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Synchronism control relay SCH-2

Usage instruction



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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.

SCH-2 relay 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

Synchronism control relay SCH-2 is used for preventing against turning-on the switch, when the phase, amplitude or frequency difference of the combined voltage exceeds the admissible set values.

- Especially, it can be used for preventing against turning-on the generator in the network with excessive phase deviation at manual synchronisation. It allows to connect, when all following conditions are fulfilled at the same time: voltage, frequency and phase difference values are in the set angle sector. It allows to turning-on only, when the network and generator voltage vectors meet together or the synchronous operation is available. Usage of SCH-2 for manual synchronisation is represented on Figure 3, 4 and 5.

- The relay can be used as a redundant device for automatic synchronisation.

- a) in most simplest way – when SCH-2 terminals are connected serially with turning-on terminals on the synchronizer;

- b) exchanging the information through the communication interface with SM-06 synchronizer.

fss settings are determining how fast the phase can be changed, to acknowledge that the synchronous operation is available. The fulfilment of the conditions is controlled by comparing measured values on ongoing basis by SCH-2 with the corresponding settings. All details regarding SCH-2 relay operation are described in chapter "SCH-2 algorithm".

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

The start-up procedure of the device should be performed after installation of the synchronism control relay according to the generally applied rules regarding protecting devices, automation and control systems. Special attention should be paid to connections with voltage transformers, especially regarding the corresponding phases of the measurement voltages.

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 synchronism control relay SCH-2 was manufactured based on the microprocessor technology. All sub-assemblies of the synchronisation control relay are placed in BOPLA CombiNorm-Classic enclosure, type CN 55 AK, used for mounting on 35 mm bus (DIN EN 60715 TH35).

Measurement voltages L1 (network) and L2 (synchronised object) are supplied to SCH-2 device. These are alternating voltages with rated value of 100 V. The two-state signals are also supplied. These are ST (Start) and BL (Blockage) signals with rated value of 220 V. From SCH-2 device are outputted SY (signalization) signals (relay terminals) and Z1 and Z2 signals (permission for turning-on).

The synchronism control relay is equipped with RS485 serial interface, galvanically insulated, used for communication with PC computer or IT systems.

The signalling lamps are placed on the front plate that allow reading of the two-state inputs and outputs states, and also are determining the communication activity through the serial interface.

6 TECHNICAL DATA

6.1 Environmental conditions

SCH-2 relay should be used in conditions providing contamination degree 2. The ambient temperature should be within the range from 0 °C to 40 °C. Relative humidity should not exceed 90%.

6.2 Information about completeness

The manufacturer delivers the device in the following set:

- synchronism control relay SCH-2,
- set of connections,
- CD with SCHRS program (used for entering settings through the RS485 connection),
- usage instruction,
- warranty card.

6.3 General characteristics of the inputs

SCH-2 relay has two analogue inputs and two two-state inputs. The two-state inputs are two-terminal inputs insulated galvanically from other electronics and from each other. The analogue inputs are two-terminal differential inputs.

6.4 Analogue inputs data

Tablica 1. 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)	< ±1°
Frequency measurement error (0 °C < T < 40 °C)	< ±0,01 Hz

6.5 Two-states inputs data

Tablica 2. Two-states inputs parameters

Number of inputs	2
Input of galvanic insulation - power supply; input - output, input – RS485	2,5 kV, 50 Hz, 1 min
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

*) For request, we can deliver the device for other values of rated voltage.

6.6 Power supply characteristics

Tablica 3. Power supply parameters

Rated power supply voltage *)	220 V DC
Admissible range of power supply voltage	100...250 V DC
Maximum power consumption	7 W

*) For request, we can deliver the device configured for other values of power supply voltage.

6.7 Outputs characteristics

Tablica 4. 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

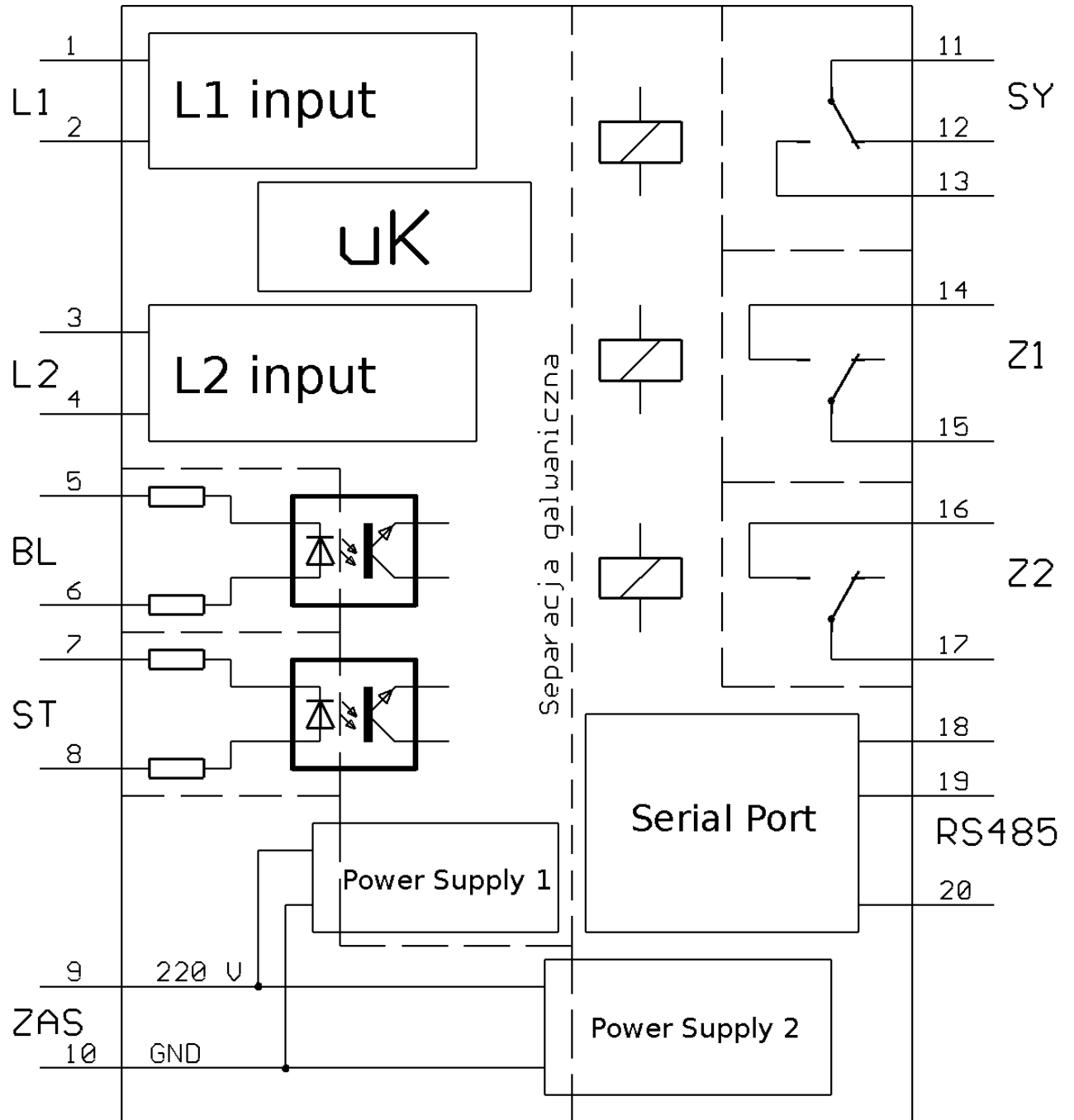
Remarks and recommendations:

- Before first start-up of power supply or application of voltage on the input terminals, the device should be stored for at least two hours in the room, where it will be installed, to compensate temperature differences and to avoid moisture of the device.
- The device should be properly mounted and protected against any mechanical damages and also against accidental access of non-authorized personnel. At least second degree of protection against contaminations should be provided for the device. Synchronism control relay is adapted for installation on 35 mm bus (DIN EN 60715 TH35). External connections are provided through the spring separable connection manufactured by WAGO. For relay connections, we recommend to use wires of LY type with cross-section 0.5...1.5 mm².
- The device can be installed only by the person with proper qualifications required for electric installations.
- The electric installation should be performed in the way that will provide safe operation using rated voltage 220 V DC. It is recommended to use power supply connector and over-current circuit breakers, taking into account total current consumption by the device and external device connected to the terminals. The power supply connector should be installed near the device, it should be easily accessible for the operator and should be marked as the device disconnecting instrument.
- Before installation of the device, there is necessary to check that the device was properly configured. This refers especially for slave address of serial bus. If the device will be operated in the communication system, it is necessary to provide proper settings, before installation of the device.
- Before installation of the device, it is necessary to make sure that circuits to which the device will be connected are disconnected from the power supply, and there are no dangerous voltages on the measuring and control wires.
- Connection of the wires should be performed according to diagrams represented on Figures 2 and 3 and Table 5. The wires should be connected to the terminals delivered with the device, and then to the corresponding slots of the device.
- In case, when stranded wires will be used, it is necessary to put insulating bushes on their terminals.

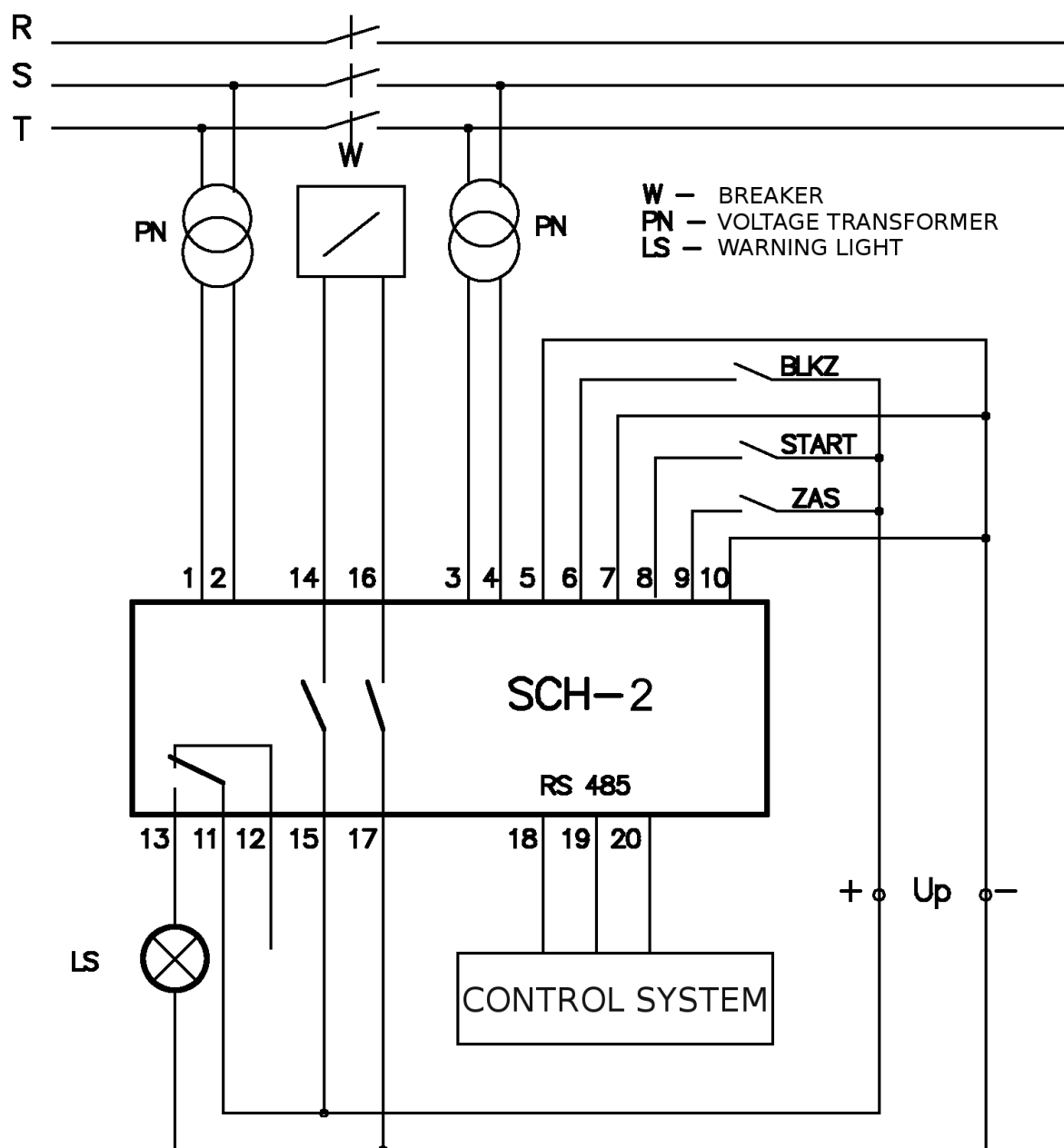
Tablica 5. Relay connections

Terminal No.	Symbol	Description
1	L1	measuring input L1
2	N1	referencing input L1
3	L2	measuring input L2
4	N2	referencing input L2
5	BL-	blockade signal input – negative terminal
6	BL+	blockade signal input – positive terminal
7	ST-	START signal input – negative terminal
8	ST+	START signal input – positive terminal
9	ZAS-1	power supply terminal +
10	ZAS-2	power supply terminal -
11	SY-1	signalization output – common terminal
12	SY-2	signalization output – N.C. contact (closed at rest)
13	SY-3	signalization output – N.O. contact (opened during actuation)
14	Z1-1	terminals of turning-on contact Z1, N.O. contact
15	Z1-2	
16	Z2-1	terminals of turning-on contact Z2, N.O. contact
17	Z2-2	
18	D0	RS485 connection line (D0 according to MODBUS, A according to TIA/EIA-485)
19	D1	RS485 connection line (D1 according to MODBUS, B according to TIA/EIA-485)
20	SG	the signal GND in the RS485 connector

Rys. 1. Block diagram



Rys. 2. Simplified diagram of SCH-2 with two external circuits



8 USAGE

Actual operation of the relay is limited only to turning-on the power supply. After 1 second, the relay will start automatically. If the device is operated in the communication system, it can be used for reading various informations and changing settings. All details are provided in Chapter 1. *COMMUNICATION THROUGH THE SERIAL INTERFACE.*

9 SCH-2 ALGORITHM

SCH-2 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

Tablica 6. 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 Tables 6. and 7., 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 1. COMMUNICATION THROUGH THE SERIAL INTERFACE (page 23).

Tablica 7. 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	<i>reserved</i>			0	0	0	
11	<i>reserved</i>						
12	Switch closing time	tw	ms	20	320	100	1
13	Increase of output signal duration time	tp	ms	0	1000	50	10
14	<i>reserved</i>						
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	Uzd1	%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	Uzd2	%Un	0	5	2	1
26	Highest residual voltage of dead busways on Line L2	Usg2	%Un	0	20	15	1
27	<i>reserved</i>						

* 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 $F_n = 50$ Hz, it is possible to manufacture version $F_n = 60$ Hz.

Used symbols:

U_n – rated voltage

F_n – 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:

$$|d|fi|/dt| < fss$$

9.4 SCH-2 operation algorithm in SSN mode**9.4.1 Condition for SY relay actuation**

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

Voltage 1. $U1 > U1d$

Voltage 2. $U2 > U2d$

Voltage 3. $Urd \leq dU \leq Urg$

Frequency $frd \leq dfr \leq frg$

Phase – one of the following conditions is fulfilled:

Phase 1. (phase difference is decreasing) and ($|d|fi| \leq fi1$)

Phase 2. (synchronous operation) and ($|d|fi| \leq fi1$)

9.4.2 Condition for SY relay de-actuation

SY relay is de-actuated, when none of the above mentioned conditions is fulfilled for SY relay actuation.

9.4.3 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 $BL = 0\text{ V}$

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

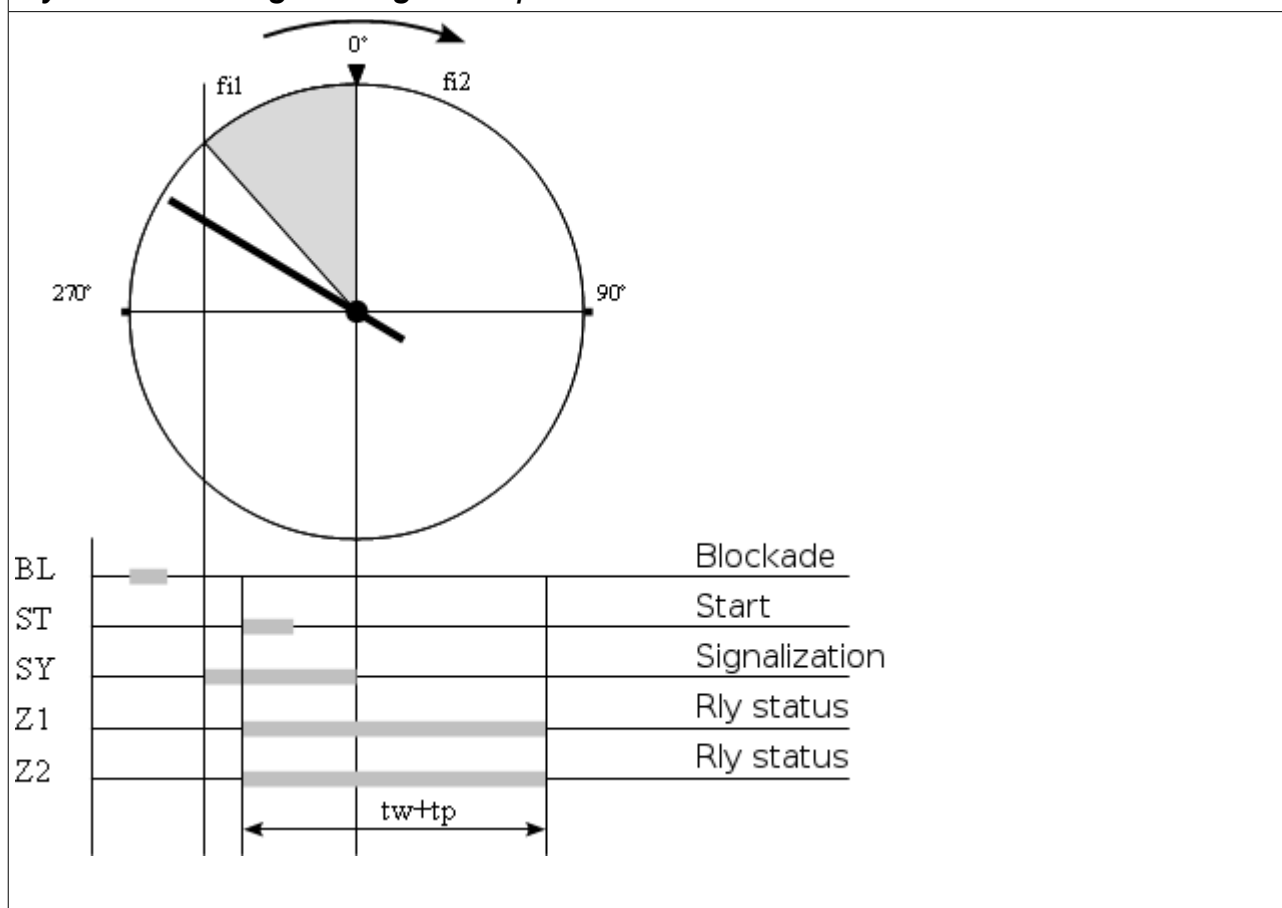
Attention! The start signal is ignored, if in the last second previous start signal is appearing. Duration time of this blockade is deducted from any previous ascent of this signal.

9.4.4 Conditions for Z1 and Z2 relays de-actuation

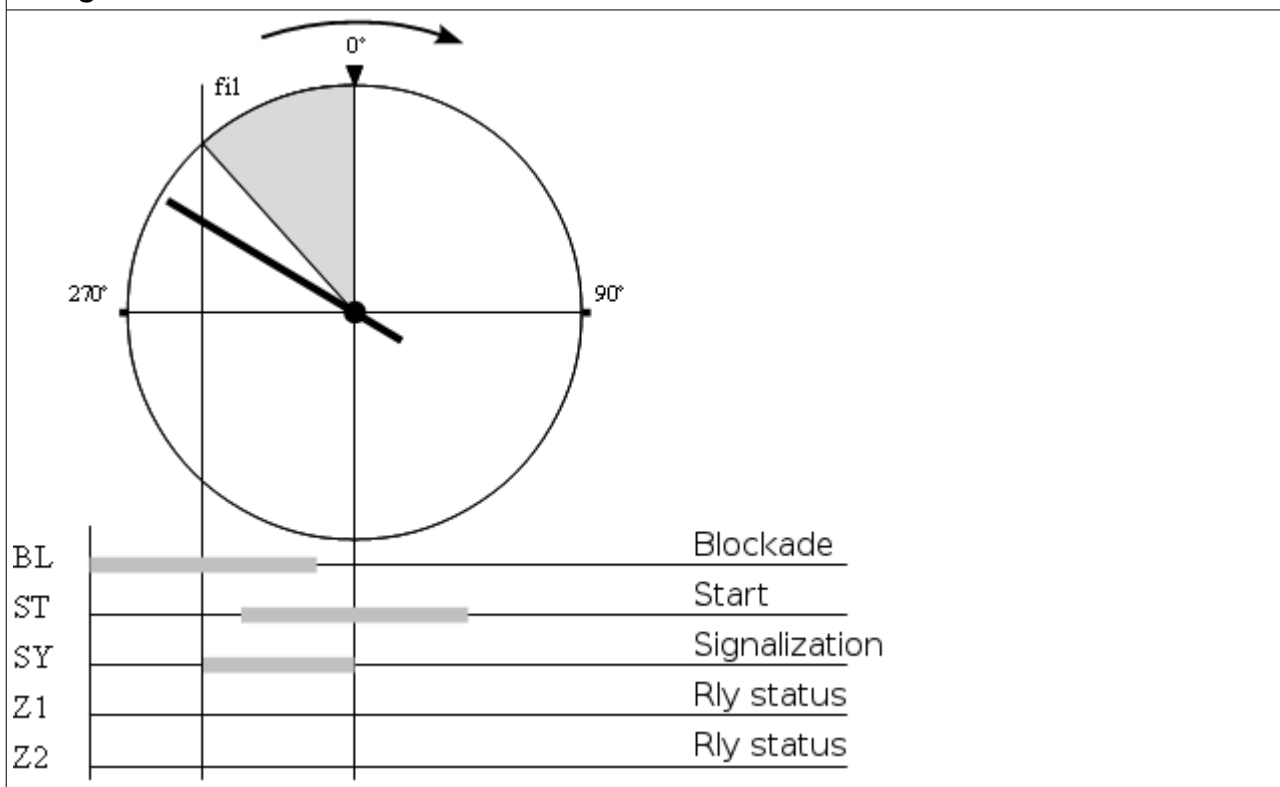
Actuation of Z1 and Z2 relays lasts until the time $(tw+tp)$ will be deducted, measured from actuation time of these relays.

9.5 Graphical representation of SCH-2 operation

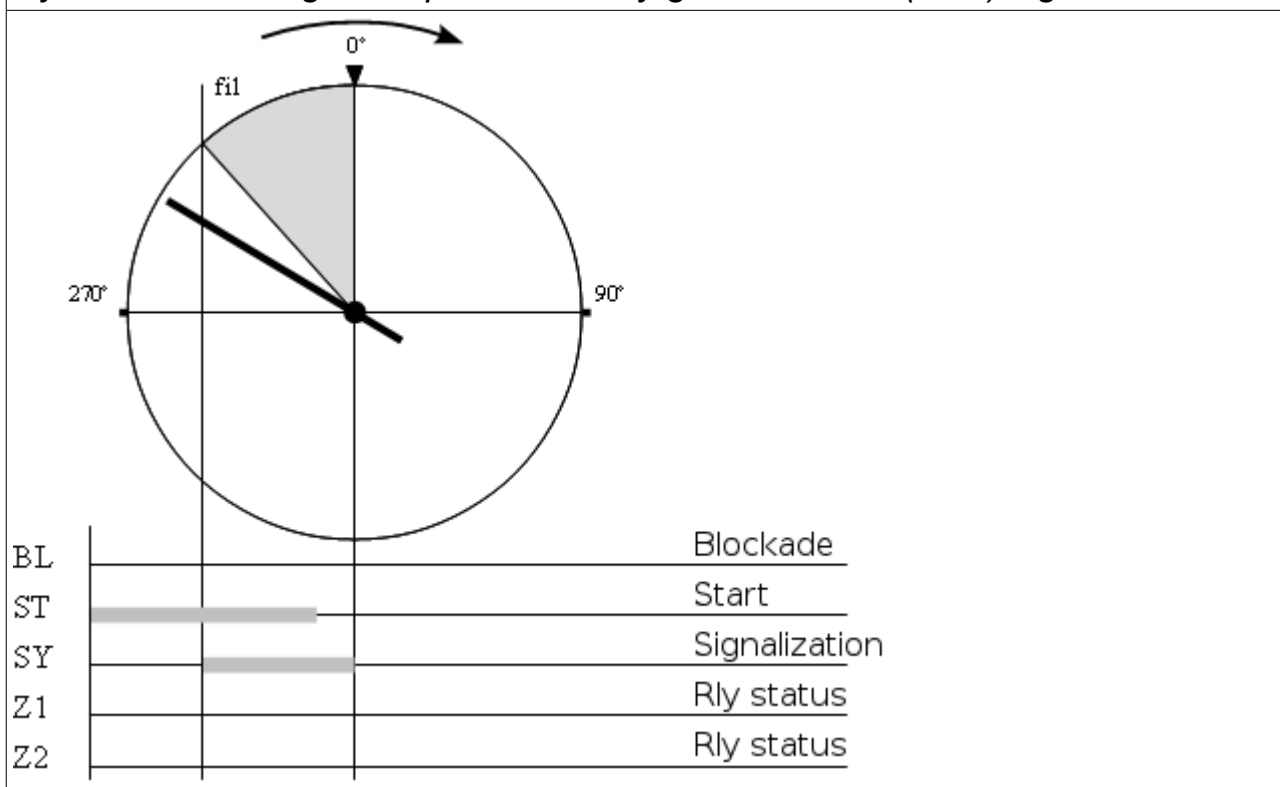
Rys. 3. Sending turning-on impulse



Rys. 4. No turning-on impulse ST (start) signal is blocked by BL (blockade) signal



Rys. 5. No turning-on impulse To early generated ST (start) signal



9.6 SCH-2 operation algorithm in SGD mode

9.6.1 Condition for SY relay actuation

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

Voltage 1. $U_{sd1} < U1 < U_{sg1}$ //residual voltage

Voltage 2. $U_{d2} < U2 < U_{g2}$

9.6.2 Condition for SY relay de-actuation

SY relay is de-actuated, when none of the above mentioned conditions is fulfilled for SY relay actuation.

9.6.3 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.

9.6.4 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 SCH-2 operation algorithm in SND mode

9.7.1 Condition for SY relay actuation

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

Voltage 1. $U_{d1} < U1 < U_{g1}$

Voltage 2. $U_{sd2} < U2 < U_{sg2}$ //residual voltage

9.7.2 Condition for SY relay de-actuation

SY relay is de-actuated, when none of the above mentioned conditions is fulfilled for SY relay actuation.

9.7.3 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.

9.7.4 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 Condition for SY relay actuation

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

Voltage 1. U_{sd1} < **U1** < U_{sg1} //residual voltage

Voltage 2. U_{sd2} < **U2** < U_{sg2} //residual voltage

9.8.2 Condition for SY relay de-actuation

SY relay is de-actuated, when none of the above mentioned conditions is fulfilled for SY relay actuation.

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 relay is equipped with serial asynchronous interface operated in TIA/EIA-485 standard. This interface is galvanically separated from other parts of the system. Denotations of terminals are according to MODBUS standard. Different manufacturers are using different denotations for terminals of such interface, therefore to avoid any mistakes we recommend to use the following Table (the second part of the Table provides symbols used for TIA/EIA-485 and TIA/EIA-422 standards).

Tablica 8. 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, read-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.

Tablica 9. 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.

Tablica 10. 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.

Tablica 11. 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.

Tablica 12. MODBUS register addresses (MODBUS holding registers)

Addresses	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)
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]

Addresses	Symbol	Content
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*)
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 is provided in Table <i>Functions of bits in wMBHR_WAR0, MBHR_WAR1, MBHR_WAR2, MBHR_WAR3 registers</i>
49	MBHR_WAR1	
50	MBHR_WAR2	
51	MBHR_WAR3	
52..53		Reserve
54	MBHR_DFi	Phase difference Fi2 – Fi1 (fig - fis) [0.01°]

Addresses	Symbol	Content
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)
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.

Tablica 13. 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

Register	Address	Symbol	Content	Units
%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
%R3636	3635	MBHR06_DFi	Value of phase difference between Ug and Us synchronizer inputs	0.01°
%R3637	3636	MBHR06_DFi1	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

Tablica 14. 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.

Comments. Entering the command under proper address (see *Control registers* in Table *MODBUS registers addresses* in page 25) will cause execution of the defined action. Entering the command must be preceded by entering the MB_HASLO_1 password.

Tablica 15. 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
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.

Tablica 16. 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 containing settings are provided in Table *MODBUS registers addresses (MODBUS holding registers)* on page 25.

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 unique slave 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 25. 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 25. Writing is performed in standard way using MODBUS command **Write Multiple registers**. Existing *slave* address can be also used (if 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 25. Interpretation of read values (e.g. physical magnitude values) for most registers are provided also in this Table. Meaning of the 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.



Tablica 17. Relay type (version) coding in MBHR_WER_TYP register

Code	Symbol	Meaning
0x02xx	WERSJA_SCH_2	SCH-2 version

– **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.

Tablica 18. 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 $Urd \leq dU$ (1 = green, 0 = yellow)
3	0l.3 warunek_Urg	fulfilment of condition $dU \leq Urg$ (1 = green, 0 = yellow)
4	0l.4 warunek_frd	fulfilment of condition $frd \leq dfr$ (1 = green, 0 = yellow)
5	0l.5 warunek_frg	fulfilment of condition $dfr \leq frg$ (1 = green, 0 = yellow)
6	0l.6 warunek_fss	fulfilment of condition $ dfi/dt < fss$ (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	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)



Bite		Symbol	Meaning
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)
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 \leq 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 \leq 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 \leq 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 \leq 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 \leq 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 \leq 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 \leq fi2$ for synchronization from the bottom, passing through the zero up (1 = green, 0 = yellow)

Bite	Symbol	Meaning	
55	3l.7	warunek_fi2sd_dn	fulfilment of condition $ dfi \leq 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 \leq \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 \leq \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 \leq \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 \leq \min(fi1, fi2)$ for synchronous 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

During ordering, please provide type of the device and the rated voltage. It is possible to enter for free settings other than standard settings. Then, to the order please attach the following Table (Table 19) together with required setting values.

SCH-2 codes table:

Device type	Rated power voltage	Rated voltage of two-state inputs
SCH-2-220-220	220 V DC / AC	220 V DC
SCH-2-220-110	110 V DC / AC	110 V DC
SCH-2-220-24	24 V DC / AC	24 V DC
SCH-2-110-220	220 V DC / AC	220 V DC
SCH-2-110-110	110 V DC / AC	110 V DC
SCH-2-110-24	24 V DC / AC	24 V DC
SCH-2-24-220	220 V DC / AC	220 V DC
SCH-2-24-110	110 V DC / AC	110 V DC
SCH-2-24-24	24 V DC / AC	24 V DC

Tablica 19. 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	<i>reserved</i>			0	0	–	–
11	<i>reserved</i>					–	–
12	Switch closing time	tw	ms	20	320		1
13	Increase of output signal duration time	tp	ms	0	1000		10
14	<i>reserved</i>						
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

No.	Parameter	Symbol	Unit	Range		Value of setting	Discretization
				min.	max.		
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

<p>Manufacturer:</p> <p>PUP KARED Sp. z o.o. 80-180 Kowale 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</p>	<p>Distributor:</p>
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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.