STATIC SWITCHES

The Static Switch (SKB) is an electronic reserve tripping system. It controls power lines and, in the case of break of supply voltage (or exceeding of a specific range by the parameters), switches loads to supply from another power supply field of parameters meeting the electric requirements.

The SKB system ensures uninterrupted (5 ms switching time), binary power supply for devices and entire industrial facilities, telecommunication and computer switches, public utility facilities, and other, where continuity of operation of devices must be ensured.

THE CHARACTERISTICS OF THE SKB, MWB TYPE STATIC SWITCHES:

- a microprocessor control system;
- an advanced power lines voltage parameters analysis algorithm;
- quick switching within the range (0 to 10 ms depending on the synchronisation of voltages);
- a possibility to select the basic or reserve line;
- a possibility to block automatic return to the basic line;
- a possibility to manually switch power supply between the lines;
- selection of the basic line return mode in the case of cessation of the cause of the switch (or an option to remain on the reserve line);
- operation in the wide load cos Φ range;
- high resistance to overload and difficult operating conditions;
- a built-in synoptic panel, indication of the operating status and power lines;
- high efficiency;
- advanced communication between the user and the device: keyboard, control console with LCD, indicating LEDs, application of all binary signals to potential-free relay contacts;
- data archiving and events buffer on SD card;
- RS485, USB and Ethernet integrated communication interfaces;
- wide selection of data transmission protocols: Modbus RTU, IEC 60870-5-103, IEC 61850, SNMP; APS6000; other
- SAN 8 microprocessor monitoring of the entire system.

View of the SKB compact

View of the SKB cabinet

METHOD OF DESIGNATION OF THE SKB TYPE STATIC SWITCHES

SKB ☐☐ ☐ ☐

Device type: SKB - Static Switch
Power, [kVA]
Configuration of the SKB bypass system*
AC rated voltage, [V] By standard: 220; 230; 240; 380; 400; 415 Other solutions depend on the order
Type of enclosure: M - 19" module without controller MC - 19" module with mounted controller MCE - 19" module with an external console MS - an industrial cabinet CS - standing compact CSE - standing compact with an external console CW - wall-mounted compact CWE - wall-mounted compact with an external console

METHOD OF DESIGNATION OF THE MWB TYPE STATIC SWITCHES

MWB ☐☐ ☐ ☐

Device type: MWB - bypass module that enables parallel operation of inverters
Power, [kVA]
Configuration of the SKB bypass system*
AC rated voltage, [V] By standard: 220; 230; 240; 380; 400; 415 Other solutions depend on the order
Type of enclosure: M - 19" module without controller MC - 19" module with mounted controller MCE - 19" module with an external console

Note: The MWB type static switches is a module that enables parallel operation of the inverters.

* - it means the configuration of thyristor switches in the SKB system:

S - Single-phase circuit. Thyristors switch only the L phase voltages. The neutral conductors (N) are permanently connected;

S2 - Single-phase or two-phase circuit. Thyristors switch L and N voltages in a single-phase circuit or L1 and L2 voltages in a two-phase circuit;

T - Three-phase circuit. Thyristors switch only the L1, L2, L3 phase voltages. The neutral conductors (N) are permanently connected;

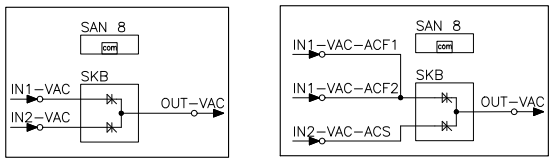
T4 - Three-phase circuit. The thyristors switch the L1, L2, L3, N voltages.

THE SKB / MWB TYPE STATIC SWITCHES – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS

PARAMETER	VALUE
AC* INPUT, NO. 1, NO. 2	
Input voltage:	1×220 / 1×230 / 1×240 / 2×120 / 2×230 / 2×480 / 3×380 / 3×400 / 3×415 V
Input voltage tolerance	+10 % to -15 %
Frequency of input voltage	50 Hz
Input voltage frequency tolerance	±10 %
AC OUTPUT	
Output voltage:	1×220 / 1×230 / 1×240 / 2×120 / 2×230 / 2×480 / 3×380 / 3×400 / 3×415 V
Output voltage tolerance	+10 % to -15 %
Output voltage frequency	50 Hz
Output voltage frequency tolerance	±10 %
Overload indication	In
The time of switching to reserve power supply	5 ms
Overload capacity	1.1×In long-term <1.25×In within 10 min <1.5×In within 60s >1.5×In within 1s
Short-circuit strength	10×In within 20 ms
Cos Φ range	from -1.0 to 1.0
Inverter efficiency	>99%
Available menu language versions	PL | EN | CZ | RU
OPERATING ENVIRONMENT	
Operating temperature (EN 50178 class 3k3)	+5 to +40 °C*
Storage temperature (EN 50178 class 1k4)	-25 to +55 °C*
Humidity (EN 50178 class 3k3)	5 to 85 % (non-condensing)*
Access to the device	operation and maintenance from the front*
Cable entry	from the bottom / from the top**
Maximum height above the sea level without change of the rated parameters	1,000 m ASL

* – it is possible to design different parameters upon agreement with the manufacturer;

** – only for installation in the industrial cabinet (MS enclosure type).



a) b)

Fig. 77. General block diagram of the static switch system:
a) the SKB type; b) the MWB type.

KEY OF THE ABBREVIATIONS USED IN THE DIAGRAMS IN THE CHAPTER

BR – maintenance bypass	com – communication
I – current measurement	OUT – output
IN – power supply	SAN 8 – console
IN-ACF – AC supply from the inverter	SKB – automatic bypass
IN-ACS – AC supply from the mains	VAC – alternating current (AC)

The SKB type Static Switch (also known as the automatic bypass) is a quick thyristor switch that ensures switching of loads to the AC reserve line power supply in the case of break of the alternating current in the basic line. The switching time is 5 ms or 10 ms (depending on the synchronisation of those voltages – see table "STATIC SWITCH SYSTEM SWITCHING CHARACTERISTICS"). It is used to increase the reliability of the AC power supply system. The SKB system is presented in Fig. 77 a).

Fig. 77 b) presents a version of the MWB type static switch, in which one of the inputs is double, which allows connecting with two inverters operating in parallel.

STATIC SWITCH SYSTEM SWITCHING CHARACTERISTICS

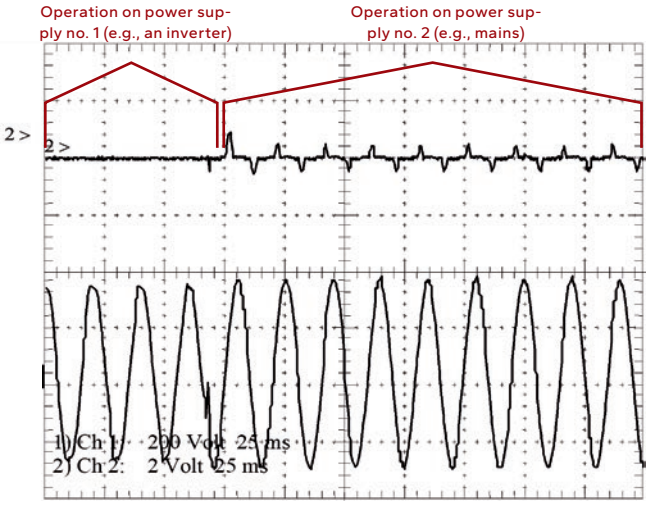


Fig. 78. Switching of the SKB system from line no. 1 (e.g., an inverter) to the voltage of the line no. 2 (e.g., mains).

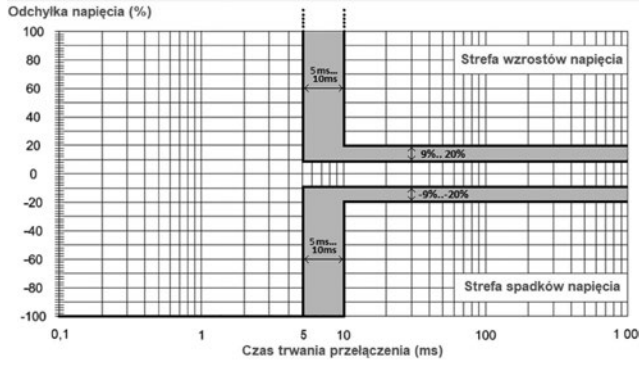
where: Ch1 – system output voltage

Ch2 – current drawn from the mains

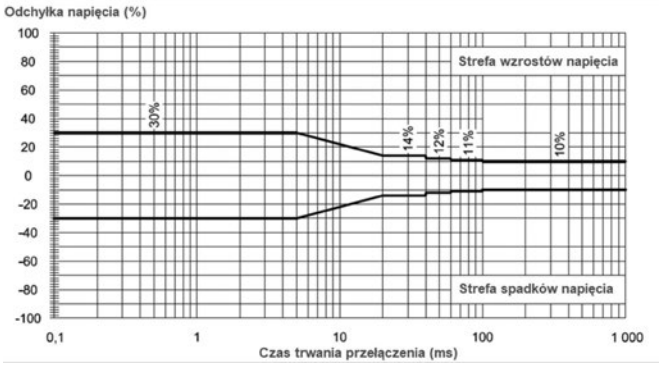
The oscillogram in Fig. 78 presents an uninterrupted (<5 ms) switching of the microprocessor bypass system (SKB) to supplying loads from the AC reserve line in the case of damage to the basic AC power line. There is a maintenance bypass switch at the output of this Static Switch system.

Switching of the SKB system is done within 5 ms only if both switched sources operate synchronously (i.e., during normal operation of the system). In other cases, switching is done with a 10 ms interruption.

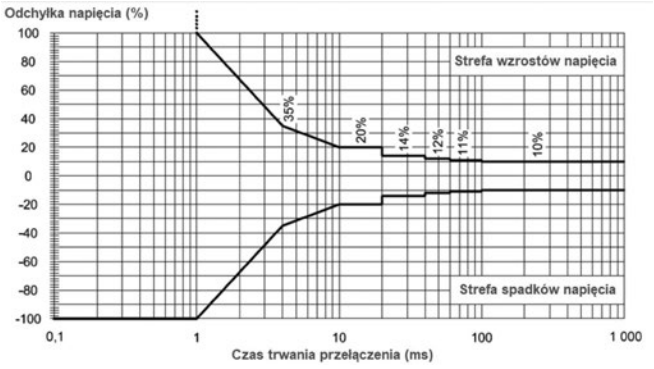
This characteristic is default for both SKB and MWB system.



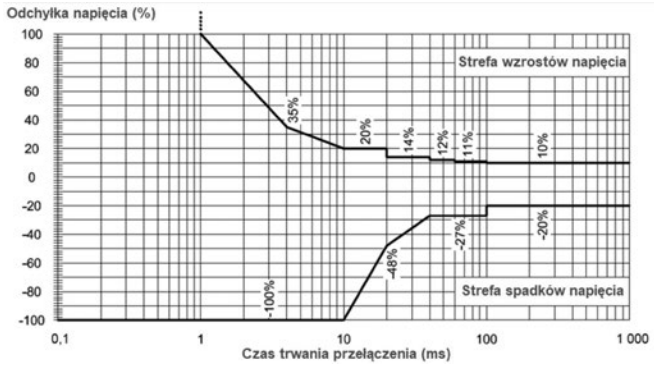
a)



b)



c)



d)

Fig. 79. Line voltage fault characteristics:
a) the APS4 type; b) as per EN62040 – 3 Class 1; c) EN62040 – 3 Class 2; d) EN62040 – 3 Class 3.

The task of the Static Switch system is to ensure continuity of power supply of the alternating current load during disturbances in the power line. The bypass is supplied from two lines. The switching time is 1ms to 10 ms depending on the moment of occurrence of the failure in the power line.

Fig. 79 presents possible characteristics of the power line failure, i.e., allowed values of a momentary failure of voltage in the device's input lines. Depending on the needs, any characteristic accordant with EN62040 – 3 or an individual characteristic adapted to the needs of a given power supply system may be implemented in the device. By default, the SKB has the characteristics presented in Fig. 79 a).

This system may detect current at the zero, thus allowing switching of synchronised voltages, as well as guaranteeing maintenance of the continuity of the current of loads and lack of disturbances associated with commutation.

THE SKB STATIC SWITCHES USER INTERFACE

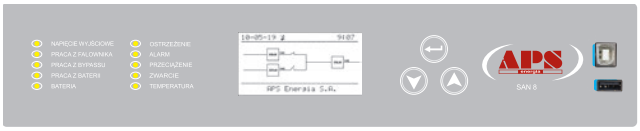
Communication between the user and the device (HMI – Human Machine Interface) takes place locally or remotely. Local communication is done via the console. Active power lines and the state of operation of the connector are presented synoptically. Indicating lamps show the active operation mode of the device.

View of the controller without a display

Remote communication takes place via potential-free contacts and the RS485 communication port with an implemented Modbus RTU transmission protocol.

Extended communication options are available.

For systems of high power (≥100kVA), the SKB type static switches are equipped with the SAN 8 control and monitoring system.



View of the controller with a console

The user may set the following parameters:

- sensitivity of the system – defining a set of power supply parameters that cause switching;
- switching time – adaptation of the system to supplied loads by defining the time of switching from one power supply field to another;
- alarm thresholds – setting the alarm threshold appropriately to the observed alarm situations, allowing ideal adjustment of the system to the electric environment in the facility.

SPECIAL DESIGNS OR EQUIPMENT OPTIONS FOR THE SKB STATIC SWITCHES

Special designs	Upon request, it is possible to adapt the devices to special requirements of a given project in relation to: 1) greater power of switches; 2) standard of the AC voltages and frequencies: a) single-phase static switches: (110 V, 115 V, 120 V, 127V, 50 / 60 Hz); b) three-phase static switches: (3×190 V, 3×200 V, 3×208V, 3×220 V, 50 / 60 Hz); 3) environmental requirements related to ambient temperature (-20 °C ÷ + +55 °C), presence of aggressive factors, etc.; 4) enclosure design, including seismic resistant designs, IP degree of protection, design of the bus bars, access to the cables from the top, coating colour, etc.; 5) measurements and communication: digital or analogue meters of appropriate class, signalling of states, visualisation of operating modes, synoptic of connections, communication protocols, etc.
Bypass system	An internal system of connections and switches that allows feeding a voltage from the selected AC power network to loads, bypassing the static connector. Maintenance bypass – a mechanical switch that allows manual switching of loads to power supply from the selected power line.
"N" cable switching system	Regardless of quick switching of L phase cables for single-phase switches of L1, L2, L3 cables for three-phase switches, there is a possibility to design switches with the "N" circuit switching from various sources.
Protections of the input lines	Static switches may be equipped with protections of the input lines in accordance with the design of the entire system.
Output circuits distribution board:	In the device's enclosure, you may separate a space and incorporate an AC guaranteed voltage distribution panel equipped with protections for particular input circuits.
Cable entry from the top	It is possible to design the enclosure in a way to allow cables entering from the top (applies only to the cabinet version).
Advanced communication options	Equipping the SKB system with the SAN 8 monitoring system.
Adjustment of parameters	The users may adjust the sensitivity of the system and the switching time.

MODULAR DESIGN STATIC SWITCHES

This chapter presents the SKB and MWB single-phase and three-phase Static Switch systems in a form of a 19" module of standard height of 4U or 6U. They are adapted for mounting in industrial cabinets. The main task of the Static Switch system is ensuring uninterrupted operation of electrical devices by activating the reserve in the case of break of the supply voltage.

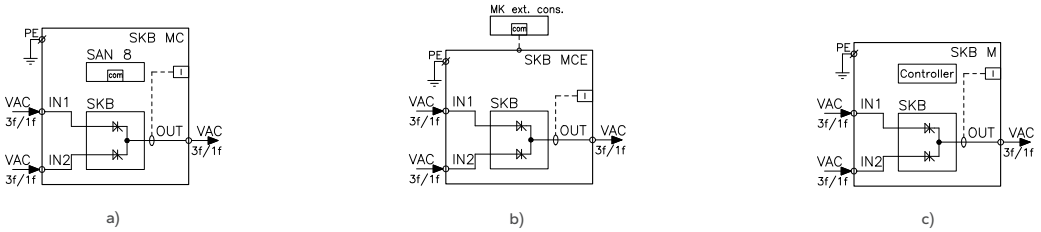


Fig. 80. Block diagram of the SKB type static switch:
a) with a built-in console; b) with an external MK console; c) with a controller.

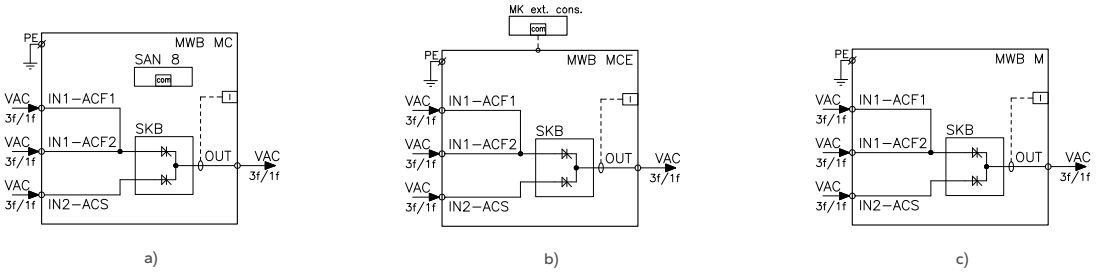


Fig. 81. Block diagram of the MWB type static switch:
a) with a built-in console; b) with an external MK console; c) without a console.

Fig. 80 presents solutions for the SKB type static switch modules (automatic bypass). The SKB module is supplied by two AC voltages. By standard, the static switch module is equipped with the SAN 8 microprocessor operating parameters control system. The SKB modules with the SAN 8 console belong to the MC modules family (Fig. 80 a), the modules with an external MK console are a part of the MCE modules family (Fig. 80 b), while the modules with a controller belong to the M modules family (Fig. 80 c). The module presented in Fig. 80 c) does not have the SAN 8 console for communication with the client.

The BFIz / BFI inverter module cooperates with the MWB module and the transformer, which, apart from providing a galvanic isolation, also adapts the inverter module's output voltage to an appropriate value. The MWB module contains special LC filters, which are responsible for high quality of the inverter's voltage, and the Static Switch system (optionally).

The BFIz / BFI inverter module cooperates with the MWB module and the transformer, which, apart from providing a galvanic isolation, also adapts the inverter module's output voltage to an appropriate value. The MWB module contains special LC filters, which are responsible for high quality of the inverter's voltage, and the Static Switch system (optionally).

The MWB type static switch module, presented in Fig. 81, has special LC filters responsible for high quality of the voltage and, optionally, may have an automatic bypass system.

This module is used when:

- connecting two inverter modules for parallel operation with a common automatic bypass in the MWB module;
- cooperating with the inverter and the 50 Hz transformer to obtain three-phase voltage at the output of the power supply system.

The MWB modules with the SAN 8 console belong to the MC modules family (Fig. 81 a), the modules with an external MK console are a part of the MCE modules family (Fig. 81 b), while the modules with a controller belong to the M modules family (Fig. 81 c).

In the case of the SKB devices, the key parameter impacting the size of the device is the rated current. For example: SKB 30S 230 M and SKB 60S 480 M will have the same size.

Each module is cooled by fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, significantly increasing their lifetime.

SERIES TYPE: 1-PHASE AND 3-PHASE SKB TYPE STATIC SWITCHES MODULES 1 ÷ 60kVA FOR AUTONOMOUS AND PARALLEL OPERATION

Power, [kVA]	Maximum current, [A]	Rated AC* output voltage, [V]	Example type	Enclosure dimensions**
from 1 to 60	140	230	SKB 1S 230 M***	M4

* – possible options: see table "THE SKB / MWB TYPE STATIC SWITCHES – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS";
** – M4 (4U): 482×142×496. (W×H×D);
*** – possible options: M / MC / MCE.

SERIES TYPE: 1-PHASE AND 3-PHASE MWB TYPE STATIC SWITCHES MODULES 1 ÷ 10kVA FOR AUTONOMOUS AND PARALLEL OPERATION

Power, [kVA]	Rated AC* output voltage, [V]	Example type	Enclosure dimensions**
from 1 to 10	230	MWB 1S 230 M***	M3

* – possible options: see table "THE SKB / MWB TYPE STATIC SWITCHES – TECHNICAL CHARACTERISTICS – standard parameters";
** – M3 (6U): 482×267×496; (W×H×D);
*** – possible options: M / MC / MCE.

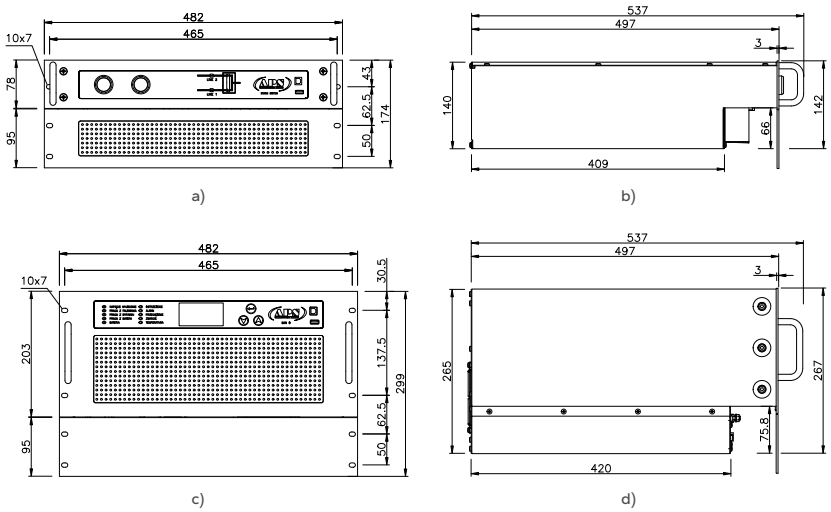


Fig. 82. Views with dimensions of the static switch module:
a) front view of the SKB M type – M4 module; b) left-side view of the M4 module; c) front view of the MWB MC type – M3 module; d) left-side view of the M3 module.

STATIC SWITCHES BUILT IN A CABINET

This chapter presents the SKB type single-phase and three-phase Static Switch system in a form of a 19" industrial cabinet for installation on a substrate. The main task of the Static Switch system is ensuring uninterrupted operation of electrical devices by activating the reserve in the case of break of the supply voltage.

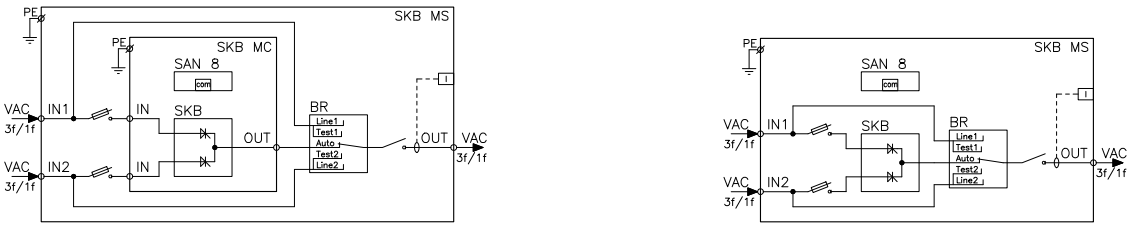


Fig. 83. Block diagram of the SKB type static switch cabinet:
a) modular design; b) free design.

Fig. 83 a) presents a standard solution of the SKB type modular single-phase or three-phase static switches incorporated into an industrial cabinet. The description of the SKB module is presented in chapter "MODULAR DESIGN STATIC SWITCHES".

Fig. 83 b) presents a standard solution for the SKB type single-phase or three-phase static switches in a free design in an industrial cabinet.

The SKB type Static Switch cabinet is supplied by two AC voltages. By standard, the SKB static switch cabinet (automatic bypass) is equipped with the maintenance bypass system and the SAN 8 operating parameters control system.

The automatic bypass system is supplied from two alternating voltage lines. These voltages are fed to the thyristor switches. Based on the decision algorithm, the control system turns on/off a specific group of thyristors. The repair bypass allows uninterrupted switching of loads to power supply from network 1 or network 2, bypassing the system's power electronics.

The industrial cabinet is cooled by a forced air circulation via redundant roof fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, which significantly increases their lifetime.

ADDITIONAL OPTIONS

- Maintenance bypass;
- ATSE (duplex AC power supply);
- Isolating transformer in the bypass circuit;
- Cable entry from the top;
- Special designs – upon agreement;
- Built-in output circuits distribution board – upon agreement;
- High IP.

SERIES TYPE: 1-PHASE AND 3-PHASE STATIC SWITCHES CABINETS 1 ÷ 100kVA FOR AUTONOMOUS AND PARALLEL OPERATION

Power, [kVA]	Maximum current, [A]	Rated AC* output voltage, [V]	Example type	Min. dimensions of the enclosure [W×D×H**], [mm]
from 10 to 100	450	230 or 3×400	SKB 10S 230 MS	600×800×2,000
from 110 to 350	550	3×400	SKB 110T 400 MS	800×800×2,000
from 400 to 500	750		SKB 400T 400 MS	1,200×800×2,000

* – possible options: see table "THE SKB / MWB TYPE STATIC SWITCHES – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS";

** – add the height of the pedestal to the height of the device: by standard, 100 mm.

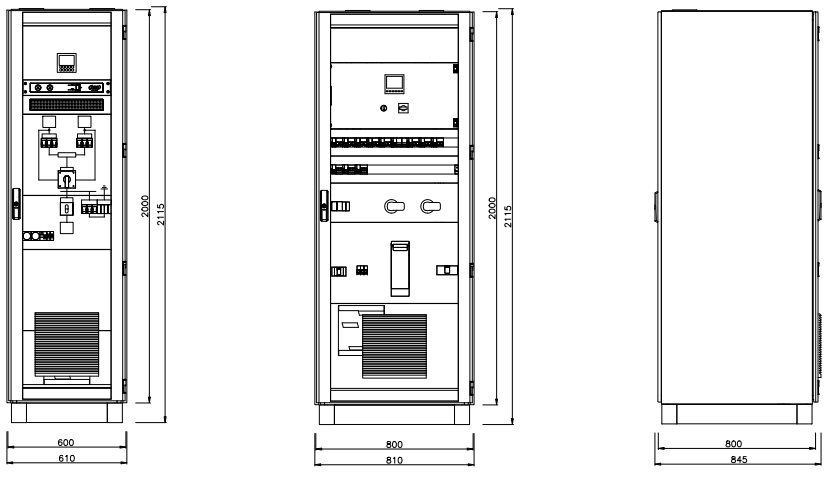
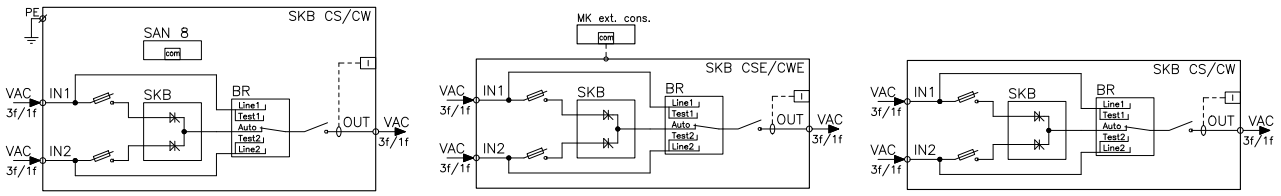


Fig. 84. Views with dimensions of the static switch cabinet:
a) 600×800×2,000 cabinet – front view; b) 800×800×2,000 cabinet – front view; c) cabinet of depth of 800 mm – left-side view.

STATIC SWITCHES IN A COMPACT ENCLOSURE

This chapter presents the SKB single-phase and three-phase static switches in a compact form. They are intended for installation on a substrate (CS standing compact) or on a wall (CW wall-mounted compact). The main task of the Static Switch system is ensuring uninterrupted operation of electrical devices by activating the reserve in the case of break of the supply voltage.



a) b) c)

Fig. 85. Block diagram of the SKB type static switch compact:
a) with a built-in console; b) with an external MK console; c) without a console.

The SKB Static Switch compact is supplied from two AC voltages. By standard, the SKB static switch compact (automatic bypass) is equipped with the maintenance bypass system and the SAN 8 operating parameters control system.

The compact with a built-in SAN 8 console is presented in Fig. 85 a), the compact with an external MK console is presented in Fig. 85 b), while the compact without a console is presented in Fig. 85 c).

The automatic bypass system is supplied from two alternating voltage lines. These voltages are fed to the thyristor switches. Based on the decision algorithm, the control system turns on/off a specific group of thyristors. The maintenance bypass allows uninterrupted switching of loads to power supply from network 1 or network 2, bypassing the system's power electronics.

Each compact is cooled with fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, which significantly increases their lifetime.

ADDITIONAL OPTIONS

- Maintenance bypass;
- Special designs;
- Protection of circuits at the input and the output (standard);
- Built-in output circuits distribution board;

SERIES TYPE: 1-PHASE AND 3-PHASE STATIC SWITCHES CABINETS 1 ÷ 100kVA FOR AUTONOMOUS AND PARALLEL OPERATION

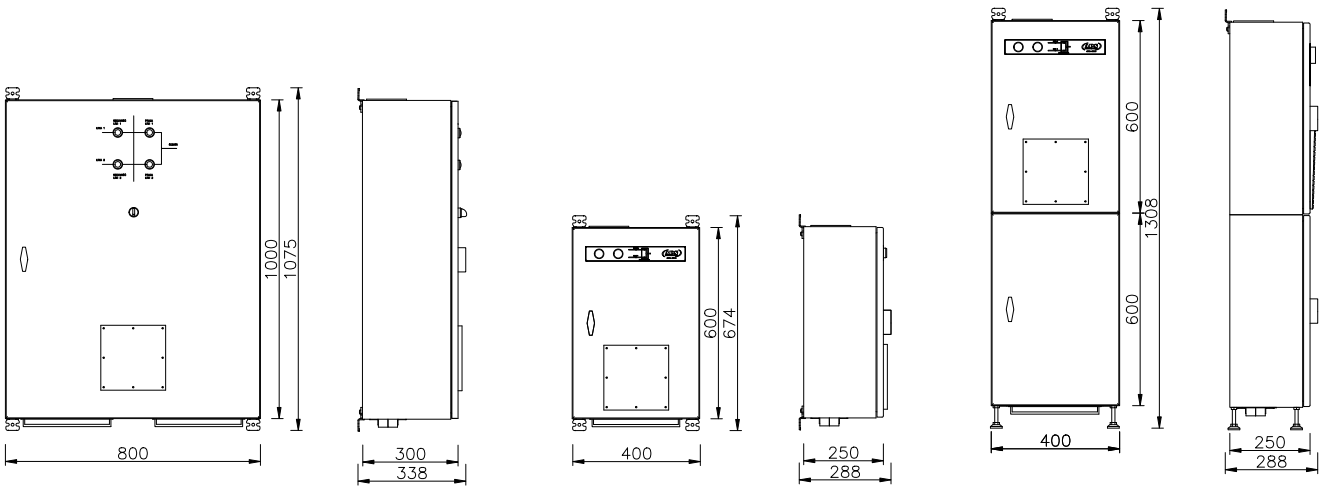
Power, [kVA]	Maximum current, [A]	Rated AC* output voltage, [V]	Example type	Enclosure dimensions**
from 1 to 60	140	230	SKB 1S 230 CS***	CS4 / CW4
70 to 100****	180	3×400	SKB 70T 400 CS***	CW1

* – possible options: see table "THE SKB / MWB TYPE STATIC SWITCHES – TECHNICAL CHARACTERISTICS – standard parameters";

** – CS4: 400×(2×600)×250; CW1: 800×1,000×300; CW4: 400×600×250. (W×H×D);

*** – possible options: CS / CSE / CW / CWE;

**** – only for 3-phase voltages.



a) b) c) d) e) f)

Fig. 86. View with dimensions of the SKB type static switch compact:
a) CW1 compact – front view; b) CW1 compact – left-side view; c) CW4 compact – front view;
d) CW4 compact – left-side view; e) CS4 compact – front view; f) CS4 compact – left-side view.