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Synchronoscope
type: SMV-1d

Operating Instructions

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Spis treści

1. Understanding these instructions

In case of any doubts concerning interpretation of the content of these instructions, please be sure to address the manufacturer to clarify your doubts.

We will be grateful for any users' suggestions, opinions and critical comments. Please, submit your comments in writing or verbally. They will help us improve these instructions and make it easier to use and to take users' requests and requirements into account.

This requires one to carefully read, understand and follow the operating instructions, especially the safety guidelines.

The instructions adapt the units of physical quantities and their notation that comply with the decree of the Minister of Economy, Labour and Social Policy of 12th May 2003, concerning legal measurement units (Journal of Laws No. 103, item 954). The units that fall outside the scope of this decree (especially those related to quantity of information and rate of transmission) are used according to the recommendations of the National Institute of Standards and Technology (http://physics.nist.gov/cuu/Units/index.html).

2. Note on conformity

The device described in these instructions is designed to be used in industrial environment. The process of constructing and manufacturing of this device was subjected to the requirements of determined standards. Realization of assumed safety principles and means is ensured by compliance with these requirements, on condition the user complies with the below-specified guidelines concerning installation, start-up and operation of the device.

SMV-1d is a class A device. It can generate radio electric interference, when used in housing environment. In such cases, one may require the user to apply appropriate remedial measures.

The device complies with the provision of the following EU directives:

- the low voltage directive (73/23/EEC), implemented with the Decree of the Minister of Economy, Labour and Social Policy of 12th March 2003 (Journal of Laws No. 49, item 414) and
- the electromagnetic compatibility directive (89/336/EEC), implemented with the Decree of the Minister of Economy, Labour and Social Policy of 2nd April 2003 (Journal of Laws No. 90, item 848).

Compliance with the directives is confirmed by tests carried out measurement and research laboratories that are independent of the manufacturer.

The SMV-1d device meets the principal requirements provided in the low-voltage directive and electric compatibility directive, as it complies with the following standards:

The standard harmonized with directive 73/23/EEC

- **PN-EN 61010-1:2004** Safety specifications for electrical measurement, control and laboratory devices. General requirements.

The standards harmonized with directive 89/336/EEC

- **PN-EN 61000-6-2:2003** Electromagnetic Compatibility (EMC) – Part 6-2: General standards. Immunity for Industrial Environments.
- **PN-EN 61000-6-4:2004** Electromagnetic Compatibility (EMC) – Part 6-4: General Standards. Emissions Standard for Industrial Environments.

3. Application of the SMV-1d device

The SMV-1d device is a semi-automatic synchronizer (without automatic comparison of voltages and frequencies function) designed for connecting AC power facilities for parallel operation with a fixed lead time in terms of the frequency difference changes from zero to one Hz.

Distinguished with original way to visualize the synchronization process, readable even from a distance of several meters and phase deviation of connection less than 4 degrees. SMV-1d has an

insulated RS 485, which enables the tracking of the synchronization process in real time in superior network.

After adjusting external voltage and frequency values within the preset ranges by the device and the START signal, SMV-1d generates a single signal switching on the circuit breaker with the set lead time, if and only if both synchronization conditions are simultaneously met: voltage, frequency and phase.

4. Safety principles

Information provided in this section are aimed at familiarizing the user with the principles of proper installation and operation of the device. It is assumed that the personnel in charge of the installation, start-up and operation of the device is properly qualified and aware of the potential hazard related to works performed with electric devices.

The device meets the safety requirements of the regulations and standards in force. The design of the device focused in particular on the operator's safety.

4.1. Device installation

Attention!

One should get acquainted with the content of these instructions, before setting to operate or install the device.

The device should be installed as described in section 7. *Installation.*

4.2. Device start-up

Once SMV-1d 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.

4.3. Device operation

The device should operate in conditions that are described in the technical specifications.

Device operators should be authorized to operate it and acquainted with its operating instructions.

4.4. Opening the housing

Before setting to perform any works that involve the need to open the housing, one must disconnect all voltage sources and then cut the device off from external circuits by unplugging all plug-in connectors.

The sub-assemblies used in the device are susceptible to electrostatic discharges. Therefore, if the device is opened without appropriate anti-electrostatic equipment, it can get damaged.

4.5. Operation

Once installed, the device does not require additional operation activities. In case a fault is identified, one should address the supplier, from whom the device was purchased.

The supplier – in cooperation with the manufacturer – provides guarantee and post-guarantee servicing. Guarantee conditions are determined in the guarantee card.

4.6. Modifications and changes

For safety reasons, it is forbidden to introduce any modifications and changes of the functions of the device discussed herein. Device modifications introduced without a written consent of the manufacturer void all liability claims against the PUP Kared company.

4.7. Interference

In case the device is identified to operate defectively, one should immediately report this fact to the person in charge of the facility or to the distributor.

Repairs may be performed exclusively by persons authorized by the manufacturer.

4.8. Rating plates, information plates and stickers

One must strictly follow guidelines provided in the form of descriptions provided on the device, information plates and sticker and maintain them in a condition that ensures their good legibility. The plates and stickers that got damaged or became illegible should be replaced.

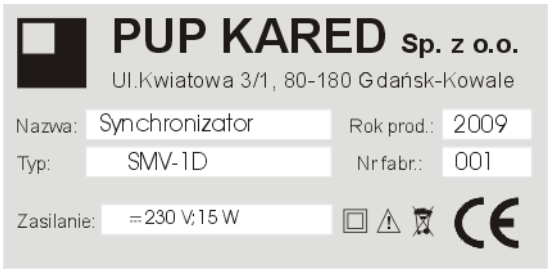

Fig. 1. Model of the rating plate

4.9. Symbols

The device is protected with double or reinforced insulation

Direct current

The symbol indicates the need to apply selective disposal of electric and electronic equipment

5. Technical description

5.1. General description

The device front panel view is shown in Figure 2.

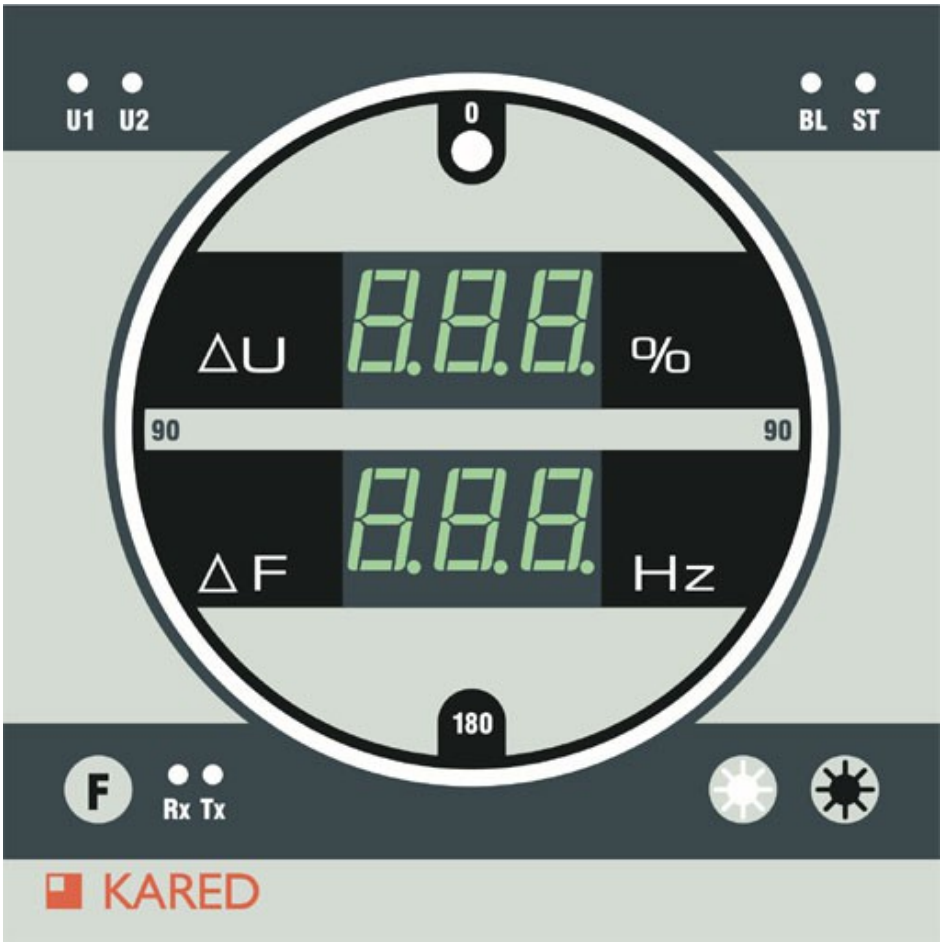

Fig. 2. *The SMV-1d device front panel*

The device combines the function of semi-automatic synchronizer switching on circuit breaker with a fixed lead time with the function of synchronization column. At the front of the device the voltage difference ΔU (in percents), the frequency difference ΔF (in Hz) and the phase difference (with slightly less than 2 degrees discretization) in the form of a glowing arc of gradually reduced brightness (so-called "comet") is shown. The voltage and frequency differences are shown on 14 mm LED displays, and the phase difference in a circle with a diameter of 100 mm, which provides good visibility of indications from a long distance. The current phase difference shows the head of a "comet", and its "tail" direction of rotation of the vector voltage difference. If the voltage frequency U2 (generator) is less than the voltage frequency U1 (mains), a "comet" moves counter-clockwise around a circle. If the voltage frequency U2 is greater than the voltage frequency U1, then the "comet" moves clockwise clock along the circle. Presenting the phase difference in the form of rotating "comet" makes it very clear to read the current phase and the direction of rotation from a long distance for very small as well as very large frequency differences.

Under ΔU and ΔF displays mini bar graphs are placed, that in red color signal the value exceeding ΔU and ΔF over set limit values.

Mini bar graph 1. It is located under the ∆U display. It is composed from the green and the red on edges LED's in a central part. The LED's on the right side of the symmetry axis of the bar graph illuminate when the voltage difference ∆U = U2 - U1 > 0 (has a positive value), and on the left side when ∆U < 0 (has a negative value). When the absolute value of the voltage difference is less than allowable (Urd or Urg - see settings, Table 10), then lit the corresponding green LED's and when it is greater than allowable, the red LED's.

Mini bar graph 2. It is located under the ∆F display. Just like bar graph 1, it consists in the middle of the green color LED's and the red LED's on the edges. The right part of the bar graph is lit when the frequency difference

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

where: f1 – voltage frequency U1 (mains),

f2 – voltage frequency U2 (generator)

and left when $\Delta F = f2 - f1 < 0$.

When the absolute value of the ∆F frequency difference has a lower value than the set limit value (frd or frg – see settings, Table 10), the relative green sector lights, when higher than allowable – the relative red sector.

On the front panel indicator lights are located, which indicate the state of the signals on the binary **ST**art and **BL**ocade inputs and on measurement inputs **U1** (L1 line) and **U2** (L2 line), **Rx** and **Tx** LED's indicate communication activity by serial link RS485.

Using the **dark sun** (P1) and **bright sun** (P2) buttons it is possible to manually adjust the light of LED's display to adjust the contrast to the surrounding conditions. By pressing the **„F"** (P3) button reading of the basic settings is possible. Viewing is done by repeatedly „F" pressing. Automatic exit from the settings if in a period of 5 s "F" is not pressed.

The SMV-1d device is equipped with an galvanically isolated RS485 serial link, for communicating with a PC or superior information system. Optionally, instead of the RS485 interface, the SMV-1d device can be equipped with RS232 interface or fiber optic link.

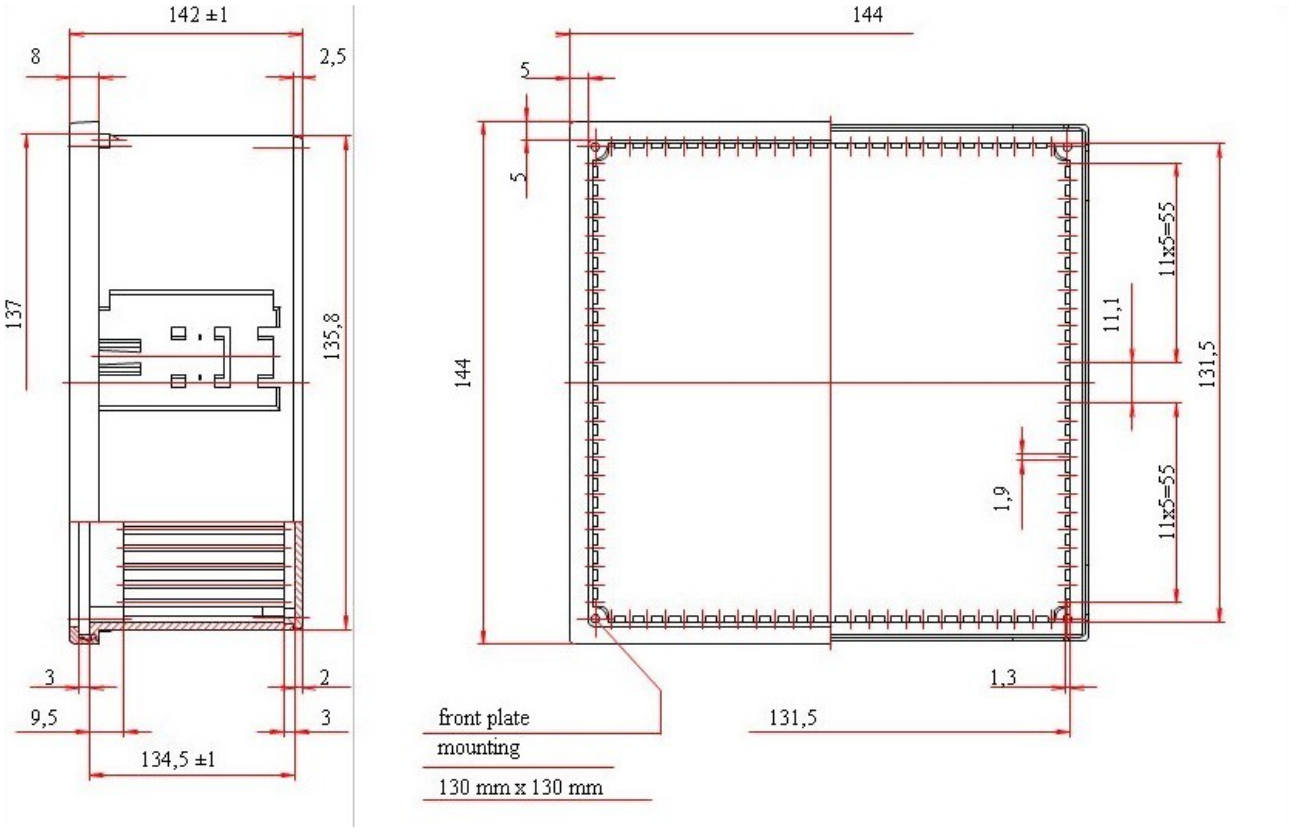

Fig. 3. Housing dimensions

6. Technical specifications

6.1. Ambient conditions

The SMV-1d 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. Elements of a complete set

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

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

6.3. Power-supply characteristics

Table 1. 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 inputs

The SMV-1d 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. Characteristics of measurement inputs

Table 2. Parameters of measurement inputs

Measurement category (according to standard PN-EN 61010-1:2004)	III
Number of measurement inputs	2
Rated measuring voltage	100 V rms
Measuring range of analog-to-digital transducers (minimum)	±220 V DC
Sampling frequency	2,5 kHz
Resolution	10 bits
Error in measuring RMS voltage (0 °C < T < 40 °C)	< ±2 % Un
Phase angle measurement error (0 °C < T < 40 °C)	< ±2°
Frequency measurement error (0 °C < T < 40 °C)	< ±0,01 Hz
Realized lead time	from 20 to 320 ms
Phase deviation of connection	< ±4°
Rated insulation voltage	230 V AC
Galvanic isolation input - power, input - output, input – RS485	2,5 kV, 50 Hz, 1 min
Continuous non-destructive maximum measuring voltage	330 Vrms
The maximum instantaneous voltage between any two of the four input terminals for measuring the linear range of input circuits	±420 V
Resistance to impulse voltage between any given pair of measurement input terminals	1 kV 1,2 / 50 µs (acc. to PN-EN-61000-4-5)
Power dissipation at the measurement rating voltage	< 0,1 W

6.6. Characteristics of binary inputs

Table 3. Parameters of binary inputs

Number of inputs	2
Galvanic isolation: input - power supply, input – output, input - RS485	2.5 kV, 50 Hz, 1 min
Rated voltage *)	220 V DC
Maximum continuous non-destructive voltage	± 400 V DC
Resistance to voltage impulse appearing between binary input terminals (in compliance with PN-EN-61000-4-5)	1 kV 1.2 / 50 μs
Power dissipation at the rated voltage	< 0.3 W
Rated switching voltage **)	From 80 V DC 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. Characteristics of outputs

Table 4. Contact outputs

Rated voltage	220 V DC
Admissible voltage value	250 V DC
Admissible value of continuous current intensity	1 A
Admissible value of instantaneous current intensity (up to 2 s)	4 A
Admissible value of disconnecting current intensity	0.4 A DC or 8 A AC

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 5. 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	contact terminals switching on the **ZW** circuit breaker
6	Z1-2	
7	Z2-1	contact terminals of **SY** signaling
8	Z2-2	

Table 6. 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

Terminal No.	Symbol	***Description***
16	ST-	ST signal input – negative terminal
17	ZAS-1	power-supply terminal – positive terminal
18	ZAS-2	power-supply terminal – negative terminal

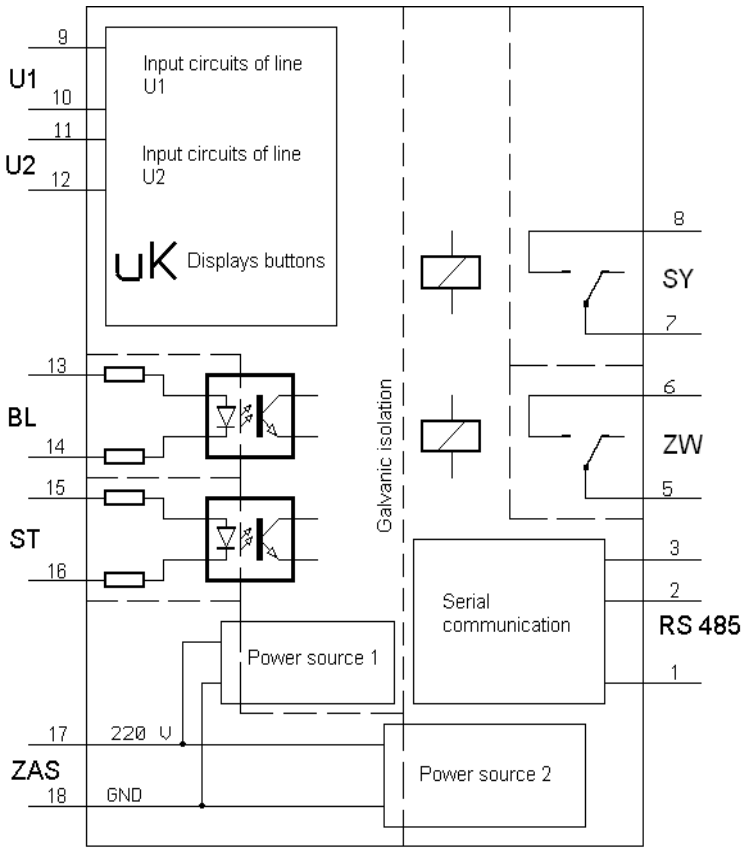

Fig. 1. Interlock diagram

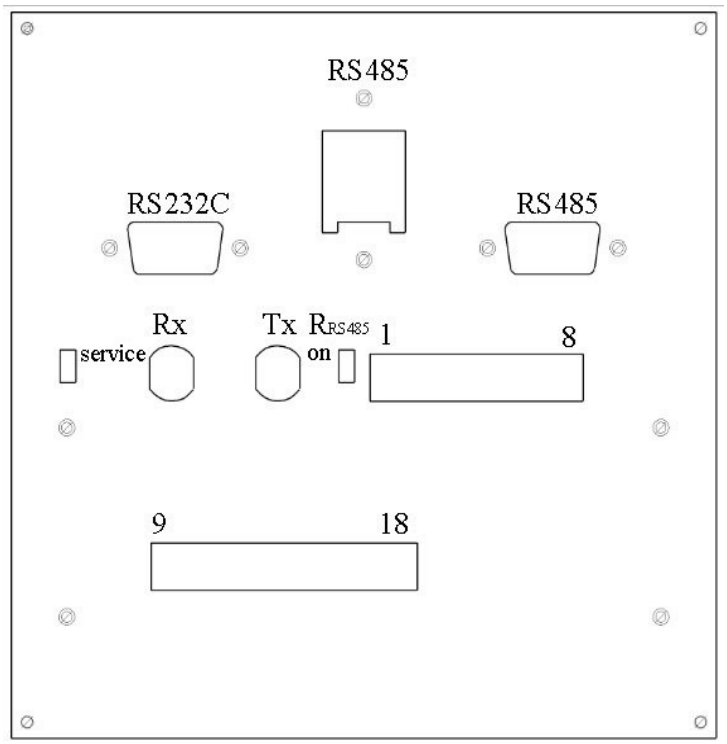

Fig. 2. Arrangement of connectors

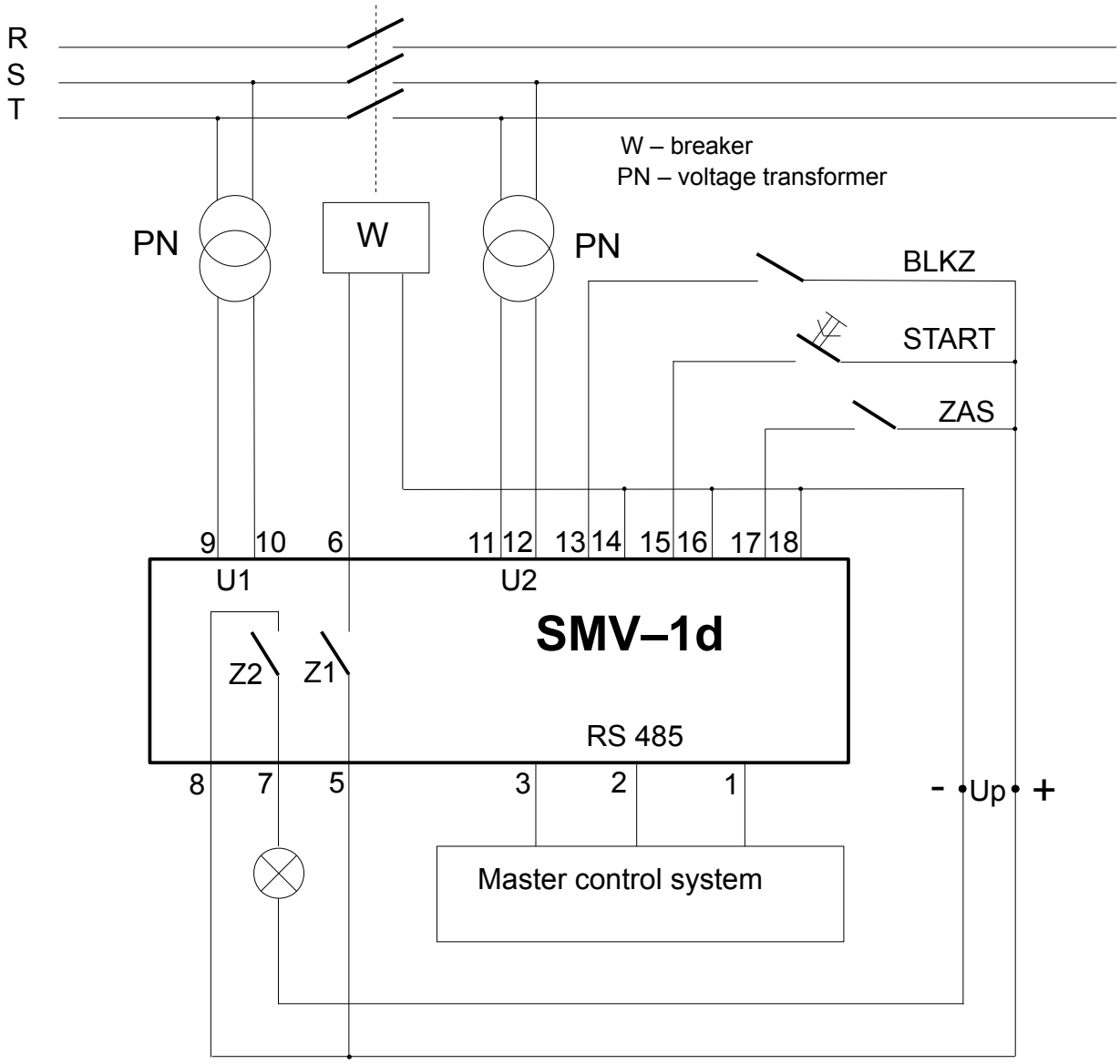

Fig. 3. Simplified diagram showing, how to connect the SMV-1d device to external circuits

8. Operation

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*** *(page 25*).

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-1d 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-1d 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. The SMV-1d algorithm

9.1. Adopted symbols

Table 1. Symbols used in the algorithm

Symbol	Description	***Formula***
dU	current value of the difference between voltages	U2 - U1
dfr	current value of the difference between frequencies	f2 - f1
dfi	current difference between phases (including rotation direction)	fi2 - fi1
f1	U1 voltage frequency	
f2	U2 voltage frequency	
U1	effective voltage U1 (on line L1)	
U2	effective voltage U2 (on line L2)	

9.2. Settings

In the table and in the entire text, the names of settings are provided in **bold font** (as opposed to, for instance, measured and calculated values).

Note: The units provided in the 4th column of table 9 (see below) apply to the displayed set values.

Table 2. Device settings

Address	Parameter	Sym.	Unit.	Range		Default value	Discr.
				Min	**Max**		
-	Slave1 address	-	-	1	* 247	254	-
6	Switching interlock, when voltage U1 on line L1 is insufficient	U1d	% Un	0	100	80	1
7	Switching interlock, when voltage U2 on line L2 is insufficient	U2d	% Un	0	100	80	1
8	Admissible lower difference of voltages U2 - U1	Urd	% Un	-50	+50	-5	1
9	Admissible upper difference of voltages U2 - U1	Urg	% Un	-50	+50	+5	1
10	Frequency difference for "bottom-to-top" synchronization (when f1 > f2)	frd	mHz	0	999**	300	1
11	Frequency difference for "top-to-bottom" synchronization (when f1 < f2)	frg	mHz	0	999**	300	1
12	Frequency difference for synchronous operation	fss	mHz	0	200	30	1
13	Compensation for constant phase displacement	fi0	º	-75	+75	0	1
14	Limit value of the angle for decreasing absolute value of the phase difference and synchronous operation	fi1	º	0	+60	15	1
15	Window width	uf	°	1	60	9	1
16	*reserved*	-	-	-	-	-	-
17	Switch closing time	tw	ms	20	320	100	1
18	Increase in the duration of the output signal	tp	ms	0	990	50	10
19	*reserved*	-	-	-	-	-	-
20	Lower value of voltage U1 on line L1	Ud1	% Un	80	120	90	1
21	Upper value of voltage U1 on line L1	Ug1	% Un	80	120	110	1
22	Lower value of voltage U1 frequency	fd1	Hz	47,5	52,5	49,5	0,1
23	Upper value of voltage U1 frequency	fg1	Hz	47,5	52,5	50,5	0,1
24	Lower value of voltage U2 on line L2	Ud2	% Un	80	120	90	1
25	Upper value of voltage U2 on line L2	Ug2	% Un	80	120	110	1
26	Lower value of voltage U2 frequency	fd2	Hz	47,5	52,5	49,5	0,1
27	Upper value of voltage U2 frequency	fg2	Hz	47,5	52,5	50,5	0,1
28	*reserved*	-	-	-	-	-	-
29	*reserved*	-	-	-	-	-	-
30	*reserved*	-	-	-	-	-	-
31	*reserved*	-	-	-	-	-	-
32	*reserved*	-	-	-	-	-	-

* It is possible to introduce any number between 0 and 255. However, the MODBUS standard requires the number to be within the range between 1 and 247. The servicing address is pre-

defined at the factory. It allows the operator to introduce the required address by means of the software supplied by the manufacturer together with the device.

** option - the connecting possibility with the slipping bigger than 2% of the limited lead angle α< 120 calculated from the value of the permissible slipping and lead time

Adopted symbols:

Un - rated voltage; fn – rated frequency

Compensation for constant phase displacement – If the value is positive, it means voltage U2 is delayed with respect to voltage U1.

9.3. Definitions

Phase difference decreases – It means that the absolute value of the phase displacement between voltages U1 and U2 decreases at a significant rate, i.e. at a rate that cannot be considered to constitute synchronous operation. This corresponds to a situation, when the following condition is met:

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

Phase difference increases – It means that the absolute value of the phase displacement between voltages U1 and U2 increases at a significant rate, i.e. at a rate that cannot be considered to constitute synchronous operation. This corresponds to a situation, when the following condition is met:

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

Synchronous operation – It means that the absolute value of the phase displacement between voltages U1 and U2 is constant or varies very slowly.

This corresponds to a situation, when the following condition is met:

$|dfi/dt| <$ **fss**

9.4. The algorithm of SMV-1d operation

Conditions to stimulating SY signaling (LED)

all of the following conditions are met at the same time:

Voltage 1. U1 > **U1d**

Voltage 2. U2 > **U2d**

Voltage 3. **Urd** ≤ dU ≤ **Urg**

Frequency **frd** ≤ dfr ≤ **frg**

Phase – one of the following conditions is met:

Phase 1. phase difference decreases and $|dfi| \leq 2\pi(dfr)$**tw±uf**

Phase 2. synchronous operation and $|dfi| \leq$ **fi1**

If in-phase synchronous operation activation during 60 s does not occur, the Z2 relay generates warning signals with a period of 4s. A warning signal will be switched off, when the activating signal will be generated.

Conditions of signaling deactivation

Lack of compliance with any of the conditions of signaling.

Conditions of Z1 relay activation– activating circuit breaker

Voltage and phase conditions as for the signaling activation and one of the phase conditions:

Phase 1. phase difference decreases and |dfi| = 2π(dfr) **tw±uf**

Phase 2. synchronous operation and |dfi| ≤ **fi1**

and:

Start signal	ST = +Up
External interlock signal	BL = 0 V

Note 1:

1. The stimulation of Z1 is single. Z1 re-activation is possible after the power supply of automatic device has been disconnected and its restarting.

Conditions of Z1 relay deactivation

1. Time deduction tw+tp

or

2. Turning off the power supply od SMV-1d device.

Condition of the Z2 relay activation - signaling

In the SMV-1d semi-automatic synchronizer the Z2 relay is used for remote signaling.
When the conditions of synchronization are met, Z2 is activated with the Z1 relay.
If after sending the switching pulse (tv + tp) the switching signal (BL=Up) does not appear or phase exceeds 60 degrees, the alarm is actuated. Z2 pulses at a frequency of 1 Hz. Permanent deactivation of the Z2 relay occurs by turning off the power supply.

Conditions of Z2 relay deactivation

1. The appearance of the BL=+Up signal prior to tw+tp time calculation

or

2. Turning off the SMV-1d device power supply.

If Z2 deactivation took place by turning off the SMV-1d power supply, despite the cause of the alarm is not removed, after powering it is possible to regenerate the switching signal on, if the BL=0 and ST = Up signal and the conditions for synchronization are met.

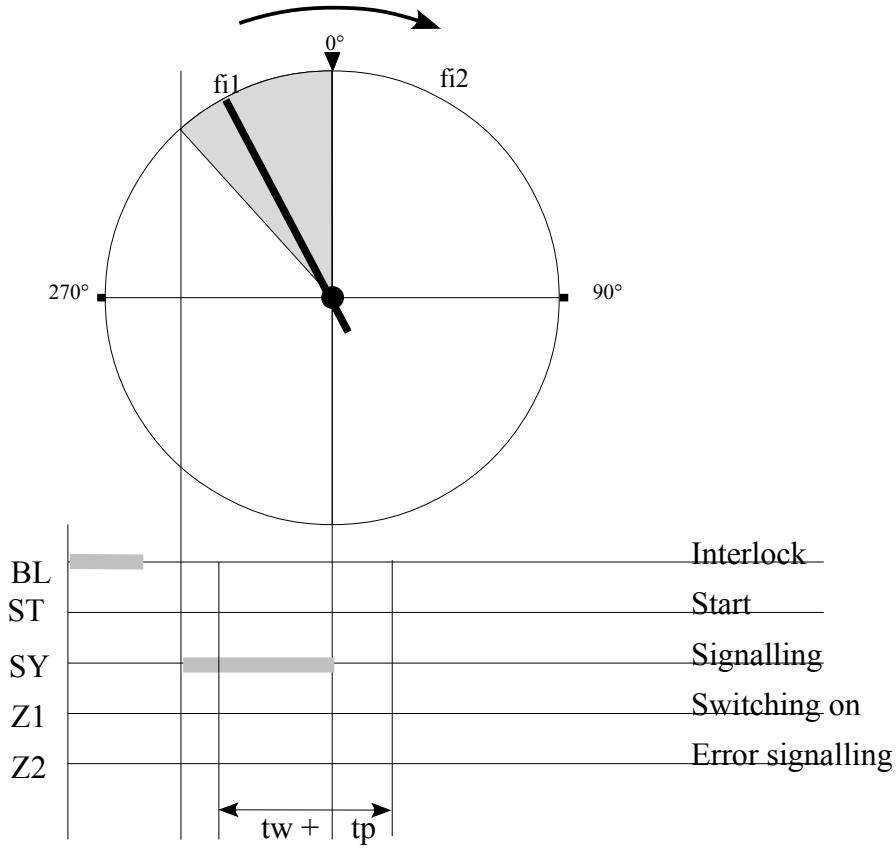

Fig.7. No switching pulse caused by the lack of a ST signal (start)

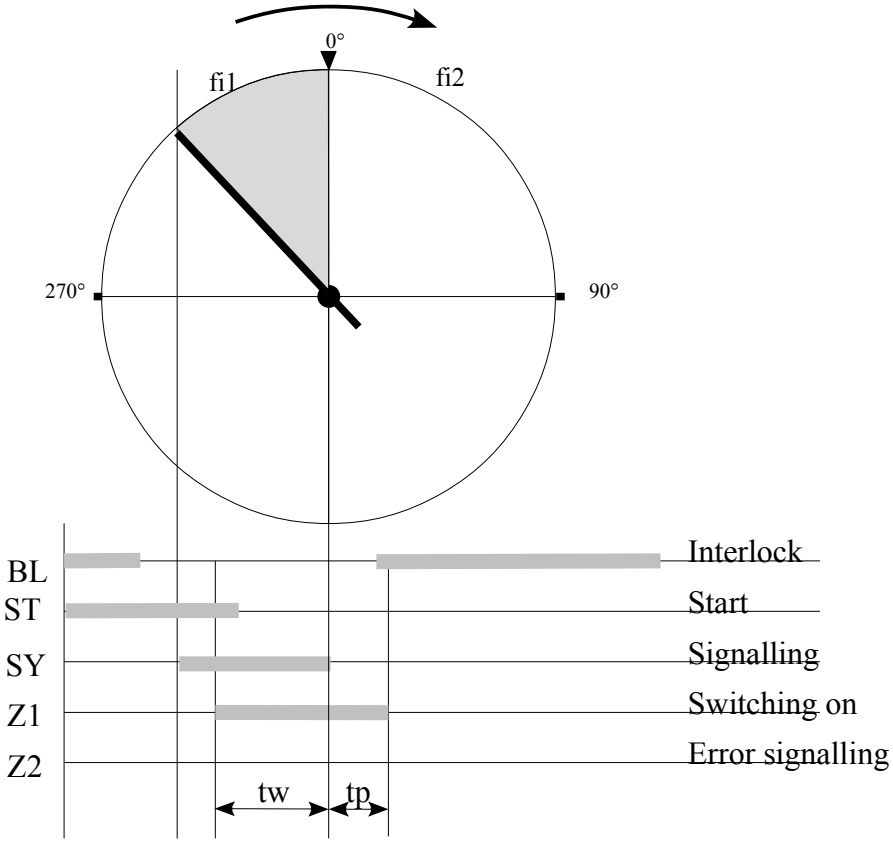

Fig. 8. Diagram of signals with the correct connection

Note: Start signal as activating signal will be sent only once, next the device will block sending of Z1 signals. **Retrying inclusion should take place only when the cause of circuit breaker non-activation will be removed.**

In Figure 7 the signals generated by the SMV-1d device, when there is no start signal are shown. In Figure 8 typical for proper connecting signals, and in Fig. 9 when after sending the signal switching the circuit breaker, there is no switching confirmation signal or circuit breaker has not been closed.

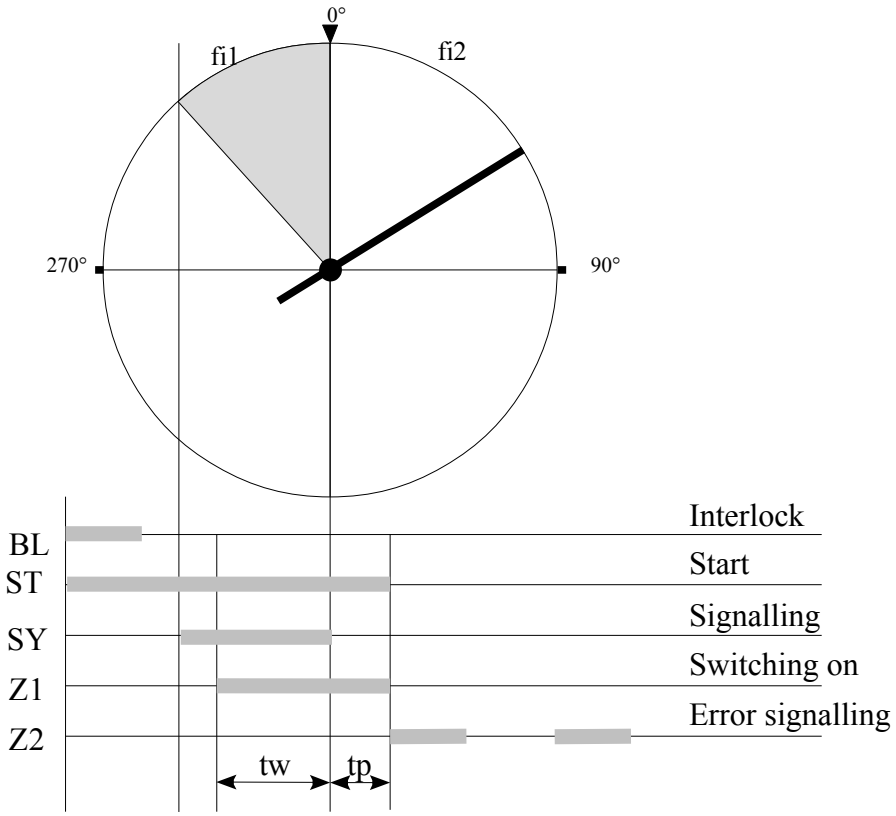

Fig. 9. Error caused by no beaker state change feedback

10. Communication over the serial port

10.1. Basic information

The SMV-1d 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 1. Symbols used to mark signals and lines of an RS485 connection

logical levels		
logical level	0	1
signal	START, SPACE, ON	STOP, MARK, OFF
voltage level	u(D0) > u(D1)	u(D0) < u(D1)
other used symbols		
D0 *(brown)*	A, RDA, SDA, SDB, SD+, RDB, RD+, SIG-B, L1, L3, SD+, UTX H, URX H, L(+), TD(B)+, A+, B+, TX+, RX+	

logical levels	
***D1** (yellow)*	B, RDB, SDB, SDA, SD-, RDA, RD-, SIG-A, L2, L4, SD-, UTX L, URX L, L(-), TD(A)-, A-, B-, TX-, RX-
***SG** (gray)*	Common, FG, SHIELD, G, 0V, GND

The device is delivered with a computer program that can be used to perform all the operations that are available over the MODBUS connection. It allows the operator to read and modify parameter settings, read the values of selected voltage parameters, read the status of input and output signals, etc. A detailed description is provided below. The program is designed to operate in Windows environment (it has been tested under win98, XP, 2000). Software description is provided in the attachment.

10.2. Transmission rate

It is possible to set the following values: 4800 Bd, 9600 Bd, 19200 Bd, 38400 Bd, 57600 Bd. Tests of transmission rates of 115200 Bd, 128000 Bd and 256000 Bd were successful, but they are applied with an error that exceeds the limits required by MODBUS RTU. They should be used only for testing or servicing purposes. The same applies to the rate of 2400 Bd.

In the servicing mode (activated with the "service" switch on the back of the housing), the transmission rate is set to 19200 Bd. It can be modified by typing the required value into the MBHR_BAUD register. The modified transmission rate will apply, once the switch is switched off and the program is restarted.

Table 2. Setting of the 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 – the value introduced into the MBHR_BAUD register

BRGH – configuration bit in the micro-controller

SPBRG – the value introduced into the register of the divider of the clock that times the operation of the serial interface in the micro-controller

10.3. Parity bit

Attention! In the present version, the parity bit support has not been implemented. If need be, it can be implemented according to the below-presented procedure on the user's request.

Bit No. 8 in the ASCII mode and bit No. 9 in the RTU mode can function as the parity bit.

The bit numbering in the sequence of transmitting one byte or character in asynchronous transmission:

0 – start bit

1 – the youngest bit of the transmitted byte

etc.

Modes of parity bit setting that can be programmed:

- even parity flag,
- odd parity flag,
- additional stop bit (logical value: 0).

The setting of the parity bit setting method is recorded together with the setting of the transmission rate in bits 4 and 5 of the older byte of this setting. The table below presents the coding method.

Table 1. Setting of the mode of counting the parity bit in transmitted bytes

Code		***Parity bit counting mode***
Hi	Lo	
..00	....	additional stop bit (logical value: 0)
..10	....	even parity flag
..11	....	odd parity flag

10.4. Protocol

The asynchronous transmission over an RS485 port functions in a protocol based on MODBUS ASCII or MODBUS RTU. Only the ASCII protocol is supported in the servicing mode.

The setting of the asynchronous transmission protocol is recorded together with the setting of the transmission rate in bit6 of the older byte of this setting. The table below presents the coding method.

Table 2. Setting of the asynchronous transmission protocol

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

10.5. Data accessible over the asynchronous port

The following table presents the data accessible with MODBUS protocol commands. The table covers all settings that are used in the SCH and SMV series. Some of them are not used in SMV-1d.

Table 3. MODBUS register addresses (MODBUS holding registers)

Address	Symbol	***Content***
		INFORMATION CONCERNING THE AUTOMATION DEVICE AND PROGRAM
1	MBHR_WER_DTA	Software compilation date (read only)
2	MBHR_WER_NR	Software version number (read only)
3	MBHR_WER_TYP	Device type (version) (read only)
4	MBHR_BAUD	Transmission rate
5	MBHR_MB_ADDR	Slave address (non-volatile memory*)
		SETTINGS (non-volatile memory*)
6	MBHR_U1d	Interlock caused by too low voltage U1 on line L1 [% Uz]
7	MBHR_U2d	Interlock caused by too low voltage U2 on line L2 [% Uz]
8	MBHR_Urd	Admissible upper difference of voltages U2 - U1 [% Uz]
9	MBHR_Urg	Admissible lower difference of voltages U2 - U1 [% Uz]
10	MBHR_frd	Frequency difference for "bottom-to-top" synchronization (f1 > f2) [mHz]
11	MBHR_frg	Frequency difference for "top-to-bottom" synchronization (f1 < f2) [mHz]
12	MBHR_fss	Frequency difference for synchronous operation [mHz]
13	MBHR_fi0	Compensation for constant phase displacement [°]
14	MBHR_fi1	Limit value of the angle for decreasing absolute value of the phase difference [°]
15	MBHR_fi2	Limit value of the angle for increasing absolute value of the phase difference [°]
16	MBHR_uf	Admissible phase misalignment [°]
17	MBHR_tw	Switch closing time [ms]
18	MBHR_tp	Increase in the duration of the output signal [ms]
19	MBHR_tk	Switch-on conditions verification period [ms]
		Settings – voltage free connections (non-volatile memory*)
20	MBHR_Ud1	Lower value of voltage U1 [% Uz]
21	MBHR_Ug1	Upper value of voltage U1 [% Uz]
22	MBHR_fd1	Lower value of voltage U1 frequency [mHz]
23	MBHR_fg1	Upper value of voltage U1 frequency [mHz]
24	MBHR_Ud2	Lower value of voltage U2 [% Uz]

Address	Symbol	***Content***
25	MBHR_Ug2	Upper value of voltage U2 [% Uz]
26	MBHR_fd2	Lower value of voltage U2 frequency on line L2 [mHz]
27	MBHR_fg2	Upper value of voltage U2 frequency on line L2 [mHz]
28	MBHR_Usd1	Lower value of residual voltage U1 on line L1 [% Uz]
29	MBHR_Usg1	Upper value of residual voltage U1 on line L1 [% Uz]
30	MBHR_Usd2	Lower value of residual voltage U2 on line L2 [% Uz]
31	MBHR_Usg2	Upper value of residual voltage U2 on line L2 [% Uz]
		binary settings
32	MBHR_ZEZW	Permissions to carry out the pre-set switching modes (non-volatile memory*)
32_0	TRYB_ZSK	Permission to switch on within the pre-set angle sector ("1" means "permitted")
32_1	TRYB_SBN	Permission to connect, when voltage U1 is absent (on line L1) ("1" means "permitted")
32_2	TRYB_GBN	Permission to connect, when voltage U2 is absent (on line L2) ("1" means "permitted")
32_3	TRYB_SGBN	Permission to switch on in a voltage free state ("1" means "permitted")
32_(4..15)		Reserve
32..35		Reserve
		Calibration (non-volatile memory*)
36	MBHR_KAL_S	Calibration of voltage measurement on L1 (the value calculated on the basis of ADC converter samples for U1 = 100 V AC RMS)
37	MBHR_KAL_G	Calibration of voltage measurement on L2 (the value calculated on the basis of ADC converter samples for U2 = 100 V AC RMS)
38	MBHR_EEPRCRC	EEPROM checksum
39	MBHR_LRST	Restart counter
		Measured values
40	MBHR_US	Value of measuring voltage U1 [0.1 V]
41	MBHR_UG	Value of measuring voltage U2 [0.1 V]
42	MBHR_DU	Difference of voltages U2 - U1 [0.1 V]
43	MBHR_TS	Voltage U1 period [0.8 µs]
44	MBHR_TG	Voltage U2 period [0.8 µs]
45	MBHR_DTGS	Difference between periods of voltages U1 and U2 [0.8 µs]
46	MBHR_TSG	Difference between the zero-crossing times t(U2) - t(U1) [0.8 µs]
47	MBHR_TGS	Difference between the zero-crossing times t(U1) - t(U2) [0.8 µs]
48	MBHR_WAR0	The state, when the software-verified conditions are met. Data are made accessible on particular register bits. Detailed description provided in the table entitled *Functions of bits in registers: MBHR_WAR0, MBHR_WAR1, MBHR_WAR2, MBHR_WAR3*

Address	Symbol	***Content***
49	MBHR_WAR1	
50	MBHR_WAR2	
51	MBHR_WAR3	
52..69		Reserve
		Control registers
70	MBHR_LRCCODE_W	Software checksum (introduced)
71	MBHR_LRCCODE_O	Software checksum (calculated)
72	MB_CMD	Command (list of commands is provided below)
73		Reserve
74	MB_CMD_R	Response upon carrying out a command
75		Reserve
76	MB_HASLO	Password – younger 16 bits (password functioning is described below)
77		Password – older 16 bits (password functioning is described below)
78..96		Reserve

The unit ascribed to a given value is presented in square brackets.

* The content of the registers is written to the non-volatile memory (EEPROM) by means of the relevant command. The content of the registers is read from the EEPROM after every software restart.

Certain registers have been made accessible to be read by the MODBUS protocol, in order to achieve a partial compatibility with the SM-06B synchronizer. A part of the registers duplicates the values of the hitherto used registers, while some of them provide new values. These addresses are within the range from %R3585 to %R3840 (addresses between 3584 and 3839, i.e. the older byte of the address of the read registers must be equal to 0x0E). It is admissible only to read registers with these addresses by means of the Read Holding Registers function. If a register is not listed in table16, its value will be made available as 0.

Table 1. MODBUS register addresses (MODBUS holding registers)

Registry	***Address***	***Symbol***	***Content***	Units
%R3625	3624	MBHR06_US	Value of voltage U1	0.1%Un
%R3626	3625	MBHR06_UG	Value of voltage U2	0.1%Un
%R3627	3626	MBHR06_FS	Value of frequency F1	0.01 Hz
%R3628	3627	MBHR06_FG	Value of frequency F2	0.01 Hz

Registry	***Address***	***Symbol***	***Content***	Units
%R3633	3632	MBHR06_DU	Value of the voltage difference U2 – U1	0.01%U1
%R3634	3633	MBHR06_DF	Value of the frequency difference F2 - F1	0.01%F1
%R3636	3635	MBHR06_DFi	Value of phase difference between synchronizer inputs U2 and U1	0.01°
%R3637	3636	MBHR06_DFi1	Value of phase difference between synchronizer inputs U2 and U1, with setting fi0*) taken into account	1°

* – value fi0 is deducted from the measured phase displacement value

Values 0x8000 and 0x8001 indicate an undetermined value

Un – nominal voltage value: 100 V RMS

Table 2. Constants in the communication over the MODBUS port

Symbol	Value	***Description***
MB_HASLO_1	0x3425A0B2	The password allows one to modify the settings and type commands in (it eliminates the risk of accidental setting modification).
MODBUS_ADR_SRV	0xFE	The MODBUS slave address for servicing purposes. It functions independently of the position of the "service" switch. It allows one to read and write the appropriate 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 3. Commands recommended to be performed over the MODBUS connection

Code	Symbol	***Task***
0x7829	MBCMD_RESET	Carry out the processor command: RESET
0x783A	MBCMD_WR_EEPR	Save registers to EEPROM (the ones that are saved to non-volatile memory)
0x7312	MBCMD_KAL_S	Run calibration
0x7325	MBCMD_KAL_E	Terminate calibration
0x735A	MBCMD_KAL_B	Abort calibration

Table 4. Responses to commands recommended to be performed over the MODBUS connection

Code	Symbol	***Description***
0x0101	MBCMD_RST	The value of the MB_CMD_R register (containing responses to commands) is introduced after software restart.

Code	Symbol	***Description***
0x1223	MBCMD_KAL_ST	Confirmation that calibration is started
0x1234	MBCMD_KAL_OK	Confirmation that calibration is finished successfully
0x1245	MBCMD_KAL_BR	Confirmation that calibration is discontinued

10.6. Reading of setting values

Settings are read in a standard manner, by means of the MODBUS function: "**Read Holding Registers**". The addresses of registers that store set values are presented in the table entitled *MODBUS register addresses (MODBUS holding registers),* page *26*.

10.7. Writing setting values

If the RS485 bus is connected to only one controller, one can use the servicing address MODBUS_ADR_SRV. If there are more controllers, the servicing address MODBUS_ADR_SRV cannot be used (because several controllers would respond simultaneously). One should use the known, unique slave address or the MODBUS_ADR_ZW address that is enable with the "service" switch, available on the housing back wall. Obviously, if this address is to be used, the switch should be enabled only in one controller.

To write a setting value, one should follow the following procedure:

- Read the slave address of the controller by means of the servicing address MODBUS_ADR_ZW (it functions, when the "service" switch is enabled).
- If there is no response to the slave address MODBUS_ADR_ZW, read the slave address of the controller by means of the servicing address MODBUS_ADR_SRV (it functions all the time, but only on controller can be connected to the bus).
- Check, if the slave address is correct (within the range from 1 to 247) and if the controller responds to this address (e.g. read the basic information about the automation device: the version, etc.). If it is not, ask the operator to provide this address and write it in the controller (as described below).
- Introduce a 32-bit MB_HASLO_1 password (see sub-section: *Constants in the program)* into two registers designed to accept the password (see table: *MODBUS register addresses (MODBUS holding registers),* page 26. Settings are saved in a standard manner, by means of the MODBUS function: ***Write Multiple registers***. The slave servicing address can be used for this purpose. Attention! The password is deleted (reset) upon carrying out another MODBUS command ***Write Multiple registers***.
- Write setting values by means of the MODBUS function: ***Write Multiple registers***.
- Transfer the content of registers into the non-volatile memory (EEPROM) by means of the command MBCMD_WR_EEPR that is introduced at the address MB_CMD.

10.8. Writing of the slave address

To write the slave address, one should follow the following procedure:

- Read the slave address of the controller by means of the servicing address.
- Check, if the address has been correctly introduced (which includes checking, if it falls within the range of addresses that are admissible in the Modbus protocol, as the default address is set outside this range). If it has, this address should be used further on. If it has not, the servicing address should be used.
- Introduce a 32-bit MB_HASLO_1 password (see sub-section: *Constants in the program*) into two registers designed to accept the password (see table: *MODBUS register addresses (MODBUS holding registers),* page 26. Settings are saved in a standard manner, by means of the MODBUS function: ***Write Multiple registers***. This can be done by means of the read slave address (if it is correct) or else by means of the servicing slave address. Attention! The password is deleted (reset) upon carrying out another MODBUS command ***Write Multiple registers***.
- Write the slave address by means of the MODBUS function: ***Write Multiple registers***.
- Transfer the content of registers into the non-volatile memory (EEPROM) by means of the command MBCMD_WR_EEPR that is introduced at the address MB_CMD.

10.9. Data reading

Information concerning the device, software, calibration and values measured by SMV-1d is read in a standard manner, by means of the MODBUS function: ***Read Holding Registers***. The addresses of registers that store information about the automation device, software, calibration and measured values are presented in the table entitled *MODBUS register addresses (MODBUS holding registers)*, page 26. This table also shows, how to interpret the read values (e.g. units of physical quantities) for the majority of registers. The remaining registers (not described in detail in this table) have the following meaning:

1.1. Software compilation date.

This register contains the number identifying software compilation date. Data are coded in the same manner as in calculation sheets (e.g. *OpenOffice.org*) and Delphi complier libraries designed for processing dates.

Examples of dates and their corresponding day numbers:

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

- Device type (version) code.

The following code definitions apply:

Tablica 1. Coding of the device type (version) in register MBHR_WER_TYP.

Code	Symbol	***Description***
0x12xx	WERSJA_SP-01K_1	Version of "SMV-1d device"

- **The state, when the software-verified conditions are met.**

  Registers MBHR_WARx contain information concerning the status of particular conditions for switching a facility on. If the relevant bits are set to "1", it means the corresponding condition is met.

Table 1. Functions of bits in registers: MBHR_WAR0, MBHR_WAR1, MBHR_WAR2, MBHR_WAR3

Bit		***Symbol***	***Description***
0	0l.0	warunek_U1d	condition U1 > U1d is met (1 = green, 0 = yellow)
1	0l.1	warunek_U2d	condition U2 > U2d is met (1 = green, 0 = yellow)
2	0l.2	warunek_Urd	condition Urd <= dU is met (1 = green, 0 = yellow)
3	0l.3	warunek_Urg	condition dU <= Urg is met (1 = green, 0 = yellow)
4	0l.4	warunek_frd	condition frd <= dfr is met (1 = green, 0 = yellow)
5	0l.5	warunek_frg	condition dfr <= frg is met (1 = green, 0 = yellow)
6	0l.6	warunek_fss	condition |dfi/dt| < fss is met (1 = green, 0 = yellow)
7	0l.7	warunek_war_pr	reserve
8	0h.0		reserve
9	0h.1		reserve
10	0h.2	warunek_err_us	a break in the grid voltage measurement circuit (1 = red, 0 = gray)
11	0h.3	warunek_err_ug	a break in the generator voltage measurement circuit (1 = red, 0 = gray)
12	0h.4	warunek_Ud1	condition Ud1 < U1 is met (1 = green, 0 = yellow)
13	0h.5	warunek_Ug1	condition U1 < Ug1 is met (1 = green, 0 = yellow)
14	0h.6	warunek_fd1	condition fd1 < f1 is met (1 = green, 0 = yellow)
15	0h.7	warunek_fg1	condition f1 < fg1 is met (1 = green, 0 = yellow)
16	1l.0	warunek_Ud2	condition Ud2 < U2 is met (1 = green, 0 = yellow)
17	1l.1	warunek_Ug2	condition U2 < Ug2 is met (1 = green, 0 = yellow)
18	1l.2	warunek_fd2	condition fd2 < f2 is met (1 = green, 0 = yellow)
19	1l.3	warunek_fg2	condition f2 < fg2 is met (1 = green, 0 = yellow)
20	1l.4	warunek_Usd1	condition U1d1 < U1 is met (1 = green, 0 = yellow)
21	1l.5	warunek_USg1	condition U1 < U1g1 is met (1 = green, 0 = yellow)
22	1l.6	warunek_Usd2	condition U1d2 < U2 is met (1 = green, 0 = yellow)
23	1l.7	warunek_Usg2	condition U2 < U1g2 is met (1 = green, 0 = yellow)

Bit		Symbol	Description
24	1h.0	war_frq_blk	frq_blk period countdown (1 = red, 0 = gray)
25	1h.1	stan_war_sp	conditions fulfilled continuously during the permission signal (1 = green, 0 = yellow)
26	1h.2		reserve
27	1h.3	warunek_fazy	phase condition is met (1 = green, 0 = yellow)
28	1h.4	warunek_s_ok	correct period of (grid) voltage U1 (1 = green, 0 = yellow)
29	1h.5	warunek_g_ok	correct period of (generator) voltage U2 (1 = green, 0 = yellow)
30	1h.6	sync_up	"top-to-bottom" synchronization (1 = green, 0 = yellow)
31	1h.7	sync_dn	"bottom-to-top" synchronization (1 = green, 0 = yellow)
32	2l.0	stan_BLOK	status of the BLOK transoptor input (1 = orange, 0 = gray)
33	2l.1	stan_START	status of the START transoptor input (1 = orange, 0 = gray)
34	2l.2	stan_SY	status of the SY relay input (1 = orange, 0 = gray)
35	2l.3	stan_Z1	status of the Z1 relay input (1 = orange, 0 = gray)
36	2l.4	stan_Z2	status of the Z2 relay input (1 = orange, 0 = gray)
37	2l.5		reserve
38	2l.6		reserve
39	2l.7		reserve
40	2h.0	mb_serwis	MODBUS frame with the servicing address (1 = red, 0 = gray)
41	2h.1	kalibracja_on_j	calibration mode activated with the "service" switch (1 = red, 0 = gray)
42	2h.2	kalibracja_on_m	calibration mode activated with over modbus (1 = red, 0 = gray)
43	2h.3	mb_err_eeprom	settings checksum error (1 = red, 0 = gray)
44	2h.4	mb_err_prog	software checksum error (1 = red, 0 = gray)
45	2h.5	mb_err_kalibr	no calibration of measurement inputs (1 = red, 0 = gray)
46	2h.6	serwis_on	servicing mode activated (with the "service" switch) (1 = red, 0 = gray)
47	2h.7	nst_err	settings error (1 = red, 0 = gray)
48	3l.0	warunek_fi1su_up	condition |dfi| <= fi1 met for "top-to-bottom" synchronization, increasing value passes zero point (1 = green, 0 = yellow)
49	3l.1	warunek_fi1su_dn	condition |dfi| <= fi1 met for "top-to-bottom" synchronization, decreasing value passes zero point (1 = green, 0 = yellow)
50	3l.2	warunek_fi2su_up	condition |dfi| <= fi2 met for "top-to-bottom" synchronization, increasing value passes zero point (1 = green, 0 = yellow)
51	3l.3	warunek_fi2su_dn	condition |dfi| <= fi2 met for "top-to-bottom" synchronization, decreasing value passes zero point (1 = green, 0 = yellow)
52	3l.4	warunek_fi1sd_up	condition |dfi| <= fi1 met for "bottom-to-top" synchronization, increasing value passes zero point (1 = green, 0 = yellow)
53	3l.5	warunek_fi1sd_dn	condition |dfi| <= fi1 met for "bottom-to-top" synchronization, decreasing value passes zero point (1 = green, 0 = yellow)

Bit		Symbol	Description
54	3l.6	warunek_fi2sd_up	condition |dfi| <= fi2 met for "bottom-to-top" synchronization, increasing value passes zero point (1 = green, 0 = yellow)
55	3l.7	warunek_fi2sd_dn	condition |dfi| <= fi2 met for "bottom-to-top" synchronization, decreasing value passes zero point (1 = green, 0 = yellow)
56	3h.0	warunek_fi1ss_up	condition |dfi| <= min(fi1, fi2) is met for synchronous operation, increasing value passes zero point (1 = green, 0 = yellow)
57	3h.1	warunek_fi1ss_dn	condition |dfi| <= min(fi1, fi2) is met for synchronous operation, decreasing value passes zero point (1 = green, 0 = yellow)
58	3h.2	warunek_fi2ss_up	condition |dfi| <= min(fi1, fi2) is met for synchronous operation, increasing value passes zero point (1 = green, 0 = yellow)
59	3h.3	warunek_fi2ss_dn	condition |dfi| <= min(fi1, fi2) is met for synchronous operation, decreasing value passes zero point (1 = green, 0 = yellow)
60	3h.4	war_t_start	t_start period countdown – START signal activation blocked for 1 s since the pervious activation of this signal (previous slope) – see section 9.4.3.2
61	3h.5	war_t_tp	tp period countdown (1 = blue, 0 = gray)
62	3h.6	war_t_tk	tk period countdown (1 = blue, 0 = gray)
63	3h.7	mb_blokada	interlock over MODBUS (1 = orange, 0 = gray)

The colour of status lamps in the supplied program for PC (SCHRS.exe) is provided between parenthesis.

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

11. Calibration

11.1. Calibration without the aid of a PC

Voltage measurement circuits are calibrated by the manufacturer. In justified cases, calibration can be performed by the servicing team. It is recommended to carry out line calibration by means of the software provided for this purpose (see below) and installed on a PC connected to SMV-1d over an RS485 connection. Calibration can also be performed without a PC. The following procedure should be followed:

- Turn on the "service" switch on the back of the housing.
- Apply the reference voltage of 100 V AC to the terminal clamps of both measurement inputs.
- Switch the power supply on.
- Open the contacts of the "service" switch after a few seconds (or later). At this moment, the calibration coefficients determined on the basis of measurements performed during the last 0.5 second will be written into the EEPROM. It should be ensured that the reference voltage is precisely 100 VAC during the last second before opening the contacts of the test connection.

- If the power supply voltage is turned off without opening the test contacts, the calibration coefficients will not be modified.
- Neither are the coefficients changed, when their established value considerably exceeds typical values. This can happen, when the reference voltage is incorrect or the measurement system does not operate correctly.

11.2. Calibration by means of commands issued from a PC

Calibration of voltage measurement circuits is carried out in the following manner:

- Apply the reference voltage of 100 V AC to the terminal clamps of both measurement inputs.
- Switch the power supply on.
- Type password MB_HASLO_1. Then, introduce command MBCMD_KAL_S.
- Wait one second or more.
- Send password MB_HASLO_1. Then, send command MBCMD_KAL_S. At this moment, the calibration coefficients determined on the basis of measurements performed during the last 0.5 second will be written into the EEPROM. It should be ensured that the reference voltage is precisely 100 VAC during the last second before this command is sent.
- If the power supply voltage is turned off or command MBCMD_KAL_B (proceeded with password MB_HASLO_1) is sent before command MBCMD_KAL_E, the calibration coefficients will not be changed.
- Neither are the coefficients changed, when their established value considerably exceeds typical values. This can happen, when the reference voltage is incorrect or the measurement system does not operate correctly.

12. Packing, storage and transport

Transport packaging unit should ensure the degree of vibration and shock resistance provided for in standards PN-EN 60255-21-1:1999 and PN-EN 60255-21-2:2000 for sharpness class 1.

The device should be stored in a dry and clean place at room temperature. It should not be exposed to direct operation of heat sources.

If properly packaged, the device can be transported in any position.

13. Disposal

If there arises a need to dismantle (or even liquidate) the device, because it is defective or its service life is over, one should first of all cut power supply off and disconnect all external facilities. This procedure should be carried out by a person with the same licensing that is required for device installation.

A disassembled device should be treated as electronic equipment waste that should be disposed in compliance with the relevant regulations applicable to used-up electric and electronic equipment.

It is forbidden to dispose of used-up equipment with other waste. The device contains metals that should not penetrate into the environment, as they can lead to contamination.

14. Guarantee and servicing

The supplied device is covered by a 12-month guarantee since the date of sale (unless the agreement provides otherwise). Guarantee conditions are provided in the guarantee card.

The manufacturer provides technical support for the device start-up procedure and provides guarantee servicing and post-guarantee servicing according to the terms and conditions specified in the relevant servicing agreement.

Failure to follow the principles of these instructions shall void the guarantee.

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 k. Gdańska, 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 1. Table of user-requested setting values

Address	Parameter	Sym.	Unit.	Range		Setting value	Discr.
				Min	**Maks**		
-	Slave1 address	-	-	1	247		-
6	Switching interlock, when voltage U1 on line L1 is insufficient	U1d	% Un	0	100		1
7	Switching interlock, when voltage U2 on line L2 is insufficient	U2d	% Un	0	100		1
8	Admissible lower difference of voltages U2 - U1	Urd	% Un	-50	+50		1
9	Admissible upper difference of voltages U2 - U1	Urg	% Un	-50	+50		1
10	Frequency difference for "bottom-to-top" synchronization (when f1 > f2)	frd	mHz	0	999		1
11	Frequency difference for "top-to-bottom" synchronization (when f1 < f2)	frg	mHz	0	999		1
12	Frequency difference for synchronous operation	fss	mHz	0	200		1
13	Compensation of constant phase displacement	fi0	º	-75	+75		1
14	Limit value of the angle for decreasing absolute value of the phase difference and synchronous operation	fi1	º	0	+60		1
15	*reserved*	-	-	-	-	-	-
16	*reserved*	-	-	-	-	-	-
17	Switch closing time	tw	ms	20	320		1
18	Increase in the duration of the output signal	tp	ms	0	990		10
19	*reserved*	-	-	-	-	-	-
20	Lower value of voltage U1 on line L1	Ud1	% Un	80	120		1
21	Upper value of voltage U1 on line L1	Ug1	% Un	80	120		1
22	Lower value of voltage U1 frequency	fd1	Hz	47.5	52.5		0.1
23	Upper value of voltage U1 frequency	fg1	Hz	47.5	52.5		0.1
24	Lower value of voltage U2 on line L2	Ud2	% Un	80	120		1
25	Upper value of voltage U2 on line L2	Ug2	% Un	80	120		1
26	Lower value of voltage U2 frequency	fd2	Hz	47.5	52.5		0.1
27	Upper value of voltage U2 frequency	fg2	Hz	47.5	52.5		0.1
28	*reserved*	-	-	-	-	-	-
29	*reserved*	-	-	-	-	-	-
30	*reserved*	-	-	-	-	-	-
31	*reserved*	-	-	-	-	-	-
32	*reserved*	-	-	-	-	-	-