

SZPW AUXILIARY POWER SUPPLY SYSTEM

Intended for
the following industries:



The energy system can be divided into three subsystems, namely:

- Production subsystems - various types of power plants (thermal, nuclear, water, renewable, etc.).
- Transmission subsystems - transmission stations and high voltage networks;
- Distribution subsystems - creating distribution substations and distribution channels;

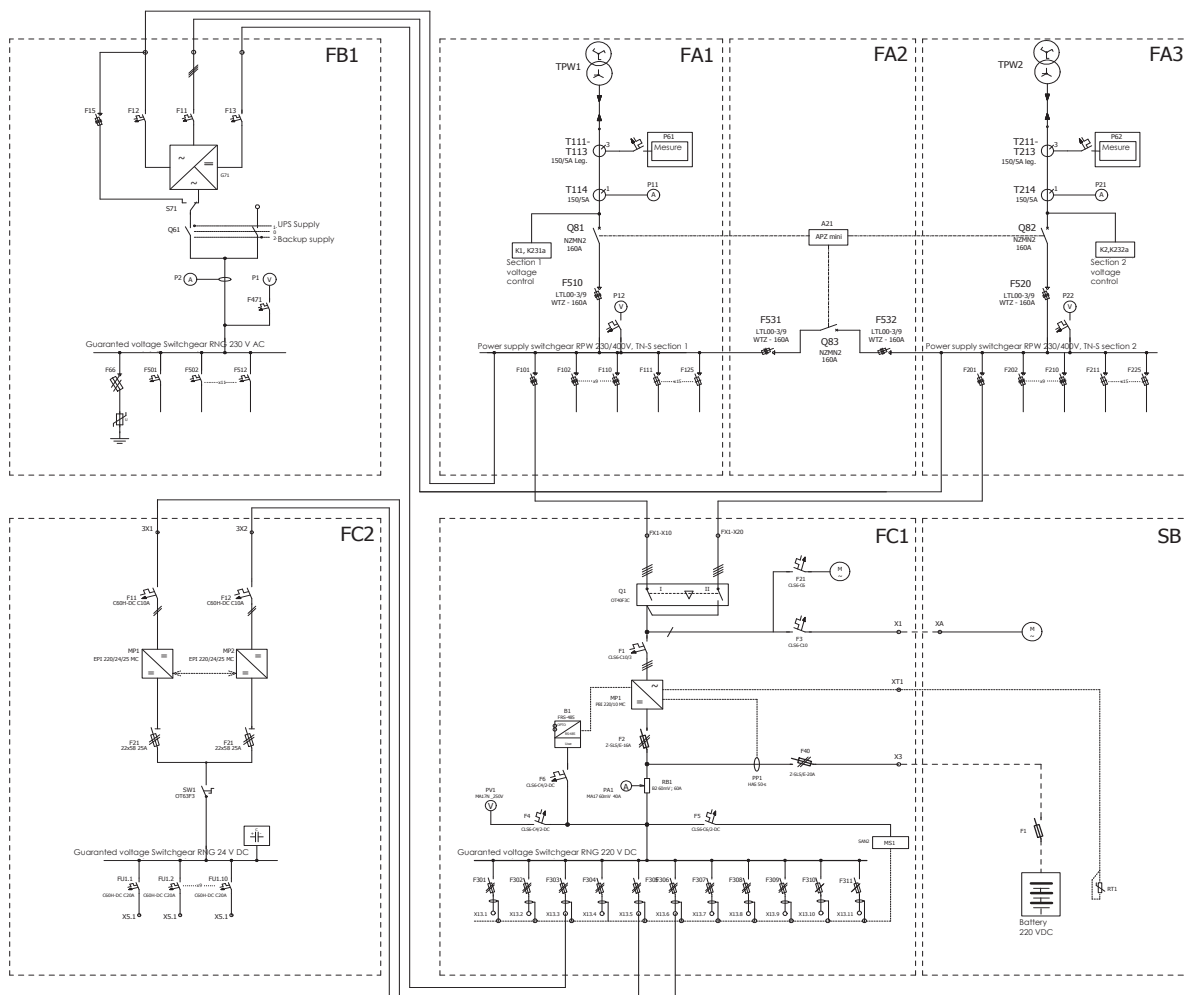
So that the entire energy system can operate properly, it is necessary to use multiple automation, measurement, monitoring systems, etc. They are located at the respective substations or power plants. The above-mentioned systems of automation and remote control require extremely reliable sources of power supply for their operation. Those sources must surely supply the above receivers independently of the presence of suitable voltage values in the power system. For this reason, the auxiliaries power supply sources must today be supplied independently of the energy system power supplying, from additional sources. Backup sources of energy (substation autonomous maintaining) are the most common batteries and generators.

SZPW auxiliary power supply system is used to power supply all the devices available in the electric substation during normal and autonomous operation.



PIC. SZPW in industrial cabinet

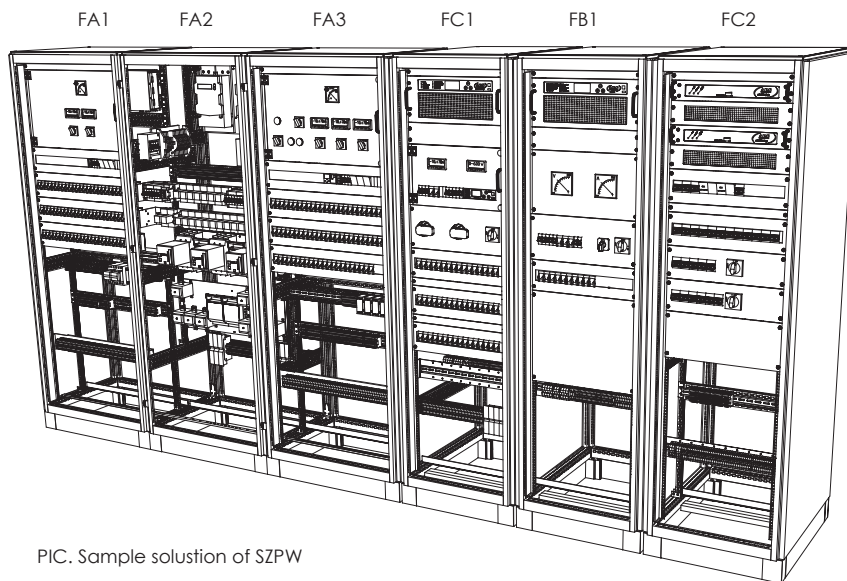
PIC. SZPW - POWER SUPPLY SYSTEM (SAMPLE SOLUTION)



AUXILIARIES POWER SUPPLY SYSTEMS IN THE ENERGY SECTOR

In auxiliaries systems essential components can be determined based on the exemplary solution:

- 230/400 VAC main LV auxiliaries switchgear;
- Primary DC switchgear (220 or 110VDC) of DC uninterruptible voltages
- Battery pack with rectifier (AC/DC transformer);
- 230V AC uninterruptible voltage switchgear with DC/AC converter with galvanic isolation;
- DC (24, 48V DC) auxiliary switchgear of uninterruptible DC voltage with DC/DC converters - change of one DC voltage value into another DC voltage value with galvanic isolation;
- Control and monitoring systems;
- Other elements.



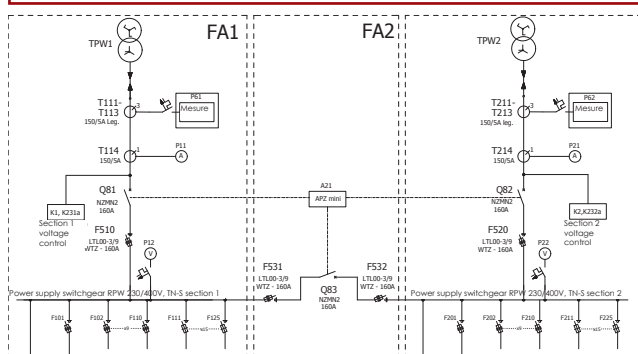
PIC. Sample solution of SZPW

0.4 KV MAIN SWITCHGEAR

RPW-0.4 kV main switchgear (230/400VAC) is used to distribute power to all devices available in the electric substation. In order to increase reliability, the switchgear is supplied on both sides and has integrated automatics systems for switching power supply between the available power supply sources. 0.4 kV RPW switchgear supplies circuits of lighting installation of the substation premises, heating circuits of cable cabinets and HV appliances, circuits supplying drives of HV switchgear connectors, circuits supplying drives high voltage transformers attachments, and uninterruptible voltage switchgears:

- 220/110 VDC switchgear including rectifier circuit
- 230AC uninterruptible switchgear with inverter system
- 48VDC switchgear (telecommunications voltage) and/or 24 VDC switchgear (control voltage)

PIC. MSG-0,4 kV (FA3)



Guaranteed voltage Switchgear RING 220 V DC

MSG-0.4 KV (CABINET FA1, FA2, FA3) - MAIN SWITCHGEAR OF AUXILIARIES SYSTEM

Switchgear type	Double section in-door switchboard in cabinet version
Insulation rated voltage	690 VAC
Switching rated voltage	400 VAC
Surge withstand voltage	min 4 kV
Rated continuous current of busbars	200 A for 100 kVA transformer; 300 A for 160 kVA transformer; 500 A for 250 kVA transformer
Structure	3 cabinets: Section I; Section II; connector and electricity meters
Outgoings	For each section: 10 three phase outgoings fields with fuse switch disconnections, 15 single phase outgoings fields with fuse switch disconnections, 6 to 63 A
Power supply fields and clutch	Equipped with contactors or switch. 100 kV Compact type 160 A LV contactor or circuit breaker Compact 160 A, 250 kVA LV power switch Compact 250 A, 250 kVA LV power switch Compact 400 A, 250 kVA LV power switch
ATS Automation	ATS type microprocessor controller mini manufactured by APS Energia. ATS automation operates at power failure at one power supply or main fuse burn-out in any phase of the power supply from transformer. After cessation of interference, ATS Automation causes restoring of the basic supply system to the initial state. Automation and manual control system do not allow for parallel operation of transformers. It is possible to manually control ATS automation at the front part of the switchgear
Control and signaling	At the front part of the switchgear, buttons for manual control of ATS automation are placed, to enable activation or deactivation of the lighting and heating circuits. Switchgear alarm signals are transmitted to the connections terminal
Overvoltage protection	In the power supplying fields of MSG-0.4 kV switchgear class 2 (varistor) surge arresters were installed
Electric shock protection	Network power supplied from MSG-0.4 kV switchgear is protected against indirect contact by fast disconnection in TN-S system with "N" operating and "PE" protecting buses. Each metal housing is connected to "PE" grounded protective bus
Measurements	Measurements of voltage and current are performed using digital panel meter. The power supplying fields are equipped with system of active energy and reactive energy measuring system. The meters are placed in FA1 and FA3 cabinets
Comments	For 400/220/110/15 kV and 220/110/15 kV substations the switchgear is built for the special needs

*MSG - main switchgear

Inverters

Static Switch

Converter Hz/Hz

Rectifiers

Converter DC/DC

Control Systems

Special Systems

220 VDC SWITCHGEAR

AC/DC converters are used for supplying with DC current protection automation systems, control systems, monitoring systems and auxiliary electric substations. DC power system is galvanically connected to the battery pack in order to ensure uninterrupted power supply. To ensure sufficiently long battery life it is important that it cooperates with the appropriate rectifier complying with the requirements of EURO-BAT.

Battery and rectifier set should ensure secure power supply not only in static states but also in dynamic states, e.g., elimination of various EMI adverse effects (pulse interferences), etc.

In accordance with the European standard requirements maintenance of EURO-BAT battery during the preset operation should be charged with the current of constant value with low content of alternate component. Preservative charging voltage should be adjusted to the battery ambient temperature, according to the battery manufacturer requirements.

In the state of discharge modern batteries often require protection against deep discharge. In the state of charging, the battery should be most frequently charged with a constant charging current value according to feature enabling for full charge. Failure to comply with the cooperation parameters of the assembly, the battery rectifier may cause damage to the battery or reduce capacity.

BATTERY PACK

Batteries used in auxiliary power supply systems play a very important role of backup energy sources. They must ensure uninterruptible power supply of DC primary auxiliary circuits and supply energy to DC/DC and DC/AC converters providing uninterruptible circuits power supply of other DC voltages and circuits supplying critical alternating current (AC) receivers. Selection of the battery is determined by a number of factors, e.g. operating temperature, expected number of cycles and required operating time (back-up), load quantity and assumed lifetime of the battery, etc. The battery capacity and type of cells are selected depending on the above factors (lead cells with electrodes different designs, nickel-cadmium cells, ion cells, etc.) .

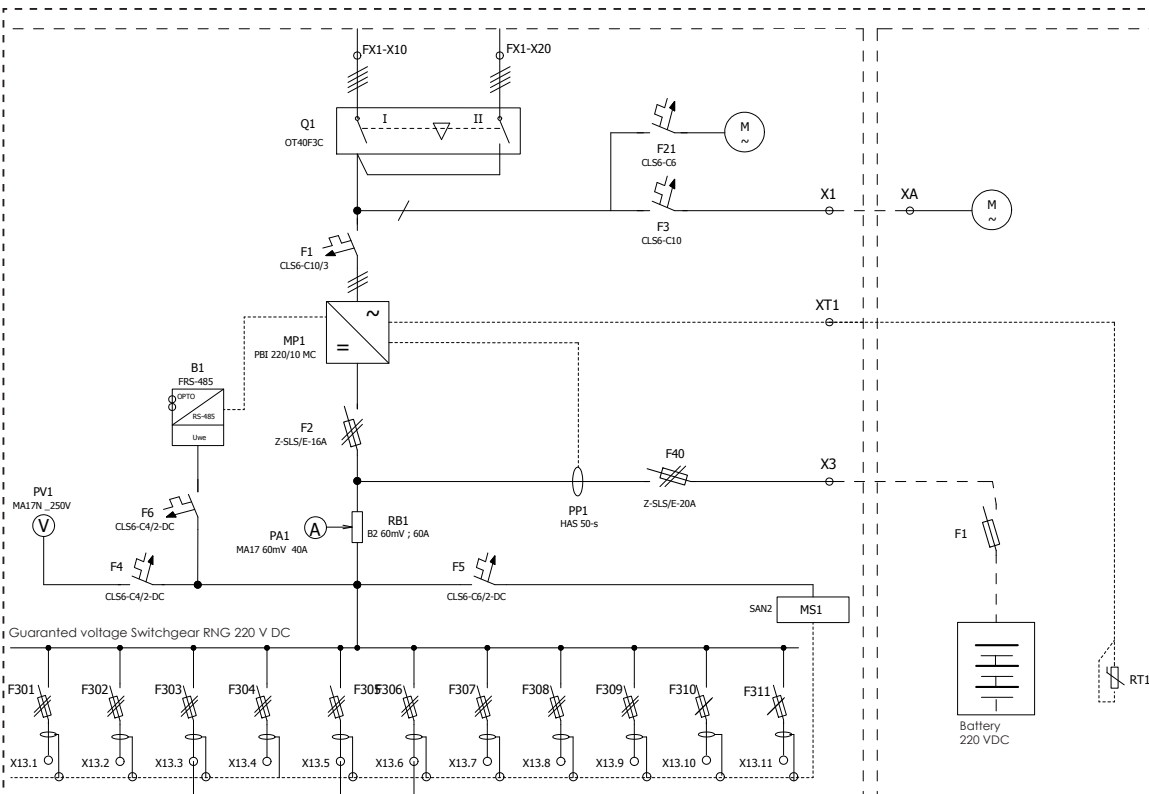
Battery packs in auxiliary power supply systems operate in series connection of many individual cells. Battery for the assumed 220 V standard consists of 102-108 connected cells

Two or more sets of battery pack with rectifiers are used in order to increase the reliability.

R-220 VDC (FC1 CABINET) - AUXILIARY POWER SUPPLY SYSTEM DC SWITCHBOARD

Switchgear type	Single or double section in-door switchboard in cabinet version, with manual connector of sections
Switchgear power supplying method	Single section: of one buffer power supply unit with substation battery. Double section: of two buffer power supply units with substation battery.
Output rated voltage	220 VDC
Insulation rated voltage	500 VDC
Busbar rated current	100 A
Structure	1 cabinet: section I or 2 cabinets: section I, 1 cabinet: section II 2 cabinets
Outgoings	Each section equipped with 24 outgoing fields equipped with circuit breakers with an insert up to 63A.
Buffer power supply unit	PBI 220/30 MC (PBI 220/50 MC)
Rated current	30 A (50 A)
Substation battery	type: lead-acid battery
Rated capacity	100 - 500 Ah depending on the substation size
Protection against direct contact	The network supplied form 220VDC auxiliary switchboard operates in IT system with ground fault monitoring. Each metal housing of the device is connected to "PE" grounded protective bus
Measurements	Measurements of voltage and current are performed using digital panel meter. Additionally, information concerning the operation of the buffer power supply unit and ground-fault control meter displayed on the local LCD panels
Monitoring	See the description at the end of the chapter.

PIC. R-220 VDC (FC1) - MAIN DC SWITCHGEAR IN POWER SUPPLY SYSTEM



230 VAC SWITCHGEAR

DC/AC CONVERTER – Bf1z TYPE INVERTER WITH SKB TYPE BYPASS

An important element of the auxiliary power supply systems is inverter (DC/AC converter) which supplies the AC loads with uninterruptible voltage.

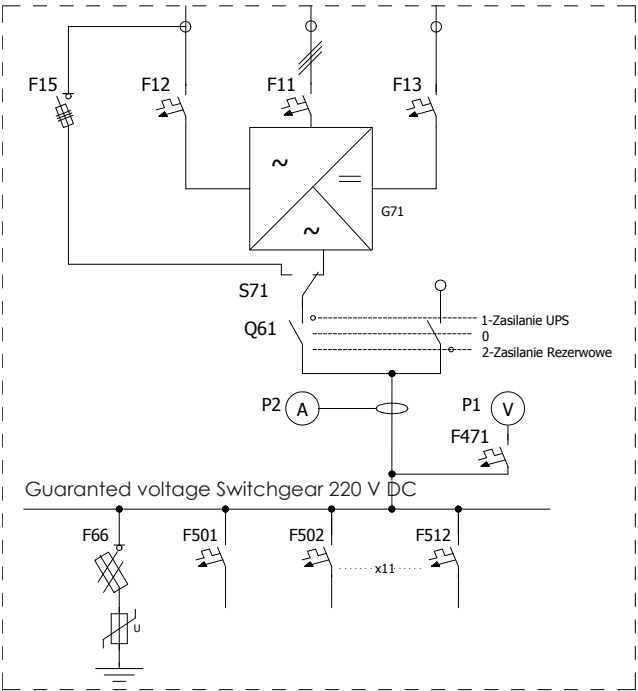
DC/AC converters used in auxiliary power supply systems should:

- Ensure appropriate temporary overload on the output.
- This means that the temporary overload current (short circuit) should obtain the value of 3-9 times the rated current value;

- Have galvanic isolation between DC power supplying voltage and converter output;
- Adequate stabilization of the sinusoidal output voltage with a low content of harmonics.

DC/AC converters can be connected in parallel to improve their operation security

PIC. R-230 VAC (FB1) - AC POWER SUPPLY SYSTEM



UNINTERRUPTIBLE R-230VAC (FB1 CABINET) - SZPW

Switchgear type	Single section in-door switchboard in cabinet version
Switchgear power supplying method	BFI 220/230/3Z type uninterruptible voltage inverter equipped with an automatic bypass
Output rated voltage	230 V 50 Hz
Insulation rated voltage	690 VAC
Busbar rated current	50 A
Structure	1 cabinet: inverter with switchboard
Outflows	14 outflow fields with overcurrent circuit breakers.
Uninterruptible Voltage Inverter:	Type: BFI 220/230/3; Rating power: 3 kVA (5kVA); Basic supply: from R-0.4 kV switchgear Backup power supply: from 220VDC substation battery
Protection against overvoltage	The switching station is equipped with overvoltage protectors
Protection against indirect contact	Network power supplied from R-230 VAC uninterruptible switchgear shall be protected against indirect contact by fast disconnection in TN-S system with "N" operating and "PE" protecting buses.
Measurements	Measurements of voltage and current are performed using digital panel meters. Additionally, information on uninterruptible voltage inverter operation is displayed on the local panel

Monitoring See the description at the end of the chapter.

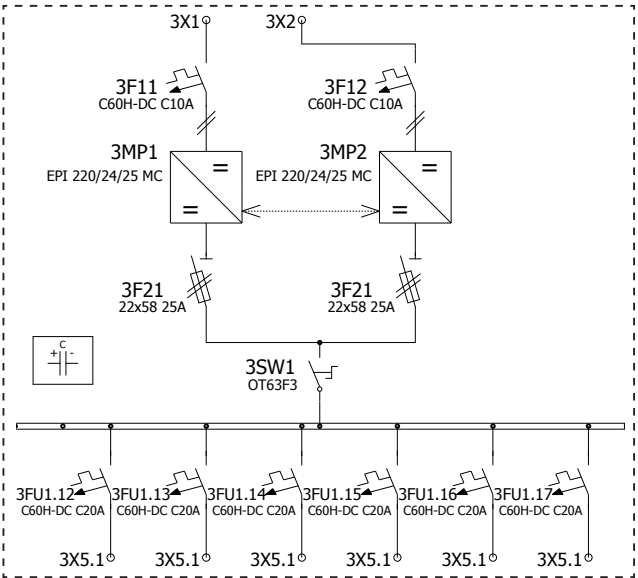
48 VDC (24 VDC) SWITCHING STATION

DC/DC converter used in electric energy auxiliary power supply systems is used to obtain DC voltages of values different than the battery voltage value. Additionally, by applying a DC/DC converter galvanic isolation between the two circuits can be obtained.

When selecting a suitable DC/DC converter, attention should be paid to the coefficient of output current overload in dynamic states. Proper selection of this factor allows for appropriate protections selection. The

advantage of using DC/DC converters is the ability to build auxiliary-power supply systems (parallel configuration, redundant configuration) with much greater reliability than, e.g. single battery systems.

PIC. R-48 VDC (24 VDC) (FC2) - AXILIARY VOLTAGE SWITCHGEAR



R-48 VDC (R-24 VDC) (FC2 CABINET) - DC SZPW AUXILIARY VOLTAGE SWITCHGEAR

Switchgear type	Single section in-door switchboard in cabinet version
Switchgear power supplying method	With a minimum of two DC/DC converters operating in parallel
Output rated voltage	48 VDC (24 VDC)
Busbar rated current	100 A
Structure	1 separate cabinet, or placed in 230 VAC uninterruptible switchgear cabinet
Outflows	10 outgoings fields with circuit breakers
DC/DC converters	Type: EPI 220/48/25 (EPI 220/24/25); Rated current: 25 A; Number of converters: min. 2 operating in parallel; Power supply: from R-220 VDC switchgear
Measurements	Measurements of voltage and current are performed using digital panel meters. Additionally, information on DC/DC converters operation is displayed on the local panel
Monitoring	See the description at the end of the chapter.

• CONTROL AND MONITORING SYSTEMS USED IN SZPW AUXILIARIES POWER SUPPLYING SYSTEMS

Due to the very important role of auxiliary systems in the electric power system increasingly sophisticated technical Informatics systems are used nowadays to control and monitor the operation of the auxiliary power supply system. SAN 3 automatic monitoring system is designed to monitor voltage, current, temperature, state

of connectors, state of the battery operation in auxiliary switching stations. Measurements and analysis of measured values are performed continuously. SAN 3 allows for rapid detection of irregularities in the power supply system operation and for notifying the user about any alarm states.



PIC. SAN 3 module

TAB. BASIC FUNCTIONS OF SZPW CONTROL AND MONITORING SYSTEM	THE SYSTEM RESPONSIBLE FOR THE MONITORING FUNCTIONS IN SZPWS MANUFACTURED BY APS ENERGIA
Substation battery monitoring;	System of monitoring and supervision in the PBI rectifier - measurement of continuity of the substation battery circuit, ground fault measurement for battery poles, voltage and temperature throughout the battery.
Substation battery monitoring: measurements of the substation battery cells state;	SAN 5 – measurement of voltage on individual cells (monoblocs) of the battery, measurement of current and voltage of the entire battery, measurement of the battery and ambient temperature. Faults are signaled when the measurements values exceed the threshold values.
Monitoring of connectors, switches and circuit breakers;	SAN 3 - data entered to the terminal of potential-free relay outputs and SAN 3 monitoring system.
Monitoring of isolation in DC networks;	SAN 2 - ground fault resistance measurement with respect to the ground fault potential and location of the ground fault outflows.
SZPW output circuits monitoring;	Binary signals terminal - data from auxiliary contacts entered to the terminal of potential-free relay outputs and SAN 3 .
Monitoring of operation of the rectifier and other converting systems;	SAN 3 - Local monitoring systems of PBI , BFI, EPI devices connected with SAN 3;
Measurement of the power system relevant parameters;	Meters, sensors, etc. placed in the system - data collected, displayed and transmitted to SCADA by SAN 3;
Data analysis and archiving;	SAN 3 - Collects data, analyzes and compares to the threshold values, operates chronologically. Archiving all data and signals;
Undertaking operations in automatic or manual mode;	ATS with a microprocessor controller - redundant systems of power supply sources, circuit breakers maneuvering systems;
Collecting data from the entire SZPW;	SAN 3 – central unit continuously collects data from the entire system;
Local information service;	SAN 3 Console - visualization, signaling and description of data collected from the system, synopsis, lamps and LEDs, local control panels;
Transmission of data, alerts and alarms to SCADA master system;	SAN 3 – communication via RS 232; RS 485; Ethernet (IEEE 802.3); fiber optic link; Communication protocols: APS 6000 and APS 5000 own protocols, MODBUS RTU, MODBUS TCP/IP, SNMP, IEC 61850, Profibus DP protocols device support: SZR06, IRDH575, EDS460; Other protocols are available on request.

SPECIAL VERSIONS OR OPTIONS OF AUXILIARIES POWER SUPPLYING SYSTEM EQUIPMENT

Upon request, it is possible to adapt the equipment to the specific design requirements;

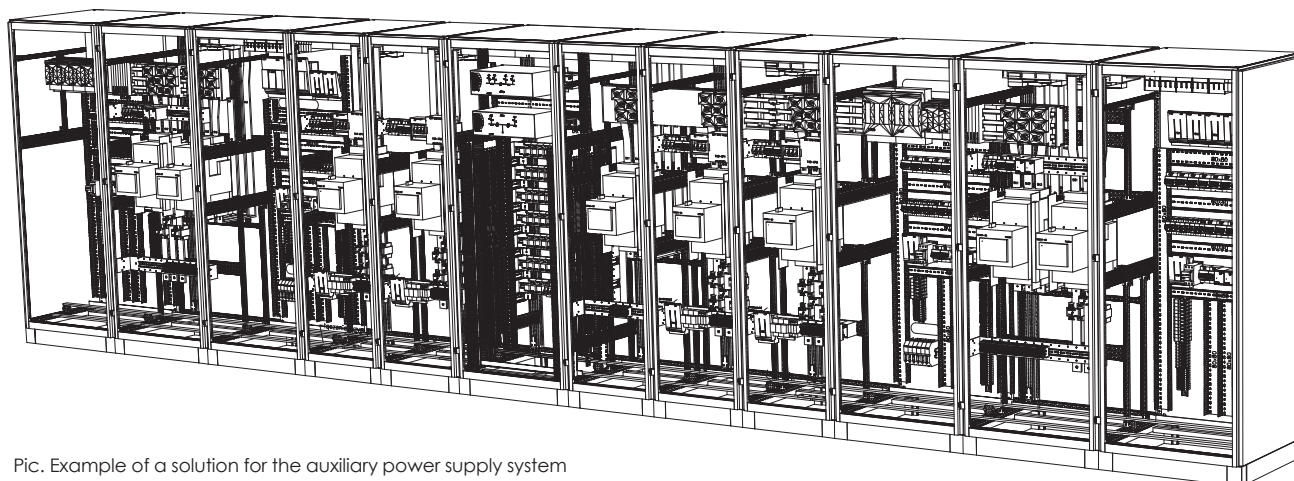
- a. DC battery rated voltage range 110 VDC, 400 VDC, other;
- b. AC voltage and frequency standard - 110 VAC, 115 VAC, 120 VAC, 127 VAC , 50/60 Hz, other;
- c. Uninterruptible DC voltage standard - 24 VDC, 48 VDC, 60 VDC, 110 VDC, other;
- d. Extending the scope of AC input voltages;

e. Environmental requirements in the ambient temperature range (-20 °C to + 55 °C), presence of aggressive factors, etc.;

f. Housing construction, including seismically resistant constructions, IP protection degree, construction of busbars, cables access from the top, paint color, etc.;

g. Measurement and communication: appropriate class digital or analog meters, fault indication, operating modes visualization, synoptic connections, communication protocols, etc.

h. Cable entry from the top



Pic. Example of a solution for the auxiliary power supply system produced by APS Energia for 220/110 kV electric substation