# APZmini

# Operating manual

# (program rev. 2)


**Gliwice, october 2012**

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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.

## Tabel of contents

## INFORMATION OF COMPLIANCE

Devices being the subject of this instruction were 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

Supply switching-over automation based on automatic change-over unit type APZmini and a few interlocking relays type PB or PB-04 are dedicated for simply solutions like:

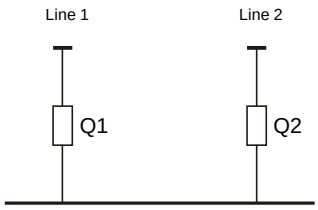
- MV switchgears and LV switchgears with voltage transformers
- LV switchgears without voltage transformers
- MV switchgears without voltage transformers

Supply change-over system can works with circuit breakers or with contactors

That system of automatics can be used in one of the seven most popular configurations of switchgears.

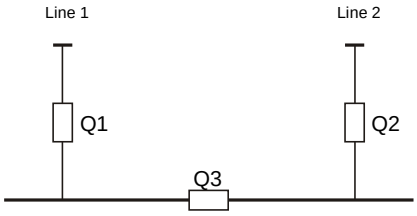
Configuration 1

Two lines without coupling



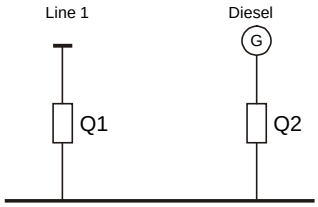

Configuration 2

Two lines with coupling



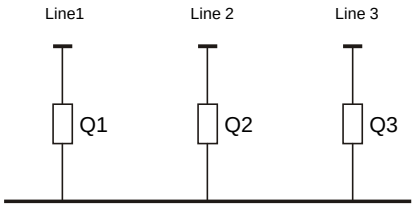
Configuration 3

One line and diesel



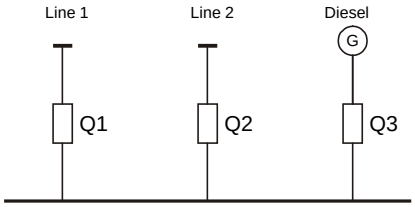

Configuration 4

Three lines



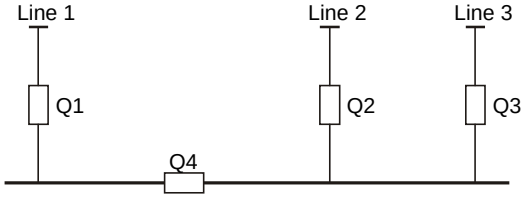

Configuration 5

Two lines and diesel



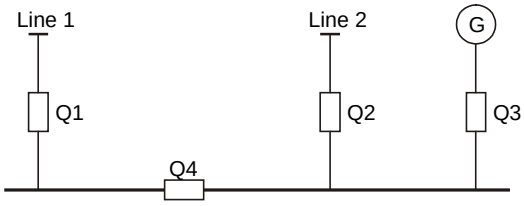

Configuration 6

Three lines and coupling




Configuration 7

Two lines with coupling and diesel




## 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.

**Units installation**

The devices 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 units**

After installing automatic change-over unit type APZmini and interlocking relays type PB or PB-04 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 devices**

The units 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 unit 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, units don't request any extra services with the exception of routine test , which are regulated by appropriate 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 units 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.

**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

System of automatics supply change-over automation being the subject of this instruction has dispersed framework, composed of:

- Unit type APZmini, which is responsible for control of power supply switching-over automation. Unit type APZmini can be installed at any places on front board of switchgear
- A few interlocking relays PB or PB-04, which are responsible for collecting information from particular bay (they are responsible for the control of voltage presence also). Interlocking relays PB or PB-04 are executive elements of supply switching-over automation. Interlocking relays should be installed in particularly bays of switchgears. Interlocking relays can work with circuit breakers or with contactors

Connections between automatic change-over unit type APZmini and interlocking relays are made by control cables (lengthener of connectors type DB9)

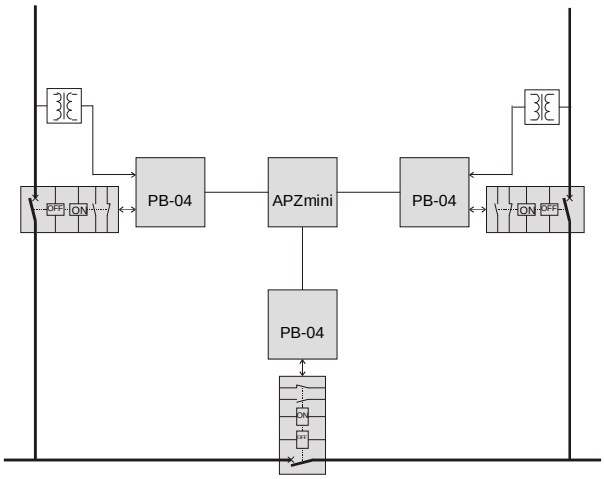
The system is dedicated to the solutions, like:

- MV switchgears and LV switchgears with voltage transformers. Measuring units are fed with voltage from secondary circuits of voltage transformers. Automatic change-over unit type APZmini has to work with interlocking relays type PB-04 equipped for standard measuring units fed with voltage 100/57,7V.
- LV switchgears without voltage transformers. Measuring units are fed directly with voltage 0,4kV from primary circuits. Automatic change-over unit type APZmini has to work with interlocking relays type PB-04 equipped for standard measuring units fed with voltage 400/230V.
- MV switchgears without voltage transformers. Voltage measurement is realized by reactance insulators. Automatic change-over unit type APZmini has to work with interlocking relays type PB equipped for measuring units, which compare isolator output current value and setting threshold current value

There is only one difference between above solutions. This difference is the construction of interlocking relays type PB and PB-04 (which is joined with the method of voltage control). Apart from solution: construction and principle of operation; schemes of external connections in so far as supply change-over system; and communications connections between automatic change-over unit type APZmini and interlocking relays are the same

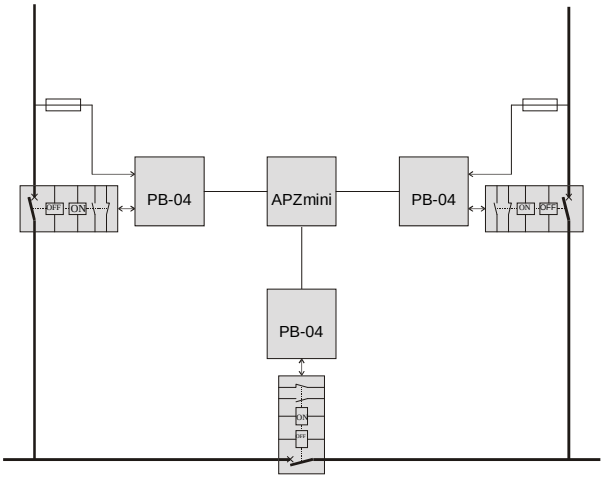
MV switchgear and LV switchgear with voltage transformers

Automatic change-over unit type APZmini
Interlocking relays type PB-04 – version 100/57,7V




LV switchgear without voltage transformers

Automatic change-over unit type APZmini
Interlocking relays type PB-04 – version 400/230 V




MV switchgear without voltage transformers

Automatic change-over unit type APZmini
Interlocking relays type PB

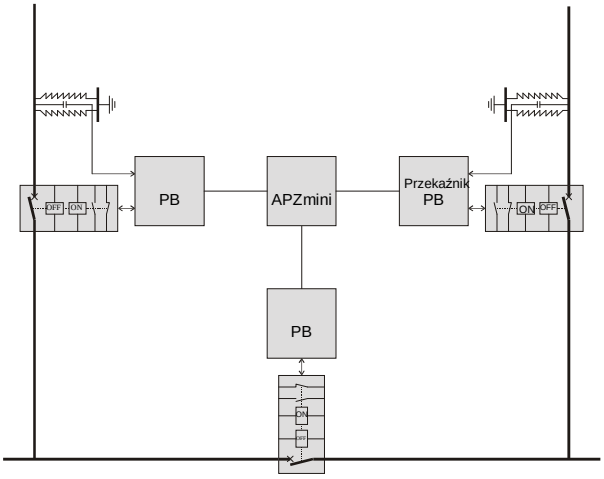



Fig. 1. Example structure of supply change-over system for switchgear with two sources with coupling

This operating manual describes principle of operation of system of automatics supply change-over automation and shows detailed information about automatic change-over unit type APZmini and interlocking relays type PB and PB-04 (shows only information about interlocking relays in system of automatics). More information about interlocking relays type PB and PB-04 can be founded in their Operating Manuals

That system of automatics can be used in one of the seven most popular configurations of switchgears. System settings are made during assembling and activity of unit. The system automatics may realize change-over cycles in all possible directions in particular configuration of switchgear.

The service staff decide about system settings. The service staff can change the settings, and chose appropriate settings of cycles realized by system of automatics.

The system of automatics based on APZmini is dedicated for simply not complicated switchgears.

The system realizes following cycles of change-over operations:

- **ATS –** automatic transfer switching **–** 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 or from supply of electric power system into emergency supply (stand-by generator).
- **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 ATS from voltage decay. Realized from reserve supply into primary supply. It is change-over operation recovering primary supply in switchgear: it is also known as “return ATS” or “self-return”.
- **ASS** – automatic supply switching – realized automatically by automatic unit (on base of conditions existing in switchgear), when the switchgear remains without voltage and the voltage recovers from one of supplying lines.
- **PTS** – planed transfer switching – activated manually by service staff is realized in normal operating conditions between two circuit breakers indicated by service staff.

Notes:

It is possible to activate ASS and ARS by respective settings of unit, if after switching on automatic there is no voltage on the busbars of switchgear. In that case after return of voltage in supplying line automatics realizes automatic recovering primary supply in switchgear

The change-over are realized like slow with interruptions in consumers’ supply. After opening the circuit breaker of the previous supply, the automatic unit closes impulse to the circuit breaker of the new supply

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.
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.

## 3.2 Casing of the unit

Automatic unit is accommodated behind the panel casing type Bopla CombiBac 160. The casing of the unit carry out protection degree type IP54. The casing is described on drawing 2.

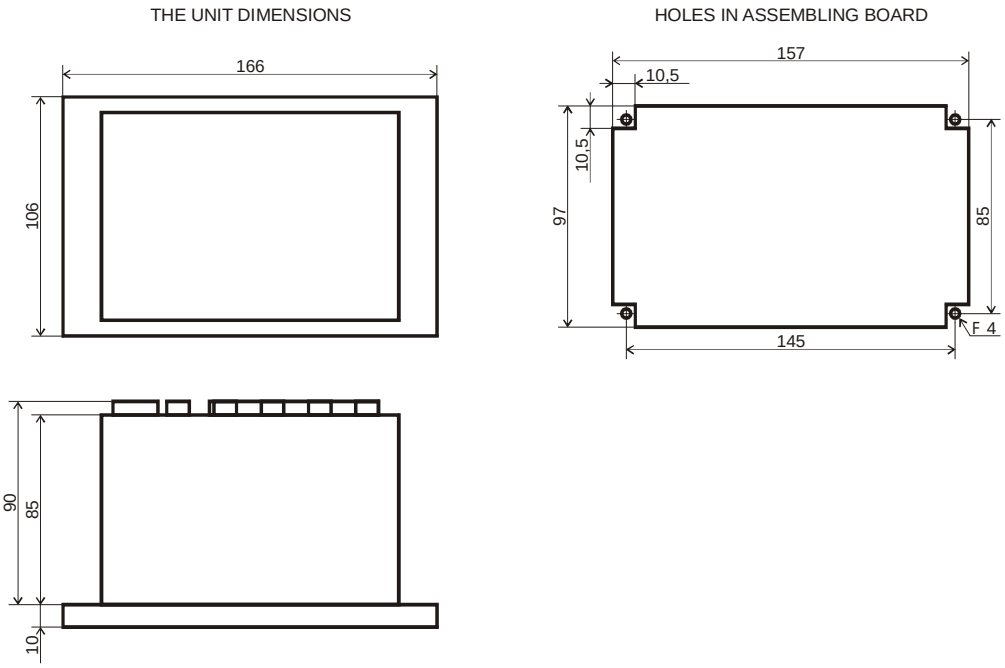



Fig. 2. Casing of the unit type APZmini.

## 3.3 Front board of automatic unit

The front board of the automatic unit (Fig. 3) is divided into following segments:

- the signal lamps signalling actual state of automatic unit operation (see details in point 3.5),
- the push-buttons, which are used for control of automatic (see details in point 3.7),
- the switchgear diagram there is shown actual configuration of switchgear and the signals of presence of particular voltages or absence of particular voltages

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

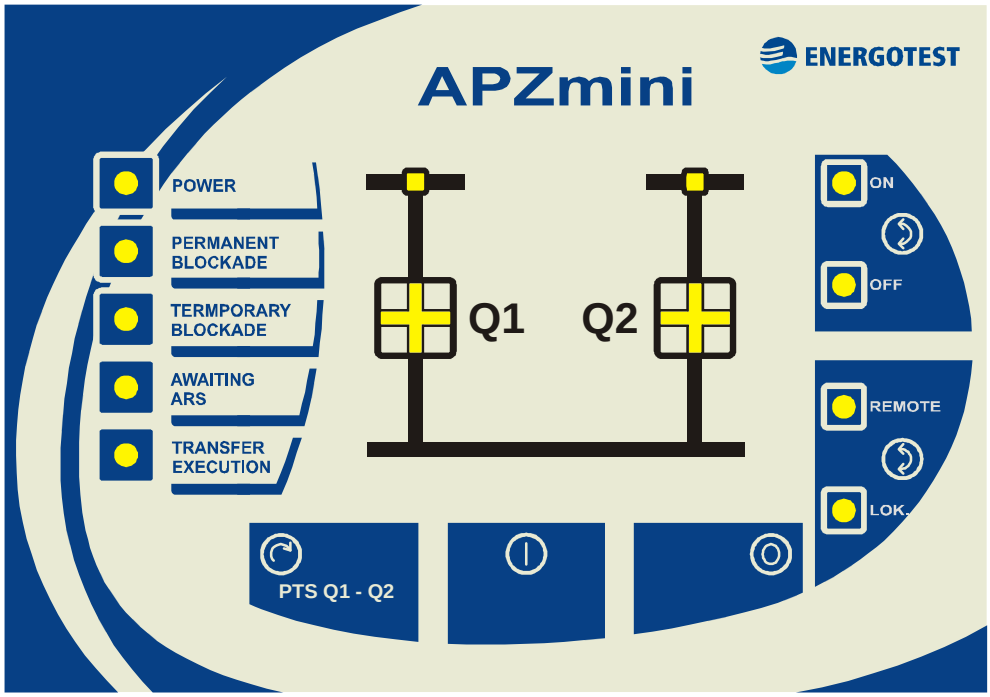



Fig. 3. Example front board of the automatic unit type APZmini – for configuration of switchgear: two sources without coupling.

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. Green lamps signal that the voltage on supplying lines and terminals of standby generator exist.

### 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 of automatic unit is equivalent to permanent interlock

  During permanent interlock there is activated signalling:

  – internal : "*permanent interlock*",

  – external: „*interlocking*".

During out-of-operation position of automatic unit, there is activated signalling:

- internal: „*out of operation*”
- external: *„out of service”*.

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

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

  - internal: “*transient interlock or not ready*”
  - external: „*out of operation*”

Interlock is activated in following cases:

a. Shut down of auxiliary supplying voltage or switch off the unit is equivalent to permanent interlock.
b. Sending the permanent interlock signal of automatic (for example: from overcurrent protection or differential residual current circuit breaker) into terminals C4-C5 of interlocking relay PB (or PB-04) causes permanent interlock of automatic unit type APZmini.
c. During realization of change over in PTS cycle, there is transiently interlocked ATS and ASS automatics.
d. During realization of change over in ARS cycle, there is transiently interlocked ATS and ASS automatics (awaiting for conditions for realizing the ARS cycle the AS and ASS automatics is not interlocked).
e. During realization of change over in ATS cycle, there are transiently interlocked PTS, ARS and ASS automatics.
f. After realizing some change-over in ATS and ARS cycle the unit is permanently interlocked; see details in point 3.8
g. Absence of voltage in incoming feeder causes transient interlock of PTS and ARS automatics
h. Absence of voltage in reserve incoming feeder causes transient interlock of ATS and ASS automatics
i. 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 through switch off (out of service of automatic unit) and switch on (uninterlock) the automatic unit.

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 present. 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 contact outpouts used for control of external signaling

### 3.5.1 Internal signalling

The signal lamps are signaling the following operating conditions of automatic unit:

a. REMOTE/ LOCAL – chosen method of control annunciation
b. SWITCHED ON/ SWITCHED OFF – switching on annunciation (uninterlocking) and switching off annunciation (out of operation) of automatic.
c. POWER – signal, which informs that automatic unit is switched on or the unit is connected with computer software for entering settings and readout of events register
d. PERNAMENT BLOCKING - permanent interlock annunciation.
e. TRANSINENT BLOCKING - transient interlock annunciation or not ready annunciation
f. AWAITING FOR ARS – this signal, informs that automatic unit is waiting for conditions to realize change-over operation on ARS cycle
g. REALIZING CHANGE-OVER OPERATION – signal of activating the unit to realize change-over operation on PTS, ARS, ATS cycles or awaiting for conditions to realize change-over operation on ARS cycle.

### 3.5.2 External signalling

Automatic unit enables external signalling and registration the following signals:

a. OUT OF OPERATION – out of operation (switching off) annunciation or lack of auxiliary voltage. Out of operation annunciation can be denied in settings of unit, and then this signal determines switching on annunciation (uninterlocking) or lack of auxiliary voltage
b. BLOCKING OF AUTOMATIC UNIT – permanent interlock annunciation, transient interlock annunciation or not ready annunciation
c. OPERATION - – signal of activating the unit to realize change-over operation on PTS, ARS, ATS cycles or awaiting for conditions to realize change-over operation on ARS cycle.

## 3.6 Operating mode of automatic unit

Automatic unit can operate in three modes:

- realization the change over mode (this is basic mode),
- local control of circuit breakers and power generating unit mode,
- entering settings and readout of events register mode

Operating mode is signaled by luminous lamp “power”. In realization the change-over mode the lamp is green light shining. In other operating modes the lamp is blinking.

## 3.7 Control of automatic unit

### 3.7.1 General information

Automatic unit can be control in the following way:

- local control – control by the push-buttons located on front board of automatic unit
- remote control – control by binary signals, which are introduced on automatic unit's terminals, or control by commands from control system (communication link RS485)

The push-buttons for local control (located on front board of automatic unit) fulfil the following functions:

- „remote/local" it used for selection the control method
- „switched on/switched off" it used for local switching on (uninterlocking) an switching off (out of operation) of automatic unit
- Three push-buttons „PTS" with symbols ⟲ ① ⓪ fulfil double function:
  - in the change-over mode – they are used for activation of PTS automatics
  - in the local control of circuit breakers and diesel mode– the are used for switching on and switching off individual circuit breakers and diesel.

Binary signals for remotely controlled (introduced on automatic unit's terminals) enable:

- switching on (uninterlocking) an switching off (out of operation) of automatic unit
- activating the unit to realize change-over operation on PTS.

Commands from control system (communication link RS485) enable:

- switched on (uninterlocking) and switched off (out of operation) of automatic unit
- activating the unit to realize change-over operation on PTS.
- switched on and switched off individual circuit breakers and diesel.

### 3.7.2 Choice of the control mode

The control mode is chosen by push-button "remote/local" which is located on the front board of automatic unit. Each pushing the push-button change the control method for opposite. Present chosen control method is signaled by the lamps next the push-button "remote/local"

If has been chosen local control, then the push-buttons located on the front board of automatic unit are active, and the signals introduced on automatic unit's terminals. The commands from control system are inactive. If has been chosen remote control, then the signals introduced on automatic unit's terminals and the commands from control system are active. The push-buttons located on the front board of automatic unit are inactive.

### 3.7.3 Switching on (uniterlocking) and switching off (out of operation) of the automatic unit

Automatic unit can be switch on and switch off by local control and remote control.

Local switching on and switching off is realized by push-button “switch on/switch off” which is located on the front board of the automatic unit. Each pushing the push-button change status of automatic unit into opposite.

Remote switching on and switching off can be realized by impulse (every sending the impulse causes change of status of automatic unit into opposite state ) or by binary key (the position of the automatic unit is the same like the position of binary key) which is introduced on automatic unit’s terminals.

The control method is chosen by setting “switch on/switch off by binary key”. Automatic unit can be controlled from control system by respective commands from system.

If has been chosen in settings the impulse control method (the setting “switch on/switch off by binary key” is inactive), than the control method by impulse introduced on automatic unit’s terminals and the control system control method are equivalent.

The table below shows principle of operation of automatic unit.

| External signal „switched on/ switched off automatics” | Command from control system „switch off automatic unit” | Command from control system „switched on automatic unit” | Automatic unit status |
|---|---|---|---|
| Signal appearance (impulse) | Lack of command | Lack of command | Changes status into opposite |
| Lack of signal | Command appearance | Lack of command | Switched on (uninterlocked) |
| Lack of signal | Lack of command | Command appearance | Switched off (out of operation) |

If has been chosen in settings “switch on/switch off by binary key”, then this is supervisory control and the control system control method is active only when the key is turned on (if the key is turned off, it is impossible to switch on the automatic unit by the command from system)

The table below shows capabilities of automatic unit

| External signal „switched on/ switched off automatics” | Command from control system „switched off automatic unit” | Command from control system „switched on automatic unit” | Automatic unit status |
|---|---|---|---|
| Signal appears (key is closing) | Lack of command | Lack of command | Switched on (uninterlocked) |
| Signal presents (key is closed) | Lack of command | Command apears | Switched off (out of operation) |

| | | | |
|---|---|---|---|
| Signal presents (key is closed) | Command apears | Lack of command | Switched on (uninterlocked) |
| Signal fades (key is opening) | Lack of command | Lack of command | Switched off (out of operation) |
| Lack of signal (key is opened) | Command apears | Lack of command | Switched off (out of operation) |
| Lack of signal (key is opened) | Lacko f command | Command apears | Switched off (out of operation) |

Present automatic unit status is signaled by the lamps next the push-button “switched/switched off” and is signaled by external signaling “out of operation” (out of operation annunciation can be denied in settings).

If automatic unit is switched on (uninterlocked), than automatics is active. If automatic unit is switched off (out of operation), then automatics is inactive.

### 3.7.4 Activation of PTS automatics

There is possible to realize cycle PTS, if automatic unit is switched on (uninterlocked) and conditions for realizing change-over described in point 3.8.3 are accomplished. Automatics PTS can be activated by local or remote control.

Local activation of automatics PTS is realized by push-buttons “PTS” located on the front board of automatic unit. Pushing the push-button causes realizing change over between circuit breakers shown on push-button description.

Remote activation of automatics PTS is realized by impulses introduced on automatic unit’s terminals or respective command from control system.

### 3.7.5 Manually control (switching on and switching off) of circuit breakers and with power generating unit

The circuit breakers and power generating unit can be controlled locally, if the automatic unit is switched off (out of operation). Local control is possible after changing status from the change over mode to local control of circuit breakers and power generating unit.

Particular push-buttons fulfil the following functions:

- ⟳ – enter to the local control of circuit breakers and power generating unit, and exit from that mode (it is necessary to hold down the push-button for 5 s), or selection the controlled circuit breaker’s or power generating unit also;
- ① – switch on selected circuit breaker or power generating unit;
- ⓪ – switch off selected circuit breaker or power generating unit.

When the local control of circuit breakers is activated, the lamps located on synoptic system, which indicate position of selected circuit breaker for control, are blinked. When the local control of

power generating unit is activated, the lamp which indicates presence of power generating unit voltage is blinked.

In order to select the local control of circuit breakers or power generating unit should be carried out the following routines:

- The local control method should be selected by push-button „remote/local" and the automatic unit should be switched off (out of operation" by push-button "switch on/switch off"
- The local control of circuit breakers or power generating unit should be entered by push-button ⟲ (it is necessary to hold down the push-button for 5 s), the lamps located on synoptic system will start blink;
- Requested circuit breaker or power generating unit is selected by push-button ⟲ (If has been selected the circuit breaker, the lamps indicate position of circuit breaker are blinked. If has been selected power generating unit the lamp indicates presence of power generating unit voltage is blinked);
- Requested circuit breaker or power generating unit is switched on and switched off by the push-buttons ⏽ ⏾
- Exit from the local control of circuit breakers or power generating unit is selected by push-button ⟲ ((it is necessary to hold down the push-button for 5 s), the lamps located on synoptic system will stop blinking

If in the local control of circuit breakers or power generating unit is pushed the push-button "local/remote" or "switch on/switch off" than the automatic unit will change form the local control mode of circuit breakers or power generating unit to realization the change over mode.

Remote control of circuit breakers or power generating unit is realized by respective command from control system. The circuit breakers can be control remotely if the automatic unit is out of service. The power generating unit can be control remotely always (independently from the mode of automatic unit).

During realizing manually control of circuit breakers it is possible to select in the settings the parallel operation of supply sources. The setting "blocking the parallel operation of supply source during realizing manually control

<u>Notes about the control of automatic unit:</u>

- After the source voltage is switched on, the selected control mode (remote/local) and the status of automatic unit (switch on/switch off) are the same, which they were in switching off moment.
- The push-buttons are equipped in retardant circuits. After pushing the push-button it is necessary to hold down them for 1 s
- The time of the control impulses introduced on automatic unit's terminals should be minimum 1s

The table below shows capabilities of automatic unit

| Choice of the control mode and status of automatic unit | Local Switched on | Local Switched off | Remote Switched on | Remote Switched off |
|---|---|---|---|---|
| Status of cycles ATS, PTS, ARS, ASS | active | inactive | active | inactive |
| The possibility of switching on or switching off the automatic unit by push-button located on the front board | yes | yes | no | no |
| The possibility of switching on or switching off the automatic unit by the signals introduced on automatic unit's terminals or by the commands from control system | no | no | yes | yes |
| The possibility of realizing PTS cycle by the push-buttons located on the front board | yes | automatics is inactive | no | automatics is inactive |
| The possibility of realizing PTS cycle by the signals introduced on automatic unit's terminals or by the commands from control system | no | automatics is inactive | yes | automatics is inactive |
| The possibility of controlling circuit breakers by the push-buttons located on the front board | no | yes | no | no |
| The possibility of controlling power generating unit by the push-buttons located on the front board | no | yes | no | no |
| The possibility of controlling circuit breakers by the commands from control system | no | no | no | yes |
| The possibility of controlling power generating unit by the commands from control system | no | no | yes | yes |

## 3.8 Description of operation

The automatic unit realizes four cycles of change-over:

- **ATS** - automatic transfer switching – 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 ATS from voltage decay. Realized from reserve supply into primary supply. It is change-over operation recovering primary supply in switchgear: it is also known as “return ATS” or “self-return”
- **PTS –** planed transfer 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 the emergency situations (Disturbance in switchgear appears for example: if the switchgear is supplied from reserve supply source or if after finish another change-over there is no voltage on busbars). The direction of that operation is into circuit breaker which remains with voltage (priority is into main circuit breaker). Its goal is to return the supply, when the switchgear remains without voltage and there is no possibility fro realizing another change-over operation

Notes:

- It is possible (by respective settings) to activate ASS and ARS cycle, when after switching on automatics there is no voltage on the bus bar. In that case after returning the supply voltage automatics will restore the primary supply of switchgear automatic.

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

a. ATS 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.

b. ATS 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 ATS from primary supply into reserve

Primary voltage recovers – the unit realizes ARS from reserve supply into primary

c. Incorrect ATS (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 ATS, switchgear remains without voltage.

ATS change-over is finishing – the unit realizes ASS in a direction into circuit breaker which remains under voltage.

d. PTS:

Before start of change-over operation the switchgear is fed from primary source.

PTS is activated by service staff – the unit realizes PTS.

e. Incorrect PTS (i.e. caused by incorrect settings of unit) and following ASS:

Before start of change-over operation the switchgear is fed from primary source.

PTS is activated by service staff – the unit realizes incorrect PSS, switchgear remains without voltage.

PTS change-over is finishing – the unit realizes ASS in a direction into circuit breaker which remains under voltage.

f. 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.

g. ASS, if after switching on automatic there is no voltage on bus bars of switchgear.:

Before start of change-over operation there is no voltage on the switchgear.

The reserve voltage is returning – automatic unit irealizes ASS cycle in a direction into circuit breaker which remains under voltage (primary source)

h. AZZ i SPP, if after switching on automatics there is no voltage on the busbar

Before start of change-over operation there is no voltage on the switchgear .

The reserve voltage is returning – automatic unit is realizes ASS cycle in a direction into circuit breaker which remains under voltage (reserve source)

The reserve voltage is returning – automatic unit realizes ARS cycle from reserve source to primary source

Notes:

- Sequences “g” i “h” (these sequences can be realizing, when there is no voltage on the busbar of switchgear after switching on the automatics) are available when the setting “ASS and ARS after switching on automatics” is activated

Each of change-over operation may bye activated or interlocked in settings mode. . After realization of ATS 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

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:

- **CBO** – opened circuit breaker, which was the switchgear supplied before start of change-over operation.
- **CBC** – closed circuit breaker, which will be the switchgear supplied after end of change-over operation.

### 3.8.1 Automatic transfer switch automatics (ATS)

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 ATS cycle is initiated self-acting by automatic unit. 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. The condintion of change-over operation in that cycle (ATS) is presence of voltage in CBC (reserve line). The positions of the circuit breakers should be unequivocal. Iit is possible to allow or deny the realization of ATS cycle by appropriate setting of automatic unit.

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

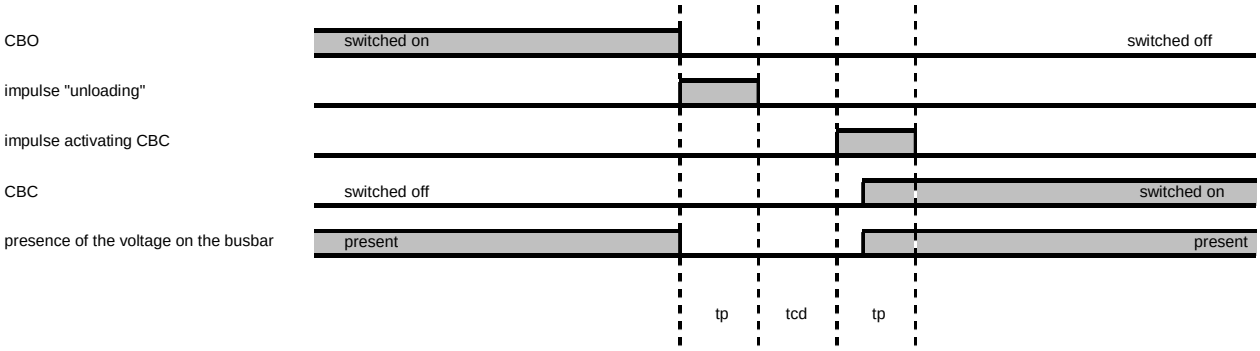
The change-over cycles are realized in limiting time *tlATS* or *tlATSa.* If in this time the change-over cycle will not be finished, then de-energizing of ATS automatics appears.

The change-over in ATS 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 from the lowest number of circuit breaker to the highest number of circuit breaker. 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.

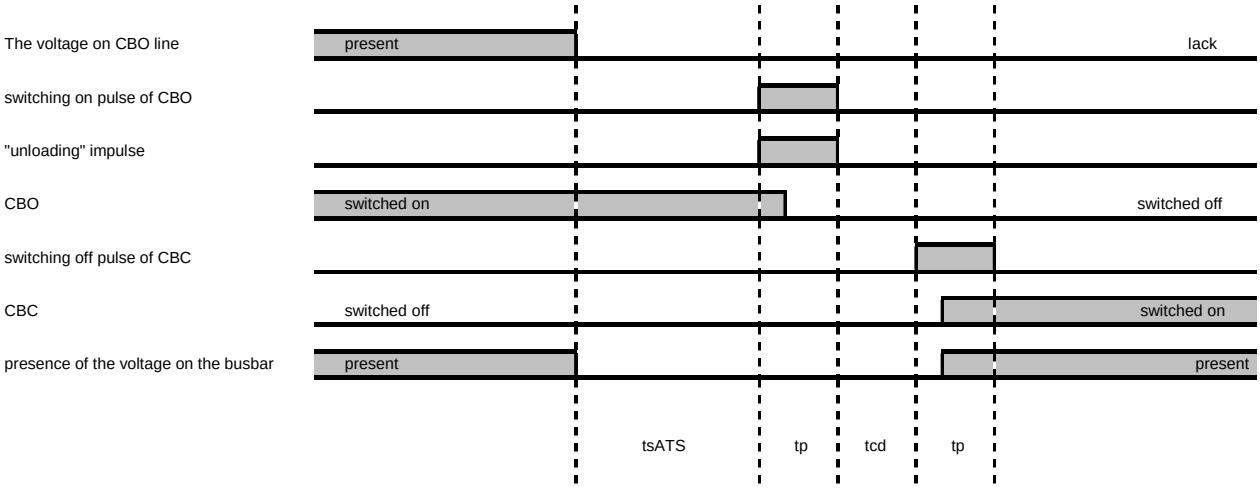
### 3.8.1.1 ATS cycle from circuit breakers which supply the switchgear from electric power system into circuit breaker which supplies the switchgear from electric power system caused by voltage decay on busbars at opened circuit breaker in supplying line




*tp* – duration time of controlling impulses

*tcd* – delay time of closing circuit breaker

### 3.8.1.2 ATS cycle from circuit breakers which supply the switchgear from electric power system into circuit breaker which supplies the switchgear from electric power system caused by voltage decay on busbars at closed circuit breaker in supplying line

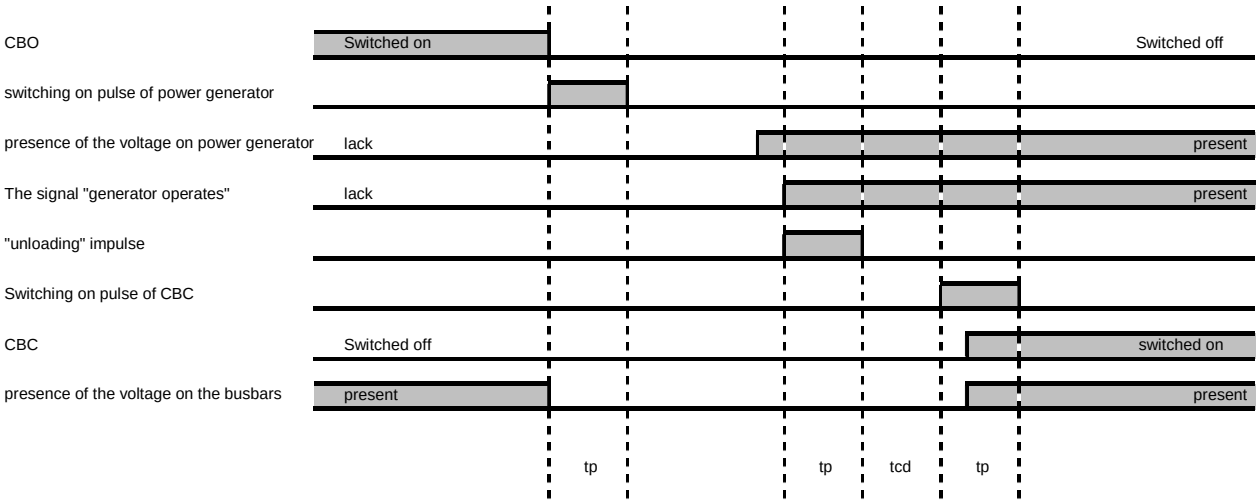



*tsATS* – time units of start up delay in ATS cycle from voltage decay

*tp* – duration time of controlling impulses

*tcd* – delay time of closing circuit breaker

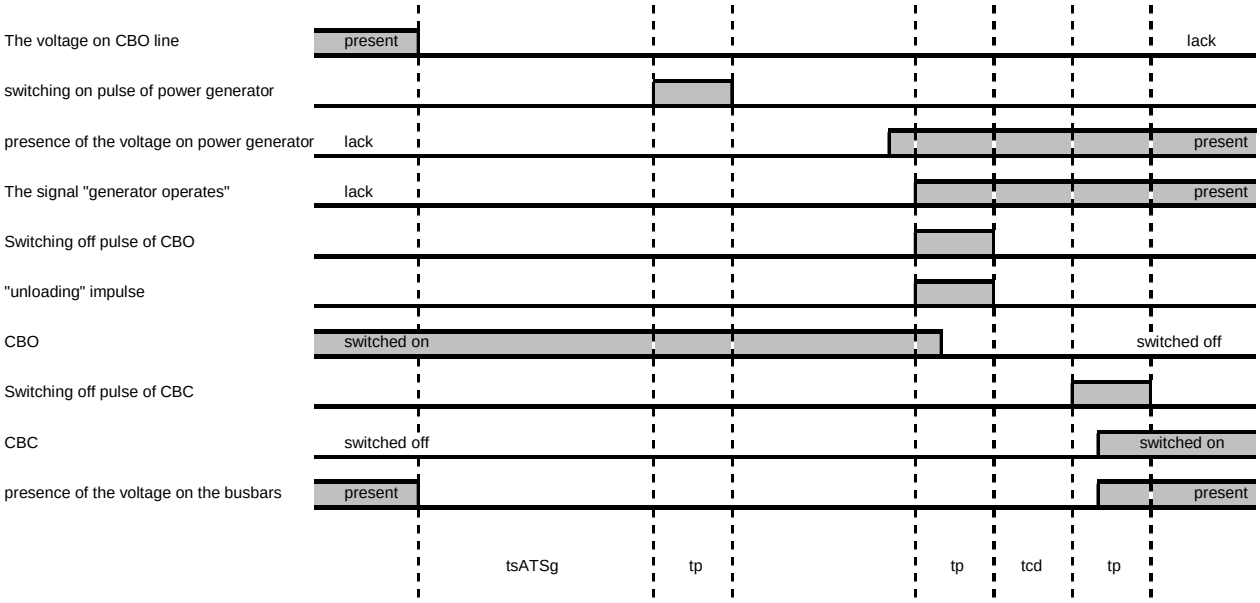
### 3.8.1.3 ATS cycle from electric power system into stand-by power generator caused by opening circuit breaker in supplying line




*tp* – duration time of controlling impulses

*tcd* – delay time of closing circuit breaker

### 3.8.1.4 ATS cycle from electric power system into stand-by power generator caused by voltage decay on busbars at closed circuit breaker in supplying line




*tsATSg* – time of start-up delay of ATS cycle switching on power generating unit

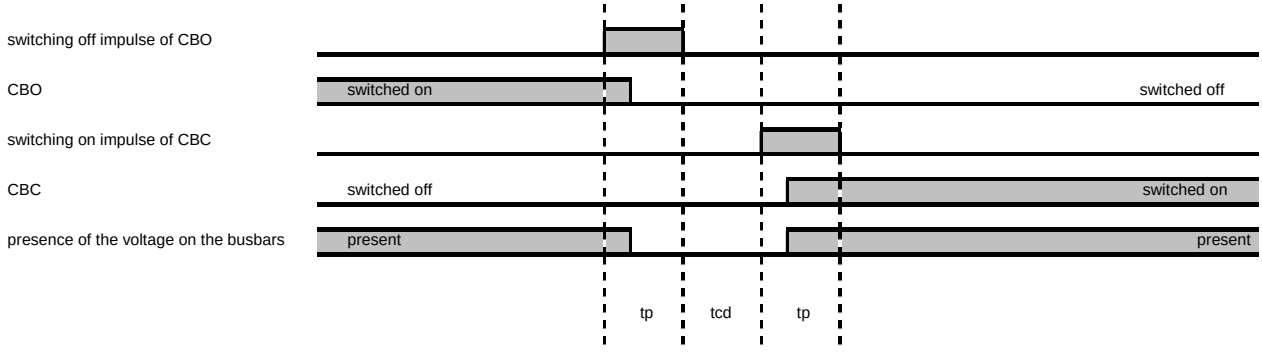
*tp* – duration time of controlling impulses

*tcd* – delay time of closing circuit breaker

### 3.8.2 Planned transfer switching automatics (PTS)

The change-over operations may be realized in optional direction between two circuit breakers, at participation of power generating unit also. The PTS automatics cycle is manually initiated by service staff. Operation of PTS 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 condition of realizing change-over PTS cycle is the voltage presence on line CBO and on line CBC an on the switching busbar of switchgear also. The positions of the circuit breakers should be unequivocal. If it is predicted change-over in PTS 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 PTS 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 PTS cycle there is activated signalling *"operation of unit"*
Change-over operations are realized in limit time *tlPSS.*. If during limit time change-over is not finished, than PTS cycle stops. After finished change-over in PSS cycle the automatics is blocking for about 10 s.

#### 3.8.2.1 PTS cycle from CBO into CBC




*tp* – duration time of controlling impulses
*tcd* – delay time of closing circuit breaker

### 3.8.3 Automatic return switching automatics (ARS)

If after realizing change-over operation in ATS cycle from voltage decay or after realizing ASS cycle there appears voltage in primary line, then the unit may realize automatic return switching of switchgear supply into main supply. It is possible to initiated change over ARS cycle, when after switching on automatics there is there is no supplying voltage on the busbar of switchgear (the setting “ASS and ARS after switching on automatics” is activated.

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

The condition of realizing change-over ARS cycle is the voltage presence on line CBO and on line CBC an on the switching busbar of switchgear also. The positions of the circuit breakers should be unequivocal. The changes-over in ARS cycle are being realized the same like in PTS cycle.

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 time 30s 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.

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. It is possible to cancel the limit of time needed for realizing change-over by setting “twARS, tlASS – infinity**”**

During waiting time (from the moment of finish ATS till finish change-over in ARS cycle) there is activated signalling *“waiting for ARS”*.

During realizing change-over there is activated signalling “*operation of unit*” Change-over operations are realized during limit time *tlARS*. If during limit time change-over operation is not finished, than break of ARS cycle appears.

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

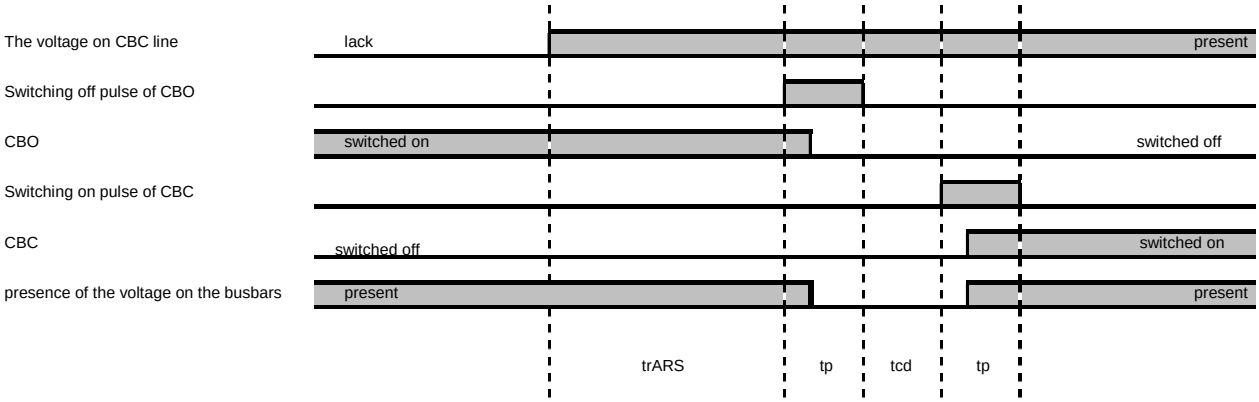
If during waiting appears activation of PTSautomatics, than ARS automatics is deactivated and there is realized PTS automatics.

If in the waiting time for ARS, the voltage on bus bars fade (caused by the fade of reserve voltage), and there is no possibility of for realizing ATS or ASS operation (i.e. time dedicated for starting realizing the change-over has come and the automatics is deactivated the automatics is block in the settings), than after the counting tsARS ARS automatics will be deactivated.

If in the awaiting time PTS automatics has been activated, then the ARS automatics will be deactivated, and the PTS cycle will be realized.

If the contactors, which are working in the switchgear and were supplied by non-warranted voltage from supplying lines, that for the correct realizing of automatics ARS should be the setting “the contactors are supplied by non-warranted voltage” activated.

#### 3.8.3.1 ARS cycle from CBO to CBC.




*tsARS* – time of start-up delay of ARS cycle

*tp* – duration time of controlling impulses

*tcd* – delay time of closing circuit breaker

### 3.8.4 Automatic 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 ATS 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.

It is possible to initiate realizing of ASScycle in situation, when after switching on automatics there is no supplying voltage of switchgear (it is necessary to activate the setting ““ASS and ARS after switching on automatics”)

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 ATS change-over cycle, but the difference is that ATS 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 ATS 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”

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. There is the possibility of blocking time limitation by activating the setting “twARS, tlASS – infinity”

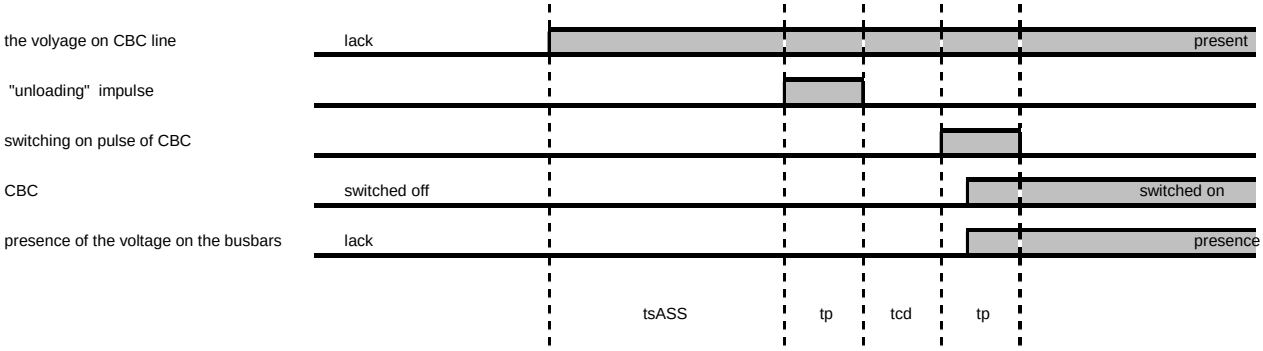
- come into stand-by status (ready for realizing another change-over operations),
- permanently interlock.

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,
- if after switching on automatics there is there is no supplying voltage on the busbar of switchgear (the setting “ASS and ARS after switching on automatics” is activated)

Automatics realizes the change-over between all particular circuit breakers supplying particular section (when the coupling is closed – automatics realizes the change-over between 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 opening any of circuit breakers, or during realizing unsuccessful attempts of closing in turn all circuit breakers.
If the the long-lasting lack of supplying voltage of switchgear appears, than there is the possibility of destination opening of all circuit-breakers. In that case it is necessary to activate setting “Openning of circuit-breakers, if there is not the presence of supplying voltages”
If the contactors, which are working in the switchgear and were supplied by non-warranted voltage from supplying lines, that for the correct realizing of automatics ASS should be the setting “the contactors are supplied by non-warranted voltage” activated

### 3.8.4.1 ASS cycle into the circuit-breaker, which supplies the switchgear from electric power system, if there are opened all circuit-breakers in supplying lines

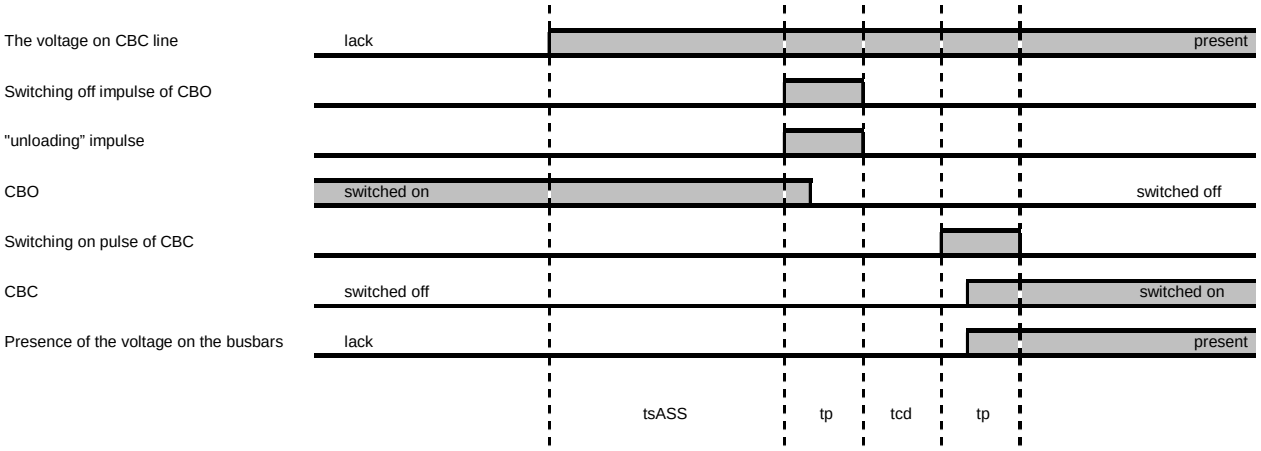



*tsASS* – time of start-up delay of ASS cycle

*tp* – duration time of controlling impulses

*tcd* – delay time of closing circuit breaker

### 3.8.4.2 ASS cycle into the circuit-breaker, which supplies the switchgear from electric power system, if there is closed the circuit-breaker in supplying line

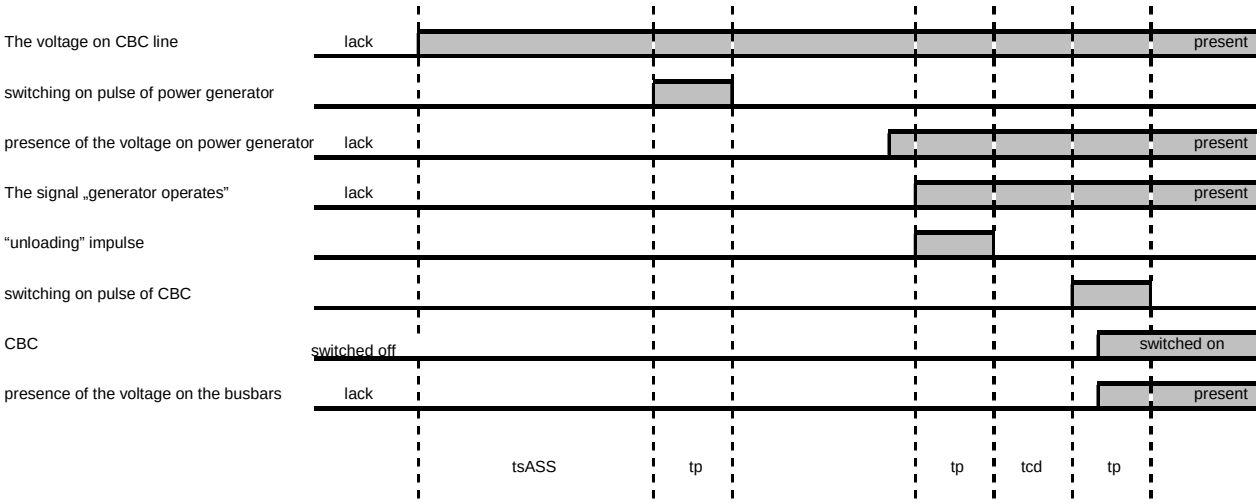



*tsASS* – time of start-up delay of ASS cycle

*tp* – duration time of controlling impulses

*tcd* – delay time of closing circuit breaker

### 3.8.4.3 ASS cycle into power generating unit, if there are opened all circuit-breakers in supplying lines

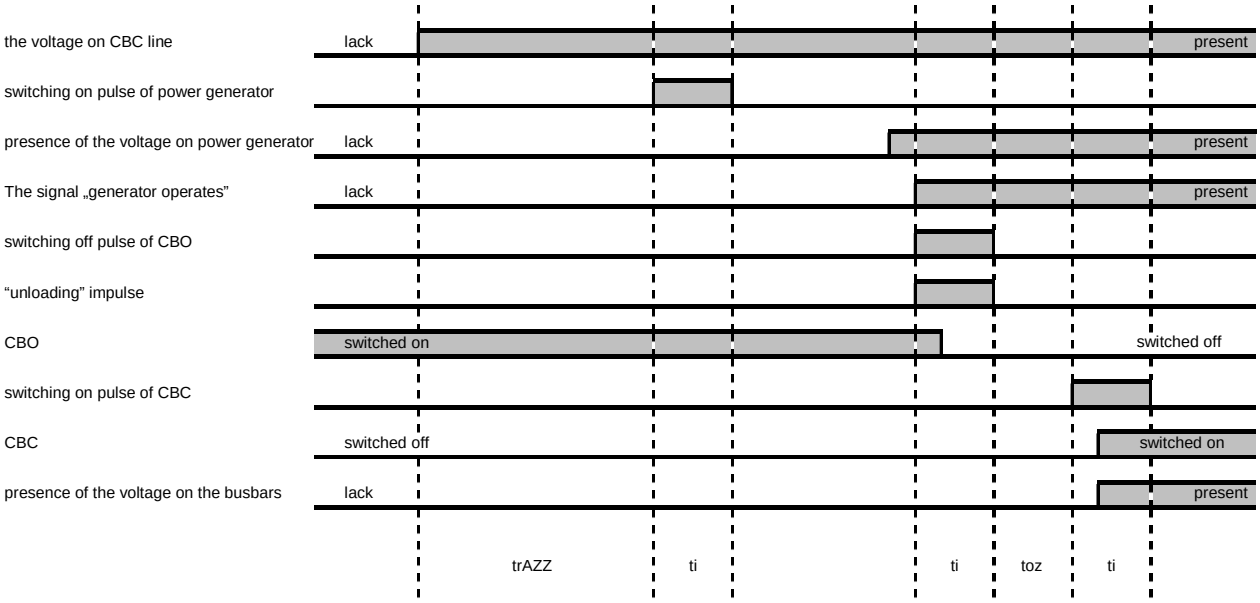



*tsASS* – time of start-up delay of ASS cycle

*tp* – duration time of controlling impulses

*tcd* – delay time of closing circuit breaker

### 3.8.4.4 ASS cycle into power generating unit, if there is closed the circuit-breaker in supplying line




*tsASS* – time of start-up delay of ASS cycle

*tp* – duration time of controlling impulses

*tcd* – delay time of closing circuit breaker

## 4 Technical data

| | | |
|---|---|---|
| **auxiliary supplying voltage** | rated auxiliary voltage Vra<br>(warranted or non warranted) | Chosen from range:<br>24...220 V DC or<br>24...230 V AC |
| | operating range of auxiliary supply voltage | 0,8...1,1 Vn |
| | permissible maximum level of the auxiliary voltage range | 1,3Vn (permanent) |
| | power consumption from the auxiliary voltage circuit | <5 W / VA |
| **time units** | tlATS – units of limit time for ATS | 0,5...126 s |
| | tlATSg – units of limit time for ATS cycle switching power generator | 0,5...126 s |
| | tlPTS– units of limit time for PTS | 0,5...126 s |
| | tlARS – units of limit time for ARS | 0,5...126 s |
| | tlASS – units of limit time for ASS | 50...1260 min |
| | twARS – time units of waiting for ARS | 50...1260 min |
| | tsATS – time units of start up delay in ATS cycle from voltage decay | 0,5...126 s |
| | tsATSg – time units of start up delay in ATS cycle switching power generator | 0,5...126 s |
| | tsASS – time units of start up delay in ASS cycle from voltage decay | 0,5...126 s |
| | tsARS – time units of start up delay in ARS cycle | 0,5...126 s |
| | tp – time units of duration of controlling pulses | 0,5...126 s |
| | tad – units of delay time of not ready annunciation | 1,0 s (unalterable) |
| | tcd – time units of delay of closing circuit breaker | 0,3 s (unalterable) |
| | Warranty error of setting scale of time units in the range: 0,5...126 s: | |
| | - for the setting lower than 12,6 s | ±0,15 s |
| | - for the remaining settings: | ±1,5 s |
| | Warranty error of setting scale of time units in the range 50...1260 min: | ±15 min |
| | Warranty error of setting scale of unalterable time units : | ±0,15 s |
| **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 |
| | Except the circuits of voltage 24 V and the connector RS against themselves and against the earth (terminal A3) | 500 V, 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 point 3.2 |
| | assembly | zatablicowy |
| | weight | 0,7 kg |
| | protection degree | IP54 |
| | terminals | WAGO screwless |

Notes: The Producer reserves the right for making modifications in products as result of scientific and technological progress.

## 5 Schedule of applied standards

During constructing and production of the automatic unit APZmini 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 60255-5:2002(U)
  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 APZmini automatic units fulfil requirements mentioned above:

- 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 APZmini
- A few interlocking relays type PB or PB-04 (the number of relays depend on configuration of the switchgear)
- Set of plug terminals for automatic unit APZmini and for realys type PB or PB-04
- The control cables (lengthener of connectors type DB9) for communication between relays type PB or PB-04 and automatic unit APZmini
- Control cables (lengthener of connectors type DB9) for communication between interlocking relays anf automatic unit APZmini
- Disc with installation software for the settings „APZmini.exe”
- Operating manuals of APZmini
- Routine test report
- Guarantee certificate

Delivered automatic unit and the relays are factory programmed and setting, which allowed for working that devices after induction on auxiliary supplying voltage immediatly.

# 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 automatic unit APZmini and the interlocking relaysunits should operate in conditions described in technical data.

## 7.2 Automatic devices installing

Automatic unit APZmini can be installed at any places on front board of switchgear. The interlocking relays should be installed on front boards of respective bays of switchgear.

## 7.3 Arrangement of input sockets

Input sockets and setting components are located on the back plate of automatic unit APZmini. As As shown on the below Fig.4

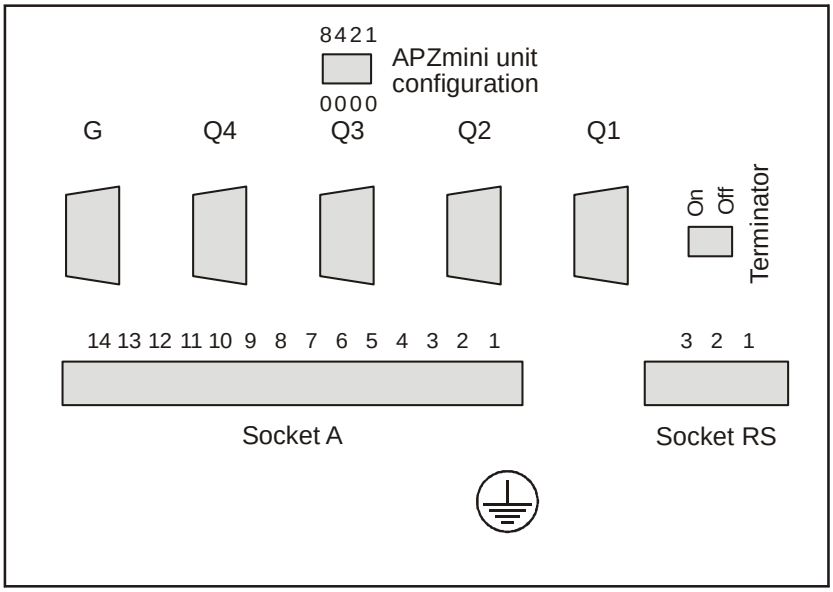



Fig. 4. The back plate of automatic unit APZmini

On the back plate are located:

- sockets DB9 „Q1”, „Q2”, „Q3”, „Q4”, „G” for connectring comunication between automatic unit APZmini and interlocking relays PB or PB-04
- socket „A” for connecting external circuits of the automatic unit,

- socket „RS” for connecting the personal computer or control system by communication link RS485
- terminator (resistor) of bus RS485 (socket „RS”),
- the jumpers „APZmini unit configuration” for setting the automatic unit configuration (configuration of switchgear and variations of change-over cycles)

## 7.4 Communications connections between automatic change-over unit and interlocking relays

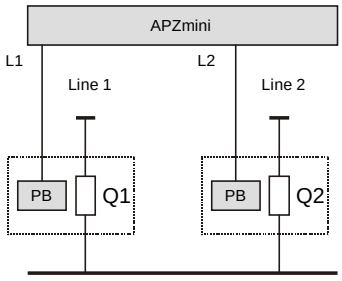
Connections between automatic change-over unit type APZmini and interlocking relays are made by control cables (lengthener of connectors type DB9). The length or control cables is 2m, and the control cables are delivered by the producer. In case of using the longer cables, it is possible to connect a few cables serial or perform other cable. The maximum length of the cable is 100 m. There are necessary to perform the cable the following thinks:

- Female terminal type DB9
- Male terminal type DB9
- free-form signal cable, which has minimum 9 streaks (there is no requested shield in communications cable) . Section of streak should be minimum 0,08mm$^2$ (to maximum 28AWG)

Connection into interlocking realys located on the bays of switchgear, should be introduced to sockets located on the back plate of automatic unit APZmini (to the number of particular circuit-breaker). Connection into relays located on power generating unit should introduced to the socket signed “G” (Generator).

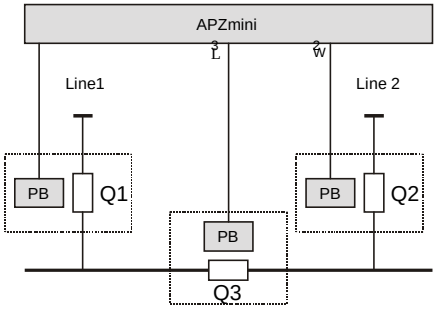
Configuration 1

Two lines without coupling



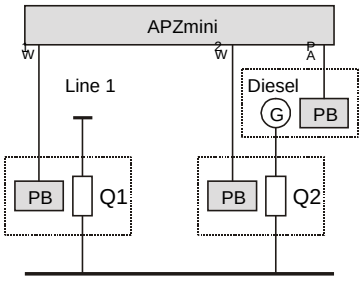

Configuration 2

Two lines with coupling



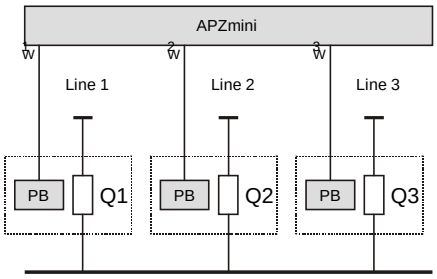
Configuration 3

One line and diesel



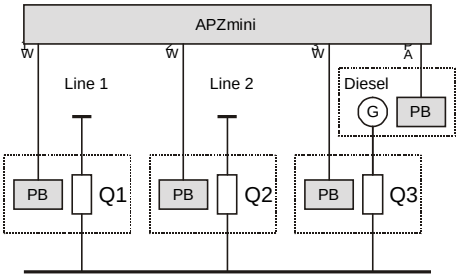

Configuration 4

Three lines



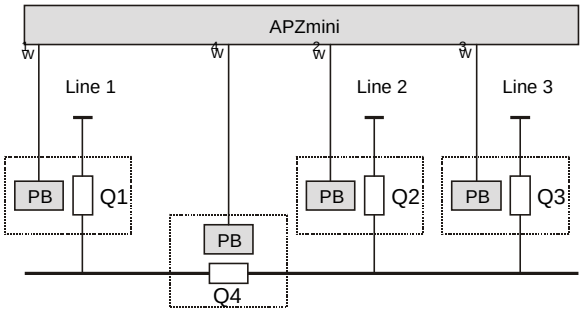

Configuration 5

Two lines and diesel




Configuration 6

Three lines and coupling




Configuration 7

Two lines with coupling and diesel

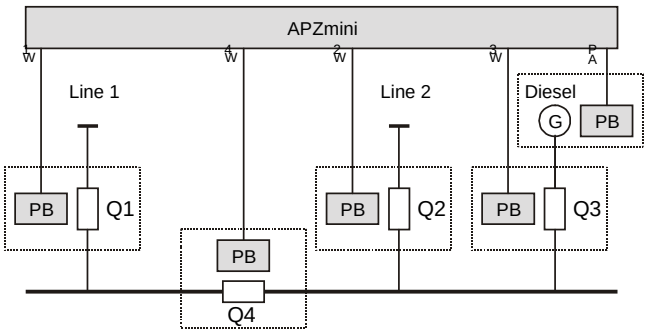



Fig. 5. Arrangement of automatic change-over devices and communications connections between relays PB (or PB-4) and automatic unit APZmini.

## 7.5 External connections

### 7.5.1 External connections of APZmini

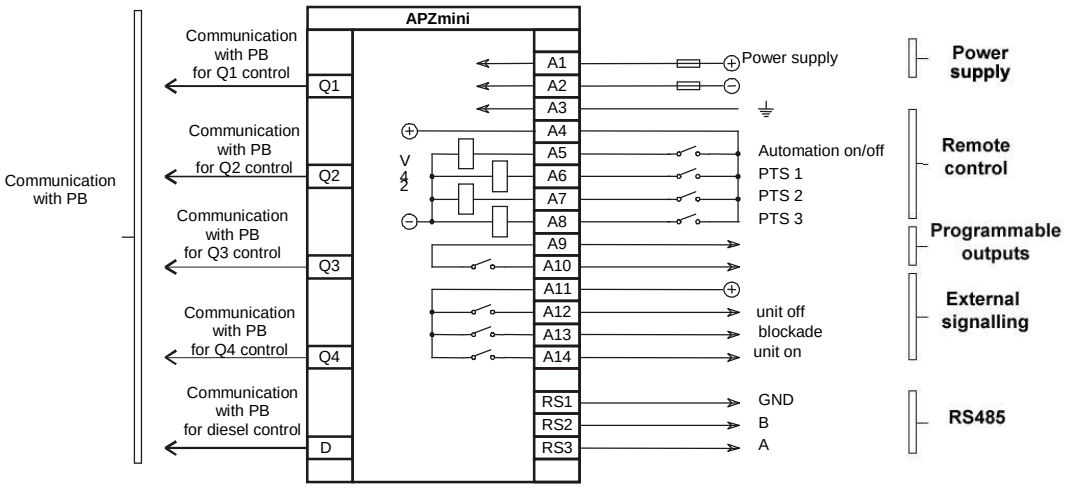



Fig. 6. APZmini external connections scheme

External connections of APZmini include connections with execution modules PB (by communication cables) and the following external circuits:

- Power Supply. DC in default (polarity like on the picture), or uninterruptible AC, optionally AC from bus (by link relay system). Unit sends „unit off" signal in case of powers supply lost.
- Ground. For the sake of EMC compatibility A3 clamp should be connected by grounding clamp on the device casing (not directly to grounding terminal). Cable length between A3 and casing grounding clamp should not be longer than 100mm.
- Remote control:
  - Automation on/off. Unit can be switched on/off by impulsee (every impulsee change unit state on opposite) or by two-position key (unit state base on key position). You can change this in the settings (two-position key on/off).
  - PTS 1, PTS 2, PTS 3. Activation of PTS automation (planned transfer switch). Depending on switchgear configuration the following change is executed:

| switchgear configuration | CBs that participate in transfer switch | | |
|---|---|---|---|
| | PTS 1 signal | PTS 2 signal | PTS 3 signal |
| 1, 3 | Q1 – Q2 | Not used | Not used |
| 2, 4, 5 | Q1 – Q2 | Q2 – Q3 | Q1 – Q3 |
| 6, 7 | Q1 – Q4 | Q2 – Q4 | Q2 – Q3 |

- Programmable output. The function of this output can be changed in settings:
  - Load rebound. Turn off the power supply of for the chosen loads, that are not participate in start process during ATS and ASS automation.
  - Control place „local” – inform that local control has been „switched on” on front panel
- External signalling:
  - Unit off (this signal can be blocked in settings).
  - Blockade.
  - Unit on.

### 7.5.2 Connection of interlocking relay type PB

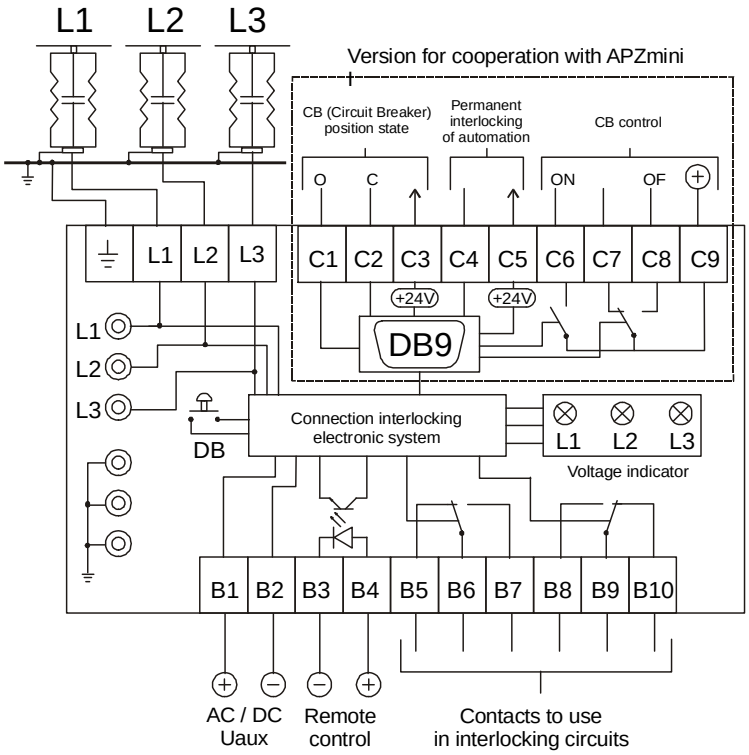



Fig. 7. Scheme of connections of connection interlocking relay type PB equipped in additional executive module of supply switching-over automation

Detailed description of PB relay is included in it’s own manual. Here you can find only connections schemes of connecting PB to circuit breaker, Contactor and diesel.

### 7.5.3 Connection of PB-04 relay

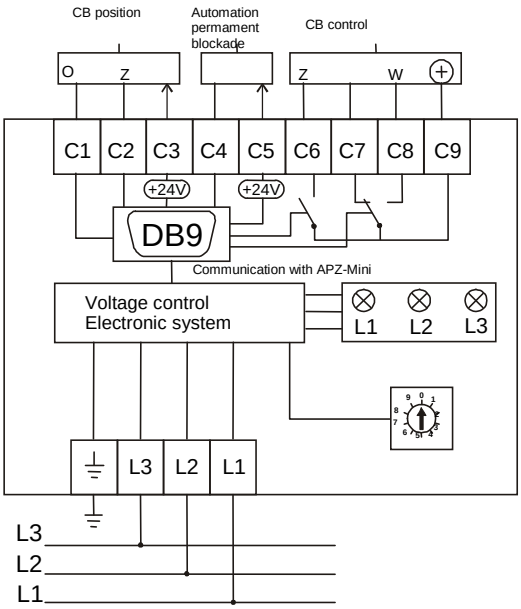



Fig. 8. Scheme of connections of PB-04.

Detailed description of PB relay is included in it's own manual.

### 7.5.4 Connection of PB (or PB-04) with Circuit Breaker

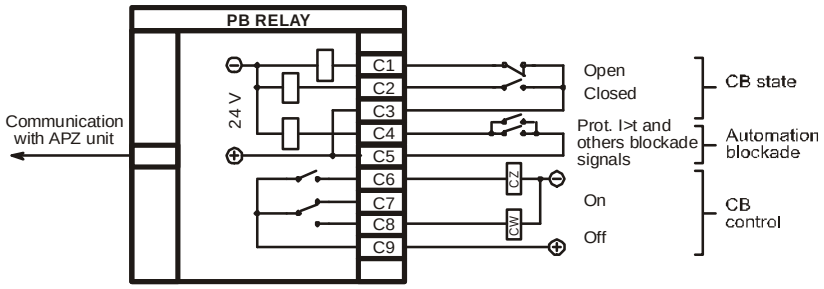



Fig. 9. Scheme of connection of PB (or PB-04) with Circuit Breaker

External connection of relay with circuit breaker:

- CB control (from uninterrupted supply). Relay generates CB on/off signal.
- Permanent blockade. Used in case of protection tripping or manual emergency breaker activation, etc. Any relay input C4-C5 can be activated for permanent blockade of entire APZmini system.
- CB state. This information is transmitted to the relay both from open and closed contacts of CB.

### 7.5.5 Connection of PB (or PB-04) with Contactor.

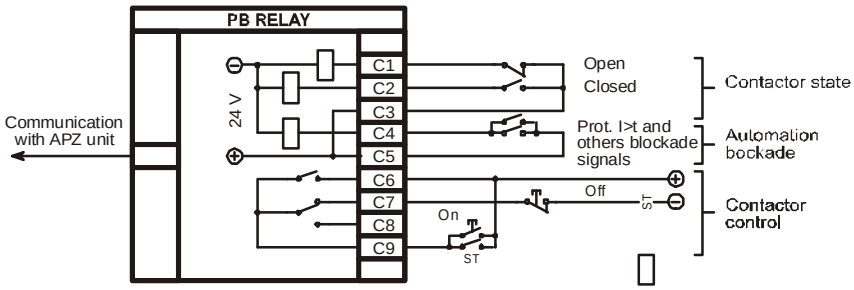



Fig. 10. Scheme of connection of PB (or PB-04) with Contactor.

External connection of relay with Contactor.:

- Contactor control (from uninterrupted supply). Relay generates Contactor. on/off signal. After impulsee, Contactor holds with own contact.
- Permanent blockade. Used in case of protection tripping or manual emergency breaker activation, etc. Any relay input C4-C5 can be activated for permanent blockade of entire APZmini system.
- Contactor state. This information is transmitted to the relay both from open and closed contacts of Contactor.

For appropriate ARS and ASS automation, setting “Contactor from AC not uninterrupted” should be activated, If Contactor in the switchgear are supplied from AC (not uninterrupted - from main bus)

### 7.5.6 Connection of PB (or PB-04) with Diesel

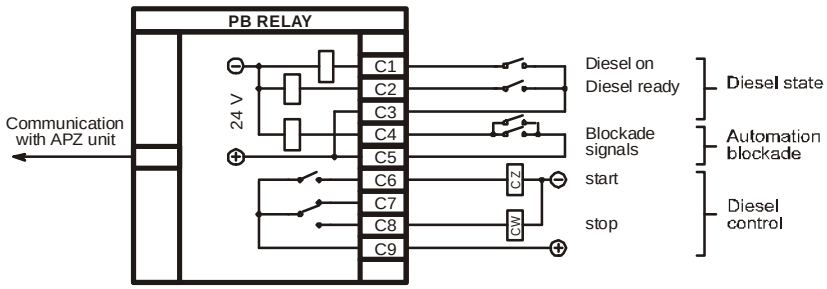



Fig. 11. Scheme of connection of PB (or PB-04) with diesel

External connection of relay with diesel:

- Contactor control (from uninterrupted supply). Relay generates diesel start and stop signal.

- Permanent blockade. Used in case of protection tripping or manual emergency breaker activation, etc. Any relay input C4-C5 can be activated for permanent blockade of entire APZmini system.
- Diesel state:
  - Diesel ready. Diesel is ready to be switched on (there is control voltage, fuel level, etc.). If diesel doesn't have this signal it should be permanently simulated by closing C2-C3 relay clamps.
  - Diesel on. Information regarding correct work of diesel (voltage and frequency allowing for diesel loading). If diesel doesn't have this signal it should be permanently simulated by closing C1-C3 relay clamps.

## 7.6 General information

After installation the system must be commissioned with regard to the proper norms, that include:

- Checking correctness of the design with device documentation and information on device technical labels, in particular:
  - Nominal values of voltages and polarity,
  - Proper protections of supply voltage circuit (fuse nominal values, nominal currents and breakers characteristics),
  - Acceptable relay outputs load,
- checking correctness of assembly,
- checking continuity of grounding circuits,
- terminator on/off (if device is not connected to the system, this has no meaning.)
- checking settings (configuration of the switchgear, transfer modes, etc) by jumpers on the back site of the device,
- checking settings of time unit delay (in typical situation default settings should be correct),
- settings of transfer switching (in typical situation default settings should be correct).

After connection and checking of external circuits you can start commissioning of the device. After connecting device to the voltage , the proper status is being signaled by led „power supply" on the front panel of APZmini and PB relays. Device is broken, if the led is not activated on any of the devices. Commissioning should finalized with functional trials of transfer automation together with eventual corrects in the settings.

## 7.7 Terminators

Terminator (cooptation resistor) is used only in case of connecting the device to the master system by RS485. Decision regarding activation of terminator should be made by system operator. The proper switch is on the back site of the device.

## 7.8 Transfer switch settings

### 7.8.1 Device configuration

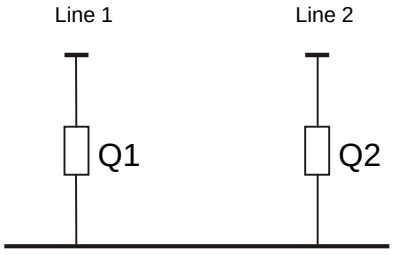
Device configuration include input of the switchgear configuration and possible switching modes. Configuration is being made by jumpers on the back site of the device. Switchgear configuration means primary CB configuration in which the switchgear is normally powered. APZmini is able to work in 7 standard switchgear configurations labeled witch digits 1..7

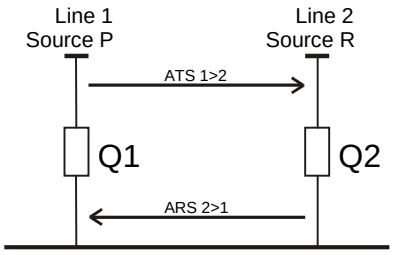
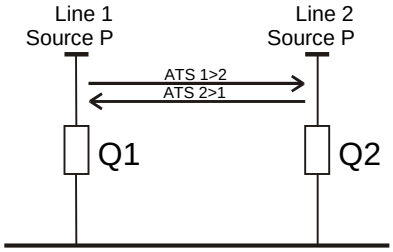
Additional property of the switchgear is power source priority (primary, reserve, etc, or equality of power sources priority) For each of 7 switchgear configuration the set of available direction of transfer switch is declared, which is important in case of ATS and ARS. (in case of PTS and ASS the priority of power source has no meaning). Variants of available transfer switch are labeled with letter A…D

In the table below you can find switchgear configuration and available switching sets for ATS and ARS. (on the pictures B = circuit breaker)

**Configuration 1**

Two lines without coupling




| Transfer variants (sources priority)<br>Device setting (jumper position) | ATS and ARS transfer directions |
|---|---|
| **Variant A**<br>**Line 1** – primary source<br>**Line 2** – reserve source<br><br>**Setting 0** (jumper position 0+0+0+0) |  |
| **Variant B**<br>**Lines 1 and 2** – equal priority (primary)<br><br>**Setting 1** (jumper position 0+0+0+1) |  |
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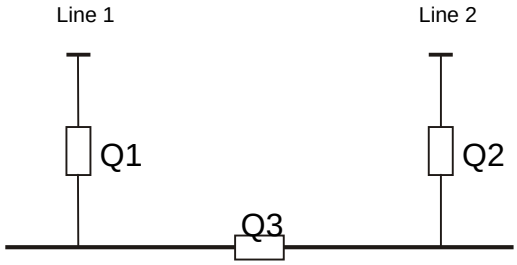
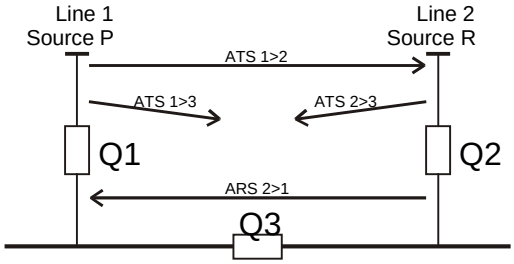
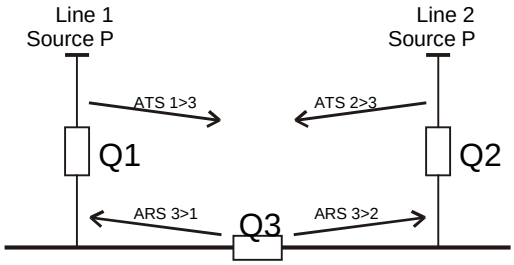
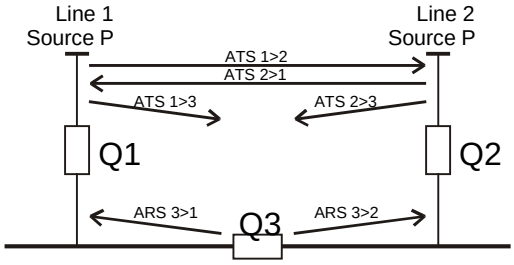
**Configuration 2**

Two lines with coupling




| Transfer variants (sources priority)<br>Device setting (jumper position) | ATS and ARS transfer directions |
|---|---|
| **Variant A**<br>**Line 1** – primary source<br>**Line 2** – reserve source<br>**Setting 2** (jumper position 0+0+2+0) |  |
| **Variant B**<br>**Lines 1 and 2** – equal priority<br>**Setting 3** (jumper position 0+0+2+1) |  |
| **Variant C**<br>**Lines 1 and 2** – equal priority<br>**Setting 4** (jumper position 0+4+0+0) |  |
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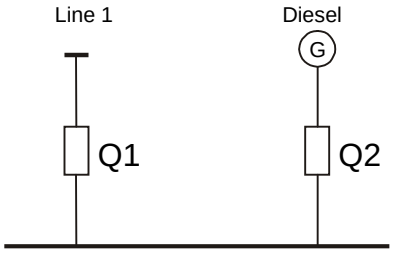
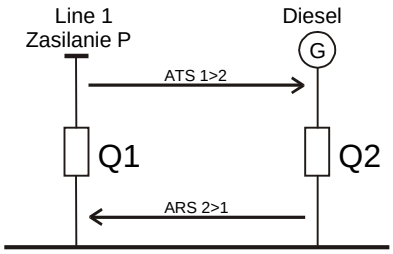
**Configuration 3**

One line and diesel




| Transfer variants (sources priority)<br>Device setting (jumper position) | ATS and ARS transfer directions |
|---|---|
| **Variant A**<br>**Line 1** – primary source<br>**Diesel** – reserve source<br><br>**Setting 6** (jumper position 0+4+2+0) |  |
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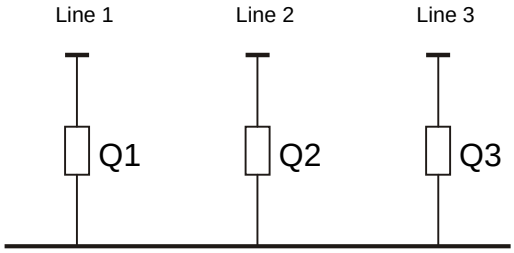
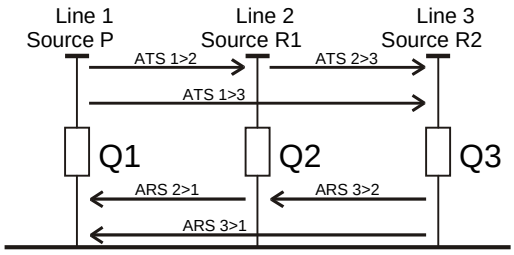
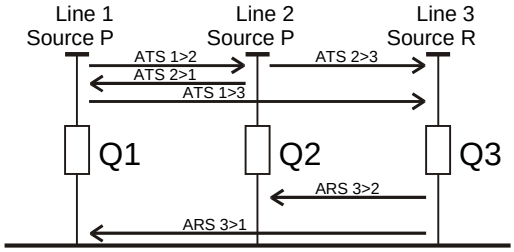
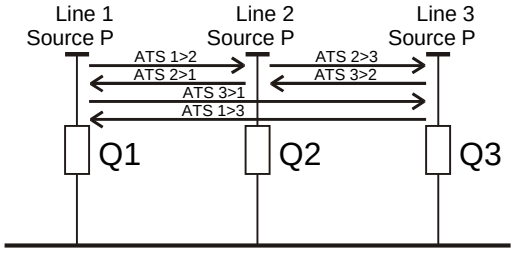
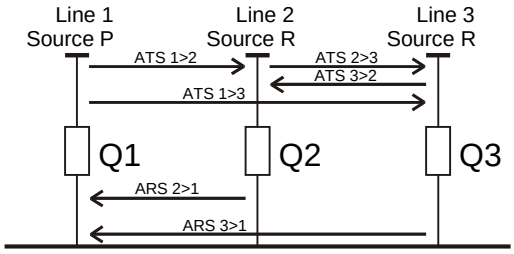
**Configuration 4**

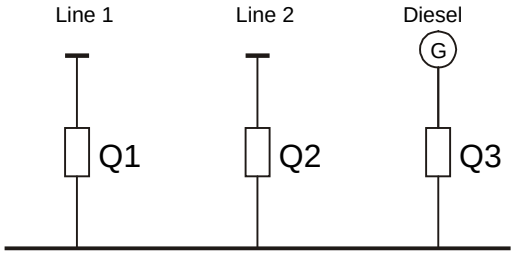
Three lines

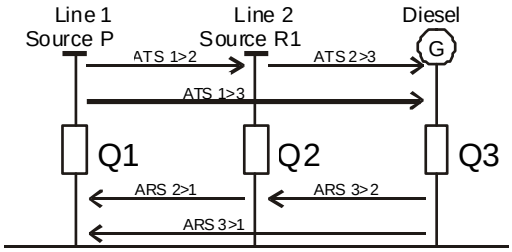
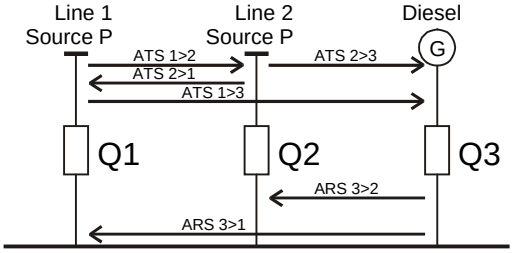



| Transfer variants (sources priority)<br>Device setting (jumper position) | ATS and ARS transfer directions |
|---|---|
| **Variant A**<br>**Line 1** – primary source<br>**Line 2** – reserve source 1 lev.<br>**Line 3** – reserve source 2 lev.<br>**Setting 8** (jumper position 8+0+0+0) |  |
| **Variant B**<br>**Lines 1 and 2** – equal priority (primary)<br>**Line 3** – reserve source<br>**Setting 9** (jumper position 8+0+0+1) |  |
| **Variant C**<br>**Lines 1, 2, 3** – equal priority<br>**Setting 10** (jumper position 8+0+2+0) |  |
| **Variant D**<br>**Line 1** – primary source<br>**Lines 2 and 3** – equal priority (reserve)<br>**Setting 11** (jumper position 8+0+2+1) |  |

**Configuration 5**

Two lines and diesel




| Transfer variants (sources priority)<br>Device setting (jumper position) | ATS and ARS transfer directions |
|---|---|
| **Variant A**<br>**Line 1** – primary source<br>**Line 2** – reserve source 1 lev.<br>**Diesel** – reserve source 2 lev.<br><br>**Setting 12** (jumper position 8+4+0+0) |  |
| **Variant B**<br>**Lines 1 and 2** – equal priority (primary)<br>**Diesel** – reserve source<br><br>**Setting 13** (jumper position 8+4+0+1) |  |
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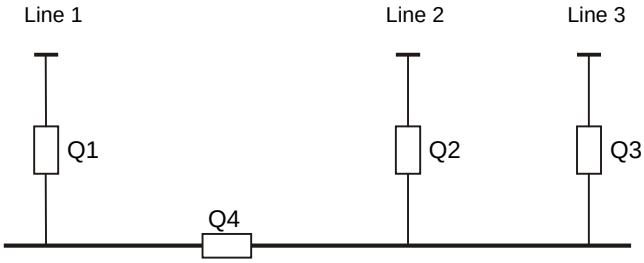
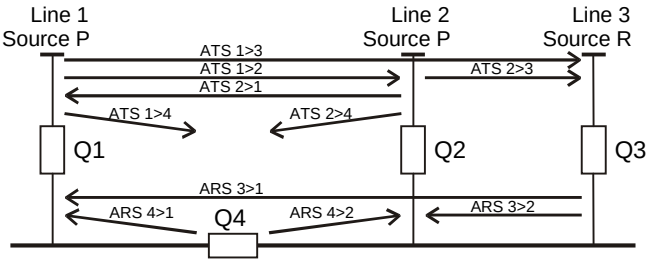
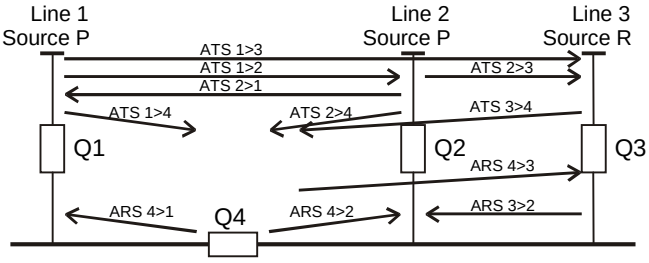
**Configuration 6**

Three lines and coupling




| Transfer variants (sources priority)<br>Device setting (jumper position) | ATS and ARS transfer directions |
|---|---|
| **Variant A**<br>**Lines 1 and 2** – equal priority (primary)<br>**Line 3** – reserve source 2 lev.<br>**CB4** – reserve source 1 lev.<br><br>**Setting 14** (jumper position 8+4+2+0) |  |
| **Variant B**<br>**Lines 1 and 2** – equal priority (primary)<br>**Line 3** – reserve source 1 lev.<br>**CB4** – reserve source 2 lev.<br><br>**Setting 15** (jumper position 8+4+2+1) |  |
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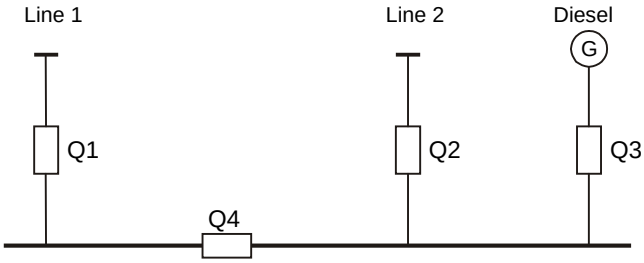
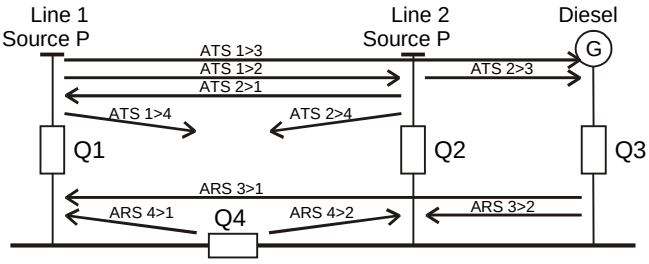
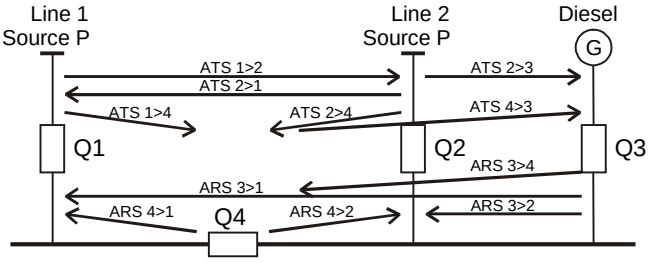
**Configuration 7**

Two lines with coupling and diesel




| Transfer variants (sources priority)<br>Device setting (jumper position) | ATS and ARS transfer directions |
|---|---|
| **Variant A**<br>**Lines 1 and 2** – equal priority (primary)<br>**Diesel** – reserve source<br>Diesel for both lines<br><br>**Setting 5** (jumper position 0+4+0+1) |  |
| **Variant B**<br>**Lines 1 and 2** – equal priority (primary)<br>**Diesel** – reserve source<br>Diesel only for second line<br><br>**Setting 7** (jumper position 0+4+2+1) |  |
| | |
| | |

Attention:

The following steps should be executed in order to change the settings:

a. turn off power supply,
b. change the jumper on the beck site of the device
c. turn on power supply (device reads jumper states)
Change of jumpers during devise operations is ignored.

### 7.8.2 Voltage modules

The sensitivity of the voltage modules is set in PB and PB-04 relays – it is described in details in their manual.

### 7.8.3 Time modules

1. ***tlATS*** – limit time for ATS.
Time dedicated for realizing the change-over in ATS cycle. If operation will not be finished during *tlATS* time ATS cycle is break. Countdown of the time is started at the moment of voltage drop on the line.

2. ***tlATSd*** – limit time for ATS for diesel.
Time dedicated for realizing the change-over in ATS cycle for diesel. If operation will not be finished during *tlATS* time ATS cycle is break.. Countdown of the time is started at the moment of voltage drop on the line.

3. ***tlPTS*** – limit time for PTS
Time dedicated for realizing the change-over in PTS cycle for diesel. If operation will not be finished during *tlPTS* time PTS cycle is break. Countdown of the time is started at the moment of starting PTS automatics.

4. ***tlARS*** – limit time for ARS.
Time dedicated for realizing the change-over in ARS cycle. If operation will not be finished during *tl*ARS time ARS cycle is break. Countdown of the time is started at the moment of voltage drop on the line.

5. ***tlASS***– limit time for ASS.
Time dedicated for realizing the change-over in ASS cycle. If operation will not be finished during *tl*ASS time ASS cycle is break. Countdown of the time is started at the moment of other unsuc-

cessful transfer switch or voltage drop on the line. tlASS can be set for “infinity” (in that case there is no ASS limit) – both tdARS and twASS should be set for “infinity”.

6. ***twARS*** – waiting time for ARS.
Time dedicated for starting realizing the change-over in ARS cycle. If operation will not be started during *twARS* time ARW cycle is break and device change into stand-by status. Countdown of the time is started at the moment of CB opening in ATS cycle from voltage drop. twARS can be set for “infinity” – both tdARS and twASS should be set for “infinity”.

7. ***tdATS***– time of start-up delay of ATScycle.
This is the time of delay of realizing change-over operation on ATS cycle in order to protect from the situation of momentary voltage drop in supplying line. Countdown of the time is started at the moment of voltage drop on the line.

8. ***tdATSd***– time of start-up delay of ATScycle for diesel.
This is the time of delay of realizing change-over operation on ATS cycle for diesel in order to protect from the situation of momentary voltage drop in supplying line. Countdown of the time is started at the moment of voltage drop on the line.

9. ***tdASS***– time of start-up delay of ASS.
This is the time of delay of realizing change-over operation on ASS cycle in order to protect from the situation of momentary voltage appearance in supplying line. Countdown of the time is started at the moment of voltage appearance on the line.

10. ***tdARS***– time of start-up delay of ARS.
This is the time of delay of realizing change-over operation on ARS cycle in order to protect from the situation of momentary voltage appearance in supplying line. Countdown of the time is started at the moment of voltage appearance on the line.

11. ***tp*** – duration time of controlling impulsees.
Duration time of impulsees controlling circuit breakers and duration time of impulsees controlling diesel.

12. **tcb** delay time of blockade signalization (fixed)
This is the time of delay of blockade signalization caused by voltage drop or wrong signals from CB. If the problem last shorter than tcb the blockade is not activated.

11. ***tcd*** – delay time of closing circuit breaker (fixed)
This is the time of delay of generating impulsee closing circuit breaker. Timing of this time is started at the moment of opening circuit breaker and voltage drop on the line.

tdASS and tdARS are counted from the point of relay voltage unit activation. Relay activation time is between 0,1…0,3 s. This time should be included in the settings – settings should be 0,2 s decreased.
tdATS and tdATSd are counted from the point of relay voltage unit deactivation. Relay deactivation time is between 0,4..0,8 s. This time should be included in the settings – settings should be 0,6 s decreased.

Times: *tlPTS*, *tlARS* , *tlASS*, *twARS*, *tdASS* and *tdARS* are set on the same value.

### 7.8.4 Device programming

**1. Permission for switching cycle is set separately for every mode**
For „y" (yes) device will be able to execute the proper mode.
For „n" (no) device will not be able to execute the proper mode.
This can be set for the following modes:

- ATS – automatic transfer switch
- PTS – planned transfer switch
- ARS – automatic return switch
- ASS – automatic supply switch

2. **Load rebound for the line**
This is the impulsee that switch off the chosen outgoings in case of transfer switch. Lines that are not ready for full load should be declared.
For "y" device will generate load rebound signal for the transfer to the chosen line.
For "n" device will not generate load rebound signal for the transfer to the chosen line.

**3. Device blockade after proper ATS or ASS**
For "y" device will be permanently blocked after proper ATS or ASS
For "n" device will go into stand-by mode after proper ATS or ASS
Proper transfer means, that there is voltage on the switchgear main bus after transfer execution.
If several transfers have been activated simultaneously, device will be blocked after the last transfer.

**4. Device blockade after improper ATS or ASS**

For “y” device will be permanently blocked after improper ATS or ASS

For “n” device will go into stand-by mode after improper ATS or ASS

Improper transfer means, that there is no voltage on the switchgear main bus after transfer execution. If several transfers have been activated simultaneously, device will be blocked after the last transfer.

**5. Negation of „device off” signaling**

For “y” signal is activated if device automation is on or that there is no voltage

For “n” signal is activated if device automation is off or that there is no voltage

**6. twARS, tlASS – infinity**

For “y” **twARS, tlASS** values are set for “infinity”, there is no time limit for transfer switch execution

For “n” **twARS, tlASS** values are set according to settings

**7. Blockade of parallel work during local control**

For “y” there is no possibility of lines parallel work made by local control

For “n” there is a possibility of lines parallel work made by local control

**8. Contactors feed by non uninterrupted voltage**

For “y” during voltage disappearance contactors are disconnected

For “n” during voltage disappearance contactors and circuit breakers remain in their current state

**9. CB opening in case of power supply disappearance**

For “y” <30s after power supply disappearance all CB’s are being opened

For “n” CB’s are not being opened in case of power supply disappearance

**10. Automatics on/off by two-positioning key**

For “y” device is controlled by two-positioning key, device state is equal to key state

For “n” device is controlled by impulsee signal, every impulsee change the state on opposite

**11. ASS and ARS automation activation**

For “y” after power supply disappearance on the main bus, ASS and ARS modes are activated and will make proper switch in case of any voltage appearance

For “n” after power supply disappearance on the main bus automation is permanently blocked

**12. Programmable output**

- Load rebound. Output will work as load rebound signal in case of ATS and ASS. Load rebound is set for every switch direction in the setting.
- Local control. Inform that local control has been activated on the front panel. „

### 7.8.5 Manufacturer settings.

Manufacturer settings can be applied in most switchgears. Manufacturer settings are shown in the table below:

| Setting | | | Time setting | | | | | | | | Permissions | | | | Load rebound | | | | Port | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Setting | Switchgear configuration | Transfer variant | tIAT | tIATSA | tIPTS and tgARS | tIASS and twARS | tdATS | tdATSA | tdASS and tdARS | tp | ATS | PTS | ARS | ASS | line 1 load rebound | line 2 load rebound | line 3 load rebound | line 4 load rebound | Device address | Communication speed |
| 0 | 1 | A | 10s | 60s | 5s | 10h | 2,0s | 10s | 20s | 0,5s | Y | Y | Y | Y | N | Y | N | N | 1 | 19200 |
| 1 | 1 | B | 10s | 60s | 5s | 10h | 2,0s | 10s | 20s | 0,5s | Y | Y | Y | Y | N | N | N | N | 1 | 19200 |
| 2 | 2 | A | 10s | 60s | 5s | 10h | 2,0s | 10s | 20s | 0,5s | Y | Y | Y | Y | N | Y | N | N | 1 | 19200 |
| 3 | 2 | B | 10s | 60s | 5s | 10h | 2,0s | 10s | 20s | 0,5s | Y | Y | Y | Y | Y | Y | N | N | 1 | 19200 |
| 4 | 2 | C | 10s | 60s | 5s | 10h | 2,0s | 10s | 20s | 0,5s | Y | Y | Y | Y | Y | Y | N | N | 1 | 19200 |
| 5 | 7 | A | 10s | 60s | 5s | 10h | 2,0s | 10s | 20s | 0,5s | Y | Y | Y | Y | N | N | Y | N | 1 | 19200 |
| 6 | 3 | A | 10s | - | 5s | 10h | 2,0s | - | 20s | 0,5s | Y | Y | Y | Y | N | Y | N | N | 1 | 19200 |
| 7 | 7 | B | 10s | 60s | 5s | 10h | 2,0s | 10s | 20s | 0,5s | Y | Y | Y | Y | N | N | Y | N | 1 | 19200 |
| 8 | 4 | A | 10s | 60s | 5s | 10h | 2,0s | 10s | 20s | 0,5s | Y | Y | Y | Y | N | Y | Y | N | 1 | 19200 |
| 9 | 4 | B | 10s | 60s | 5s | 10h | 2,0s | 10s | 20s | 0,5s | Y | Y | Y | Y | N | N | Y | N | 1 | 19200 |
| 10 | 4 | C | 10s | 60s | 5s | 10h | 2,0s | 10s | 20s | 0,5s | Y | Y | Y | Y | N | N | N | N | 1 | 19200 |
| 11 | 4 | D | 10s | 60s | 5s | 10h | 2,0s | 10s | 20s | 0,5s | Y | Y | Y | Y | N | Y | Y | N | 1 | 19200 |
| 12 | 5 | A | 10s | - | 5s | 10h | 2,0s | - | 20s | 0,5s | Y | Y | Y | Y | N | Y | Y | N | 1 | 19200 |
| 13 | 5 | B | 10s | - | 5s | 10h | 2,0s | - | 20s | 0,5s | Y | Y | Y | Y | N | N | Y | N | 1 | 19200 |
| 14 | 6 | A | 10s | - | 5s | 10h | 2,0s | - | 20s | 0,5s | Y | Y | Y | Y | N | N | Y | N | 1 | 19200 |
| 15 | 6 | B | 10s | - | 5s | 10h | 2,0s | - | 20s | 0,5s | Y | Y | Y | Y | N | N | Y | N | 1 | 19200 |

„-„ means that the particular setting has no meaning

**„APZmini.exe" program**

### 7.8.6 Introduction

„APZmini.exe" program is used for:

- time unit setting input
- automation setting input
- access to event recorder
- printout of device settings and event logs
- device setting load (switchgear configuration, transfer switch variant)

In order to show information regarding time settings and automation settings program has to receive the following information:

- device configuration (switchgear configuration, transfer switch variant)
- name labels– examples of names labels: „*trATS*", „*ATS CB1>CB2*"
- settings values – numbers or logical.

In order to show event records program has to receive the following information:

- device configuration (switchgear configuration, transfer switch variant)
- event name labels– examples of names labels: – example „Usz ^"
- event code –numbers.

„APZmini.exe" creates 3 files with data.

- **labels.nzw** – contains settings and events labels for all possible device configuration. This file is load automatically at the moment of staring APZmini.exe application.
- **file_name.nst** – contains the values of time settings, transfer switch mode, and additional configuration set in the device.
- **file_name.rzd** – contains codes of particular events load from the device and additional configuration set in the device.

„APZmini.exe" and labels.nzw" files are delivered by manufacturer together with the device. They should be placed in the same directory. Other files are created when they are necessary. Device has manufacturer setting load into memory.

### 7.8.7 Communication

Device is equipped with one port RS485 (WAGO terminal) placed on the back site. It is dedicated for communication with local computer or master system. „APZmini.exe" can be run both on local

computer or in the system. In particular situations RS232/485 converter may be necessary for communication.
Communication between device and computer is activated by commands: “connect” and “disconnect”

For the connection of device to the program following steps should be performed:

a) turn off the device
b) connect computer to the device
c) run APZmini.exe application (labels.nzw will be loaded automatically)
d) execute command “connect”

For the disconnection of device to the program following steps should be performed:

a) execute command “disconnect”
b) close APZmini.exe application
c) disconnect communication cable

Device change to the mode from „transfer execution” to the „settings and events recorder” automatically after connecting. After communication disconnection, device automatically goes back to the “transfer execution” mode and remain off.
Program itself can work without connection to the device – for example for settings preparation or events analysis.

### 7.8.8 Program settings

The following options are available in the program:

- Load setting from disk (menu: „*Settings*” -> „*Open file*”)
- Save setting to disk (menu: „*Settings*” -> „*Save file as*”)
- Load setting from device (menu: „*Settings*” -> „*Open settings from APZmini*”)
- Save setting to device (menu: „*Settings*” -> „*Save to APZmini*”)
- Compare settings between file and APZmini (menu: „*Settings*” -> „*Compare*”)
- Settings printout (menu: „*Settings*” -> „*Print*”)
- Settings exploration and edition.

APZmini settings change

a. Connect computer with the device and activate the communication.

b. Load settings from APZmini (menu: „*Settings*” -> „*Open settings from AZPmini*”); (switchgear configuration and transfer mode will be loaded automaticaly). In the “mode and configuration” chart proper values from settings will be loaded as well as in the „time” and “algorithms” charts.
c. Change chosen setting values.
d. Save new settings in the device (menu „*Settings*” -> „*Save to AZPmini*”).
e. You can also save new settings to disk (menu „*Settings*” -> „*Save file as*”).
f. Terminate communication and disconnect the device.

Creation of settings file in the laboratory environment (without the device) in case of no source file.
a. Chose proper configuration in the chart „configuration and mode”. In time” and “algorithms” charts proper values will be calculated automatically according to the „configuration and mode” chart.
b. Change chosen setting values.
c. Save new settings on the disk (menu „*Settings*” -> „*Save file as*”).

Creation of settings file in the laboratory environment (without the device) in case of source file.
a. Load settings from disk (menu: „*Settings*” -> „*Open file*”); Settings values in „configuration and mode”, time” and “algorithms” charts will be loaded.
b. Change chosen setting values.
c. Save new settings on the disk (menu „*Settings*” -> „*Save file as*”).

Loading of prepared setting to the device:
a. Connect computer with the device and activate the communication.
b. Load settings from disk (menu: „*Settings*” -> „*Open file*”); Settings values in „configuration and mode”, time” and “algorithms” charts will be loaded.
c. Write new settings to the device (menu „*Settings*” -> „*Save to AZPmini*”)
d. Terminate communication and disconnect the device.

It is also possible to print setting on the pictures. Printout includes:

- device manufacturer number
- settings labels (in case of digitals settings “1” means “y” and “0” means “n”

### 7.8.9 Events recorder

The following options are available by the program:

- Load events registry from the device (menu:”Events” > „Load events from APZmini”)
- Load events registry from the disk, available when device is not connected to the computer (menu: „*Events*” ->„*Open file*”)

- Save events registry on disk (menu: „*Events*” -> „*Save file as*”)
- Printout of the events registry (menu: „*Events*” -> „*Print*”)
- Analysis of the events registry buffer.

Read and analysis of events from the device:
a. Connect computer with the device and activate the communication.
b. Load events from APZmini (menu:”Events” > „Load events from APZmini”)
Settings values in “events”, „configuration and mode”, time” and “algorithms” charts will be loaded.
Information regarding device manufacturer serial number will be shown in “events” chart.
c. Analyze events.
d. Events can be save on disk (menu „*Events*” -> „*Save file as*”).
e. Terminate communication and disconnect the device.

Analysis of events from the disk:
a. Load events from the disk (menu:”Events” > „Open file”)
Settings values in “events”, „configuration and mode”, time” and “algorithms” charts will be loaded.
Information regarding device manufacturer serial number will be shown in “events” chart.
b. Analyze events.

It is possible to print events. There is device manufacturer serial number on the printout. Events registry is read only – it’s edition is not possible

<u>Events analysis</u>
Events registry is available in „Events chart. Proper list of events appear after Reading of events registry (or registry file open). Events list include:

- Device manufacturer serial number
- Switchgear configuration
- Transfer variant
- Events numbers (1 for youngest events)
- Events time
- Events duration in [s] (information for maintenance)
- Events names.

Signal information:

- ^ – up slope, signals appears.
- v – down slope, signals disappears

You can scroll events list and select few for detail analysis . Below you can find list of all signals. Signals that had changed state during event are marked red. By scrolling the list you can control how signals where being changed.

Device does not have processor battery. Internal clock counts working time only when device is on. Events are storage in non-volatile memory, and power supply lost does not cause events lost.

Computer program adjust the time counted in the device to the computer time and gives time label to each event in the moment of events registry reading. Events that occurred before last power supply lost have times shifted by the value of power supply lost, whoever chorology is kept. Events times from the moment of last power supply lost are real (proper). Events that occurred before last power supply lost are marked yellow. Device restart (power on) is marked red.

List of recorder signals

| Name of the signal | Description |
|---|---|
| UX present | UX voltage is present |
| UX not present | UX voltage is not present |
| UbusX present | UbusX voltage is present |
| UbusX not present | UbusX voltage is not present |
| QX on | „Q WX on” signal |
| QX off | „Q WX off” signal |
| QX imp on | Q WX Impulse on |
| QX imp off | Q WX Impulse off |
| Diesel imp on | Diesel impulse on |
| Diesel imp off | Diesel impulse off |
| PTS exe | PTS or ARS execution signal |
| ASS exe | ASS execution signal |
| ARS wait | ARS waiting signal |
| ASS wait | ASS waiting signal |
| Imp LR | Load rebound Impulse |
| ATS X>Y exe | ATS WX>WY execution signal |
| Restart | Restart |
| Manual control | Manual control of Q is chosen |
| Local control | Local control of the device is chosen |
| Off | Device off signalling |
| PTS X<>Y | PTS WX<>WY |

| | |
|---|---|
| I> trip | Line protection trip signalling |

Description:

QX, QY – circuit breakers

UX – line voltage

UbusX – bus voltage

Current events can be printed „*Events*" -> „*Print*".

### 7.8.10 Program additional options

The window with information regarding realized function is available in the „communication with APZmini" chart. There is "clear" button next to it.

There are information regarding the device on the right.

- proccesor temperature
- APZmini build-in software version
- Whrs – device working hours
- Device serial number

This information are available after successful communication with the device.

Below you can find port selection window and button for connect and disconnect.

„RS485 setting" chart is for setting network address and transmission speed. In case of device working in master system it should have address from the range 1….31

Serial port configuration saving is available only in "online" mode and after using proper password in "login" window. The password is text "APZmininnnn" where nnnn is the device serial number – case sensitive.

Serial port configuration reading is done during device setting reading (menu: „*Settings*" -> „*Open settings from AZPmini*").

Change of port parameters in APZmini

a. Connect computer with the device and activate the communication.

b. Load settings from APZmini (menu: „*Settings*" -> „*Open settings from AZPmini*"); (switchgear configuration and transfer mode will be loaded automaticaly). In the "mode and configuration" chart proper values from settings will be loaded as well as in the „time" and "algorithms" charts.

c. Enter password in the login window

d. Change chosen parameters.

d. Save new settings in the device (menu „*Settings*" -> „*Save to AZPmini*").

e. You can also save new settings to disk (menu „*Settings*" -> „*Save file as*").

f. Terminate communication and disconnect the device.

## 7.9 Communication protocol description

### 7.9.1 General information

Device is using RS485 communication interface. Communication with the system is made by "Modbus" protocol. Communication parameters (speed, address) are set in "APZmini.exe" program, described in section above.

RS485 port should be connect as follows:

| RS port clamp | RS485 signal |
|---|---|
| 1 | GND |
| 2 | B |
| 3 | A |

### 7.9.2 Registry table

| Address | Atribute | Description |
|---|---|---|
| 00hMSB | load/save | Commands from MS (master system) – description below |
| 00hLSB | load/save | Reserved |
| 01hMSB | load/save | Reserved |
| 01hLSB | load/save | Reserved |
| 02hMSB | load/save | Reserved |
| 02hLSB | load/save | Reserved |
| 03hMSB | load/save | Reserved |
| 03hLSB | load/save | Reserved |
| 04hMSB | load/save | Reserved |
| 04hLSB | load/save | Reserved |
| 05hMSB | load/save | Reserved |
| 05hLSB | load/save | Reserved |
| 06hMSB | load/save | Reserved |
| 06hLSB | load/save | Reserved |
| 07hMSB | load/save | Reserved |
| 07hLSB | load/save | Reserved |
| 08hMSB | load | Input 0 – description below |
| 08hLSB | load | Input 1 – description below |
| 09hMSB | load | Input 2 – description below |
| 09hLSB | load | Switch state on back site of the device -4bits<br>Front panel buttons state -4bits |

| | | |
|---|---|---|
| 0AhMSB | load | Output0 – description below |
| 0AhLSB | load | Output1 – description below |
| 0BhMSB | load | Output2 – description below |
| 0BhLSB | load | Output3 – description below |
| 0ChMSB | load | Working seconds 1 LSB |
| 0ChLSB | load | Working seconds 2 |
| 0DhMSB | load | Working seconds 3 |
| 0DhLSB | load | Working seconds 4 MSB |
| 0EhMSB | load | Restart counter |
| 0EhLSB | load | Processor temperature |
| 0FhMSB | load | RS Setting |
| 0FhLSB | load | Firmware version |
| 10hMSB | load | Event selector |
| 10hLSB | load | Transfer variant (4MSb) Switchgear configuration (4LSb) |
| 11hMSB | load | Device serial number LSB |
| 11hLSB | load | Device serial number MSB |
| 400h-9FFh | load | Event buffer |

### 7.9.3 Output and input registers states

Outputs:

| Bit | Output0 | Output1 | Output2 | Output3 |
|---|---|---|---|---|
| 0 | Int signal „Local” | LED_D_kz | CB3 Impulse on | Ext signal „Load R.” |
| 1 | Int signal „Off.” | LED_Z_1 | CB3 Impulse off | Ext signal „off” |
| 2 | Int signal „ON” | LED_C_kz | CB2 Impulse on | Ext signal „on” |
| 3 | LED_A_ko | LED_D_ko | CB2 Impulse off | Ext signal „block.” |
| 4 | Int signal „Bl_temp | LED_Y_1 | CB1 Impulse off | diesel on impulse |
| 5 | Int signal ARS wait | LED_C_ko | CB1 Impulse on | diesel off impulse |
| 6 | Int signal „Power” | LED_B_ko | LED_A_kz | CB4 impulse on |
| 7 | Int signal „Bl perm” | LED_B_kz | UX_1 | CB4 impulse off |

Bits started with „LED_” describe led on the front panel. Led designation depends on particular configuration.

Inputs:

| Bit | Input 0 | Input 1 | Input 2 |
|---|---|---|---|
| 0 | U1 voltage present | Prot. I> and other blockades | PTS Q1-Q2 |
| 1 | Q2 off | Q3 off | iLA_zw |

| | | | |
|---|---|---|---|
| 2 | Q2 on | U3 voltage present | Q4 on |
| 3 | U2 voltage not present | U3 voltage no present | „diesel ready” Signal |
| 4 | „diesel on” Signal | Q1 on | U4 voltage not present |
| 5 | PTS Q2-Q3 | U2 voltage present | Q4 off |
| 6 | PTS Q1-Q3 | U1 voltage not present | Q3 on |
| 7 | ButPTS1 | Q1 off | U4 voltage present |

### 7.9.4 Commands from master system

Value in 00h registry (KSS command) generate device to execute proper command (command makes 00h registry to be reset)

| Value | Command |
|---|---|
| 01h | Device Off |
| 02h | Device On |
| 10h | Q1 Off |
| 11h | Q1 On |
| 12h | Q2 Off |
| 13h | Q2 On |
| 14h | Q3 Off |
| 15h | Q3 On |
| 16h | Q4 Off |
| 17h | Q4 On |
| 18h | Diesel Off |
| 19h | Diesel On |
| 20h | Activate PTS 1 |
| 21h | Activate PTS 2 |
| 22h | Activate PTS 3 |

18h and 19h commands (Diesel on/off) are executed independently from control place(local/remote). Other commands are executed only in case of remote control.

Depending on switchgear configuration 20h, 21h, 22h (PTS activation) commands activate transfer between the following circuit breakers.

| Switchgear configura-tion | circuit breakers transfer | | |
|---|---|---|---|
| | PTS 1 command | PTS 2 command | PTS 3 command |
| 1, 3 | Q1 – Q2 | Not used | Not used |

| | | | |
|---|---|---|---|
| 2, 4, 5 | Q1 – Q2 | Q2 – Q3 | Q1 – Q3 |
| 6, 7 | Q1 – Q4 | Q2 – Q4 | Q2 – Q3 |

### 7.9.5 Events registry description

Events are saved to non-volatile memory organized as circular buffer with structure 12 Byte table. This table is available under addresses 400h-9FFh in “Modbus” protocol. Events indicator shows number of the last event save to the buffer. 256 events can be stored in the buffer.

Events structure is as follows:

| Byte | Description |
|---|---|
| 0-3 | Time [s] – number of working seconds |
| 4-10 | Binary signals state |
| 11 | CRC – symmetrical sum of first 11 bytes in the structure |

Device is tracking states of chosen digital signals. All changes are treated as a new event. Bytes 4...10 contain information regarding signals states after the change has occured.
Table below contains detailed description of events bits. Save mode is made by signal direction change: (up-slope - U down-slope –D )

| Name: | Byte number | Bit number | Save mode |
|---|---|---|---|
| U1 voltage present | 4 | 00h | U,D |
| Signal „Q2 off” | 4 | 01h | U,D |
| Signal „Q2 on” | 4 | 02h | U,D |
| U2 voltage not present | 4 | 03h | U,D |
| Ubus4 voltage not present | 4 | 04h | U,D |
| Local control | 4 | 05h | U,D |
| Impulse „load rebound” | 4 | 06h | U,D |
| Device off | 4 | 07h | U,D |
| „Protection tripping” signal | 5 | 00h | U,D |
| Signal „Q3 off” | 5 | 01h | U,D |
| U3 voltage present | 5 | 02h | U,D |
| U3 voltage not present | 5 | 03h | U,D |
| Signal „CB1 on” | 5 | 04h | U,D |
| Present voltage U2 | 5 | 05h | U,D |
| U1 voltage not present | 5 | 06h | U,D |
| Signal „Q1 off” | 5 | 07h | U,D |

| | | | |
|---|---|---|---|
| ASS signalling | 6 | 00h | U,D |
| Reserved | 6 | 01h | U |
| Signal „Q4 on” | 6 | 02h | U,D |
| Ubus4 voltage present | 6 | 03h | U,D |
| Ubus5 voltage not present | 6 | 04h | U,D |
| Signal „Q4 off” | 6 | 05h | U,D |
| Signal „Q3 on” | 6 | 06h | U,D |
| Ubus5 voltage present | 6 | 07h | U,D |
| Ubus1 voltage present | 7 | 00h | U,D |
| Ubus1 voltage not present | 7 | 01h | U,D |
| Ubus2 voltage present | 7 | 02h | U,D |
| Ubus2 voltage not present | 7 | 03h | U,D |
| Ubus3 voltage present | 7 | 04h | U,D |
| Ubus3 voltage not present | 7 | 05h | U,D |
| Impulse on Q1 | 7 | 06h | U,D |
| Impulse off Q1 | 7 | 07h | U,D |
| Impulse on Q2 | 8 | 00h | U,D |
| Impulse off Q2 | 8 | 01h | U,D |
| Impulse on Q3 | 8 | 02h | U,D |
| Impulse off Q3 | 8 | 03h | U,D |
| Impulse on Q4 | 8 | 04h | U,D |
| Impulse off Q4 | 8 | 05h | U,D |
| Impulse on Diesel | 8 | 06h | U,D |
| Impulse off Diesel | 8 | 07h | U,D |
| ATS in direction 1 | 9 | 00h | U,D |
| ATS in direction 2 | 9 | 01h | U,D |
| ATS in direction 3 | 9 | 02h | U,D |
| ATS in direction 4 | 9 | 03h | U,D |
| ATS in direction 5 | 9 | 04h | U,D |
| ATS in direction 6 | 9 | 05h | U,D |
| ATS in direction 7 | 9 | 06h | U,D |
| ATS in direction 8 | 9 | 07h | U,D |
| PTS 1 activation | 10 | 00h | U,D |
| PTS 2 activation | 10 | 01h | U,D |
| PTS 3 activation | 10 | 02h | U,D |

| | | | |
|---|---|---|---|
| PTS or ARS signaling | 10 | 03h | U,D |
| ARS waiting signaling | 10 | 04h | U,D |
| ASS waiting signaling | 10 | 05h | U,D |
| Hand control over circuit breakers | 10 | 06h | U |
| Device restart | 10 | 07h | U |

Voltage described as „Ubus" are used to describe voltage on the bus. Their designation depends on particular switchgear configuration.

| Switchgear configuration | Voltage on the bus |
|---|---|
| 1 | Ubus4 |
| 2 | bus 1 – Ubus1<br>bus 2 – Ubus2 |
| 3 | Ubus4 |
| 4 | Ubus5 |
| 5 | Ubus5 |
| 6 | bus 1 – Ubus1<br>bus 2 – Ubus2 |
| 7 | bus 1 – Ubus1<br>bus 2 – Ubus2 |

Relation between transfer direction and switchgear configuration regarding real circuit breakers transfer in ATS mode is shown in the table below:

| Switchgear configuration | ATS Directions | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | Q1>Q2 | Q2>Q1 | | | | | | |
| 2 | Q1>Q3 | Q2>Q3 | Q1>Q2 | Q2>Q1 | | | | |
| 3 | Q1>Q2 | | | | | | | |
| 4 | Q1>Q2 | Q2>Q1 | Q1>Q3 | Q3>Q1 | Q2>Q3 | Q3>Q2 | | |
| 5 | Q1>Q2 | Q2>Q1 | Q1>Q3 | Q2>Q3 | | | | |
| 6 | Q1>Q2 | Q2>Q1 | Q2>Q4 | Q2>Q3 | Q2>Q4 | Q1>Q4 | Q1>Q3 | Q3>Q4 |
| 7 | Q1>Q2 | Q2>Q1 | Q2>Q4 | Q1>Q4 | Q1>Q4 | Q2>Q3 | Q1>Q3 | Q4>Q3 |

# 8 Operating

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

## 8.1 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.

## 8.2 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.

# 9 Transporting and storing

Transport packing should have the same resistance degree for vibrations and strokes, ATS 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.

## 10 Utilization

If there is necessary to disassemble the device (and eventually removal), ATS 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 ATS electronic scrap which should be treated in accordance to regulations concerning waste management.

## 11 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.

## 12 Ordering

CODE DESIGNATION FOR ORDERING

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | / | | | | | | / | | | |
| Type | A | P | Z | m | i | n | i | | | | | | | | | | |
| Power supply | 24V | | | | | | | | 0 | 2 | 4 | | | | | | |
| | 110 | | | | | | | | 1 | 1 | 0 | | | | | | |
| | 220 | | | | | | | | 2 | 2 | 0 | | | | | | |
| | Voltage | | | | | | | | | | | D | C | | | | |
| | Voltage | | | | | | | | | | | A | C | | | | |
| Configuration | 1 – two lines without coupling | | | | | | | | | | | | | | 1 | | |
| | 2 – two lines with coupling | | | | | | | | | | | | | | 2 | | |
| | 3 – one line and diesel | | | | | | | | | | | | | | 3 | | |
| | 4 – three lines | | | | | | | | | | | | | | 4 | | |
| | 5 – two lines and diesel | | | | | | | | | | | | | | 5 | | |
| | 6 – three lines and coupling | | | | | | | | | | | | | | 6 | | |
| | 7 – three lines, coupling and diesel | | | | | | | | | | | | | | 7 | | |
| Variant | | | | | | | | | | | | | | | | A | |
| | | | | | | | | | | | | | | | | B | |
| | | | | | | | | | | | | | | | | C | |
| | | | | | | | | | | | | | | | | D | |
| | Not set | | | | | | | | | | | | | | | O | |
| Example | | | | | | | | | | | | | | | | | |
| | A | P | Z | m | i | n | i | / | 2 | 2 | 0 | D | C | / | 2 | A | |
| Type | A | P | Z | m | i | n | i | | | | | | | | | | |
| Power supply | 220 | | | | | | | | 2 | 2 | 0 | | | | | | |
| | Voltage | | | | | | | | | | | D | C | | | | |
| Configuration | 2 – two lines with coupling | | | | | | | | | | | | | | 2 | | |
| Variant | Variant | | | | | | | | | | | | | | | A | |

The orders should be sent to the following address:

Energotest Ltd.

Chorzowska 44B; 44-100 Gliwice

tel. +48 032-270 45 18, fax +48 032-270 45 17.

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