AUTOMATIC CHANGE-OVER UNIT

TYPE AZRS-2

Operating Manual

Gliwice, April 2008

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Automatic unit type AZRS-2 was made in cooperation with P.U.P. KARED Gdańsk

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MEANING OF OPERATING MANUALS

In case of doubts regarding to appropriate interpretation of manuals content we would necessarily like to ask for explanation to manufacturer.
We will be grateful for any suggestions, opinions and critical remarks of users and so we ask for its transmission written or verbal. This may help us make the manuals easier to use and give consideration to wishes and requirements of user.
Device, to which the manuals has been added, includes impossible to eliminate, potential menace for persons and material values. That is why every person, working at this device or performing any activities connected with operating and service of device, has to be previously trained and has to know potential hazard.
It requires careful reading, understanding and obeying of operating manuals, particularly hints concerning safety.

Table of contents

INFORMATION OF COMPLIANCE

Device being the subject of this instruction was constructed and prepared and it is manufactured for the purpose of use in industrial environment.

This device is compatible to directive resolutions: low voltage 73/23/EWG – Decree of Economy, Labour and Society Minister dated on 12.03.2003 (Act Register no. 49 item 414) and electromagnetic compatibility 89/336/EWG – Decree of Infrastructure Minister dated on 02.04.2003 (Act Register no. 90 item 848).

Accordance to directives was confirmed by test performed in laboratory of Energotest and in independent from manufacturer measurement laboratories and research and develop centres in accordance to requirements of harmonised standards: PN-EN 60255-5 (for directives LVD) and PN-EN 50082-2 and PN-EN 50263 (for directives EMC), and also for other standards (see item 5 of manuals).

1 Application of unit

Microprocessing automatic unit type AZRS-2 for self stand by and planned power supply switching is dedicated for switchgear systems requiring supply reliability, operating with emergency reserve or operating reserve.

Unit may be used for following switching over:

- **Uninterrupted synchronous change-over („fbl" for short).**
  Change over is possible if at the initiation time all the synchronous change-over conditions are fulfilled, i.e. the values of *dphi („dfi" in polish version)*, *dV („dU" in polish version)* and *df* are within permitted limits. The automatic unit sends a closing impulse to the circuit breaker of the new supply line and when the closed position of this circuit breaker is confirmed, it sends an opening impulse to the previous supply circuit breaker. There are no interruptions in consumers' supply during the change-over operation.
- **Synchronous change-over with short power supply interruption („fwb" for short).**
  Change over is possible to realise if at the initiation time all the synchronous change-over conditions are fulfilled. After opening the previous supply line circuit breaker, the automatic unit immediately sends a closing impulse to the new circuit breaker of the new supply line. The time of supply interruption depends only on operating time of the circuit breaker.
- **Quasi-synchronous change-over („qs" for short).**
  Quasi-synchronous change-over is foreseen for limited voltage level of electric motors during this kind of operation and can be realised when differential voltage between the reserve supply line and the residual voltage is equal or below limited value of *dV („dU" in polish version)_qs* and *df_qs („df_sz" in polish version)*.

The measuring unit enables at adV („dU" in polish version)ance time the determination of value of differential voltage between the reserve supply line and the residual voltage between the reserve supply line and the residual voltage on the substation bus bar. This kind of measuring unit has not been used in any AS devices installed up till now.

Change-over operation can be performed independently of synchronous change-over conditions. When the circuit breaker of the previous supply line is opened, the automatic unit is waiting till the conditions for quasi-synchronous change over is fulfilled. Then it sends a closing impulse to the circuit breaker of the new supply line at adV („dU" in polish version)ance time corresponding to the closing time of this circuit breaker. The time of supply interruption depends on time necessary to fulfil the quasi-synchronous change-over conditions.

- **Slow change-over („s" for short).**

  When the circuit breaker of the previous supply is opened and the residual voltage on the substation bus bar drops down below the set threshold value, the automatic unit sends a closing impulse to the circuit breaker of the new supply line. The time of supply interruption depends on velocity of voltage drop at the bus bars down to the threshold value.

By appropriate setting of duty parameters there is possible to activate or deactivate particular type of change-over.

Automatic unit may realise the following cycles of change-over operation:

- Automatic switch-on of reserve power supply („AS" for short)
  - uninterrupted synchronous AS („AS fbl" for short) activated by an external initiation signal.
  - synchronous AS with short power supply interruption („AS fwb" for short) activated by an external initiation signal,
  - synchronous AS with short power supply interruption („AS fwb" for short) activated by an external electric signal opening the circuit breaker of the supply line,
  - synchronous AS with short power supply interruption („AS fwb" for short) activated when the circuit breaker of the basic supply line is mechanically opened,
  - quasi-synchronous AS („AS qs" for short) activated when the circuit breaker of the basic supply line is mechanically opened,
  - slow AS („AS s" for short) activated when the circuit breaker of the basic supply line is mechanically opened,
  - quasi-synchronous AS („AS fwb" for short) activated by sudden voltage drop at the bus bars when the circuit breaker of the basic supply line is closed,
  - slow AS („AS s" for short) activated by voltage decay at the bus bars with the closed circuit breaker of the basic supply line.

- If the automatic change-over cycles: uninterrupted synchronous, synchronous with short interruption or quasi-synchronous are unsuccessful (e.g. because the circuit breaker is not closed) the change-over operation can be finalised in slow cycle.

- Automatic planned change-over of power supply – PSS
  - uninterrupted synchronous PSS („PSS fbl" for short)
  - synchronous PSS with short power supply interruption („PSS fwb" for short)
  - quasi-synchronous PSS („PSS qs" for short)
  - slow PSS („PSS s" for short).
- Automatic self-recovery change-over of power supply – ARS
  - uninterrupted synchronous ARS („ARS fbl" for short)
  - synchronous ARS with short power supply interruption („ARS fwb" for short)
  - quasi-synchronous ARS („ARS qs" for short)
  - slow ARS („ARS s" for short).

Type of change-over depends on voltage conditions and the preferred type of operation cycle in automat settings.

In automatic unit there are built in additional measurement units controlling voltage levels on bus bars of both sections with adjustable time delay. They may be used for activating of other automatic units.

2 Safety rules

Information included in this chapter are dedicated to teach the user the right installation, operating and service of unit. There is made an assumption that installing personnel, activating and operating this device is properly qualified and is aware of potential danger connected with working at electrical devices.

The device fulfils all requirements of obligatory standards and rules in scope of safety. Its construction is particularly prepared because of user security.

Unit installation

The device should be installed in place making possible proper environmental conditions specified in technical data. Unit should be properly fastened, protected from mechanical damage and from accidental access of unauthorized persons. Automatic unit is prepared to fastening on table or behind the table (depending on casing version) in internal switchgears or in control room. Automatic unit should be connected in accordance to electric diagram. External connections are delivered through uncoupling connections type WAGO. To the connections of automatic unit there is suggested to use conductors type LY of 0,5...1,5mm^2 cross-section.

Casings of automatic units require connection the earth into earthing terminal.

Activation of unit

After installing automatic unit AZRS-2 there should be carried out the activation in accordance to general rules concerning protection devices, instrumentation and control.

Insulation test may cause loading into dispersed capacitance up to dangerous level of voltage. After finish of each test the capacitance should be discharged.

Operating of device

The unit should run in environment specified in technical data.

Personnel operating the device should be authorized and acquainted with operating manuals.

Opening the casing

Before start of any duties connected with the necessity of opening the casing of unit there should be stringently switched off all the supplying and measurement voltage and then disconnect AZRS-2 from external circuits by uncoupling all plug-ins.

Applied subunits are very sensitive for electrostatic discharges and that is why opening the unit without special anti-electrostatic equipment may cause its damage.

Service

There is necessity of period battery exchange in accordance to item 9.1 and periodical check-up required by applicable regulations. In case appearance of any defect the user should turn to producer for help.

The producer offers service in scope of activating, commissioning, warrantee and post warrantee service. Warrantee conditions are described in guarantee card.

Modifications and changes

Because of security matters all modifications and changes of unit activities which are subject of this manual are forbidden. Modification of device which were not certified on written document by manufacturer, cause loss of any claims to legal responsibilities in relation to Energotest.

Exchange of any elements or subassemblies the device is composed of and coming from another producers than already applied, may cause hazard for user and eventually result in incorrect functioning.

Energotest does not take responsibility for damage caused by applying inappropriate elements or subassemblies at the device.

Disturbances

It is strongly advised to immediately inform authorised person about any disturbances or other damages noticed during operating.
Repairs may be realised only by qualified specialists.

Nominal data, informing plates and sticks

It is obligatory to obey and accommodate to hints located on device as descriptions or informing plates and sticks and it is necessary to keep them in proper condition making possible to read from it. Plates and stocks, which become damaged or illegible, should be exchanged.

3 Technical description

3.1 General description

The AZRS-2 unit is microprocessor-based design. The unit has been assembled in a housing made by Rittal and can be mounted on a board or behind the panel.
The AZRS-2 is provided with measured voltage, signals or present positions of circuit breakers, interlock signals or other control impulses. On their basis the automatic unit confirms condition for operation.
In the AS cycle the unit automatically changes over supply from the basis feeder line to the reserve one in case of fault and enables the self-recovery automatic change-over cycle (ARS), if the AS cycle by voltage loss has been done correctly. The planned supply change-over cycle (PSS) is performed under standard operating conditions.
The AS cycle is realised in emergency state from primary supply CBM or CBR into reserve supply CBR, but also can be changed over from CBM supply into CBR or from CBR supply into CBM supply .
The ARS cycle is realised in situation, when after realising AS after voltage decay or realising AS after jump drop of voltage, the voltage in supplying line appears. The cycle's goal is to bring back the supply system of switchgear into the existing before change-over in AS cycle. Change-over of ARS cycle is realised in opposite direction than AS cycle realised before.
Te PSS cycle can be realised in every direction between two optional circuit breakers supplying the particular section of substation CBM and CBR. The operator on duty, who is to chose the relevant circuit breakers involved in change-over operation, initiates the PSS cycle. The direction of PSS cycle is automatically established by the unit on the basis of the present position of circuit breakers. In case of failure of the PSS cycle of the substation, the automatic unit will restore the previous supply.
The automatic unit always operates only once. That means every change–over of automatic unit is realised only once – there is no attempt of realising change-over again.

Apart from control impulses of the circuit breakers, the automatic unit generates impulses to the central signalling system.

The automatic unit is equipped in additional measurement units controlling voltage levels on bus bars. These measurement units, as substitute of usually used under-voltage relays, make a full use of to activate another automatic units in case of voltage decrease.

On the front plate there are located internal annunciation system, system of present position of the circuit breakers and diode system indicating particular levels of voltage in the substation. The LCD displays the information on operation of the automatic unit and discrepancies in the supply change-over system, if any appears.

The standard version of unit, supports Modbus RTU protocol. Communication provides RS232 dedicated to work with your laptop and RS232 / RS485 / fiber dedicated to work with the system of control and supervision.

Optionally, it is possible to install in the unit a communication module supports Modbus TCP protocols, IEC 60870-5-103, IEC 61850. Module is equipped with two Ethernet ports.

The automatic unit can operate with the computerised control system using the Modbus protocol through the suitable RS232 or RS485 connectors as well as through fibre optic connection.

The automatic unit enables the recording of 2000 events essential for its operation and the whole supply change-over system. The event record is available through PC connected to the additional RS232 connector.

Upon the Customer's request, the automatic unit can be equipped with the additional keypad for the control of circuit breakers, the initiation of planned supply change-over and for putting the unit out of operation.

3.2 Casting of the unit

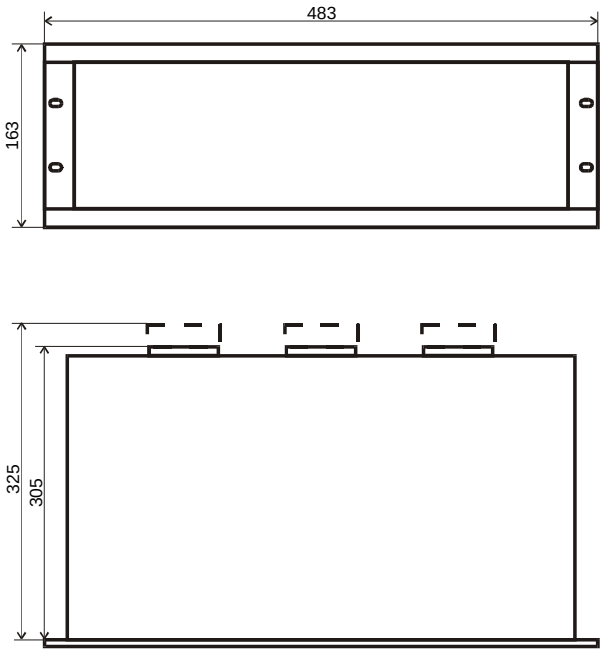
Automatic units of AZR type are usually produced in eight typical casings. The AZRS-2 units are available in versions 5 up to 8:

- **version 5** – on the panel casing, 63T wide, to be mounted on the relay board or on the back wall inside the relay compartment of the switchgear or inside the relay cabinet.
- **version 6** – behind the panel casing, 84T wide, to be mounted on the board in the control room or on the elevation of the switchgear as well as in the typical cabinet suitable for assembling a 19'' chassis,
- **version 7** – behind the panel casing, 49T wide, to be mounted on the board in the control room or on the elevation of the switchgear,
- **version 8** – behind the panel casing, 84T wide, (without additional keypad) to be mounted in a typical cabinet suitable for assembling a 19'' chassis,

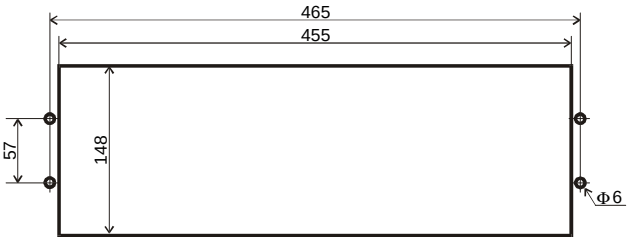
The automatic units are available to order in non-typical casing order, with a prior approval of the Manufacturer.

Typical versions of casing are presented in Figs 3.2.

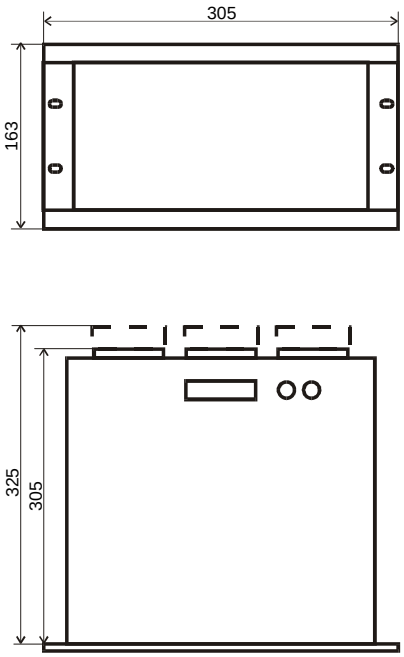
Version 6: Behind the panel casing, 84T wide



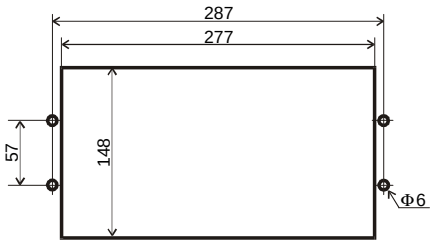
HOLES IN THE MOUNTING PLATE



Version 7: Behind the panel casing, 49T wide



HOLES IN THE MOUNTING PLATE



Version 8: Behind the panel casing, 84T wide (to be mounted inside the cabinet)

Version 5: Behind the panel casing, 63T wide

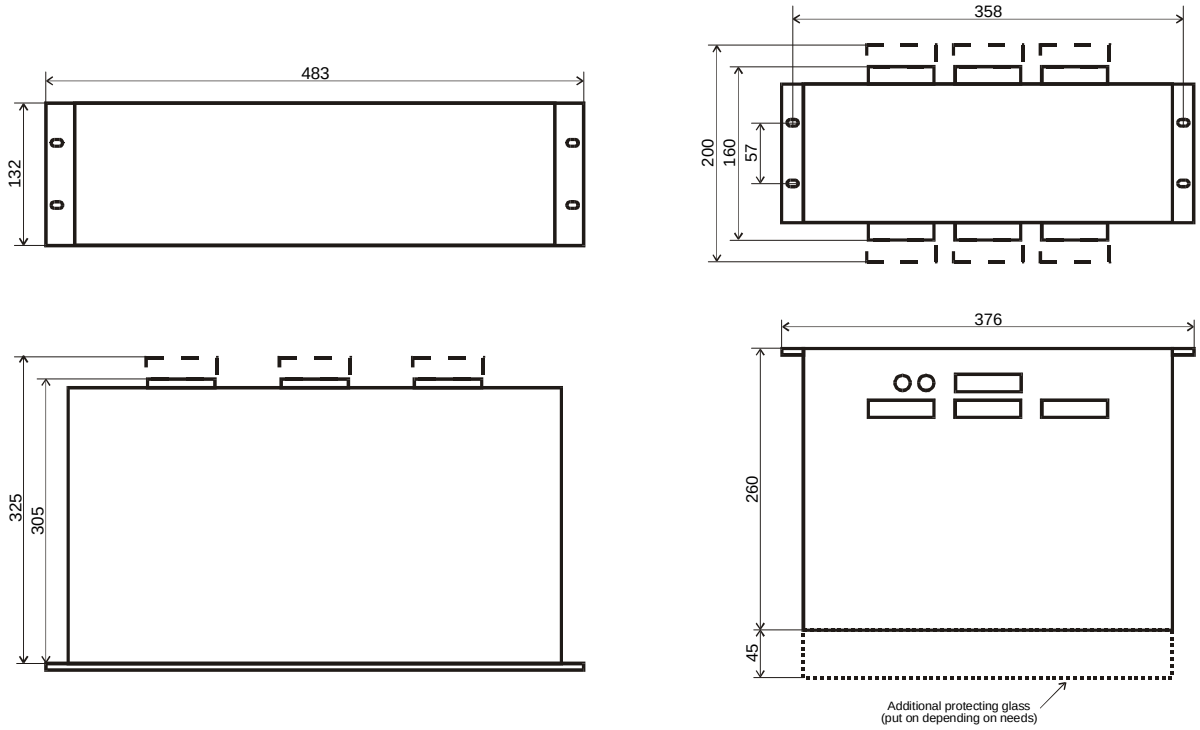


Fig. 3.2. Dimension of automatic unit.

3.3 Front board of automatic unit

The front board of the automatic unit (Fig. 3.3) is divided into following segments:

- from the left side there are located the signal lamps signalling actual state of automatic unit operation and there is also located socket providing computer connection,
- at right side, on the switchgear diagram, there is shown actual configuration of switchgear and the levels of particular voltages,
- at the right side there is also located LCD with the handling push-button set designated for scrolling and changing the actual set of automatic unit and to scrolling the history of changing-over and readout of the actual levels of particular voltages.

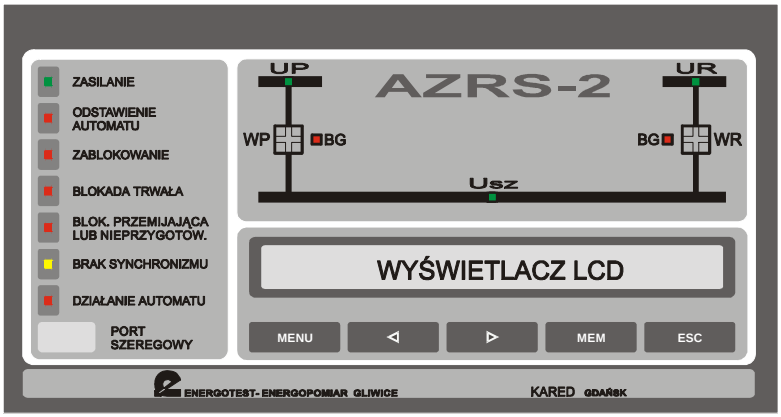


Fig. 3.3. Front board of the automatic unit.

On the switchgear diagram there is shown operation condition of particular circuit breakers. The red lamps mean the circuit breaker is closed, the green –circuit breaker is opened. Next to circuit breakers there are located red lamps "NR" signalling the lack of availability of circuit breaker.

Three-colour lamps indicate the voltage levels in supplying lines (VM and VR („UR" IN POLISH VERSION)) and on bus bars of the switchgear (VbusM and VbusR). Particular colours mean fulfilling following conditions:

lack of light	V<*Vl („Ug" in polish version)t*
red colour	*Vl („Ug" in polish version)t*<V<*Vl („Ug" in polish version)*
yellow colour	*Vl („Ug" in polish version)*<V<*Vr („Ur" in polish version)*
green colour	V>*Vr („Ur" in polish version)*

Which means:

- V – actual value of voltage
- *Vl („Ug" in polish version)t, Vl („Ug" in polish version), Vr („Ur" in polish version)* – set values of voltage (see item 3.7)

The LCD display shows:

- current voltage values on incoming feeders VM12 (phase-phase voltage L1-L2 on incoming feeder A), VR („UR" IN POLISH VERSION)12 (phase-phase voltage L1-L2 on incoming feeder B), and VR („UR" IN POLISH VERSION)32 (phase-phase voltage L3-L2 on incoming feeder B), [V],
- current voltage values on switchgear bus bars Vs12 (phase-phase voltage L1-L2), VsA32 (phase-phase voltage L3-L2), [V],

- current differential voltage value dV (b-M) (differential voltage between voltage on bus bar and voltage in incoming feeder M), dV (b-R) (differential voltage between voltage on bus bar and voltage on incoming feeder R), [V],
- current phase angel value dphi („dfi" in polish version)(b-M) (phase angle between the voltage on bus bar and the voltage on incoming feeder M), dphi („dfi" in polish version)(b-R) (phase angle between the voltage on bus bar and the voltage on incoming feeder R), [^{o}]; if one of the voltage value does not exceeds 60 V the LCD displays „---„ ,
- current frequency values fM (frequency of voltage on incoming feeder M), fR (frequency of voltage on incoming feeder R), [Hz], if one of the voltage value does not exceeds 60 V the LCD displays „---„ ,
- current differential values of frequency df(b-M) (the difference of frequency between voltage on bus bar and voltage on incoming feeder), df(b-R) (the difference of frequency between voltage on bus bar and voltage on incoming feeder R), [Hz]; if one of the voltage value does not exceeds 60 V the LCD displays „---„ ,
- number of already realized AS cycles for each direction of change-over,
- number of already realized ARS cycles for each direction of change-over,
- report about last 10 operations of supply change-over including time of realizing the change-over,
- actual time,
- setting values of particular parameters (after selecting the time setting and read mode using "MENU" key).

Word messages, giving an information about last change-over, concern:

- type of realized change-over (AS, PSS or ARS),
- direction of change-over (CBM>CBR, CBR>CBM),
- in case of AS the way of initiating the change-over (opening the circuit breaker, switch-off impulse, external signal of initiating the AS, sudden voltage drop, decay of voltage),
- in case of unsuccessful change-over the reason of unsuccessful change-over (the circuit breaker didn't open, the circuit breaker didn't close, the limit time was exceeded).

In a base mode on the LCD there are shown values of voltage together with their designations. To obtain the readout of other parameters there should be changed LCD functions using „<" or ">" pushbuttons. To get back into base mode it is necessary to push only „ESC" pushbutton.

3.4 Blocking and unblocking the automatic unit

There is possibility to block the automatic unit externally by use of leaded-in particular signal into terminals of automatic unit and self blocking of automatic unit based on information of switchgear status.

The blocking of automatic unit can be permanent or transient:

- **Permanent interlock** causes permanent blocking of automatic unit. If it is initiated during the change-over cycle, it will block all the control impulses and will deactivate the automatics in unit. After permanent interlock, the automatic unit should be unblocked manually. The deactivation with use of SA key is equivalent to permanent interlock.

During permanent interlock there is activated signalling:

- internal: *„permanent blocking"* and *„interlocking"*
- external: *„permanent interlock".*

During stand by position of automatic unit, there is activated signalling:

- internal: *„off-automatic"*
- external: *„out of service"*.

- **Transient interlock** causes transient blocking of certain functions or delay in sending control impulses, depending on the reason of interlock. After disappearance of reason of interlock, the blockade is cancelled.

During transient interlock of automatic unit, there is activated signalling:

- internal: *„transient blocking, not ready"* and *„interlocking"*
- external: *„transient interlock or not ready"*.

Interlock is activated in following cases:

- Shut down of auxiliary supplying voltage or switch off the SA key causes out-of-service position of automatic unit.
- Feeding with the voltage +220V (+110V) on terminals B8 causes following operations:
  - transient interlock of automatics PSS,
  - transient interlock of automatics AS,
  - transient interlock of automatics ARS,
- Feeding with the voltage +220V (+110V) on terminals B9 causes following operations:
  - transient interlock of automatics PSS,
  - transient interlock of automatics AS,
  - transient interlock of automatics ARS,
- During realisation of change over in PSS cycle, there is transiently interlocked AS automatics.
- During realisation of change over in ARS cycle, there is transiently interlocked AS automatics (during waiting for appropriate conditions to realise the change-over in ARS cycle, the automatics of AS is not interlocked).
- During waiting for appropriate conditions to realise the change-over in ARS cycle and during realisation of change over in ARS cycle, there is transiently interlocked PSS automatics.
- During realisation of change over in AS cycle, there is transiently interlocked PSS automatics.

- After realising some change over in AS cycle, the automatic unit is permanently interlocked. See details at item.3.6.1.
- During lack of stand by of circuit breaker, occurs transient interlock of PSS automatics.
- During lack of stand by of circuit breaker, occurs transient interlock of ARS automatics.
- During lack of stand by of circuit breaker, occurs transient interlock of AS automatics from external initiating signal, AS automatics from external impulse opening the circuit breaker, AS automatics from drop voltage decrease.
- During lack of stand by of CBR circuit breaker, occurs transient interlock of AS automatics from voltage decay and AS automatics from opening the circuit breaker in the direction CBM>CBR.
- During lack of stand by of CBM circuit breaker, occurs transient interlock of AS automatics from voltage decay and AS automatics from opening the circuit breaker in the direction CBR>CBM.
- Decrease of voltage below setting value *Vr („Ur" in polish version)* causes transient interlock of PSS automatics.
- Decrease of voltage below setting value *Vr („Ur" in polish version)* causes transient interlock of AS automatics in direction determined by low voltage level.
- In case of ambiguous responses of state of circuit breakers conditions, the automatic unit interlocks transiently.
- Appearance of external shut down impulse for the circuit breaker causes transient interlock of PSS automatics.
- Appearance of external shut down impulse for the circuit breaker causes transient interlock of ARS automatics.

After permanent interlock the automatic unit should be unblocked manually in the following way:

- SA switch should be put into on position; however if SA key is in on position, then it is necessary to switch it off and then on.
- Press the ESC pushbutton on the front board and keep it pressed for 0,5 sec. time.

After auxiliary voltage is switched on and in the moment of unblocking, the automatic unit checks the operating conditions of switchgear and interlocks only in case, if two circuit breakers are closed, the voltage on bus bars is higher than setting value *Vl („Ug" in polish version)*, if there are no shut-down impulses for circuit breakers of particular feeders and if there is no external initiating signal activating AS automatics. If at least one condition is not fulfilled, the automatic unit will be blocked permanently.

Similar checking happens for automatic unit if at the moment of changing the setting, at the moment of external signal appearance allowing for doing change-over of AS cycle and at the moment of changing the setting.

3.5 Disturbances annunciation

The automatic unit is equipped in internal annunciation on the front plate. Moreover it is equipped in contact outputs used for control of external signalling.

3.5.1 Internal annunciation

The lights indicate following states of operation of automatic unit:

a. POWER – indicates the state of automatic unit being on with auxiliary voltage,
b. OFF AUTOMATIC – indicates that automatic unit is not in operation (switched off),
c. INTERLOCKING – activated simultaneously with the signals *„permanent blocking”* or *„transient blocking, not ready”*,
d. PERMANENT BLOCKING – indicates permanent blockade of automatic unit.
e. TRANSIENT BLOCKING, NOT READY – indicates transient interlock of automatic unit.
f. LOSS OF SHORT-TIME SWITCHING CONDITIONS – indicates exceeding in automatic unit of the following setting parameters: permitted phase displacement angle *dphi („dfi” in polish version),* or permitted differential voltage *dV*, or permitted frequency difference *df* at which the synchronous change-over operations are still possible,
g. LIMIT TIME – indicates its initiation to realise PSS, ARS, AS automatics or awaiting for fulfilling of the ARS cycle conditions.

The recording system allows for display on LCD the information about last 10 change-over operations performed by automatic unit in scope of kind of change-over and time of its operation.

3.5.2 External annunciation

The automatic unit enables external annunciation and recording of the following signals:

a. OUT OF SERVICE – indicates that automatic unit is out of operation (switched off)or there is the lack of auxiliary voltage,
b. PERMANENT INTERLOCK – indicates permanent blockade of automatic unit,
c. TRANSIENT INTERLOCK OR NOT READY – indicates transient blockade or lack of readiness for operation,
d. UNSUCCESFUL AS – indicates unsuccessful operation (for example due to failure of circuit breaker) of auto stand by (actuated during the time *tpst („tiw” in polish version)* or *tap („tip” in polish version)* after finish of change-over),
e. UNSUCCESFUL PSS OR ARS – indicates unsuccessful operation (for example due to failure of circuit breaker) of planned supply change-over or self recovery change-over (actuated during the time *tpst („tiw” in polish version)* or *tap („tip” in polish version)* after finish of change-over),
f. OPERATED AS – indicates operation of the AS cycle (actuated during the time *tpst („tiw” in polish version)* or *tap („tip” in polish version)* after finish of change-over),

g. PSS OR ARS INITIATION – indicates the activation of the automatic unit to perform the cycle of planned supply change-over or self recovery change-over,
h. OPERATION OF AUTOMATIC UNIT – indicates the activation of the automatic unit to perform the PSS, ARS, AS cycles or waiting fur the fulfilment of ARS cycle conditions.

3.6 Description of operation

Below there are some typical examples of automatic unit operation.

The change-over may be realised in six directions: from CBM into CBR, from CBR into CBM. Particular change-over operations are described for direction of changing over realised between the circuit breakers called conventionally: opened circuit breaker CBO and closed circuit breaker CBC. Depending on direction of realised change-over, there should be for opened circuit breaker CBO and closed circuit breaker CBC announced the circuit breakers designations as in table below:

Direction of change-over	opened circuit breaker CBO	closed circuit breaker CBC
from CBM into CBR	CBM	CBR
from CBR into CBM	CBR	CBM

The automatic unit realises three cycles of change-over:

- **AS** – auto stand by– realised automatically by automatic unit (based on conditions appeared in switchgear) in emergency cases (in the moment the interruption appears in switchgear supply) realised from primary supply into stand by supply.
- **ARS** – automatic return switching – realised automatically by automatic unit (based on conditions appeared in switchgear) in case of primary supply return after previous realisation of AS cycle from voltage decay; realised form stand by supply into primary supply. This is change-over recovering the major, primary supply of switchgear. It is also known as „returning AS" or „self-return".
- **PSS** – planned power supply switching – activated manually by service of switchgear, realised in normal operating conditions.

Each of change-over operations may be activated or interlocked in setting mode. After realising correct AS cycle (it means after change-over realised automatically in emergency situation) by appropriate setting it is possible to permanently interlock the automatic unit. Details are described in item 8.2.

3.6.1 Auto stand by cycle (AS ("SZR" in polish version))

The change –over operation may be realised in following directions: from CBM into CBR, from CBR into CBM. Realisation of AS cycle is initiated self-acting by automatic unit. The automatic unit operates only once and it proceeds in direction determined on base of circuit breakers condition and voltage levels.

The automatic unit realises following operations:

- uninterrupted synchronous change-over (fbl)
- synchronous change-over with short power supply interruption (fwb)
- quasi-synchronous change-over (qs)
- slow change-over (s).

Kind of the switching over depends on a conditions for realising particular short-time switching (angel between voltage vectors, differential voltage and frequency difference) during initiating the change-over. The quick AS may be realised if the these parameters do not exceed the unit's settings. If the parameters exceed the setting values the slow AS is initiated.

There should be focused on change-over started as synchronous with short power supply interruption or quasi-synchronous change-over may be finished as slow. This may appear for example in case of failure of the closing circuit breaker.

By appropriate setting of automatic unit there is possible for every direction to allow for realisation of every kind of change-over or it is possible to bring it out of service.

Setting „*permission for AS fbl*" applies to uninterrupted synchronous change-over at the time of AS caused by appearance external initiating signal. Setting „*permission for AS fbl, fwb, qs*" applies to uninterrupted synchronous change-over, synchronous change-over with short power supply interruption and quasi-synchronous change-over. Setting this parameter on *„N"* position allows for realisation only the slow change-over. Setting *„permission for AS qs at drop voltage fall"* allows for realisation the change-over caused by drop voltage decrease.

Independently from individual permission for realisation the selected change-over there is possible to put the AS automatics out of service for all directions of change-over, by making the setting „*permission for AS*" into *„N"*. this way of setting the automatic unit is particularly described in paragraph 8.2.

Accept the set permission there is in automatic unit foreseen possibility of external putting the unit out of service in particular directions of AS cycles. To realise change–over in AS cycle, there is necessary constant signal (+220 V or +110 V) on suitable input „ *permission for AS CBM>CBR*" or „*permission for AS CBR>CBM*". Lack of signal causes that change-over in particular directions are blocked.

During realisation the change-over in AS cycle there is activated external and internal annunciation *„operating of automatic unit"*.

After successful finish of AS cycle the automatic unit interlocks itself permanently or passes into stand by state (ready to realise next change-over) depending on setting *„interlock of automatic unit after realisation correct AS"*.

There is generated external signal *„operation of AS"*. Operation counter AS for selected direction of change-over increases its value by 1. At LCD there is shown information of realising successful AS cycle.

After realising successful AS cycle caused by drop voltage decrease or voltage decay on bus bars (it means when there is no necessity direct intervention of switchgear service personnel) there is possible to realise reverse change-over in ARS cycle. In case of setting the ARS automatics on operation duty the automatic unit after realising AS cycle awaits for establishing conditions and after adjusted time *tsARS („trSPP" in polish version)* it starts to realise change-over into primary supply.

The change-over cycles are realised in limiting time *tlAS („tgSZR" in polish version)*. If in this time the change-over cycle will be not finished (for example the circuit breaker will not close), then further operation of automatic unit is contingent upon realised type of cycle and reason of fault. After finish unsuccessful AS cycle there is generated external signal *„unsuccessful AS"*.

The change-over in AS cycle will be initiated if:

- the external initiating signal will be applied
- the external electric impulse appears to open the circuit breaker in supplying line
- the circuit breaker will be mechanically opened in supplying line
- the supplying voltage will decrease in drop way on bus bars at closed circuit breaker in supplying line
- the supplying voltage will decay on bus bars at closed circuit breaker in supplying line.

3.6.1.1 AS cycle caused by external initiating signal

The external initiating signal for AS automatics may be generated by other automatic systems or by other technologic systems in the situation demanding the shut down of primary supply of switchgear.

Typical example of this way of activation of automatic unit is used in unit switchgears in power stations as initiation signal of relay of generator reverse power. During shut down of generator first step is to cut the steam flow into turbine. If the valves are effectively closed, the generator starts working as a motor. There happens activation of relay of generator reverse power, which after set short-time delay (about 2 sec) opens the generator circuit breaker. The initiation signal of relay of generator reverse power is used to activate AS automatics and previous switch-over of switchgear into stand by supply.

As initiating signal for automatics there may be used optional signal available in switchgear. External signal initiates change-over only when there exist conditions for realising synchronous change-over. The change-over may be realised as uninterrupted synchronous change-over or synchronous change-over with short power supply interruption.

Below there are matched various alternatives of AS automatics operation depending on unit settings (permission for realising the change-over) and on conditions to realise synchronous change-over at the moment of initiation AS cycle. Designation „-" means the setting, which has no influence

on automatics operation during this change-over. The shortage „dV („dU" in polish version)d" means „drop voltage decrease".

Item	Setting		Conditions for realising the synchronous change-over	No conditions for realising the syn-chronous change-over
1	perm. for AS fbl perm. for AS fbl, fwb, qs perm. for AS from dV („dU" in polish version)d	Y Y -	realise AS uninterrupted synchro-nous	no change-over
2	perm. for AS fbl perm. for AS fbl, fwb, qs perm. for AS from dV („dU" in polish version)d	N Y -	realise AS synchronous with short power supply interruption	no change-over
3	perm. for AS fbl perm. for AS fbl, fwb, qs perm. for AS from dV („dU" in polish version)d	- N -	no change-over	no change-over

3.6.1.1.1 AS uninterrupted synchronous (fbl) caused by sending external initiating signal

1. Initial conditions:

- The opening circuit breaker (CBO) is closed.
- The closed circuit breaker (CBC) is opened.
- The voltage on changed bus Vbus is higher than setting value *Vl („Ug" in polish version).*
- Stand by voltage VR („UR" IN POLISH VERSION) is higher than 90% of setting value *Vr („Ur" in polish version).*
- There are conditions for synchronous change-over (*dphi („dfi" in polish version)*, *dV („dU" in polish version)*, *df* are less than setting values).
- In the setting there is permission for AS fbl.
- In the setting there is permission for AS fbl, fwb, qs.

2. The automatic unit operation at efficient devices of supply change-over system in switchgear:

- Appearance of external initiating signal.
- At the moment of external initiating signal appearance, there is started timing of limit time *tlAS („tgSZR" in polish version)* and simultaneously there is generated impulse closing the opened circuit breaker CBC sent in non-interruption line. Time of duration of impulse in named *tpft („tis" in polish version)*.

- After closing the closed circuit breaker CBC and timing the efficiency switch-on time *tscc („tskz" in polish version)*, there is generated shut down impulse into opening circuit breaker CBO.
- After opening the opening circuit breaker CBO and timing the efficiency switch-off time *tsco* the automatics is deactivated. If *„interlock of automatic unit after realisation correct AS"* was set on *„Y"*, than the automatic unit is permanently interlocked. If *„interlock of automatic unit after realisation correct AS"* was set on *„N"*, than the automatic unit comes into stand by state (ready to realise next change-over).

3. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the closing circuit breaker did not close CBC:

- After finish of impulse closing the closing circuit breaker CBC and timing the efficiency switch-over time *tscs*, the automatics id deactivated. Independently from a setting *„interlock of automatic unit after realisation correct AS"*, the automatic unit comes into stand by state (ready to realise next change-over).

4. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the opening circuit breaker did not open CBO:

- After finish of impulse opening the opening circuit breaker CBO and timing the efficiency switch-over time *tscs*, there is generated shut down impulse into closing circuit breaker CBC. Time of duration of impulse in named *tpst („tiw" in polish version)*.
- After opening the closed circuit breaker CBC and timing the efficiency switch-off time *tsco* the automatics id deactivated. Independently from a setting *„interlock of automatic unit after realisation correct AS"*, the automatic unit comes into stand by state (ready to realise next change-over).

3.6.1.1.2 AS synchronous change-over with short power supply interruption caused by sending external initiating signal

1. Initial conditions:

- The opening circuit breaker (CBO) is closed.
- The closed circuit breaker (CBC) is opened.
- The voltage on changed bus Vbus is higher than setting value *Vl („Ug" in polish version).*
- Stand by voltage UR is higher than 90% of setting value *Vr („Ur" in polish version).*
- There are conditions for synchronous change-over (*dphi („dfi" in polish version)*, *dV („dU" in polish version)*, *df* are less than setting values).
- In the setting there is no permission for AS fbl.
- In the setting there is permission for AS fbl, fwb, qs.

2. The automatic unit operation at efficient devices of supply change-over system in switchgear:

- Appearance of external initiating signal.

- At the moment of external initiating signal appearance, there is started timing of limit time *tlAS („tgSZR" in polish version)* and simultaneously there is generated impulse closing the opened circuit breaker CBC and the impulse opening the closed circuit breaker CBO sent in non-interruption line. Time of duration of impulse in named *tpft („tis" in polish version)*. The impulse closing the opened circuit breaker CBC does not come into coil closing the opened circuit breaker CBC because the opened circuit breaker CBO is closed.
- After opening the opening circuit breaker CBO, the closing impulse comes into coil of the opening circuit breaker CBC.
- After closing the closing circuit breaker CBC and timing the efficiency switch-on time *tscc („tskz" in polish version)* the automatics is deactivated. If *„interlock of automatic unit after realisation correct AS"* was set on *„Y"*, than the automatic unit is permanently interlocked. If *„interlock of automatic unit after realisation correct AS"* was set on *„N"*, than the automatic unit comes into stand by state (ready to realise next change-over).

3. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the opening circuit breaker did not open CBO:

- After finish of impulse opening the opening circuit breaker CBO and timing the efficiency switch-over time *tscs*, the automatics id deactivated. Independently from a setting *„interlock of automatic unit after realisation correct AS"*, the automatic unit comes into stand by state (ready to realise next change-over).

4. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the closing circuit breaker did not close CBC:

- After finish of impulse closing the closing circuit breaker CBC and timing the efficiency switch-over time *tscs*, the automatic unit comes into realisation of slow AS cycle from opening circuit breaker.

3.6.1.2 AS caused by appearance of external electric impulse opening the circuit breaker in supplying line

The impulse opening the circuit breaker in supplying line is a signal for opening the circuit breaker in a short time period. It is used for purpose of acceleration of AS cycle operation. The opening impulse initiates change–over, when there are conditions for synchronous change-over. The AS initiated from external impulse opening the circuit breaker in primary supply line is realised only in synchronous AS cycle with short power supply interruption.

Below there are matched various alternatives of AS automatics operation depending on unit settings (permission for realising the change-over) and on conditions to realise synchronous change-over at the moment of initiation AS cycle. Designation „-" means the setting, which has no influence on automatics operation during this change-over. The shortage „dV („dU" in polish version)d" means „drop voltage decrease".

Item	Setting		Conditions for realising the synchronous change-over	No conditions for realising the synchronous change-over
1	perm. for AS fbl perm. for AS fbl, fwb, qs perm. for AS from dV („dU" in polish version)d	- Y -	realise AS synchronous with short power supply interruption	no change-over
2	perm. for AS fbl perm. for AS fbl, fwb, qs perm. for AS from dVd	- N -	no change-over	no change-over

3.6.1.2.1 AS synchronous with short power supply interruption (fwb) caused by appearance of external electric impulse opening the circuit breaker in primary supply line

1. Initial conditions:

- The opening circuit breaker (CBO) is closed.
- The closed circuit breaker (CBC) is opened.
- The voltage on changed bus Vbus is higher than setting value *Vl („Ug" in polish version).*
- Stand by voltage UR is higher than 90% of setting value *Vr („Ur" in polish version).*
- There are conditions for synchronous change-over (*dphi („dfi" in polish version)*, *dV („dU" in polish version)*, *df* are less than setting values).
- In the setting there is permission for AS fbl, fwb, qs.

2. The automatic unit operation at efficient devices of supply change-over system in switchgear:

- Appearance of external initiating signal opening the opening circuit breaker CBO.
- At the moment of external initiating signal appearance, opening the opening circuit breaker CBO, there is started timing of limit time *tIAS („tgSZR" in polish version)* and simultaneously there is generated impulse closing the opened circuit breaker CBC. Duration time of impulse is *tpft („tis" in polish version)*. The impulse closing the opened circuit breaker CBC does not come into coil closing the opened circuit breaker CBC because the opened circuit breaker CBO is closed.
- After opening the opening circuit breaker CBO, the closing impulse comes into coil of the opening circuit breaker CBC.
- After closing the closing circuit breaker CBC and timing the efficiency switch-on time *tscc („tskz" in polish version)* the automatics is deactivated. If *„interlock of automatic unit after realisation correct AS"* was set on *„Y"*, than the automatic unit is permanently interlocked. If *„inter-*

lock of automatic unit after realisation correct AS" was set on *„N"*, than the automatic unit comes into stand by state (ready to realise next change-over).

3. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the opening circuit breaker did not open CBO:

- After finish of impulse closing the closing circuit breaker CBC and timing the efficiency switch-over time *tscs*, the automatics id deactivated. Independently from a setting *„interlock of automatic unit after realisation correct AS"*, the automatic unit comes into stand by state (ready to realise next change-over).

4. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the closing circuit breaker did not close CBC:

- After finish of impulse closing the closing circuit breaker CBC and timing the efficiency switch-over time *tscs*, the automatic unit comes into realisation of slow AS cycle from opening circuit breaker.

3.6.1.3 AS caused by mechanical open of circuit breaker in supplying line

The mechanical open of circuit breaker in supplying line initiates the change-over in AS cycle. Depending on existing voltage conditions the change-over may be realised as synchronous with short power supply interruption, quasi- synchronous or slow.

Below there are matched various alternatives of AS automatics operation depending on unit settings (permission for realising the change-over) and on conditions to realise synchronous change-over at the moment of initiation AS cycle. Designation „-" means the setting, which has no influence on automatics operation during this change-over. The shortage „dV („dU" in polish version)d" means „drop voltage decrease".

Item	Setting		Conditions for realising the synchronous change-over	No conditions for realising the synchronous change-over
1	perm. for AS fbl perm. for AS fbl, fwb, qs perm. for AS from dV („dU" in polish version)d	- Y -	realise AS synchronous with short power supply interruption	realise AS quasi-synchronous
2	perm. for AS fbl perm. for AS fbl, fwb, qs perm. for AS from dV („dU" in polish version)d	- N -	realise slow AS	realise slow AS

3.6.1.3.1 AS synchronous with short power supply interruption caused by mechanical open of circuit breaker in supplying line

1. Initial conditions:

- The opening circuit breaker (CBO) is closed.
- The closed circuit breaker (CBC) is opened.
- The voltage on changed bus Vbus is higher than setting value *Vl („Ug" in polish version).*
- Stand by voltage UR is higher than 90% of setting value *Vr („Ur" in polish version).*
- There are conditions for synchronous change-over (*dphi („dfi" in polish version)*, *dV („dU" in polish version)*, *df* are less than setting values).
- In the setting there is permission for AS fbl, fwb, qs.

2. The automatic unit operation at efficient devices of supply change-over system in switchgear:

- Mechanical opening of the opening circuit breaker CBO.
- After opening the opening circuit breaker CBO, there is started timing of limit time *tlAS („tgSZR" in polish version)* and simultaneously there is generated impulse closing the opened circuit breaker CBC. Time of duration of impulse in named *tpft („tis" in polish version)*.
- After closing the closing circuit breaker CBC and timing the efficiency switch-on time *tscc („tskz" in polish version)* the automatics is deactivated. If *„interlock of automatic unit after realisation correct AS"* was set on *„Y"*, than the automatic unit is permanently interlocked. If *„interlock of automatic unit after realisation correct AS"* was set on *„N"*, than the automatic unit comes into stand by state (ready to realise next change-over).

3. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the closing circuit breaker did not close CBC:

- After finish of impulse closing the closing circuit breaker CBC and timing the efficiency switch-over time *tscs*, the automatic unit comes into realisation of slow AS cycle from opening circuit breaker.

3.6.1.3.2 AS quasi-synchronous caused by mechanical open of circuit breaker in supplying line

1. Initial conditions:

- The opening circuit breaker (CBO) is closed.
- The closed circuit breaker (CBC) is opened.
- The voltage on changed bus Vbus is higher than setting value *Vl („Ug" in polish version).*
- Stand by voltage UR is higher than setting value *Vr („Ur" in polish version).*
- There are conditions for synchronous change-over (*dphi („dfi" in polish version)*, *dV („dU" in polish version)*, *df* are less than setting values).
- In the setting there is permission for AS fbl, fwb, qs.

2. The automatic unit operation at efficient devices of supply change-over system in switchgear:

- Mechanical opening of the opening circuit breaker CBO.
- After opening the opening circuit breaker CBO, there is started timing of limit time *tlAS („tgSZR" in polish version).*
- If there appears that after setting time „switch on" of closing circuit breaker CBC there will be conditions for realising quasi-synchronous change-over (the differential voltage will be lower than setting value *dV („dU" in polish version)_qs*), than there will be generated impulse closing the closing circuit breaker CBC and sent in line with break. Duration time of this impulse is *tpft („tis" in polish version)*.
- After closing the closing circuit breaker CBC and timing the efficiency switch-on time *tscc („tskz" in polish version)* the automatics is deactivated. If *„interlock of automatic unit after realisation correct AS"* was set on *„Y"*, than the automatic unit is permanently interlocked. If *„interlock of automatic unit after realisation correct AS"* was set on *„N"*, than the automatic unit comes into stand by state (ready to realise next change-over).

3. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the closing circuit breaker did not close CBC:

- After finish of impulse closing the closing circuit breaker CBC and timing the efficiency switch-over time *tscs*, the automatic unit comes into realisation of slow AS cycle from opening circuit breaker.

3.6.1.3.3 AS slow caused by mechanical open of circuit breaker in supplying line

1. Initial conditions:

- The opening circuit breaker (CBO) is closed.
- The closed circuit breaker (CBC) is opened.
- The voltage on changed bus Vbus is higher than setting value *Vl („Ug" in polish version).*
- Stand by voltage UR is higher than setting value *Vr („Ur" in polish version).*
- In the setting there is permission for AS fbl, fwb, qs.

2. The automatic unit operation at efficient devices of supply change-over system in switchgear:

- Mechanical opening of the opening circuit breaker CBO.
- After opening the opening circuit breaker CBO, there is started timing of limit time *tlAS („tgSZR" in polish version).*
- When the voltage on bus bars is lower than setting value *Vl („Ug" in polish version)t*, than there is started timing of delay time in closing the circuit breaker *tcd („toz" in polish version)*.
- If *„excitation for unloading automatics"* is set on *„Y"* value, then there will be sent an impulse of unloading to shut down particular drives, which will not take part in self-starting. Duration time of this impulse is *tpls(„tiodc" in polish version)*.

- At the moment the *tcd („toz" in polish version)* time limit, there will be generated impulse closing the closing circuit breaker CBC and sent in line with break. Duration time of this impulse is *tpst („tiw" in polish version)*.
- After closing the closing circuit breaker CBC and timing the efficiency switch-on time *tscc („tskz" in polish version)* the automatics is deactivated. If *„interlock of automatic unit after realisation correct AS"* was set on *„Y"*, than the automatic unit is permanently interlocked. If *„interlock of automatic unit after realisation correct AS"* was set on *„N"*, than the automatic unit comes into stand by state (ready to realise next change-over).

3. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the closing circuit breaker did not close CBC:

- After finish of impulse closing the closing circuit breaker CBC and timing the efficiency switch-over time *tscs*, the automatic unit is deactivated. The automatic unit is permanently interlocked.

3.6.1.4 AS caused drop voltage decrease on bus bars at closed circuit breaker in supplying line

In some factories or firms, because of continuity of technologic processes, instantaneous decay of supplying switchgear voltage may cause serious heavy material losses.

To originate with offer satisfying needs of customer there was introduced new type of auto stand by making, which moves ahead or makes shorter the time of break in energy supply. This kind of change-over was called „auto stand by operating from drop voltage decrease" (for short „AS from dV („dU" in polish version)d").

Below there are described interruptions causing drop voltage decrease and there is carried out analysis of AS operation from drop voltage decrease.

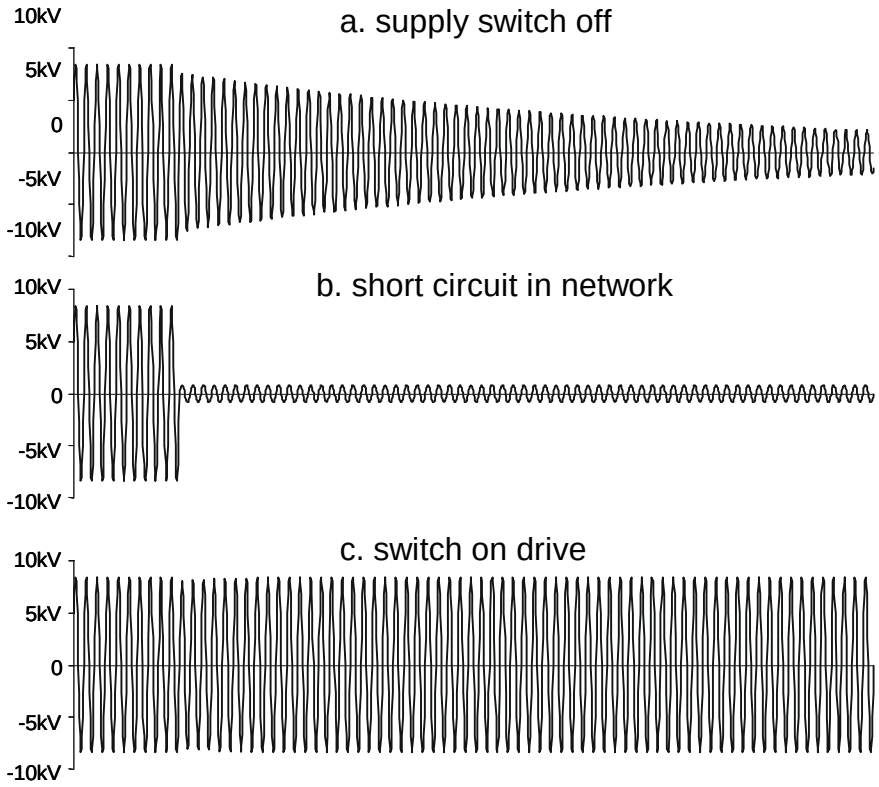


Fig. 3.6.1.4a. Voltage oscillations during interruption.

Typical example of disturbance in energy supply is shut down the transformer supplying the switchgear. After shutting down the transformer on the switchgear bus bars there appears voltage which is an effect of residual voltage generated by spinning engines fed from this switchgear. Value of this voltage and speed of its fading is related among other things to power of engines, their load character and power of non-engine receivers. The AS automatics from voltage decrease is dedicated to restore energy supply during voltage decay. Up to now in the description here in case of voltage decay there is realised AS free from voltage decrease. After identifying voltage decrease to the value usually about 0,3...0,5 Vn („Un" in polish version) the time of start up delay of AS is counted and then the automatic unit starts change-over. Time of start up delay was introduced in order to avoid useless change-over during time of momentary voltage decay and to make possible gradation of operation of change-over devices in complex switchgear system.

Another voltage oscillation occurs during short circuit in middle voltage power network. First there appears voltage decrease up to value depending on place and kind of short circuit and than after operation of protecting devices and stopping the short circuit the voltage will recover. Nominal time of disturbance may be up to 2 sec and in some switchgears even up to 3 sec because of necessity of gradation of operation time of particular protecting devices.

There should be also considered situation when short time voltage decrease may be caused bay switched on energy receivers, particularly by large power engines or self start up of group of engines. They should take no longer than 1 sec time and in extreme events several seconds.

Up to now there existed conviction that in case of supplying voltage decay the change-over should be realised after voltage decrease on bus bars until value making impossible switching stand by supply safe for engines.

The assumption mentioned above means that in case of voltage decrease there is possible to realise change-over after unequivocal statement of permanent voltage decay. As a criterion of permanent voltage decay of switchgear supply there was taken voltage decrease appearing for specified time. This time should be longer than longest occurring supply voltage decrease eliminated by other devices. In practise the time of AS automatics operation since voltage decrease may amount to 0,5 till 2 sec and sometimes even longer.

Long time of break in supply causes complications in technological process. Supplying of switchgear returns but if the break takes too long, there is necessary to switch off receivers. If from the switchgear there are fed engines, than too long time of break causes their stopping (braking) and this is connected with current surge at starting up. That is why after too long voltage decrease some less important energy receivers are automatically shut down. After shutting down the supply there is also decreased frequency of voltage. If technological process requires applying synchronous drives, than at every decrease of frequency there is necessary to shut down of drives and after recovering the voltage, starting tem up once more.

The only one possibility to reduce interruption in technological process is to maximally limit the time of break in supply. To fulfil this condition these was taken an assumption, that automatics should realise switch-over as soon as possible when the first signals about break in supply appear. For this assumption the switch-over would be realised in all cases. For this assumption the change-over would be realised in all cases of disturbances in power supply of switchgear, both during the time of permanent shut down of supply and during short drop voltage decreases.

Because of necessity of shortage the time of automatics operation, this would have to be quasi-synchronous change-over. That means the necessity of introducing brand new type of change-over. Appropriate operation of automatic unit would certainly decrease considerably the negative effects of disturbance.

As a criterion for start up of automatic unit there was taken appearance of drop voltage change. During every interruption there appears drop voltage decrease lasting for some particular time. Setting of automatic unit should fulfil the condition of operation during the time of shut down of energy supply and during short-circuit, while not operation during time of switching on the engines. Time of voltage control should be as long as necessary to manage to activate the protecting device in supplying line in case of short-circuit in switchgear and to interlock the automatics. Simultaneously the time should be as short as necessary to realise change-over in really short time. If the

voltage on bus bars decrease in a drop way for value bigger than setting value *Vs*, than after waiting through setting delay time to *tsAS_qs („trSZR_sz" in polish version)* , which is about tens of milliseconds, there will appear the start up of AS automatics. Correct setting of automatic unit will limit the number of redundant change-over.

Drop voltage decrease is controlled in every of three phase-to-phase voltages L1-L2, L2-L3, L3-L1. To activate the automatic unit there is only needed drop voltage change of in one of phase-to-phase voltages. Thanks this the automatic unit is activated both during three phase short-circuit and during two phase short-circuit.

The standard is that in supplying line of switchgear there are applied over-current protections, which activate if there appear short-circuit in switchgear or in one of lead-outs, whereas they should not activate during short-circuit in supplying line. Interlock of automatic unit during short-circuit is particularly described in item 7.2.8.

During short-circuit in supplying line there appear flow of current through protection in supplying line. This will be current caused by residual (reminding) voltage of spinning engines fed from this switchgear. The flow of this current should not activate the protection (should not interlock the automatic unit).

There should be analysed possibility of activating the measuring element of protection (to compare setting start up value with the expected current value) and if from this analysis follows that over-current protection will activate, than for the correct operation of AS automatics from drop voltage decrease there is necessary to apply another criterion of interlock of automatic unit. For instance at the place of standard over-current protection there may be applied the over-current protection with direction interlock. This solution was described on fig. 3.6.1.4b.

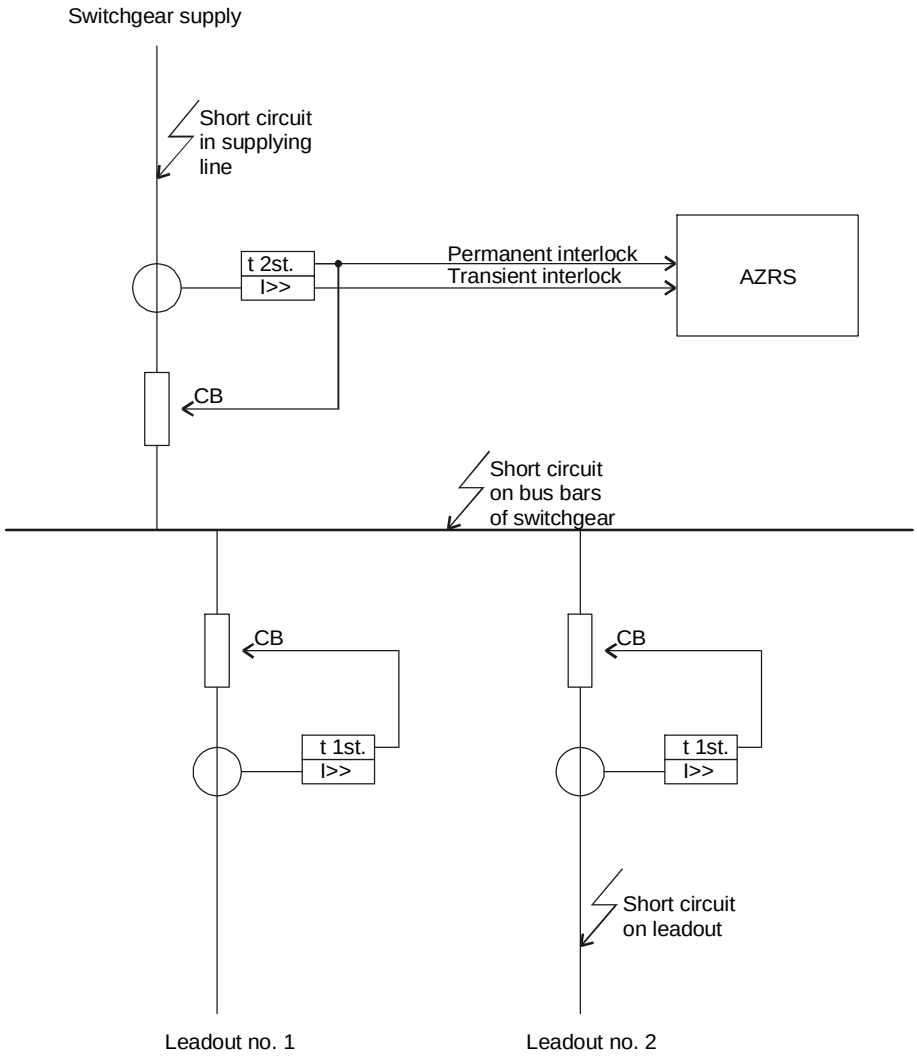


Fig. 3.6.1.4b. Over-current protection with direction interlock in supplying line.

Over-current protection with direction interlock is activated only in case of flow of current in the direction from feeding bay into switchgear. In case of flow of current in the opposite direction the protection will not activate.

The necessity of use of another protection than over-current protection in practice only appears when in the automatic unit there are active change-over cycles of AS from drop voltage decrease. If in the automatic unit these change over cycles are blocked, than applying the over-current protection is sufficient.

AS automatics from drop voltage decrease is activated in every situation of disturbance in supplying voltage of switchgear. This concerns both the permanent and temporary voltage decay.

By suitable setting *„permission for AS from drop voltage decrease”* there is possible for every direction to permit for realisation of change-over in AS cycle from drop voltage decrease or it is possible to put the change-over out of service.

Drop voltage decrease initiates change-over independently from conditions of synchronous change-over. The change-over may be realised as quasi-synchronous.

Below there are matched various alternatives of AS automatics operation depending on unit settings (permission for realising the change-over) and on conditions to realise synchronous change-over at the moment of initiation AS cycle. Designation „-” means the setting, which has no influence on automatics operation during this change-over. The shortage „dV („dU” in polish version)d” means „drop voltage decrease”.

Item	Setting		Conditions for realising the synchronous change-over	No conditions for realising the synchronous change-over
1	perm. for AS fbl perm. for AS fbl, fwb, qs perm. for AS from dV („dU” in polish version)d	- Y -	realise AS quasi-synchronous	realise AS quasi-synchronous
2	perm. for AS fbl perm. for AS fbl, fwb, qs perm. for AS from dV („dU” in polish version)d	- N -	no change-over	no change-over
3	perm. for AS fbl perm. for AS fbl, fwb, qs perm. for AS from dV („dU” in polish version)d	- - N	no change-over	no change-over

3.6.1.4.1 AS quasi-synchronous caused by drop voltage decrease on bus bars at closed circuit breaker in supplying line

1. Initial conditions:

- The opening circuit breaker (CBO) is closed.
- The closed circuit breaker (CBC) is opened.
- The voltage on changed bus Vbus is higher than setting value *Vl („Ug” in polish version).*
- Stand by voltage UR is higher than setting value *Vr („Ur” in polish version).*
- In the setting there is permission for AS fbl, fwb, qs.
- In the setting there is permission for quasi-synchronous AS from drop voltage decrease

2. The automatic unit operation at efficient devices of supply change-over system in switchgear:

- Drop voltage decrease on bus bars.
- After appearance of drop voltage decrease on bus bar for value more than setting value *Vs*, there is started timing of limit time *tlAS („tgSZR" in polish version)* and start up delay time *tsAS_qs („trSZR_sz" in polish version)*.
- At the moment of coming time *tsAS_qs („trSZR_sz" in polish version)*, if the voltage on bus bar was not recovered, than there is generated impulse opening the opening circuit breaker CBO. Duration time of this impulse is *tpst („tiw" in polish version)*.
- After opening the opening circuit breaker CBO and timing the efficiency switch-on time *tsco*, the automatic unit awaits for proper conditions to close the closing circuit breaker CBC.
- If there appears that after setting time „switch on" of closing circuit breaker CBC there will be conditions for realising quasi-synchronous change-over (the differential voltage will be lower than setting value *dV („dU" in polish version)_qs*), than there will be generated impulse closing the closing circuit breaker CBC and sent in line with break. Duration time of this impulse is *tpft („tis" in polish version)*.
- After closing the closing circuit breaker CBC and timing the efficiency switch-on time *tscc („tskz" in polish version)* the automatics is deactivated. If *„interlock of automatic unit after realisation correct AS"* was set on *„Y"*, than the automatic unit is permanently interlocked. If *„interlock of automatic unit after realisation correct AS"* was set on *„N"*, than the automatic unit comes into stand by state (ready to realise next change-over). If there was activated automatics ARS of automatic return switching, than independently from setting of *„interlock of automatic unit after realisation correct AS"* the automatic unit will start realising automatic return switching ARS.

3. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the opening circuit breaker did not open CBO:

- After finish of impulse opening the opening circuit breaker CBO and timing the efficiency switch-over time *tscs*, the automatics id deactivated. Independently from a setting *„interlock of automatic unit after realisation correct AS"*, the automatic unit comes into stand by state (ready to realise next change-over).

4. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the closing circuit breaker did not close CBC:

- After finish of impulse closing the closing circuit breaker CBC and timing the efficiency switch-over time *tscs*, the automatic unit comes into realisation of slow AS cycle from opening circuit breaker.

3.6.1.5 AS caused by voltage decay on bus bars at closed circuit breaker in supplying line

Voltage decay is typical signal for initiation of change-over in AS cycle. The change-over may be realised only as slow one.

Below there are matched various alternatives of AS automatics operation depending on unit settings (permission for realising the change-over) and on conditions to realise synchronous change-over at the moment of initiation AS cycle. Designation „-" means the setting, which has no influence on automatics operation during this change-over. The shortage „dV („dU" in polish version)d" means „drop voltage decrease".

Item	Setting		Conditions for realising the synchronous change-over	No conditions for realising the synchronous change-over
1	perm. for AS fbl perm. for AS fbl, fwb, qs perm. for AS from dV („dU" in polish version)d	- - -	realise slow AS	realise slow AS

3.6.1.5.1 AS slow caused by voltage decay on bus bars at closed circuit breaker in supplying line

1. Initial conditions:

- The opening circuit breaker (CBO) is closed.
- The closed circuit breaker (CBC) is opened.
- The voltage on changed bus Vbus is higher than setting value *Vl („Ug" in polish version).*
- Stand by voltage UR is higher than setting value *Vr („Ur" in polish version).*

2. The automatic unit operation at efficient devices of supply change-over system in switchgear:

- Voltage decay on bus bars.
- When the voltage decrease till setting value *Vl („Ug" in polish version)*, there is started timing of limit time *tlAS („tgSZR" in polish version)* and start up delay time *tsAS_qs („trSZR_sz" in polish version)*.
- After appearance of drop voltage decrease on bus bar for value more than setting value *Vl („Ug" in polish version)t*, there is started timing of start up delay time *tsAS_lt („trSZR_w" in polish version)*.
- At the moment of coming time *tsAS_lt („trSZR_w" in polish version)*, if the voltage on bus bar was not recovered, than there is generated impulse opening the opening circuit breaker CBO. Duration time of this impulse is *tpst („tiw" in polish version)*.

- After opening the opening circuit breaker CBO and timing the efficiency switch-on time *tsco*, there is started timing of delay in closing the circuit breaker time *tcd („toz" in polish version)*.
- If *„activation of unload automatics"* is set on value *„Y"*, than there is generated impulse shutting down selected drives, which will not take a part in self start up. Duration time of this impulse is *tpls(„tiodc" in polish version)*.
- At the moment of coming time *tcd („toz" in polish version)*, there is generated and sent with break line the impulse closing the closing circuit breaker CBC. Duration time of this impulse is *tpst („tiw" in polish version)*.
- After closing the closing circuit breaker CBC and timing the efficiency switch-on time *tscc („tskz" in polish version)* the automatics is deactivated. If *„interlock of automatic unit after realisation correct AS"* was set on *„Y"*, than the automatic unit is permanently interlocked. If *„interlock of automatic unit after realisation correct AS"* was set on *„N"*, than the automatic unit comes into stand by state (ready to realise next change-over). If there was activated automatics ARS of automatic return switching, than independently from setting of *„interlock of automatic unit after realisation correct AS"* the automatic unit will start realising automatic return switching ARS.

3. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the opening circuit breaker did not open CBO:

- After finish of impulse opening the opening circuit breaker CBO, the automatic unit awaits for timing the limit time *tlAS („tgSZR" in polish version)*, and then the automatics is deactivated. The automatic unit is permanently interlocked.

4. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the closing circuit breaker did not close CBC:

- After finish of impulse closing the closing circuit breaker CBC and timing the efficiency switch-over time *tscs*, the automatics is deactivated. The automatic unit is permanently interlocked.

3.6.2 Automatic return switching (PSS)

The change-over operations may be realised in following directions: from CBM into CBR, from CBR into CBM. The automatic cycle PSS is initiated manually by service personnel with pushbuttons „*start PSS CBM>CBR or CBR>CBM*". The automatics PSS operation happens once only and follows in specified direction determined automatically on base of circuit breakers status of switchgear supply system.

Activation of PSS cycle is purposely deleted of 50...100 ms in order to increase resistance for interruptions.

The automatic unit realises change-over as follows:

- uninterrupted synchronous change-over (fbl)
- synchronous change-over with short power supply interruption (fwb)

- quasi-synchronous change-over (qs)
- slow change-over (s).

Kind of the switching over depends on the conditions for realising particular switching, existing during initiating the PSS automatic change-over.

The change-over, which start as synchronous with short power supply interruption or quasi-synchronous change-over, may finish as slow. This may appear if for instance in case of the circuit breaker failure.

By appropriate setting of automatic unit there is possible for every direction to allow for realisation of every kind of change-over or it is possible to bring it out of service. Moreover there is possible to permit or bring it out of service the unit in selected direction using for this purpose the setting *„permission for PSS"*.

At the moment of activating the PSS automatics, there is checked setting *„permission for PSS"* for appropriate direction. If the automatics is activated, than there are checked conditions for realising following change-over kinds. The automatic unit realises change-over if it founds that there are conditions for realisation this change-over and this given change-over kind is not out of service in settings.

The change-over operations are realised in limit time *twPSS,ARS*. If in limit time the change-over operation will not finish successfully, the PSS cycle will be paused.

During time of change-over realisation in PSS cycle, there is activated internal and external annunciation system *„operation of automatic unit"* and *„activation PSS or ARS"*. The terminals, which interlock EO signals of circuit breakers taking part in change-over, are opened.

After finish PSS cycle the automatic unit comes into stand by position. If the cycle was failure, there is activated external annunciation *„unsuccessful PSS or ARS"*.

The information about realisation of PSS cycle is shown on LCD.

In case the switchgear remain without voltage after finish PSS cycle (for instance because of circuit breaker failure of fault settings), the automatic unit will realise AS cycle.

After finish the change-over cycle the PSS automatics is interlocked fir time about 10 seconds.

Below there are matched various alternatives of automatics operation for few unit settings. Operation depends on conditions to realise synchronous change-over at the moment of initiation the automatic unit.

1. – permission for realising all kinds of change-over
2. – slow change-over out of service
3. – permission for realising only uninterrupted synchronous change-over
4. – uninterrupted synchronous change-over and slow change-over out of service
5. – permission for realising only synchronous change-over with short power supply interruption

6. – permission for realising only slow change-over.

Item	Setting		Conditions for realising the synchronous change-over	No conditions for realising the synchro-nous change-over
1	permission PSS fbl permission PSS fwb permission PSS qs permission PSS s	Y Y Y Y	realise PSS uninterrupted synchronous	realise PSS quasi-synchronous
2	permission PSS fbl permission PSS fwb permission PSS qs permission PSS s	Y Y Y N	realise PSS uninterrupted synchronous	realise PSS quasi-synchronous
3	permission PSS fbl permission PSS fwb permission PSS qs permission PSS s	Y N N N	realise PSS uninterrupted synchronous	no change-over
4	permission PSS fbl permission PSS fwb permission PSS qs permission PSS s	N Y Y N	realise PSS synchronous with short power supply interruption	realise PSS quasi-synchronous
5	permission PSS fbl permission PSS fwb permission PSS qs permission PSS s	N Y N N	realise PSS synchronous with short power supply interruption	no change-over
6	permission PSS fbl permission PSS fwb permission PSS qs permission PSS s	N N N Y	realise PSS slow	realise PSS slow

3.6.2.1 PSS uninterrupted synchronous change-over (fbl)

1. Initial conditions:

- The opening circuit breaker (CBO) is closed.
- The closing circuit breaker (CBC) is opened.
- The voltage on changed bus Vbus is higher than setting value *Vl („Ug" in polish version).*
- Stand by voltage UR is higher than setting value *Vr („Ur" in polish version).*
- There are conditions for synchronous change-over (*dphi („dfi" in polish version)*, *dV („dU" in polish version)*, *df* are less than setting values).

2. The automatic unit operation at efficient devices of supply change-over system in switchgear:

- Appearance of initiating signal for PSS.
- At the moment of PSS initiating signal appearance, there is started timing of limit time *tlAS („tgSZR" in polish version)* and simultaneously there is generated impulse closing the closing circuit breaker CBC sent in non-interruption line. Time of duration of impulse in named *tpft („tis" in polish version)*.
- After closing the closing circuit breaker CBC and timing the efficiency switch-on time *tscc („tskz" in polish version)*, there is generated impulse opening the closing circuit breaker CBO
- After opening the opening circuit breaker CBO and timing the efficiency switch-off time *tsco*, the automatic unit is deactivated.

3. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the closing circuit breaker did not close CBC:

- After finish of impulse closing the closing circuit breaker CBC and timing the limit time *tscs* the automatics is deactivated.

4. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the opening circuit breaker did not open CBO.

- After finish of impulse opening the opening circuit breaker CBO and timing the efficiency switch-over time *tscs*, there is generated impulse closing the closing circuit CBC. Duration time of this impulse is *tpst („tiw" in polish version)*.
- After closing the closing circuit breaker CBC, there is activated timing of unset time 50msec.
- After finish the timing of 50ms the automatic unit is deactivated.

3.6.2.2 PSS synchronous change-over with short power supply interruption (fwb)

1. Initial conditions:

- The opening circuit breaker (CBO) is closed.
- The closing circuit breaker (CBC) is opened.
- The voltage on changed bus Vbus is higher than setting value *Vl („Ug" in polish version).*
- Stand by voltage UR is higher than setting value *Vr („Ur" in polish version).*
- There are conditions for synchronous change-over (*dphi („dfi" in polish version)*, *dV („dU" in polish version)*, *df* are less than setting values).

2. The automatic unit operation at efficient devices of supply change-over system in switchgear:

- Appearance of initiating signal for PSS.
- At the moment of PSS initiating signal appearance, there is started timing of limit time *tlAS („tgSZR" in polish version)* and simultaneously there is generated impulse closing the closing circuit breaker CBC and impulse opening the opening circuit breaker CBO, sent in non-interruption line. Time of duration of impulse in named *tpft („tis" in polish version)*. The impulse

closing the closing circuit breaker CBC does not come into coil closing the closing circuit breaker CBC because the opening circuit breaker CBO is now closed.

- After opening the opening circuit breaker CBO there is generated impulse coming to coil and closing the closing circuit breaker CBC
- After closing the closing circuit breaker CBC and timing the efficiency switch-on time *tscc („tskz" in polish version)*, the automatic unit is deactivated.

3. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the opening circuit breaker did not open CBO:

- After finish of impulse opening the opening circuit breaker CBO and timing the limit time *tscs* the automatics is deactivated.

4. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the closing circuit breaker did not close CBC, opening circuit breaker CBO is closed in quick mode:

- After finish of impulse closing the closing circuit breaker CBC and timing the efficiency switch-on time *tscs*, the automatic unit awaits for proper conditions to close opening circuit breaker CBO.
- If there was found that after set own time „close" of opening circuit breaker CBO there will be conditions for quasi-synchronous switch on (differential voltage will be lower than setting value *dV („dU" in polish version)_qs*), than there is generated impulse closing the opening circuit CBO sent in line with break. Time of duration of impulse is *tpft („tis" in polish version)*.
- After closing the opening circuit breaker CBO there is started timing the efficiency switch-on time of closing the opening circuit breaker *tscc („tskz" in polish version)*.
- After finish timing the *tscc („tskz" in polish version)*, if the opening circuit breaker CBO is closed, the automatics is deactivated.

5. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the closing circuit breaker did not close CBC, opening circuit breaker CBO is closed in slow mode:

- After finish of impulse closing the closing circuit breaker CBC and timing the efficiency switch-over time *tscs*, the automatic unit awaits for proper conditions to close opening circuit breaker CBO.
- When the voltage on bus bar decrease below setting value *Vl („Ug" in polish version)t*, than there is started timing of delay of closing the circuit breaker time *tcd („toz" in polish version)*.
- If *„activation of unload automatics"* is set on value *„Y"*, than there is generated impulse shutting down selected drives, which will not take a part in self start up. Duration time of this impulse is *tpls(„tiodc" in polish version)*.

- After finish timing the *tcd („toz" in polish version)*, there is generated impulse closing the opening circuit CBO and sent in line with break. Time of duration of impulse is *tpst („tiw" in polish version)*.
- After closing the opening circuit CBO, there is activated timing of the efficiency switch-on time of circuit breaker *tscc („tskz" in polish version)*.
- After finish timing the *tscc („tskz" in polish version)*, if the opening circuit breaker CBO is closed, the automatics is deactivated.

3.6.2.3 PSS quasi-synchronous change-over (qs)

1. Initial conditions:

- The opening circuit breaker (CBO) is closed.
- The closed circuit breaker (CBC) is opened.
- The voltage on changed bus Vbus is higher than setting value *Vl („Ug" in polish version).*
- Stand by voltage UR is higher than setting value *Vr („Ur" in polish version).*

2. The automatic unit operation at efficient devices of supply change-over system in switchgear:

- Appearance of initiating signal for PSS.
- At the moment of PSS initiating signal appearance, there is started timing of limit time *tlAS („tgSZR" in polish version)* and simultaneously there is generated impulse closing the opening circuit breaker CBO. Time of duration of impulse in *tpst („tiw" in polish version)*.
- After closing the opening circuit breaker CBO and timing the efficiency switch-off time *tsco*, the automatic unit awaits for proper conditions to close the closing circuit breaker CBC.
- If there was found that after set own time „close" of closing circuit breaker CBC there will be conditions for quasi-synchronous switch on (differential voltage will be lower than setting value *dV („dU" in polish version)_qs*), than there is generated impulse closing the closing circuit breaker CBC sent in line with break. Time of duration of impulse is *tpft („tis" in polish version)*.
- After closing the closing circuit breaker CBC and finish timing efficiency switch-on time *tscc („tskz" in polish version)*, the automatics is deactivated.

3. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the opening circuit breaker did not open CBO:

- After finish of impulse opening the opening circuit breaker CBO and timing the limit time *tscs* the automatics is deactivated.

4. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the closing circuit breaker did not close CBC, opening circuit breaker CBO is closed in quick mode:

- After finish of impulse closing the closing circuit breaker CBC and timing the efficiency switch-on time *tscs*, the automatic unit awaits for proper conditions to close opening circuit breaker CBO.

- If there was found that after set own time „close" of opening circuit breaker CBO there will be conditions for quasi-synchronous switch on (differential voltage will be lower than setting value *dV („dU" in polish version)_qs*), than there is generated impulse closing the opening circuit CBO sent in line with break. Time of duration of impulse is *tpft („tis" in polish version)*.
- After closing the opening circuit breaker CBO there is started timing the efficiency switch-on time of closing the opening circuit breaker *tscc („tskz" in polish version)*.
- After finish timing the *tscc („tskz" in polish version)*, if the opening circuit breaker CBO is closed, the automatics is deactivated.

5. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the closing circuit breaker did not close CBC, opening circuit breaker CBO is closed in slow mode:

- After finish of impulse closing the closing circuit breaker CBC and timing the efficiency switch-over time *tscs*, the automatic unit awaits for proper conditions to close opening circuit breaker CBO.
- If the voltage on bus bar decrease below setting value *Vl („Ug" in polish version)t*, than there is started timing of delay of closing the circuit breaker time *tcd („toz" in polish version)*.
- If *„activation of unload automatics"* is set on value *„Y"*, than there is generated impulse shutting down selected drives, which will not take a part in self start up. Duration time of this impulse is *tpls(„tiodc" in polish version)*.
- After finish timing the *tcd („toz" in polish version)*, there is generated impulse closing the opening circuit CBO and sent in line with break. Time of duration of impulse is *tpst („tiw" in polish version)*.
- After closing the opening circuit CBO, there is activated timing of the efficiency switch-on time of circuit breaker *tscc („tskz" in polish version)*.
- After finish timing the *tscc („tskz" in polish version)*, if the opening circuit breaker CBO is closed, the automatics is deactivated.

3.6.2.4 PSS slow change-over (s)

1. Initial conditions:

- The opening circuit breaker (CBO) is closed.
- The closing circuit breaker (CBC) is opened.
- The voltage on changed bus Vbus is higher than setting value *Vl („Ug" in polish version).*
- Stand by voltage UR is higher than setting value *Vr („Ur" in polish version).*

2. The automatic unit operation at efficient devices of supply change-over system in switchgear:

- Appearance of initiating signal for PSS.

- At the moment of PSS initiating signal appearance, there is started timing of limit time *tlAS („tgSZR" in polish version)* and simultaneously there is generated impulse closing the opening circuit breaker CBO. Time of duration of impulse in *tpst („tiw" in polish version)*.
- After opening the opening circuit breaker CBO and timing the efficiency switch-off time *tsco*, the automatic unit awaits for proper conditions to close the closing circuit breaker CBC.
- If the voltage on bus bar decrease below setting value *Vl („Ug" in polish version)t*, than there is started timing of delay of closing the circuit breaker time *tcd („toz" in polish version)*.
- If *„activation of unload automatics"* is set on value *„Y"*, than there is generated impulse shutting down selected drives, which will not take a part in self start up. Duration time of this impulse is *tpls(„tiodc" in polish version)*.
- After finish timing the *tcd („toz" in polish version)*, there is generated impulse closing the closing circuit CBC and sent in line with break. Time of duration of impulse is *tpst („tiw" in polish version)*.
- After closing the closing circuit breaker CBC and finish timing efficiency switch-on time *tscc („tskz" in polish version)*, the automatics is deactivated.

3. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the closing circuit breaker did not close CBO:

- After finish of impulse closing the closing circuit breaker CBC and timing the limit time *tscs* the automatics is deactivated.

4. Operation of automatic unit in case of fault of devices of change-over system in switchgear supply: the closing circuit breaker did not close CBC, opening circuit breaker CBO is closed in slow mode:

- After finish of impulse closing the closing circuit breaker CBC and timing the efficiency switch-over time *tscs*, the automatic unit starts timing return delay time *trd („top" in polish version)*.
- After finish timing the *trd („top" in polish version)*, there is generated impulse closing the opening circuit CBO and sent in line with break. Time of duration of impulse is *tpst („tiw" in polish version)*.
- After closing the opening circuit CBO, there is activated timing of the efficiency switch-on time of circuit breaker *tscc („tskz" in polish version)*.
- After finish timing the *tscc („tskz" in polish version)*, if the opening circuit breaker CBO is closed, the automatics is deactivated.

3.6.3 Automatic return switching (ARS)

After realisation the correct change-over in AS cycle from drop voltage decrease or in AS cycle from voltage decay, if the voltage in supplying line appears, than the automatic unit may independently realise automatic return switch of supply in switchgear into supply before realising the AS. The system of automatic return switch ARS is activated independently from setting *„interlock of*

automatic unit after realising correct AS". The change-over operations may be realised in direction from CBM into CBR, from CBR into CBM. Operation of ARS automatics is possible only once and proceeds in opposite direction than previously realised AS.

Change-over in ARS cycle is realised similarly to change-over in PSS cycle.

The automatic unit realises change-over as follows:

- uninterrupted synchronous change-over (fbl)
- synchronous change-over with short power supply interruption (fwb)
- quasi-synchronous change-over (qs)
- slow change-over (s).

Kind of the switching over depends on conditions for realising particular switching automatic change-over.

By appropriate setting of automatic unit there is possible for every direction to allow for realisation of every kind of change-over or it is possible to bring it out of service. At the moment of finish AS change-over, it means at the moment of activating ARS cycle, the automatic unit checks if in the settings there is permission for change-over in particular direction. After return of voltage in supplying line the automatic unit realises reverse change-over.

To realise change-over in ARS cycle there is necessary to announce the signal into input *„permission for ARS"*. Lack of this signal causes interlocking of ARS change-over.

Change-over operations have to be initiated during time of awaiting for proper conditions to realise ARS cycle, *twARS („twSPP" in polish version)*.

If during this time the change-over operation will not be started, the realisation of ARS cycle will be interrupted and the automatic unit moves into stand by position.

Change-over operations are realised in limit time *tlPSS,ARS*. If during limit time the change-over operation will not be finished, the realisation of ARS cycle will be interrupted.

During awaiting (from the moment of finish AS cycle to moment of finish change-over in ARS cycle) there is activated internal and external signalling *„operation of automatic unit"*. During time of change-over there is activated internal and external signalling *„ operation of automatic unit"* and *„activation of PSS or ARS"*. The contacts, blocking EO signals of circuit breakers taking part in change-over, are opened.

After realising ARS the automatic unit is in stand by position. If the cycle was failure, than the external annunciation is activated *„incorrect PSS or ARS"*.

On LCD there is shown information about realising ARS cycle.

In case after finish ARS cycle the switchgear lasts without voltage (i.e. because of defect of circuit breaker or settings fault) the automatic unit will realise AS cycle (see item 3.6.1).

If during awaiting there appear conditions for realising AS cycle, than the ARS cycle will be stopped and the AS cycle will be realised.

3.6.3.1 Automatic return switching

1. Initial conditions:

- The opening circuit breaker (CBO) is closed.
- The closing circuit breaker (CBC) is opened.
- The voltage on changed bus Vbus is higher than setting value *Vl („Ug" in polish version).*
- Automatic unit has finished correct AS in quasi-synchronous cycle from drop voltage decrease or slow AS cycle from voltage decay.

2. The automatic unit operation at efficient devices of supply change-over system in switchgear:

- Finish of correct change-over in AS cycle.
- At the moment of finish the correct change-over in AS cycle, the counting of awaiting time *twARS („twSPP" in polish version)* starts.
- When voltage in stand by supplying line is recovered above setting value *Vr („Ur" in polish version)*, there is started counting of start up delay time *tsARS („trSPP" in polish version)*.
- At the moment of *tsARS („trSPP" in polish version)* time comes, the change-over in ARS cycle is started. Change-over is realised similarly to PSS change-over cycles and described in item 3.6.2.

4 Technical data

supplying masuring voltage	rated measured voltage Vn („Un" in polish version)	100 V AC
	long term thermal resistance	1,5 Vn („Un" in polish version)
	10-second thermal resistance	2,5 Vn („Un" in polish version)
	rated power consumption	<0,3 VA
frequency	rated frequency	50 Hz
	permitted range of frequency fluctuation	45...55 Hz
Auxiliary supplying voltage	rated auxiliary voltage Vpn	24...220 V DC or 24...230 V AC (option)
	operating range of auxiliary supply voltage	0,8...1,1 Vpn
	permissible maximum level of the auxiliary voltage range	1,3Vpn (permanently)
	power consumption of supply unit	<8 W
	total power consumption from the auxiliary voltage circuit	<15 W
voltage units	Vn („Un" in polish version) – rated voltage of grid (1)	100 V...99 kV
	Vr („Ur" in polish version) – over-voltage control units of permissible stand by voltage (2)	50...120 V

	Vl („Ug” in polish version) – under-voltage units of start up voltage of unit tIAS („tgSZR” in polish version) (3)	30...100 V
	Vlt („Uw” in polish version)– under-voltage units of voltages of start up units tsAS_lt („trSZR_w” in polish version) and tcd („toz” in polish version) (4)	20...60 V
	Vs („Us” in polish version)– over-voltage units of voltages of start up units tsAS_qs („trSZR_sz” in polish version) (5)	5...50 V
	Vv1 („Uu1” in polish version) – under-voltage units of voltages of start up units V< 1 st. (6)	20...120 V
	Vv2 („Uu2” in polish version) – under-voltage units of voltages of start up units V< 2 st. (7)	20...120 V
	dV („dU” in polish version) – control units of differential voltage for synchronous change-over (22)	10...150 V
	dV („dU” in polish version)_qs – control units of differential voltage for quasi-synchronous change-over (23)	50...200 V
	Upon special request setting scopes of dV („dU” in polish version) and dV („dU” in polish version)_qs units may be reduced in range 5...200 V, and for other units in range 5...120 V.	
	Warranty error of the setting scale of voltage units:	
	for settings higher than 40 V	±2,5%
	for the remaining settings	±1V
	Drop-off factor of over-voltage units	>0,97
	Drop-off factor of under-voltage units	<1,03
	Error of voltage units for the frequency range 30...45 Hz	±5%
time units	tIAS („tgSZR” in polish version) – limit time units for AS (8)	0,5...10,0 s
	tIPSS,ARS („tgPPZ,SPP” in polish version)– limit time units for PSS and ARS (9)	0,5...10,0 s
	twARS („twSPP” in polish version) – awaiting time units for ARS (10)	0,1...500,0 h
	tsAS_lt („trSZR_w” in polish version) – start up delay	

	units of AS slow from voltage decay (11)	0,1...5,0 s
	tsAS_qs („trSZR_sz" in polish version) – start up delay units of AS quasi-synchronous from drop voltage decrease (12)	0,02...0,20 s
	tsARS („trSPP" in polish version) – start up delay units of ARS (13)	10...500 s
	tcd („toz" in polish version) – switch on delay units of circuit breaker (14)	0,02...5,00 s
	trd („top" in polish version) – return delay units at PSS slow (15)	0,1...5,0 s
	tscc („tskz" in polish version) – efficiency control units of closing circuit breaker (16)	0,02 0,20 s
	tct („twz" in polish version) – self timing units of circuit breaker „close" (17)	0,02...0,50 s
	tpst („tiw" in polish version) – creating units of control impulses for slow change-over (18)	0,1...5,0 s
	tpft („tis" in polish version) – creating units of control impulses for quick change-over (19)	0,02...0,50 s
	tpls(„tiodc" in polish version) – creating units of unload impulses (20)	0,1...5,0 s
	tad („tos" in polish version) – delay units of annunciation not ready (26)	0,0...10,0 s
	tap („tip" in polish version) – units of minimal duration of impulses in fading annunciation (27)	0,0...10,0 s –0,01 – permanent impulse
	tv1 („tu1" in polish version) – delay units of unit operation V< 1 st. (28)	0,0...5,0 s
	tv2 – delay units of unit operation V< 2 st. (29)	0,0...20,0 s
	Upon special request setting scopes of time units may be reduced in range 0,02 s...60 s	
	Warranty error of setting scale of time units:	
	for the setting lower than 1 s	±25 ms
	for the remaining settings	±2,5%
angle control	dphi („dfi" in polish version) – angle control unit of volt-	

units	age part for synchronous change over (21)	1...90^{o}
	Warranty error of scale of angle control unit	2,5^{o}
	Return factor of angle control units	1,5^{o}
Control units of frequency difference	df – frequency difference control unit for change-over synchronous (23)	0,1...10,0 Hz
	df_qs („df_sz" in polish version) – frequency difference control unit for change-over quasi-synchronous (25)	1,0...10,0 Hz
	Warranty error of scale of frequency difference control	10%
	Return factor of control units of frequency difference	>0,97
Contact load	Carry continuous current	5 A
	Make and break for DC current at T=40 ms	30 W
Electric insulation	Insulation resistance	2 kV, 50 Hz, 1min
Environmental conditions	Ambient temperature	-10...+55^{o}C
	Maximum range of ambient temperature	-25 i +70^{o}C
	Relative humidity	45...75%
	Atmospheric pressure	86...106kPa
Casing	Dimensions	According to item 3.2
	Assembly	on-the-panel or behind-the-panel
	Weight	5kg
	Protection degree	IP40
	Terminals	WAGO screwless

Explanations:

- numbers given in brackets mean following numbers of particular units in setting mode of automatic unit.
- In automatic unit it is possible to introduce two sets of settings switched over with external signal „*change of settings set*". Technical data of particular units are identical for both sets of settings.

Notes:

- For special request the Producer adapts the automatic units for auxiliary AC voltage guaranteed.
- The Producer reserves the right for making modifications in products as result of scientific and technological progress.

5 Schedule of applied standards

During constructing and production of the automatic unit AZRS there were applied standards, which fulfilling provides realisation of assumed rules and safety means, under condition that the user will follow the instruction and guidelines of installing and setting in motion and maintenance.
Automatic unit fulfils all standards specified in directives: low-voltage and electromagnetic compatibility, by accordance to harmonised standards mentioned below:
Standard harmonised with low-voltage directive 73/23/EWG:

- PN-EN 60255-5(U):2002
  Energoelectrical relays. Part 5: Coordination of insulation of measurement relays and protection devices. Requirements and research.

Standards harmonised with electromagnetic compatibility directive 89/336/EWG:

- PN-EN 50082-2:1997
  Electromagnetic compatibility (EMC). Requirements concerning resistance from disturbances. Industrial environment.
- PN-EN 50263:2002(U)
  Electromagnetic compatibility (EMC). Standard of product concerning measurement relays and protection devices
  - in scope of standards mentioned above and referring to this standard:
- PN-EN 60255-22-2:1999
  Energoelectrical relays. Research of resistance of measurement relays and protection devices from electrical disturbances. Research of resistance from disturbances caused by electrostatic discharge.
- PN-EN 61000-4-2:1999
  Electromagnetic compatibility (EMC). Methods of research and measurement. Research of resistance from electrostatic discharge. Primary publication EMC.
- PN-EN 60255-22-4:2003(U)
  Energoelectrical relays. Part 22-4: Research of resistance from electrical disturbances of measurement relays and protection devices. Research of resistance from quick-change transient disturbances.
- PN-EN 61000-4-4:1999

Electromagnetic compatibility (EMC). Methods of research and measurement. Research of resistance from series of quick-change electrical transient disturbances. Primary publication EMC.

- PN-EN 61000-4-5:1998
  Electromagnetic compatibility (EMC). Methods of research and measurement. Research of resistance from surge.
- PN-IEC 255-11:1994
  Energoelectrical relays. Decay and variable components of supplying auxiliary quantities of direct current measurement relays.

Moreover AZR automatic units fulfil requirements mentioned above:

- PN-EN 60255-6:2000
  Energoelectrical relays. The measurement relays and protection devices (in scope of operating correctness in nominal range of ambient temperature and resistance from limit temperatures).
- PN-EN 60255-21-1:1999
  Energoelectrical relays. Research of resistance of measurement relays and protection devices from vibrations, single and multiplying strokes and seismic shocks. Research of resistance from vibrations (sinusoidal).
- PN-EN 60255-21-2:2000
  Energoelectrical relays. Research of resistance of measurement relays and protection devices from vibrations, single and multiplying strokes and seismic shocks. Research of resistance from single and multiplying strokes.
- PN-EN 60255-21-3:1999
  Energoelectrical relays. Research of resistance of measurement relays and protection devices from vibrations, single and multiplying strokes and seismic shocks. Seismic research.

6 Data of completeness

The complete delivery for recipient includes:

- Automatic unit AZRS-2
- Set of plug terminals
- Cable RS232 for communication with PC
- Disc with installation software
- Operating manuals of AZRS-2
- Routine test report
- Guarantee certificate

7 Installing

7.1 General information

Before first plug in under voltage, the device should spend at least two hours in room, it is going to be installed, in order to compensate the level of temperature ant to avoid moisturising.
The AZRS-2 automatic unit should operate in conditions described in technical data.

7.2 External connection

There will be described in details the standard version of automatic unit supplied with auxiliary direct voltage without additional pulpit with switches and pushbuttons.
In item 7.2.3 there is described possibility of supplying the automatic unit with auxiliary alternating voltage.
In item 7.2.18 there is described version of automatic unit quipped in additional pulpit with switches to control circuit breakers and controlling the automatic unit.

Way of connection the automatic unit in standard version is shown on Fig. 7.2.

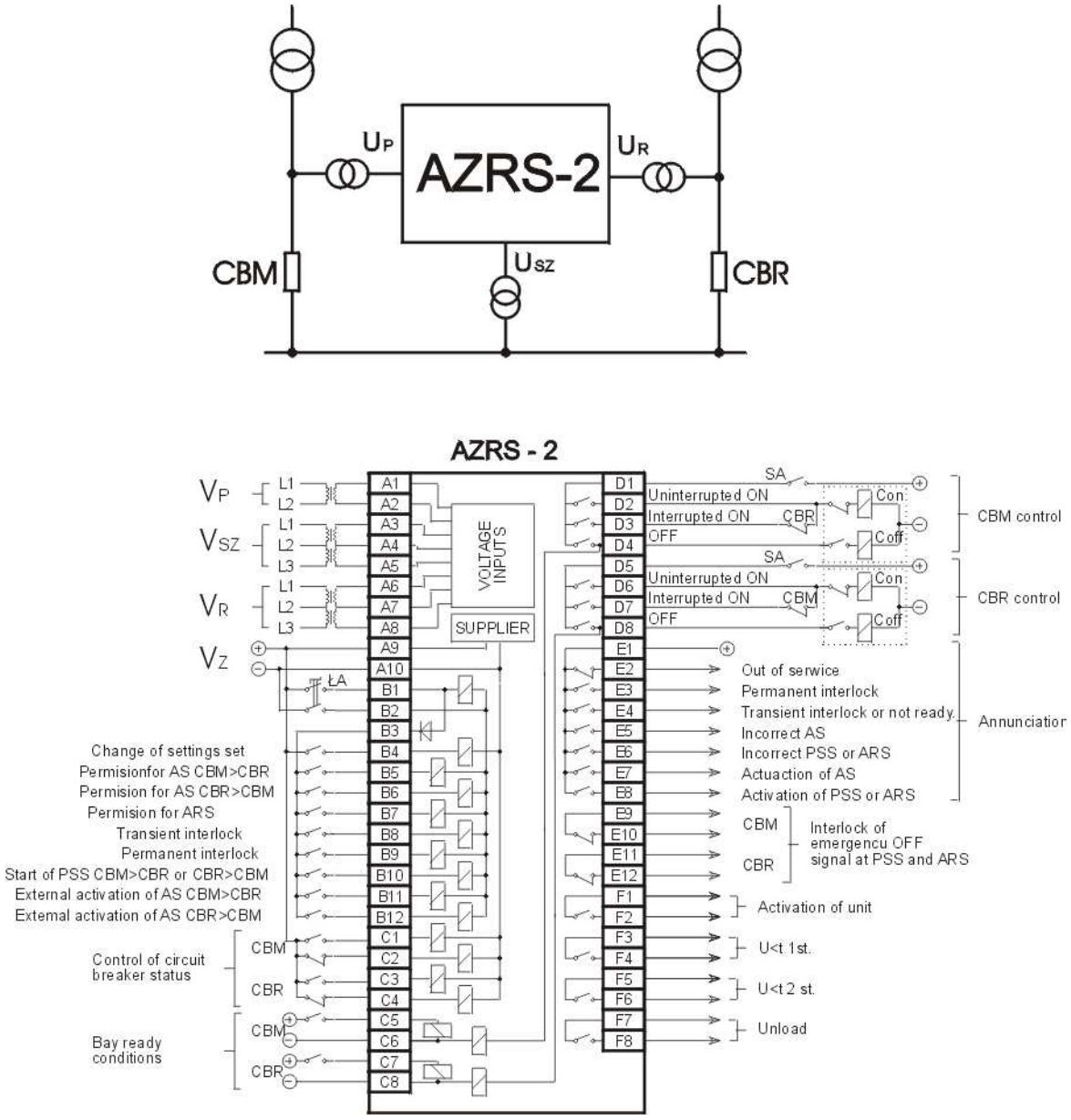


Fig. 7.2. Diagram of connection the automatic unit AZRS-2 in standard version.

7.2.1 Measured voltage supply

The automatic unit is supplied with following measured alternating voltage 100 V:

- VM – phase-to-phase voltage L1-L2 in supplying line M (main)
- VR („UR" IN POLISH VERSION) – phase-to-phase voltage L1-L2 in supplying line R (stand by)
- Vbus – phase-to-phase voltage L1-L2 and L3-L2 on bus bars

To the automatic unit should be introduced phase-to-phase voltage with use of voltage transformers in star (Y or V) or delta system.

For voltage circuits from voltage measurement bay in section there is required the instantaneous protection with automatic circuit breaker, which NC contact should be introduced into output transiently interlocking operation of automatic unit (B8).

7.2.2 Supply with direct auxiliary voltage

The automatic unit in standard option is supplied with auxiliary voltage 220 V DC (or 110 V DC). In case of auxiliary voltage decay, on the device there is activated external annunciation *„out of service"*.

The auxiliary voltage feeds bistable inputs which operate such signals as circuit breakers positions, bay ready for operation and many other. Decay of auxiliary voltage or decrease of voltage is interpreted as lack of input signal. In order to eliminate failure operations caused by decrease of auxiliary voltage in automatic unit there was built in additional measuring unit controlling instantaneous value of feeding auxiliary voltage. If the voltage has to low value, than the automatic unit becomes interlocked.

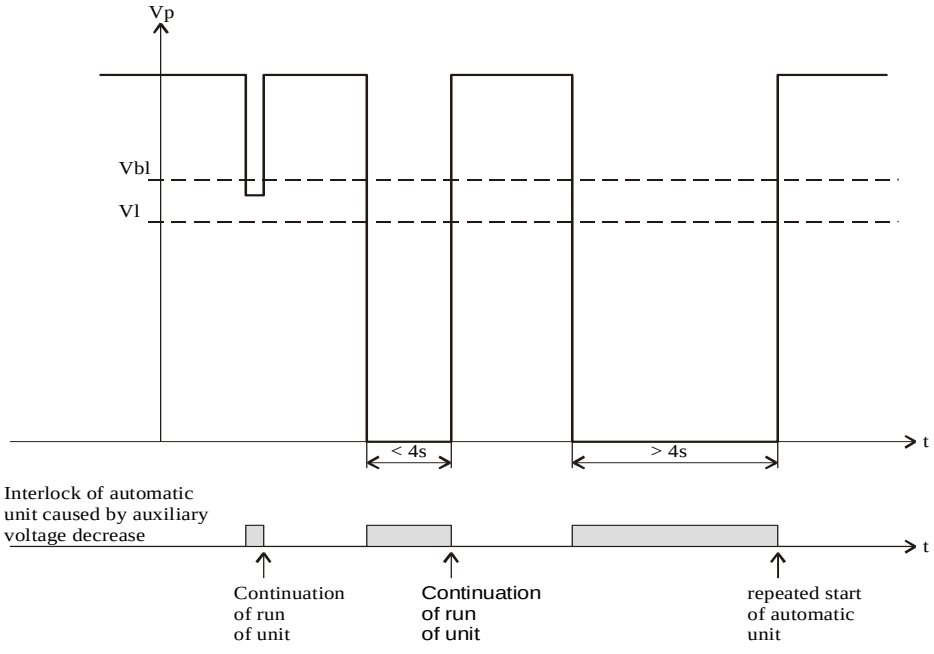


Fig.7.2.2. Operation of automatic unit at decrease of auxiliary voltage.

On the fig. 7.2.2 there was described operation of automatic unit during interruption time in supply voltage. Vt is a limit voltage value at which there follows the change of status of bistable input. If the introduced voltage to the input is lower from value of Vt, than it will be interpreted as lack of signal; if the voltage value is higher, that means, that this particular signal exists. Vbl is limit voltage of interlocking the automatic unit. If the voltage decrease until value of Vbl, than the automatic unit becomes interlocked. The voltage Vbl is higher than Vt, because at decrease of auxiliary voltage interlocking of the automatic unit should come out previously than incorrect readout of status of inputs.

The microprocessing systems are equipped in units sustaining supply with auxiliary voltage through particular period of time after shutting down the supply voltage of automatic unit. That is why short time disturbances do not cause interruptions in their operation. Thanks this there is no need for permanent interlock or putting the unit out of service every time after voltage decrease. In case of voltage decrease lasting for less than 4 second time, the automatic unit is transiently interlocked and after recovering the voltage it continues duty. For instance if the automatic unit was in stand by status, than after short break in supply it will be still at stand by status. It is very important that if automatic unit realises change-over and there appears short time (less than 4 second) interruption in supplying voltage, than after recovering the voltage it continues change-over.
If the break lasts for more than 4 second, than it is considered as permanent voltage decay and after recovering the voltage the automatic unit realises restart and other procedures connected with switching on the auxiliary voltage.

7.2.3 Supply with guaranteed auxiliary alternating voltage

The automatic unit in standard version may be supplied only with direct voltage. It applies supplying of automatic unit (terminals A9-A10) and most of input circuits (terminals B1...B12, C1...C4). To use existing in switchgear auxiliary alternating voltage there should be applied external feeding unit of power at least 30W and input alternating voltage appropriate for particular object and output direct voltage 220V (or 110V). This may be feed mechanism produced by Energotest, or any other fulfilling conditions described above.
Remaining input circuits (terminals C5...C8, D4-C6, D8-C8) may be supplied with alternating voltage; this operation requires modifications inside of automatic unit. Nominal value of auxiliary alternating voltage may be optional, chosen from the range from 24 V to 230 V. the automatic unit has to be prepared individually for selected voltage.

On fig. 7.2.3 there is shown method of connecting the automatic unit to additional feed mechanism making possible using the automatic unit in switchgear with auxiliary alternating voltage.

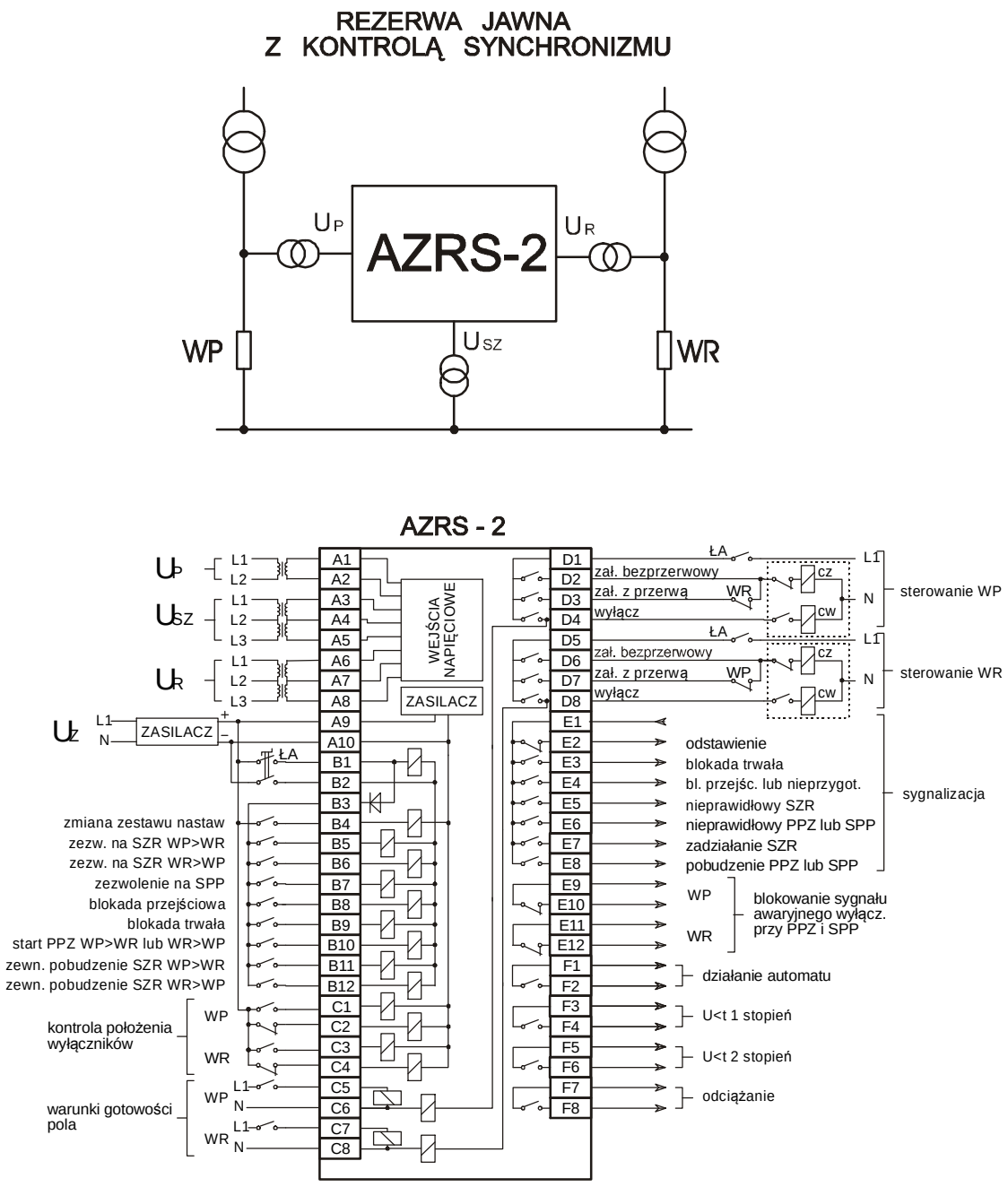


Fig. 7.2.3. Diagram of connections of automatic unit AZRS-2 supplied with auxiliary alternating voltage.

7.2.4 Switch on (unlocking) and switch off (out of service) of automatic unit

For switch on (unlocking) and switch off (out of service) of automatic unit there is used a switch of automatics, also called SA key. Through the SA switch there is given auxiliary voltage into terminals B1-B2. Closing of switch, it means existence of voltage on these terminals, causes the stand by state for duty of automatic unit. Shut down the voltage by opening the switch causes putting the automatic unit out of operation. Through the SA switch there is given auxiliary voltage into terminals B3.

If the automatic unit is out of operation, than there is activated internal and external annunciation *„out of operation"*.

7.2.5 Change of setting sets

In the automatic unit it is possible to introduce two independent sets of settings. For their change-over there is used external signal *„change of settings set"* introduced into terminal B4. Lack of external signal activates the first set of settings and appearance of signal activates the second set of settings.

If during realisation of change-over, it means when the automatic unit is activated, the change of set will take a place (appearance or decay of signal *„change of settings set"*), than from the moment of finish change-over the active set will be that one, which was active during start of change-over. This is was shown on fig. 7.2.5.

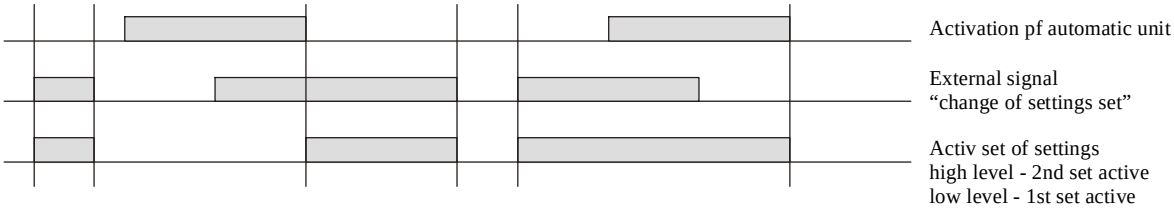


Fig. 7.2.5. Activating of setting set.

Low status of signal „active set of settings" means, that in that particular moment there is activated the first set and high status of signal means, that in particular moment there is activated the second set.

After the change of settings set the automatic unit checks if voltage on bus bars is higher than present value of setting *Vl („Ug" in polish version)* (value causing start up of AS automatics from voltage decrease) and if the condition is not fulfilled, than the automatic unit is permanently interlocked.

7.2.6 Permission for realising the change-over in AS cycle

The automatic unit makes possible realising change-over in AS cycle in two directions. There may be realised change-over in direction from CBM into CBR and also change-over in direction from CBR into CBM. External signals „*perm. for AS CBM>CBR*" and „*perm. for AS CBR>CBM*" introduced into terminals B5 and B6 provide programming types of realised change-over. In order to make possible to realise change-over in appropriate direction, the supplying voltage +220 V (or +110 V) should be introduced into particular terminal.

Approving signal should be introduced in continuous method. Lack of this signal, at the moment of appearance of conditions adequate initiating the change-over, effects not realising the change-over in AS cycle.

After sending the signal of permission for realising the change-over in AS cycle, the automatic unit checks operating conditions of switchgear and, in case there are two circuit breakers closed, the voltage on bus bars is higher than setting value *Vl („Ug" in polish version)* and there is lack of impulse opening the primary supply circuit breaker, the device comes up to stand by status. If these conditions are nor fulfilled (that means, if at the moment of initiating permission the conditions for initiating change-over in AS cycle already exist), than the automatic unit is permanently interlocked.

7.2.7 Permission for realising the change-over in ARS cycle

After realising successful change-over in AS cycle from voltage decay or from drop voltage decrease and after recovering the voltage in supplying line, there is possibility of automatic return switching in the direction opposite to previous direction of AS cycle. In order to make possible realising the change-over, to the terminal B7 *„permission for ARS"* there should be introduced voltage +220 V (+110 V).

Initiating signal should be introduced as continuous. Lack of this signal at the moment of finish the change-over in AS cycle or interruption of this signal during awaiting for realisation of ARS cycle cause no realisation of change-over in ARS cycle.

7.2.8 External interlock signals

To the terminals B8 and B9 there may be introduced external signals interlocking operation of the automatic unit. The unit posses two inputs: transient interlock and permanent interlock. All circuits of interlocking signals are supplied from B3 terminal of automatic unit.

Primary task of external signals of interlock is to make possible to interlock the automatics during short circuit. If the short circuit appears, then the voltage on bus bars fade and automatic unit is activated for operating. Realisation of change-over would cause switching on the stand by line straight into short circuit and that is why the automatic unit should be interlocked in transient or permanent way.

To the input there should be introduced signals from overcurrent protection located in supplying bay of switchgear. To the input of transient interlocked there should be introduced the signal acti-

vating immediate measuring unit (I> or I>>) and the signal of shut down measurement circuits from voltage measurement bay. To the input of permanent interlock should be introduced the signal of operating the delay unit of overcurrent protection (I>>t).

Accept the signals from protections at input of permanent interlock there should be also introduced information from emergency shut down pushbutton of circuit breakers in supplying lines. If the operator will open the circuit breaker in emergency mode, then the automatics should become permanently interlocked.

7.2.9 Activation of PSS automatics

Voltage on terminal B3 of automatic unit should be introduced into control pushbuttons of PSS, where the signals are sent into terminal B10 of automatic unit.

Controlling signal should be sent in impulse method. Duration time of signal should be at least 0,2s. Automatics is activated at the moment of appearance of activation signal.

7.2.10 Control of circuit breaker position

To the automatic unit there are introduced information about circuit breaker position. They are delivered in two lines from NO and NC contacts of circuit breakers.

Ambiguous responses of particular circuit breaker (simultaneous lack of voltage or simultaneous existence of voltage at both inputs) is received as information about fault in jest system, which causes transient interlock of automatic unit (item .3.4).

The voltage supplying the automatic unit is the voltage supplying control circuits of circuit breaker position.

7.2.11 Conditions of bays readiness

To the automatic unit there are delivered information about readiness of bay (of circuit breaker) in the system described below on fig. 7.2.11.

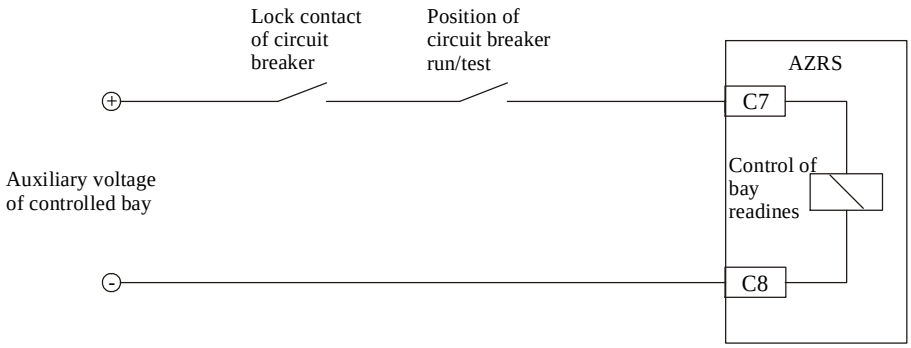


Fig. 7.2.11. Control of bay readiness.

The existence of voltage on terminals of automatic unit means bay readiness and lack of voltage means lack of readiness, which causes transient interlock of automatic unit (see item .3.4).

Circuits of readiness control are fed with auxiliary voltage from particular bay. The contacts informing about circuit breaker status are delivered into the circuit. These may be contacts of preparing to operation of circuit breaker, contacts of circuit breaker position or other. Signal of bay readiness comes to the automatic unit only in case, when in the bay there exists controlling voltage and when there are closed all contacts in this circuit.

7.2.12 Interlock of emergency shut down signals (EO) during PSS and ARS

In many switchgears there is applied systems of central signalling. To them there are delivered among other things the signals EO of emergency open of circuit breaker. If there appears the shut down impulse, than the central signalling is activated. The automatic units also generate impulses opening particular circuit breakers. If the automatic unit generates these impulses during time of change-over realisation in PSS or ARS cycle, than there should not be activated the central annunciation. In connection with this statement the signals EO of circuit breakers taking part in change-over should be blocked.

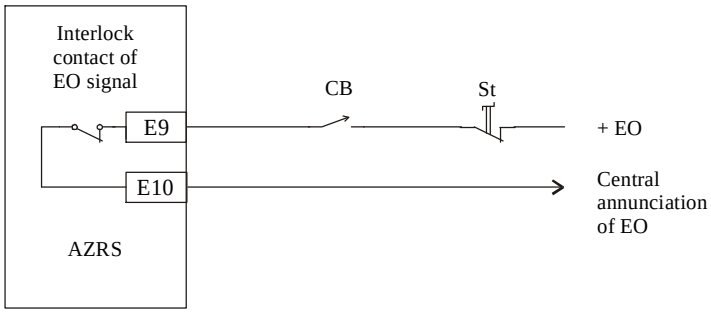


Fig. 7.2.12. Blocking the signals EO during PSS and ARS.

For that purpose the contacts E9-E10 and E11-E12 should be switched into signalling circuits of emergency open of particular circuit breakers, as it is shown on fig. 7.2.12. During normal operation the contacts are closed and so the annunciation is not blocked. At the moment of realisation the change-over in PSS and ARS cycle (when occurs planned opening and closing the circuit breakers) the contacts of interlock EO are opened and they block central signalling of emergency shut down.

7.2.13 Control of circuit breakers

The way of controlling circuit breaker is shown on fig. 7.2.13.

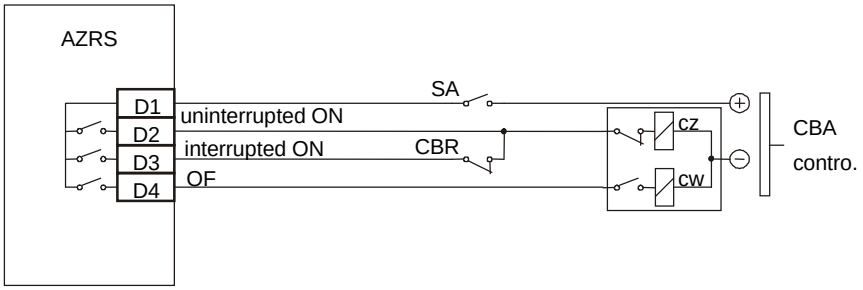


Fig. 7.2.13. Control of circuit breaker.

The automatic unit generates impulses controlling three paths:

- „Non-interruption close" (also called „synchronous close") – delivers closing impulses at non-interruption synchronous change-over (impulses are delivered directly into switching coil of particular circuit breaker). Delivering the closing impulses with this path there is achieved parallel running of both supply sources. The path is used at change-over in PSS and ARS cycles, uninterrupted synchronous and during AS uninterrupted synchronous from external activating signal.
- "Close with interruption" (also called „slow close") – delivers closing impulses at other change-over (impulses are delivered through auxiliary contacts of another circuit breakers in order to realisation of interlock between circuit breakers). Delivering the closing impulses with this path there is not possible to achieve parallel running of supply sources. The path is used at all change-over operations during which the parallel running does not exist.
- „Open" – delivers closing impulses at both non-interruption synchronous change-over and change-over with interruption (impulses are delivered directly into switching coil of particular circuit breaker). The path is used at all change-over operations.

Control voltage of particular circuit breakers should be delivered from the bay of particular circuit breaker. It is advantageous if the voltages on terminals D1 and D5 were delivered through additional contacts of SA switch.

7.2.14 External signalling and recording

For excitation of external signalling there was dedicated non-potential contact inputs, and thanks this it is possible to activate them with optional signalling voltage used in particular switchgear.

7.2.15 Units V<t

To the contacts F3...F8 there were delivered from undervoltage units *V<t* controlling the voltage level on bus bars of both sections. The signals are used to activate another systems of automatics (i.e. shutting down receivers at long term decay of voltage). Each of units has settings independent from other units, the start up value and operating time. Measuring units *V<t* are separate units and their operation does not depend on automatics AS, PSS, ARS. Putting the automatic unit out of service, permanent or transient interlock of automatic unit does not cause interlock of units *V<t*.

7.2.16 Activation of unload automatics

The automatic unit was equipped in two contact outputs (separately for each section) activating the unload automatics, which shuts down selected drives not taking part in self start-up. The impulses of unload are generated during realisation of slow change-over (see item 3.6). Unload operation is contingent upon setting *„activation of unload automatics”* (see item 8.2).

7.2.17 Activation of AS automatics from shut down impulse

The automatic unit is controlling the circuits opening the circuit breakers in supplying lines in purpose to find that the external shutting down impulse of particular circuit breaker appeared. The controlling units are connected between terminals D4, D8 and correspondently C6, C8.

Appearance of opening impulse for primary supply circuit breaker causes activation of AS automatics and operation in accordance to assumed schedule.

7.2.18 Control desk with additional switches and pushbuttons

The automatic unit may be developed on additional control desk with additional switches and pushbuttons destined to control the circuit breakers and generally to control the automatic unit. Control desk is situated in the front wall of automatic unit, next to standard front board.

An additional panel can be installed in the automatic units in a panel casing, 84T wide (19” casing).

Front view of panel with additional switches and pushbuttons is shown on fig. 7.2.18a.

The connection diagram of additional switches and pushbuttons inside the automatic units is described on fig. 7.2.18b.

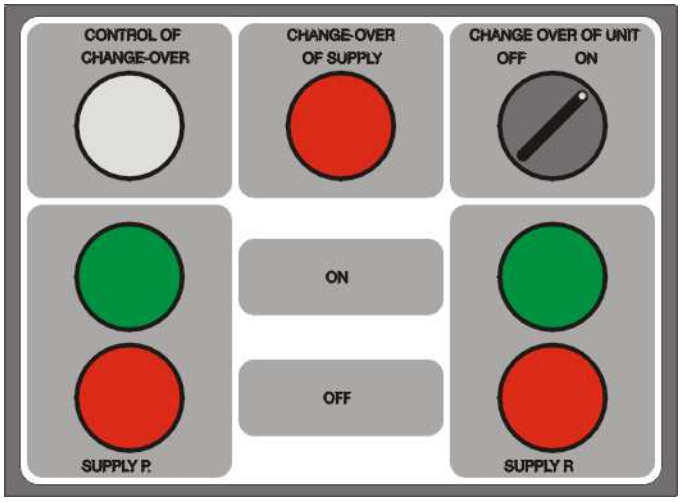


Fig. 7.2.18a. Additional keypad.

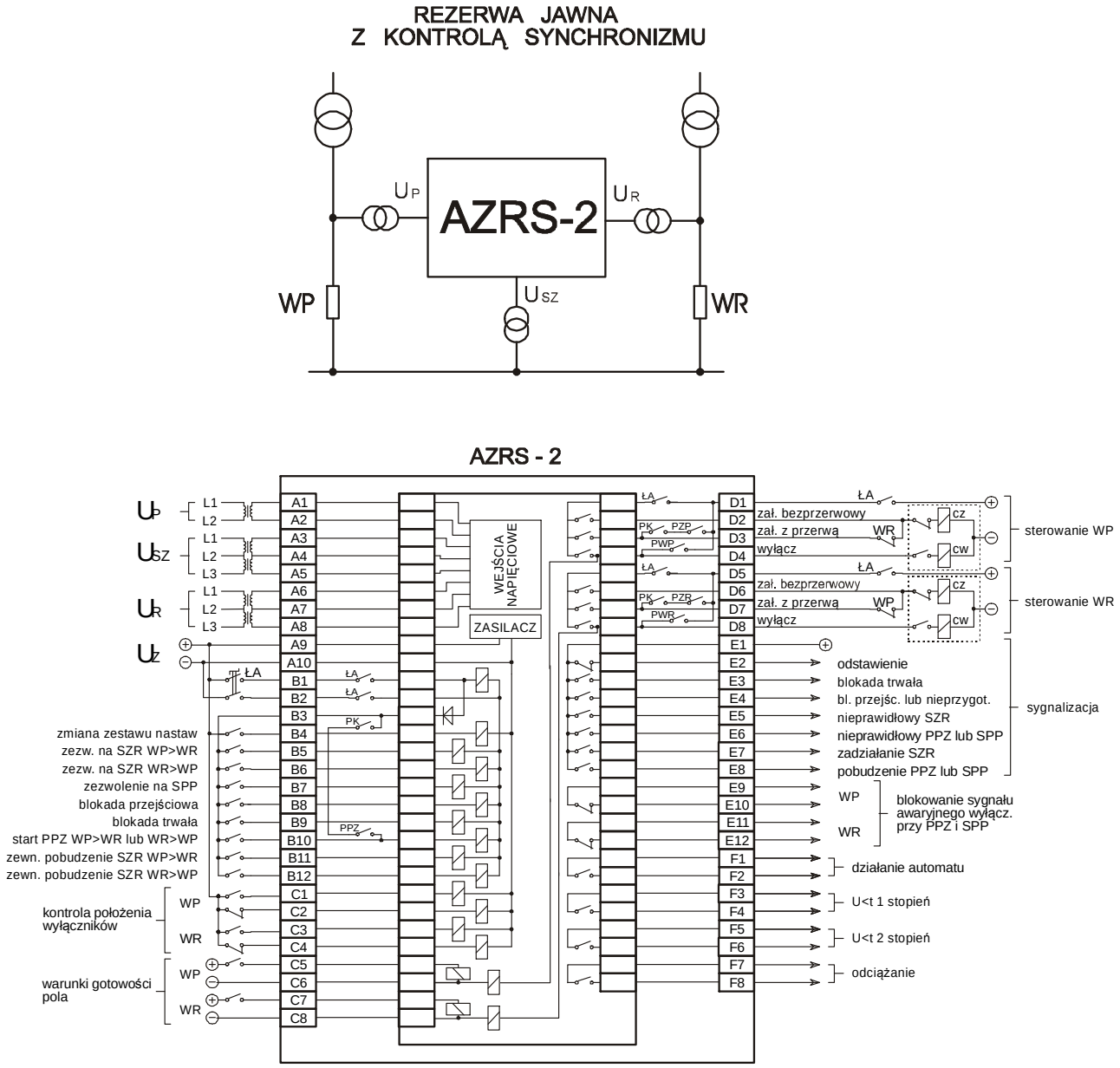


Fig. 7.2.18b. Connection diagram of automatic unit AZRS-2 equipped in additional panel.

Particular switches and pushbuttons have following functions (symbols given in brackets correspond to the designations on schemes):

Change-over check (CC).

Causes interlock of following change-over:

- planned supply change-over
- switching on the circuit breaker.

To perform change-over operations it is necessary to simultaneously push the pushbutton of change-over control CC and pushbutton PSS or CC and pushbutton of switching on the circuit breaker.

Switch-over of the automatic unit (SA).

This is binary switch used for switching on (un-interlock) and switching off (out of service) the automatic unit.

Supply change-over – change-over initiation (PSS).

Pressing the pushbutton causes the planned change-over supply operation in the selected direction.

To perform this operation it is necessary to press simultaneously the pushbutton of change-over check.

Circuit breaker closing in supply A (CPM).

Causes generating of an impulse closing the circuit breaker CBM.

It is necessary to press simultaneously the pushbutton of change-over check.

Circuit breaker closing in supply B (CPR).

Causes generating of an impulse closing the circuit breaker CBR.

It is necessary to press simultaneously the pushbutton of change-over check.

Opening the supplying circuit breaker in supply A (OPM).

Pressing he pushbutton causes generating of an impulse opening the circuit breaker CBM.

It is not necessary to press simultaneously the pushbutton of change-over check.

Circuit breaker opening in supply B (OPR).

Causes generating of an impulse opening the circuit breaker CBR.

It is not necessary to press simultaneously the pushbutton of change-over check.

Putting the control desk inside of automatic unit enables to eliminate some switches outside the deice. In this purpose it is possible to make some simplifications of internal connections diagram.

If there is no need to use external switch SA for switching on (un-interlocking) and switching on (putting out of service) of automatic unit, than into terminals B1 and B2 there should be delivered 220 V DC (or 110 V DC) connecting terminal B1 with A9 and B2 with A10.

If there is no need to use external pushbuttons for activating of planned power supply switching PSS cycle, than terminal B10 should stay free.

8 Activation

8.1 General information

After installing the AZRS-2 automatic unit there should be performed starting up in accordance to general rules concerning to devices of protection, automatics, control and implementation. This includes following operations:

- checking of design accordance to automatic system together with documentation of automatic unit and its nominal data plate, particularly giving attention on:
  - nominal values of supplying auxiliary voltages and their polarity
  - nominal value of measurement voltage
  - correctness of applied protecting devices in voltage circuits (nominal values of fuse links or nominal currents and characteristics of automatic circuit breakers)
  - if there is not exceeded limit value of load of relay outputs
- checking of correct assemble
- settings of time unit delays
- setting of operation program of automatic unit
- continuity of earthing circuits
- start up should be finished with performing of performance tests of automatic unit operation together with possible corrections in scope of operation setting parameters.

8.2 Parameters rated in automatic unit

1. ***Vn („Un" in polish version)*** – nominal voltage of network

Nominal voltage of network determines voltage values on LCD display. To the automatic unit with use of voltage transformers there is delivered voltage of nominal value 100 V. It corresponds to nominal voltage of network. During setting the nominal value of network on the LCD will be displayed voltages of primary values.

2. ***Vr („Ur" in polish version)*** – permissible stand by voltage

Minimal permissible stand by voltage, to make possible realisation of change-over in direction of selected measurement point.

There is controlled highest value from both phase-to-phase voltages L1-L2 and L3-L2.

The parameter is set individually for each point of voltage measurement.

3. ***Vg*** – start up voltage of unit tIAS („tgSZR" in polish version)

The voltage value on bus bars, below which there is activated counting of limit time tIAS („tgSZR" in polish version) and started operation of AS automatics from voltage decrease.

The highest value from both phase-to-phase voltages L1-L2 and L3-L2 is controlled.

4. ***Vlt („Uw" in polish version)***– start up voltage of units *tsAS_lt („trSZR_w" in polish version)* and *tcd („toz" in polish version)*
The voltage value on bus bars, below which there is activated counting of limit time *tsAS_lt („trSZR_w" in polish version)*, and the voltage value on bus bars, below which there is activated counting of delay time of closing circuit breaker *tcd („toz" in polish version)* in cycles AS and PSS.
The highest value from both phase-to-phase voltages L1-L2 and L3-L2 is controlled.

5. ***Vs („Us" in polish version)***– start up voltage of unit *tsAS_qs („trSZR_sz" in polish version)*
The value of drop voltage decrease on bus bars, below which there is activated counting of start up time *tsAS_qs („trSZR_sz" in polish version)*.
The drop change value from three phase-to-phase voltages L1-L2, L2-L3 and L3-L1 is controlled. To the activation of automatic unit there is only needed drop change value of one of voltages.

6. ***Vv1 („Uu1" in polish version)*** – start up voltage of unit V< 1 st.
Start up voltage value of undervoltage unit V< 1 degree controlling voltage on bus bars.
The highest value from both phase-to-phase voltages L1-L2 and L3-L2 is controlled.

7. ***Vv2 („Uu2" in polish version)*** – voltage of start up unit V< 2 st.
Start up voltage value of undervoltage unit V< 2 degree controlling voltage on bus bars.
The highest value from both phase-to-phase voltages L1-L2 and L3-L2 is controlled.

8. ***tIAS („tgSZR" in polish version)*** – limit time for AS
The time predicted for realisation of change-over in AS cycle. In case, when during time *tIAS („tgSZR" in polish version)* the change-over will not be finished, there appear break in realisation of AS cycle. The countdown is started at the moment of opening the circuit breaker of primary supply (AS from opening the circuit breaker), decrease of voltage value on bus bars below setting value *Vl („Ug" in polish version)* (AS from voltage decay), drop voltage change (AS from drop voltage decrease), appearance of external impulse opening the circuit breaker of primary supply (AS from shutting down impulse) or appearance of external activating impulse the AS automatics (AS from external activating impulse).
The parameter is set individually for each change-over direction.

9. ***tIPSS,ARS („tgPPZ,SPP" in polish version)***– limit time for PSS and ARS
The time predicted for realisation of change-over in PSS and ARS cycle. In case, when during limit time *twPSS,ARS* the change-over will not be finished, there appear break in realisation of PSS or

ARS cycle and unit will move into stand by position. The countdown is started at the moment of activation of PSS automatics or starting the change-over in ARS cycle.

10. ***twARS („twSPP" in polish version)*** – awaiting time for ARS
Time dedicated for initiation of change-over in ARS cycle. In case, when during awaiting time *twPSS* the change-over will not be finished, there appear break in realisation of ARS and unit will move into stand by position. The countdown is started at the moment of finish successful AS cycle from voltage decay or from drop voltage decrease.

11. ***tsAS_lt („trSZR_w" in polish version)*** – delay of AS from voltage decay
Time dedicated for slow change-over in AS cycle from voltage decay. This is the time of opening delay of circuit breaker of primary supply delivered in purpose to secure from AS operation in case of momentary voltage decay and voltage decrease on bys bars of switchgear. The countdown is started at the moment of decrease of voltage on bus bars below the setting value *Vl („Ug" in polish version)t*.
The parameter is set individually for each change-over direction.

12. ***tsAS_qs („trSZR_sz" in polish version)*** – delay of AS qs from drop voltage decrease
Time dedicated for quick change-over in AS cycle from drop voltage decrease. This is the time of opening delay of circuit breaker of primary supply delivered in purpose to make possible activation of protecting devices and secure from AS operation in case of short circuit in switchgear. The countdown is started at the moment of drop decrease of voltage on bus bars below the setting value not more than *Vs*.
The parameter is set individually for each change-over direction.

13. ***tsARS („trSPP" in polish version)*** – start up delay ARS
This is the time of delay of change-over realisation during time of ARS delivered in purpose to protect from momentary voltage appearance in supplying line. The countdown is started at the moment of voltage appearance in supplying line over the setting value more than *Vr („Ur" in polish version)*. After timing *tsARS („trSPP" in polish version)* there is started change-over.
The parameter is set individually for each change-over direction.

14. ***tcd („toz" in polish version)*** – delay in closing the circuit breaker
This is the time of delay of generating the impulse closing the circuit breaker. The countdown is started at the moment of voltage decrease on bus bars below the setting value *Vl („Ug" in polish version)t*.

15. ***trd („top" in polish version)*** – return delay at slow PSS

This is the time used at unsuccessful slow PSS cycle (the circuit breaker did not close). It causes delay in generating the impulse closing the circuit breaker of so far supply source. The countdown is started at the moment of decay of impulse closing the damaged circuit breaker.

16. ***tscc („tskz" in polish version)*** – efficiency control of closing the circuit breaker

Time of testing the efficiency control of closing the circuit breaker of new supply source. Introduced in purpose to elimination the failure operation of automatic unit in case of return of contacts of circuit breaker. The countdown is started at the moment of closing the circuit breaker. If after countdown the time *tscc („tskz" in polish version)* the circuit breaker is still closed, that means that closing was successful. If the circuit breaker close and during time *tscc („tskz" in polish version)* it opens, that means the automatic unit operates the same as in case of not closing the circuit breaker.

17. ***tct („twz" in polish version)*** – self tim of circuit breaker „close"

Time used at quasi-synchronous change-over. This is the time of advance in generating the closing impulse during change-over.

The parameter is set individually for each circuit breaker.

18. ***tpst („tiw" in polish version)*** – slow control impulse

The time of forming slow control impulses and time of forming signalling impulses *„incorrect AS"*, *„ incorrect PSS or ARS"* and *„operation of AS"*. The real time of duration of control impulses for circuit breakers is limited till the moment of circuit breakers status change.

19. ***tpft („tis" in polish version)*** – quick control impulse

The time of forming quick control impulses. The real time of duration of control impulses for circuit breakers is limited till the moment of circuit breakers status change.

The parameter is set individually for each change-over cycle (fbl, fwb, qs).

20. ***tpls(„tiodc" in polish version)*** – unloading impulse

The time used at slow change-over cycle. The time of forming unloading impulse shutting down selected drives, which will not take a part in group self start up. The real time of duration of unloading impulse is limited till the moment of closing circuit breakers status change and recover of voltage on bus bars in switchgear.

21. ***dphi („dfi" in polish version)*** – permissible angle of half-opened supplying voltages

value of angle between particular voltages which can not be more than particular value to realise synchronous change-over. The choice of change-over cycle is made because of angle at the moment of initiating the change-over.
The phase-to-phase change-over operations are controlled L1-L2.

22. ***dV („dU" in polish version)*** – permitted differential voltage
Value of geometric voltage difference between two particular voltages. Above this value there is no permission for realising synchronous change-over. The choice of change-over cycle is made because of differential voltage at the moment of initiating the change-over.
The phase-to-phase voltages are controlled L1-L2.

23. ***df*** - permitted frequency difference
Value of frequency difference between two particular voltages. Above this value there is no permission for realising synchronous change-over. The choice of change-over cycle is made because of frequency difference at the moment of initiating the change-over.
The phase-to-phase voltages are controlled L1-L2.

24. ***dV („dU" in polish version)_qs*** – permitted differential voltage (qs)
Value of geometric voltage difference between two particular voltages. Above this value there is no permission for realising quasi-synchronous change-over.
The phase-to-phase voltages are controlled L1-L2.

25. ***df_qs („df_sz" in polish version)*** - permitted frequency difference (qs)
Value of frequency difference between two particular voltages. Above this value there is no permission for realising quasi-synchronous change-over. The possibility of quasi-synchronous change-over cycle is made because of frequency difference at the moment of initiating the change-over.
The phase-to-phase voltages are controlled L1-L2.

26. ***tad („tos" in polish version)*** – delay in not ready annunciation
the time of external annunciation in not ready message caused by voltage decrease or not synonymous responses of circuit breakers status. In case the reason lasts longer than *tad („tos" in polish version)*, the annunciation is not activated.

27. ***tap („tip" in polish version)*** – minimal time of pass by impulses of annunciation

The minimal time of pass by impulses of external annunciation "*transient interlock or not ready status*", *„incorrect AS”*, *„incorrect PSS or ARS”* and *„ operation AS”*. If the time of excitation is longer than *tap („tip” in polish version)*, than excitation will not last any longer.
In case of setting -0,1 the external annunciation will be hold up to reset appearing at the moment of stop of interlocking the automatic unit.
The parameter is set individually for every signal.

28. ***tv1 („tu1” in polish version)*** – delay in unit operating *V<t* 1 st
The delay in operating of undervoltage unit *V<t* 1 degree controlling voltage on bus bars.

29. ***tv2*** - delay in unit operating *V<t* 2 st
The delay in operating of undervoltage unit *V<t* 2 degree controlling voltage on bus bars.

30. ***permission for AS***
The permission for realising the change-over in AS cycle is set individually for every direction of change-over. In case of setting *„Y”*, the automatic unit will be able to realise the change-over in AS cycle for every direction and in case of setting *„N”* the change-over in AS cycle for particular direction will be out of service.

31. ***permission for AS fbl***
The permission for realising the uninterrupted synchronous change-over in AS cycle from external initiating signal set individually for every direction of change-over. In case of setting *„Y”*, the automatic unit will be able to realise the uninterrupted synchronous change-over for particular direction. In case of setting *„N”* the uninterrupted synchronous change-over for particular direction will be out of service.

32. ***permission for AS fbl, fwb, qs***
The permission for realising the change-over in AS cycle uninterrupted synchronous, AS synchronous with short time delay in supply and AS quasi- synchronous set individually for every direction of change-over. In case of setting *„Y”*, the automatic unit will be able to realise the synchronous and quasi- synchronous change-over for particular direction. In case of setting *„N”* the change-over in AS cycle synchronous and quasi- synchronous for particular direction will be out of service and it will be possible to realise the change-over in slow cycle.

33. ***permission for AS qs from drop voltage decrease (for short „AS from dVd”)***
The permission for realising the change-over in AS cycle quasi-synchronous from drop voltage decrease set individually for every direction of change-over. In case of setting *„Y”*, the automatic

unit will be able to realise the change-over in AS cycle quasi-synchronous from drop voltage decrease for particular direction. In case of setting *„N”* the change-over in AS cycle quasi-synchronous from drop voltage decrease for particular direction will be out of service.

34. ***permission for PSS***

The permission for realising the change-over in PSS cycle set individually for every direction of change-over. In case of setting *„Y”*, the automatic unit will be able to realise the change-over in PSS cycle for particular direction. In case of setting *„N”* the change-over in PSS for particular direction will be out of service. The setting *„N”* is equivalent to simultaneous moving out of service of possibilities to realise all change-over types in PSS cycle.

35. ***permission for PSS fbl***

The permission for realising the change-over in PSS cycle uninterrupted synchronous, set individually for every direction of change-over. In case of setting *„Y”*, the automatic unit will be able to realise the change-over in PSS cycle uninterrupted synchronous for particular direction. In case of setting *„N”* the change-over in PSS uninterrupted synchronous cycle for particular direction will be out of service and it will be possible to realise only other kinds of change-over.

36. ***permission for PSS fwb***

The permission for realising the change-over in PSS cycle synchronous with short time delay in supply will be set individually for every direction of change-over. In case of setting *„Y”*, the automatic unit will be able to realise the change-over in PSS cycle synchronous with short time delay in supply for particular direction. In case of setting *„N”* the change-over in PSS cycle synchronous with short time delay in supply for particular direction will be out of service and it will be possible to realise only other kinds of change-over.

37. ***permission for PSS qs***

The permission for realising the change-over in PSS cycle quasi-synchronous will be set individually for every direction of change-over. In case of setting *„Y”*, the automatic unit will be able to realise the change-over in PSS cycle quasi-synchronous for particular direction. In case of setting *„N”* the change-over in PSS cycle quasi-synchronous for particular direction will be out of service and it will be possible to realise only other kinds of change-over.

38. ***permission for PSS s***

The permission for realising the change-over in slow PSS cycle will be set individually for every direction of change-over. In case of setting *„Y”*, the automatic unit will be able to realise the change-over in slow PSS cycle for particular direction. In case of setting *„N”* the change-over in

slow PSS cycle for particular direction will be out of service and it will be possible to realise only other kinds of change-over.

39. ***permission for ARS***

The permission for realising the change-over in ARS cycle set individually for every direction of change-over. In case of setting *„Y"*, the automatic unit will be able to realise the change-over in ARS cycle for particular direction. In case of setting *„N"* the change-over in ARS cycle for particular direction will be out of service. The setting *„N"* is equivalent to simultaneous moving out of service of possibilities to realise all change-over types in ARS cycle.

40. ***permission for ARS fbl***

The permission for realising the change-over in ARS cycle uninterrupted synchronous, set individually for every direction of change-over. In case of setting *„Y"*, the automatic unit will be able to realise the change-over in ARS cycle uninterrupted synchronous for particular direction. In case of setting *„N"* the change-over in ARS uninterrupted synchronous cycle for particular direction will be out of service and it will be possible to realise only other kinds of change-over.

41. ***permission for ARS fwb***

The permission for realising the change-over in ARS cycle synchronous with short time delay in supply will be set individually for every direction of change-over. In case of setting *„Y"*, the automatic unit will be able to realise the change-over in ARS cycle synchronous with short time delay in supply for particular direction of change-over. In case of setting *„N"* the change-over in ARS cycle synchronous with short time delay in supply for particular direction of change-over will be out of service and it will be possible to realise only other kinds of change-over.

42. ***permission for ARS qs***

The permission for realising the change-over in ARS cycle quasi-synchronous will be set individually for every direction of change-over. In case of setting *„Y"*, the automatic unit will be able to realise the change-over in ARS cycle quasi-synchronous for particular direction of change-over. In case of setting *„N"* the change-over in ARS cycle quasi-synchronous for particular direction of change-over will be out of service and it will be possible to realise only other kinds of change-over.

43. ***permission for ARS s***

The permission for realising the change-over in slow ARS cycle ill be set individually for every direction of change-over. In case of setting *„Y"*, the automatic unit will be able to realise the change-over in slow ARS cycle for particular direction of change-over. In case of setting *„N"* the change-

over in slow ARS cycle for particular direction of change-over will be out of service and it will be possible to realise only other kinds of change-over.

44. ***interlock of automatic unit after realising correct AS***

The setting of operation method after realisation of correct change-over in AS cycle. In case of setting *„Y”*, the automatic unit after realising AS will be permanently interlocked and in case of setting *„N”,* after realisation of correct change-over the automatic unit will move into stand by status (ready for realisation of next change-over).

The setting of parameter has no influence on possibility of realisation of automatic return switching. If the automatic unit realises correct change-over in AS cycle quasi-synchronous from drop voltage decrease or slow AS from voltage decay and the automatics of ARS is activated, than independently from setting *„interlock of automatic unit after realisation of correct AS”*, the automatic unit will move into realisation automatic return switching cycle.

If the automatic unit realises incorrect change-over in AS cycle (i.e. the circuit breaker does not close), than next operation of automatic unit depends on realised change-over type and the reason for fault of this change-over. This subject was particularly described in item 3.6.1.

45. ***excitation of unload automatics***

The command of generating the unload impulse shutting down selected drives, which will not take a part in group self start up. In case of setting *„Y”*, the automatic unit will generate unload impulses for particular section and in case of setting *„N”* the automatics of unloading of particular section will be put of service.

8.3 Control keys on synoptic board (mimics)

Front board of automatic unit is equipped in five control key buttons, which are dedicated to access to all functions of device. The key buttons are intended for using multi-level menu of automatic unit. The structure of menu was described on fig. 8.3.

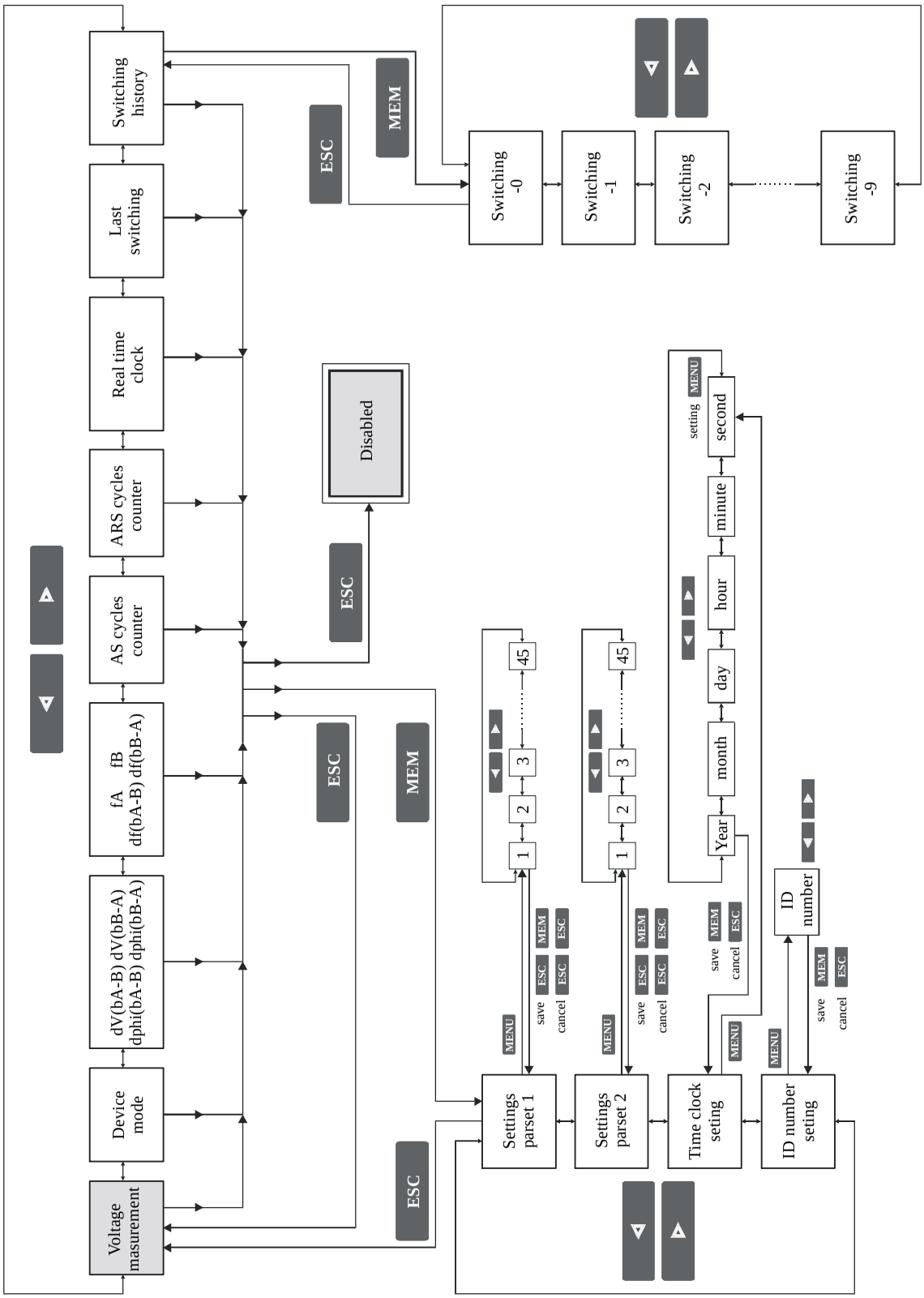


Fig. 8.3. Structure of menu.

8.3.1 Main level of menu

After switching on the automatic unit on the LCD there is shown presume (primary) screen of menu main level including voltage measurements. Main level of menu contains ten following screens, between which the operating person moves using keys **<** and **>**:

- Voltage measurements (default)
- Status of automatic unit
- Measurements dV („dU" in polish version), dphi („dfi" in polish version)
- Measurements f, df
- Counter of AS cycles
- Counter of ARS cycles
- Real time clock RTC
- The message about last change-over
- History of change-over.

Pushing the **ESC** key on any screen on main level causes automatic transition into primary default screen with voltage measurements.

Pushing the **ESC** key on any screen on main level for >0,5sec time causes **OUT OF SERVICE** of automatic unit.

8.3.2 History of change-over

The automatic unit enables review of ten messages about last change-over operations with date and hour of their incidence. Access to them is possible from history screen of change-over operations situated in main level of menu. After moving into the history screen using **MEM** key the user has the access for ten messages about last change-over operations, between which the user can move using **<** and **>** pushbuttons. Every message about change-over operation is equipped in additional information, for instance successive number, date and hour of appearance of particular change-over operation. The change-over operations have numbers from 0 up to 9, but last change-over operation is number 0.

Return to main level of menu takes place after pushing the **ESC** key on any optional screen of history level.

8.3.3 Level of setting

Pushing up the **MENU** key on any screen on main level of menu during the time >2s causes moving into setting level of menu. The setting level of menu includes four screens, as folows below, between which it is posible to move with use of **<** and **>** keys:

- Settings – set 1
- Settings – set 2
- Setting of real time clock RTC

- Setting of address of automatic unit for serial port links.

Return to main level of menu takes place after pushing the **ESC** key on any optional screen of settings level.

8.3.4 Setting of clock

The setting of clock is possible after selection from the setting level menu „*setting of real time clock*". Pushing the **MENU** key causes flashing of indicator of clock seconds. Following pushing of the **MENU** key increases the flashing indicator of seconds. Keys **<** and **>** cause change-over for actually set indicator of minute, hour, day, month and year. The flashing indicator may be increased by pushing the **MENU** key. Confirmation of new setting occurs after pushing the **MEM** key and the abort is available after pushing the **ESC** key.

8.3.5 Setting of automatic unit address

To make communication with automatic unit it is necessary to set the station number fir it. This is necessary because of specification of MODBUS protocol, which is used in automatic unit.

Setting of address is possible after choosing from settings level of screen „setting of address for serial link". Pushing the **MENU** key causes projection of star sign next to current address. The change of address may occur after pushing **<** and **>** keys. Confirmation of new setting occurs after pushing the **MEM** key and the abort is available after pushing the **ESC** key.

8.3.6 Review and settings change of automatic unit

The automatic unit has two sets of settings, 45 settings in each. From the setting level of menu there should be chosen the set, which the user wants to review or change by selection of screen „Settings – *set 1*" or „ Settings – *set 2*". Pushing the **MENU** key causes moving into selected settings set. Review of settings is possible with use of **<** and **>** keys.

Introduction of new setting value occurs after pushing **MENU** key (which is announced by lightning star next to changed setting) and change of setting with use of **<** and **>** keys. If selected setting has more than one parameter (for instance directions of change-over) the star is lightened next to all parameters and, as follows, all the parameters are change simultaneously. To change only selected parameter of particular setting , it is necessary to choose it by pushing the **MENU** key for several times.

Confirmation of new setting occurs after pushing the **MEM** key and the abort is available after pushing the **ESC** key. Then it is possible to review next settings.

Recording and activating of settings set or cancelling all achieved changes is possible after pushing the **ESC** key on the screen with optional confirmed setting. Than the automatic unit is going to ask if new setting should be recorded or cancelled. Pushing the **MEM** key causes recording of settings, pushing the a **ESC** key causes cancelling of settings.

Up to the moment of recording new settings the device is using previous settings. If during edition the optional change-over starts, than even after recording new se of settings the change-over will be finished with settings, which were valid at the moment of initiating the change-over operation.
During review or making any changes in settings the device becomes and remains in stand by status and any changes are eventually activated at the moment of their recording, under condition the automatic unit is not activated during this time. It was described in item 7.2.5.

8.4 Transmission protocol

8.4.1 Introduction

Automatic units type AZRS-2 are constructed with possibility to communication with superordinated system of control and implementation. Among others it allows for:

- Readout of actual switchgear status,
- Readout of actual automatics status AS,
- Control of circuit breakers,
- Control of AS and PSS automatics,
- Readout from buffer of event recorder,
- Readout of information about realised change-over operations,
- Introduction and readout of settings,

Communication can be sent in two variants

• Standard version - only the Modbus RTU protocol,

• Version with additional communication module - Modbus RTU (as in the standard version) and, additionally, Modbus TCP, IEC 60870-5-103, IEC 61850.

8.4.2 Communication link

Standard version of unit equipped with the following links:

- "Serial port" – socket DB9 located on front plate, dedicated to cooperation with transportable PC, standard RS-232
- "Serial port 2", optional installing – 12-contact socket WAGO, built-in close to output sockets of automatic unit, dedicated to cooperation with transportable computer control system, with possibility of choosing the standard RS-232/RS-485/fibre optic link (optional).

Unit with additional communication module has two ports with the standard version plus:

• Ethernet connector 1 - built in the vicinity of outlets machine, dedyko-important to cooperate with the system of control and supervision,

• Ethernet connector 2 - built in the vicinity of outlets machine, inactive.

Description pins socket "Serial Port 2":

No. of introduction	Function
1	SET
2	RS 232
3	RS 485
4	FIBR
5	GND
6	RxD
7	TxD
8	GND
9	Tx+
10	Tx-
11	Rx-
12	Rx+

Selection of link standard “Serial port 2” is realized by connection the output no. 1 (Set) with:

- leadout no. 2 for RS-232
- leadout no. 3 for RS-485
- leadout no. 4 for fibre optic link.

Comunication with PC Control System

Link RS 232 should be delivered as follows:

Socket contact	Signal RS 232
5	GND
6	RxD
7	TxD

Łącze RS 485 należy doprowadzić następująco:

Socket contact	Signal RS 232
8	GND
9-12	Rs+
10-11	Rs-

NOTE:

IN CASE OF INCORRECT OPERATION OF COMPUTER CONTROLLING SYSTEM OR FORCING THE OUT OF SERVICE STATE OR BREAK OF COMMUNICATION WITH SYSTEM DONE BY COMPUTER SYSTEM, THERE IS POSSIBILITY OF ELIMINATING FORCED SIGNALS FROM COMPUTER SYSTEM.

For this purpose there should be for at least 10 sec time switched off the supply of automatic unit and then, at pushed up 2 extreme left keys on local keypad of automatic unit, to switch on the supplying source of automatic unit.
There may be reset only status of signals delivered from computer system. Values of the settings will not change.

8.4.3 Communication with automatic unit – MODBUS protocol

8.4.3.1 Communication with automatic unit

Communication with automatic unit is realised with use of serial ports in accordance to Modbus-RTU protocol.
Transmission parameters:

Type of transmission	Asynchronous
Speed	9600 bit/s
Number of data bits	8
Stop bits	1
Evenness bit	Lack
Network number (station address).	1..247. Possibility of setting only from local keypad of automatic unit. Production setting is number 31.

8.4.3.2 Input status

Readout: Read Registers (function code: 3)

Register	Bit no.	Signal	Signal status
%R2049	0	External signal of permanent interlock	0-lack of signal 1-signal
	1	External start signal PSS	0-lack of signal 1-signal
	2	External signal of activation AS CBM->CBR	0-lack of signal 1-signal
	3	External signal of activation AS CBR->CBM	0-lack of signal 1-signal
	4..7	Reserved	
	8	Status of supplying voltage of automatic unit	0-too low 1-correct
	9	Reserved	

	10	Switch status SA	0-off 1-on
	11	Reserved	
	12	Permission for AS CBM->CBR	0-no permission 1-permission
	13	Permission for AS CBR->CBM	0-no permission 1-permission
	14	Permission for ARS	0-no permission 1-permission
	15	External signal of transient interlock	0-lack of signal 1-signal
%R2050	0..9	Reserved	
	10	Signal “CBM closed”	0-lack of signal 1-signal
	11	Signal “CBM opened”	0-lack of signal 1-signal
	12	Signal “ready CBM”	0-lack of signal 1-signal
	13	External impulse shut down CBM	0-lack of signal 1-signal
	14..15	Reserved	
%R2051	0..7	Reserved	
	8	Signal “CHANGE OF SETTINGS SET”	0-brak sygnału 1-jest sygnał
	9	Reserved	
	10	Signal “CBR closed”	0-lack of signal 1-signal
	11	Signal “CBR opened”	0-lack of signal 1-signal
	12	Signal “ready CBR”	0-lack of signal 1-signal
	13	External impulse shut down CBR	0-lack of signal 1-signal
	14,15	Reserved	

Note:

Activity of signals delivered into terminals B4..B12 of automatic unit is controlled only at closed switch SA (“1” at 10-th bit of register R2049). It comes from diagram of external connections of automatic unit.

Signals are controlled only at closed switch SA:

Terminal no	Name of signal
B4	Change of settings set
B5	Permission for AS CBM>CBR
B6	Permission for AS CBR>CBM
B7	Permission for ARS
B8	Transient interlock
B9	Permanent interlock
B10	Start of PSS CBM>CBR or CBR>CBM
B11	External activation AS CBM>CBR
B12	External activation AS CBR>CBM

8.4.3.3 Output status

Readout: Read Registers (function code: 3)

Register	Bit no.	Signal	Signal status
%R2113	0	Relay status “Activation PSS”	0-opened 1-closed
	1	Relay status “Operation AS”	0-opened 1-closed
	2	Relay status “Out of service”	0-opened 1-closed
	3	Relay status “Permanent interlock”	0-opened 1-closed
	4	Relay status “Transient interlock”	0-opened 1-closed
	5	Relay status “Incorrect PSS”	0-opened 1-closed
	6	Relay status “Incorrect AS”	0-opened 1-closed
	7	Reserved	
	8	Relay status V<t 2 degree	0-opened 1-closed
	9	Reserved	

	10	Relay status V<t 1 degree	0-opened 1-closed
	11	Reserved	
	12	Relay status Operation AZRS	0-opened 1-closed
	13..15	Reserved	
%R2114	0..7	Reserved	
	8	Relay status “Close with no interruption CBM”	0-opened 1-closed
	9	Relay status “ Close CBM in free line”	0-opened 1-closed
	10	Relay status “Open CBM”	0-opened 1-closed
	11	Relay status “Unload”	0-opened 1-closed
	12	Relay status “Signal EO interlock of CBM circuit breaker”	0-opened 1-closed
	13..15	Reserved	
%R2115	0..7	Reserved	
	8	Relay status “Close with no interruption CBR”	0-opened 1-closed
	9	Relay status “ Close CBR in free line”	0-opened 1-closed
	10	Relay status “Open CBR”	0-opened 1-closed
	11	Reserved	
	12	Relay status “Interlock of emergency shut down CBR”	0-opened 1-closed
	13..15	Reserved	

8.4.3.4 Values of V, dV („dU” in polish version), df, dphi („dfi” in polish version)

Readout: Read Registers (function code:3)

Register	Parameter	Data type	Unit

%R3672	Vmr	unsigned	The same as Vn („Un” in polish version) of active settings set (see item 8.4.6 – setting Vn („Un” in polish version))
%R3674	Vbusr	unsigned	
%R3675	Vbust	unsigned	
%R3676	Vr („Ur” in polish version)r	unsigned	
%R3677	Vr („Ur” in polish version)t	unsigned	
%R3678	dV („dU” in polish version)(bus-R)	unsigned	
%R3679	dV („dU” in polish version)(bus-M)	unsigned	
%R3680	dphi („dfi” in polish version)(bus-R)	signed	[st]
%R3681	dphi („dfi” in polish version)(bus-M)	signed	[st]
%R3682	fM	signed	[0.01 Hz]
%R3683	fR	signed	[0.01Hz]
%R3684	df(bus-M)	signed	[0.01Hz]
%R3685	df(bus-R)	signed	[0.01Hz]

Note:

In registers R3680..R3685 “1” on the oldest bit of register means that patameter is non-measureble because of too low voltage.

8.4.3.5 Settings set

Readout: Read Registers (function code: 3)

Record: Preset Multiple Registers (function code: 16)

No.	Address		Setting	Unit
	Settings set 1	Settings set 2		

0	%R2177	%R2433	Vn („Un” in polish version) – Nominal voltage of network -setting value: bits b9..b0 -b13..b10-shoud have value 0 -definition: See schedule “Definition of nominal network voltage Vn („Un” in polish version)”	b15 b14	Unit:
				0 0	1 [V]
				0 1	0.1 [kV]
				1 0	0.01[kV]
1	%R2178	%R2434	Vr („Ur” in polish version)M	[%]	
2	%R2179	%R2435	Vr („Ur” in polish version)R	[%]	
3	%R2180	%R2436	Vr („Ur” in polish version)s	[%]	
4	%R2181	%R2437	Vl („Ug” in polish version)	[%]	
5	%R2182	%R2438	Vl („Ug” in polish version)t	[%]	
6	%R2183	%R2439	Vs	[%]	
7	%R2184	%R2440	Vv1 („Uu1” in polish version)	[%]	
8	%R2185	%R2441	Vv2 („Uu2” in polish version)	[%]	
9	%R2186	%R2442	tIAS („tgSZR” in polish version)	[0.1 s]	
10	%R2187	%R2443	tIPSS,ARS	[0.1 s]	
11	%R2188	%R2444	twARS („twSPP” in polish version)	[0.1 h]	
12	%R2189	%R2445	tsAS_lt („trSZR_w” in polish version) CBM>CBR	[0.1 s]	
13	%R2190	%R2446	tsAS_lt („trSZR_w” in polish version) CBR>CBM	[0.1 s]	
14	%R2191	%R2447	ts_AS_qs CBM>CBR	[0.01 s]	
15	%R2192	%R2448	ts_AS _qs CBR>CBM	[0.01 s]	
16	%R2193	%R2449	tsARS („trSPP” in polish version) CBR>CBM	[s]	
17	%R2194	%R2450	tsARS („trSPP” in polish version) CBM>CBR	[s]	
18	%R2195	%R2451	tcd („toz” in polish version)	[0.01 s]	
19	%R2196	%R2452	trd („top” in polish version)	[0.1 s]	
20	%R2197	%R2453	tscc („tskz” in polish version)	[0.01 s]	
21	%R2198	%R2454	tct („twz” in polish version) CBM	[0.01 s]	

22	%R2199	%R2455	tct („twz” in polish version) CBR	[0.01 s]
23	%R2200	%R2456	tpst („tiw” in polish version)	[0.1 s]
24	%R2201	%R2457	tpft („tis” in polish version)	[0.01 s]
25	%R2202	%R2458	tpls(„tiodc” in polish version)	[0.1 s]
26	%R2203	%R2459	dphi („dfi” in polish version)	[st]
27	%R2204	%R2460	dV („dU” in polish version)	[%]
28	%R2205	%R2461	df	[0.1 Hz]
29	%R2206	%R2462	dV („dU” in polish version)_qs	[%]
30	%R2207	%R2463	df_qs („df_sz” in polish version)	[0.1 Hz]
31	%R2208	%R2464	tad („tos” in polish version)	[0.1 s]
32	%R2209	%R2465	tap („tip” in polish version)	[0.1 s]
33	%R2210	%R2466	tv1 („tu1” in polish version)	[0.1 s]
34	%R2211	%R2467	tv2	[0.1 s]

Definition of setting of nominal network voltage Vn („Un” in polish version)

from	to	sw-gear	from	to	sw-gear	from	to	sw-gear
0 V	199 V	1 V	1,00 kV	1,99 kV	0,01 kV	10,0 kV	19,9 kV	0,1 kV
200 V	498 V	2 V	2,00 kV	4,98 kV	0,02 kV	20,0 kV	49,8 kV	0,2 kV
500 V	995 V	5 V	5,00 kV	9,95 kV	0,05 kV	50,0 kV	90,0 kV	0,5 kV

No.	Address		Setting	Unit
	Setting set 1	Setting set 2		
35	%R2212	%R2468	permission for AS CBM>CBR	[Y/N] (0=N, 1=Y)
36	%R2213	%R2469	permission for AS CBR>CBM	[Y/N] (0=N, 1=Y)
37	%R2214	%R2470	permission for AS fbl CBM>CBR	[Y/N] (0=N, 1=Y)
38	%R2215	%R2471	permission for AS fbl CBR>CBM	[Y/N] (0=N, 1=Y)
39	%R2216	%R2472	permission for AS fbl,fwb,qs CBM>CBR	[Y/N] (0=N, 1=Y)
40	%R2217	%R2473	permission for AS fbl,fwb,qs CBR>CBM	[Y/N] (0=N, 1=Y)
41	%R2218	%R2474	permission for AS qs from dr. volt. decr. CBM>CBR	[Y/N] (0=N, 1=Y)
42	%R2219	%R2475	permission for AS qs from dr. volt. decr. CBR>CBM	[Y/N] (0=N, 1=Y)
43	%R2220	%R2476	permission for PSS CBM>CBR	[Y/N] (0=N, 1=Y)
44	%R2221	%R2477	permission for PSS CBR>CBM	[Y/N] (0=N, 1=Y)
45	%R2222	%R2478	permission for PSS fbl CBM>CBR	[Y/N] (0=N, 1=Y)

46	%R2223	%R2479	permission for PSS fbl CBR>CBM	[Y/N] (0=N, 1=Y)
47	%R2224	%R2480	permission for PSS fwb CBM>CBR	[Y/N] (0=N, 1=Y)
48	%R2225	%R2481	permission for PSS fwb CBR>CBM	[Y/N] (0=N, 1=Y)
49	%R2226	%R2482	permission for PSS qs CBM>CBR	[Y/N] (0=N, 1=Y)
50	%R2227	%R2483	permission for PSS qs CBR>CBM	[Y/N] (0=N, 1=Y)
51	%R2228	%R2484	permission for PSS s CBM>CBR	[Y/N] (0=N, 1=Y)
52	%R2229	%R2485	permission for PSS s CBR>CBM	[Y/N] (0=N, 1=Y)
53	%R2230	%R2486	permission for ARS CBR>CBM	[Y/N] (0=N, 1=Y)
54	%R2231	%R2487	permission for ARS CBM>CBR	[Y/N] (0=N, 1=Y)
55	%R2232	%R2488	permission for ARS fbl CBR>CBM	[Y/N] (0=N, 1=Y)
56	%R2233	%R2489	permission for ARS fbl CBM>CBR	[Y/N] (0=N, 1=Y)
57	%R2234	%R2490	permission for ARS fwb CBR>CBM	[Y/N] (0=N, 1=Y)
58	%R2235	%R2491	permission for ARS fwb CBM>CBR	[Y/N] (0=N, 1=Y)
59	%R2236	%R2492	permission for ARS qs CBR>CBM	[Y/N] (0=N, 1=Y)
60	%R2237	%R2493	permission for ARS qs CBM>CBR	[Y/N] (0=N, 1=Y)
61	%R2238	%R2494	permission for ARS s CBR>CBM	[Y/N] (0=N, 1=Y)
62	%R2239	%R2495	permission for ARS s CBM>CBR	[Y/N] (0=N, 1=Y)
63	%R2240	%R2496	automatic interlock after correct AS CBM>CBR	[Y/N] (0=N, 1=Y)
64	%R2241	%R2497	automatic interlock after correct AS CBR>CBM	[Y/N] (0=N, 1=Y)
65	%R2342	%R2498	activation of unload automatics	[Y/N] (0=N, 1=Y)

8.4.3.6 Identification of automatic unit type and software version

Readout: Read Registers (function code: 3)

Type and version of automatic unit may be red from register R3705..R3713. This is sequence of signs ASCII, per 2 signs in every register:

%R3705	older byte	1 name sign	ASCI
%R3705	younger byte	2 name sign	ASCI

('2' – automatic unit type Azrs-2; '3' – automatic unit type AZRS-3)

%R3706	older byte	3 name sign	ASCI
%R3706	younger byte	4 name sign	ASCI
%R3707	older byte	5 name sign	ASCI
%R3707	younger byte	6 name sign	ASCI
%R3708	older byte	7 name sign	ASCI
%R3708	younger byte	8 name sign	ASCI

etc. up to %R3713

For instance from the automatic unit AZRS-2 there may be red following sequence of signs: B301032720010327.

8.4.3.7 Events buffer

Function: Read Registers (function code: 3). Parameter “number of registers” **must be** always set on 125.

Readout from events buffer

The contents of events buffer is obtained by connecting data from following readouts:

Read Registers %R4001

Read Registers %R4002

Read Registers %R4032

The readout is complete after reaching %R4032 or before, when the automatic unit negates the oldest bit of function code (response is not type Normal Response).

In case of events buffer there appears departure from linear memory model, the readout is correct only in case of readout from frames per 125 register.

Events buffer analysis:

To the events buffer analysis of automatic unit there is predicted program AzrsSN.exe, delivered by producer together with automatic unit. The program automatically recognizes type and version of automat, permit for readout and record of settings sets and readout and analysis of events buffer.

8.4.3.8 RTC clock

Readout: Read Registers (function code: 3).

Record: Preset Multiple Registers (function code: 16).

%R2809 - sekonds

%R2810 - minutes

%R2811 - hours

%R2812 - day

%R2813 - month

%R2814 - year (last two digits)

8.4.3.9 Status of automatic unit

Readout: Read Registers (function code: 3)

Value in older byte of register R3688: code of automatic unit status; data type: unsigned

Value in younger byte of register R3688: code of status reason; data type: unsigned

Operation status of automatic unit

Code of unit status (%R3688 older byte)	Automatic unit status

0	Interlock
1	Out of service
2	Stand by
3	Activation

Reasons of status

code of status reason (%R3688 younger byte)	Status reason
3	Waiting for conditions for ARS CBR>CBM
4	Waiting for conditions for ARS CBM>CBR
5	Ambiguous circuit breaker status
6	Incorrect circuit breaker status
7	External signal of permanent interlock
8	Permanent interlock from superordin. system
9	External shut down impulse
10	External signal of AS Activation
11	Too low voltage on bus bars
12	Fault in settings – set 1
13	Fault in settings – set 2
14	Fault in RTC settings
15	Unknown
Notes: Values: 5,6,7,9,10,11 – these are codes of reason for permanent interlock appearing after switching on the automatic unit	

8.4.3.10 Information of last change-over

Readout: Read Registers (function code: 3).

%R3689 Message no.; data type: unsigned

Schedule of messages

MESSAGE NUMBER	CONTENT OF FIRST VERSE OF MESSAGE
6	Lack of conditions for PSS
7	Lack of conditions for ARS
11	Unsuccessful AS from drop voltage decrease
12	Unsuccessful AS from shutting down impulse
13	Unsuccessful AS from voltage decay

14	Unsuccessful AS from external signal
15	Unsuccessful AS from opening the circuit breaker
16	Unsuccessful PSS
17	Unsuccessful ARS
21	AS quasi synchronous: from drop voltage decrease
22	AS quasi synchronous: from shutting down impulse
23	AS quasi synchronous: from voltage decay
24	AS quasi synchronous: from external signal
25	AS quasi synchronous: from opening the circuit breaker
26	PSS quasi synchronous
27	ARS quasi synchronous
31	AS slow from drop voltage decrease
32	AS slow from shutting down impulse
33	AS slow from voltage decay
34	AS slow from external signal
35	AS slow from opening the circuit breaker
36	PSS slow
37	ARS slow
41	AS uninterrupted synchronous from drop voltage decrease
42	AS uninterrupted synchronous from shutting down impulse
43	AS uninterrupted synchronous from voltage decay
44	AS uninterrupted synchronous from external signal
45	AS uninterrupted synchronous from opening the circuit breaker
46	PSS uninterrupted synchronous
47	ARS uninterrupted synchronous
51	AS synchronous with break from drop voltage decrease
52	AS synchronous with break from shutting down impulse
53	AS synchronous with break from voltage decay
54	AS synchronous with break from external signal
55	AS synchronous with break from opening the circuit breaker
56	PSS synchronous with break
57	ARS synchronous with break
reminding	Exit without sending message and time

Information about fault change-over: %R3690.

Readout: Read Registers (function code: 3)

Given in schedule reason of fault change-over occurred if logical product of register contents %R3690 and mask given for reason is a number different than zero:

Register	Mask	Reason
%R3690	0x8000	Did not switch off CBC (closing circuit breaker)
%R3690	0x2A00	Did not switch on CBC (closing circuit breaker)
%R3690	0x0080	Did not switch off CBO (opening circuit breaker)
%R3690	0x002A	Did not switch on CBO (opening circuit breaker)

Notes:

In the place of CBC and CBO there should be put names given in register %R3691

%R3691

Readout: Read Registers (function code: 3)

older byte: counter of messages modulo 256 (status increased by 1 after every new message).

younger byte: names of circuit breaker and information of exceeding tl:

Meaning of particular bits of register younger byte %R3691:

Register	Bit No.	Meaning	Values
%R3691	0	Exceeding tl	0- not exceeded tl 1- exceeded tl
	5,4	Closed circuit breaker	00 CBM 10 CBR
	7,6	Opened circuit breaker	00 CBM 10 CBR

Date and time of last change-over:

Readout: Read Registers (function code: 3)

Register	Older byte	Younger byte
%R3692	Seconds	Minutes
%R3693	Hours	Day
%R3694	Month	Year (last two 2 digits)

8.4.3.11 Status of LED diodes on synoptic board

Status of diodes is included in 1.5 of register. Every bit includes information of status of one diode or part of two-colour diode. Zero means lighting.

Readout: Read Registers (function code: 3).

Automatic change-over units type AZRS-2 are produced in standard version and “mirror” version. Depending on unit version there is different layout of elements on synoptic board and there are different information addresses about status of particular diodes:

Register	Bit no.	Annunciation	
		AZRS-2 standard version	AZRS-2 “mirror” version
%R3695	0	Not ready CBR	Not ready CBM
	1	Not used	Not used
	2	CBM OPENED	CBR OPENED
	3	CBM CLOSED	CBR CLOSED
	4	CBR OPENED	CBM OPENED
	5	CBR CLOSED	CBM CLOSED
	6,7	Not used	Not used
%R3696	0	VM green colour	VR („UR” IN POLISH VERSION) green colour
	1	VM red colour	VR („UR” IN POLISH VERSION) red colour
	2	VR („UR” IN POLISH VERSION) green colour	VM green colour
	3	VR („UR” IN POLISH VERSION) red colour	VM red colour
	4	Vbus green colour	Vbus green colour
	5	Vbus red colour	Vbus red colour
	6,7	Not used	Not used
	8	Not ready CBM	Not ready CBR
	9	Supply	Supply
	10	Out of service	Out of service
	11	Interlock	Interlock
	12	Permanent interlock	Permanent interlock
	13	Transient interlock or not ready	Transient interlock or not ready
	14	No conditions for quick change-over	No conditions for quick change-over
	15	Limit time	Limit time

Note:

Lamps for voltage signalling (VM, VR („UR” IN POLISH VERSION), VbusM, VbusR) are lighting in red, green or yellow colour.

If the bits informing of lighting in green and red colour are in low status, that means about diode lighting in yellow colour.

8.4.3.12 Counters of AS and ARS

Counters of realised change-over operations AS and ARS are presented in register %R3697.. %R3704.

Readout: Read Registers (function code: 3), data type: unsigned.

Register	Counter
%R3699	AS CBM>CBR
%R3700	AS CBR>CBM
%R3703	ARS CBR>CBM
%R3704	ARS CBM>CBR

8.4.3.13 Control of AS and PSS automatics

Readout: Read Registers

Record: Preset Single Register. Function code: 6.

Recorded values: 0 means setting of particular variable into false. Record of value 1 (optional number <> 0) means setting of particular variable into true.

Register	Command
%R2705	Switch on/off (un-interlock/out of service) of automatics – equivalent of switch SA 0 – automatics off (out of service) 1 – automatics on (un-interlock)
%R2716	Start PSS CBM>CBR, CBR>CBM – equivalent of switch “start PSS CBM>CBR, CBR>CBM” Introduced value 1 is equivalent of pushing pushbutton “start PSS CBM>CBR, CBR>CBM”. After receiving the command the automatic unit clears register contents.

Notes:

Automatics is switched on (unblocked), if (%R2705=1) **and** key SA is switched on. In every other case (when %R2705=0 or key SA is opened) automatics is switched off (out of service). **Actual status of automatics** is determined by bit 8 of register %R2062 (0:automatics out of service; 1:automatics unblocked).

Change-over in PSS cycle may be activated with pushbutton “start PSS” **or** from system through entry into register the value 1.

8.4.3.14 Control of circuit breakers

Record: Preset Single Register

It is possible to control the circuit breakers only in case when the automatic unit is out of service (bit 8 of register %R2062 in status “0”). Control of circuit breakers of automatic unit is realised by recording of adequate code of command (data type: unsigned) into register %R2719, with use of **Preset Single Register** command (function code: 6). This register is booked by automatic unit immediately after receiving the command.

Register	Command code	Command
%R2719	1	Switch on CBM through line with no break
	2	-
	3	Switch on CBR through line with no break
	4	Switch on CBM through line with break
	5	-
	6	Switch on CBR through line with break
	7	Switch off CBM
	8	-
	9	Switch off CBR

8.4.4 Communication with the unit - IEC 60870-5-103 protocol (for version with additional communication module)

Description of communication is in a separate document.

8.4.5 Communication with the unit - IEC 61850 protocol (for version with additional communication module)

Description of communication is in a separate document.

9 Operating

Automatic units type AZRS-2 made by Energotest are constructed in such way, not to require from user any special exploitation performance accept battery exchange.

9.1 Battery exchange in automatic units AZRS-2

The automatic unit was equipped in battery, which duration is 10 years under condition, the automatic unit is at least for 90% of time supplied from network (than the battery is not loaded). Before the life time passes by the battery exchange should be suggested and announced to the producer (i.e. at routine test). Realisation of this duty by user is impossible because of necessity of interference into microprocessing systems. After battery exchange and performing appropriate routine tests, the automatic unit is ready for operation. There should be considered that during battery exchange there will be lost data contained in register of events.

In case of exceeding the life time of battery there will appear discharge of battery characterised by permanent putting the automatic unit into out of service position. On the LCD there may appear misinformation about incorrect duties of clock operation or about incorrect data controlling by RS or about battery discharge. In such event the battery should be immediately exchanged.

9.2 Routine tests

At least twice a year there should be performed basic tests of functioning of automatics.
Routine tests in scope of manufacture test should be performed every 3 years. To the realisation of this test there is suggested to apply special tester i.e. TAZR. Test results should be noted in documentation.

9.3 Detection and elimination of damage

In case it was found any incorrectness in operation of automatic unit, wrong annunciation or incorrect reflection of circuit breaker status on the front board the automatic unit should be immediately put out of service and deprived of auxiliary voltage. If the incorrect operation is not caused with incorrect status of external connections, than the external connections should be unplugged from automatic unit AZRS-2 (by switching off the plugs) and it is necessary to contact with representative of producer's service, to achieve the instructions of further procedure.
During announcement of damage producer's representative there should be mentioned such information:

- type of automatic unit,
- production number,
- place of installation of unit,
- symptoms of damage,
- name of responsible/managing person,
- contact telephone number.

10 Transporting and storing

Transport packing should have the same resistance degree for vibrations and strokes, as specified in standards PN-EN 60255-21-1:1999 and PN-EN 60255-21-2:2000 for sharpness class 1.
The device delivered by producer should be unpacked carefully, not with use of too much strenth and not adequate tools. After unpacking it should be visually checked if the device has no outside damage.
The device should be stored in dry and clean place and the temperature of storage is at range of from –25°C up to +70°C.

Relative humidity should be in such range, to make possible avoiding condensation and hoarfrost effect.

Before delivering the supply voltage the device should be installed at operation place for about 2 hours in purpose of compensation of temperature and to avoid influence of humidity and condensation.

During very long period of storage it is suggested each year to feed the device with auxiliary voltage for period of two days, in purpose of regenerating the electrolytic capacitors.

11 Utilization

If there is necessary to disassemble the device (and eventually removal), as the result of damage or operation life time finish, than there should be previously switched off all the supplying, measuring units and other connections.

Disassembled device should be received as electronic scrap which should be treated in accordance to regulations concerning waste management.

12 Warranty and service

For the delivered automatic unit Energotest gives 12-month warranty calculated from the date of purchasing (unless contract notation says otherwise), based on rules specified in guarantee certificate.

In case of start up the device by qualified specialists of Energotest the warranty term is extended up to 24 months.

The producer ensures technical assistance at start up of the device and provides warranty service on the commonly accepted conditions and after warranty service on the conditions mutually agrees on.

Not obeying the rules specified above causes loss of warranty.

13 Ordering

CODE DESIGNATION FOR ORDERING THE AUTOMATIC UNIT OF AZR TYPE

							/						/		
Automatic unit type	A	Z	R	S	-	2									
	A	Z	R	S	-	3									
Volue and kind of auxiliary voltage	24V							0	2	4					
	110V							1	1	0					
	220V							2	2	0					
	Direct Voltage										D	C			
	Alternating Voltage										A	C			
Casinng	Non-standard version													0	
	Version 5 - panel casing 63T													5	
	Version 6 - 19" behind panel casing casing CC+													6	
	Version 7 - 14" behind panel casing													7	
	Version 8 - 19" panel casing													8	
Additional keypad (avialable for devices in 19" casing)	without														B
	with														P

Example of order

	A	Z	R	S	-	2	/	2	2	0	D	C	/	7	B
Automatic unit type	A	Z	R	S	-	2									
Volue and kind of auxiliary voltage	220V							2	2	0					
	Cirect voltage										D	C			
Casing	Version 7 - 14" behind panel casing													7	
Additional keypad	withour														B

The orders should be sent to the following address:

Energotest sp. z o.o.
ul. Chorzowska 44B; 44-100 Gliwice
phone 032-270 45 18, fax 032-270 45 17.
e-mail: **handel@energotest.com.pl**
www.energotest.com.pl