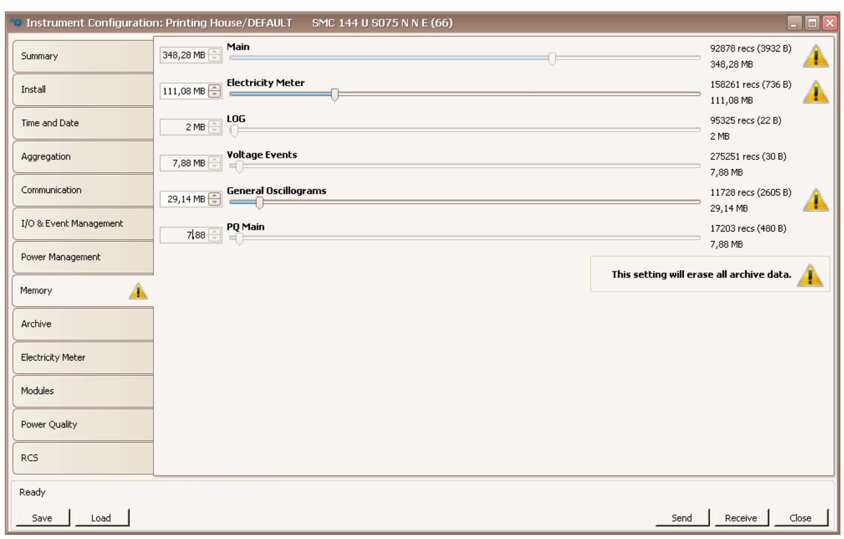


Figure 21: ENVIS.Daq - memory partitioning for each separate archive/data type.

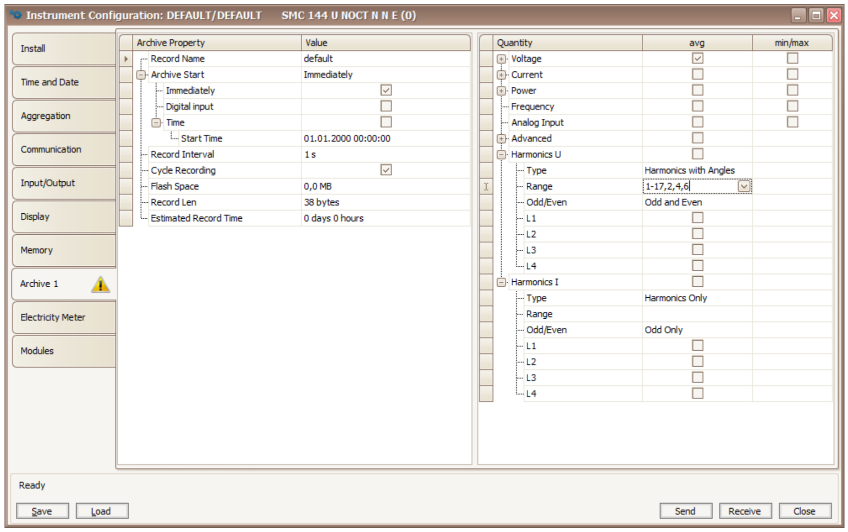


Figure 22: ENVIS.Daq - configuration of the recorded quantities for the main archive.

2.5.7 Main archive configuration (Archiv 1, fig. 22)

Archive configuration options split into archive properties panel and puantity selection list panel.

- *Record Name* – naming the measurements helps users to identify them correctly during evaluation. For example the transformer or circuit breaker ID could be a good descriptor. Record name is a string of up to 32 charactetrs.
- *Archive Start:*
  - *Immediately* - starts recording immediately after the instrument is turned on;
  - *Digital input* - saves records only when the digital input state is active;
  - *Preset time* - starts recording only after the given date and time.
- *Record Interval* – this aggregation interval defines the frequency of creation of the main archive readings. valid value is between 200 milliseconds (10/12 periods) and 2 hours.
- *Cycle Recording* – this switch defines what happens when main archive is fully recorded. When active, the archive continues to overwrite archives in a cyclic manner (FIFO). When disabled the recording stops and the oldest measured data is kept.
- *Flash Space* — total memory space assigned for the archive data.
- *Record Len* — actual length of the configured record.
- *Estimated Record Time* - this provides estimation of the overal capacity of the archive at the actual configuration. It is updated only after the configuration is written into the instrument and read back.
- *Quantities* — in this section user can choose quantities which should be recorded. required values should be enabled in the *avg* and/or *min/max* column .
  - *Power*: in the *I/E* line user can choose to separately evaluate and record consumed and generated active power resp. the inductive and capacitive reactive power.
  - *Harmonics* - user choses which data should be recorded in regard to harmonics.

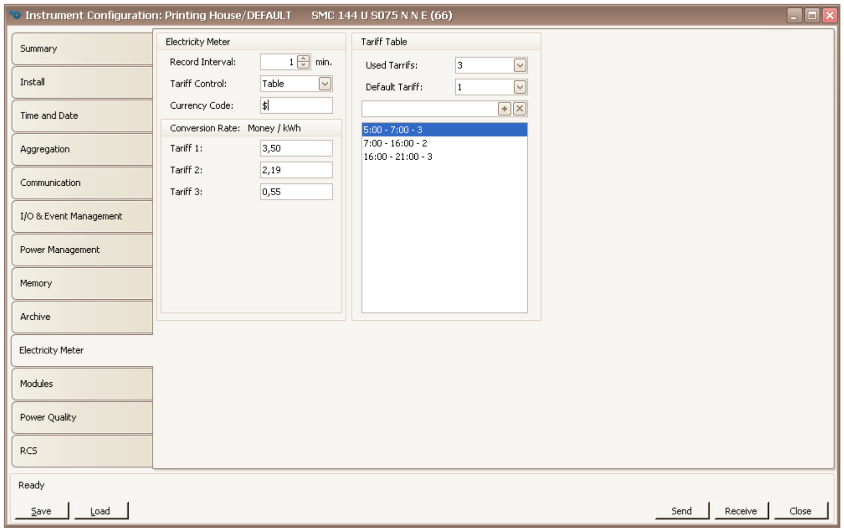


Figure 23: ENVIS.Daq - electricity meter configuration panel - tarrifs, prices, etc.

2.5.8 Electricity meter (fig. 23)

SMY 133 can be used as a standalone energy meter and register for submetering applications to record four-quadrant active and reactive energies (watt- and var-hour meter).

- *Record Interval:* period of creation of the automated meter readings in memory.
- *Tariff Control* - tariffs can be controlled by user defined tarrif table or by state of the input.
- *Tariff Table* - this panel configures number of tariffs, number of measured wires and tim based table of tariffs.
- *Currency Code* - name of currency is used for reporting and energy audits.
- *Conversion rate:* - defines prices (rates) for energy 1 kWh for each tariff per unit of currency.

Firmware Modules (fig. 24) This tabs allows the user to activate or deactivate optional firmware modules by providing a valid activation code. State of each supported module is indicated.

2.6 Measurement ID configuration

This configuration can be performed in the main ENVIS.Daq window on an *Identification* panel. it is crucial for correct identification and categorization of the archived data.

- *Object* - Is a number or name of object (generally a text string), where was performed the measurement. This is a basic identification element, that will organize the measurement archive in a database record of the ENVIS program. In our case (object name is “DEFAULT”) it was retrieved directly from the instrument. It can later be adjusted manually.
- *Record Name* - The individual records in the measured object can be distinguished by their name (name of the transformer in the building). In that case “DEFAULT”. This is again a text string of maximum length of 32 characters which can be adjusted later.

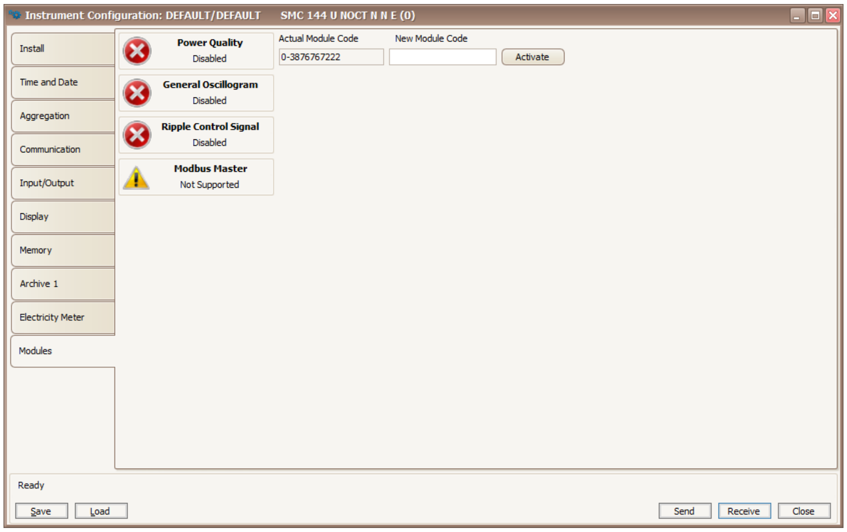


Figure 24: ENVIS.Daq - activation and deactivation of the supported special firmware options.

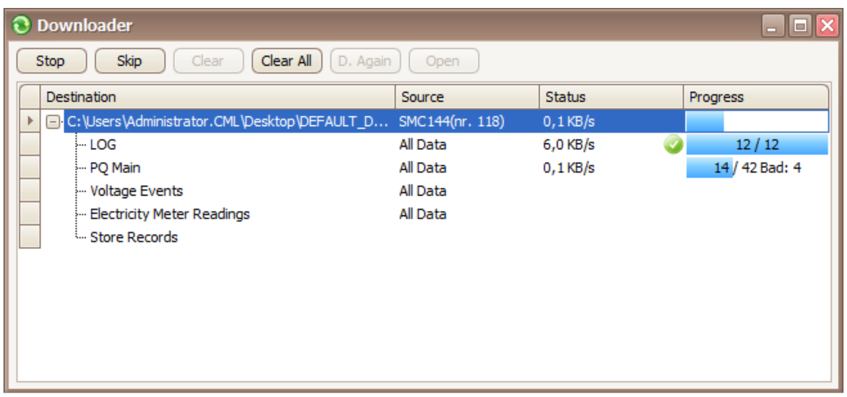


Figure 25: A window providing information about the download progress.

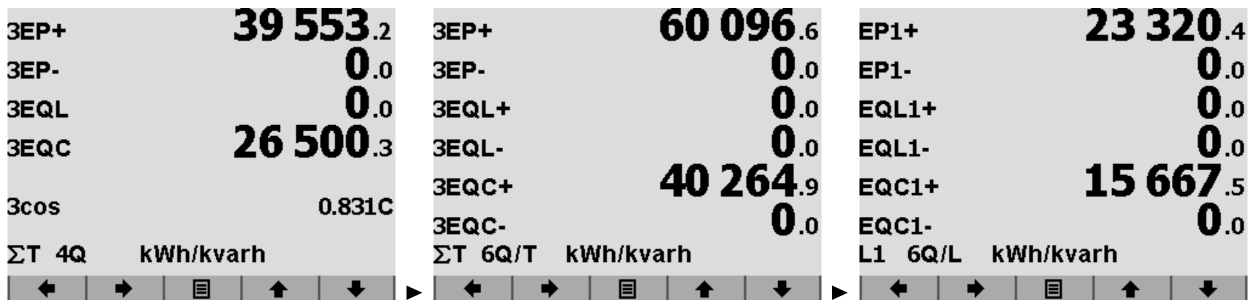
To write the new values for *Object* and *Record Name* push the *Set* button in the *Identification* panel. Other informative parameters of this tab group do indicate the type of connected device (model, serial number, firmware and hardware versions etc.) and they can not be changed.

2.7 Downloading data to PC

Connect the instrument to the PC and run ENVIS.Daq application (fig. 13). Select the appropriate communication option (as described in section 2.5) and connect to the instrument. In the next screen press *Refresh All* (fig. 15). This will load and display the actual status of each supported archive.

Device Information section contains editable description and name under which the actual record is stored. *Time Frame for Other Archives* tab allows you to limit the date ranges of all archives by the time interval of the main archive. In the *Destination* section the actual storage can be selected - either to the SQL database or to the file (CEA, XLS, PQDIF file formats). The check boxes in *Archives to Download* determines which specific archive(s) you want to download.

The actual download will start by pressing the *Download All* button. Progress of the data acquisition is displayed in a window as in figure 25. After complete transmission the window will close automatically. Data



(a) Three phase registers of active and reactive energy - sums of quadrants.

(b) Three phase active energy + and - , reactive energy displayed separately for each quadrant.

(c) Active energy + and -, reactive energy separately for each quadrant, values shown for each phase separately.

Figure 26: Meter reading screens of SMY 133 . Scrolling the instrument screens vertically user lists meter readings for each tarif and sums (EP, EQL+, EQL-, EQC+ a EQC-) and single phase (L1, L2 and L3) values respectively.

can be than viewed in the ENVIS application. user can open the downloaded file directly from ENVIS.Daq: in *Downloaded Files* panel in the left column of the main window there is a list of recently downloaded files.

2.8 Energy meter readings

SMY 133 has an embedded three phase, four-quadrant energy meter with automatic meter reading functions and tariff (Time-of-Use, TOU). The instrument registers active and reactive energy separately (EP+, EP-). For reactive energy it measures — capacitive EQC and inductive EQL for four-quadrant meter resp. reactive EQC+, EQC- and EQL+, EQL- separately for active power demanded and supplied for six-quadrant meter. According to the configuration of meter (ch. 23) readings are shuffled to the respective tariffs. It automatically provides summaries per phase. For star connections and single phase measurements it can also register energy for each phase separately.

Readings can be displayed on the instrument screen. Basic hierarchy is shown on the fig. 26 — button ③ enters the main instrument menu, use buttons ④ and ⑤) to navigate to electricity meter icon, press button ③ again and enter the meter reading screen (fig. 26a). Meter data readings can be downloaded and analyzed in ENVIS or via the standard ModBus protocol in any other system.

2.9 Embedded Webserver

All of instruments with Ethernet communication option are equipped with a native embedded webserver. Over this feature all important actual main measurements, registers and instrument setting can be viewed with a standard web browser with support for HTML5. It requires to set properly the instrument remote communication parameters and to connect it to the network. Then in the web browser enter an appropriate IP address of the instrument and information from the instrument appears.

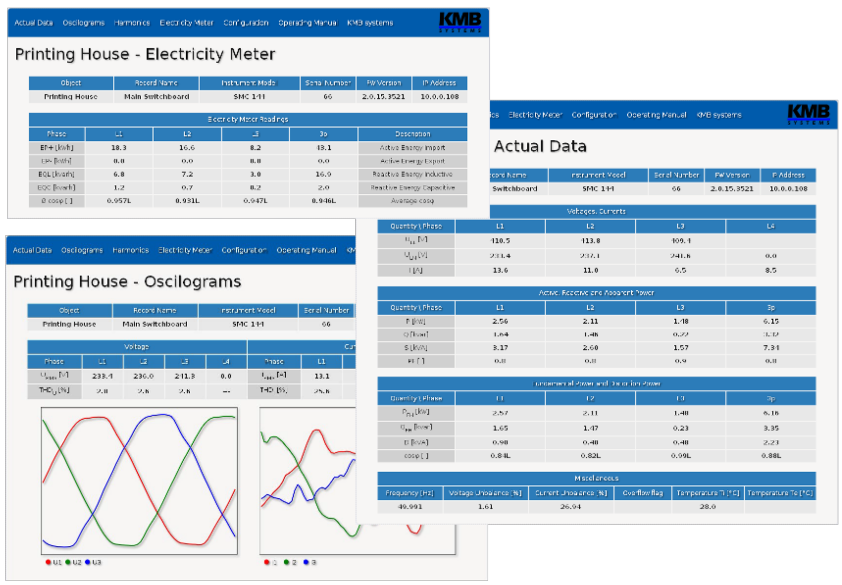


Figure 27: Sample pages of the embedded web server - actual data, electricity meter, oscilograms.

3 The Method of Measurement and Evaluation of Individual Variables

Measurement includes three continuously performed processes: frequency evaluation, sampling voltage and current signals and evaluation of these sampled data.

Frequency of the fundamental harmonic voltage component is continuously measured and evaluated every 10 seconds. The measured signal is a line voltage of first phase signal modified with a low pass filter. Frequency is assessed as a percentage of the number of full cycles of the network established within each 10 seconds and the cumulative duration of full cycles.

Voltages and currents are evaluated continuously without gaps. Basic evaluation interval is 10/12 cycles of the network ($\sim 200\,ms$ for both $50\,Hz$ or $60\,Hz$ network). All channels are sampled at the frequency of 128 samples per network cycle. Sampling is controlled by the measured frequency in channel U_1. If the value of the frequency is in measurable range it also controls the sampling — sampling is automatically adjusted to the frequency change. Otherwise, the sampling runs according to the preset nominal frequency ($50\,Hz$ or $60\,Hz$). RMS voltage and currents are evaluated from the sampled values for the measuring cycle according to equations:

3.1 Basic quantities (RMS)

Line-to-Neutral and Line-to-Line voltages, currents:

$$U_1 = \sqrt{\frac{1}{n}\sum_{i=1}^{n} U_{1i}^2},\; U_{12} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(U_{1i} - U_{2i})^2},\; I_1 = \sqrt{\frac{1}{n}\sum_{i=1}^{n} I_{1i}^2}$$

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

n........................... number of samples per cycle of measurement (128)

$U_{1,i}$, $U_{2,i}$, $I_{1,i}$ .... individual samples of voltage and current

3.2 Powers and power factor (PF)

Active and reactive power (single phase, three phase)[6]:

$$P_1 = \frac{1}{n}\sum_{i=1}^{n} U_{1i} \times I_{1i},\; 3P = P_1 + P_2 + P_3$$

$$Q_1 = \sum_{k=1}^{N} U_{1,k} \times I_{1,k} \times \sin\triangle\varphi_{1,k},\; 3Q = Q_1 + Q_2 + Q_3$$

[6] The equations are valid for a three phase star connection.

where: k .... index of the order of each harmonic
N .... highest harmonic (63)
$U_{1,k}$, $I_{1,k}$ .... k-th harmonic of voltage and current (1^{st} phase)
$\Delta\varphi_{1,k}$ .... angle between $U_{1,k}$, $I_{1,k}$ (1^{st} phase)

Apparent and Distortion power (per phase, three phase):

$$S_1 = U_1 \times I_1,\ 3S = S_1 + S_2 + S_3$$

$$D_1 = \sqrt{S_1^2 - P_1^2 - Q_1^2},\ 3D = \sqrt{3S^2 - 3P^2 - 3Q^2}$$

Power factor (per phase, three phase):

$$PF_1 = \frac{|P_1|}{S_1},\ 3PF = \frac{|3P|}{3S}$$

3.3 Harmonic distortion of voltages and currents

is continuously evaluated by FFT up to 63rd harmonic. The calculation is performed by using a rectangular window of each measurement cycle. Following parameters are evaluated from the harmonic analysis:

Fundamental (1^{st}) harmonic of voltage and current:

$$Ufh_1,\ Ifh_1$$

The absolute angle of the fundamental harmonic voltage and current phasors:

$$\varphi U_1,\ \varphi I_1$$

The angle between the corresponding phasors of the fundamental harmonic components of voltage and current:

$$\triangle\varphi_1$$

The angle between a voltage and the corresponding current phasors of the i-th order:

$$\triangle\varphi_i$$

Total harmonic distortion of voltage and current (as defined in 61000-4-30):

$$THDU = \frac{\sqrt{\sum_{i=2}^{40} Uh_i^2}}{Uh_1} \times 100,\ \ THD\text{–}R_U = \frac{\sqrt{\sum_{i=2}^{max} Uh_i^2}}{U} \times 100\,[\%]$$

$$THDI = \frac{\sqrt{\sum_{i=2}^{40} Ih_i^2}}{Ih_1} \times 100,\ \ THD\text{–}R_I = \frac{\sqrt{\sum_{i=2}^{max} Ih_i^2}}{I} \times 100\,[\%]$$

where: U .... voltage TRMS (line-to-neutral or line-to-line)
I .... current TRMS
i .... order of the respective harmonic component
Uh_i, Ih_i .... i-th harmonic of voltage and current

Power factor (of the fundamental harmonic components):

$$\cos \triangle\varphi_1$$

$$3cos\triangle\varphi = cos\left(\arctan\left(\frac{3Qfh}{3Pfh}\right)\right)$$

Reactive and reactive power of the fundamental harmonic component:

$$Pfh_1 = Ufh_1 \times Ifh_1 \times cos\triangle\varphi_1,\ 3Pfh = Pfh_1 + Pfh_2 + Pfh_3$$

$$Qfh_1 = Ufh_1 \times Ifh_1 \times sin\triangle\varphi_1,\ 3Qfh = Qfh_1 + Qfh_2 + Qfh_3$$

3.4 Symmetrical components

Voltage, current unbalance and negative sequence current is evaluated as a decomposition to the positive and negative sequence of fundamental harmonic:

$$unb_U = \frac{negative\_sequence\_component}{positive\_sequence\_component} \times 100\%$$

$$unb_I = \frac{negative\_sequence\_component}{positive\_sequence\_component} \times 100\%$$

$$\varphi nsl$$

3.5 Aggregation and recording

Values are aggregated and stored in the archive in instrument memory according to the settings of the recording interval. By default all average values are recorded. Additionally extreme (maximum and minimum) values in each aggregation interval can be also recorded.

Aggregation of each interval starts at the beginning of the cycle (determined by RTC tick), following the expiration of the previous time interval as required by the standards - 61000-4-30 for class S. If all the available memory capacity for main archive is used than the archivation stops or restarts according to the Main Archive configuration. If *Cyclic Recording* is not selected, the instrument stops recording until it is reconfigured (and thus erased) by user or software. Otherwise the recording continues with the new measured values overwriting the oldest values in memory (FIFO). The device contains the “latest” set of records, which corresponds to the memory capacity of the actual device and configuration.

4 Technical Specifications

4.1 Basic Parameters

Instrument Auxiliary Power Supply Voltage			
	model „U“	**model „L“**	**model „S“**
aux. voltage range AC: f=40÷450 Hz; DC	100 ÷ 275 V_{AC} 90 ÷ 350 V_{DC}	20 ÷ 50 V_{AC} 20 ÷ 75 V_{DC}	10 ÷ 26 V_{AC} 10 ÷ 36 V_{DC}
power supply	3 VA / 3 W		
overvoltage category	III		
pollution degree	2		
connection	isolated, polarity free		

„X/333mV“ Instrument Model Auxiliary Voltage for Current Sensors	
connection	non-isolated (connected with the instrument internal circuitry)
output voltage	+5 V_{DC} ± 5 %
maximum permanent load	60 mA_{DC}
short-circuit current, max. duration	approx. 100 mA_{DC}, 5 seconds

Other Specifications	
operational temperature	- 20 to 60°C
storage temperature	- 40 to 80°C
operational and storage humidity	< 95 % - non-condensable environment
EMC – immunity	EN 61000 – 4 - 2 (4kV / 8kV) EN 61000 – 4 - 3 (10 V/m up to 1 GHz) EN 61000 – 4 - 4 (2 kV) EN 61000 – 4 - 5 (2 kV) EN 61000 – 4 - 6 (3 V) EN 61000 – 4 - 11 (5 periods)
EMC – emissions	EN 55011, class A EN 55022, class A (not for home use)
communication ports	USB 2.0, optional RS-485 or Ethernet 10/100 Base-T
communication protocols	KMB, Modbus RTU and TCP, web server, DHCP
display	colour TFT-LCD, 320 x 240 pixels
RTC : accuracy	+/- 2 seconds per day
backup battery capacity	> 5 years (without supply voltage applied)
protection class front panel back panel	IP 40 (IP 54 with cover sheeting) IP 20
dimensions front panel built-in depth installation cutout	96 x 96 mm 80 mm 92^{+1} x 92^{+1} mm
weight	max. 0.3 kg

4.2 Measured Quantities

Voltage characteristics			
Frequency			
f_{NOM}– nominal frequency	50 / 60 Hz		
measuring range	40 ÷ 57 / 51 ÷ 70 Hz		
uncertainty	± 10 mHz		
Voltage			
voltage input option	**„400“**	**„230“**	**„100“**
U_{NOM} (U_{DIN})– rated voltage	300 ÷ 415 V_{AC}	180 ÷ 250 V_{AC}	57.7 ÷ 125 V_{AC}
measuring range (line-to-line)	10 ÷ 600 V_{AC}	6 ÷ 360 V_{AC}	3 ÷ 180 V_{AC}
measuring range (line-to-neutral)	20 ÷ 1040 V_{AC}	8 ÷ 620 V_{AC}	5 ÷ 310 V_{AC}
intrinsic uncertainty (t_A=23±2ºC)	+/- 0.05 % of rdg ± +/- 0.02 % of rng		
temperature drift	+/- 0.03 % of rdg ± +/- 0.01 % of rng / 10 ºC		
measurement category	300V CATIII,600VCATII	300V CAT III	150V CAT IV
permanent overload	1000 V_{AC} ($U_{L–N}$)	600 V_{AC} ($U_{L–N}$)	300 V_{AC} ($U_{L–N}$)
peak overload, 1 second	2000 V_{AC} ($U_{L–N}$)	1200 V_{AC} ($U_{L–N}$)	600 V_{AC} ($U_{L–N}$)
burden power (impedance)	< 0.05 VA (Ri=6 MΩ)	< 0.025 VA (Ri=3.6 MΩ)	<0.013 VA (Ri=1.8 MΩ)
Voltrage Unbalance			
measuring range	0 ÷ 10 %		
measuring uncertainty	± 0.3		
THDU			
measuring range	0 ÷ 20 %		
measuring uncertainty	± 0.5		
Harmonics (up to 50th order)			
reference conditions	other harmonics up to 200 % of class 3 acc. to IEC 61000–2-4 ed.2		
measuring range	10 ÷ 100 % of class 3 acc. to IEC 61000–2-4 ed.2		
measuring uncertainty	twice the levels of class II acc. to IEC 61000–4-7 ed.2		

Mains Signalling Voltage (with optional firmware module „RCS“ only)	
measuring range	0 ÷ 20 % U_{NOM} , f_{Msv} : 100 ÷ 3000 Hz
measuring uncertainty	twice the levels of class II acc. to IEC 61000–4-7 ed.2

Measured Quantities – Current, Temperature			
Current			
current input option	**„X/5A“**	**„X/100mA“**	**„X/333mV“**
I_{NOM} (I_B) – rated (basic) current	1 ÷ 5 A_{AC}	0.1 A_{AC}	I @ 333mV
measuring range	0.005 ÷ 7 A_{AC}	0.001 ÷ 0.39 A_{AC}	0.002 ÷ 0.5 V_{AC}
intrinsic uncertainty (t_A=23±2ºC)	+/- 0.05 % of rdg ± +/- 0.02 % of rng		
temperature drift	+/- 0.03 % of rdg ± +/- 0.01 % of rng / 10 ºC		
measurement category	150V CAT III	150V CAT III	undefined
permanent overload	7.5 A_{AC}	1 A_{AC}	15 V_{AC}
peak overload 1 second, maximum repetition frequency > 5 minutes	70 A_{AC}	10 A_{AC}	15 V_{AC}
burden power (impedance)	< 0.5 VA (Ri<10mΩ)	< 0.01 VA (Ri<40mΩ)	< 3 μVA (Ri>100kΩ)
Current Unbalance			
measuring range	0 ÷ 100 %		
measuring uncertainty	± 1 % of rdg or ± 0.5		
Harmonics & Interharmonics (up to 50th order)			
reference conditions	other harmonics up to 1000 % of class 3 acc. to IEC 61000–2-4 ed.2		
measuring range	500 % of class 3 acc. to IEC 61000–2-4 ed.2		
measuring uncertainty	Ih <= 10% I_{NOM} : ± 1% I_{NOM}		
	Ih > 10% I_{NOM} : ± 1% of rdg		
THDI			
measuring range	0 ÷ 200 %		
measuring uncertainty	THDI <= 100% : ± 0.6		
	THDI > 100% : ± 0.6 % of rdg		
Temperature (internal sensor, measured value affected by the instrument power dissipation)			
measuring range	- 40 ÷ 80°C		
measuring uncertainty	± 2 ºC		

Measured Quantities – Power, Power Factor, Energy	
Active / Reactive Power, Power Factor (PF), cos φ ($P_{NOM} = U_{NOM} \times I_{NOM}$)	
reference conditions "A" : ambient temperature (t_A) U, I for active power, PF, cos φ for reactive power	 23 ±2 ºC U = 80 ÷ 120 % U_{NOM}, I = 1 ÷ 120 % I_{NOM} PF = 1.00 PF = 0.00
act. / react. power uncertainty	± 0.5 % of rdg ± 0.005 % P_{NOM}
PF & cos φ uncertainty	+/- 0.005
"reference conditions "B" : ambient temperature (t_A) U, I for active power, PF, cos φ for reactive power	 23 ±2 ºC U = 80 ÷ 120 % U_{NOM}, I = 2 ÷ 120 % I_{NOM} PF >= 0.5 PF <= 0.87
act. / react. power uncertainty	± 1 % of rdg ± 0.01 % P_{NOM}
PF & cos φ uncertainty	+/- 0.005
temperature drift of powers	+/- 0.05 % od rdg ± +/- 0.02 % P_{NOM} / 10 ºC
Energy	
measuring range	6 „quadrants", corresponds to U & I measuring ranges
active energy uncertainty	class 0.5S acc. to EN 62053 – 22
reactive energy uncertainty	class 2 acc. to EN 62053 – 23

4.3 Inputs and Outputs

Digital Outputs & Digital Input	
„R"-type (relay)	
type	N.O. contact
load rating	250 V_{AC} / 30 V_{DC}, 5 A
„I"-type (solid state, opto-MOS)	
type	Opto-MOS, bipolar
load rating	60 V_{AC} / 100 V_{DC}, 100 mA
Digital Input	
type	optoisolated, bipolar
maximum voltage	100 V_{DC} / / 60 V_{AC}
voltage for "logical 1"	> 10 V_{DC}
voltage for "logical 0"	< 3 V_{DC}
input current	1 mA @ 10V / 5 mA @ 24V / 10 mA @ 48V

4.4 Power Quality and Energy Management

4.4.1 IEC 61000-4-30, 61000-4-15, 61000-4-7:

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

1) … according to IEC 61000-4-7 ed.2.0

2) … with optional firmware module „PQ S"

3) … with optional firmware module „RCS"

4.4.2 EN 50160

Voltage Quality acc EN 50160 (with optional firmware module „PQ S“ only)	
evaluation period	weekly
Interharmonics (up to 50th order)	
reference conditions	other harmonics up to 200 % of class 3 acc. to IEC 61000–2-4 ed.2
measuring range	10 ÷ 100 % of class 3 acc. to IEC 61000–2-4 ed.2
measuring uncertainty	twice the levels of class II acc. to IEC 61000–4-7 ed.2
Flicker	
measuring range	0.4 ÷ 10
measuring uncertainty	± 5 % of rdg (acc. to IEC 61000–4-15 ed.2.0)
Voltage Dips & Swells	
measuring uncertainty	+/- 0.1 % of rdg ± +/- 0.05 % of rng
Voltage Interruptions	
measuring uncertainty	+/- 0.2 % of rdg ± +/- 0.1 % of rng
duration measuring uncertainty	± 1 cycle
Mains Signalling Voltage	
evaluation period	3s interval

4.4.3 IEC 61557-12: Classification of the power monitoring instrument

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

Function characteristics according to IEC 61557-12 Model **„230 X/5A“**, U_{NOM} = 230 V, I_{NOM} = 5 A				
Symbol	Function	Class	Measuring range	Notes
P	total effective power	0.5	0 ÷ 5400 W	
Q_A, Q_V	total reactive power	1	0 ÷ 5400 var	
S_A, S_V	total apparent power	0.5	0 ÷ 5400 VA	
E_a	total active energy	0.5	0 ÷ 5400 Wh	
E_{rA}, E_{rV}	total reactive energy	2	0 ÷ 5400 varh	
E_{apA}, E_{apV}	total apparent energy	0.5	0 ÷ 5400 Vah	
f	frequency	0.02	40 ÷ 70 Hz	
I	phase current	0.2	0.005 ÷ 6 A_{AC}	
I_N	neutral current measured	–	–	
I_{Nc}	neutral current calculated	0.2	0.005 ÷ 18 A_{AC}	
U_{LN}	line-to-neutral voltage	0.2	40 ÷ 280 V_{AC}	
U_{LL}	line-to-line voltage	0.2	70 ÷ 480 V_{AC}	
PF_A, PF_V	power factor	0.5	0 ÷ 1	
P_{st}, P_{lt}	flicker	5	0.4 ÷ 10	1, 2)
U_{dip}	voltage dips	0.5	10 ÷ 230 V_{AC}	2)
U_{swl}	voltage swells	0.5	230 ÷ 280 V_{AC}	2)
U_{tr}	transients overvoltage	–	–	
U_{int}	voltage interruption	1	0 ÷ 10 V_{AC}	2)
U_{nba}	voltage unbalance (amp.)	0.5	0 ÷ 10 %	4)
U_{nb}	voltage unbalance (ph.&amp.)	0.5	0 ÷ 10 %	
U_h	voltage harmonics	2	up to 50^{th} order	1)
THD_u	voltage total harmonic distortion (rel. to fund.)	2	0 ÷ 20 %	1)
$THD\text{-}R_u$	voltage total harmonic distortion (rel. to RMS)	2	0 ÷ 20 %	1, 4)
I_h	current harmonics	2	up to 50^{th} order	1)
THD_i	current total harmonic distortion (rel. to fund.)	2	0 ÷ 200 %	1)
$THD\text{-}R_i$	voltage total harmonic distortion (rel. to RMS)	2	0 ÷ 200 %	1, 4)
M_{SV}	mains signalling voltage	2	0 ÷ 46 V_{AC} f_{Msv} : 100 ÷ 3000 Hz	1,3)

1) … according to IEC 61000-4-7 ed.2.0, IEC 61000-4-15 ed.2.0

2) … with optional firmware module „PQ S“

3) … with optional firmware module „RCS“

4) … value available in the ENVIS program only

5 Maintenance, Service, Warranty

Maintenance: the SMY 133 power analyzer does not require any maintenance during its operation. For reliable operation it is only necessary to meet the operating conditions specified and not expose the instrument to violent handling and contact with water or chemicals which could cause mechanical damage.

The lithium cell built in the instrument can backup a real time circuit for more than 5 years without power supply, at average temperature $20^\circ C$ and load current in the instrument less than $10\,\mu A$. If the cell is empty, it is necessary to ship the instrument to the manufacturer for battery replacement.

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

KMB Systems, s. r. o.
Tř. dr. M. Horákové 559
460 05 Liberec 7
Czech Republic
Tel. 485 130 314, Fax 482 739 957
E-mail: kmb@kmb.cz, Web: `www.kmb.cz`

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

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

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

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

Type of product:	SMY 133	Serial number:	....
Date of dispatch:	....	Final quality inspection:	....
		Manufacturer's seal:	....
Date of purchase:	....	Supplier's seal:	....