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Synchronoscope
type: SMV-1B

Operating Instructions

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CE

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1 . IMPORTANCE OF THE USAGE INSTRUCTION

In case of any doubts regarding interpretation of this usage instruction, please contact directly with the manufacturer.

We look forward to hear from our users about any suggestions, opinions and critical remarks. All suggestions and opinions can be submitted by telephone or in written form. This will help us to make this instruction more friendly for our users, including their request and requirements.

The device, to which this instruction is attached contains impossible to remove potential threats for peoples and material properties. Therefore, each person who operates this device or performs any activities connected with operation and maintenance of this device must be properly trained and familiar with potential threats generated by this device.

Each user of this device must carefully read, understand and observe all usage instruction, especially guidelines regarding safety.

In this instruction are used units of the physical magnitudes and their writing methods according to the Ordinance of the Minister of Economy, Labour and Social Politics of May 12, 2003 regarding legal measurements units (Journal of Laws, No. 103, item 954). All units not regulated by this Ordinance (especially regarding information values and transmission rates) are used according to recommendation of the National Institute of Standards and Technology (http://physics.nist.gov/cuu/Units/index.html).

2 . INFORMATION ABOUT CONFORMITY

The device described in this instruction is designed for use in the industrial environment. During construction and production of this device were used norms that provide realization of safety rules and measures provided that, all instructions described below regarding installation, start-up and usage of this device will be observed by the user.

This device is Class A device. In residential buildings it can generate radio-electrical interferences. In such cases, the user of this device can be requested to apply proper remedial measures and actions.

This device is in conformity with the following EU directives:

- Low Voltage Directive 72/73/EC – applied on the basis of the Ordinance of the Minister of Economy, Labour and Social Politics of March 12, 2003 (Journal of Laws, No. 49, item 414) and
- Electromagnetic Compatibility Directive 89/336/EC – applied on the basis of the Ordinance of the Minister of Infrastructure of April 02, 2003 (Journal of Laws, No. 90, item 848).

Conformity with such directives was approved by the researches conducted in the independent from the manufacturer measurement and research laboratories.

SMV-1Bb device fulfils all basic requirements described in low voltage and electromagnetic compatibility directives through the compatibility with the following norms:

Harmonized norm with Directive 73/23/CE

– **PN-EN 61010-1:2004** Safety requirements for electric measuring instruments, automation systems and laboratory equipment. General requirements.

Harmonized norms with Directive 89/336/CE

– **PN-EN 61000-6-2:2003** Electromagnetic compatibility (EMC) – Part 6-2: General norms – Resistance in the industrial environments.

– **PN-EN 61000-6-4:2004** Electromagnetic compatibility (EMC) – Part 6-4: General norms – Requirements regarding emission performance in the industrial environment.

3 . APPLICABILITY OF THE DEVICE

The microchip-based SMV-1b device is designed to control the process of connecting AC electric power facilities to operate in parallel and, as it contains an integrated "switching synchronizer with a permanent angle of advance", to prevent a switch from being switched on with excessive current surges. It can be used as a redundant device for manual or automatic synchronization. It allows a switch-on operation, when voltage, frequency and phase (the phase difference falls within the set angle sector and the absolute value of the phase difference decreases or is almost constant) switch-on conditions are met simultaneously. The fact that these conditions are met is signalled with yellow status lamp "0".

SMV-1b generates a signal that allows a switch-on operation, when the START signal appears, when status lamp "0" is lit.

Figure 1 shows an overview of the front plate of the device:

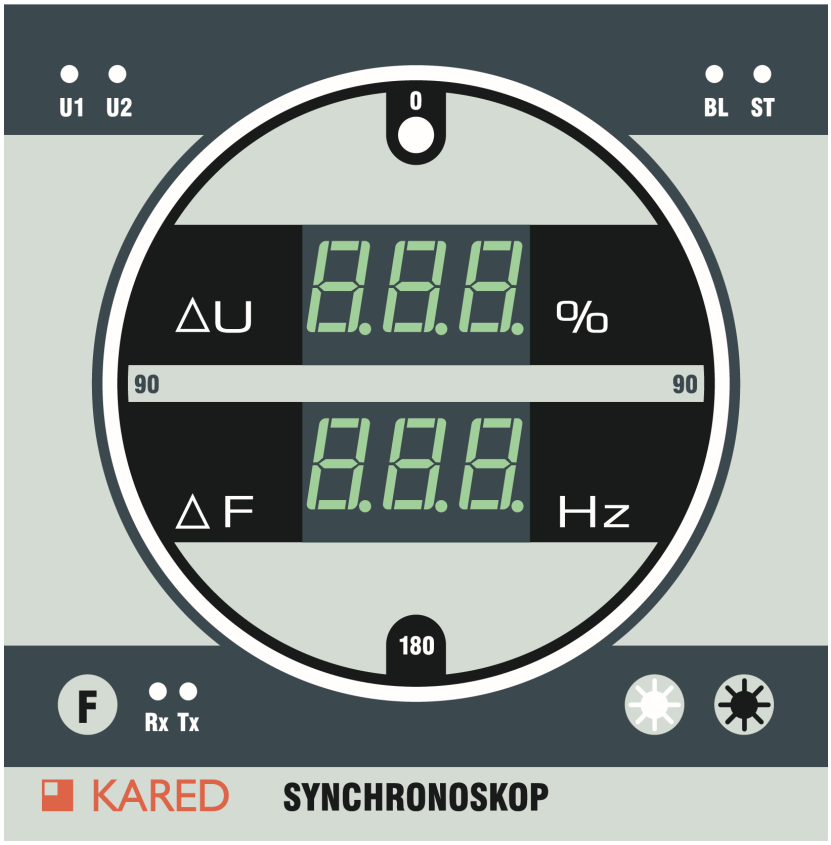

Fig. 1. Overview of the front plate of the SMV-1b device.

The device shows the difference between voltages and the difference between frequencies at the synchronized facilities and does so in a digital form, on a LED display. It also shows the difference between phases in the form of a luminous arc with gradually decreasing brightness (the so-called "comet"). The "comet" rotates along a circle with the diameter of about 100mm, which ensures good visibility of the indication from a large distance. The head of the "comet" shows the current difference between phases, while the "tail of the comet" allows one to identify the direction of rotation of the phase difference vector. If voltage frequency U2 (of the generator) is higher than voltage frequency U1 (of the grid), then the "comet" shifts clockwise along the circle. If voltage frequency U2 is lower than voltage frequency U1, then the "comet" shifts counter clockwise along the circle. The presentation of the phase difference in the form of a rotating "comet" allows one to read the current phase and the rotation direction with high precision, both in the case of very low and very high rotation speeds of the vector of the difference between the voltages at the facilities to be synchronized.

4 . SAFETY RULES

Information provided in this chapter are meant for familiarizing the user with proper installation and operation of the device. It is assumed, that personnel responsible for installation, start-up and usage of this device has proper qualifications and is aware of potential threats connected with handling and operating electric equipment.

This device conforms all requirements regarding safety rules and standards. During designing stage of this device, a special attention was paid to user safety.

4.1 Symbols

The device is protected by the double insulation or reinforced insulation.

Direct current

Symbol that represents selective recycling of the electric and electronic equipment.

4.2 Installation of the device

Attention!
Please read and familiarize yourself with this usage instruction before usage or installation of the device.

The device should be installed in the way described in chapter 7 "Installation"

4.3 Start-up of the device

Once **SMV-1b** is installed, one should start the device up in compliance with the principles generally accepted for protection, automation and control devices. Particular attention should be focused on connections with voltage transformers, and especially on ensuring the phase of measurement voltages are consistent.

4.4 Usage of the device

This device should operate in the conditions described in the technical data.
All persons who operate this device should be authorized and familiarized with usage instruction. Usage of the device not consistent with the recommendations of the manufacturer can cause that the protections providing safety of the device can not be effective.

4.5 Opening the enclosure

Before starting any works that will require opening the enclosure, all voltages connected to the device should be disconnected, and then the device should be disconnected from the external circuits by uncoupling all terminals.

All integrated circuits used in this device are very sensitive to electrostatic discharges, and therefore opening of the device without proper anti-electrostatic equipment can cause damage to the device.

4.6 Usage

After installation the device does not need any additional operation. In case of any malfunctions, please contact with distributor, from which the relay was purchased.

Distributor together with manufacturer provides all warranty/after-warranty services. All warranty conditions are provided on the warranty card.

4.7 Modifications and changes

Because of safety precautions, all modifications and changes regarding functionality of the device described in this instruction are prohibited. Any modification of

the device performed without written consent of the manufacturer will cause loss of right to any contractual and tort liability claims against PUP KARED.

4.8 Abnormalities

In case of abnormal operation of the device, please immediately inform about this fact the person responsible for building management and the distributor.

All repairs should be performed only by persons authorized by the manufacturer.

4.9 Rating plates, information plates and stickers

All advices provided in the form of descriptions placed on the device and on the information plates and stickers should be absolutely observed. All damaged or illegible rating plates and stickers should immediately replaced for new ones.

5 . TECHNICAL DESCRIPTION

5.1 General description

The SMV-1b device is equipped with a galvanically-isolated serial RS485 connection for communication with a PC workstation or a master IT system. Optionally, instead of the RS485 interface, it can be equipped with an RS232 interface or an optic fibre connection.

There are status lamps on the front panel that allow one to read the status of binary inputs ST and BALLASTLESS and the presence of voltage at input U1 on line L1 and U2 on line L2. Moreover, LEDs Rx and Tx indicate active communication at the serial connection.

By means of "light sun" (P2) and "dark sun" (P1), it is possible to manually adjust the highlighting of LED displays, to adapt their contrast to the prevailing ambient conditions. The basic settings can be read by means of push button "F" (P3).

Table 1. Control buttons on the front plate

P1	dim the readings on LED displays, increase a parameter value	Dark sun
P2	brighten up the readings on LED displays, decrease a parameter value	Light sun
P3	read settings	F

Two mini bar graphs are located under the LED displays.

Mini bar graph 1. It is located below the ΔU display. It consists of green diodes in the middle and red diodes in its extreme parts. The segments located to the right of the bar graph symmetry axis are lit up, when the voltage difference ΔU = U2 - U1 > 0 (the value is positive). The segments to the left are lit up, when ΔU < 0 (the value is negative). When the absolute value of the voltage difference is lower than an admissible value (Urd or Urg – see settings, table 10), two corresponding green diodes are lit up. When the absolute value is higher than an admissible value, the corresponding red diode is lit up.

Mini bar graph 2. It is located below the ΔF display. As in the case of bar graph 1, it consists of green diodes in the middle and red diodes in its extreme parts. The right-hand part of the bar graph is lit up, when the frequency difference

$$\Delta F = f2 - f1 > 0$$

where: f1 – U1 voltage frequency (grid),

f2 – U2 voltage frequency (generator)

and the left-hand part is lit up, when $\Delta F = f2 - f1 < 0$.

When the absolute value of frequency difference ΔF is lower than the set admissible value (frd or frg – see settings, table 10), the corresponding green sector is lit up. When the absolute value is higher than an admissible value, the corresponding green sector is lit up.

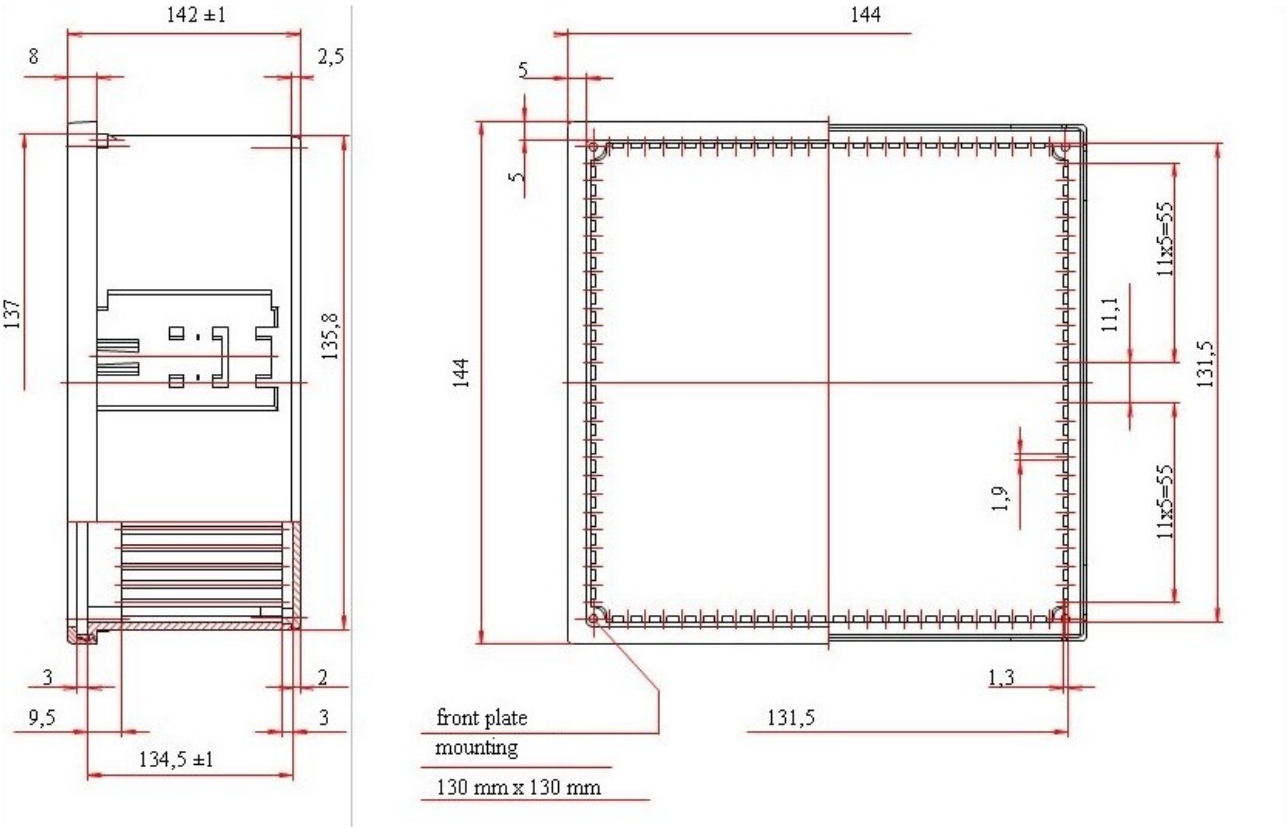

Fig. 2. Housing dimensions

6 . TECHNICAL DATA

6.1 Environmental conditions

The SMV-1b device should operate in conditions, where 2nd pollution degree is ensured. The ambient temperature should fall within the range between 0 °C and 40 °C. Relative humidity should not exceed 90%.

6.2 Information about completeness

The manufacturer provides the device set consisting of the following elements:

- the SMV-1b device,
- a complete set of connections,
- software for introducing setting values over the RS485 connection,
- documentation,
- guarantee.

6.3 Power-supply characteristics

Table 2. Power-supply parameters

Rated power-supply voltage	220 V DC
Admissible power-supply voltage range	from 100 V DC to 250 V DC
Maximum power consumption	15 W

6.4 General characteristics of the inputs

The SMV-1b device has got 2 analogue inputs and 2 binary inputs. The binary inputs are double-terminal inputs that are galvanically isolated from the rest of electronic equipment and from each other. The analogue inputs are differential double-terminal inputs.

6.5 Analogue inputs data

Table 3. Measurement inputs parameters

Measurement category	III
Number of inputs	2
Measurement rated voltage	100 V rms
Input of galvanic insulation - power supply; input - output, input – RS485	2,5 kV, 50 Hz, 1 min
Sampling frequency	2.5 kHz
Resolution	10 bit
Measurement range of analogue-digital transducers (minimum)	±220 V DC
Maximum constant non-destroying measurement voltage	330 Vrms
Maximum temporary voltage between any two out from four measurement input voltages for linear range of input circuits	±420 V (300 V AC)
Resistance for voltage impulse supplied between any pair of measurement input terminals	1 kV 1,2 / 50 μs (according to PN-EN-61000-4-5)
Power lose for measurement rated voltage	< 0,1 W
Measurement error for voltage effective value (0 °C < T < 40 °C)	< ±2 % Un
Phase measurement error (0 °C < T < 40 °C)	< ±2°
Frequency measurement error (0 °C < T < 40 °C)	< ±0,01 Hz

6.6 Two-states inputs data

Table 4. Two-states inputs parameters

Number of inputs	2
Input of galvanic insulation - power supply; input - output,	2,5 kV, 50 Hz, 1 min

input – RS485	
Rated voltage *)	220 V DC
Maximum constant non-destroying voltage	± 400 V DC
Resistance for voltage impulse supplied between measurement input terminals	1 kV 1,2/50 µs (according to PN-EN-61000-4-5)
Power lose for rated voltage	< 0,3 W
Switching voltage **)	(from 80 to 176) V DC

*) On request, the manufacturer can supply a device supporting other power-supply voltages and auxiliary voltages, e.g. 12 V, 24 V, 48 V, 110 V.

**) The ST input switching threshold is higher than the BL input switching threshold.

6.7 Outputs characteristics

Table 5. Contact outputs

Rated voltage	220 V DC
Admissible voltage value	250 V DC
Admissible value of constant current	1 A
Admissible value of temporary current (up to 2 s)	4 A
Admissible value of disconnection current	0,4 A DC or 8 A AC
Other parameters	as for Relpol RM96 relay
Accuracy of turning-on impulse duration	± 10 ms

7 . INSTALLATION

Before power supply is switched on for the first time or voltage is transmitted to the input terminals, the device should stay for at least three hours in the room, where it is to be installed, in order to balance temperatures and prevent humidity formation.

The device should be properly secured, protected against mechanical damages and against access of unauthorized persons. The device is designed to be installed on boards in indoors switching stations. It should be installed in a room that is not accessible to third persons and that ensures the second degree of protection against pollution. The device should be connected in compliance with the electric connections diagram presented in figure 6 and in compliance with tables 5 and 6. External connections are made through disconnetable PHOENIX CONTACT connectors. It is recommended to use LY type conductors with the cross-section between 0.5 mm^2 and 1.5 mm^2 to connect the device. In case stranded conductors are used, isolated terminal sleeves should be applied to conductor terminals.

The device can be installed exclusively by a person who is appropriately licensed to prepare electric installations.

The electric installation should be prepared to ensure safe operation at the rated voltages provided in the following tables: 2, 3, 4, 5.

Before the device is installed, one should make sure that the circuits the device is going to be connected to are cut off from power supply and that there is not dangerous voltage between measuring conduits and control conduits.

Conduits should lead to the plug-in connectors supplied with the device. Then, the connectors should be plugged into the corresponding device sockets.

Before the device is installed, one should make sure it is correctly configured.

It should be checked in particular, whether the slave address for the serial bus has been set. If the device is not intended to work within a communication system, it is recommended to define the relevant settings before the device is installed.

In the basic version, the RS485 connection leads are connected only to terminal clamps 1, 2 and 3 in connector I. On the user's request, it is possible to install additional RS485 interface connectors or replace the interface with an RS232C connector or optic fibre connectors. Figure 5 shows all proposed communication ports.

Table 6. Connector I

Terminal No.	Symbol	Description
1	SG	the signal GND in the RS485 connector
2	D1	RS485 connection line (**D1** according to MODBUS, **B** according to TIA/EIA-485)
3	D0	RS485 connection line (**D0** according to MODBUS, **A** according to TIA/EIA-485)
4		not connected
5	Z1-1	terminals of switching contact Z1
6	Z1-2	
7	Z2-1	terminals of switching contact Z2
8	Z2-2	

Table 7. Connector II

Terminal No.	Symbol	***Description***
9	U1	input of measuring voltage U1 on line L1
10	N1	reference input of measuring voltage U1 on line L1
11	U2	input of measuring voltage U2 on line L2
12	N2	reference input of measuring voltage U2 on line L2
13	BL+	interlock signal input – positive terminal
14	BL-	interlock signal input – negative terminal
15	ST+	ST signal input – positive terminal
16	ST-	ST signal input – negative terminal
17	ZAS-1	power-supply terminal – positive terminal
18	ZAS-2	power-supply terminal – negative terminal

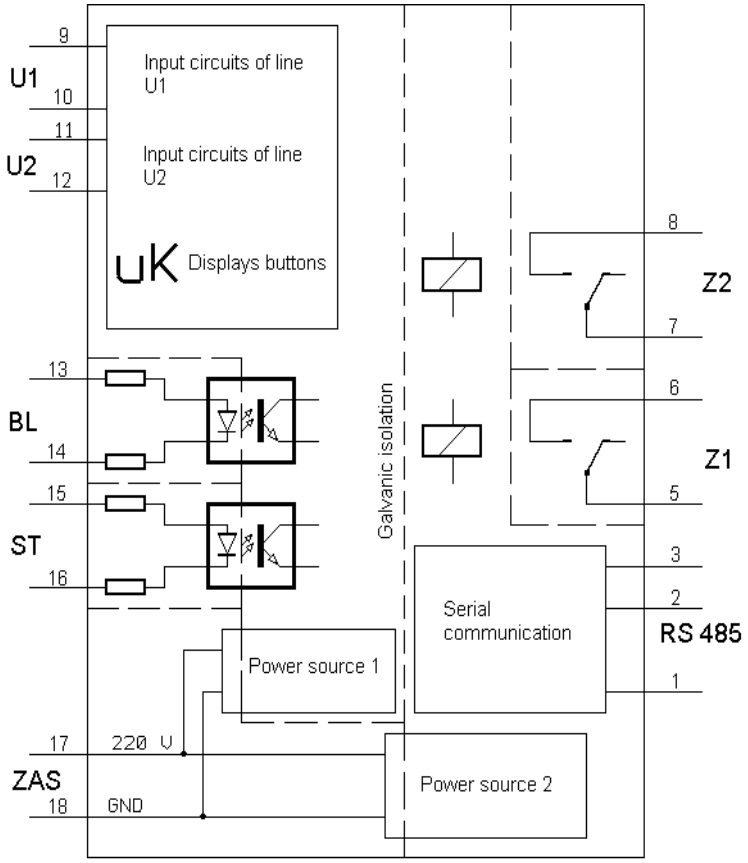

Fig. 3. Interlock diagram

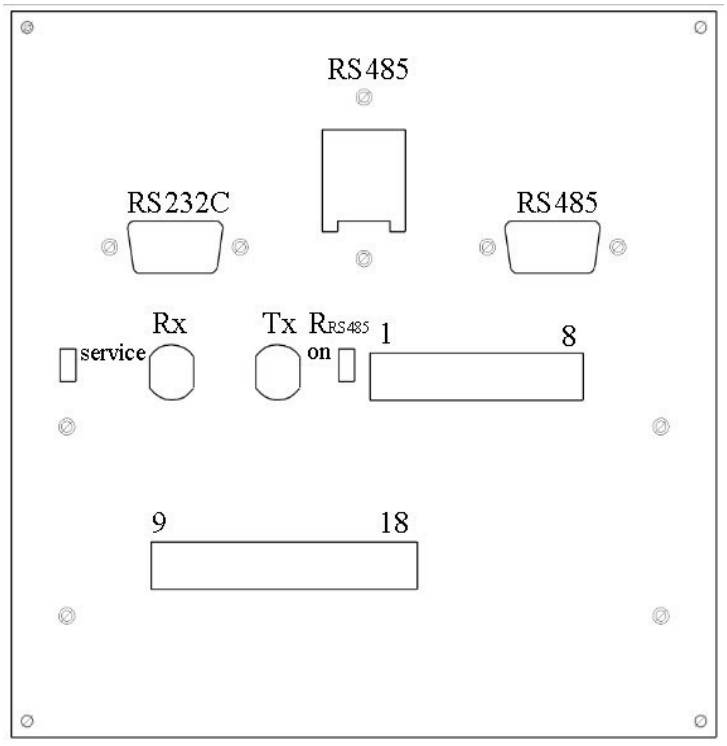

Fig. 4. Arrangement of connectors

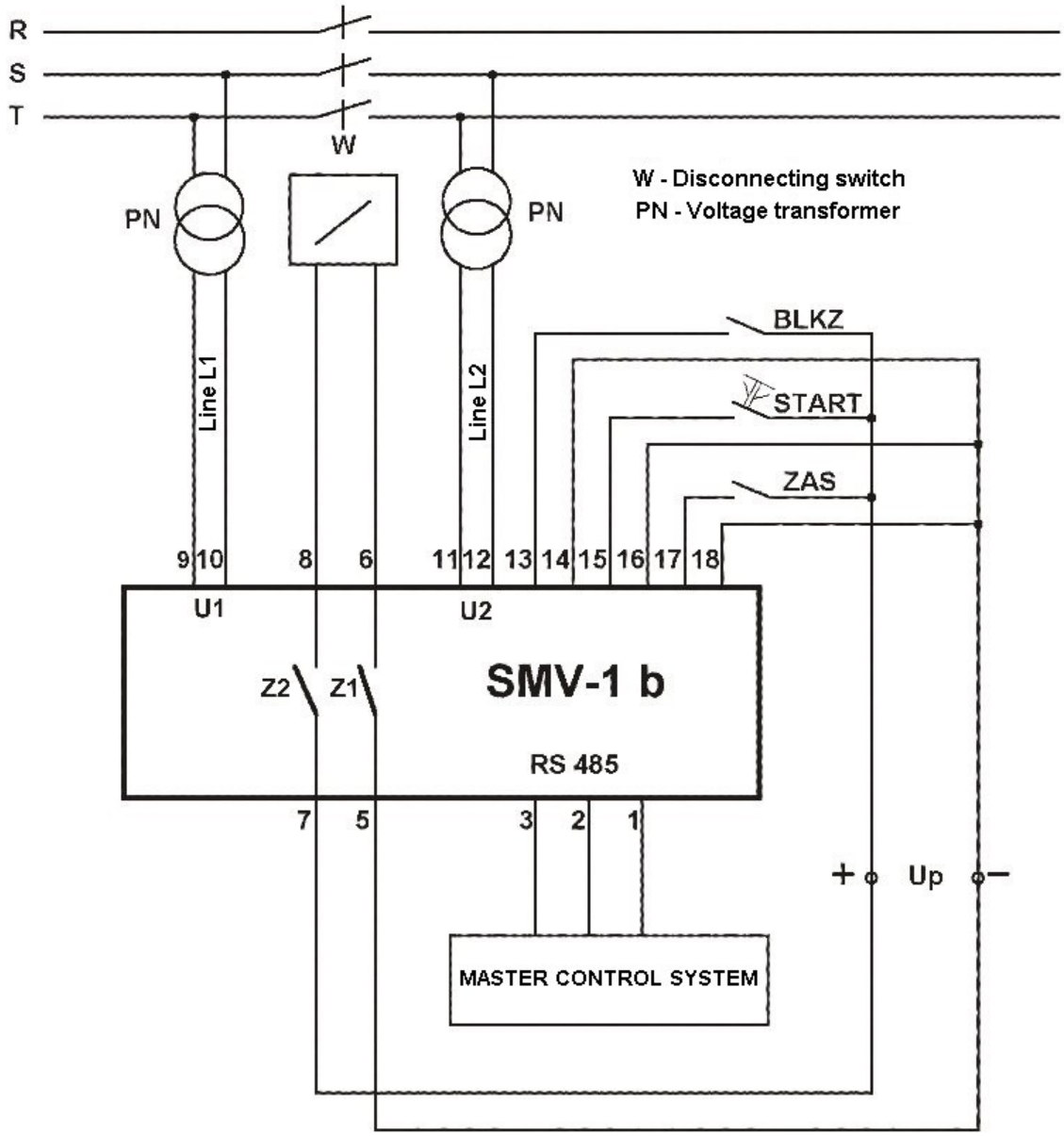

Fig. 5. Simplified diagram showing, how to connect the SMV-1b device to external circuits

8 . USAGE

8.1 Regular operation

Regular operation of the device boils down to switching the power supply on. The device will automatically start its operation after an interval of up to 1 s. If the device operates within an IT system, one can read various data from the device and change its settings. The relevant details are provided in section ***10.0 Communication over the serial port*** .

By means of buttons P1 (dark sun) and P2 (light sun), the operator can adjust the brightness of displays and adapt it to the prevailing ambient conditions.

The SMV-1b device is pre-programmed at the factory according to the buyer's specifications. The operator may change the settings over the RS connection with a PC workstation with installed software supplied by the manufacturer.

8.2 Manual readout of settings

The basic settings defined in **the SMV-1b** device can be viewed by means of push button "F".

1. After pressing "F" for the first time, the top display ("∆U") shows "Pro" (program), while the bottom display ("∆F") shows the software version.
2. When "F" is pressed again, the top display shows the cell address of the first parameter on the settings list, while the bottom display shows the value of the parameter.
3. All settings can be viewed by pressing "F" repeatedly. Once the entire settings list is scrolled down, pressing "F" again starts scrolling the list from the beginning.
4. After about 5 seconds after the last activation of pushbutton "F", the displayed parameters and value disappear and the displays show the current values of ∆U and ∆F.

9 . SMV-1b algorithm

The SMV-1b allows to select following operating modes:

SSN - switching synchronous network

SGD - switching generator on dead bar

SND - switching network on dead generator field (BAY)

SWV - switching without voltage, turning on the breaker to a dead network system and generator

9.1 Used symbols

Table 8. Symbols

Symbol	*Description*	*Formula*
dU	actual value of voltages difference	U2 - U1
dfr	actual value of frequency difference	f2 - f1
dfi	actual value of phase difference (including sign)	fi2 - fi1
f1	voltage frequency of L1 input	–
f2	voltage frequency of L2 input	–
U1	effective voltage of L1 input	–
U2	effective voltage of L2 input	–

9.2 Settings

In table and also in this document, all settings are provided using **bold** characters (in contrast to measuring and calculating values). All setting can be read and changed through the RS485 interface. For this purpose can be used also SCHRS program delivered together with the device or any other program that will provide functions described on Chapter 10. COMMUNICATION THROUGH THE SERIAL INTERFACE .

Table 9. Settings

No.	*Parameter*	*Symbol*	*Unit*	*Range*		*Standard value*	*Discr.*
				min.	*max.*		
	Slave address			1	256 (247)*	254	
1	Turning-on blockade at to small voltage U1	U1d	% Un	0	100	80	1
2	Turning-on blockade at to small voltage U2	U2d	% Un	0	100	80	1
3	Admissible lower value of voltage difference U2 - U1	Urd	% Un	-50	+50	-5	1
4	Admissible upper value of voltage difference U2 - U1	Urg	% Un	-50	+50	+5	1
5	Frequency difference for "from the bottom" synchronization (f1 > f2)	frd	Hz	0	1	0.3	0.001
6	Frequency difference for "from the top" synchronization (f1 < f2)	frg	Hz	0	1	0.3	0.001
7	Frequency difference for synchronous operation	fss	Hz	0	0.2	0.03	0.001
8	Compensation of constant phase shift	fi0	°	-75	+75	0	1
9	Angle limit value for descending absolute phase difference value and asynchronous operation	fi1	°	0	+60	15	1
10	*reserved*			0	0	0	
11	*reserved*						
12	Switch closing time	tw	ms	20	320	100	1

No.	*Parameter*	*Symbol*	*Unit*	*Range*		*Standard value*	*Discr.*
				min.	*max.*		
13	Increase of output signal duration time	tp	ms	0	1000	50	10
14	*reserved*						
15	Lower value of L1 line voltage	Ud1	% Un	80	120	90	1
16	Upper value of L1 line voltage	Ug1	% Un	80	120	110	1
17	Lower value of U1** voltage frequency	fd1	Hz	45.0	55.0	49.5	0.001
18	Upper value of U1** voltage frequency	fg1	Hz	45.0	55.0	50.5	0.001
19	Lower value of L2 line voltage	Ud2	% Un	80	120	90	1
20	Upper value of L2 line voltage	Ug2	% Un	80	120	110	1
21	Lower value of U2** voltage frequency	fd2	Hz	45.0	55.0	49.5	0.001
22	Upper value of U2** voltage frequency	fg2	Hz	45.0	55.0	50.5	0.001
23	Lowest residual voltage of dead busways on Line L1	Usd1	%Un	0	5	2	1
24	Highest residual voltage of dead busways on Line L1	Usg1	%Un	0	20	15	1
25	Lowest residual voltage of dead busways on Line L2	Usd2	%Un	0	5	2	1
26	Highest residual voltage of dead busways on Line L2	Usg2	%Un	0	20	15	1
27	reserved						

* It is possible to enter any number from 0 to 255, however the MODBUS standard requires to use number from 1 to 247.

** In standard version, rated frequency Fn = 50 Hz, it is possible to manufacture version Fn = 60 Hz.

Used symbols:

Un – rated voltage , Fn – rated frequency

Compensation of constant phase shift – positive value means that L2 voltage is delayed in relation to L1 voltage.

9.3 Definitions

Phase difference is decreasing – this means that the absolute value of U1 and U2 voltage phase shift is decreasing with substantial rate, in other words, it cannot be treated as the synchronous operation. The following condition is fulfilled:

$d|fi|/dt \leq$ -**fss**

Phase difference is increasing – this means that the absolute value of U1 and U2 voltage phase shift is increasing with substantial rate, in other words, it can be treated as the synchronous operation. The following condition is fulfilled:

$d|fi|/dt \geq$ **fss**

Synchronous operation – this means that the absolute value of U1 and U2 voltage phase shift is constant or changes very slowly, in other words not quicker than it can be treated as the synchronous operation. The following condition is fulfilled:

|dfi/dt| < **fss**

9.4 SMV-1b operation algorithm in SSN mode

9.4.1 Condition for energizing SY signalling circuit (LED)

All the following conditions are met in a continuous manner during a set time tk ("the verification time of switching conditions"):

Voltage 1. U1 > U1d

Voltage 2. U2 > U2d

Voltage 3. Urd □ **dU** □ Urg

Frequency frd □ dfr □ frg

Phase – one of the following conditions is fulfilled:

Phase 1. (phase difference is decreasing) and (|dfi| ≤ fi1)
Phase 2. (synchronous operation) and (|dfi| ≤ fi1)

9.4.2 Condition for de-energizing the signalling circuit

Any of the signalling conditions is not met.

9.4.3 Conditions for energizing relays Z1, Z2

As in the case of energizing the signalling circuit plus the following:

No external blockade signal BL = 0 V
Start signal ST – change from 0 V to +Up

Attention! A start signal is ignored if the proceeding start signal appears during the last second. The start signal (ST = +Up) activates output signal relays (Z1 and Z2) only when it appears within a pre-set angle sector and when there is no external interlock signal

at the same time. The external interlock signal (BL = +Up) blocks their activation. The interlock signal is effective only when it appears before relays Z1 and Z2 are activated.

9.4.4 Conditions for de-energizing Z1 and Z2

The relay activation interval for relays Z1 and Z2 – equal to the sum of the pre-set values (**tw+tp**) – has been counted down and any of the conditions for energizing the SY signalling circuit has not been met (or was not met for some time) during the interval of relay Z1/Z2 activation. In other words, the interval of relay Z1/Z2 activation lasts as long as the conditions for energizing the SY signalling circuit are continuously met, yet it is not shorter than **(tw+tp)**. Moreover, the start signal must disappear (activation of relays Z1/Z2 is prolonged until the end of the star signal, no matter whether other conditions are met).

The signal that switches Z1 and Z2 on is also de-energized if the power supply to the SMV-1b device is cut off.

9.5 Graphical representation of SMV-1b operation

Figure 6 presents the signals generated by the SMV-1b device. Figures 7 and 8 present typical situations, when signals are not generated. The position of the difference between the voltages of facilities to be connected is presented in the top part of the figures. The thick line below represents the active states of input and output signals of the SMV-1b device.

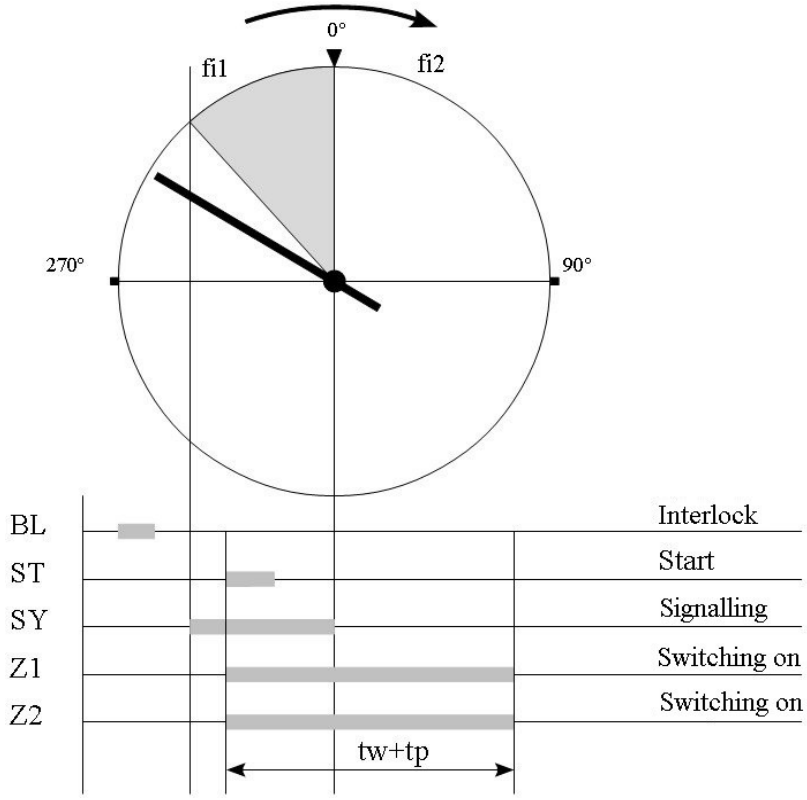

Fig. 6. The switch-on impulse is sent in SMV-1b

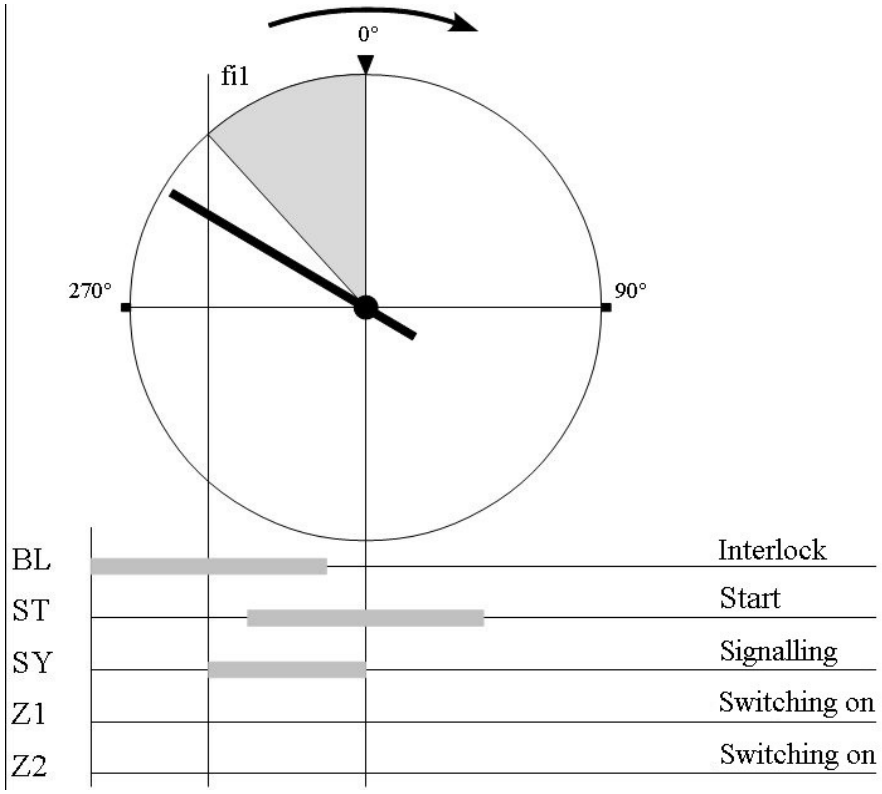

Fig. 7. No switch-on impulse. The ST signal (start) is blocked by the BL signal (interlock)

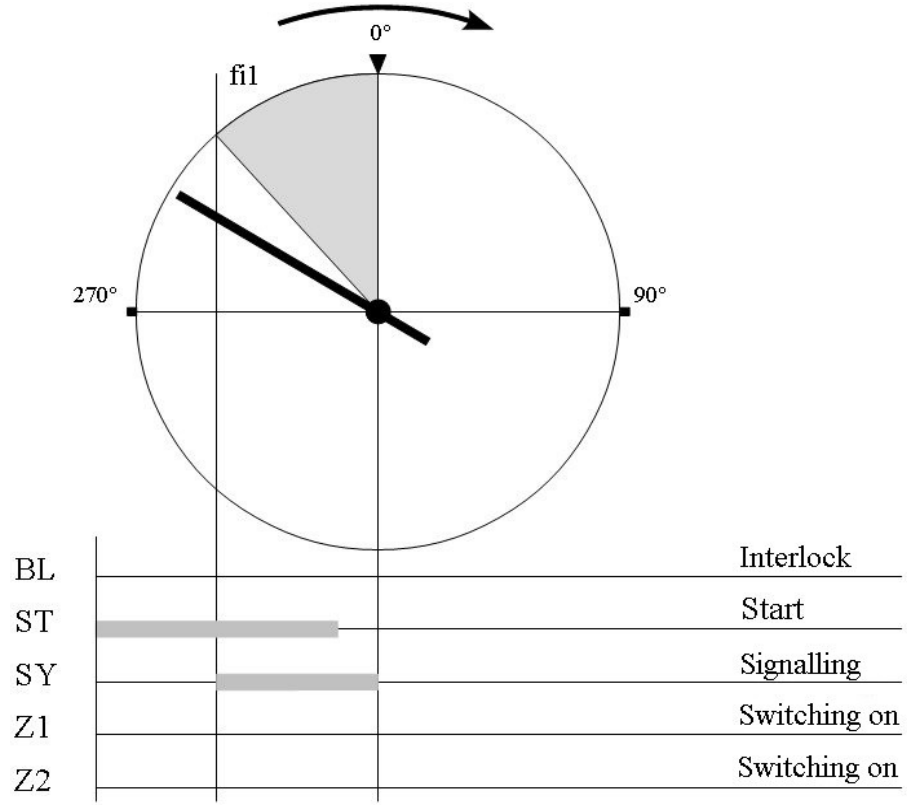

Fig. 8. No switch-on impulse. The ST (start) impulse sent to early

9.6 SCH-2 operation algorithm in SGD mode

9.6.1 Conditions for energizing SY signalling circuit (LED)

SY relay is actuated, when at the same time the following conditions are fulfilled:

Voltage 1. Usd1 <**U1** < Usg1 **//residual voltage**

Voltage 2. Ud2 <**U2**< Ug2

9.6.2 Conditions for de-energizing the signalling circuit

Any of the signalling conditions is not met.

9.6.3 Conditions for energizing relays Z1, Z2

As in the case of energizing the signalling circuit plus the following:

No external blockade signal BL = 0 V

Start signal ST – change from 0 V to +Up

Attention!

The start signal is ignored, if in the last second previous start signal is appearing. Duration time of this blockade is deducted from any previous ascent of this signal.

9.6.4 Conditions for Z1 and Z2 relays de-actuation

Actuation of Z1 and Z2 relays lasts until the time **(tw+tp)** will be deducted, measured from actuation time of these relays.

9.7 SMV-1b operation algorithm in SND mode

9.7.1 Conditions for energizing SY signalling circuit (LED)

SY relay is actuated, when at the same time the following conditions are fulfilled:

Voltage 1. Ud1 <**U1** < Ug1

Voltage 2. Usd2 <**U2**< Usg2 **//residual voltage**

1.1.1.1.

9.7.2 Conditions for de-energizing the signalling circuit

Any of the signalling conditions is not met.

9.7.3 Conditions for energizing relays Z1, Z2

Z1 and Z2 relays are actuated, when the following conditions are fulfilled for actuation of SY relay, and:

No external blockade signal BL = 0 V

Start signal ST – change from 0 V to +Up

Attention!

The start signal is ignored, if in the last second previous start signal is appearing. Duration time of this blockade is deducted from any previous ascent of this signal.

9.7.4 Conditions for Z1 and Z2 relays de-actuation

Actuation of Z1 and Z2 relays lasts until the time **(tw+tp)** will be deducted, measured from actuation time of these relays.

9.8 SCH-2 operation algorithm in SWV mode

9.8.1 Conditions for energizing SY signalling circuit (LED)

SY relay is actuated, when at the same time the following conditions are fulfilled:

Voltage 1. Usd1 <**U1** < Usg1 **//residual voltage**

Voltage 2. Usd2 <**U2**< Usg2 **//residual voltage**

9.8.2 Conditions for de-energizing the signalling circuit

Any of the signalling conditions is not met.

9.8.3 Conditions for Z1 and Z2 relays actuation

Z1 and Z2 relays are actuated, when the following conditions are fulfilled for actuation of SY relay, and:

No external blockade signal **BL** = 0 V

Start signal **ST** – change from 0 V to +Up

Attention!

The start signal is ignored, if in the last second previous start signal is appearing. Duration time of this blockade is deducted from any previous ascent of this signal.

9.8.4 Conditions for Z1 and Z2 relays de-actuation

Actuation of Z1 and Z2 relays lasts until the time **(tw+tp)** will be deducted, measured from actuation time of these relays.

10 . COMMUNICATION THROUGH THE SERIAL INTERFACE

10.1 Basic informations

The SMV-1b device is equipped with an asynchronous serial connection that operates according to standard TIA/EIA-485. The interface is galvanically isolated from the rest of the system. Terminal clamps are marked in compliance with the MODBUS standard. Different manufacturers adopt different conventions for marking the terminals of such an interface (occasionally, opposite conventions are adopted). Therefore, one can use the following table to avoid any mistakes (the second part of the table presents symbols used according to standards TIA/EIA-485 and TIA/EIA-422).

Table 10. Denotations for signals and RS485 interface

Logical levels		
logical level	0	1
signal	START, SPACE, ON	STOP, MARK, OFF
voltage levels	u(D0) > u(D1)	u(D0) < u(D1)
Used symbols		
acc. to MODBUS	***other used symbols***	
D0 *(brown)*	A, RDA, SDA, SDB, SD+, RDB, RD+, SIG-B, L1, L3, UTX H, URX H, L(+), TD(B)+, A+, B+, TX+, RX+	
D1 *(yellow)*	B, RDB, SDB, SDA, SD-, RDA, RD-, SIG-A, L2, L4, UTX L, URX L, L(-), TD(A)-, A-, B-, TX-, RX-	
SG *(grey)*	Common, FG, SHIELD, G, 0V, GND	

10.2 Program for entering settings

The relay is delivered together with SCHRS computer program that allows to perform all operations available for MODBUS interface. This program allows to read and change settings, red-out of measured values and calculated parameters of voltages, input and output signal states, etc. The detailed description of the communication between the program and the controller is provided below. This program is adopted for operation in Windows operating system (was tested for Win98, XP, 2000). Program description is available in the Appendix.

10.3 Transmission rate

It is possible to set the following values: 4800 Bd, 9600 Bd, 19200 Bd, 38400 Bd, 57600 Bd. 115200 Bd, 128000 Bd, 256000 Bd rates were tested with positive results, however they are generated with error that slightly exceeds MODBUS RTU requirements, and usage of these values should be limited only to testing or servicing purposes. The same applies to 2400 Bd rate.

Table 11. Settings for asynchronous transmission rate

Code			***BRGH***	***SPBRG***	***Transmission rate [Bd]***
Hi	***Lo***				
.... 0100	0xFF	1279	0	255	2400
.... 0100	0x81	1153	0	129	4800
.... 0100	0x40	1088	0	64	9600
.... 0000	0x81	129	1	129	19200
.... 0000	0x40	64	1	64	38400
.... 0000	0x2A	42	1	42	57600
.... 0000	0x15	21	1	21	115200
.... 0000	0x13	19	1	19	128000
.... 0000	0x09	9	1	9	256000

Code – value entered to MBHR_BAUD register

BRGH – configuration bit in micro-controller

SPBRG – value entered to the register of timer divider that is clocking the serial interface in micro-controller

10.4 Parity bit

Attention!

In actual version, the parity bit operation is not implemented. If necessary, for the user request it can be accomplished according to the following method.

In ASCII mode, bit no. 8 and in RTU mode bit no. 9 can be used as the parity bits.

Numeration of bits in sequence of sending one byte or sign in asynchronous transmission:

0 – start bit

1 – youngest bit of the sent byte

etc.

Possible for programming modes of parity bit settings are:

- parity mark
- odd parity mark
- additional stop bit (logical value 0).

All setting for parity bit are saved together with the settings for transmission rate in bits no. 4 and 5 of the older byte in this setting. The coding method is provided in the following Table.

Table 12. Settings for parity bit calculation mode in the send bytes

Code		***Parity bit calculation mode***
Hi	***Lo***	
..00	....	additional stop bit (logical value 0)
..10	....	parity mark
..11	....	odd parity mark

10.5 Protocol

Asynchronous transmission through the RS485 interface is available through the protocol based on MODBUS ASCII or MODBUS RTU.

All setting for asynchronous transmission protocol are saved together with the settings for transmission rate in bits no. 6 of the older byte in this setting.

The coding method is provided in the following Table:

Table 13. Settings for asynchronous transmission protocol

Code		***Protocol***
Hi	***Lo***	
.0..	....	ASCII mode
.1..	....	RTU mode

10.6 Informations available through the asynchronous connection

All informations available through the commands of MODBUS protocol are provided in the following Table:

Table 14. MODBUS register addresses (MODBUS holding registers)

Address	***Symbol***	***Content***
		INFORMATIONS ABOUT DEVICE AND PROGRAM
1	MBHR_WER_DTA	Program compilation date (read-only)
2	MBHR_WER_NR	Program version number (read-only)
3	MBHR_WER_TYP	Relay type (version) (read-only)

Address	*Symbol*	*Content*
4	MBHR_BAUD	Transmission rate
5	MBHR_MB_ADDR	Slave address (non-volatile memory*)
		SETTINGS (non-volatile memory*)
6	MBHR_U1d	Blockade of to low L1 line voltage [% Un]
7	MBHR_U2d	Blockade of to low L2 line voltage [% Un]
8	MBHR_Urd	Admissible upper value of voltage difference U2 - U1 [% Un]
9	MBHR_Urg	Admissible lower value of voltage difference U2 - U1 [% Un]
10	MBHR_frd	Frequency difference for "from the bottom" synchronization (f1 > f2) [mHz]
11	MBHR_frg	Frequency difference for "from the top" synchronization (f1 < f2) [mHz]
12	MBHR_fss	Frequency difference for synchronous operation [mHz]
13	MBHR_fi0	Compensation of constant phase shift [°]
14	MBHR_fi1	Angle limit value for descending absolute phase difference value [°]
15	MBHR_fi2	Angle limit value for ascending absolute phase difference value [°] (not available in SCH-2)
16	MBHR_uf	Admissible phase deviation [°] (nor available in SCH-2 version)
17	MBHR_tw	Switch turning-off time [ms]
18	MBHR_tp	Increase of output signal duration time [ms]
19	MBHR_tk	Control time of turning-on conditions [ms]
		Settings – voltage-free switches (non-volatile memory*)
20	MBHR_Ud1	Lower value of L1 line voltage [% Un]
21	MBHR_Ug1	Upper value of L1 line voltage [% Un]
22	MBHR_fd1	Lower value of U1 voltage frequency [mHz]
23	MBHR_fg1	Upper value of U1 voltage frequency [mHz]
24	MBHR_Ud2	Lower value of L2 line voltage [% Un]
25	MBHR_Ug2	Upper value of L2 line voltage [% Un]
26	MBHR_fd2	Lower value of U2 voltage frequency [mHz]
27	MBHR_fg2	Upper value of U2 voltage frequency [mHz]
28..31		Reserve
		Two-state settings
32..35		Reserve
		Calibration (non-volatile memory*)

Address	***Symbol***	***Content***
36	MBHR_KAL_S	Calibration of L1 voltage measurement (value calculated on the basis of ADC transducer samples for U1 = 100 V AC RMS)
37	MBHR_KAL_G	Calibration of L2 voltage measurement (value calculated on the basis of ADC transducer samples for U2 = 100 V AC RMS)
38	MBHR_EEPRCRC	Control sum of EEPROM
39	MBHR_LRST	Restarts counter
		Measured values
40	MBHR_US	Measuring voltage value U1 [0.1 V]
41	MBHR_UG	Measuring voltage value U2 [0.1 V]
42	MBHR_DU	Voltage difference U2 – U1 [0.1 V]
43	MBHR_TS	U1 voltage period [0.8 μs]
44	MBHR_TG	U2 voltage period [0.8 μs]
45	MBHR_DTGS	U1 and U2 voltage periods difference [0.8 μs]
46	MBHR_TSG	Difference of passing times through the zero tL2 - tL1 [0.8 μs]
47	MBHR_TGS	Difference of passing times through the zero tL1 - tL2 [0.8 μs]
48	MBHR_WAR0	State of fulfilment of conditions controlled by the program. Informations are available on the respective register bits. Detailed description id provided in Table *Functions of bits in wMBHR_WAR0, MBHR_WAR1, MBHR_WAR2, MBHR_WAR3 registers*
49	MBHR_WAR1	
50	MBHR_WAR2	
51	MBHR_WAR3	
52..53		Reserve
54	MBHR_DFi	Phase difference Fi2 – Fi1 (fig - fis) [0.01°]
55	MBHR_FS	Frequency F1 (fs) [0.01 Hz]
56	MBHR_FG	Frequency F2 (fg) [0.01 Hz]
57		Reserve
58	MBHR_U0_S	Constant component of L1 voltage
59	MBHR_U0_G	Constant component of L2 voltage
60..69		Reserve
		Control registers
70	MBHR_LRCCODE_W	Program control sum (entered)
71	MBHR_LRCCODE_O	Program control sum (calculated)
72	MB_CMD	Command (list of commands is provided below)

Address	*Symbol*	*Content*
73		Reserve
74	MB_CMD_R	Response after command execution
75		Reserve
76	MB_HASLO	Password – youngest 16 bits (password description is provided below)
77		Password – older 16 bits (password description is provided below)
78..96		Reserve

The unit is provided in square brackets.

* Rewriting of the registers content to the non-volatile memory (EEPROM) is performed by the proper command, and reading of the registers content from EEPROM is performed after each restart of the program. Writing to the EEPROM is possible only, when the device is blocked.

To obtain partial conformity with SM-06B synchronizer, additional registers are provided for read-out purposes using MODBUS protocol. Part of these registers duplicate values of the existing registers, and some of them are providing new values. These addresses are from %R3585 to %R3840 (addresses from 3584 to 3839, in other words older byte of the address of read registers must be equal to 0x0E). Reading of registers only from these addresses is admissible using function Read Holding Registers. If the given register is not included in Table 13, its value will be available as 0.

Table 15. MODBUS register addresses (MODBUS holding registers)

Register	*Address*	*Symbol*	*Content*	*Units*
%R3625	3624	MBHR06_US	Voltage value Us	0.1%Un
%R3626	3625	MBHR06_UG	Voltage value Ug	0.1%Un
%R3627	3626	MBHR06_FS	Frequency value Fs	0.01 Hz
%R3628	3627	MBHR06_FG	Frequency value Fg	0.01 Hz
%R3633	3632	MBHR06_DU	Value of voltage difference Ug – Us in U2 code	0.01%Us
%R3634	3633	MBHR06_DF	Value of frequency difference Fg – Fs in U2 code	0.01%Fs

Register	Address	Symbol	Content	Units
%R3636	3635	MBHR06_DFi	Value of phase difference between Ug and Us synchronizer inputs	0.01°
%R3637	3636	MBHR06_DFi 1	Value of phase difference between Ug and Us synchronizer inputs, including setting fi0*)	1°

* – fi0 value is deducted from measured value of phase shift

Values 0x8000 and 0x8001 stand for undefined value

Un – voltage nominal value equal to 100 V RMS

Table 16. Constants available in the communication through the MODBUS interface

Symbol	Value	Description
MB_HASLO_1	0x3425A0B2	Password that allows to change settings and enter commands (to eliminate the risk of accidental modification of the settings).
MODBUS_ADR_SRV	0xFE	Slave MODBUS address for servicing purposes. It allows reading and writing of the proper slave address.
MODBUS_ADR_ZW	0xFD	The MODBUS slave address for servicing purposes. It functions in the servicing mode activated with the "service" switch. It allows one to read and write the appropriate slave address.

Commands. When a command is introduced at an appropriate address (see *Control registers* in the *MODBUS register addresses* table), the corresponding action will be carried out. Password MB_HASLO_1 must be provided before a command can be introduced.

Table 17. Commands recommended for execution through MODBUS interface

Code	Symbol	Task
0x7829	MBCMD_RESET	Execute RESET command from processor
0x783A	MBCMD_WR_EEPR	Write registers to EEPROM (registers that are saved in non-volatile memory)
0x7312	MBCMD_KAL_S	Start application
0x7325	MBCMD_KAL_E	Finish calibration
0x735A	MBCMD_KAL_B	Interrupt calibration
0x74F0	MBCMD_BLK_0	Turn-off blockade

Code	Symbol	Task
0x740F	MBCMD_BLK_1	Turn-on blockade Attention! This function is used for short-term blockade of the device, e.g. for changing settings. During restart, the blockade is cancelled.

Table 18. Responses for commands recommended for execution through MODBUS interface

Code	Symbol	Meaning
0x0101	MBCMD_RST	MB_CMD_R register value (containing responses for commands), entered after restart of the program
0x1223	MBCMD_KAL_ST	Confirmation of calibration start-up
0x1234	MBCMD_KAL_OK	Confirmation of proper completion of the calibration
0x1245	MBCMD_KAL_BR	Confirmation of calibration interruption

10.7 Reading the settings

Reading of the settings is performed in standard way using MODBUS command "**Read Holding Registers**". Addresses of registers congaing settings are provided in Table *MODBUS registers addresses (MODBUS holding registers)* on page 30.

10.8 Writing the inputs

If to the RS485 bus is connected only one controller, it is possible to use service address MODBUS_ADR_SRV. Of more controllers is connected, we recommend to use uniqueslave address.

To write the settings, the following procedure must be performed:

- If controller's slave address is unknown, or can be read using the service address MODBUS_ADR_SRV (functioning always, however only one controller can be connected to the bus),
- Make sure that the slave address is proper (from 1 to 247), and whether controller for this address is responding (e.g. it is possible to read basic informations about the relay – version, etc.). If not, ask operator for this address and write it to the controller (according to the description provided below).
- Enter 32-bit password MB_HASLO_1 (see point: *Constant parameters available in the program*) to two registers provided for entering the password (see Table: *MODBUS registers addresses (MODBUS holding registers)* on page 30. Writing of the settings is performed in standard way using MODBUS command "***Write Multiple***

registers. For this purpose, *slave* servicing address can be used. Attention! Password is cancelled after execution of another MODBUS command ***Write Multiple registers***.

- Enter setting using MODBUS command ***Write Multiple registers***.
- Rewrite content of the registers to the non-volatile memory (EEPROM) using command MBCMD_WR_EEPR entered under MB_CMD address.

Attention! Writing to the EEPROM is possible only, when the device is blocked.

10.9 Writing the slave address

To write the slave address, the following procedure must be performed:

- Using servicing address it is possible to read controller's slave address.
- Make sure, the address is correct. If yes, use this address, and if not, use servicing address.
- Enter 32-bit password MB_HASLO_1 (see point: *Constant parameters available in the program*) to two registers provided for entering the password (see Table: *MODBUS registers addresses (MODBUS holding registers)* on page 30. Writing is performed in standard way using MODBUS command ***Write Multiple registers***. Existing *slave* address can be also used (of was entered correctly), eventually servicing *slave* address. Attention! Password is cancelled after execution of another MODBUS command ***Write Multiple registers***.
- Enter slave address using MODBUS function ***Write Multiple registers***.
- Rewrite content of the registers to the non-volatile memory (EEPROM) using command MBCMD_WR_EEPR entered under MB_CMD address.

Attention! Writing to the EEPROM is possible only, when the device is blocked.

10.10 Reading the informations about relay and measured values

Reading of informations about relay, program, calibration and values measured by the relay is performed in standard way using MODBUS function ***Read Holding Registers***. Addresses of registers containing informations about relay version and its software are provided in Table 12 *Addresses of MODBUS registers (MODBUS holding registers)* on page 30. Interpretation of read values (e.g. physical magnitude values) for most registers are provided also in this Table. Meaning of he other registers, not described in this Table, is following:

- **Program compilation date.**

This register contains program compilation date. Coding method is same as used in spreadsheets (e.g. *OpenOffice.org*) and libraries of Delphi compiler for operations on dates.

Examples of dates and corresponding day numbers:

1899-12-30	0
2003-01-01	37622
01/01/2004	37987
01/01/2005	38353
01/01/2006	38718

- **Relay type code (version).**

Older byte of this register defines set of settings. This the information is used mostly for the program used for entering settings (running on the PC computer) that allow automatic opening of the proper set of settings. Definitions of codes are provided in the following Table.

Table 19. Relay type (version) coding in MBHR_WER_TYP register

Code	*Symbol*	*Meaning*
0x12xx	WERSJA_SP-01K_1	Version of "SMV-1b device"

- **State of fulfilment of conditions controlled by the program.**

MBHR_WARx registers contain information about fulfilment of the conditions required for turning-on procedure. Setting of proper bits on “1” means that the condition is fulfilled.

Table 20. Functions of bits in MBHR_WAR0, MBHR_WAR1, MBHR_WAR2, MBHR_WAR3 registers

Bite		*Symbol*	*Meaning*
0	0l.0	warunek_U1d	fulfilment of condition U1 > U1d (1 = green, 0 = yellow)
1	0l.1	warunek_U2d	fulfilment of condition U2 > U2d (1 = green, 0 = yellow)
2	0l.2	warunek_Urd	fulfilment of condition Urd <= dU (1 = green, 0 = yellow)
3	0l.3	warunek_Urg	fulfilment of condition dU <= Urg (1 = green, 0 = yellow)
4	0l.4	warunek_frd	fulfilment of condition frd <= dfr (1 = green, 0 = yellow)
5	0l.5	warunek_frg	fulfilment of condition dfr <= frg (1 = green, 0 = yellow)
6	0l.6	warunek_fss	fulfilment of condition |dfi/dt| < fss (1 = green, 0 = yellow)

Bite		Symbol	Meaning
7	0l.7	warunek_war_pr	reserve
8	0h.0		reserve
9	0h.1		reserve
10	0h.2	warunek_err_us	open circuit for network voltage measurement (or other error?) (1 = red, 0 = grey)
11	0h.3	warunek_err_ug	open circuit for generator voltage measurement (or other error?) (1 = red, 0 = grey)
12	0h.4	warunek_Ud1	fulfilment of condition Ud1 < U1 (1 = green, 0 = yellow)
13	0h.5	warunek_Ug1	fulfilment of condition U1 < Ug1 (1 = green, 0 = yellow)
14	0h.6	warunek_fd1	fulfilment of condition fd1 < f1 (1 = green, 0 = yellow)
15	0h.7	warunek_fg1	fulfilment of condition f1 < fg1 (1 = green, 0 = yellow)
16	1l.0	warunek_Ud2	fulfilment of condition Ud2 < U2 (1 = green, 0 = yellow)
17	1l.1	warunek_Ug2	fulfilment of condition U2 < Ug2 (1 = green, 0 = yellow)
18	1l.2	warunek_fd2	fulfilment of condition fd2 < f2 (1 = green, 0 = yellow)
19	1l.3	warunek_fg2	fulfilment of condition f2 < fg2 (1 = green, 0 = yellow)
20	1l.4	warunek_Usd1	fulfilment of condition Usd1 < U1 (1 = green, 0 = yellow)
21	1l.5	warunek_Usg1	fulfilment of condition U1 < Usg1 (1 = green, 0 = yellow)
22	1l.6	warunek_Usd2	fulfilment of condition Usd2 < U2 (1 = green, 0 = yellow)
23	1l.7	warunek_Usg2	fulfilment of condition U2 < Usg2 (1 = green, 0 = yellow)
24	1h.0	war_frq_blk	time count down frq_blk (1 = red, 0 = grey)
25	1h.1	stan_war_sp	continuity of condition fulfilment during permission signal duration (1 = green, 0 = yellow)
26	1h.2		reserve
27	1h.3	warunek_fazy	fulfilment of phase condition (1 = green, 0 = yellow)
28	1h.4	warunek_s_ok	network (U1) period correct (1 = green, 0 = yellow)
29	1h.5	warunek_g_ok	network (U2) period correct (1 = green, 0 = yellow)
30	1h.6	sync_up	synchronization "from the top" (1 = green, 0 = yellow)
31	1h.7	sync_dn	synchronization "from the bottom" (1 = green, 0 = yellow)
32	2l.0	stan_BLOK	state of optocoupler input BLOK (1 = orange, 0 = grey)
33	2l.1	stan_START	state of optocoupler input START (1 = orange, 0 = grey)
34	2l.2	stan_SY	state of relay input SY (1 = orange, 0 = grey)
35	2l.3	stan_Z1	state of relay input Z1 (1 = orange, 0 = grey)
36	2l.4	stan_Z2	state of relay input Z2 (1 = orange, 0 = grey)

Bite		Symbol	Meaning
37	2l.5		reserve
38	2l.6		reserve
39	2l.7		reserve
40	2h.0	mb_serwis	MODBUS frame with servicing address (1 = red, 0 = grey)
41	2h.1	kalibracja_on_j	calibration mode enabled by the jumper (1 = red, 0 = grey)
42	2h.2	kalibracja_on_m	calibration mode enabled by modbus(1 = red, 0 = grey)
43	2h.3	mb_err_eeprom	error of settings control sum (1 = red, 0 = grey)
44	2h.4	mb_err_prog	error of program control sum (1 = red, 0 = grey)
45	2h.5	mb_err_kalibr	no calibration for measuring inputs (1 = red, 0 = grey)
46	2h.6	serwis_on	servicing mode enabled (by the jumper) (1 = red, 0 = grey)
47	2h.7	nst_err	error in settings (1 = red, 0 = grey)
48	3l.0	warunek_fi1su_up	fulfilment of condition |dfi| <= fi1 for synchronization from the top, passing through the zero up (1 = green, 0 = yellow)
49	3l.1	warunek_fi1su_dn	fulfilment of condition |dfi| <= fi1 for synchronization from the top, passing through the zero down (1 = green, 0 = yellow)
50	3l.2	warunek_fi2su_up	fulfilment of condition |dfi| <= fi2 for synchronization from the top, passing through the zero up (1 = green, 0 = yellow)
51	3l.3	warunek_fi2su_dn	fulfilment of condition |dfi| <= fi2 for synchronization from the top, passing through the zero down (1 = green, 0 = yellow)
52	3l.4	warunek_fi1sd_up	fulfilment of condition |dfi| <= fi1 for synchronization from the bottom, passing through the zero up (1 = green, 0 = yellow)
53	3l.5	warunek_fi1sd_dn	fulfilment of condition |dfi| <= fi1 for synchronization from the bottom, passing through the zero down (1 = green, 0 = yellow)
54	3l.6	warunek_fi2sd_up	fulfilment of condition |dfi| <= fi2 for synchronization from the bottom, passing through the zero up (1 = green, 0 = yellow)
55	3l.7	warunek_fi2sd_dn	fulfilment of condition |dfi| <= fi2 for synchronization from the bottom, passing through the zero down (1 = green, 0 = yellow)
56	3h.0	warunek_fi1ss_up	fulfilment of condition |dfi| <= min(fi1, fi2) for synchronous operation, passing through the zero up (1 = green, 0 = yellow)
57	3h.1	warunek_fi1ss_dn	fulfilment of condition |dfi| <= min(fi1, fi2) for synchronous operation, passing through the zero down (1 = green, 0 = yellow)
58	3h.2	warunek_fi2ss_up	fulfilment of condition |dfi| <= min(fi1, fi2) for synchronous operation, passing through the zero up (1 = green, 0 = yellow)
59	3h.3	warunek_fi2ss_dn	fulfilment of condition |dfi| <= min(fi1, fi2) for synchronous

Bite		*Symbol*	*Meaning*
			operation, passing through the zero down (1 = green, 0 = yellow)
60	3h.4	war_t_start	time count-down t_start – blocking START signal actuation during 1 s from previous actuation of this signal (previous ascent) – see point 9.4.3.2 (1 = orange, 0 = grey)
61	3h.5	war_t_tp	time count down tp (1 = blue, 0 = grey)
62	3h.6	war_t_tk	time count down tk (1 = blue, 0 = grey)
63	3h.7	mb_blokada	blocking by MODBUS (1 = orange, 0 = grey)

Colours of signalling lamps are provided in parentheses in the delivered program for PC computers (SCHRS.exe).

Bits 0..15 are contained in ***MBHR_WAR0*** register, and bits 16..31 in ***MBHR_WAR1*** *register, etc.*

11 . CALIBRATION

For calibration can be used a PC computer with running SCHRS program with connected relay. Such calibration process is described in usage instruction for the program. Below we describe the calibration process performed by this program – using commands send through the RS485 interface. The user can create own program that will calibrate the relay in the same way.

Attention! Calibration process is possible only for blocked device.

Calibration of measurement paths is performed in the following way:

- Connect reference voltage 100 V AC to the terminals of both measuring inputs.
- Turn-on the power supply.
- Enter password MB_HASLO_1, and then command MBCMD_KAL_S.
- Wait one second or longer.
- Send password MB_HASLO_1, and then command MBCMD_KAL_E. In this moment, calibration factors defined on the basis of measurements performed during last 0.5 second will be write to EEPROM. It is important to make sure that during the last second before sending this command the reference voltage is equal to 100 V AC.
- If the power supply voltage will be turned-off or command MBCMD_KAL_B will be send (preceded with password MB_HASLO_1) before MBCMD_KAL_E command, calibration factors will not be changed.

– They will be not changed also in situation, when defined value of the factors will substantially exceed the typical values. It possible, when the reference voltage will be incorrect or measuring system will not operate correctly.

12 . PACKAGING, STORAGE AND TRANSPORT

Transport packaging should provide that during transport the endurance parameters will not be exceeded regarding vibrations and impacts (PN-EN 60255-21-1:1999 and PN-EN 60255-21-2:2000 for severity class 1).

The device should be stored in dry and clean place, in temperature from -10 °C do +70 °C without exposing to operations of any heat sources.

Properly packed device can be transported in any position.

13 . UTILIZATION

If, as a result of damage or decommissioning, disassembly of the device is needed (and eventually utilized), all power supplies and other active connections should be disconnected. Disconnection procedure should be performed by the person with same authorizations that are needed for installation.

Disassembled device should be treated as the electronic wastes that should be handled according to the rules regarding used electric and electronic equipment. Storage of used equipment together with other waste materials is prohibited. This device contains metals that should not be penetrate to the environment, because they can cause environmental contamination.

14 . WARRANTY AND SERVICE

KARED warrants the delivered device for the period of 12 months from the date of sale (unless the agreement stipulates otherwise) on conditions provided on the warranty card.

Manufacturer offers the technical support during start-up of the device and other warranty and after-warranty services, as defined in the corresponding agreement fir such service.

In case, when the instructions provided in this document will not be observed, the warranty will be void.

15 . ORDERING METHOD

The required device type and the rated voltage should be specified in an order.

It is possible to have non-standard parameter values set in the device for free. In such case, the relevant order should be accompanied with the following table filled in with the required setting values.

Our address:

PUP KARED Sp. z o.o.
80-180 Kowale/Gdańsk, ul. Kwiatowa 3/1
Phone: +48 58 322 82 31
Fax: +48 58 324 86 46
e-mail: kared@kared.com.pl
WWW: http://www.kared.com.pl/

Table 21. Settings ordered by the user

No.	Parameter	Symbol	Unit	Range		Value of setting	Discretization
				min.	max.		
	Slave address			1	247		
1	Blockade against switching from to low U1 voltage	U1d	% Un	0	100		1
2	Blockade against switching from to low U2 voltage	U2d	% Un	0	100		1
3	Admissible lower value of voltage difference U2 - U1	Urd	% Un	-50	+50		1
4	Admissible upper value of voltage difference U2 - U1	Urg	% Un	-50	+50		1
5	Frequency difference for "from the bottom" synchronization (f1 > f2)	frd	Hz	0	1		0.001
6	Frequency difference for "from the top" synchronization (f1 < f2)	frg	Hz	0	1		0.001
7	Frequency difference for synchronous operation	fss	Hz	0	0.2		0.001
8	Compensation of constant phase shift	fi0	°	-75	+75		1
9	Angle limit value for descending absolute phase difference value	fi1	°	0	+60		1
10	*reserved*			0	0	–	–
11	*reserved*					–	–
12	Switch closing time	tw	ms	20	320		1
13	Increase of output signal duration time	tp	ms	0	1000		10
14	*reserved*						
15	Lower value of L1 line voltage	Ud1	% Un	80	120		1
16	Upper value of L1 line voltage	Ug1	% Un	80	120		1
17	Lower value of U1** voltage frequency	fd1	Hz	45.0	55.0		0.001
18	Upper value of U1** voltage frequency	fg1	Hz	45.0	55.0		0.001
19	Lower value of L2 line voltage	Ud2	% Un	80	120		1
20	Upper value of L2 line voltage	Ug2	% Un	80	120		1
21	Lower value of U2** voltage frequency	fd2	Hz	45.0	55.0		0.001
22	Upper value of U2** voltage frequency	fg2	Hz	45.0	55.0		0.001
23	Lowest residual voltage of dead busways on Line L1	Usd1	%Un	0	5	2	1
24	Highest residual voltage of dead busways on Line L1	Usg1	%Un	0	20	15	1
25	Lowest residual voltage of dead busways on Line L2	Usd2	%Un	0	5	2	1
26	Highest residual voltage of dead busways on Line L2	Usg2	%Un	0	20	15	1

Manufacturer:	**Distributor:**
PUP KARED Sp. z o.o. 80-180 Kowale/Gdańsk ul. Kwiatowa 3/1 telephone: +48 58 322 82 31 fax: +48 58 324 86 46 e-mail: kared@kared.com.pl www: www.kared.pl	

APPENDIX A. SCHRS PROGRAM USAGE INSTRUCTION

The usage instruction for SCHRS program is delivered with SCHRS program in electronic version. For user request, delivery of the printed version is also possible.