ENERGOTEST

AUTOMATIC CHANGE-OVER UNIT

TYPE APZ

Operating Manual

Gliwice, May 2004

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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 have 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.

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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

Automatic units - type APZ, are dedicated for switchgears of high, medium and low voltage. They are configured for each individually switchgear. They may operate in switchgear equipped in circuit breaker of number from 2 to 10, with possibility of supplying from generating set unit. They have possibility of opening circuit breakers located at upper side of transformer supplying the switchgear.
The number in type of automatic unit determines the number of circuit breakers taking part in change-over operations on switchgear.

Unit may be used for following switching over:

- **Uninterrupted synchronous change-over**
  Change over is possible if at the initiation time conditions for the synchronous change-over exist, i.e. the differential voltage between in corresponding measuring points contains between assumed permitted limits. The automatic unit closes the circuit breaker of the new supply and after confirmation the closed position of this circuit breaker, it opens the previous supply circuit breaker. There are no interruptions in consumers' supply during the change-over operation.
- **Slow change-over**
  After opening the circuit breaker of the previous supply, when the voltage on busbars drops down below the set threshold value, the automatic unit closes impulse to the circuit breaker of the new supply. The time of supply interruption depends on velocity of voltage drop at the busbars down to the threshold value.

Automatic unit realizes change-over in cycles as follows:

- **Auto stand by AS**
  - AS slow caused by opening the circuit breaker in supply circuit,
  - AS slow caused by voltage decay on busbars at closed circuit breaker in supply circuit.
- **Planned power supply switching PSS**
  - PSS synchronous non-interrupted,
  - PSS slow.
- **Automatic self-recovery change-over of power supply – ARS**
  - ARS synchronous non-interrupted,
  - ARS slow.
- **Automatic supply switching ASS**
  - ASS slow.

2 Safety rules

Information included in this chapter is 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...1,5mm2 cross-section.

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

Activation of unit

After installing automatic unit APZ 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 APZ 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

After installing APZ automatic unit it is necessary to switch on the battery by pulling out the strip standing out from upper cover of unit. 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 not certified device on document written by manufacturer, cause loss of any claim to legal and responsibilities in relation to Energotest.

Exchange of any elements or subassemblies the device is composed of and coming from other 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.

Any repairs may be realized only by qualified specialists of the Energotest Ltd.

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 APZ automatic unit is based on simple-design controller. Structure of unit and applied software enables the modification and applying the device into specific configuration of switchgear.

The following documentation shows general opportunities of automatic unit. Solution for selected switchgear depends on its operating system.

Configuration of unit for switchgear system demand is realized by producer. Using the software delivered by producer it is possible to change operation program of automatic unit on site (block or permit of change-over) and change the setting values of operating times in unit. There is foreseen no possibility of changes of setting values in voltage units on site.

The unit has been assembled in a housing made by Rittal and can be mounted on a board or behind the panel.

The APZ automatic unit is autonomous device. Inputs and outputs are adapted directly to connect the plant signals. Into automatic unit there are delivered measurement voltages, layout status of circuit breakers, interlock signals and other control impulses. On their basis the unit estimates operating conditions. The unit is able to directly control circuit breaker positions. All inputs and outputs are galvanic insulated from each other.

In the AS cycle the unit automatically realizes change-over of stand by supply and makes possible the planned power supply change-over cycle (PSS) after realizing correct AS from voltage decay. Also the unit performs automatic supply switching operation (ASS) in case the switchgear remains without voltage and there is no possibility of realizing any other change-over operations.

The planned supply change-over cycle (PSS) is performed under standard operating conditions.

The AS cycle may be realized in emergency conditions: from primary supply into reserve supply or from the supplying of electro-energetic system into emergency supply (power generating unit).

The PSS cycle can be realized between two optional circuit breakers supplying the particular section. 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 PSS cycle is realized when after realizing AS cycle from voltage decay there appears voltage in primary supplying line. Its goal is to restore the system of switchgear operation existing before realizing change-over in AS cycle from voltage decay. Change-over in ARS cycle appears in the direction of primary supply from electro-energetic system.

ASS cycle is realized in emergency case when the switchgear remains without voltage and there is no possibility of realizing any other change-over cycle.

The automatic unit always operates only once. That means every change–over of automatic unit is realized only once – there is no attempt of realizing change-over again, even in case of any fault.
Apart from control impulses of the circuit breakers and the activating and deactivating impulses (de-energising), the automatic unit generates impulses to the central signalling system.
The unit may be additionally equipped in external annunciation system of voltage level on busbars. It may be substitute of generally applied under voltage relays used at the moment of voltage decrease on busbars up to the moment of excitation other systems of automatics.
On the front plate there are synoptic system representing the present position of the circuit breakers together with diode system indicating particular levels of voltage in the substation and internal annunciation system. Signals are configured individually for Client's requirements.
The automatic unit is equipped in internal buffer making possible registering of events. Optionally it may be applied to operate together with computer control system.

3.2 Casing of the unit

Automatic unit is accommodated in cassette casting EURO made by Rittal firm. There are available following versions of casing:

- Because of the way of mounting (upon the Customer's decision):
  - on the panel casing – version 1,
  - behind the panel casing – version 2,
- Because of the width (upon the Customer's decision):
  - 63T,
  - 84T,
- Because of the depth (depth depends on number of separators built-in and it is decided by producer):
  - 260mm,
  - 320mm,
- Because of the additional protecting window (upon the Customer's decision):
  - Without window,
  - With window.

It is also available to order in non-typical casing order, with a prior approval of the Manufacturer.

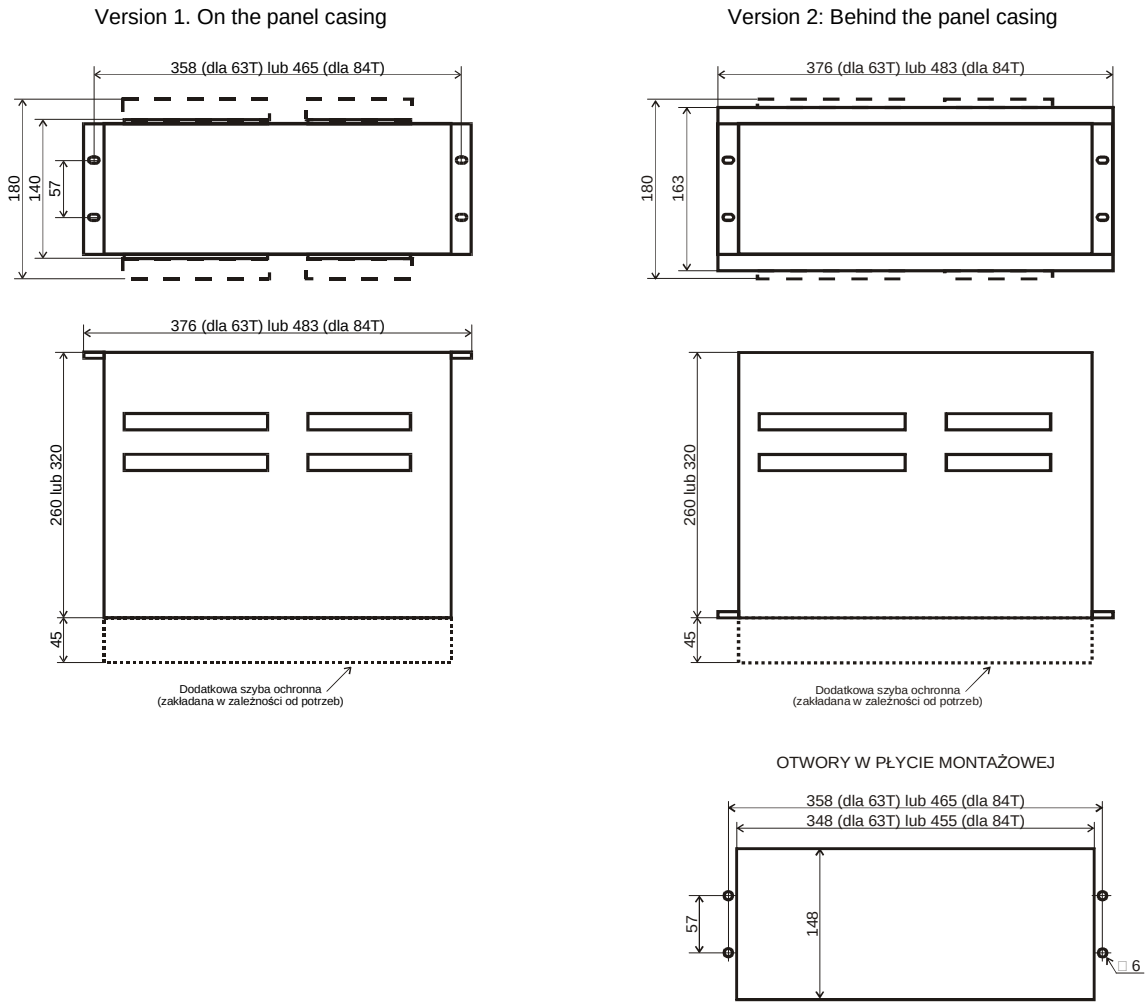

Fig. 1 Dimension of automatic unit.

3.3 Front board of automatic unit

The front board of the automatic unit (Fig. 2) 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.

Front boards are designed individually for each automatic unit particularly for switchgear system. Example front board of APZ-5 unit is shown on fig. 2.

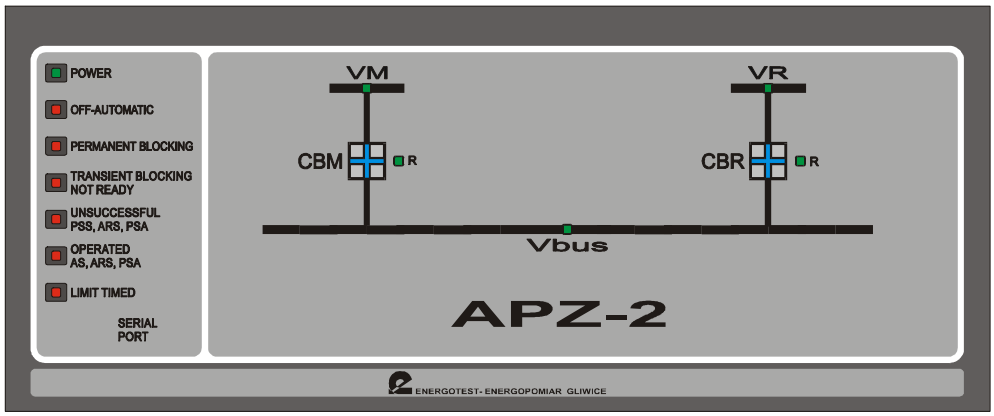

Fig. 2 Front board of the automatic unit APZ-2

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 "G" signalling the lack of availability of circuit breaker.

Green lamps signal that the voltage on supplying lines, busbars of switchgear and terminals of standby generator exist. The lights indicate the existence of voltage no phases L1-L2.

On the front board of automatic unit it is possible to locate any other signalling lamps indicating switchgear status i.e. readiness of standby generator.

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 "*permanent interlock*".

  During out-of-operation position of automatic unit, there is activated signalling "*out of service of automatic unit*" or "*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 "*transient interlock or not ready*".

Interlock is activated in following cases:

a. Shut down of auxiliary supplying voltage or switch off the SA key causes out-of-service position of automatic unit which is equivalent to permanent interlock.
b. Feeding with the voltage into input of transient interlock causes transient interlock of automatic unit.
c. Feeding with the voltage into input of permanent interlock causes permanent interlock of automatic unit.
d. During realization of change over in PSS cycle, there is transiently interlocked AS and ASS automatics.
e. During realization of change over in ARS cycle, there is transiently interlocked AS and ASS automatics (awaiting for conditions for realizing the ARS cycle the AS and ASS automatics is not interlocked).
f. During realization of change over in AS cycle, there are transiently interlocked PSS, ARS and ASS automatics.
g. After realizing some change-over in AS and ARS cycle the unit is permanently interlocked; see detains in item 3.6.1.
h. During lack of stand by of circuit breaker, occurs transient interlock of PSS and ARS automatics in the direction designated by this circuit breaker.
i. During lack of stand by of circuit breaker, occurs transient interlock of AS and ASS automatics in the direction designated by stand-by circuit breaker (closing one).
j. Decrease of voltage in incoming feeder below setting value *Vr* causes transient interlock of PSS and ARS automatics.
k. Decrease of voltage in reserve incoming feeder below setting value *Vr* causes transient interlock of AS and ASS automatics.
l. In case of ambiguous responses of state of circuit breaker conditions, the automatic unit interlocks transiently for change-over operations of this circuit breaker.

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

- SA switch should be put into on position (out of service/local uninterlock); however if SA key is in on position, then it is necessary to switch it off and then on,
- Uninterlocking the unit remotely with use of "*out of service/remote uninterlock*", it the unit is not out of service, than the signal should be sent twice in order to put the unit out of service and uninterlock it.

After auxiliary voltage is switched on or in the moment of unblocking, the automatic unit checks the operating conditions of switchgear and uninterlocks only in case, if circuit breaker position gives information about correct status in switchgear and the voltage on busbars is higher than setting value *Vl*. If any of conditions mentioned before is not fulfilled than the automatic unit is permanently interlocked.

3.5 Disturbances annunciation

The automatic unit is equipped in internal annunciation on the front plate and in control with external annunciation.

Specification of signals is selected individually depending on client's needs. Below there is matched set of signals offered by producer:

- Out of service,
- Permanent interlock,
- Transient interlock or not ready,
- Incorrect AS,
- Incorrect PSS, ARS or ASS,
- Operation of AS,
- Operation of ARS,
- Operation of ASS,
- Activating of PSS or ARS,
- Lack of synchronism,
- Awaiting for ARS,
- Awaiting for ASS,
- Operating of automatic unit.

Actual number of signals used in particular unit depends on individual need of client.

3.6 Description of operation

The automatic unit realizes four cycles of change-over operations:

- **AS** – auto stand-by – realized automatically by automatic unit (on base of conditions existing in switchgear) in emergency situations (at the moment disturbances in switchgear occur). It is realized from primary supply into stand-by supply.
- **ARS** – automatic return switching – realized automatically by unit (on base of conditions existing in switchgear), in case of return of primary supply voltage after previous realizing correct AS from voltage decay. Realized from reserve supply into primary supply. It is change-over operation recovering primary supply in switchgear: zit is also known as "return AS" or "self-return".
- **PSS** – planed power supply switching – activated manually by service staff is realized in normal operating conditions between two circuit breakers indicated by service staff.
- **ASS** – automatic supply switching – realized automatically by automatic unit (on base of conditions existing in switchgear) in emergency situations (if at the moment disturbances in switchgear supplying occur there is no conditions for realizing AS, i.e. the switchgear is supplied from reserve supply source, or if after finishing another change-over there is no voltage

on switchgear busbars). It is realized in the direction of circuit breaker, which points the voltage behind itself (priority is on circuit breaker of primary supply). The goal of this change-over operation is to recover supply in case the switchgear remains without voltage and there is no possibility of realizing any other change-over operation.

Below there are represented example sequences of operation of automatic unit realizing particular cycles of change-over:

- AS form opening the circuit breaker of primary supply:
  - Before start of change-over operation the switchgear is fed from primary source.
  - Opening of circuit breaker occurs – the unit realizes AS from primary supply into reserve.
- ASR form voltage decay and following ARS:
  - Before start of change-over operation the switchgear is fed from primary source.
  - Primary voltage fades – the unit realizes AS from primary supply into reserve.
  - Primary voltage recovers – the unit realizes ARS from reserve supply into primary.
- Incorrect AS (i.e. caused by damaged circuit breaker) and following ASS:
  - Before start of change-over operation the switchgear is fed from primary source.
  - Primary voltage fades – the unit realizes incorrect AS, switchgear remains without voltage.
  - AS change-over is finishing – the unit realizes ASS in a direction into circuit breaker which remains under voltage.
- PSS:
  - Before start of change-over operation the switchgear is fed from primary source.
  - PSS is activated by service staff – the unit realizes PSS.
- Incorrect PSS (i.e. caused by incorrect settings of unit) and following ASS:
  - Before start of change-over operation the switchgear is fed from primary source.
  - PSS is activated by service staff – the unit realizes incorrect PSS, switchgear remains without voltage.
  - PSS change-over is finishing – the unit realizes ASS in a direction into circuit breaker which remains under voltage.
- ASS:
  - Before start of change-over operation the switchgear is fed from reserve source (no possibility of realizing AS change-over).
  - Disturbance in switchgear appears – the unit realizes ASS in a direction into circuit breaker which remains under voltage.

Each of change-over operation may bye activated or interlocked in settings mode. After realization of AS or ASS (which means after change-over operations realized automatically in emergency situations) by appropriate setting it is possible to permanently interlock automatic unit. Details are described in item 8.2.

3.6.1 Auto stand-by operation (AS)

The change–over operation may be realized in a direction from primary supply into reserve supply or from supply of electric power system into emergency supply (stand-by generator). If the change-over operation is realized into stand-by generator, then automatic unit activates stand-by generator with appropriate signal. Realization of AS cycle is initiated self-acting by automatic unit. The automatic unit operates only once.

In automatic unit there may be simultaneously activated more than one change-over. For instance: the automatic unit may realize AS between circuit breakers of switchgear supply from electric power system and simultaneously realize AS into stand-by power generator. Reciprocal interlocks between currently realized change-over operations do not allow for generating impulses controlling circuit breakers, if it would cause effect on operating in another AS cycle. If there is realized AS used change-over into stand-by power generator, than the generator will be switched on (activated) unconditionally, but impulses controlling circuit breakers may be generated after finishing change-over operation between circuit breakers of switchgear supplying from electric power system.

By appropriate setting of automatic unit it is possible to allow or make impossible to realize change-over operation for particular directions. Method of setting the automatic unit is described in details in item 8.2.

During realization the change-over in AS cycle there is activated annunciation *"operating of automatic unit"*.

After successfully finished of AS cycle there is generated signal *"realization of AS"*.

The change-over cycles are realized in limiting time *tIAS* or *tIASa*. If in this time the change-over cycle will not be finished, then de-energizing of AS automatics appears. After finish unsuccessful AS cycle there is generated *"unsuccessful AS"* external signal.

After finishing the change over in AS cycle further operation of automatic unit depends on setting "*unit interlock after realization of AS or ASS*" and "*permission for realizing ASS*". The automatic unit may:

- go into stand-by status (ready to realize ARS change-over or other change-over operation),
- start realizing change-over operation in ASS cycle,
- interlock permanently.

Details are shown in chart.

AS change-over	Setting "*unit interlock after realization of AS or ASS*"	Setting "*permission for realizing ASS*"	Following operation of automatic unit
Correct – after finishing there exist voltage n switchgear busbars	N	N	go into stand-by status
	N	Y	go into stand-by status
	Y	N	permanent interlock
	Y	Y	permanent interlock

Incorrect – after finishing change-over the switchgear remains without voltage	N	N	go into stand-by status
	N	Y	change-over operation in ASS cycle
	Y	N	permanent interlock
	Y	Y	change-over operation in ASS cycle

Details considering automatic unit settings are described in item 8.2.

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

- the circuit breaker will be opened in supplying line (it causes voltage decay on busbars)
- the supplying voltage will decay on busbars at closed circuit breaker in supplying line.

Automatics may be realized as one-step (change-over operations may be realized between primary supply circuit breaker and one of reserve supply circuit breaker) or multi-step (change-over operations realized between primary supply circuit breaker and several reserve supply circuit breaker). If the automatics is realized as multi-step, than automatic unit tries to switch on circuit breakers in sequence determined during configuration of automatic unit. The change-over becomes finished at the moment of closing any of reserve circuit breakers, or during realizing unsuccessful attempts of closing all reserve circuit breakers.

Below there are described particular cycles of change-over.

Change-over operations may be realize between circuit breakers supplying switchgear from electric power system or between circuit breakers supplying switchgear from electric power system or and stand-by power generator. Particular change-over is described for direction of realized operation between circuit breakers conventionally named:

- opened circuit breaker: CBO
- closed circuit breaker: CBC.

3.6.1.1 AS from CBO into CBC caused by opening circuit breaker in supplying line

1. Initial conditions:

- CBO is closed.
- CBC is opened.
- The voltage on changed busbars *Vbus* is higher than setting value *Vl.*
- Stand by voltage *VR* is higher than setting value *Vr*.

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

- Opening of opened circuit breaker CBO and voltage decay on busbars.
- When voltage on busbars decreases below setting value *Vl*, there is started timing of limit time *tlAS*.
- When voltage on busbars decreases below setting value *Vlt*, there is started timing of delay time of closing circuit breaker *tcd*.

- If *"activation of unload automatics"* is set on *"Y"*, than the automatic unit sends impulse about unloading. Duration time of impulse is *tp* and it is shutting down selected drives, which will not take part in self-activation.
- After timing the time *tcd*, there is generated impulse of duration time *tp* into closing circuit breaker CBC.
- After closing the closed circuit breaker CBC and finishing the closing impulse the automatics is deactivated.

3. Operation of automatic unit at inefficient devices of change-over system of switchgear: the closed circuit breaker CBC did not close:

- If there is possibility of closing following reserve circuit breaker (the multi-step automatics is realized), than the unit repeats attempting to close following reserve circuit breaker.
- If there is no possibility of closing following reserve circuit breaker (there is realized one-step automatics or multi-step automatics and previous attempts of closing circuit breakers finished as unsuccessful), than the unit deactivates itself after finishing impulse closing the closed circuit breaker CBC.

3.6.1.2 AS from CBO into CBC caused by voltage decay on busbars at closed circuit breaker in supplying line

1. Initial conditions:

- CBO is closed.
- CBC is opened.
- The voltage on changed busbars *Vbus* is higher than setting value *Vl.*
- Stand by voltage *VR* is higher than setting value *Vr*.

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

- Voltage decay on busbars.
- When the voltage on busbars decreases below setting value *Vl*, there is activated timing the limit time *tlAS* and the time of start-up delay *tsAS*.
- At the moment of timing the time of start-up delay *tsAS* – if the voltage on busbars did not recover – there is generated impulse of duration time *tp* closing the opened circuit breaker CBO.
- After opening the circuit breaker CBO, automatic unit awaits for conditions for closing the closed circuit breaker CBC.
- When the voltage on busbars decreases below setting value *Vlt*, there is activated timing the limit delay time of closing circuit breaker *tcd*.
- If *"activation of unload automatics"* is set on *"Y"*, than there is sent unload impulse of duration time *tp* shutting down selected drives, which will not take part in self-activation.
- At the moment of timing the *tcd* time, there is generated impulse of duration time *tp* closing the closed circuit breaker CBC.

- After closing the closed circuit breaker CBC and finishing closing impulse the automatics is deactivated.

3. Operation of automatic unit at inefficient devices of change-over system of switchgear: the opened circuit breaker CBO did not open:

- After finishing impulse opening the opened circuit breaker CBO, the unit awaits for timing the limit time *tlAS,* and then the automatics is deactivated.

4. Operation of automatic unit at inefficient devices of change-over system of switchgear: the closed circuit breaker CBC did not close:

- If there is possibility of closing following reserve circuit breaker (the multi-step automatics is realized), than the unit repeats attempting to close following reserve circuit breaker.
- If there is no possibility of closing following reserve circuit breaker (there is realized one-step automatics or multi-step automatics and previous attempts of closing circuit breakers finished as unsuccessful), than the unit deactivates itself after finishing impulse closing the closed circuit breaker CBC.

3.6.1.3 AS from electric power system into stand-by power generator caused by voltage decay on busbars

1. Initial conditions:

- The voltage on changed busbars *Vbus* is higher than setting value *Vl*.
- Stand-by generator is ready for operation (active external signal “readiness of generator”).

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

- Voltage decay on busbars.
- When the voltage on busbars decreases below setting value *Vl*, there is activated timing the limit time *tlASg* and the time of start-up delay *tsASg*.
- At the moment of timing the time of start-up delay *tsASg* – if the voltage on busbars did not recover and there is still active external readiness signal of generator – there is generated impulse activating the stand-by generator, duration time of impulse may be *tp* or it may be continuous impulse depending on settings of parameter *“generating of continuous impulse for controlling the stand-by generator”*.
- When the voltage on terminals of stand-by generator exceeds setting value *Vr* and the voltage on busbars did not recover there are generated impulses of duration time *tp* opening the circuit breakers of switchgear supply from power system. Necessary condition for generating impulses is finishing of other change-over operations in AS cycle and presence of external active signal “*operation of stand-by generator*”.
- If *“activation of unload automatics”* is set on *“Y”*, than there is sent unload impulse of duration time *tp* shutting down selected drives, which will not take part in self-activation.

- After opening circuit breakers there is activated timing of delay time of closing circuit breaker of stand-by generator *tcdg*.
- At the moment of timing the *tcdg* time, there is generated impulse of duration time *tp* closing the closed circuit breaker of stand-by generator and other circuit breakers enabling feeding the switchgear from stand-by generator.
- After closing the closed circuit breaker CBC and finishing closing impulse the automatics is deactivated.

3. Operation of automatic unit at inefficient devices of change-over system of switchgear: the circuit breaker of supplying switchgear from power system did not open:

- After finishing impulse opening the opened the circuit breaker of supplying switchgear from power system, the unit awaits for timing the limit time *tlASg,* and then the automatics is deactivated.

4. Operation of automatic unit at inefficient devices of change-over system of switchgear: the circuit breaker enabling feeding the switchgear from stand-by generator did not close:

- After finishing closing impulse the automatics is deactivated.

5. Operation of automatic unit at inefficient devices of change-over system of switchgear: stand-by generator did not start (did not activate):

- After finishing activating impulse the automatic unit awaits for timing limit time *tlASg* and than the automatics is deactivated.

3.6.2 Planned power supply switching automatics (PSS)

The change-over operations may be realized in optional direction between two circuit breakers supplying particular section, also at participation of power generating unit. The PSS automatics cycle is manually initiated by service staff with use of *"PSS start"* pushbutton. Operation of PSS automatics is single-time and realizes in the direction specified automatically on base of position of circuit breakers in particular supply system of switchgear.

The automatic unit realizes following change-over operations:

- synchronous non-interrupted change-over,
- slow change-over.

The change-over cycle depends on conditions for realizing particular change-over cycles existing at the moment of activating PSS automatics and on settings of unit.

By appropriate setting of automatic unit it is possible to allow for or to put out of operation the possibility of realizing change-over operations for exact directions.

At the moment of excitation of PSS automatics there is checked setting *"permission for PSS"* for following direction. It the automatics is active, than there are checked conditions for realizing non-interrupted change-over operation and following there are checked conditions for slow change-over

(with break in supply). The unit realizes change-over if there are conditions for realizing this change-over and particular cycle is not out of operation in settings.

The change-over with use of power generating unit may be realized only as slow.

If it is predicted change-over in PSS cycle from electro-energetic system supply into power generating unit, than the power generating unit should be turned on (activated) manually. If there is realized change-over from power generating unit into another circuit breaker, than unit is turned off (deactivated) automatically by automatic unit after *towa* timed from the moment of finish change-over in PSS cycle. Turn-off signal (deactivating) of power unit is generated only in situation when the circuit breaker of automatic unit is opened and voltage on switchgear busbars exists.

During realizing change-over in PSS cycle there is activated signalling *"operation of unit"* and *"activation of PSS or ARS"*.

Change-over operations are realized in limit time *tlPSS, ARS*. If during limit time change-over is not finished, than PSS cycle stops.

After finish unsuccessful PSS cycle there is generated signal *"incorrect PSS or ARS"*.

After finish change-over in PSS cycle the following operation of unit depends on setting *"permission for realizing ASS"*. The unit may do:

- come into stand-by status (ready for realizing another change-over),
- start realizing the change-over in ASS cycle.

Details are described in chat below.

PSS change-over	Setting "*permission for realizing ASS"*.	Following operation of unit
Correct – after finish the change-over the voltage on busbars exists	N	Go into stand-by status
	Y	Go into stand-by status
Incorrect – after finish change-over the switchgear remains without voltage	N	Go into stand-by status
	Y	Realizing change over in ASS cycle

After finish change-over operation the PSS automatic is interlocked for time about 10 sec.

3.6.2.1 PSS synchronous non-interrupted from CBO into CBC

1. Initial conditions:

- CBO closed.
- CBC opened.
- Voltage on switching busbars *Vbus* higher than setting value *Vg.*
- Voltage in front of circuit breakers (CBO) and (CBC) are higher than setting value *Vr* (also apples to supplying lines) or *Vl* (applies to busbars).
- There exist conditions for non-interrupted change-over (*dV* is lower than setting value).

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

- Appearance of signal activating PSS

- At the moment of appearance of signal activating PSS there is activated timing the limit time *tsPSS,ARS* and simultaneously there is generated impulse of duration time *ti* closing the closing circuit breaker CBC.
- After closing the closing circuit breaker there is generated impulse of duration time *ti* opening the opening circuit breaker CBO.
- After opening the opened circuit breaker CBO and finishing opening impulse the automatics is deactivated.

3. Operation of automatic unit at inefficient devices of change-over system of switchgear: the closing circuit breaker CBC did not close:

- After finishing impulse closing the closed circuit breaker CBC the automatics is deactivated.

4. Operation of automatic unit at inefficient devices of change-over system of switchgear: the opening circuit breaker CBO did not open:

- After finishing impulse opening opened circuit breaker CBO, there is generated impulse of duration time *ti* opening closed circuit breaker CBC.
- After opening closed circuit breaker CBC and finishing opening impulse the automatics is deactivated.

3.6.2.2 PSS slow from CBO into CBC

1. Initial conditions:

- CBO closed.
- CBC opened.
- Voltage on switching busbars *Vbus* higher than setting value *Vg.*
- Voltage in front of circuit breakers (CBO) and (CBC) are higher than setting value *Vr* (also apples to supplying lines) or *Vl* (applies to busbars).

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

- Appearance of signal activating PSS
- At the moment of appearance of signal activating PSS there is activated timing the limit time *tsPSS,ARS* and simultaneously there is generated impulse of duration time *ti* opening the opening circuit breaker CBO.
- After opening the opening circuit breaker CBO the automatic unit awaits for conditions for the closing the closing circuit breaker CBC.
- When the voltage on busbars decreases below setting value *Vlt* then there is activated timing the delay time of closing the circuit breaker *tcd*.
- If "*activation of unload automatics*" is set on "*Y*" then is sent unload impulse of duration time tp shutting down selected drives, which will not take part in self-activation.
- At the moment of timing the *tcd* time, there is generated impulse of duration time *tp* closing the closed circuit breaker CBC.

- After closing the closed circuit breaker CBC and finishing closing impulse the automatics is deactivated.

3. Operation of automatic unit at inefficient devices of change-over system of switchgear: the opening circuit breaker CBO did not open:

- After finishing impulse opening the opened circuit breaker CBO the automatics is deactivated.

4. Operation of automatic unit at inefficient devices of change-over system of switchgear: the closing circuit breaker CBC did not close:

- After finishing impulse closing closed circuit breaker CBC, there is activated timing the delay time of return *trd*.
- At the moment of timing the *trd* time, there is generated impulse of duration time *tp* closing the opened circuit breaker CBO.
- After closing opened circuit breaker CBO and finishing closing impulse the automatics is deactivated.

3.6.3 Automatic return switching automatics (ARS)

If after finishing correct change-over operation in As cycle from voltage decay there appears voltage in supplying line, then the unit may realize automatic return switching of switchgear supply into main supply.

After opening the circuit breaker in As cycle from voltage decay the automatic unit remembers which circuit breaker was opened and after recovering voltage from power generating system it realizes return change-over operation in the direction of circuit breaker previously opened. If in one cycle or several cycles realized as follows there were opened some circuit breakers, than the unit will realize several change-over operations in ARS cycle separately for each circuit breaker. Sequence of these change-over operations in ARS cycle depends on order of recovering voltage in supplying lines.

Change-over operations are realized only in direction into main supply. Operation of ARS automatics for particular direction is realized only once.

Change-over operations in ARS cycle are realized in the same way as change-over operations in PSS cycle.

The automatic unit realizes following change-over operations:

- synchronous non-interrupted change-over,
- slow change-over.

The change-over cycle depends on conditions for realizing particular change-over cycles existing at the moment of activating change-over operation and on settings of unit.

The change-over with use of power generating unit may be realized only as slow.

If there is realized change-over from power generating unit into another circuit breaker, than the power generating unit should be turned off (deactivated) by unit after *towa* time counted from the

moment of finishing change-over operation in ARS cycle. Power unit may be turned-off (deactivated) only in situation when the circuit breaker of power generating unit is opened and voltage on switchgear busbars exists.

By appropriate setting of automatic unit it is possible to allow or put out of operation for possibility of realizing change-over in particular direction. At the moment of finish correct change-over AS operation, which means at the moment of activating ARS automatics, the unit checks if in settings there is allowed change-over operation in selected direction. After return of voltage in supplying line the unit realizes return change-over.

Change-over operations must be started during time *twARS* waiting for conditions for realizing ARS.

If during waiting the change-over will not start, than ARS cycle will break and unit comes into stand-by status.

During waiting time (from the moment of finish AS till finish change-over in ARS cycle) there is activated signalling "*operation of unit*" and *"waiting for ARS"*.

During realizing change-over there is activated signalling "*operation of unit*" and "*activation of PSS or ARS*".

Change-over operations are realized during limit time *tlPSS,ARS*. If during limit time change-over operation is not finished, than break of ARS cycle appears.

After finish of incorrect ARS cycle there is generated signal *"incorrect PSS or ARS"*.

After finish change-over in ARS cycle following operations of automatic unit are the same as after finish of change-over in PSS cycle (see item 3.6.2).

If during waiting there appear conditions for realizing AS operation, than change-over operation in AS cycle appears. During realizing AS the automatics of ARS is transiently interlocked.

If during waiting appears activation of PSS automatics, than ARS automatics is deactivated and there is realized PSS automatics.

3.6.3.1 Change-over in ARS cycle

1. Initial conditions:

- CBO closed.
- CBC opened.
- Voltage on switching busbars *Vbus* higher than setting value *Vg.*
- Automatic unit has finished correct change-over in AS slow cycle from voltage decay.

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

- Finish of correct change-over operation in AS cycle.
- At the moment of finish correct change-over in AS cycle there is activated timing the wait time *twARS.*

- When the voltage in main supplying line recovers above setting value *Vr* and the time *twARS* did not come than there is activated timing the delay time of start up *tsARS*.
- At the moment of timing the *tsARS* time, there is started realizing the change-over in ARS cycle. The change-over operation is realized identical as in PSS cycle. It is described in item 3.6.2.

3.6.4 Auto supply switching automatics (ASS)

Change-over operation in ASS cycle is realized if at the moment of disturbance appearance there are no conditions for realizing AS cycle (for instance the switchgear is supplied from reserve supply source), or if after finish another change-over there is no voltage on busbars. Its goal is to return the supply, when the switchgear remains without voltage and there is no possibility fro realizing another change-over operation.

The ASS automatics cycle is initiated automatically by unit. The operation is realized only once and direction of it is into circuit breaker which remains with voltage (priority is into main circuit breaker).

Change-over operations in ASS cycle are realized similar as in AS change-over cycle, but the difference is that AS automatics may be switched on only on reserve circuit breaker and during ASS operation it is possible to close optional circuit breaker. ASS automatics may switch on the stand-by generator (similar as during AS cycle into generator). Impulse closing (activating) the generator is sent if there are no conditions for previous closing the circuit breaker supplying switchgear from electric power system.

By appropriate setting of automatic unit it is possible to allow or put out of operation the possibility of realizing change-over operation.

During realizing change-over operation in ASS cycle there is activated signalling “operation of unit” and *“waiting for ASS”*.

After finish change over in ASS cycle there is generated signal *“operation of ASS”*.

Change-over operations are realized in limit time *tlASS*. If during limit time the change-over is not finished than deactivating of ASS automatics appears.

After finish incorrect ASS cycle there is generated signal *“incorrect ASS”*.

After finish change-over in ASS cycle the following operation of unit depends on setting “*interlock of unit after realizing AS or ASS*”. The unit may:

- come into stand-by status (ready for realizing another change-over operations),
- permanently interlock.

Details are described in chart below.

ASS change-over	Setting “*interlock of unit after realizing AS or ASS”*	Following operation of unit
Correct – after finish change-over the voltage on switchgear busbars exists	N	stand-by status
	Y	permanent interlock
Incorrect – after finish change-	N	stand-by status

over the switchgear remains without voltage	Y	permanent interlock

The change-over in ASS cycle will be initiated in case of:

- voltage decay on switchgear busbars in situation of no conditions for activation the AS automatics (i.e. the switchgear is supplied from reserve power source),
- if after finish another change-over operation there is no voltage on switchgear busbars.

Automatics realizes the change-over between may circuit breakers. It carries out tests of closing successively all circuit breakers supplying particular section (and if the coupler in switchgear is closed – closing all circuit breakers supplying connected sections). Automatic unit tries to switch on circuit breakers in sequence determined during configuration of automatic unit. Priority is established for main circuit breaker. The change-over becomes finished at the moment of closing any of circuit breakers, or during realizing unsuccessful attempts of closing in turn all circuit breakers.

3.6.4.1 ASS caused by voltage decay on switchgear busbars in a situation when there are no conditions for activating AS automatics

1. Initial conditions:

- No conditions for activation the AS automatics.
- CBC opened.
- Voltage on switching busbars *Vbus* higher than setting value *Vg.*

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

- Voltage decay on busbars.
- When the voltage on busbars decreases below setting value *Vl*, there is activated timing the limit time *tlASS* and if in switchgear there is built in stand-by generator, than there is additionally activated timing the delay time for start-up delay *tsASS* into power generating unit.
- If the voltage on any supplying line is recovered above setting value *Vr*, than there is activated timing the start-up delay time *tsASS* timed individually for each circuit breaker.
- At the moment of timing the time of start-up delay *tsASS* for circuit breaker of currently higher priority (from all circuit breaker with voltage present), there is started change-over in ASS cycle. If the change-over is realized in direction into circuit breaker of supply from electric power system, than following operation is similar to AS cycle from voltage decay (if there is closed opened circuit breaker CBO), or similar to AS cycle from opening the circuit breaker (if all circuit breakers are opened). If there is realized change-over into power generating unit, than following algorithm of operation is identical as during AS cycle into power generator.

3. Operation of automatic unit at inefficient devices of change-over system of switchgear: the closed circuit breaker CBC did not close:

- If there is possibility of closing following circuit breaker, than the unit repeats attempting to close following circuit breaker.

- If there is no possibility of closing following circuit breaker (previous attempts of closing circuit breakers finished as unsuccessful), than the unit deactivates itself after finishing impulse closing the closed circuit breaker CBC.

3.6.4.2 ASS caused by voltage decay on switchgear busbars after finish another change-over (AS, PSS, ARS)

1. Initial conditions:

- Another change-over operation has finished.
- CBC opened.
- Voltage on switching busbars *Vbus* higher than setting value *Vg.*

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

- Finish of another change-over operation.
- At the moment of finish another change-over, there is activated timing the limit time *tlASS* and if in switchgear there is built in stand-by generator, than there is additionally activated timing the delay time for start-up delay *tsASS* into power generating unit.
- If the voltage on any supplying line is recovered above setting value *Vr*, than there is activated timing the start-up delay time *tsASS* timed individually for each circuit breaker.
- At the moment of timing the time of start-up delay *tsASS* for circuit breaker of currently higher priority (from all circuit breaker with voltage present), there is started change-over in ASS cycle. If the change-over is realized in direction into circuit breaker of supply from electric power system, than following operation is similar to AS cycle from voltage decay (if there is closed opened circuit breaker CBO), or similar to AS cycle from opening the circuit breaker (if all circuit breakers are opened). If there is realized change-over into power generating unit, than following algorithm of operation is identical as during AS cycle into power generator.

3. Operation of automatic unit at inefficient devices of change-over system of switchgear: the closed circuit breaker CBC did not close:

- If there is possibility of closing following circuit breaker, than the unit repeats attempting to close following circuit breaker.
- If there is no possibility of closing following circuit breaker (previous attempts of closing circuit breakers finished as unsuccessful), than the unit deactivates itself after finishing impulse closing the closed circuit breaker CBC.

4 Technical data

supplying	rated measured voltage Vn	100 V AC
measuring	long term thermal resistance	1,5 Vn
voltage	10-second thermal resistance	2,5 Vn
	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	chosen from range: 24..220 V DC or 24..230 V AC
	operating range of auxiliary supply voltage	0,8...1,1 Vn
	permissible maximum level of the auxiliary voltage range	1,3 Vn (permanent)
	power consumption of supply unit	<10 W
	total power consumption from the auxiliary voltage circuit	<15 W
voltage units	**Vr** – over-voltage control units of permissible reserve voltage	20...120 V
	Vl – under-voltage units of start up voltage of AS automatics	20...120 V
	Vlt – under-voltage units of permissible voltage allowing for closing circuit breaker	20...120 V
	dV – over-voltage control units of permissible differential voltage interlocking uninterrupted change-over	20...120 V
	Vv – under-voltage units of voltage control on busbars	20...120 V
	Upon special request setting scopes of voltage units may be changed in range 5...200 V.	
	Warranty error of the setting scale of voltage units:	
	for settings higher than 40 V	±2,5 %
	for the remaining settings	±1 V
	return factor of over-voltage units	>0,85 (difference between start-up value and return value 1...3 V)
	return factor of under-voltage units	<1,15 (difference between start-up value and return value 1...3 V)

	Error of voltage units for the frequency range 30...45 Hz	±5 %
time units	**tsAS** – time units of start up delay in AS cycle from voltage decay	20...30000×0,01 s
	tlAS – units of limit time for AS	50...30000×0,01 s
	tsASg – time units of start up delay in AS cycle switching power generator	20...30000×0,01 s
	tlASg – units of limit time for AS cycle switching power generator	50...30000×0,01 s
	tsARS – time units of start up delay in ARS cycle	20...30000×0,01 s
	twARS – time units of waiting for ARS	50...30000×1 min
	tsASS – time units of start up delay in ASS cycle from voltage decay	20...30000×0,01 s
	tlASS – units of limit time for ASS	50...30000×1 min
	tlPSS,ARS – units of limit time for PSS and ARS	50...30000×0,01 s
	tp – time units of duration of controlling pulses	20...30000×0,01 s
	tcd – time units of delay of closing circuit breaker	20...30000×0,01 s
	tcdg – time units of delay of closing circuit breaker of power generator	20...30000×0,01 s
	trd – time units of return delay at slow PSS and ARS	20...30000×0,01 s
	tdtg – time units of delay of tripping power generator	20...30000×0,01 s
	tv – time units of operating delay of voltage control units on busbars V<t	20...30000×0,01 s
	tap – units of minimal duration time of passing signalling impulses	20...30000×0,01 s
	tad – units of delay time of not ready annunciation	20...30000×0,01 s
	Upon special request of customer the setting scopes of time units may be changed in range 0,1s...30000 min.	
	Warranty error of setting scale of time units:	
	for the setting lower than 2 s	±50 ms
	for the remaining settings	±2,5 %
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, 1 min
Environmental conditions	Nominal scope of ambient temperature	-10...+55^{o} C
	Limit value of extreme range of ambient temperature	-25 i +70^{o} C
	Relative humidity	45...75 %
	Atmospheric pressure	86...106 kPa
Casing	Dimensions	According to item 2.2
	Assembly	on-the-panel or behind-the-panel
	Weight	5 kg
	Protection degree	IP40
	Terminals	WAGO screwless

Notes:

1. The Producer reserves the right for making modifications in products as result of scientific and technological progress.
2. Particular units have wide setting range. In order to ensure appropriate operation of automatic unit there is required optimum coordinating of all setting values.

5 Schedule of applied standards

During constructing and production of the automatic unit APZ there were applied standards, which fulfilling provides realization 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 APZ 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 APZ,
- Set of plug terminals,
- Cable RS232 for communication with PC,
- Disc with installation software,
- Operating manuals of APZ,
- Appendix for operating manuals,
- 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 APZ automatic units should operate in conditions described in technical data.

7.2 External connection

Automatic unit is configured individually for every switchgear.

Controller used in automatic unit posses input-output modules with 20 inputs and 12 outputs. Depending on configuration system in switchgear the controller may be equipped in appropriate number of modules. Number of inputs and outputs is multiple of number 20 and 12.

Inputs of automatic unit are general-purpose and they may be activated with direct or alternating voltage of nominal value selected from range 24…230 V. Particular inputs may fulfil the function of measurement inputs and two-status inputs. Assignment of input (measurement or two-status), kind of voltage (direct or alternating), nominal value of voltage (24…230 V) and level of switching particular input are selected during producing, depending on needs.

Particular two-status inputs may be supplied with auxiliary voltage from automatic unit, with auxiliary voltage from optional bay or any other voltage used in switchgear, i.e. 24 V from computer controlling system.

In output circuits of automatic unit there were applied relays. Outputs are accommodated for direct controlling with circuit breakers or to control of annunciation.

No drawing 3 there is shown example diagram of external connections off automatic unit APZ-2 working in switchgear with apparent stand-by system. He unit is supplied with auxiliary direct voltage.

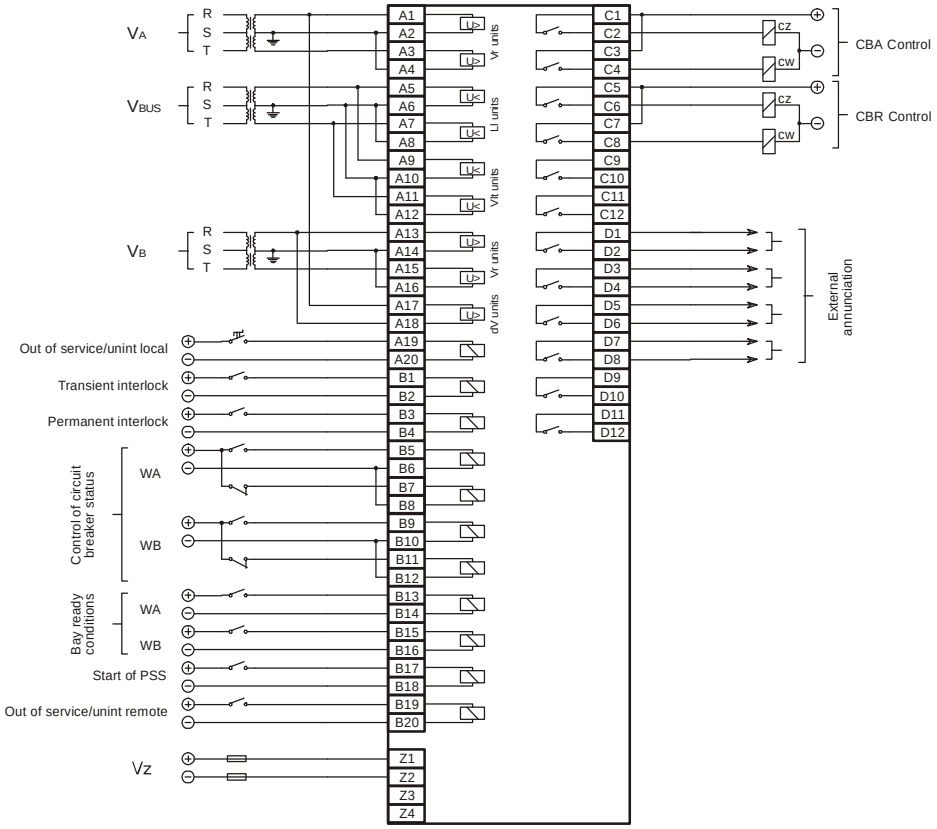

Fig. 3 Example diagram of external connections of automatic unit APZ-2

7.2.1 Measurement voltage supply

To the automatic unit there are delivered measured phase-to-phase voltages 100 V with use of voltage transformers in star system (Y or V) or in delta system. Secondary circuits of transformers should be grounded. It is possible to connect with ground also star central point or optional phase i.e. L2. For purpose of correct measurement of differential voltage it is essential to make all the secondary circuits of transformers grounded in identical way.

Automatic unit typically controls two phase-to-phase voltage L1-L2 and L3-L2. If it is needed, there is possibility of controlling three voltages L1-L2, L3-L2, L3-L1 or one voltage L1-L2.

Threshold of activating of particular measurement inputs is selected individually. One input may control only one threshold of activating. If in particular point of voltage measurement there is required controlling of two voltage thresholds (which is necessary in case of voltage measurement on busbars), than voltage signal should be delivered into two inputs and each of them will have another activating threshold.

On the drawing 3 there is presented connection of voltages from supplying lines *VA* and *VB*, which control one threshold of activating (units *Vr*) and voltages of busbars *Vbus*, which control two activating thresholds (units *Vl* and *Vlt*).

If in automatic unit there is possible realizing the uninterrupted change-over operation, than there is required control of differential voltage between voltages in adequate measuring points. Differential voltage of phase L1 should be delivered into additional measurement input (unit *dV*) as it was described on drawing 2.

For voltage circuits from measurement bay in switchgear section there is required instantaneously operating protection with automatic circuit breaker, which NC contact should be delivered into input transiently interlocking operation of automatic unit.

7.2.2 Supply with auxiliary voltage

The automatic unit in supplied with direct of alternating auxiliary voltage of nominal value selected from range 24…230 V. In case of auxiliary voltage decrease or decay, on the device there is activated external annunciation *"Out of service"*.

7.2.3 Switch on and off the automatic unit

For switch on and switch off of automatic unit there is used a switch key SA called *"out-of-op/unint"* or *"remote out-of-op/unint"*. Through the SA switch there is given auxiliary voltage into appropriate terminals. 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.

There exists possibility of impulse switching on and off the automatic unit sending single impulse on appropriate input called *"remote out-of-op/unint"*. Impulse switching on and off of automatic unit is only possible in case, when the SA key is closed. Every sending the impulse causes change of status of automatic unit into opposite state.

There are predicted two ways of switching on and off the automatic unit from computer controlling system (using contact signals):

- With two orders: switching on and off, in the system as it is shown in drawing 4a; additional contact is controlled bistable.
- With one order changing status of automatic unit into opposite, in system as it is described on drawing 4b; additional contact is controlled in impulse way.

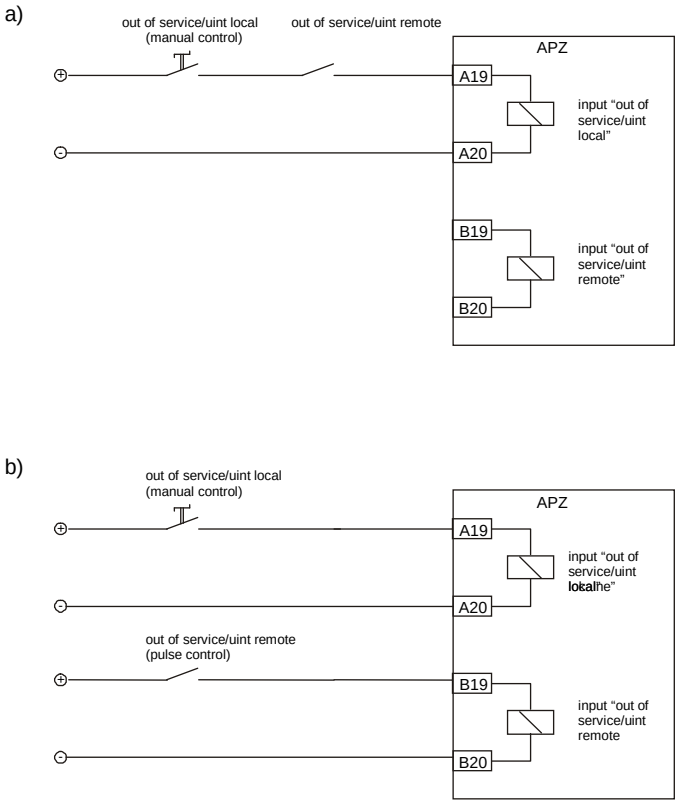

Fig. 4 Switching on and off the automatic unit from computer controlling system (with use of contact signals).

The operation of unit was described in chart below.

Input status "SA key"	Input status "impulse switching on *SA key*"	Unit status
SA key is opened	Optional	Switched off (out of service)
SA key becomes closed	Optional	Switched on (self d-interlock)
SA key is closed	Lack of impulse	Remain with no changes
SA key is closed	Impulse is sent	Changes into opposite

Direct control of unit from system by communication link RS422 (RS485) is described in item 8.4.6.

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

7.2.4 Interlock external signals

To the terminals of unit there may be introduced external signals interlocking operation of the automatic unit. The unit possesses two inputs: transient interlock and permanent interlock.

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. Realization 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 activating 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 or 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.

7.2.5 Activation of PSS automatics

Particular signals *"start of PSS"* cause activation of PSS automatics in the direction determined by particular pushbutton.

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

7.2.6 Control of circuit breaker position

To the automatic unit there is 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 system, which causes transient interlock of automatic unit in cycle PSS and ARS and if ambiguous case appears on reserve (close) circuit breaker – than also change-over in AS and ASS cycle.

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

7.2.7 Conditions of bays readiness

To the automatic unit it is possible to deliver information about readiness of bay (of circuit breaker) in the system described below on fig. 5a.

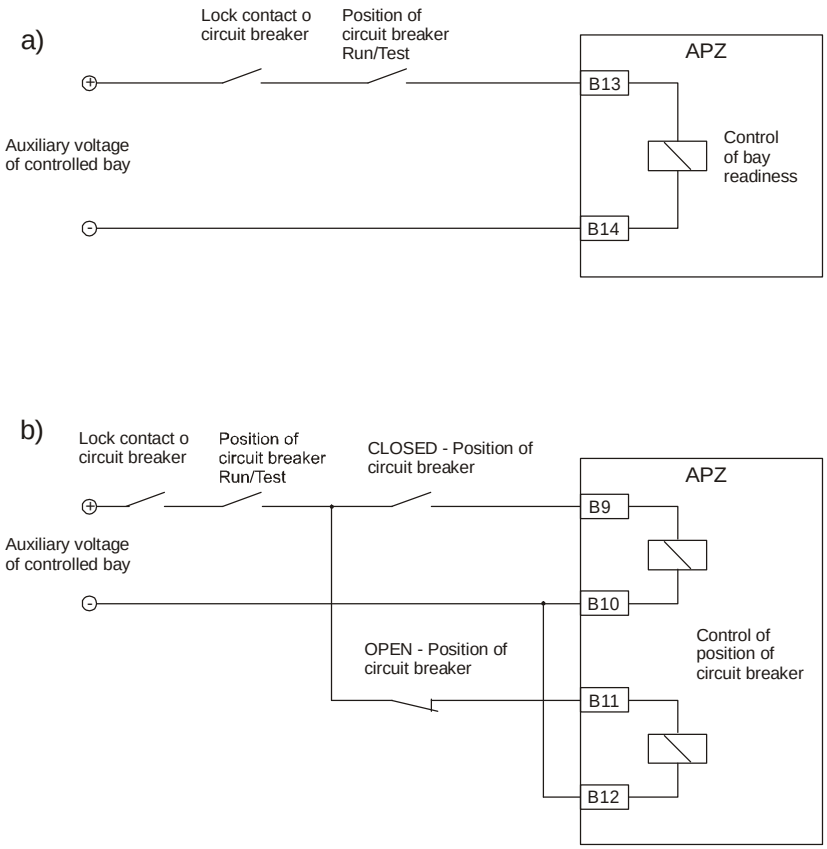

Fig. 5 Control of bay readiness

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 change-over operations in PSS and ARS cycles, which involve that particular circuit breaker. If lack of bay readiness appears on reserve circuit breaker (closed), then there are also interlocked of change-over operations in AS and ASS cycles.

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.

There is also possibility of controlling bay readiness in indirect way described on figure 5b, with use of information (contacts) of circuit breaker position status. In case of lack of controlling voltage or opening contacts of bay readiness to automatic unit there comes information about simultaneous lack of voltage and on both inputs, which means ambiguous position of circuit breaker. Automatic unit considers this situation as lack of bay readiness.

Circuit breaker in “test” position does not take part in change-over and does not interlock the change-over operations between other circuit breakers.

7.2.8 Control of circuit breakers

Control voltage of particular circuit breakers should be introduced from bay of particular circuit breaker.

Closing impulses may be introduced into coils switching on circuit breakers in two different ways:

- Directly from coil closing particular circuit breaker; this way is used during uninterrupted change-over operations in PSS and ARS cycles.
- Through auxiliary contacts of another circuit breakers. This way is used during slow change-over operations.

Shut down impulses should be introduced directly on switch-off coil.

7.2.9 Control with power generating unit

Power generating units are typically controlled with use of one method described below:

- One continuous impulse. Appearance of impulse switches on (activates) the generator and decay of this impulse switches off (deactivates) the generator. Control may be compared to operation of monostable relay.
- Two independent impulses: switching on (activating) and switching off (deactivating). This control may be compared to operation of bistable relay.

Automatic unit has possibility of control with power generating unit by use of one of given ways chosen in settings.

Control voltage of generator should be delivered from generator bay. It is advantageous to deliver controlling signals through additional contacts of SA key.

Impulses closing circuit breaker of power generator should be delivered through auxiliary contacts of another circuit breakers, in the purpose not to allow for uninterrupted change-over operations with use of power generating unit.

7.2.10 External signalling and recording

The automatic unit was equipped in contacts allowing for external signalling and recording its events. To the output terminals there were connected contacts and thanks this it is possible to activate them with optional signalling voltage used in particular switchgear.

8 Activation

8.1 General information

After installing the APZ automatic unit there should be switched on the battery in controller by pulling out the strip projecting out of upper cover of unit. Than there should be performed starting up in accordance to general rules concerning to devices of protection, automatics, control and implementation. During start-up should be realized 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),
- maximum permissible limit value of load of relay outputs,
- correctness of assembling,
- 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

8.2.1 Voltage units

Voltage units are performed during manufacturing activities by producer. There are predicted no changes of setting values of voltage setting units on site.

1. ***Vr*** – reserve limit voltage.
Minimal value of reserve voltage is allowed to realizing change-over operation in selected direction. There is controlled lower value from two phase-to-phase voltages L1-L2 and L3-L2.

2. ***Vl*** – start-up voltage of AS automatics.
Voltage value on busbars, below which there is activated timing limit times *tlAS, tlASa, tlASS* and there is started operation of AS automatics from voltage decreasing and ASS automatics.
There is controlled lower value between two phase-to-phase voltages L1-L2 and L3-L2.

3. ***Vlt*** – permissible voltage on busbars allowing for closing the circuit breaker.
Voltage value on busbars below value which closing the circuit breaker is permitted.
There is controlled higher value between two phase-to-phase voltages L1-L2 and L3-L2.

4. ***dV*** – permissible differential voltage interlocking (realizing) uninterrupted change-over.
Value of geometric difference of voltage between voltages in appropriate measuring points, above which there is no permission for uninterrupted change-over operations. The difference of voltage at the moment of initiating change-over operation determinates the selection of change-over operation cycle. There are controlled phase-to-phase voltages L1-L1.

5. ***Vv*** – activating voltage of units U<t of voltage control on busbars.
Start-up voltage of under-voltage units U<t control the voltage on busbars.
There is controlled lower value between two phase-to-phase voltages L1-L2 and L3-L2.

8.2.2 Time units

For the purpose of introducing settings of time units there is dedicated computer program "APZ_nast_rejzd".

1. ***tsAS*** – time of start-up delay of AS cycle from voltage decay.
Time used at AS cycle from voltage decay. This is the time of delay of opening circuit breaker of main supply introduced in order to protect from AS operating in case of momentary decays and drops of voltage on switchgear busbars. Timing the time is started at the moment of voltage decrease on switchgear busbars below setting value on switchgear busbars *Vl*.

2. ***tlAS*** – limit time for AS.
Time dedicated for realizing the change-over in AS cycle. In case during *tlAS* time the change-over operation has not finished, there appears breaking AS cycle. Following operation of automatic unit depends on switchgear status and settings of automatic unit and it was particularly described in item 3.6.1. Timing the time is started at the moment of decreasing voltage value on busbars below setting value *Vl*.

3. ***tsASg*** – time of start-up delay of AS cycle switching on power generating unit.
Time is realized at AS cycle switching on power generating unit. This is the time of start-up delay (activating) the generator, introduced in order to protect from switching on power generating unit in case of momentary decays and drops of voltage on switchgear busbars. Timing the time is started at the moment of decreasing voltage value on busbars below setting value *Vl*.

4. ***tlASg*** – limit time for AS cycle switching on power generating unit.
Time dedicated for realizing the change-over in AS cycle switching on power generating unit. In case during *tlASa* time the change-over operation has not finished, there appears breaking AS cycle. Following operation of automatic unit depends on switchgear status and settings of automatic unit and it was particularly described in item 3.6.1. Timing the time is started at the moment of decreasing voltage value on busbars below setting value *Vl*.

5. ***tsARS*** – time of start-up delay of ARS cycle.
This is the time of delay of realizing change-over operation on ARS cycle introduced in order to protect from appearance of momentary voltage in supplying line. Timing the time is started at the

moment of decreasing voltage value on busbars below setting value *Vl*. After timing *tsARS* time there appears starting the change-over operation.

6. ***twARS*** – waiting time for ARS.
Time dedicated for starting realizing the change-over in ARS cycle. In case during *tsARS* time the change-over operation has not started, there appears breaking ARS cycle and becoming into stand-by status. Timing the time is started at the moment of opening circuit breaker in AS cycle from voltage decay.

7. ***tsASS*** – time of start-up delay of ASS cycle.
This is the time of delay of realizing change-over operation on ARS cycle introduced in order to protect from appearance of momentary voltage in supplying line and also to protect from operating in ASS cycle in case of momentary decays and drops of voltage on switchgear busbars. Timing the time is started at the moment of decreasing voltage value on busbars above setting value *Vl*. After timing *tsASS* time there appears starting the change-over operation.

8. ***tlASS*** – limit time for ASS.
Time dedicated for starting realizing the change-over in ASS cycle. In case during *tlASS* time the change-over operation has not finished, there appears breaking ASS cycle. Following operation of automatic unit depends on switchgear status and settings of automatic unit and it was particularly described in item 3.6.4. Timing the limit time is started at the moment of finishing another incorrect change-over operation or at the moment of decreasing voltage value on busbars below setting value *Vl*.

9. ***tlPSS,ARS*** – limit time for PSS and ARS.
Time dedicated for starting realizing the change-over in PSS and ARS cycle. n case during *tlPSS,ARS* time the change-over operation has not finished, there appears breaking of PSS or ARS cycle. Following operation of automatic unit depends on switchgear status and settings of automatic unit and it was particularly described in item 3.6.2 and 3.6.3. Timing the limit time is started at the moment of activating PSS automatics and starting the change-over operation in ARS cycle.

10. ***tp*** – duration time of controlling impulses.
Duration time of impulses controlling circuit breakers and duration time of impulses controlling power generating unit.

11. ***tcd*** – delay time of closing circuit breaker.
This is the time of delay of generating impulse closing circuit breaker. Timing of this time is started at the moment of opening circuit breaker and decreasing voltage on busbars below setting value *Vlt*.

12. ***tcdg*** – delay time of closing circuit breaker of power generating unit.
This time is used at AS cycle switching on power generating unit. This is the time of delay of generating impulse closing the circuit breaker of power generating unit. Timing of this time is started at the moment of opening circuit breakers supplying switchgear from electric power system.

13. ***trd*** – delay time of return at slow PSS and ARS cycle.
This time is used at unsuccessful slow PSS and ARS cycle (the circuit breaker did not close). It causes the delay of generating impulse closing circuit breaker of up-to-now supplying source. Timing of this time is started at the moment when the impulse closing damaged circuit breaker fades.

14. ***tdtg*** – delay time of tripping power generating unit.
This time is used at PSS and ARS cycle from power generating unit into circuit breaker of switchgear supply from electric power system. This is the time of shut down delay of generator. Timing of this time is started at the moment of finishing change-over operation in PSS or ARS cycle.

15. ***tv*** – delay time of operating of units V<t of voltage control on busbars.
Delay time of operating under voltage units V<t of voltage control on busbars.

16. ***tap*** – minimal duration time of passing signalling pulses.
Minimal duration time of passing pulses of external annunciation. If the time of activating is longer then *tap*, than activating is not extended.

17. ***tad*** – delay time of not ready annunciation
Time of delay of “not ready” annunciation caused by voltage decrease or ambiguous response of circuit breakers layout status. In case when the reason for this exists shorter than *tad*, than annunciation is not activated.

8.2.3 Programming of unit operation

For programming of unit operation there is dedicated computer software “APZ_nast_rejzd”.
1. Permission for realizing the change-over operation set individually for every cycle of change-over and individually for every direction of change-over operation.

In case of setting *"Y"* – the automatic unit will be able to realize particular cycle of change-over for particular direction and in case of setting *"N"* – change-over operations will be put out of operation.
Permission may be set for following change-over operations:

- AS,
- PSSs – PSS slow,
- PSSsu – PSS synchronous uninterrupted,
- ARSs – ARS slow,
- ARSsu – ARS synchronous uninterrupted.

2. Permission for realizing change-over operation set individually for every cycle of change-over operation in all directions simultaneously.
In case of setting *"Y"* – the automatic unit will be able to realize particular cycle of change-over and in case of setting *"N"* – change-over operations will be put out of operation.
Permission may be set for following change-over operations:

- AS – auto stand-by switching,
- ASg – auto stand-by switching into power generator,
- PSS – planned power supply switching,
- ARS – automatic return switching,
- ASS – auto supply switching.

Note:
Change-over operations may be realized if simultaneously there are set permissions described in item 1 (individually for every change-over cycle and individually for every direction of change-over operation) and permissions described in item 2 (individually for every cycle of change-over operation in all directions simultaneously).
3. Interlock of automatic unit after finish AS or ASS.
Setting of operation way of automatic unit after realizing the change-over operation in AS or ASS cycle (it means after change-over operations realized automatically in emergency situations). In case of setting *"Y"* – the automatic unit after realizing AS or ASS cycle becomes permanently interlocked and in case of setting *"N"* – after realizing change-over the automatic unit comes into stand-by status (ready for realizing following change-over operations). If simultaneously there was initiated more than one change-over operation, than the automatic unit may become interlocked at the moment of finish last change-over operation.
4. Activation of unload automatics.
Command of generate the unloading pulse shutting down selected drives, which will not take part in group self start-up. In case of setting *"Y"* – the automatic unit will generate unloading pulses and in case of setting *"N"* – the unload automatics will be put out of operation.
5. Generating continuous pulse of control with power generator.

Setting of control way of power generation unit. In case of setting *"Y"* – the automatic unit generates one continuous pulse for control of power generator and in case of setting *"N"* – the automatic unit generates two independent pulses for switching on (activating) and switching off (deactivating) power generator.

8.3 Service of software "APZ_nast_rejzd"

8.3.1 Initial information

Software "APZ_nast_rejzd" serves the purpose of introducing the settings of time units, programming the operation of automatic unit and buffer readout of events register. It enables the printout of unit settings and events register. In text file "APZ_nast_rejzd_nnn.txt" (where "nnn" mans manufacturing number of automatic unit) there was included schedule of unit settings including setting values and specification of messages displayed during readout of events register. For the comfort of user there is recommended to put text file in the same catalogue as the file with software. Both files are delivered on disc together with automatic unit. Information reds out from recorder are written in file of name given by user with "dat" extension.

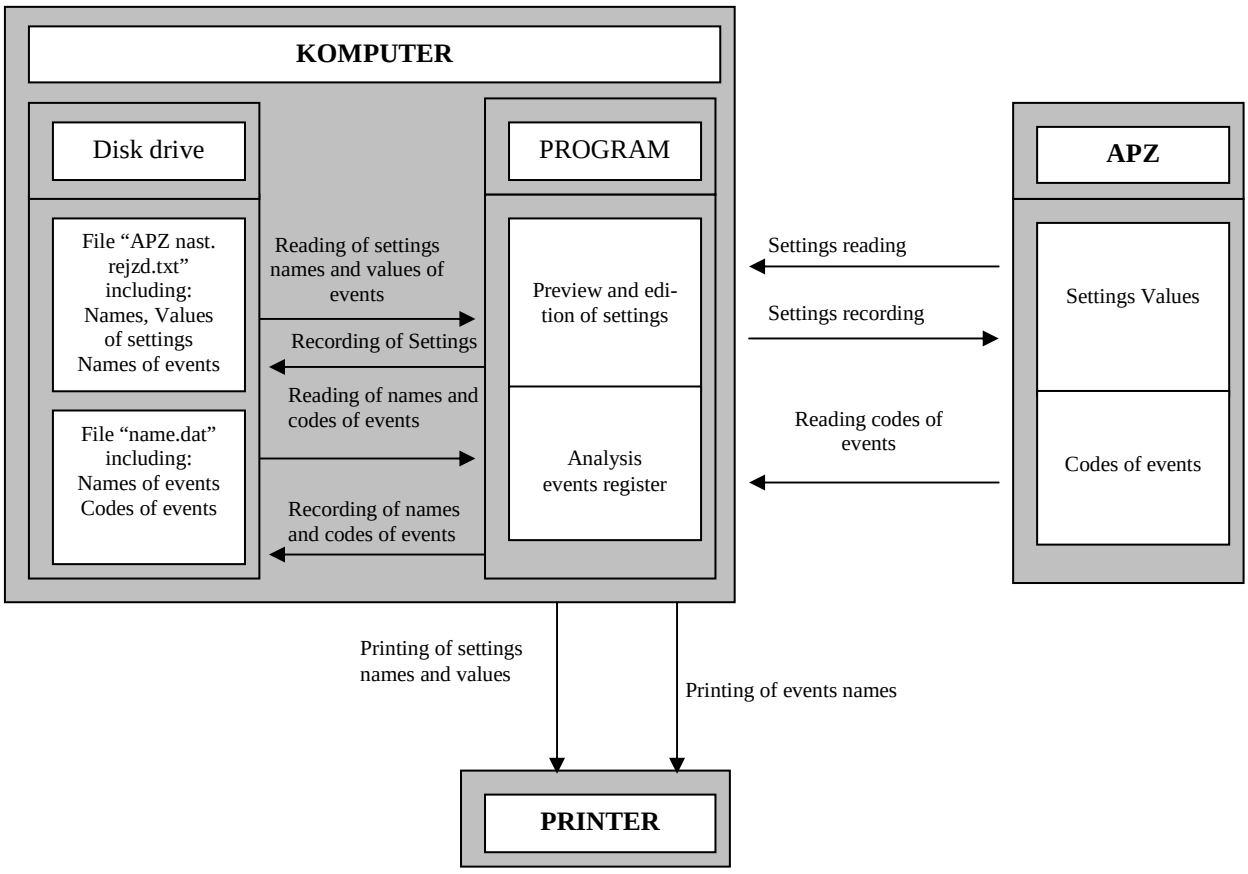

Fig.6. Functional diagram

It is necessary to pay attention on fact that in memory of unit there are recorded only values of settings and codes of events, but names of settings and names of events (i.e. information for service staff) are written in file “APZ_nast_rejzd_nnn.txt” or “file name.dat”.

8.3.2 Communication

Automatic unit was equipped in following links:

- “Serial port” – socket DB9 located on front board and dedicated for cooperation with transportable PC, standard RS232. Address 1 set permanently.
- “Serial port 2” – socket DB15 built in next to output sockets of automatic unit, dedicated for cooperation with computer control system, standard RS422 (RS485). Address 1...247 set in software “APZ_nast._rejzd.

The software may be started on transportable PC connected to “serial port” or activated in control system with use of “serial port 2”.

Transmission parameters set in bookmark “Transmission settings”:

- port	1, 2, 3, 4 – to choose by user
- speed	19200 bits by second
- evenness	lack
- data bits	8
- stop bit	1
- address of device	1 – in case of using “serial port” (RS232) 1...247 – in case of using “serial port 2” (RS422).

For activating the communication between automatic unit and computing system there are used commands “Communication” and “Connect” or “Disconnect”.

Below there is given order of activities realized at the moment of connecting the automatic unit:

a. Connect automatic unit to RS232 link of PC with use of cable delivered by producer of automatic unit.
b. Start the application “APZ_nast_rejzd.exe”.
c. Set the communication parameters (bookmark: “*Transmission settings*”).
d. Communicate with automatic unit (menu: “*Communication*” -> ”*Connect”*).
e. Open the file with settings and messages of particular automatic unit (menu: “*Settings*” -> “*Open file*”).

After realizing these routines in bookmarks “Operation times” and “Operation programming” there appear correct names of settings and values of settings red out from disc. If the automatic unit is correctly connected to PC and files “APZ_nast_rejzd.exe” and “APZ_nast_rejzd_nnn.txt” are located in the same catalogue, than routines described in items c, d, e will be realized automatically.

After realizing routines described above it is possible to do monitoring and edition of settings or to read the events register.

The software may be activated without connection with automatic unit, for instance in order to previously prepare set of settings or the analysis of events register. In this case after starting the pro-

gram tries to realize routines described above in items c, d, e for a time of dozen or so seconds and than it displays a message “No device found”.

8.3.3 Settings

The program posses following possibilities:

- Readout of setting names and setting values and event names from disc (menu: “*Settings*” -> “*Open file*”),
- Record of new setting values on disc (menu: “*Settings*” -> “*Save file as*”),
- Readout of setting values from automatic unit (menu: “*Settings*” -> “*Setting readout from APZ*”),
- Record of new setting values in memory of automatic unit (menu: “*Settings*” -> “*Setting record into APZ*”),
- Setting printout (menu: “*Settings*” -> “*Print*”),
- Monitoring and edition of setting values.

For monitoring and edition of setting values there is necessary following information:

- Setting names – they are stored on disc in file “APZ_nast_rejzd_nnn.txt” (example names of settings: “tsAS”, “AS CB1>CB2”).
- Setting values – they are recorded in memory of automatic unit and they may be stored on disc in file “APZ_nast_rejzd_nnn.txt”. Setting values may be numbers (example value of setting: “0,5 s”) or bistable information.

In purpose to make monitoring and edition of settings included in file on disc it is necessary to read file “APZ_nast_rejzd_nnn.txt” (there will be red names and values of settings).

In purpose to make monitoring and edition of settings included in memory of automatic unit it is necessary to previously read the file “APZ_nast_rejzd_nnn.txt” (there will be red names and values of settings) and following from memory of automatic unit there should be red setting values (names were previously red from file on disc).

Editions of settings are realized in standard way dedicated for programs operating in Windows system. Times of operating are available after opening bookmark “Operation times”. Program of automatic unit operation is available in bookmark “Programming of operation”.

There is possible printout of settings on printer. On the printout there is presented fabric number of automatic unit, names of particular settings and values of these settings. In case of bistable settings (permissions) number “1” means permission, number “0” means lack of permission.

8.3.4 Events register

The program posses following possibilities:

- Readout of events register from automatic unit (menu: “*Events*” -> “*Readout register from APZ*”),

- Readout of events register from disc, available if automatic unit is not connected to PC (menu: "*Events*" -> "*Open file*"),
- Record of events register on disc (menu: "*Events*" -> "*Save file as*"),
- Printout of events register (menu: "*Events*" -> "*Print*"),
- Analyses of buffer contents of events register.

For analysis of events register there is necessary following information:

- Events names – they are stored on disc in file "APZ_nast_rejzd_nnn.txt" and in files "file name.dat" (example names of events: "voltage decay on busbars").
- Events codes – they are recorded in memory of automatic unit and they may be stored on disc in file "file name.dat". Events codes are numbers.

For the purpose of reading the events register from automatic unit it is necessary to previously read from disc names of events included in file "APZ_nast_rejzd_nnn.txt", and than read the codes of events from automatic unit. Computer program assigns appropriate names into particular codes and displays on screen the names understood for operator.

Evens red from automatic unit are stored in file together with all descriptions. To make analysis of events register included in file on disc it is necessary only to open the file "file name.dat".

Events register is dedicated only for readout. There is no possibility of making edition of events register.

Events register is available after opening the bookmark "Events". If previously there was red none of events register (or opened appropriate file), than list of events is empty.

After reading events (or opening the file) there appears events list in which there are included:

- Fabric number of automatic unit,
- Time of reading events register (according to automatic unit and to computer),
- Numbers of following events (numbered from 40- the oldest to 1-the newest),
- Times of appearance of particular events (according to time of automatic unit),
- Names of particular events (together with code of selected event).

Below there is presented standard schedule of events recorded in events list:

- Switching off (out of operation) of automatic unit,
- Switching on (uninterlocking) of automatic unit,
- Appearance of external signal of permanent interlock,
- Decay of external signal of permanent interlock,
- Appearance of external signal of transient interlock (recorded only in case when automatic unit is activated),
- Decay of external signal of transient interlock (recorded only in case when automatic unit is activated),

- Closing circuit breaker (recorded only in case when automatic unit is not out of operation and it is not permanently interlocked or when automatic unit is out of operation and closing impulse is generated by automatic unit),
- Opening circuit breaker (recorded only in case when automatic unit is not out of operation and it is not permanently interlocked or when automatic unit is out of operation and opening impulse is generated by automatic unit),
- Voltage decay on busbars (recorded only in case when automatic unit is not out of operation and it is not permanently interlocked),
- Appearance of voltage on busbars (recorded only in case when automatic unit is not out of operation and it is not permanently interlocked),
- Activation of automatics AS,
- Activation of automatics AS into power generator,
- Activation of automatics ASS,
- Activation of automatics PSS or ARS,
- Deactivation of automatics AS,
- Deactivation of automatics AS into power generator,
- Deactivation of automatics ASS,
- Deactivation of automatics PSS or ARS,
- Information of not closing circuit breaker,
- Information of not opening circuit breaker,
- Appearance of signal of generator ready (recorded only in case when automatic unit is activated),
- Decay of signal of generator ready (recorded only in case when automatic unit is activated),
- Appearance of signal "generator operates" (recorded only in case when automatic unit is activated),
- Decay of signal " generator operates" (recorded only in case when automatic unit is activated),
- Generating signal "unload",
- Generating impulse switching on power generator,
- Generating impulse switching off power generator,
- Generating impulse switching on circuit breaker,
- Generating impulse switching off circuit breaker.

If simultaneously appear several events, than they are recorded in separate lines, but they have the same number. For example if voltage on switchgear busbars drops and causes activation of AS automatics, than there appear simultaneously two events (“voltage decay on busbars” and “activation of AS automatics”).

In program there is possible monitoring of signal status essential for operating of AS automatics (switchgear status and automatic unit status) at the moment of event appearance. For this purpose it is necessary to click double with mouse in appropriate line. There opens new window in which there are given:

- Time of reading events register (according to automatic unit and to computer),
- Numbers of following events (numbered from 40- the oldest to 1-the newest),
- Times of appearance of event,
- Names of event (together with code of event).
- Signal status essential for operating of AS automatics.

Below in chart there are presented schedule of signals essential for operating of AS automatics (switchgear status and automatic unit status) displayed on screen:

Name of signal	Description of signal
CBX cl	Signal “circuit breaker CBX closed”
CBX op	Signal “circuit breaker CBX opened”
CBX re	Readiness of circuit breaker CBX
CBX p cl	Pulse closing circuit breaker CBX
CBX p op	Pulse opening circuit breaker CBX
gen re	Readiness of generator
gen oper	Signal “generator operating”
gen p cl	Pulse closing generator engine
gen p op	Pulse opening generator engine
Unl sX	Signal “unloading of section X”
VX_r	Voltage VX higher than setting value Vr
VbusX_l	Voltage VbusX higher than setting value Vl
VbusX_lt	Voltage VbusX higher than setting value Vlt
Lack of synchr X	Voltage dVX higher than setting value dV
out/unint l	Signal “out of operation/local uninterlock”
out/unint r	Signal “out of operation/remote uninterlock”
out/unint s	Signal “out of operation/uninterlock from system”
tran inter	External signal of transient interlock
perm inter	External signal of permanent interlock
act PSS	Signal of activating PSS
out	Signalling “out of operation”
per int	Signalling “permanent interlock”
tran int	Signalling “transient interlock”
in AS	Signalling “incorrect AS”
in PSS, ARS, ASS	Signalling “incorrect PSS, ARS, ASS”
o AS	Signalling “operating of AS”
a PSS, ARS	Signalling “activating of PSS, ARS”
o ARS	Signalling “operating of ARS”
a ASS	Signalling “operating of ASS”
w ARS	Signalling “waiting for ARS”
w ASS	Signalling “waiting for ASS”
activ unit	Signalling “activation of automatic unit”
AS sX	Realizing AS of section X
ASG sX	Realizing ASG (SZR into power generator) of section X
ASS sX	Realizing ASS of section X
ARS sX	Realizing ARS of section X

Where:
CBX – name of circuit breaker
VX – voltage name in supplying line
VbusX – voltage name on busbars
sX – section name.
In this window it is possible to go between following analysed events b clocking with mouse into keys with arrows (they are located on right side next to space with name of event) or with use of arrows keys on keyboard of computer.
Over the space with name of event there is located key “List of events”. This key allows for return into list of events.
The register may be recorded on disc in file “file name.dat”. in this file there will be recorded codes of events and names of events corresponding to them.
It is possible to print list of events on printer.

8.3.5 Additional possibilities of program

Program possesses three additional possibilities available after opening the bookmark “Settings of APZ”:

- Time setting. Sending to automatic unit system date from PC.
- Setting of network address “serial port 2” RS422 (RS485), dedicated for communication with system. In case of unit operation in computer controlling system it is necessary to give the appropriate network address for device from the range of 1...247.
- Switching on signal “out/unint from system” applied in situation of failure of control system.

8.4 Transmission protocol

8.4.1 Introduction

Automatic units - type APZ have possibility of communication with superior control and visualisation system. Among others they allow for:

- Readout of actual switchgear status,
- Readout of actual status of AS automatics,
- Control of circuit breakers,
- Control of AS and PSS automatics,
- Readout of events register with use of software “APZ_nast._rejzd”.

Communication with automatic unit is realized through serial link in accordance to Modbus protocol.
Real names appearing in particular switchgear are given in appendix for maintenance manual.

8.4.2 Communication links

The automatic unit is equipped In following links:

- "Serial port" – socket DB9 located on front board, dedicated to cooperation with transportable PC, standard RS232. Address 1 set permanently.
- "Serial port 2" – socket DB15 built in the neighborhood of output sockets of automatic unit, dedicated to cooperation with computer control system, standard RS422 (RS485). Address 1...247 set in program "APZ_nast_rejzd.

Description of outputs of socket *Serial port 2*:

Contact	Signal	Direction	Function
1	SHLD	-	Shield conductor of cable
2, 3, 4	-		
5	P5V	Output	Supply voltage of external devices +5,1 V DC (max 100 mA)
6	RTSA	Output	Output signal Request to Send (A)
7	GND	-	Model signal 0V/GND
8	CTSB'	Input	Input signal Clear to Send (B)
9	RT	-	Terminal resistor (120 ohms) for RDA'
10	RDA'	Input	Input signal Receive Data (A)
11	RDB'	Input	Input signal Receive Data (B)
12	SDA	Output	Output signal Transmit Data (A)
13	SDB	Output	Output signal Transmit Data (B)
14	RTSB	Input	Output signal Request to Send (B)
15	CTSA'	Input	Output signal Clear to Send (A)
Casing	SHLD	-	Connection of shield conductor / connection 100 % (continuous) of conductor shielding

Link RS485 should be delivered as follows:

Socket contact *Serial port 2*	Signal RS485
9-10-12	RS -
11-13	RS +
7	GND

8.4.3 Transmission protocol

Communication with automatic unit is realized with serial link In accordance to protocol MODBUS-RTU.

Transmission protocol:

Transmission speed: 19200

Flow control: Lack

Parity: Lack

Data bits: 8

Stop bits: 1.

8.4.4 Network address (station address)

Network address: number from range 1...247. There is possibility of setting it from program "APZ_nast_rejzd". During manufacturing process automatic units are given the address 1.

8.4.5 Readout of information from automatic unit

Readout: Read Register (function code: 3).

There is possibility of reading following information:

- Layout status of circuit breakers (two-path),
- Readiness existence of circuit breakers,
- Generating by automatic unit the control impulses of circuit breakers,
- Readiness and operation of power generators,
- Generating by automatic unit the control impulses of power generators,
- Generating by automatic unit the unload signals,
- Voltage existence (exceeding set threshold value),
- Existence of signals controlling the automatic unit (SA key, interlocks etc.),
- Existence of external annunciation signals,
- Realizing of particular automatics (AS, PSS, ASS, ARS).

In the chart there are given names of signals with following indexes:

- CB1 ... CB10(CB0) – names of circuit breakers
- V1 ... V10(V0) – names of voltages in supplying lines
- Vbus1 ... Vbus5 – names of voltages on busbars
- dV01 ... dV20 – names of differential voltages
- Section1 ... section5 – names of sections
- Generator1 ... generator5 – names of generators
- PSS1 ... PSS10 – names of signals activating PSS

Register	No of bit	Signal	Signal status
%R1311	0	CB1 closed	0 – lack of signal 1 – signal present
	1	CB2 closed	0 – lack of signal 1 – signal present
	2	CB3 closed	0 – lack of signal 1 – signal present
	3	CB4 closed	0 – lack of signal 1 – signal present

	4	CB5 closed	0 – lack of signal 1 – signal present
	5	CB6 closed	0 – lack of signal 1 – signal present
	6	CB7 closed	0 – lack of signal 1 – signal present
	7	CB8 closed	0 – lack of signal 1 – signal present
	8	CB9 closed	0 – lack of signal 1 – signal present
	9	CB0 closed	0 – lack of signal 1 – signal present
	10	CB1 opened	0 – lack of signal 1 – signal present
	11	CB2 opened	0 – lack of signal 1 – signal present
	12	CB3 opened	0 – lack of signal 1 – signal present
	13	CB4 opened	0 – lack of signal 1 – signal present
	14	CB5 opened	0 – lack of signal 1 – signal present
	15	CB6 opened	0 – lack of signal 1 – signal present
%R1312	0	CB7 opened	0 – lack of signal 1 – signal present
	1	CB8 opened	0 – lack of signal 1 – signal present
	2	CB9 opened	0 – lack of signal 1 – signal present
	3	CB0 opened	0 – lack of signal 1 – signal present
	4	readiness CB1	0 – lack of signal 1 – signal present
	5	readiness CB2	0 – lack of signal 1 – signal present
	6	readiness CB3	0 – lack of signal 1 – signal present
	7	readiness CB4	0 – lack of signal 1 – signal present
	8	readiness CB5	0 – lack of signal 1 – signal present
	9	readiness CB6	0 – lack of signal 1 – signal present
	10	readiness CB7	0 – lack of signal 1 – signal present
	11	readiness CB8	0 – lack of signal 1 – signal present
	12	readiness CB9	0 – lack of signal 1 – signal present
	13	readiness CB0	0 – lack of signal 1 – signal present
	14	switching on pulse CB1	0 – lack of pulse 1 – pulse present
	15	switching on pulse CB2	0 – lack of pulse 1 – pulse present
%R1313	0	switching on pulse CB3	0 – lack of pulse 1 – pulse present
	1	switching on pulse CB4	0 – lack of pulse 1 – pulse present
	2	switching on pulse CB5	0 – lack of pulse 1 – pulse present
	3	switching on pulse CB6	0 – lack of pulse 1 – pulse present
	4	switching on pulse CB7	0 – lack of pulse 1 – pulse present
	5	switching on pulse CB8	0 – lack of pulse 1 – pulse present
	6	switching on pulse CB9	0 – lack of pulse 1 – pulse present

	7	switching on pulse CB0	0 – lack of pulse 1 – pulse present
	8	switching off pulse CB1	0 – lack of pulse 1 – pulse present
	9	switching off pulse CB2	0 – lack of pulse 1 – pulse present
	10	switching off pulse CB3	0 – lack of pulse 1 – pulse present
	11	switching off pulse CB4	0 – lack of pulse 1 – pulse present
	12	switching off pulse CB5	0 – lack of pulse 1 – pulse present
	13	switching off pulse CB6	0 – lack of pulse 1 – pulse present
	14	switching off pulse CB7	0 – lack of pulse 1 – pulse present
	15	switching off pulse CB8	0 – lack of pulse 1 – pulse present
%R1314	0	switching off pulse CB9	0 – lack of pulse 1 – pulse present
	1	switching off pulse CB0	0 – lack of pulse 1 – pulse present
	2	readiness of generator 1	0 – lack of signal 1 – signal present
	3	generator 1 operates	0 – lack of signal 1 – signal present
	4	readiness of generator 2	0 – lack of signal 1 – signal present
	5	generator 2 operates	0 – lack of signal 1 – signal present
	6	readiness of generator 3	0 – lack of signal 1 – signal present
	7	generator 3 operates	0 – lack of signal 1 – signal present
	8	readiness of generator 4	0 – lack of signal 1 – signal present
	9	generator 4 operates	0 – lack of signal 1 – signal present
	10	switching on pulse of generator 1	0 – lack of pulse 1 – pulse present
	11	switching off pulse of generator 1	0 – lack of pulse 1 – pulse present
	12	switching on pulse of generator 2	0 – lack of pulse 1 – pulse present
	13	switching off pulse of generator 2	0 – lack of pulse 1 – pulse present
	14	switching on pulse of generator 3	0 – lack of pulse 1 – pulse present
	15	switching off pulse of generator 3	0 – lack of pulse 1 – pulse present
%R1315	0	switching on pulse of generator 4	0 – lack of pulse 1 – pulse present
	1	switching off pulse of generator 4	0 – lack of pulse 1 – pulse present
	2	section unload 1	0 – lack of signal 1 – signal present
	3	section unload 2	0 – lack of signal 1 – signal present
	4	section unload 3	0 – lack of signal 1 – signal present
	5	section unload 4	0 – lack of signal 1 – signal present
	6	reserve 1	0 – lack of signal 1 – signal present
	7	reserve 2	0 – lack of signal 1 – signal present
	8	reserve 3	0 – lack of signal 1 – signal present
	9	reserve 4	0 – lack of signal 1 – signal present

	10	reserve 5	0 – lack of signal 1 – signal present
	11	reserve 6	0 – lack of signal 1 – signal present
	12	reserve 7	0 – lack of signal 1 – signal present
	13	reserve 8	0 – lack of signal 1 – signal present
	14		
	15		
%R1316	0	V1_r	0 – voltage lower than value Vr 1 – voltage higher than value Vr
	1	V2_r	0 – voltage lower than value Vr 1 – voltage higher than value Vr
	2	V3_r	0 – voltage lower than value Vr 1 – voltage higher than value Vr
	3	V4_r	0 – voltage lower than value Vr 1 – voltage higher than value Vr
	4	V5_r	0 – voltage lower than value Vr 1 – voltage higher than value Vr
	5	V6_r	0 – voltage lower than value Vr 1 – voltage higher than value Vr
	6	V7_r	0 – voltage lower than value Vr 1 – voltage higher than value Vr
	7	V8_r	0 – voltage lower than value Vr 1 – voltage higher than value Vr
	8	V9_r	0 – voltage lower than value Vr 1 – voltage higher than value Vr
	9	V0_r	0 – voltage lower than value Vr 1 – voltage higher than value Vr
	10	Vbus1_l	0 – voltage lower than value Vl 1 – voltage higher than value Vl
	11	Vbus1_lt	0 – voltage lower than value Vlt 1 – voltage higher than value Vlt
	12	Vbus2_l	0 – voltage lower than value Vl 1 – voltage higher than value Vl
	13	Vbus2_lt	0 – voltage lower than value Vlt 1 – voltage higher than value Vlt
	14	Vbus3_l	0 – voltage lower than value Vl 1 – voltage higher than value Vl

	15	Vbus3_lt	0 – voltage lower than value Vlt 1 – voltage higher than value Vlt
%R1317	0	Vbus4_l	0 – voltage lower than value Vl 1 – voltage higher than value Vl
	1	Vbus4_lt	0 – voltage lower than value Vlt 1 – voltage higher than value Vlt
	2	Vbus5_l	0 – voltage lower than value Vl 1 – voltage higher than value Vl
	3	Vbus5_lt	0 – voltage lower than value Vlt 1 – voltage higher than value Vlt
	4	lack of synchronism dV01	0 – voltage lower than value dV 1 – voltage higher than value dV
	5	lack of synchronism dV02	0 – voltage lower than value dV 1 – voltage higher than value dV
	6	lack of synchronism dV03	0 – voltage lower than value dV 1 – voltage higher than value dV
	7	lack of synchronism dV04	0 – voltage lower than value dV 1 – voltage higher than value dV
	8	lack of synchronism dV05	0 – voltage lower than value dV 1 – voltage higher than value dV
	9	lack of synchronism dV06	0 – voltage lower than value dV 1 – voltage higher than value dV
	10	lack of synchronism dV07	0 – voltage lower than value dV 1 – voltage higher than value dV
	11	lack of synchronism dV08	0 – voltage lower than value dV 1 – voltage higher than value dV
	12	lack of synchronism dV09	0 – voltage lower than value dV 1 – voltage higher than value dV
	13	lack of synchronism dV10	0 – voltage lower than value dV 1 – voltage higher than value dV
	14	lack of synchronism dV11	0 – voltage lower than value dV 1 – voltage higher than value dV
	15	lack of synchronism dV12	0 – voltage lower than value dV 1 – voltage higher than value dV
%R1318	0	lack of synchronism dV13	0 – voltage lower than value dV 1 – voltage higher than value dV

	1	lack of synchronism dV14	0 – voltage lower than value dV 1 – voltage higher than value dV
	2	lack of synchronism dV15	0 – voltage lower than value dV 1 – voltage higher than value dV
	3	lack of synchronism dV16	0 – voltage lower than value dV 1 – voltage higher than value dV
	4	lack of synchronism dV17	0 – voltage lower than value dV 1 – voltage higher than value dV
	5	lack of synchronism dV18	0 – voltage lower than value dV 1 – voltage higher than value dV
	6	lack of synchronism dV19	0 – voltage lower than value dV 1 – voltage higher than value dV
	7	lack of synchronism dV20	0 – voltage lower than value dV 1 – voltage higher than value dV
	8	signal out/unint local (SA key)	0 – lack of signal 1 – signal present
	9	signal out/unint remote	0 – lack of signal 1 – signal present
	10	external signal of transient interlock	0 – lack of signal 1 – signal present
	11	external signal of permanent interlock	0 – lack of signal 1 – signal present
	12	Activation signal of PSS	0 – lack of signal 1 – signal present
	13	signal out/unint from system	0 – lack of signal 1 – signal present
	14		
	15		
%R1319	0		
	1		
	2	signalling "out of operation"	0 – lack of signal 1 – signal present
	3	signalling "permanent interlock "	0 – lack of signal 1 – signal present
	4	signalling "transient interlock "	0 – lack of signal 1 – signal present
	5	signalling "unsuccessful AS"	0 – lack of signal 1 – signal present
	6	signalling "unsuccessful PSS, ARS, ASS"	0 – lack of signal 1 – signal present
	7	signalling "operation of AS"	0 – lack of signal 1 – signal present
	8	signalling "activation of PSS, ARS"	0 – lack of signal 1 – signal present
	9	signalling "operation of ARS"	0 – lack of signal 1 – signal present
	10	signalling "operation of ASS"	0 – lack of signal 1 – signal present
	11	signalling "waiting for ARS"	0 – lack of signal 1 – signal present

	12	signalling "waiting for ASS"	0 – lack of signal 1 – signal present
	13	signalling "activation of unit"	0 – lack of signal 1 – signal present
	14		
	15		
%R1320	0	realizing AS of section 1	0 – does not realize 1 – realizes
	1	realizing AS of section 2	0 – does not realize 1 – realizes
	2	realizing AS of section 3	0 – does not realize 1 – realizes
	3	realizing AS of section 4	0 – does not realize 1 – realizes
	4	realizing ASG of section 1	0 – does not realize 1 – realizes
	5	realizing ASG of section 2	0 – does not realize 1 – realizes
	6	realizing ASG of section 3	0 – does not realize 1 – realizes
	7	realizing ASG of section 4	0 – does not realize 1 – realizes
	8	realizing ASS of section 1	0 – does not realize 1 – realizes
	9	realizing ASS of section 2	0 – does not realize 1 – realizes
	10	realizing ASS of section 3	0 – does not realize 1 – realizes
	11	realizing ASS of section 4	0 – does not realize 1 – realizes
	12	realizing PSS or ARS of section 1	0 – does not realize 1 – realizes
	13	realizing PSS or ARS of section 2	0 – does not realize 1 – realizes
	14	realizing PSS or ARS of section 3	0 – does not realize 1 – realizes
	15	realizing PSS or ARS of section 4	0 – does not realize 1 – realizes

8.4.6 Control with automatic unit

Recording: Preset Single Register (function code: 6).

There is possibility of giving following orders:

- Switching on or off the circuit beaker,
- Switching on or off the power generator,
- Activation of PSS automatics,
- Switching on (uninterlocking) or off (putting out of operation) the automatic unit.

In chart there are given names of signals with following indexes:

- CB1...CB10(CBO) – names of circuit beakers,
- PSS1...PSS10 – names of signals activating PSS.

Real names appearing in particular switchgear are given in appendix for maintenance manual.

Register	Bit number	Signal
%R1269	0	switching on pulse CB1
	1	switching on pulse CB2
	2	switching on pulse CB3
	3	switching on pulse CB4
	4	switching on pulse CB5
	5	switching on pulse CB6
	6	switching on pulse CB7
	7	switching on pulse CB8
	8	switching on pulse CB9
	9	switching on pulse CB0
	10	switching off pulse CB1
	11	switching off pulse CB2
	12	switching off pulse CB3
	13	switching off pulse CB4
	14	switching off pulse CB5
	15	switching off pulse CB6
%R1270	0	switching off pulse CB7
	1	switching off pulse CB8
	2	switching off pulse CB9
	3	switching off pulse CB0
	4	switching on pulse generator 1
	5	switching off pulse generator 1
	6	switching on pulse generator 2
	7	switching off pulse generator 2
	8	switching on pulse generator 3
	9	switching off pulse generator 3
	10	switching on pulse generator 4
	11	switching off pulse generator 4
	12	
	13	
	14	activation of PSS1
	15	activation of PSS2
%R1271	0	activation of PSS3

	1	activation of PSS4
	2	activation of PSS5
	3	activation of PSS6
	4	activation of PSS7
	5	activation of PSS8
	6	activation of PSS9
	7	activation of PSS10
	8	reserve 1
	9	reserve 2
	10	reserve 3
	11	reserve 4
	12	reserve 5
	13	reserve 6
	14	reserve 7
	15	reserve 8
%R1272	0	
	1	
	2	Pulse out/unint from system
	3	Switching on “out/unint from system”
	4	Switching off “out/unint from system”
	5	
	6	
	7	
	8	
	9	
	10	
	11	
	12	
	13	
	14	
	15	

Notes:

Control of automatic unit is realized by writing appropriate code of command into register. Registers are cleared by automatic unit immediately after receiving the command.

Pulses switching on and off circuit breakers may be generated only In case, when the automatic unit is put out of operation. Status of putting out of operation is determined by 2 bit of register %R1319 (0 – uninterlocked, 1 – out of operation).

During generating pulses the automatic unit does not control the synchronism. Because of this reason pulses switching on circuit breakers are generated in line with break (slow), through auxiliary contacts of rest of circuit breakers. This solution excludes the parallel operation of supply sources.

Switching on (uninterlocking) and switching off (out of operation) of automatic unit from system.

For the purpose of switching on and off the automatic unit from system, In software of automatic unit there is introduced internal signal "*out/uninto from system*" (its status is determined by 13 bit of register %R1318). Moreover there were introduced orders of switching on and off the signal " *out/uninto from system*" bits 2 and 3 register %R1272) and "*pulse out/uninto from system*" (bit 4 of register %R1272).

There were predicted two ways of switching on and off the automatic unit from computer controlling system (with use of communication link RS422):

- With two commands: switching on and off the signal " *out/uninto from system*". Active status of internal signal "*out/uninto from system*", at simultaneous existence of external signal "local *out/uninto*" (delivered into terminals of do automatic unit), causes readiness for operation of automatic unit. At the moment of sale of the automatic unit this signal " *out/uninto from system*" is active.
- With one command "*pulse out/uninto from system*" changing status of automatic unit into opposite. Pulse switching on and off the automatic unit is only possible in case, when there is active external signal "*local out/uninto*" (delivered into terminals of automatic unit) and there is active internal signal "*out/uninto from system*". Everytime the command is given it causes status change of automatic unit into opposite.

Operation of automatic unit was described in chart below.

External signal "*local out/uninto*"	Internal signal "*out/uninto from system*"	Command "*pulse out/uninto from system*"	Automatic unit status
Lack of signal	Optional	Optional	Switched off (out of operation)
Optional	Lack of signal	Optional	Switched off (out of operation)
Signal present	Signal appearance	Lack of signal	Switching on (uninter-

			locks)
Signal appearance	Signal present	Lack of signal	Switched on (uninter-locked)
Signal present	Signal present	Lack of signal	Remains without changes
Signal present	Signal present	Pulse appearance	Changes into opposite

Note:

In case of incorrect operation of computer controlling system or connection loss with system at not active signal "*out/uninto from system*", there exists possibility of switching on signal " *out/uninto from system*" with use of program "APZ_nast._rejzd". In bookmark "Settings of APZ" there was introduced key causing force of status of switched on signal " *out/uninto from system*". After pushing key the program sends to the automatic unit command of setting the value "8" (active 3 bit) register %R1272.

8.4.7 Real time clock RTC

Readout: Read Register (function code: 3)

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

Numbers are given in BCD format. Year is given as two numbers.

Readout			Record		
Register	Older bit	Younger bit	Register	Older bit	Younger bit
%R1300	month	year	%R1307	month	year
%R1301	hour	day of month	%R1308	hour	day of month
%R1302	second	minute	%R1309	second	minute
%R1303	-	day of week	%R1310	-	day of week

9 Operating

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

9.1 Battery exchange n APZ automatic units

The controller In automatic unit is equipped in battery, which durability is:

- 5 years, if the automatic unit is supplied (battery is not loaded), or
- 3 months, if the automatic unit is not supplied (battery is loaded).

Before finishing this durability period the battery should be exchanged. It is possible to give an order to producer of device (i.e. taking the opportunity of routine tests) or it is possible to replace it individually. During exchanging the battery there should be done as follows:

- Switch off all supplying and measurement voltages and following plug out the automatic unit from external circuits by plugging out all contacts.
- Unscrew upper cover of automatic unit.
- Put out the container with battery from controller (drawer with inscription “BATTERY HOLDER”).
- Exchange the battery paying attention o polarity.
- Put In the container with battery into controller.
- Set on the upper cover of automatic unit.

After exchange of battery the automatic unit is ready for operation. Correctness of battery exchange should be controlled by performing functional tests of automatics, as it is required at routine tests.

There is permitted applying of following batteries:

- GE Fanuc IC200ACC001
- Panasonic BR2032.

In case of exceeding durability terms of battery there will appear discharge of battery manifesting as permanent putting the automatic unit out of operation. In such case it is necessary to immediately exchange the battery in conformance to description given above. The consequence of discharging the battery may be necessity of introducing settings once more.

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 realization of this test there is suggested to apply special tester i.e. ATU.

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 APZ (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 strength 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.

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 APZ TYPE

						/						/					/	
Automatic unit type	A	P	Z	-	2													
	A	P	Z	-	3													
	A	P	Z	-	4													
	A	P	Z	-	5													
	A	P	Z	-	6													
	A	P	Z	-	7													
	A	P	Z	-	8													
Value 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							
Casing	Non-standard version												0					
	panel casing												N					
	behind panel casing												Z					
	14" panel casing													6	3			
	19" panel casing													8	4			
	without protecting window panel															B		
	with protecting window panel															S		
Communication with control system	No (standard)																	B
	Yes																	K

Example of order

	A	P	Z	-	3	/	2	2	0	D	C	/	N	6	3	S	/	B
Automatic unit type	A	P	Z	-	3													
Value and kind of auxiliary voltage	220V						2	2	0									
	Direct Voltage									D	C							
Casing	panel casing												N					
	panel casing 63T													6	3			
	with protecting window panel															S		
Communication with control system	No (standard)																	B

In order there should be given the investment object, where the automatic unit will be applied.

The orders should be sent to the following address:

Energotest sp. z o.o.

ul. Chorzowska 44B; 44-100 Gliwice

tel. 032-270 45 18, fax 032-270 45 17.

e-mail: **handel@energotest.com.pl** **www.energotest.com.pl**