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Synchronizer

SM-06

Instruction Manual

(version 4.2)

CE

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IMPORTANCE OF INSTRUCTION MANUAL

In the event of doubt regarding the correct interpretation of the manual, please be sure to ask manufacturer for explanation.
We will be grateful for any suggestions, opinions and criticisms of users and we kindly ask you to transfer them in oral or written maner. This will help us make the instructions even easier in use and take into account the wishes and requirements of users.

The device, to which this instruction manual is attached, includes impossible to eliminate, potential threat to people and material values. Therefore, any person working on the device or performing any activities related to the handling and preservation of the device, must first be trained and know the potential danger. This requires careful reading, understanding and compliance with the instruction manual, in particular the safety instructions.

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INFORMATION ON COMPLIANCE

The device which is the subject of this manual is designed for use in industrial environment. With the development and production of this device, such standards are applied, which fulfillenes provide realization of assumed rules and safety measures, under the condition that the user respects specified further guidelines for installation and commissioning as well as the operation driving.

This device is a Class A. In a domestic environment it may cause radio frequency interference. In such cases, the user can be requested for the application of appropriate remedies.

This device is compatible with the provisions of EU directives:

- Low Voltage 73/23/EEC – introduced by the Regulation of the Minister of Economy, Labour and Social Policy of 12.03.2003 (Journal of Laws No. 49, item 414)
- Electromagnetic Compatibility (EMC) 89/336/EEC – implemented by the Regulation of the Minister of Infrastructure of 04.02.2003 (Journal of Laws No. 90 item 848).

Compliance with the directives has been confirmed by tests performed in independent from manufacturer measurement and research laboratories.

Synchronizers SM-06 meet the essential requirements set out in Directives Low Voltage and Electromagnetic Compatibility through compliance with the following standards:

The standard harmonized with Directive 73/23/EEC

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

The standards harmonized with Directive 89/336/EEC

- **PN-EN 61000-6-2:2002** Electromagnetic Compatibility (EMC) – part 6-2: General standards – Immunity for industrial environments.
- **PN-EN 61000-6-4:2002** Electromagnetic Compatibility (EMC) – part 6-4: General standards – Emission standards for industrial environments.

1. Device application

Microprocessor Automatic Synchronizer SM-06 is designed to automatically connect of AC power facilities for parallel operation. It performs the following types of connections (can operate in the following modes):

1.1. Automatic synchronization with a constant lead time (SYN)

After the power is turned on, synchronizer measures the the mains and generator voltage and control signals on binary inputs. The measured value of the voltage and frequency difference compares to the set limit values, and after signal "Start" generates regulatory pulses, that reduce these differences to the set limit values. After the "alignment" of voltages and frequencies generates switching the switch with a constant lead time. When correctly executed connection it is discontinued.

Synchronizer is discontinued even if there are circumstances which prevent the synchronization. Such discontinuation is an emergency discontinuation and causes various alarms.

In the synchronizer relay signaling an error is activated and the display shows the message indicating the reason for emergency discontinuation.

1.2. Switching on separate objects in a given angle of incompatibility phase sector (ZSK)

ZSK mode is used to connect the objects, when the synchronizer has no effect on the voltage and frequency of connected objects, if the certain specified in the settings connection conditions are fulfilled. When a signal "Start" was given, synchronizer will generate the shutdown pulse of switch only, when the voltage difference, phase difference and phase drift within the set time limit will not exceed the set limit values.

1.3. Switching on the generator switch on the mains without voltage (SBN)

SBN mode is used to close the breaker by a synchronizer, when the voltage and frequency of the generator have the required values and mains rails are not powered. When a signal "Start" was given, the synchronizer checks the voltages on both sides of

the switch and compares them to the set connecting conditions, which are the residual voltage on the network rails and the voltage parameters on generator rails. If these values fall within the preset range, generates a pulse closing switch. Checking the residual voltage is designed to detect whether the network rails are not shorted.

1.4. Switching on the mains voltage on not-powered generator field (GBN)

GBN mode is used for switching the mains voltage on the not-powered mains of generator own needs, using the synchronizer. When a signal "Start" was given, the synchronizer checks the voltages on both sides of the switch and compare them to the set connecting conditions, which are the voltage parameters on the mains rails and the residual voltage on generator rails. If these values fall within the preset range, generates a pulse for circuit breaker clousure. Checking the residual voltage is designed to detect whether the mains rails are not shorted.

1.5. Switching on the switch with the absence of main and generator voltages (SGBN)

SGBN mode is cused to the controlled by the the synchronizer circuit breaker clousure when on its two sides is no power supply. Once a signal "Start" is given, the synchronizer checks the voltage on both sides of the circuit breaker and compares it to the set connecting conditions, which are the residual voltage on the mains rails and the residual voltage on the generator rails. If these values fall within the preset range, generates a pulse for circuit breaker clousure. Checking the residual voltage is designed to detect whether the mains rails are not shorted.

1.6. The reviewing and modifying of the settings and measurements of some object parameters (TEST)

TEST mode is used to review and modify the settings of synchronizer and measurement of certain parameters of the synchronized object, among others the circuit breaker closing time.

2. Safety rules

The information contained in this section are intended to familiarize the user with the proper installation and operation of the device. It is assumed that the installing, activating and operating personnel of this device is properly qualified and is aware of the potential dangers associated with the operation on the electrical equipment.
The device complies with applicable regulations and standards in terms of safety. In its design particular attention to the safety of users was payed.

Device installation

The device should be installed on a place that provides appropriate environmental conditions specified in the technical data. The device should be properly secured and protected from mechanical damage and from accidental access of unauthorized persons. The synchronizer is designed for panel or back panel mounting (depending on housing version) in indoor switchgears. The synchronizer should be connected according to the wiring diagram. External connections are connected by detachable spring connectors of WAGO company. For connections of synchronizer it is recommended to use conductors of LY type with section diameter 0,5÷1,5 mm^2.
The synchronizer **SM 06** is executed in first protection class and must be connected to the protective conductor of the system to appropriately labeled terminal on the housing.

Commissioning

When you have installed the synchronizer its start-up in accordance with generally accepted principles concerning protection devices, automation and control is to be carried out.
Insulation test may cause a charge of the diffuse capacity to the dangerous voltage. After each part of the test these capacities have to be discharged.

Operation of device

The device should work under the conditions specified in the technical data.
Personnnel operating the machine should be authorized and acquainted with the instruction manual.

Removing the cover

Before performing any work with the necessity of housing removal, you must disconnect all power supply and measurement voltages and then disconnect synchronizer from the external circuits by dislodge all plugs.

Components used are sensitive to electrostatic discharge, thus device opening without the proper antistatic equipment, can cause its damage.

Operation

After installing the device does not require additional service beyond the periodic checks required by the relevant regulations. If you find any foult, please contact the manufacturer.

The manufacturer provides maintenance and post warranty services.

Warranty terms are specified in the Warranty Card.

Modifications and changes

Due to safety, any modifications and changes in functionality, covered by this manual are not allowed. Device modifications to which the manufacturer does not give written permission cause loss of any liability claims against the **PUP KARED Sp. z o.o.** Company. Replacement of parts and components incorporated in the device from other manufacturers than those used may affect the safety of its users and cause device malfunctions.

PUP KARED Sp. z o.o. Company is not responsible for damages caused by use of improper components and assemblies.

Disruptions

The possible disturbances observed in operation and other damage should be immediately passed to the competent person.

Repairs may only be performed by qualified specialists.

Rating and information plates, stickers

Always observe the instructions given in the form of descriptions on the device, information signs and labels, and keep them in a condition for good readability. Plates and stickers that have been damaged or become illegible, should be replaced.

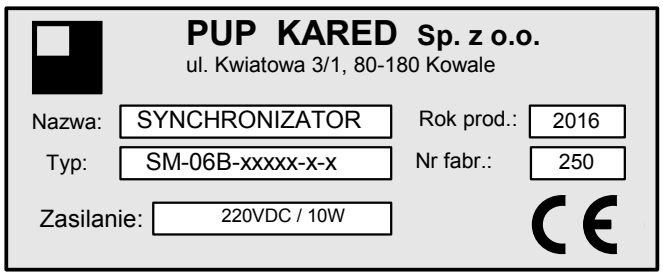


Fig 2.1. Sample of name plate

3. Technical description and device operation

3.1. General description

Synchronizer SM-06 was built based on the microprocessor technology. Components of the device are placed in APRA 63T housing in the panel embodiment or in 19-or 12-inch rack Euro 3U production of RADMOR S.A. (back panel mounting execution).
Mains measuring voltages and object synchronized voltages (alternating with a nominal value 100 V RMS) and binary signals (boosted by the DC voltage of value 220, 110 or 24 VDC, depending on the version of the device) are supplied: the type of connection, lock off, start and switches states selection, on the basis of which, synchronizer states conditions for the operation and automatically implements the selected type of connection.
The synchronizer is adapted for operation with a mains frequency of 50 Hz.
On the front panel (**Synoptic Board** or in brief **TS**) light emitting diodes are placed (LED) and liquid crystal display (**LCD**), which indicate the operating mode and allow the process of linking tracking. Faulty connections of external circuits, defects or malfunctions are indicated by displaying the appropriate voice written messages on **TS** and by stimulating internal error signals relay.

On Client's request **synchronizer SM-06** can be equipped with:

- additional synoptic board located on the control panel in the control room **(TS-10)** connected to the device using the optical fiber cable, or with,
- additional communication interface RS 485 used by the host system,
- a program that allows the observation of the synchronization process on the PC monitor, ie. so called "Virtual Synchronization Column".

3.2. Housing

Synchronizers **SM-06** are manufactured in three housing versions and are respectively indicated by a version number: 1, 2 or 3.

- **Version 1** – panel mounting housing Profi Set 63T of APRA company, designed for mounting on the relay board in the switchboard, or inside the cabinet

- **Version 2** – back panel mounting housing (cassette Euro 12” 3U) width 49T, designed for installation on the board in the control room or on the switchgear elevation,
- **Version 3** – back panel mounting housing (cassette Euro 19” 3U) width 84T designed for installation in a typical cabinet adapted for mounting 19-inch cassettes.

There are possible also other unusual versions of housings agreed with the manufacturer.

Typical versions of housing shown in Fig. 3.1, 3.2 and 3.3

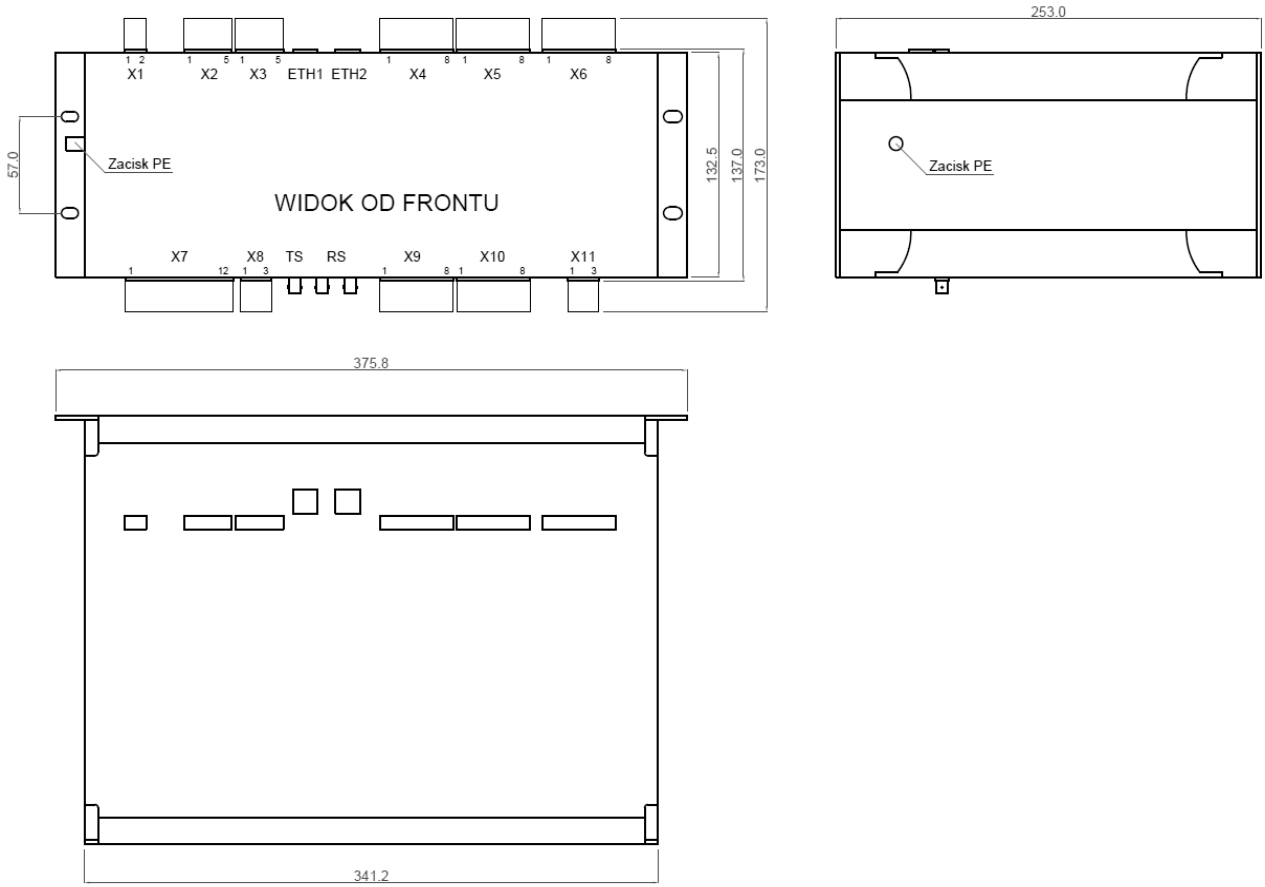


Fig. 3.1 Version 1: Panel mounted housing Profi Set 63T of APRA company

Legend:

Widok od frontu	–	Front view
Zacisk PE	–	PE terminal

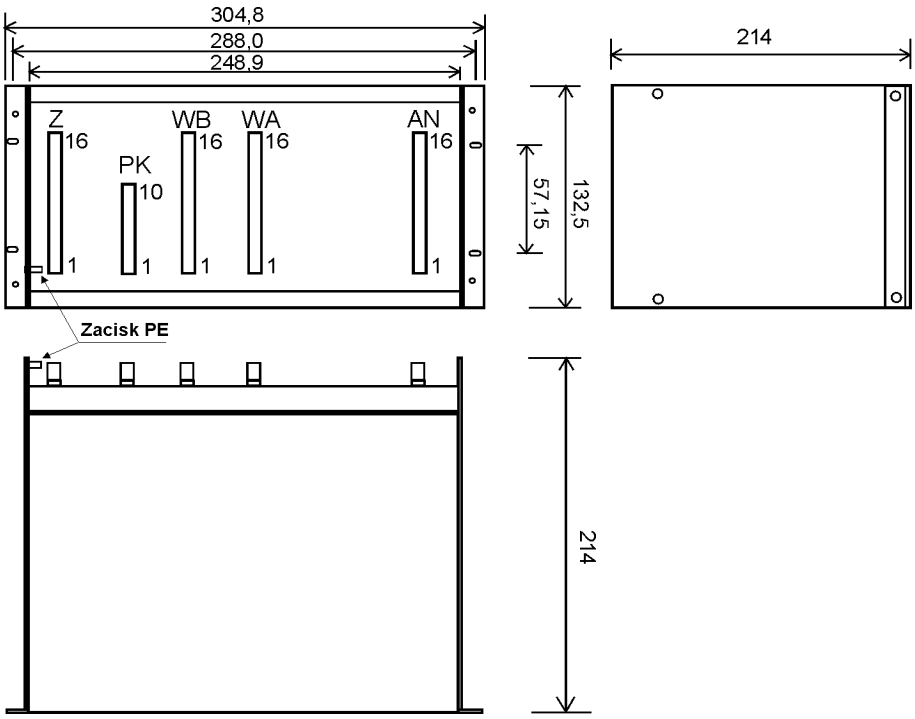


Fig. 3.2 Version 2: Back panel mounting housing with a width 49T

Legend:

Zacisk PE – PE terminal

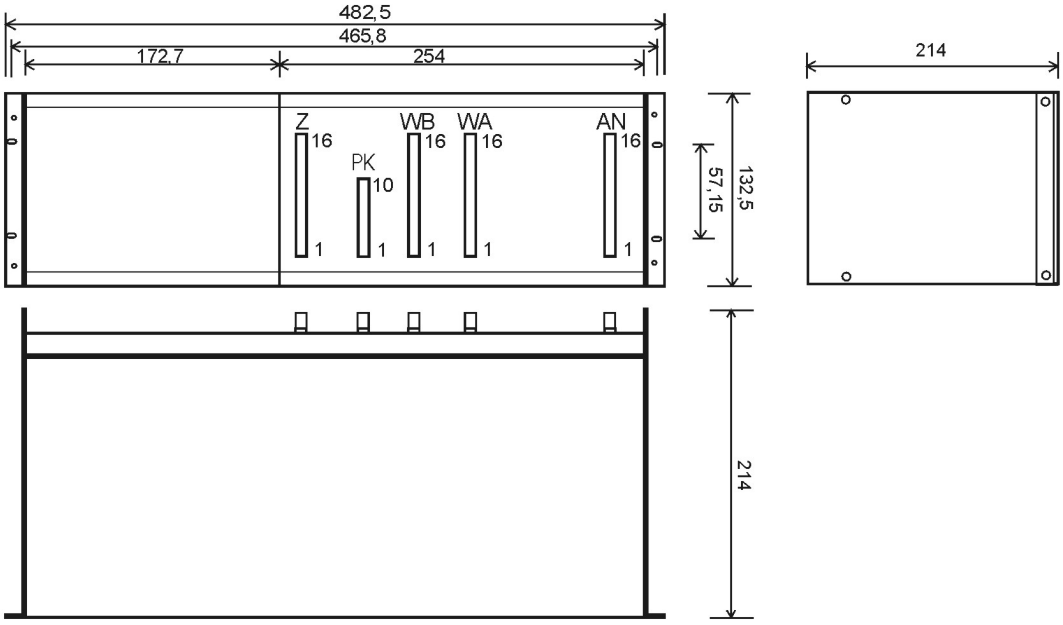


Fig. 3.3 Version 3: Back panel mounting housing housing with a width 84T

3.3. The synoptic board

Synchronizer SM-06 is equipped with a synoptic board, located on the front of the device and especially facilitating the process of automatic synchronization at the first startup.

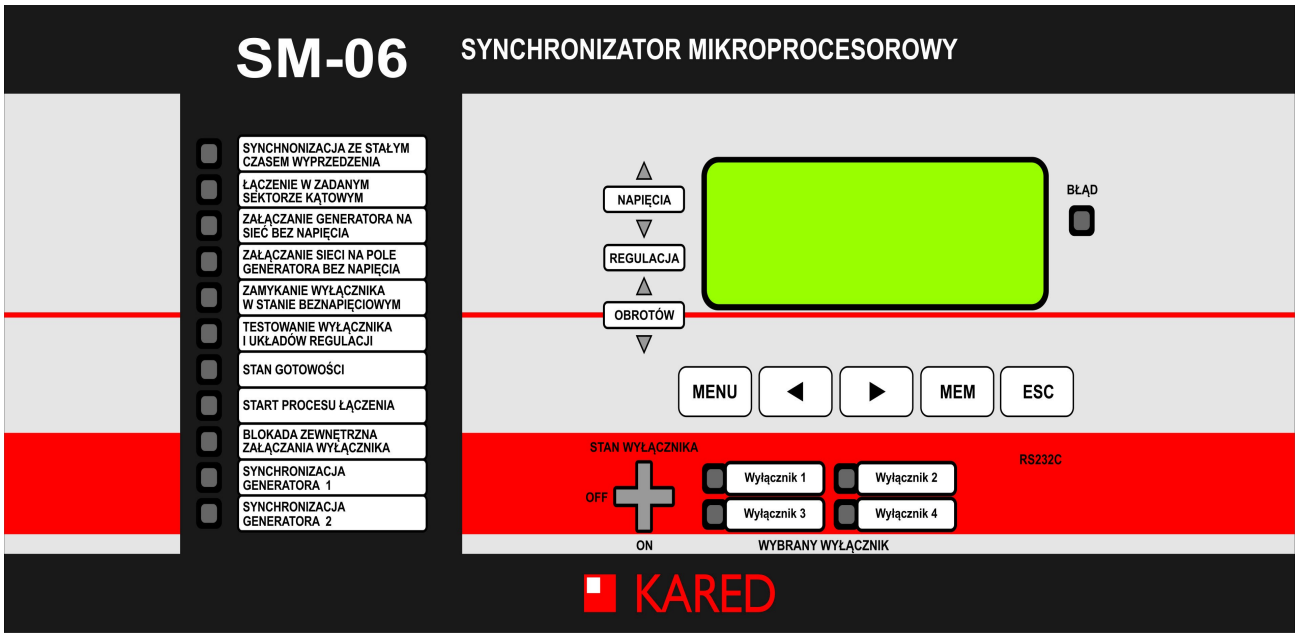


Fig. 3.4 View of the synchronizer SM-06B front panel

On the left side of the board the light emitting diodes (LEDs) are provided, to indicate among others the selected operating mode, and on the right side: liquid crystal display (LCD), keys (keyboard) and LEDs indicating the selected time of the switch closing. In the lower right corner of the synoptic board socket RS 232C port for connecting a portable PC is placed.

To the right from the LCD, the LED's indicating error are placed.

In the central part of the synoptic board under the inscription REGULATION, with inscriptions VOLTAGES and ROTATIONS, illuminated arrows in tact to generate the synchronizing pulses that affect the voltage regulators and the angular velocity of the turbine set are placed. Arrows directed upwards are illuminated, when signals increasing voltage and frequency are generated. Analogously arrows pointing downward, when the signals lowering voltage and frequency are generated.

The status of the circuit breaker depict a cross-shaped lamps. Beam of the cross illuminated in green (OFF) indicates that the circuit breaker is open, illuminated in red (ON) that it is closed.

3.4. Signalling of errors

3.4.1. External errors

External errors are indicated by a corresponding written messages on the synchronizer's LCD display. They include the damages or errors that occur outside the synchronizer, due to lack of appropriate configuration of input signals (eg. broken cable, defective terminal, etc.) or excess of signals (eg. short circuits). These errors cause the emergency discountinuation of synchronizer and the detected terror signalling.

3.4.2. Internal errors

Internal errors can occur due to infringements of work of synchronizer. Which are indicated in the form of digital code. In the event of an internal error, note its code, turn off the power of synchronizer and turn it on again. If after restarting the same error will occur, It is absolutely necessary to call the sernice, because it may indicate a internal damage of synchronizer.

3.5. Operation description

This section describes detailing operation of **SM-06** from device commissioning, handling of irregularities, disabling and finally the implementation of the selected operating mode.

3.5.1. Introduction - definitions and designations

Synchronizer power supply

1. **Up** – the auxiliary voltage of the nominal value 220 VDC or 110 VDC or 24 V DC (depending on the version of synchronizer) for providing power to synchronizer. It is used also by an internal diode and Uv clamp to stimulate inputs of operation mode selection and inputs for devices control. **The rated Up voltage, is also the rated voltage applied to all binary inputs.**

Analog input signals

1. **Us** – mains voltage with a nominal value 100 V RMS and frequency 50 Hz from the voltage relay,
2. **Ug** – voltage of object connected to the mains with a nominal value 100 V RMS from the voltage relay (eg. generating set or power subsystem).

Discrete input signals (voltage, the Up value)

A. Operation mode selection signals:

1. **SYN** – automatic SYNchronization with a lead fixed time,
2. **ZSK** – Enabling of dedicated facilities in the set sector of non-compliance phase angle,
3. **SBN** – Enabling the generator switch on a Mains Without Voltage,
4. **GBN** – Activation of mains voltage on not powered generator field (Generator Bez Napięcia - Generator Without Voltage),
5. **SGBN** – Enabling the circuit breaker in the absence of mains and generator voltages (Sieć i Generator Bez Napięcia – Mains and Generator Without Voltage),
6. **TEST** – Reviewing and modification of settings and measurements of some parameters of object.

B. Control signals:

1. **START** - START of the connecting process,
2. **BLKZ** - External interlock of signal activating a circuit breaker.

C. Switch status and selection circuit breaker settings signals:

1. **W1o** – circuit breaker W1 opened, settings of the circuit breaker W1
2. **W1z** – circuit breaker W1 closed,
3. **W2o** – circuit breaker W2 opened, settings of the circuit breaker W2
4. **W2z** – circuit breaker W2 closed,

Discrete output signals (relay contacts)

1. **ZW** – pulse switching circuit breaker on,
2. **BL** – error signaling,
3. **OG** – pulse signal increasing rotations of generator,
4. **OD** – pulse signal reducing rotations of generator,
5. **NG** – pulse signal increasing voltage of generator,
6. **ND** – pulse signal reducing voltage of generator.

3.5.2. Operating mode selection

You can select one of the following operating modes:

1. **SYN** – automatic SYNchronization with a lead fixed time
2. **ZSK** – Connecting of dedicated objects (eg. connecting of mains) in the set sector of non-compliance phase angle, working quasi synchronously
3. **SBN** – Enabling the generator switch on a Mains Without Voltage
4. **GBN** – Activation of mains voltage on not powered generator field (Generator Bez Napięcia - Generator Without Voltage)
5. **SGBN** – Enabling the circuit breaker in the absence of mains and generator voltages Mains and Generator Without Voltage
6. **TEST** – Reviewing and modification of settings and measurements of selected parameters

Setting the operating mode takes place immediately after turning the power and device auto testing. Then it is checked on which of the six inputs of operation mode selection is the voltage. Corresponding to this input mode is selected and the subsequent change is impossible, until the synchronizer power is turned off. If the voltage is on more than one of the six inputs of operating mode selection, or is not on any, the device enters the emer-

gency withdrawal state. The state of voltages on the above inputs can not be varied for all modes except for TEST, until the moment of voltage supply at the START input; and for TEST mode until the power supply is turned off. Type of the selected mode is confirmed by the illumination of the appropriate LED, on the left TS side.

3.5.3. Starting and shutting down

Synchronizer is started by switching the supply voltage Up with WZ circuit breaker (Fig. 4.1, 4.2). After powering synchronizer is performing the auto test, waits the time specified by the setpoint Td (table 3.1, l.no. 46), and then checks the correctness of of input signals (Td setpoint does not include the auto testing time, which is approx.1,8s). Correct status of input signals occurs when following conditions are met simultaneously:

- Uv voltage– derived from synchronizer - is present on one and only one input of: SYN, ZSK, SBN, GBN, SGBN, TEST,
- Uv voltage is not present at the START input,
- Uw voltage (.)is present on one and only one input of: W1o – W2o,
- Uw voltage (.) is not present on inputs W1z – W2z.

Where:

Uv – constant voltage from the output of synchronizer power supply Z14 package, with a nominal Up value,

Uw(.) – constant voltage with a nominal Up value; dot in parentheses (**.**) – is the number of the selected circuit breaker.

If the synchronizer detects an abnormal state of input signals, it proceeds to **emergency discontinuation** status, but if the configuration of the of input signals is correct, to **waiting** status (except for the TEST mode, as well as ZSK, where the standby staus is preceded by **drift measurement** status). Standby staus continues until the appearance of START signal (+Uv signal on START input), stimulating the set type of connection. When correctly executed connection the synchronizer passes to **discontinuation after switching** status.

The synchronizer can be turned off at any time by turning off the power supply Up voltage with the WZ circuit breaker.

The synchronizer uses the control system of UP supply voltage. If the value of this voltage drops below Upmin (value is given in the technical data), device will enter the state of emergency discontinuation. This is intended to prevent misinterpretation of the binary

input states, also supplied from Up voltage, in the event of voltage decrease below the switching threshold of these inputs.

3.5.4. Emergency discontinuation

Emergency discontinuation takes place when synchronizer detects a bug that prevents the proper execution of set connection.

Emergency discontinuation causes:

1. Error signalling – short circuit +BL from BL (relay contacts),
2. Display the error message on the LCD display,
3. Lighting of LED signaling an error.

If the reason for discontinuation is invalid status of the inputs, on the display after **DISCONTINUATION** inscription code 15 is displayed– incorrect configuration of the input binary signals after powering (see item 7.3.1 pag. 52).

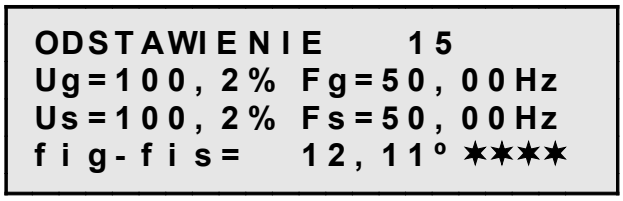


Fig. 3.5

Legend:

ODSTAWIENIE – DISCONTINUATION

✶✶✶✶ indicate that the measured angle is the actual phase-angle measuring voltages Ug and Us applied to the synchronizer inputs, (without correction of constant phase shift angle).

3.5.5. Operating modes

In this section will be discussed the performance of synchronizer individual operating modes.

3.5.5.1. Automatic synchronization with a continous lead time (SYN mode)

In order to connect alternating current objects for parallel operation with the set lead time (synchronization) it shouldt be:

1. Selector switch of the connection type (WRL, Fig. 4.1, 4.2) set in the SYN position.
2. Close the correct key of switch selection (WW1 or WW2, Fig. 4.1, 4.2).
3. Turn on the synchronizer power.

After powering synchronizer starts with auto testing and validation of input signals. After auto testing it goes to waiting status, unless earlier detects an error, then to the status of emergency discontinuation.

In the waiting status (Fig. 3.6) there are displayed the current effective values of the voltage measurements **Us** and **Ug** in % nominal value of 100V, and their frequency **Fs** and **Fg.** In the last line the phase difference is displayed **dfi** = dfg – dfs and the status of the signals on the two inputs: START - **S** and BLKZ – **B**. **„0”** - means inactive status of input (no voltage), **„1” –** active status (it is the voltage + Uv).
In addition, the waiting status is signaled by lighting of the yellow LED: STANDBY STATUS.

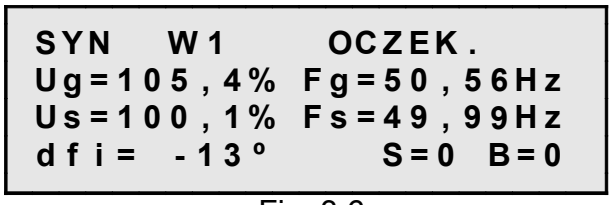


Fig. 3.6

In the waiting state the synchronizer does not send any signals and stays there until a voltage appears at the START input. The voltage at the START input, does not have to be kept, only you need a pulse.

After the START signal, if the measured mains and generator voltage meet the inequalities (3.1):

$$Us > 0.5Un$$
$$Ug > 0.5Un \qquad (3.1)$$

where: Un – nominal value of the voltage equal to 100 V RMS.
synchronizer goes into the connecting state and if not, then to the state of emergency discontinuation. In the connection state compares the measured values with set values (settings), regulates the voltage and the angular speed of the generator and enables circuit breaker with the specified lead time. When adjusting, before connecting, the display shows information as in the example in Fig. 3.7

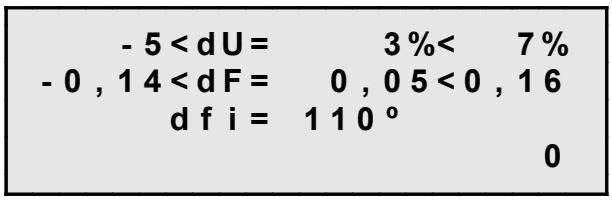


Fig. 3.7

In the middle of the LCD display, after the character „=",currently measured values are displayed: voltage difference **dU**, frequency difference **dF** and phase difference **dfi.**
On the left side of the display the set lower limits tensions „ **–dU"** (table 3.1, l.n. 3) and frequences „-**dF"**, (table 3.1, l.n. 9) displayed.
On the right side - upper limits "**+ dU"** (table 3.1, l.n. 4) and **„+dF**" (table 3.1, l.n. 10). By setting the ZL setpoint - (table 3.1, l.n. 13) on "N" it is possible to block connection from "below", that is, for dF < 0. Then, instead of the selected value -dF, the value 0 will be displayed. By setting the ZL setpoint + (table 3.1, l.n. 14) on "N" it is possible to block connection from "top", that is, for dF > 0. Then, instead of the selected value +dF, the value 0 will be displayed.
In the fourth line of the display, in the form of black line, the absolute value of the phase difference in the range of 0 to 180 degrees with discretisation ± 2 degrees is displayed. Zero line illustrating the absolute value of the difference **"0"** is placed on the right side of the display. Measured values are refreshed 25 times/sec.

The dU voltage difference is expressed in relative values:

$$dU = 100\ (Ug - Us)/Us \quad [\%] \qquad (3.2)$$

where: Ug - voltage of generator
Us - voltage of mains

The dF frequency difference is expressed in relative values:

$$dF = 100\ (Fg - Fs)/Fs \quad [\%] \qquad (3.3)$$

where: Fg - frequency of generator,
Fs - frequency of mains.

The “dfi” phase difference is expressed in degrees:

$$dfi = fig - fis \quad [^{o}] \qquad (3.4)$$

where: fig - phase of generator voltage
fis - phase of mains voltage

If in the connection status at any time the inequality will not be fulfilled (3.5):

$$-15\% < dF < 15\% \qquad (3.5)$$

then the synchronizer will go to the state of emergency discontinuation.

3.5.5.1.1. Voltage regulation

The signal of voltage regulation is a series of pulses at a frequency of 1 Hz with an adjustable filling equal to ww(.) (table 3.1, l.no. 7). The synchronizer adjusts the voltage at the difference frequency |dF| < dfu (table 3.1, l.no. 8).
If the generator's voltage does not depend on its angular velocity (table 3.1, l.n. 12 setting C = 0) i dU > (+dU/2) (table 3.1 l.no. 4) then synchronizer generates ND pulses reducing the generator's voltage. If dU < (-dU/2) (table 3.1, l.no. 3) then synchronizer generates ND pulses incrfeasing the generator's voltage. If, during the ND pulse, dU > (+dU/2) condition ceases to be met, then the adjusting signal is interrupted. Similarly if, during the ND pulse,

dU < (-dU/2) condition ceases to be met, the NG signal is also interrupted. NG and ND pulsem are also interrupted after the circuit breaker closure.
When the generator's voltage depends on its rotational speed (table 3.1, I.no. 12, setting C ≠ 0) voltage regulation is associated with frequency adjustment. Voltage control pulses are modified in such a way, that at the moment fulfillment of the conditions the frequency voltage conditions are met simultaneously.

3.5.5.1.2. Adjustment of the generator's rotational speed

The synchronizer adjust the rotational speed of the generator by changing the set value of this speed in the turbine controller driven generator. In **SM-06** adjustment takes place using pulses of preset duration (table 3.1, I.no. 11), twice during one period of voltage beats.

3.5.5.1.3. Prevention against not in-phase synchronous operation

If by 20 s no pulse speed control is not sent and during this time the absolute value of the frequency difference is less than 0,1%, then the synchronizer sends a pulse, causing the output of the generator from the state of synchronous not in-phase operation.

3.5.5.1.4. Circuit breaker activation

The synchronizer sends with the selected circuit breaker lead time (table 3.1; I.no. 1, 2), **ZW** pulse switching on the circuit breaker, if and only if all the following conditions given precise synchronization (3.6) are simutaneously met:

1. Voltage - $-dU(.) \le dU \le +dU(.)$
2. Frequency - $-dF(.) \le dF \le +dF(.)$ (3.6)
3. Phase - $|\delta\alpha| \le fia$
4. External interlock signal - BLKZ = 0
5. Minimum 2 sec. of time ha passed from the end of the last pulse of speed regulation and the next pulse has not started.

where:
-dU – the lower limit of the voltage difference with synchronization (table 3.1; I.no. 3);

+dU – the upper limit of the voltage difference with synchronization (table 3.1; I.no. 4);

-dF – permissible frequency difference when connecting "from the bottom" (table 3.1; I.no. 9);

+dF – permissible frequency difference when connecting "from the top" (table 3.1; I.no. 10);

δα – the estimated phase difference (phase deviation) at the time of closing the circuit breaker contacts;

fia – allowable angle deviation (table 3.1; I.no. 47)

If the above synchronization conditions with a fixed lead time are not met in the current period of tension beats, then the synchronizer is waiting for their performance in the next period, until it succeeds, unless it will be earlier switched off.

External interlock **BLKZ** signal blocks the signal switching on the circuit breaker, if it appears before the ZW signal. If it is in inverse, then started switching pulse lasts for a time

$$tzw \leq tw + 300\_ms \qquad (3.7)$$

where: tw - set lead time

and is interrupted at the confirmation status „clearly closed" time, on the basis of signals from the auxiliary contacts of the circuit breaker.

Pulse actuating circuit breaker can be single when setting Lp =1 (table 3.1, I.no. 15), or multiple, when Lp > 1 and there is no signal confirming switch activation.

If Lp > 1 and after the start of **ZW** pulse switching circuit breaker, by the time **tzw** there is no signal (from the switch auxiliary contacts – Fig. 4.1, 4.2) confirming the unequivocally closed state, then the synchronizer will retry connecting until exhaustion of set number of connections.

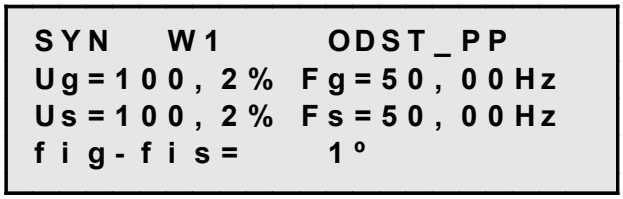


Fig. 3.8

If in another attempt merger took place, confirmed by signals from the circuit breaker, then the synchronizer migrates to the discontinuation status after switching (Fig. 3.8). Within the discontinuation status after switching the current values of measurement voltages **Ug** and **Us** are displayed, (in % of the nominal value of 100V, measured on both sides of the selected circuit breaker), **Fg** and **Fs** frequencies and dfi = **fig - fis** difference of phases, until the power supply is turned off.

If Lp = n and during the n-th **ZW** pulse, there is no signal from the the auxiliary contacts of cirtcuit breaker, confirming unequivocally closed state, then the synchronizer goes into the emergency discontinuation status (Fig. 3.9). (see item7.3.1. Code 1 - no switching confirmation,

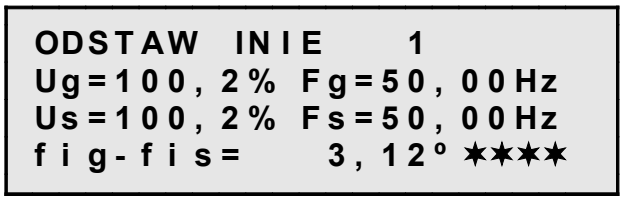


Fig. 3.9

✶✶✶✶ indicate that the measured angle is the actual phase-angle of measuring voltages Ug and Us applied to the synchronizer inputs, (without correction of constant phase shift angle).

If in another attempt merger took place, confirmed by signals from the circuit breaker, then the synchronizer migrates to the discontinuation status after switching (Fig. 3.8).

Fi1 and fi2 settings (table 3.1, l.no. 5, 6) allow the correction of constant phase shift, which the synchronizer "sees" between the inputs Ug and Us. This is useful in situation where, due to phase shifts caused by the current transformers or transformers, difference of phases on the terminals Ug and Us, is not equal to the phase difference on both sides of the circuit breaker. For situations where there is no phase shifts, these settings should be set to 0.

3.5.5.2. Switching on separate objects in a set sector of phaze incompatibility angle (ZSK mode)

In order to connect to the parallel operation two facilities working almost synchronously (eg. connection of the local mains to the national grid) it should be:

1. Selection switch to type of connection (WRL, Fig. 4.1, 4.2) set to ZSK position.
2. Close the correct key of selection switch (WW1 or WW2, Fig. 4.1, 4.2).
3. Turn on the synchronizer power supply.

After powering synchronizer starts with auto testing and validation of input signals. After auto- testing it goes into the drift measurement state (Fig. 3.10), unless earlier detects an error, so then to the emergency discontinuation status:

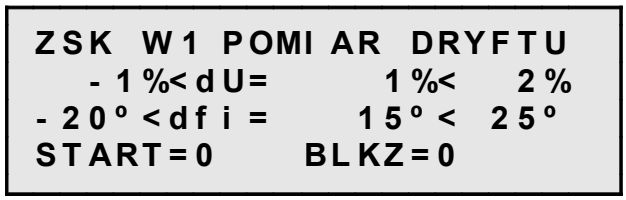


Fig. 3.10

After the Tg time, with the inactive START signal, the synchronizer goes into waiting status (Fig. 3.11). The drift of the phase difference is measured at time intervals of 0.5 s:

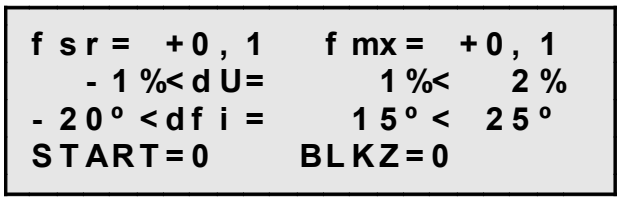


Fig. 3.11

In each time interval of 0.5 s the maximum drift "fmx" value of 50 measurements carried out at approx. 10 ms is calculated. The display shows the last measured maximum fmx value observed in the Tg time interval and the current fsr frequency difference. Du voltage difference and dfi difference of phases are updated on the display 25 times/sec.

Stimulation of the merger process in ZSK mode begins when the START signal and deducting the tg time are applied (both conditions must be simultaneously fulfilled). If the voltage at the input START appears after deducting the tg time that need not to be

maintained, the pulse is only needed. Connecting will be realized if, with the active START signal, the following conditions are met:

1. Mains measuring voltage $Usd(.) \le Us \le Usg(.)$
2. Voltage difference is less than the acceptable $dUd(.) \le dU \le dUg(.)$
3. The phase difference is less than the acceptable $-dfi(.) \le dfi \le +dfi(.)$ (3.8)
   Drift state mesurement is completed, ie. from auto-testing has elapsed timet $\ge Tg(.)$
4. The drift of the phase difference at Tg time satisfies the condition $|fmx| \le f(.)$
5. Lock signal is inactive $BLKZ = 0$

where:

Usd(.) – Lower threshold of mains voltage switched on by W(.) (table 3.1, I.no. 36, 37),
Usg(.) – Upper threshold of mains voltage switched on by W(.) (table 3.1, I.no. 38, 39),
dUd(.) – Lower value of the difference voltage connected via W(.) (table 3.1, I.no. 20,21),
dUg(.) – Lower value of the difference voltage connected via W(.) (table 3.1, I.no. 22,23),
-dfi(.) – Lower voltage phases difference connected via W(.) (table 3.1, I.no. 16, 17),
+dfi(.) – Upper voltage phases difference connected via W(.) (table 3.1, I.no. 18, 19),
Tg(.) – Time limit of measurement of phases drift when connecting via W(.) (table 3.1, I.no. 26, 27),
f (.) – Permissible drift of the phase difference when connecting via W(.) (table 3.1, I.no. 24, 25),
fmx – maximum value of the drift of the phase difference measured in the Tg time interval.(table 3.1, I.no. 26, 27),

If the START signal will appear before calculation of Tg time limit and will be supported until its calculation, then the signal switching on the circuit breaker will be sent immediately after the limit time calculation, provided that they meet the requirements (3.8).
If with the active START any of the conditions (3.8) is not satisfied after the calculation of Tg time, then the synchronizer goes into the emergency discontinuation state (Fig. 3.12, there the reason was failure to comply with condition 5; see item 7.3.1 code 12 : 36 - exceeding the set drift upper limit):

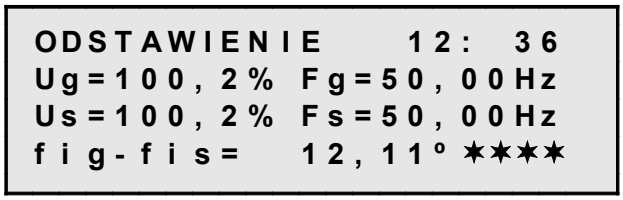


Fig. 3.12

✶✶✶✶ indicate, that the measured angle is the actual phase-angle of measuring voltages Ug and Us applied to the synchronizer inputs, (without correction of constant phase shift angle).

After correct execution of switching the synchronizer migrates to the discontinuation status after switching (Fig. 3.13):

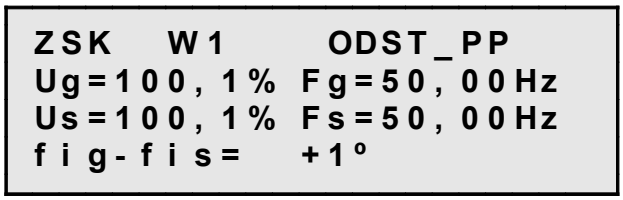


Fig. 3.13

In the state of withdrawal after switching the current values of Ug and Us measuring voltages are displayed, (% of the nominal value of 100 V, as measured on both sides of the selected circuit breaker), **Fg** and **Fs** frequencies and dfi = **fig - fis** difference of phases, until power supply is turned off.

Fi1 i fi2 setpoints (table 3.1, l.no. 5, 6) allow the correction of constant phase shift that synchronizer "sees" between the Ug and Us inputs. This is useful in situation where, due to phase shifts caused by the current transformers or transformers, difference of phases on the terminals Ug and Us, is not equal to the phase difference on both sides of the circuit breaker. For situations where there is no phase shifts, these settings should be set to 0.

3.5.5.3. Closing the switch during voltage failure from one or both sides of the circuit breaker (modes: SBN, GBN i SGBN)

The **SM-06** synchronizer can be used for closing the switch in the mode:

SBN - in the absence of voltage,
GBN - in the absence of voltage across the switch rails from the generator site,
SGBN - in the absence of voltage on the rails on both sides of the circuit breaker.

In order to connect in SBN, GBN or SBN mode, it should be:

- Selector switch connections (WRL, Fig. 4.1, 4.2) set in the correct position (SBN or GBN or SGBN).
- Close the correct selection switch key (WW1 or WW2, Fig. 4.1, 4.2).
- Turn on the synchronizer power supply.

After powering synchronizer starts with auto testing and validation of input signals. After auto- testing it goes into the drift measurement state, unless earlier detects an error, so then to the emergency discontinuation status.

In the waiting state (Fig. 3.14) current effective values of **Us** and **Ug** measurement voltages % of the nominal value of 100V, and their **Fs** and **Fg** frequencies are displayed**.** In the last line the status of the signals on the two inputs is displayed: START - **S** i BLKZ – **B** . **„0”** - means inactive input state (no voltage), **„1” –** active state (there is voltage + Uv). In addition, the waiting state is signaled by the glowing yellow LED STANDBY STATE.

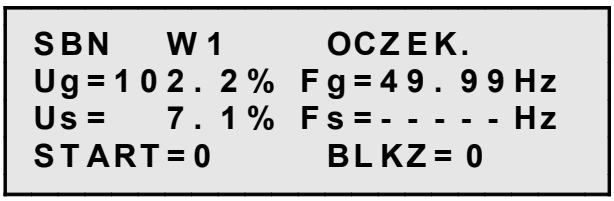


Fig. 3.14

In the waiting state the synchronizer does not send any signals and stays in it until a voltage at the input START appears. Voltage at the input START does not have to be maintained, only the pulse is required.

Once the START signal, synchronizer checks the conditions for connecting:

A. In SBN mode verifies the conditions

1. Generator voltage $U_{gd} \leq U_g \leq U_{gg}$
2. Generator frequency $F_{gd} \leq F_g \leq F_{gg}$

(3.9)

3. Mains residual voltage $U_{ssd}(.) \leq U_s \leq U_{ssg}(.)$
4. Lock signal is inactive $BLKZ = 0$

where:

U_{gd} - The lower limit value of the generator voltage switched on not powered mains (table 3.1, I.no. 28),

U_{gg} - The upper limit value of the generator voltage switched on not powered mains (table 3.1, I.no. 29),

F_{gd} - The lower limit value of generator frequency generator switched on not powered mains (table 3.1, I.no. 30),

F_{gg} - The upper limit value of generator frequency generator switched on not powered mains (table 3.1, I.no. 31),

$U_{ssd}(.)$ - The lower limit value of residual voltage on W(.)from the mains site (table 3.1, I.no. 32, 33),

$U_{ssg}(.)$ - The upper limit value of residual voltage on W(.)from the mains site (table 3.1, I.no. 34, 35).

If the conditions (3.9) are met, sends a ZW signal closing circuit breaker, if not, goes into the emergency discontinuation status.

B. In GBN mode verifies the conditions

1. Mains voltage: $U_{sd}(.) \leq U_s \leq U_{sg}(.)$

2. Mains frequency; $Fsd(.) \leq Fs \leq Fsg(.)$ (3.10)
3. Generator residual voltage: $Usgd \leq Ug \leq Usgg$
4. Lock signal is inactive $BLKZ = 0$

where:

Usd(.) - Lower threshold voltage of mains switched by W(.) (table 3.1, I.no. 36, 37),

Usg(.) - Upper threshold voltage of mains switched by W(.) (table 3.1, I.no. 38, 39),

Fsd(.) - Lower mains frequency limit switched by W(.) (table 3.1, I.no. 40, 41),

Fsg(.) - Upper mains frequency limit switched by W(.) (table 3.1, I.no. 42, 43),

Usgd - The lower limit value of the residual voltage of the generator (table 3.1, I.no. 44),

Usgg - The upper limit value of the residual voltage of the generator (table 3.1, I.no. 45).

If the conditions (3.10) are met, sends a ZW signal closing circuit breaker, if not, goes into the emergency discontinuation status.

C. In SGBN mode verifies the conditions

- Residual voltage of mains: $Ussd(.) \leq Us \leq Ussg(.)$
- Residual voltage of generator: $Usgd \leq Ug \leq Usgg$ (3.11)
- Lock signal is inactive $BLKZ = 0$

where:

Ussd(.) - Lower limit value of the residual voltage on W(.) from the mains site (table 3.1, I.no. 32, 33),

Ussg(.) - Upper limit value of the residual voltage on W(.)from the mains site (table 3.1, I.no. 34, 35).

Usgd - Lower limit value of the generator residual voltage (table 3.1, I.no. 44),

Usgg - Upper limit value of the generator residual voltage (table 3.1, I.no. 45).

If the conditions (3.11) are met, sends a ZW signal closing circuit breaker, if not, goes into the emergency discontinuation status.

After confirming the clear closing conditionof switch the synchronizer migrates to the withdrawal status after switching, and if the state of the switch at the end of the ZE signal is ambiguous, or clearly open - to the emergency discontinuation status.

Fi1 i fi2 settings (table 3.1, I.no. 5, 6) allow constant phase shift correction, which synchronizer "sees" between the Ug and Us inputs. This is useful in situations where due to the phase shifts caused by the current transformers or transformers, the phase

difference at the Ug and Us terminals, is not equal to the phase difference on both sides of the circuit breaker. For situations where there is no phase shifts, these settings should be set to 0. Although in the SBN, GBN, SGBN modes phase shift has no effect on connecting (because on the one side of circuit breaker it must be the residual voltage only), however, this fi1 and fi2 settings are taken into account, as taking into account their value is defined phase shift on the LCD in **ODST_PP** state and available through the serial connectors (section 7.3.1).

3.5.5.4. Reviewing and modifying of settings and measurements of some object parameters (TEST mode)

TEST mode allows:

1. Entering, review and change of settings, as well as entering and changing of address for serial transmission.
2. The time measurement of own tw circuit breaker closing, here the settings are taken into account.
3. Measurement of constant phase shift of fi angel between the measuring Ug and Us signals.
4. Measurement of settable C coefficient in the control voltage system of generator.

In order to start TEST mode you should:

- Connections selector switch (WRL, Fig. 4.1, 4.2) set to TEST position.
- Close the appropriate key of switch selection (WW1 or WW2, Fig. 4.1, 4.2).
- Turn on the synchronizer power supply.

After powering synchronizer starts with auto testing and validation of input signals.
If detects an error migrates to the emergency discontinuation status.
After powering, the display shows information as in the example in Fig. 3.15:

Fig. 3.15

On the right side of the display are the names of procedures:

1. **„settings”-** procedure used to reviewing and modifying the settings and the address for the serial ports,
2. **„measurements”-** the procedure used to measure the time of the own circuit breaker closing, the phase shift between the measuring Ug and Us voltages and the settable coefficient C into the control voltage system of generator.

3.5.5.4.1. Settings

The synchronizer is supplied by the manufacturer with factory settings. After installing the synchronizer these settings must must be appropriately modified to define the merger conditions, appropriate for a particular object. The full list of settings is provided in table 3.1

Columns: SYN, ZSK, SBN, GBN, SGBN, TEST determine whether the given setting is taken into account (affects the operation of the device) in the selected operating mode. “+” means that it is taken into account, and “-” means that it is not taken into account.

If in the column "Designation on LCD” designation ends with digit “1”, then this setting is taken into account only if the switch 1 is selected.

If in the column "Designation on LCD” designation ends with digit “2”, then this setting is taken into account only if the switch 2 is selected.

Table 3.1 Settings of synchronizer SM-06B.

In	Mar-king on LCD	Setting range	Resolu-tion	Name of setting	SYN	ZSK	SBN	GBN	SGBN	TEST
1	tw1	(1 – 320) ms	1 ms	Lead time for the W1 switch	+	-	-	-	-	-
2	tw2	(1 – 320) ms	1 ms	Lead time for the W2 switch	+	-	-	-	-	-
3	-dU	(1 – 20)%Us*	1 %Us	Lower threshold of voltage difference at synchronization	+	-	-	-	-	-
4	+dU	(1 – 20)%Us	1 %Us	Upper threshold of voltage difference at synchronization	+	-	-	-	-	-
5	fi1	-90° – +90°	0,1 °	Correction of the phase voltages shift connected through the W1 switch	+	+	+	+	+	-

In	Marking on LCD	Setting range	Resolution	Name of setting	SYN	ZSK	SBN	GBN	SGBN	TEST
6	fi2	-90° – +90°	0,1 °	Correction of the phase voltages shift connected through the W2 switch	+	+	+	+	+	-
7	ww	0,1 – 1	0,1	Duty ratio of pulsem regulating the voltage	+	-	-	-	-	-
8	dfu	(0,2 – 10)%Fs	0,1 %Fs	The frequency difference from which the voltage regulation begines	+	-	-	-	-	-
9	-dF	(0,2 – 3)%Fs*	0,1 %Fs	Acceptable. frequency difference when connecting „from the bottom”	+	-	-	-	-	-
10	+dF	(0,2 – 3) %Fs	0,1 %Fs	Acceptable. frequency difference when connecting „from the top”	+	-	-	-	-	-
11	TrF	(0,02 – 1) s	0,01 s	The duration of a single pulse regulating the rotations	+	-	-	-	-	-
12	C	0 – 2	0,1 %/%	Characterization ratio of generator's voltage	+	-	-	-	-	-
13	ZL-	T/N	–	Permission to connect the generator "from the bottom”	+	-	-	-	-	-
14	ZL+	T/N	–	Permission to connect the generator "from the top”	+	-	-	-	-	-
15	Lp	1 – 100	1	The number of repetitions of the signal switching circuit breaker	+	-	-	-	-	-
16	-dfi1	0 – 60 ° *	1°	Lower phase difference of voltages connected by W1	-	+	-	-	-	-
17	-dfi2	0 – 60 ° *	1°	Lower phase difference of voltages connected by W2	-	+	-	-	-	-
18	+dfi1	0 – 60 °	1°	Upper phase difference of voltages connected by W1	-	+	-	-	-	-
19	+dfi2	0 – 60 °	1°	Upper phase difference of voltages connected by W2	-	+	-	-	-	-
20	dUd1	(1 – 20)%Us*	1 %Us	The lower value of the difference voltage when connected by W1	-	+	-	-	-	-
21	dUd2	(1 – 20)%Us*	1 %Us	The lower value of the difference voltage when connected by W2	-	+	-	-	-	-
22	dUg1	(1 – 20)%Us	1 %Us	The upper value of the difference voltage when connected by W1	-	+	-	-	-	-
23	dUg2	(1 – 20)%Us	1 %Us	The upper value of the difference voltage when connected by W2	-	+	-	-	-	-
24	f1	(0,1 – 10) °/s	0,1 °/s	Allowable drift of the phase difference when connecting through W1	-	+	-	-	-	-
25	f2	(0,1 – 10) °/s	0,1 °/s	Allowable drift of the phase difference when connecting through W2	-	+	-	-	-	-
26	Tg1	(1 – 10) s	1 s	Time limit of drift phases measurement when connecting by W1	-	+	-	-	-	-
27	Tg2	(1 – 10) s	1 s	Time limit of drift phases measurement when connecting by W2	-	+	-	-	-	-
28	Ugd	(80–100)%Un	1 %Un	The lower limit value of the generator voltage switched on not powered mains	-	-	+	-	-	+
29	Ugg	(100–120) %Un	1 %Un	The upper limit value of the generator voltage switched on not powered mains	-	-	+	-	-	+
30	Fgd	(90–100)%Fn	1 %Fn	Lower limit value of the generator frequency switched on not powered mains	-	-	+	-	-	+
31	Fgg	(100–110)%Fn	1 %Fn	Upper limit value of the generator frequency switched on not powered mains	-	-	+	-	-	+
32	Ussd1	(0 – 5) %Un	0,1 %Un	Lower limit value of residual voltage on the W1 from the mains site	-	-	+	-	+	+

In	Marking on LCD	Setting range	Resolution	Name of setting	SYN	ZSK	SBN	GBN	SGBN	TEST
33	Ussd2	(0 – 5) %Un	0,1 %Un	The lower limit value of residual voltage on the W2 from the mains site	-	-	+	-	+	+
34	Ussg1	(0 – 20) %Un	0,1 %Un	The upper limit value of residual voltage on the W1 from the mains site	-	-	+	-	+	+
35	Ussg2	(0 – 20) %Un	0,1 %Un	The upper limit value of residual voltage on the W1 from the mains site	-	-	+	-	+	+
36	Usd1	(80–100) %Un	1 % Un	Lower threshold of mains voltage switched by W1	-	+	-	+	-	+
37	Usd2	(80–100) %Un	1 % Un	Lower threshold of mains voltage switched by W2	-	+	-	+	-	+
38	Usg1	(100–120) %Un	1 %Un	Upper threshold of mains voltage switched by W1	-	+	-	+	-	+
39	Usg2	(100–120) %Un	1 %Un	Upper threshold of mains voltage switched by W2	-	+	-	+	-	+
40	Fsd1	(90–100)%Fn	1 %Fn	The lower limit frequency of mains switched by W1	-	-	-	+	-	+
41	Fsd2	(90–100)%Fn	1 %Fn	The lower limit frequency of mains switched by W2	-	-	-	+	-	+
42	Fsg1	(100–110)% Fn	1 %Fn	The upper limit frequency of mains switched by W1	-	-	-	+	-	+
43	Fsg2	(100–110%Fn	1 %Fn	The upper limit frequency of mains switched by W2	-	-	-	+	-	+
44	Usgd	(0 – 5) %Un	0,1 %Un	The lower limit value of the residual voltage of the generator	-	-	-	+	+	+
45	Usgg	(0 – 20) %Un	0,1 %Un	The upper limit value of the residual voltage of the generator	-	-	-	+	+	+
46	Td	(0-10)s	0,1s	Additional delay from the switching on to configuration control	+	+	+	+	+	+
47	fia	(2-20)°	1°	Permissible deviation angle	+	-	-	-	-	-

NOTES:

* – setting is taken to the conditions and calculations when multiplied by (-1) that is, after conversion to a negative number (of course, does not apply to zero).

Reviewing and changing of settings is done in the "settings" procedure using the keys on the synoptic board. Reading of settings is also possible via RS-1 and RS-2 serial interfaces.

To view or change settings, when you see the message on the LCD as shown in Fig. 3.15 using the buttons **<** and **>,** you must set the arrow (→)next to the sign "settings" and press **MENU** key**.** After the screen appears as in Fig. 3.16 you must set the arrow opposite the inscription "settings" and again press the **MENU** key.

```
TEST → nastawy
W1     adr. sieciowy
```

Fig. 3.16

The display shows "page" (eg. like in Fig. 3.17) containing in the first column the ordinal number from settings table, in the second column the parameter symbol, in the third set value of the parameter. On each „page" at the same time four settings are displayed.

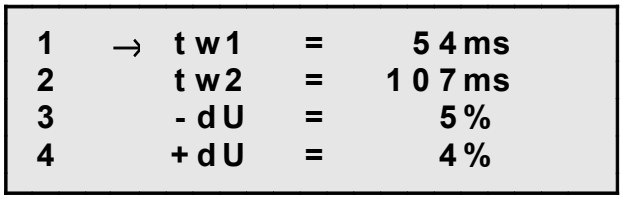


Fig. 3.17

Scrolling of settings is done by **<** **>** keys. Exit from settings is done by pressing the ESC key.

To change the settings, you need to:

- Guide the arrow (→)before the line containing the setting, we want to be changed,
- Press **MENU** key. Sign **„ ="** in the settings record will change to „*",
- In order to increase the set value press **>** and to decrease **<** ,
- Press **MEM** key in order to save the changed setting value in the registry. Confirmation of the recording procedure in the registry is change „*" for sign „=".

After completing all the changes in the settings, press **MEM** key. Synchronizer informs that the changes have been recorded in the register and asks whether to save them in non-volatile memory (Fig. 3.18)

Fig. 3.18

Pressing of **MEM** key saves in the memory the changed setting values, and confirmation of recording by a respective message (Fig. 3.19), and pressing the **ESC** key exit from the settings without saving changes. Pressing **MENU** key involves return to view/change the settings.

Fig. 3.19

3.5.5.4.2. Network address

Data transmission via RS-1 (RS232) or RS-2 (RS485) is carried out using the protocol Modbus RTU. This protocol assumes that each device slave type (and such is the synchronizer), has its own address. Allowed address values are in the range of from 1 to 247.

To check the current IP address of the synchronizer or change this address, please, when you see the message on the LCD as shown in Fig. 3.15, using the keys **<** and **>** guide and arrow (→)next to "settings" and press **MENU** key**.** When the messaage is show as in Fig. 3.20 set the arrow opposite the inscription "network adress"and press **MENU** key again:

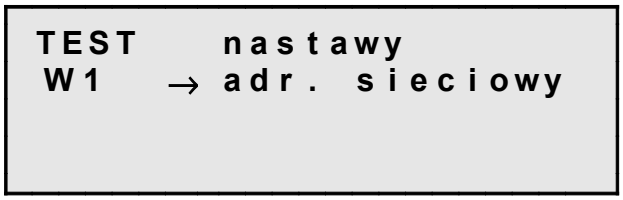


Fig. 3.20

The display shows the information as shown in Fig. 3.21 - in this example the network address of the synchronizer is 32. Pressing the **ESC** key returns to the state as shown in Fig. 3.20:

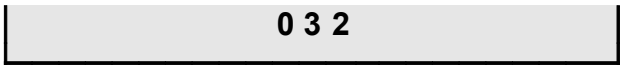


Fig. 3.21

To change the network address, press **MENU** key. In front of the address appears mark „*”.Then, using the key **<** or **>,** set the appropriate value of the network address. In order to memorize a new address, press **MEM** key, otherwise (if we want to maintain old address) **ESC** key. Mark „*”will disappear, and the display will show actual address. Returning to the previous states as far as state as shown in Fig. 3.15 are achieved by repeatedly pressing **ESC**.

3.5.5.4.3. The measurement of tw time

After the appearance on the LCD display the state as in Fig. 3.15, (example for the selected W1 switch), Rusing the keys **< >,** set arrow (→)next to the function **„measurements”** and press **MENU** key**.**
The display will show the measurement procedures like in Fig. 3.22:

Fig. 3.22

Synchronizer SM-06 in **TEST** mode measures the closing time of the circuit breaker by indirect method by measuring the time elapsed since the closing of the relay contacts on the output ZW of synchronizer until the closing the Wxz auxiliary contacts of the circuit breaker, where x – selected circuit breaker number.
The measurement of own time of closing the circuit breaker "tw" can be done in motion and during the stationary turbine set. In order to do this:

1. Selector switch for connections (WRL, Fig. 4.1, 4.2) set to position **TEST**.
2. Close the corresponding selection key of the circuit breaker (WW1 or WW2, Fig. 4.1, 4.2).
3. Open the disconnecting switch of selected circuit breaker.

4. Arm the circuit breaker.
5. Enable the synchronizer power supply.

After the appearance on the LCD display the state as in Fig. 3.22, (example for the selected W1 switch), using the keys **< >,** set arrow (→) next to function „ tw time" and press **MENU** key, will report a procedure for time measuring (Fig. 3.23).

```
POMIAR CZASU tw1
met.styki pomocnicze
podaj sygnał
START lub (MENU+ESC)
```

Fig. 3.23

If the conditions corresponding to the switched mode **SBN** or **GBN** or **SGBN** are met (3.9, 3.10 or 3.11) and the switch is uniquely open, the **START** signal from the outside or equivalent START from the synoptic board (by pressing and holding **MENU** key, and then pressing **ESC**) will cause generation of **ZW** pulse (with a duration of max. 620 ms) switching the circuit breaker and run of own timing counter timing of „tw" circuit breaker closing. Starting the counter takes place at the moment of relay contacts closure on the synchronizer ZW output. Stopping the counter takes place at the time of voltage occurance at the Wxz input, regardless of Wxo input status, where x – selected circuit breaker number.

The display shows the measurement result as in the example in Fig. 3.24 for measuring the closing time of the circuit breaker W1.

If from the closure of the relay contact on ZW output elapsed time 640 ms, and the state of signals on the auxiliary contacts will not change or be ambiguous, synchronizer will pass to the state of emergency discontinuation and the display shows an error message. Similiar would also be, if at the time of arousal of circuit breaker enabling voltage conditions are not fulfilled (3.9, 3.10 lub 3.11) or circuit breaker status is different from the clearly open:

```
POMIAR tw1= 57.3ms

ESC-powrót
```

Fig. 3.24

After pressing **ESC** returns to the state shown in Fig. (Fig. 3.22).

3.5.5.4.4. Measurement of fi angle

Procedure „fi angle" allows measurement and **compensation of constant angle phase shift** (designated by „fi"), between Us measuring network voltages and Ug generator.

$$fi = fi(Ug) - fi(Us)$$

Constant angle shift results from phase shifts on transformers and voltage transformers. Synchronizer allows to measure and compensate this angle in the range of ± 90°.

In order to determine the "fi" angle should be:

- Selector switch of connection mode (WRL, Fig. 4.1, 4.2) set to TEST position.
- Close the corresponding selection key of the circuit breaker (WW1 or WW2, Fig. 4.1, 4.2).
- Start the generating set and arouse generator.
- Close the circuit breaker with the open mains disconnector, so that the Ug and Us measuring voltages come from the same power source.
- Start the synchronizer in TEST mode.

After the appearance on the LCD display the state as in Fig. 3.22 (example for the selected W1 switch), using keys **< >,** set arrow (→) next to the function „ fi angle" and press **MENU** key**.** The display will show the measurement result as in the example in Fig. 3.25.

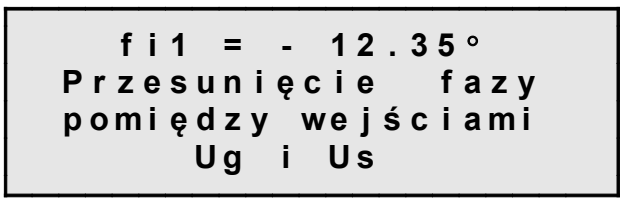


Fig. 3.25

Sign and value of the measured angle of a constant phase shift between the voltage measurements to remember and enter it into settings (table 3.1, I.no. 5, 6).

Exit from the procedure "fi angle" by pressing **ESC** key**.**

3.5.5.4.5. Measurement of C coefficient

This procedure is used to measure the slope of the characteristics of the generator voltage as a function of rotation speed (parameter „C" in settings, table 3.1, I.no. 23, 24). Synchronizer **SM-06** compensates voltages of synchronized objects, taking into account this characteristics.

In order to determine the "C" coefficient, please:

1. Selector switch of connection mode (WRL, Fig. 4.1, 4.2) set to TEST position.
2. Close the corresponding selection key of the circuit breaker (WW1 or WW2, Fig. 4.1, 4.2).
3. Start the generating set and arouse generator.
4. Enable the synchronizer power supply.

After the appearance on the LCD display the state as in Fig. 3.15, using keys **<** and **>,** set arrow (→) next to the function „measurements" and press **MENU** key and then from the menu shown in Fig. 3.22 select „generator's identification" and press **MENU** again.
After the appearance of information as in Fig. 3.26 you should manually set the start frequency of generator voltage. Current value of the Fg frequency and generator Ug voltage is displayed in the first line of the LCD display.

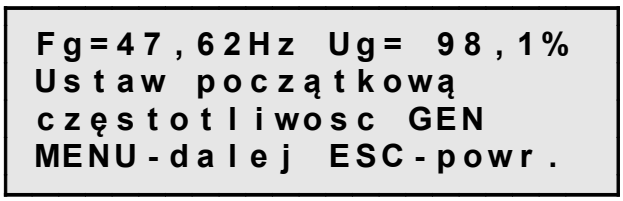


Fig.3.26

Pressing the **MENU key** will store the Fg initial frequency and initial voltage of Ug generator and message is displayed as in Fig. 3.27.

After manually setting the final value of the frequency and pressing the **MENU** key, the display will show the results of the measurement of "C" parameter like in example in Fig. 3.28:

Fig. 3.27

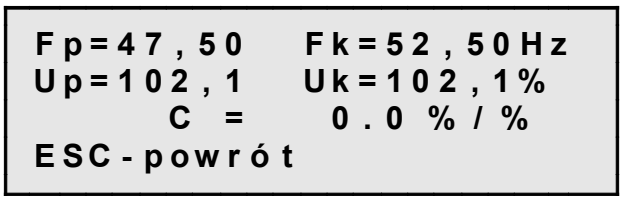


Fig. 3.28

Fp, Up – measured initial values,

Fk, Uk – measured final values.

Return to the beginning of the **TEST** mode takes place by several times pressing a **ESC** key**.**

4. Technical data

Table 4.1 Input characteristics of analog signals (Ug and Us):

Rated voltage	100 VRMS
Power dissipation at the rated voltage on one input	0,265 W
Measuring range of the effective voltage	0...120 VRMS
The maximum allowable constant voltage	120 VRMS
The maximum allowable voltage between Ugs and Uss terminals– exceeding of this value can increase measurement errors	20 VRMS
The maximum allowable instantaneous voltage between Ugs and Uss terminals	120 VRMS
Sampling frequency	8 kHz
Bandwidth (-3dB)	420 Hz

Table 4.2 Characteristics of binary signals inputs (BLKZ, START, SYN, ZSK, SBN, GBN, SGBN, TEST, W1o, W1z, W2o, W2z):

Rated voltage	220VDC	110VDC	24VDC
Power dissipation at the rated voltage on one input	0,16W	0,08W	0,017W
Typical switching voltage (threshold)	75...112VDC	38...57VDC	9...14VDC
Maximum switching voltage	154VDC	85VDC	19,6VDC
The maximum allowable constant voltage (any polarization)	300VDC	213V	33V
Sampling frequency	0,4kHz		

Table 4.3 Characteristics of the input power supply (Up):

Rated voltage	220VDC	110VDC	24VDC
The minimum voltage required for proper operation of Upmin	154VDC	85VDC	19,6VDC
Power dissipation at the rated voltage	<10W	<10W	<10W
The maximum allowable constant voltage (any polarization)	300VDC	213V	33V

Table 4.4 Characteristics of relay control outputs (ZW, OG, OD, RG, OD):

Type of relay	Relpol RM83P
The maximum allowable continuous current	1A
Power dissipation at the maximum allowable continuous current	<0,14W
The maximum permissible 10-second current	4A
Other parameters	as for Relpol RM83P

Table 4.5 Characteristics of the relay output signal (BL):

Type of relay	Relpol RM96
The maximum allowable continuous current	1A
Power dissipation at the maximum allowable continuous current	<0,14W
The maximum permissible 10-second current	4A
Other parameters	as for Relpol RM96

Device terminals with a division into groups galvanically isolated.

All devices input and output terminals, on which in normal operation it is or may appear dangerous voltage, as well as the communication connector terminals RS-485, are galvanically separated from internal electronics of device. These terminals are connected in groups, within which they are not inter-isolated, while there is insulation between the groups. Insulation resistance between a particular group of terminals, and other terminals and circuits, as well as housing, is 2,5kV/50Hz/1min. The only non-isolated element of the device I/O is local serial port RS-232, located on the synoptic board, but it works on the assumption with a a low voltage.

Table 4.6 Device terminals with a division into groups galvanically isolated.

Item no.	Terminal name	Terminal symbol	Connector name panel mounting housing	Connector name back panel mo-unting housing
Input terminals of analog signals				
1	Mains measuring voltage, phase r	Usr	X7.1	AN16
2	Mains measuring voltage, phase s	Uss	X7.2	AN15
3	Generator measuring voltage, phase r	Ugr	X7.3	AN14
4	Generator measuring voltage, phase s	Ugs	X7.4	AN13
Input terminals of control binary signals and power supply inputs				
5	External interlock of circuit breaker closing	BLKZ	X6.1	Z1
6	Start signal	START	X6.2	Z2

Item no.	Terminal name	Terminal symbol	Connector name panel mounting housing	Connector name back panel mounting housing
7	Synchronization mode selection	SYN	X6.3	Z3
8	Mode selection of connection with a fixed angle	ZSK	X6.4	Z4
9	Mode selection mains without voltage	SBN	X6.5	Z5
10	Mode selection generator without voltage	GBN	X6.6	Z6
11	Mode selection mains and generator without voltage	SGBN	X6.7	Z7
12	Test mode selection	TEST	X6.8	Z8
15	Auxiliary voltage to a WRL switch of operation mode selection	+Uv	X11.3	Z14
16	(+)synchronizer voltage power supply	+Up	X11.2	Z15
17	(-)synchronizer voltage power supply and control binary signals	-Up	X11.1	Z16
	Input terminals of the stete binary signals of W1 switch			
18	Signal of opened switch W1	W1o	X5.5	WA13
19	Signal of closed switch W1	W1z	X5.4	WA12
20	(-) switch W1 status inputs of binary signals	-W1	X5.3	WA11
	Input terminals of the stete binary signals of W2 switch			
21	Signal of opened switch W2	W2o	X5.8	WA16
22	Signal of closed switch W2	W2z	X5.6	WA14
23	(-)switch W2 status inputs of binary signals	-W2	X5.7	WA15
	Input terminals of the stete binary signals of W3 switch			
24	Signal of opened switch W3	W3o	X4.5	WB13
25	Signal of closed switch W3	W3z	X4.4	WB12
26	(-)switch W3 status inputs of binary signals	-W3	X4.3	WB11
	Input terminals of the stete binary signals of W4 switch			
27	Signal of opened switch W4	W4o	X4.8	WB16
28	Signal of closed switch W4	W4z	X4.6	WB14
29	(-)switch W4 status inputs of binary signals	-W4	X4.7	WB15
	Output relay terminals of circuit breaker closing			
30	Relay changeover contact switching off the main generator circuit breaker	ZW-C	X10.2	WA7
31	Relay changeover contact switching off the main generator circuit breaker	ZW	X10.3	WA8
	Output relay terminals of terror signalling			
32	Relay changeover contact of error signaling	BL-C	X10.7	WA1
33	Relay changeover contact of error signaling	BL	X10.8	WA2
	Output relay terminals of rotation adjustement			
34	(+)power supply voltage of rotation regulator	RO-C	X10.4	WA6
35	Rotation reduction signal	OD	X10.5	WA5
36	Rotation increase signal	OG	X10.6	WA4
	Output relay terminals of voltage control			
37	(+)power supply voltage of voltage regulator	RN-C	X9.4	WB6
38	Voltage reduction signal	ND	X9.5	WB5
39	Voltage increase signal	NG	X9.6	WB4
	Terminals of RS485 (option)			
40	Line screen RS-485	SCREEN	X3.5	PK5
41	Receiver line ″ - ″	R-	X3.4	PK6
42	Receiver line ″ + ″	R+	X3.3	PK7
43	Transmitter line ″ - ″	T-	X3.2	PK8
44	Transmitter line ″ + ″	T+	X3.1	PK9

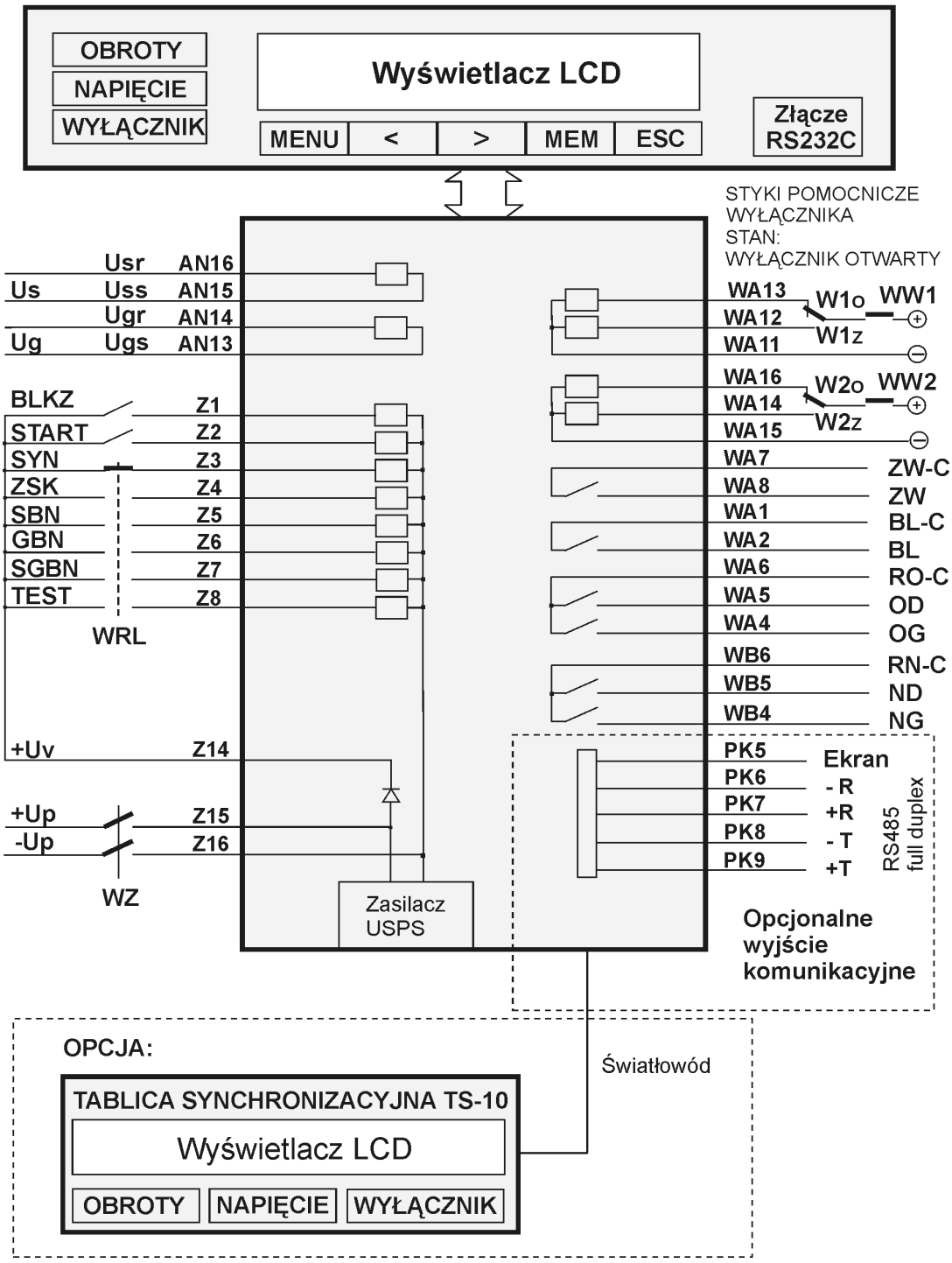
Item no.	Terminal name	Terminal symbol	Connector name panel mounting housing	Connector name back panel mo-unting housing
New and/or optional connectors (taken from SM-06D – table below)				

Item no.	Terminal name	Terminal symbol	Connector name panel mounting housing	Connector name back panel mo-unting housing
Terminals of RS485 (for TS-10) connector				

Item no.	Terminal name	Terminal symbol	Connector name panel mounting housing	Connector name back panel mounting housing
45	Line screen RS-485	SCREEN	X8.1	PK-15
46	Transmitter line ″ - ″	T-	X8.2	PK-14
47	Transmitter line ″ + ″	T+	X8.3	PK-13
Terminals of RS485 (GPS) connector				
48	Line screen RS-485	SCREEN	X2.5	PK-11
49	Receiver line ″ - ″	R-	X2.4	PK-10
50	Receiver line ″ + ″	R+	X2.3	PK-9
51	Line PPS ″ - ″	PPS-	X2.2	PK-8
52	Line PPS ″ + ″	PPS+	X2.1	PK-7
Eternet				
53	Ethernet connector ARM (unused)		E1	
54	Ethernet connector BECK		E2	

Table 4.7 Environmental conditions:

Permissible ambient temperature	0..+50C
Maximum relative humidity	No condensation, ice formation, frost
Housing protection degree	IP40



Rys. 4.1 Application scheme SM-06 in the APRA 63T

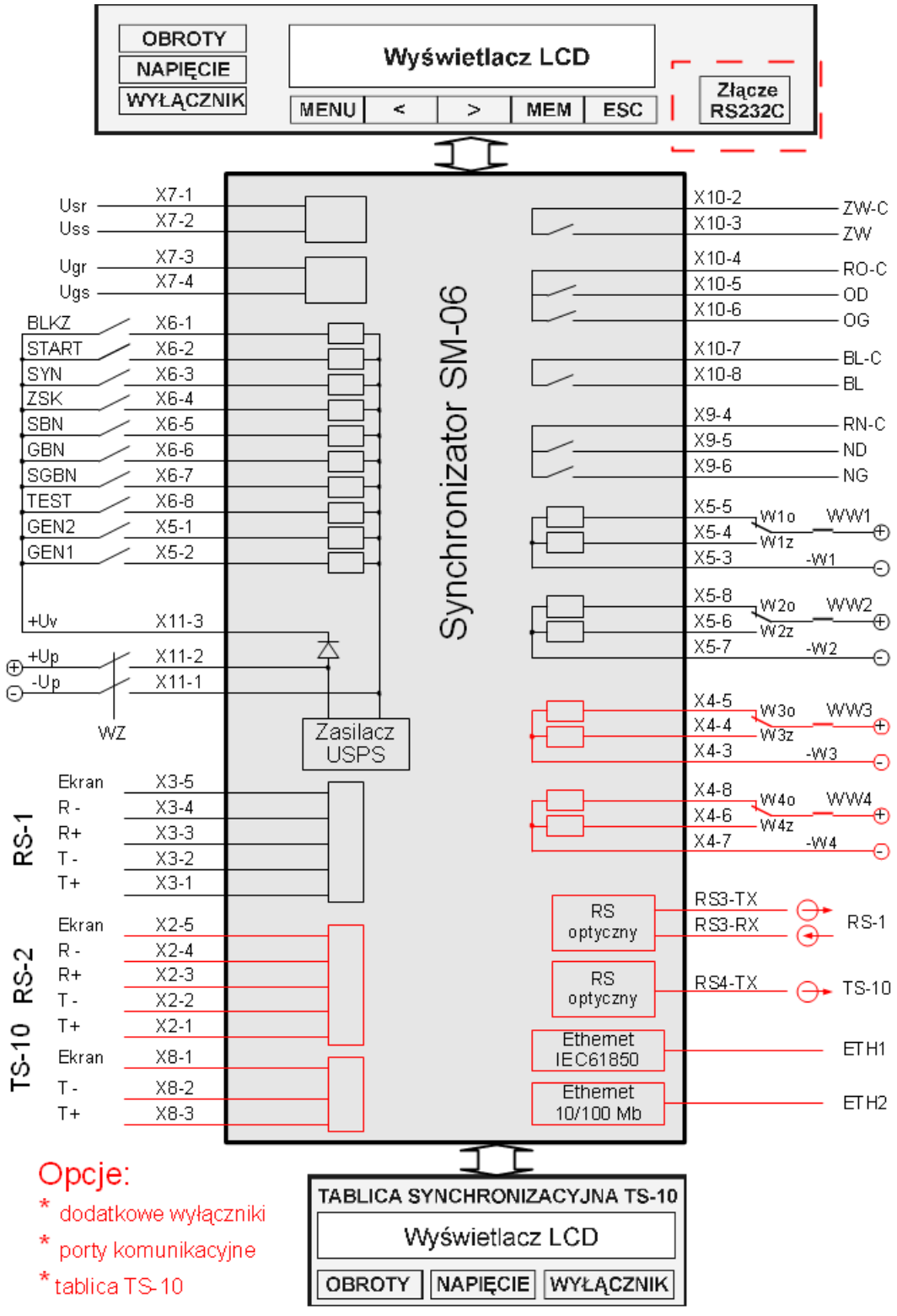


Fig. 4.2 Application scheme SM-06 in the Euro cassette

5. Data on completeness

Composed complete delivery for recipient includes:

- Synchronizer SM-06B,
- A set of plug-in connectors,
- Instruction manual of synchronizer SM-06B,
- Warranty Card.

6. Installation and Commissioning

Installation of the synchronizer must be carried out in accordance with generally accepted principles concerning protection, automation and control devices. During the installation, you should check the compatibility of the project with the automation system documentation of synchronizer and its nameplate, paying particular attention to:

- the rated voltage supplied its polarity,
- rated value of measurement voltage,
- the correctness of theapplied safeguards of voltage circuits (the rated values of fuse links or nominal currents and characteristics of automatic circuit breakers),
- permissible load of relay outputs,
- correctness of assembly,
- continuity of the protective conductor,
- corresponding to a given object modification the synchronizer settings.

Before the first start-up to the voltage, the device should be at least two hours to stay in the room in which it will be installed to equalize the temperature and prevent moisture.
Commissioning should be completed performing the tests of synchronizer functional activity as well as with possible adjustments in the range of settings.

7. Monitoring the synchronization process

7.1. Synchronization panel TS-10

Synchronization panel TS-10 (Fig. 7.1) It is designed to control the process of automatic synchronization from the operator position in the control room. The synchronization panel displays **at the same time, the same set of information** as on synoptic synchronizer board.

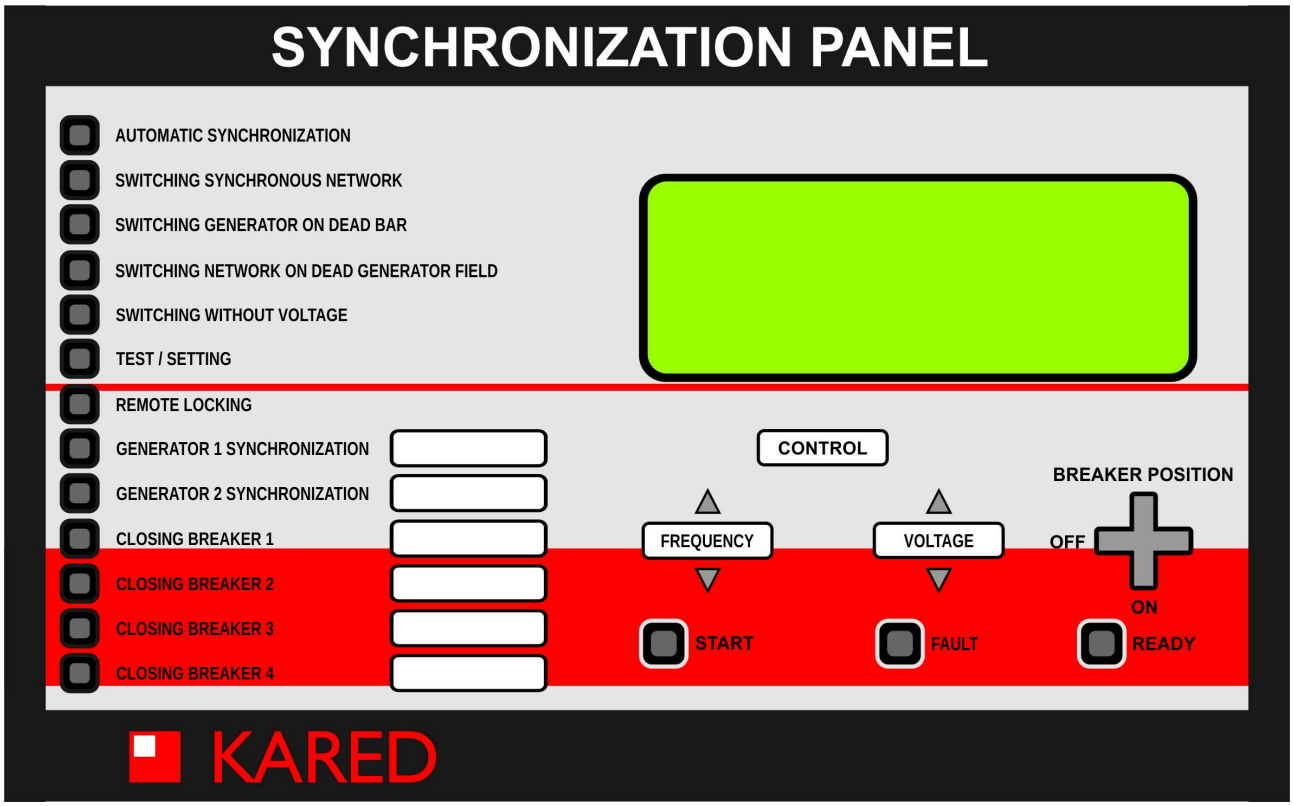


Fig. 7.1

Table 7.1 Basic technical data of TS-10

Item No.	Parameter	Value
1	Supply voltage (standard)	220 V DC or 230 V AC
2	Optional supply voltage	110/48/24/12 V
3	Power consumption from the power source	7 W
4	Dimensions WxHxT	213x125x65 mm
5	Mass	0,85 kg
6	Ambient temperature	0 to 50 º C
7	The connection with syncronizer:	glass fiber optic cable 65,5/125 µm, ST terminals
8	Distance synchronizer – synchronization panel	up to 1500 m
9	Degree of protection	IP40

Commissioning

Start-up of synchronization board takes place by applying supply voltage. If on the LCD board appears NO SIGNAL, that means that either of the following cases occurs:

- damaged or not connected fiber opic cable, between the synchronizer and the synchronization board,
- disabled power supply on synchronizer or damaged synchronizer.

Disabling the synchronization board

Disabling the synchronization board is done by switching off the supply voltage.

Dimensions and assembly

In Fig. 7.2 are given the main dimensions of the board TS-10 and its method of attachment on the control panel in the control room.

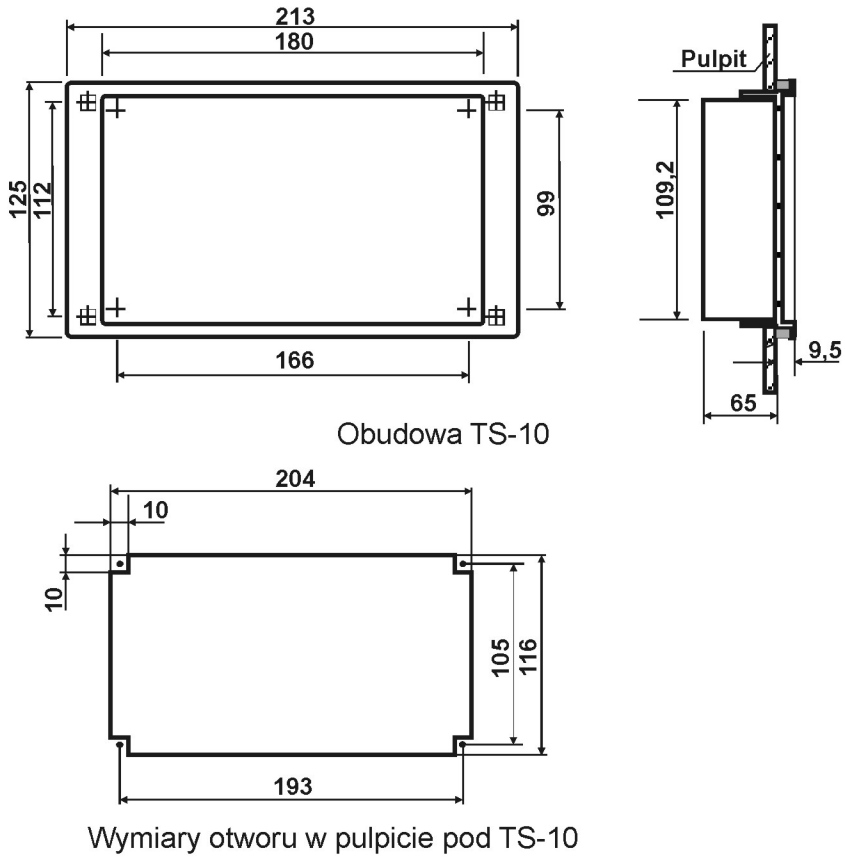


Fig.7.2 Trim panel TS-10

Legend:

Obudowa **TS-10** -	**TS -10** housing
Wymiary otworu w pulpicie pod **TS-10** -	The dimensions of the hole in the desktop for **TS-10**

7.2. Visualization of synchronization process on a computer monitor

Based on the data available through serial interfaces in **SM-06** it is possible to visualize the synchronization process on PC. In Fig. 7.3 the effect of implementing such a visualization application is shown.

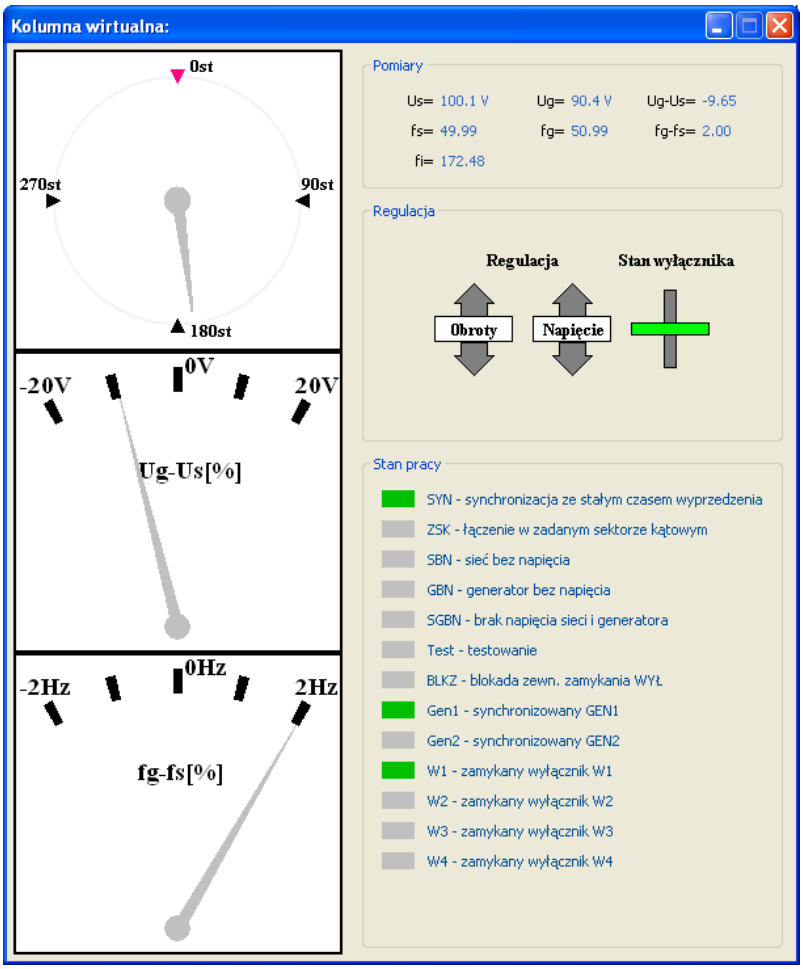


Fig. 7.3 Example visualization of synchronization process

Operating instructions of accompanying software is contained in a separate document.

7.3. Communication with the superior control system and control

Synchronizators SM-06 are equipped with two independent serial ports RS-1 and RS2. RS-1 as a standard is available on the front panel of synchronizer as an isolated RS232C. RS-2 as a standard is not derived to the outside of the housing. It can be derived on request to support the synchronization table **TS-10** or to communicate with the superior control system and control.

It is possible to simultaneously service **TS-10** board and communicate with the superior control system. In this case, the RS-1 handles communication with the superior computer system and RS-2 synchronization board on the desktop in the control room.

Serial ports in **SM-06** synchronizators are supported by protocol Modbus RTU.
The transmission parameters are as follows:

Transmission type:	asynchronous
Transmission speed:	9600 Bd
Data bits:	8
Stop bits:	1
Parity bits:	none

The device address can be changed in the **TEST** mode by selecting from the menu: → settings → network address.
When saving the factory settings the address value is set to 32.

ATTENTION!

If during the self-test after power is turned the synchronizer detects in its non-volatile memory out of range address (1...247), then it provides only port on the synoptic panel, assigning him to temporarily address the value 1.

The only available command is Read Registers, provided that the number of registers read with one command is limited to 40.

7.3.1. Information available only during the correct operation of synchronizer.

These informations are also available in cases:
- incorrect configuration after power is turned,
- configuration change during operation,
- an undervoltage power supply (but high enough to operate the internal circuits).

1. Voltage and frequency values. Values 0x8000 and 0x8001 mean undefined value.

Register	Content	Units
%R3625	Voltage value Us	0,1%Un
%R3626	Voltage value Ug	0,1%Un
%R3627	Frequency value Fs	0,01 Hz
%R3628	Frequency value Fg	0,01 Hz

2. Values of the voltage difference and the frequency difference.

   Values 0x8000 and 0x8001 mean undefined value.

Register	Content	Units
%R3633	Value of the voltage difference Ug - Us in U2 code	0,01%Un
%R3634	Value of the frequency difference Fg - Fs in U2 code	0,01%Fn

3.a. The values of the phase difference in modes **SYN, ZSK, SBN, GBN, SGBN**.

Values 0x8000 and 0x8001 mean undefined value.

Register	Content	Units
%R3635	The value of the phase difference between the synchronizer Ug and Us inputs, taking into account fi 1 and fi2 settings *)	1 dg.

*) - in the case of withdrawal due to the inability to determine which setpoint is to be active (and therefore incorrect input status after powering, configuration change during operation and a decrease in the supply voltage), the return value is undefined.

3.b. The values of the phase difference in mode **TEST**.

Values 0x8000 and 0x8001 mean undefined value.

Rejestr	Content	Units
%R3635	The value of the phase difference between the synchronizer Ug and Us inputs	0,01 dg.

4. The values of the phase difference.

Values 0x8000 and 0x8001 mean undefined value.

Register	Content	Units
%R3636	The value of the phase difference between the synchronizer Ug and Us inputs	0,01 dg.
%R3637	The value of the phase difference between the synchronizer Ug and Us inputs, taking into account fi 1 and fi2 settings *)	1 dg.

*) - in the case of withdrawal due to the inability to determine which setpoint is to be active (and therefore incorrect input status after powering, configuration change during operation and a decrease in the supply voltage), the return value is undefined.

5. Status of binary inputs. The least significant bit has the number 1 most significant 16.

Number one means that the input has voltage.

Register	Bit	Input	Comments
%R3641	9	W2O	
%R3641	10	W2Z	

Register	Bit	Input	Comments
%R3641	11	W1O	
%R3641	12	W1Z	
%R3641	1		
%R3641	2		
%R3641	3		
%R3641	4		
%R3642	13		
%R3642	14		
%R3642	15	TEST	
%R3642	16	SGBN	
%R3642	1	GBN	
%R3642	2	SBN	
%R3642	3	ZSK	
%R3642	4	SYN	
%R3642	5	START	
%R3642	6	BLKZ	

6. Status of supply voltage. The least significant bit has the number 1 most significant 16. Number one means that the voltage is normal, zero means that the voltage is too low.

Rejestr	Bit	Key
%R3642	9	Status of supply voltage

7. Keyboard state. The least significant bit has the number 1 most significant 16. Number one indicates that the key is pressed.

Register	Bit	Key
%R3643	9	MENU
%R3643	10	<
%R3643	11	>
%R3643	12	MEM
%R3643	13	ESC

8. State of relay outputs. The least significant bit has the number 1 most significant 16. Number one indicates that the relay contacts are closed.

Register	Bit	Relay	Comments
%R3649	9	OD	
%R3649	10	OG	
%R3649	13	ERROR	
%R3649	12	ZW	
%R3649	1	ND	

Register	Bit	Relay	Comments
%R3649	2	NG	

9. The status of LEDs on synoptic board. The least significant bit has the number 1 most significant 16. Number one means that the LED lights.

Register	Bit	LED	Comments
%R3650	1	GBN	
%R3650	2	SGBN	
%R3650	3	TEST	
%R3650	4	READINESS	
%R3650	5	START	
%R3650	6	BLKZ	
%R3650	7	GEN1	
%R3650	8		
%R3650	9	WZ - the middle two-color LED	
%R3650	10	WO - the middle two-color LED	
%R3650	11	tw1	
%R3650	12		
%R3650	13	tw2	
%R3650	14		
%R3650	15	WZ	
%R3650	16	WO	
%R3651	9	ERROR	
%R3651	10	OD	
%R3651	11	OG	
%R3651	12	ND	
%R3651	13	NG	
%R3651	14	SYN	
%R3651	15	ZSK	
%R3651	16	SBN	

10. Operating mode and status of the synchronizer and the reason for withdrawal.

Register	Content
%R3652	Higher byte: operating mode and status of the synchronizer. Lower byte: reason for withdrawal

Higher byte:

Higher half of byte: operating mode of synchronizer

0 : undetermined

1 : TEST

2 : ZSK

3 : SBN

4 : GBN

5 : SGBN

6 : SYN

Lower half of byte: status of the synchronizer

1 : drift measurement

2 : waiting

3 : synchronization

4 : after signal START is applied

5 : after the start of switching pulse

6 : withdrawal after proper enabling

7 : emergency withdrawal

Lower byte: reason of withdrawal

1 : no switching confirmation

2 : switch is closed

3 : switch status is ambiguous

4 : voltage condition not met

5 : dF > 15%

6 : dF < -15%

8 : Us < 50%

9 : Ug < 50%

10 : blockade at startup

12 : lack of conditions for switching (details should be read %R3653)

14 : in settings forbidden to connect "from below" and "from top”

15 : misconfiguration after powering

16 : configuration change during operation

17 : too low voltage power supply

11. Number of selected switch and details of conditions lack for switching.

Register	Content
%R3653	Higher byte, higher half: number of selected switch. Lower byte: details of conditions lack for switching

Details of conditions lack for switching:

100 : for ZSK mode: unknown drift

36 : for ZSK mode: exceeded drift

68 : for ZSK mode: exceeded drift

116 : for ZSK mode: dfi unknown

52 : for ZSK mode: dfi < -dfi (table 3.1, I.no. 16, 17)

84 : for ZSK mode ZSK: dfi > +dfi(table 3.1, I.no. 18, 19)

96 : dU unknown

32 : for ZSK mode: dU < dUd(table 3.1, I.no. 20, 21)

64 : for ZSK mode: dU > dUg(table 3.1, I.no. 22, 23)

97 : Us unknown

105 : Us unknown

33 : for SBN and SGBN modes:Us < Ussd
(table 3.1, I.no. 32, 33)

41 : for GBN and ZSK modes: Us < Usd
(table 3.1, I.no. 36, 37)

65 : for SBN and SGBN modes:Us > Ussg
(table 3.1, I.no. 34, 35)

73 : for GBN and ZSK modes: Us > Usg
(table 3.1, I.no. 38, 39)

101 : Fs unknown

37 : Fs < Fsd(table 3.1, I.no. 40, 41)

69 : Fs > Fsg(table 3.1, I.no. 42, 43)

99 : Ug unknown

107 : Ug unknown

35 : for GBN and SGBN modes: Ug < Usgd (table 3.1, I.no. 44)

43 : for SBN mode: Ug < Ugd (table 3.1, I.no. 28)

67 : for GBN and SGBN modes: Ug > Usgg (table 3.1, I.no. 45)

75 : for SBN mode: Ug > Ugg (table 3.1, I.no. 29)

103 : Fg unknown

39 : Fg < Fgd (table 3.1, I.no. 30)

71 : Fg > Fgg (table 3.1, I.no. 31)

12. State of LCD. May be obtained by reading the 40 contiguous registers (which is 80 bytes – characters sent to the display) starting from the register %R3585. Polish characters: ą = 0x08, ł = 0x09, ę = 0x0A, ó = 0x0B. Elements of bar symbolizing the state of the phase difference: one bar = 0x0C, two bars = 0x0D, three bars = 0x0E, four bars = 0x0F, five bars = 0xFF. Degree symbol = 0xDF.

13. Settings. Can be obtained by reading n consecutive registers (where n – number of settings for the given type of synchronizer), starting from the register %R2177. The sequence thus obtained settings is identical to the sequence of settings viewed on LCD. The unit in which a setting is given, is equal to its resolution (eg. setting -dF1 is determined with a resolution of 0,01%Fs, so in the given register is determined in units of 0,01%Fs). Settings type T/N are determined in this way, that value 0x0000 means N, while 0x0001 means T.

7.3.2. Information also available in certain states of damage

Information also available in certain states of damage:

- **detection of damaged hardware of synchronizer after powering (damages, which does not block the operation of the serial interface),**
- **detection of irregularities in the work of the synchronizer due to eg. the strong electromagnetic interference.**

1. Error Information.

During the correct operation all of these below 8 registers have the value equal to 0x0000.

Register	Content
%R2697	Byte of diagnostic information for service, nonzero means failure of synchronizer

Register	Content
%R2698	Byte of diagnostic information for service, nonzero means failure of synchronizer
%R2699	Byte of diagnostic information for service, nonzero means failure of synchronizer
%R2700	Unused byte
%R2701	Unused byte
%R2702	Unused byte
%R2703	Higher byte means failure code, lower contains additional information for service.
%R2704	Byte of diagnostic information for service, nonzero means failure of synchronizer

Fault codes:

0x01	Supply voltage drop below the permitted threshold.
0x02	Change of configuration during operation.
0x03	Internal error – error in the software activity caused by electromagnetic interference or damage to the synchronizer during operation.
0x04	Detection of ambiguous configuration after powering.
0x05	Error in settings or address for serial link (in the latter case available only port on the synoptic board, and address is set to 1).
0x06	Device failure.

2. The program name, date of compilation. Reading 8 registers, starting from %R3705, we get in order: the name of the program of main processor (8 characters) and the compile date in the form yyyy mm dd.

Note!

The time between the end of receiving the frame by synchronizer and the begining in sending response may be in an extreme case close to 0. Therefore, the use of the RS485 working in the so-called half-duplex system (single twisted pair) will result in incorrect operation of transmission, because the master device can not make it to switch to a reception state. Correct operation of the transmission provides a link 485 in a full-duplex system (separate twisted pair to transmit and receive), or RS232 or a pair of optical fiber cables.

8. Operation

Synchronizers type SM-06B production PUP KARED Sp. z o.o. are constructed in such a way, that the operator does not require special maintenance procedures.

8.1. Periodic checks

It is recommended to carry out a test in terms of product routine tests before the end of the warranty period. To perform testing is recommended to use specialized tester, studying synchronizer in dynamic states, eg. **Simulator of Energy Block** [Symulator Bloku Energetycznego] (in brief **SBE**). The results of testing are the basis for the extension of the warranty period of two years.

8.2. Troubleshooting

In case of any abnormality in the unit operation, please contact the manufacturer's representative who will guide the further procedure.
In the course of reporting the fault should be given:

- type of synchronizer,
- serial number,
- installation site,
- signs of damage,
- name of the person handling the case,
- contact phone number.

9. Transport and Storage

Transport packaging should have the same degree of resistance to vibration and shock, which is defined in the standards PN-EN 60255-21-1:1999 and PN-EN 60255-21-2:2000 for Class Focus 1.

Supplied by the manufacturer device must be carefully unpacked without using excessive force and inappropriate tools. After unpacking, visually inspect the device for signs of external damage.

The device should be stored in a dry and clean compartment, wherein the storage temperature is in the range from -25°C to +70 °C.

The relative humidity should be at these borders, that there is no condensation or frosting.

10. Disposal

If as a result damages or end use it is needed to disassemble (and possibly liquidation) of the device, you must first disconnect any size of power supply, measurement and other connections.

Disassembled device should be treated as electronic scrap, with which you must comply with the regulations governing waste management.

11. Warranty and Service

1. On the delivered device **PUP KARED Sp z o.o.** Company gives a 2 years warranty from date of sale (unless the provisions of a separate agreement stipulate otherwise), under the terms of the warranty card.

2. The manufacturer provides technical assistance during commissioning and provides warranty and post-warranty maintenance services under the conditions specified in the contract for this service.

3. Failure to follow this instruction will invalidate the warranty.

12. Ordering Guide

Types of synchronizers produced by PUP KARED Sp. z o.o:

SM-06A – synchronizer switching circuit breaker with a fixed lead time, without the voltage and frequency control systems, has only SYN and TEST modes,

SM-06Au – synchronizer switching circuit breaker with a fixed lead time and with a control voltage system, without control system of rotation of the turbine set, has only SYN and TEST modes,

SM-06Af – synchronizer switching circuit breaker with a fixed lead time, with the rotation control system, without a voltage regulator system, has only SYN and TEST modes,

SM-06As – semi-automatic synchronizer with the function of linking island objects, has only SYN, ZSK and TEST modes,

SM-06B – automatic synchronizer, connecting objects by one of the two switches selected by hardware (hardware manner), has all the operating modes,

SM-06C – automatic synchronizer, connecting one of the two generators through one of the four switches selected by hardware (hardware manner), has all the operating modes

The order should include the device code read from the table below and the name of the object in which the synchronizer will be installed.

SM-06x-xxxxx-x-x-x

Synchronizer type

- Semi-automatic synchronizer:
  - 2 switches ..... A
  - 2 switches with ZSK option ..... As
  - 2 switches with the control frequency option..... Af
  - 2 switches with the control voltage option..... Au
- Automatic synchronizer:
  - 1 generator, 2 switches .... B
  - 2 generators, 4 switches C

Value and type of auxiliary supply voltage

- 24 V DC 024DC
- 120 V DC 120DC
- 220 V DC 220DC

Synchronizer housing

- On the panel, Apra Profi Set 63T 1
- Behind the panel, rack, 12” 3U 49T …. 2
- Behind the panel, rack, 19” 3U 84T 3

Installed serial ports for communication with surrounding

- RS 232C 1
- RS 232C plus RS 485 2
- RS 232C plus fibre optic connector To synchronization panel TS-10 …..... 3
- RS 232C plus RS 485 fibre opitc (transmiter and receiver, type ST) 4
- 2 x RS 485 (system + TS-10) 5

Language version of synchronizer

- Polish ..... PL
- English ..... EN
- Macedonian ..... MK
- Russian (cyrillic) ..... RU
- French (in the development) ..... FR

Example:

Automatic synchronizer for 1 generator, 2 switches, for auxiliary voltage 120 V DC, in housing 19” 3U 84T, having 2 connectors: RS 232C and optical fibre connector to host system (transmiter and receiver, ST connectors), language version – Polish will be marked with the code:

SM-06B-120DC-3-4-PL