BATTERY DISCHARGE UNIT

The BRI discharger is intended for controlled discharge of the chemical battery with an applied direct current.

The controlled battery discharge is carried out in accordance with the guidelines of the producer in a way to allow comparing the measurement results with the factory data. BRI measures the battery's temperature during the battery test discharge, and applies a temperature correction to the measured values.

The device allows remote setting of parameters and reading data using APS6000 (APS Energia SA external protocol) and Modbus RTU communication protocols.

It is possible to connect the dischargers in parallel to multiply the maximum discharge current. The process is fully automatic.

The discharger is equipped in a microprocessor operation and battery state control system.

The LCD signals the following:

- battery's voltage;
- battery's discharge current;
- the charge drawn from the battery;
- operation time and the set discharge time;
- the date and time of start and end of the discharge;
- external temperature;
- the measured capacity of the battery including the external temperature.

METHOD OF DESIGNATION OF THE BRI TYPE DISCHARGER

BRI □-□/□ □

Device type: BRI - battery discharge unit
Rated battery voltage range, [V]
Maximum battery discharge current, [A] Solution depends on the order
Type of enclosure: CP - portable compact

The discharger view

THE BRI TYPE DISCHARGER – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS

PARAMETER	VALUE	
DC INPUT		
U_{BAT} output voltage	12 to 400 V	12 to 540 V
U_{MAX} maximum output current	450 V	545 V
U_{MIN} minimum output voltage	9 V	
AC INPUT (auxiliary)		
Input voltage	230 V ±10 %	
Frequency of the input voltage	50 Hz ±10 %	
DC OUTPUT		
I_{ZN} rated discharge current	50 A	30 A
P_{ZN} maximum power loss	12 kW	16 kW
I_{ROZ} maximum discharge current	If $P>P_{ZN}$, so $I_{ROZ}= P_{ZN} / U_{BAT}$ if $P<P_{ZN}$, then $I_{ROZ}=I_{ZN}$	
Discharge current stabilisation	<1 %	
Discharge current ripple	<3 %	
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	from the front and the back	
Cable entry	from the back	
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.

THE CHARACTERISTICS OF THE BRI TYPE DISCHARGER

The microprocessor controlled BRI type control discharge device is characterised by the following parameters:	• automatic completion of the discharge process after achieving set parameters; • low ripple and low level of higher harmonics of the current drawn from the battery; • displaying and archiving discharge parameters; • remote operation control and readout of parameters (APS6000 and Modbus RTU); • compact dimensions and low weight; • a mobile design with wheels for easy transport.
The device is protected against:	• overheating; • exceeding the maximum permissible voltage.
The discharger monitors the critical structural elements and indicated emergency states:	• damage of the internal temperature sensor; • damage of the external temperature sensor; • no parallel communication; • fan(s) damage; • incorrect polarisation of the battery.

THE BRI DISCHARGER USER INTERFACE

There is a control panel console on the front panel of the discharger. The glowing LEDs system and the LCD allows monitoring the operation of the device and reading the measured values.

The controlled discharge process parameters are set via 3-button keyboard and the graphic LCD located on the front panel or remotely through RS485 or USB links. Discharge is carried out until the battery's voltage reaches the set minimum level or until the set discharge time elapses.

The device allows connecting with a master system (e.g., a PC) via the RS485 (connection fields) or USB-B (front panel) links. The user may use two programs: "SAN DIR" and "BRI archive explorer," which communicate using the external APS6000 protocol. By standard, the Modbus RTU industrial communication protocol is also implemented.

Device's communication links:

- RS485 and USB B for communication with a master system (e.g., a PC).
- USB A for copying archival data to a Flash memory drive.

KEY OF THE ABBREVIATIONS USED IN THE DIAGRAMS IN THE CHAPTER

BAT – battery	IN – power supply

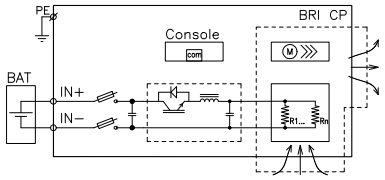
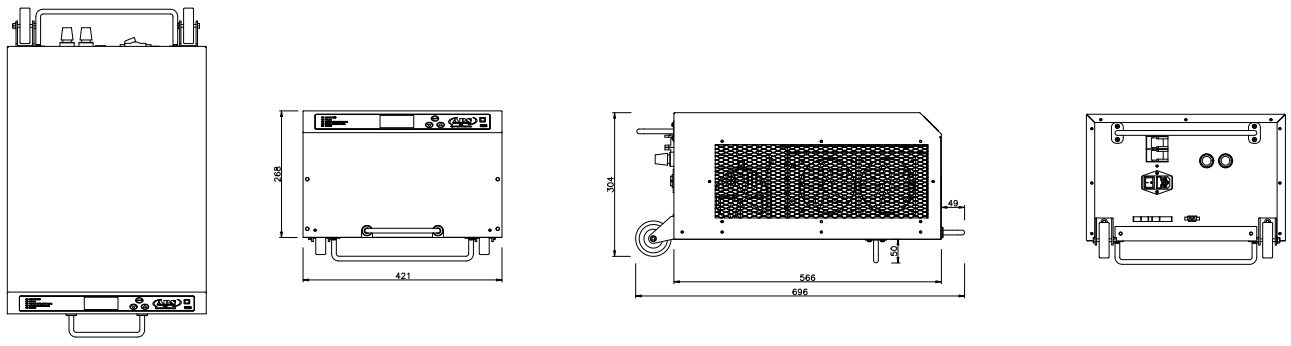


Fig. 42. Block diagram of the BRI type discharger compact.

SERIES TYPE: BRI TYPE DISCHARGER COMPACTS

DC rated input voltage, [V]	Rated discharge current, [A]	Example type	Enclosure dimensions*
from 12 to 400	50	BRI 12-400/50 CP	CP
from 12 to 540	30	BRI 12-540 / 20 CP	
Special version from 110 to 650	20	BRI 110-650 / 20 CP	

* – CP: 400×600×250. (W×H×D).



a) b) c) d)

Fig. 43. Views with the dimensions of the BRI type discharge mobile compact:
a) CP compact – top view; b) CP compact – front view; c) CP compact – left-side view; d) CP compact – back view.

INDUSTRIAL INVERTERS

An inverter, a direct current (DC) to alternating current (AC) converter, is a basic element of the guaranteed power supply systems.

The tasks of the guaranteed power supply systems in the industry is supplying critical loads which require uninterrupted power supply due to the necessity to maintain continuity of technological processes or/and perfect supply voltage parameters for proper and reliable operation.

The guaranteed power supply makes operation of crucial, from the point of view of the technological process, loads independent of the parameters of the power grid, and in the case of power failure, it ensures continuity of power supply from a reserve energy source. In the energy technology and industry, the accumulator battery or another DC energy storage is such a source.

THE BFI TYPE INVERTER CHARACTERISTICS:

The BFI type inverters – modern, microprocessor-controlled power electronics systems (DSP), operating using the high-frequency technique based on IGBT transistors with Pulse Width Modulation (PWM) – are characterised by:

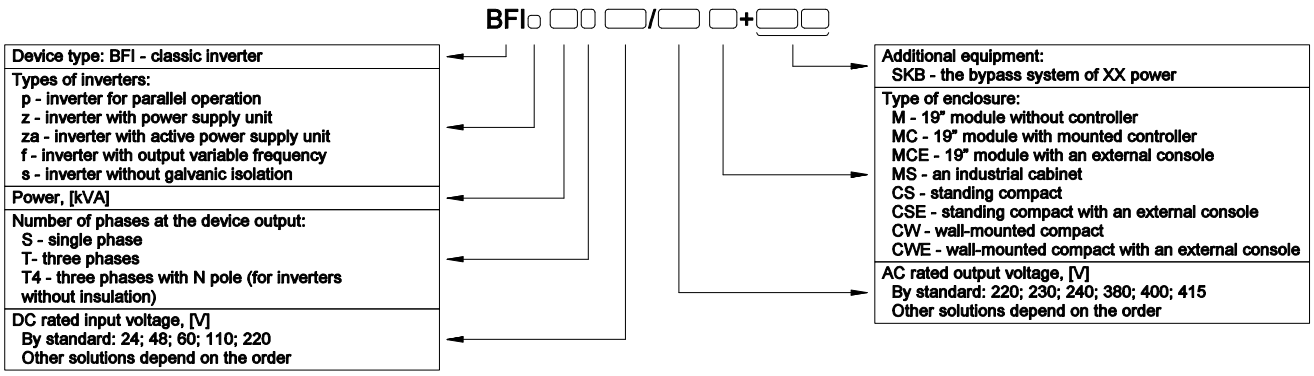
- perfectly sinusoidal output voltage shaped based on a digital pattern, minimum content of harmonic THDu;
- high stability of voltage and output frequency, both in steady and dynamic state;
- galvanic isolation of the DC and AC circuits;
- high efficiency;
- possible 100 % asymmetrical load (for three-phase inverters);
- high resistance to overload and difficult operating conditions;
- ability to operate at load characterised by any cos φ (supplying loads of inductive or capacitive nature);
- high short-circuit current factor from Izw=3×In to Izw=9×In (high selectiveness of tripping of protections);
- electromagnetic compatibility (EMC), EMI filters on input and output circuits of the device – limitation of the conducted disturbances emission, and high resistance to electromagnetic disturbances at the same time;
- 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, Modbus TCP, IEC 60870-5-103, IEC 61850, SNMP, APS6000, other;
- over-current, over-voltage, short-circuit protection;
- parallel operation with equalisation of currents, possible parallel operation of inverters to increase the power or reliability (n+1 type redundancy);
- SAN 8 microprocessor monitoring of the entire system.

View of the inverter module

View of the inverter compact

View of the inverter cabinet in a modular design

METHOD OF DESIGNATION OF THE BFI TYPE INVERTERS



AC inverters are power electronics converters that convert direct current to alternating current. They are designed to supply alternating current to loads that require high quality power supply parameters. They have two autonomous inputs:1) basic – AC input [single-phase or three-phase] and 2) reserve – DC input. BFIz inverters may be supplied by different AC and DC voltages. Switching between AC and DC supply is done without interruptions, based on the difference of potentials on the inverter's DC intermediate voltage bus. BFIz inverters are double VFI conversion systems. The configuration and adaptation capabilities of those systems make them one of the most versatile and widely used devices in the field of uninterrupted power supply. BFIz inverters are used mainly in UPSs and central or local guaranteed power supply systems.

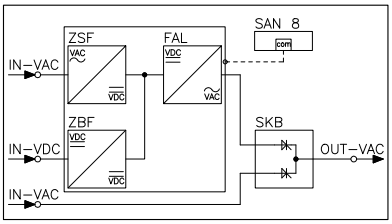


Fig. 44. General block diagram of the inverter system with the BFIz power supply unit and the SKB type bypass

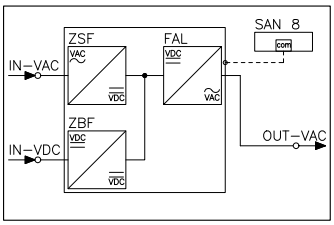


Fig. 45. General block diagram of the inverter system with the BFIz power supply unit

Static Switch. To improve reliability of the system, the BFIz inverters are most often used together with the SKB (Static Switch). The SKB system (automatic bypass) is a quick thyristor link that ensures switching of loads to AC reserve power supply in the case of a failure of an inverter. In the case of break of alternating voltage on the bypass's basic line (inverter output voltage), the SKB will automatically switch power supply of loads to the AC reserve line, bypassing the BFIz inverter. The switching time is 5 ms or 10 ms (depending on the synchronisation of those voltages).

Fig. 44 presents the most common solution: the BFIz type inverter cooperating with the Static Switch system. This cooperation may take place in the "online" or "offline" mode. In the online operation mode, the basic power supply of the Static Switch system is the output voltage of the inverter, while the reserve power supply function is provided by the reserve AC network. In the offline operation mode, the basic power supply of the Static Switch system is the AC reserve network, while the reserve power supply function is provided by the output voltage of the inverter. The BFIz inverter systems, both with (Fig. 44) and without (Fig. 45) a bypass system, may operate in a parallel configuration to increase the power or to improve the system's reliability. Each inverter may cooperate with SAN 8 (the automatic monitoring system), which ensures monitoring, registration, and visualisation of all operating states of the system, as well as alarming in the case of occurrence of an alarm state.

In the cabinet version, the inverter's power supply may be active, characterised by a sinusoidal current draw from the mains.

An inverter without a power supply is designated as BFI. The basic supply voltage of the BFI inverter is only the direct current source (the battery or a DC distribution board).

KEY OF THE ABBREVIATIONS USED IN THE DIAGRAMS IN THE CHAPTER

BR – maintenance bypass	INV – inverter
IN – power supply	IN-ACF – AC supply from the inverter
IN-ACF – AC supply from the mains	MD – diode bridge
OUT – output	SAN 8 – console
SKB – automatic bypass	TR – 50 Hz transformer
VAC – basic or reserve AC power supply	VDC – DC power supply
ZBF – inverter's power supply from DC voltage	ZSF – inverter's power supply from AC voltage
com – communication	U – voltage measurement

THE TYPE BFIz / BFI INVERTERS – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS

PARAMETER		VALUE
AC POWER SUPPLY OF THE INVERTER (mains)*		
Input voltage:	single-phase	220 / 230 / 240 V
	three-phase	380 / 400 / 415 V
Input voltage tolerance		+10 % to -15 %
Frequency of input voltage		50 / 60 Hz
Input voltage frequency tolerance		±10 %
DC POWER SUPPLY OF THE INVERTER		
Input voltage		24 / 48 / 60 / 110 / 220 V
Input voltage tolerance		±20 %*
AC POWER SUPPLY OF THE BYPASS (backup mains)**		
Input voltage:	single-phase	220 / 230 / 240 V
	three-phase	380 / 400 / 415 V
Input voltage tolerance		±15 %
Frequency of input voltage		50 / 60 Hz
Input voltage frequency tolerance		±10 %
AC OUTPUT OF THE INVERTER		
Output voltage:	single-phase	220 / 230 / 240 V
	three-phase	380 / 400 / 415 V
Voltage stability (static)		±1 %
Voltage stability (dynamic)		± 5 % within 10 ms
Voltage waveform		sinusoidal
THDu voltage distortion (linear load)		<2 %
THDu voltage distortion (non-linear load)		<5 %
Output voltage frequency		50 / 60 Hz*
Output voltage frequency tolerance		±0.1 %
Overload capacity at resistance load		<110 % constant, ≤125 % 10 min, ≤150 % 1 min
Short-circuit current		3×In (up to 9×In for the HC version)***
Crest factor		3:1 (optionally up to 5:1)
Cos φ range		from 0.7 to 1.0
Inverter efficiency		85 to 95 %
Electromagnetic compatibility		EN IEC 62040-2
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 inverters equipped with the Static Switch bypass system (SKB or MWB);

*** – see chapter "Inverter module of increased short-circuit current"

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

TYPICAL DESIGNS OR EQUIPMENT OPTIONS FOR INVERTERS

Special designs	Upon request, it is possible to adapt the devices to special requirements of a given project in relation to: • greater power of inverters; • range of DC input voltages; • standard of the AC voltages and frequencies; • single-phase inverters: e.g., 110 V, 115 V, 120 V, 127 V, 50/60 Hz; • three-phase inverters: e.g., 3×190 V, 3×200 V, 3×208 V, 3×220 V, 50/60 Hz; • extension of the range of DC and AC input voltages (BFIz); • environmental requirements related to ambient temperature (-20 °C ÷ +55 °C), presence of aggressive factors, etc.; • 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.; • measurements and communication: digital or analogue meters of appropriate class, indication of states, visualisation of operating modes, synoptic of connections, communication protocols, etc.
ATSE system (duplex power supply)	The automatic transfer switching equipment (ATSE) decides about the selection of the source of power for a device. When the source I supply voltage presence, the inverter (BFIz type) is supplied from this source. In the case of its break (complete or one of its phases), the ATSE system automatically switches the BFIz inverter power supply to source II.
Power supply 1f (single-phase power supply)	By standard, the BFIz type inverters are equipped with a three-phase power supply unit. For low powers, or in special cases, there is a possibility to use a single-phase power supply.
Protection of circuits at the input and the output	The BFI type inverters (DC/AC converter) and the BFIz inverter (AC/DC/AC converter) are power electronics converters with power circuits and output circuits. Over-current protections of those circuits may be built in the inverter itself or be located in external distribution boards or distribution panels.
Isolating transformer at the input	In the normal operation mode, it is used to ensure galvanic isolation between two internal circuits of the inverter and the mains. It allows obtaining increased safety and reliability of the system.
Automatic bypass	The microprocessor bypass system (the internal system of connections with the SKB type static switch) ensuring uninterrupted (<5 ms), automatic switching of loads to supply from a reserve network in emergency situations. Voltage on the reserve line is measured continuously; switch to a reserve line may take place only when the reserve line parameters are within the tolerance.
Isolating transformer at bypass circuit	It is used to ensure galvanic isolation of power supply and power supplying circuits also during operation in the bypass mode. The transformer is necessary on the bypass circuit when the IT system power supply (a network isolated to the grounding) is required at the output of the inverter. A special version allows limiting short-circuit currents when operation from the bypass.
Maintenance bypass	A mechanical switch that enable manual switching of loads to power supply from a reserve supply network. The maintenance bypass switch has 3 positions (with a switching gap).
Uninterrupted maintenance bypass	A mechanical switch that enable uninterrupted manual switching of loads to power supply from a reserve supply network. The two-position maintenance bypass switch is synchronised with the automatic bypass.
Isolating output transformer	During normal operation, the transformer eliminates the alternating voltage constant component, which is particularly important for supplying loads of inductive nature. In the case of a failure, it isolated AC output circuits from DC circuits, preventing damage to the loads. The output transformer is necessary when the IT system power supply (a network isolated to the grounding) is required at the output of the inverter.
Parallel operation	Possibility of operation of two or more inverters on the common AC guaranteed voltage bus. The control algorithm of the inverters ensures synchronisation of output voltages of particular inverters and even power distribution.
Built-in output circuits distribution board	In the inverter's enclosure, you may separate a space and incorporate an AC guaranteed voltage distribution panel equipped with protections for particular input circuits.
Active input filter (sinusoidal current draw from the mains)	To limit the introduced disturbances to the mains, you may use a parallel active filter to achieve a sinusoidal characteristics of the current draw from the mains by the inverter (BFIz).
Cable entry from the top	It is possible to design the enclosure in a way to allow cables entering from the top.

*NOTE: Use of options may change the dimensions of the device

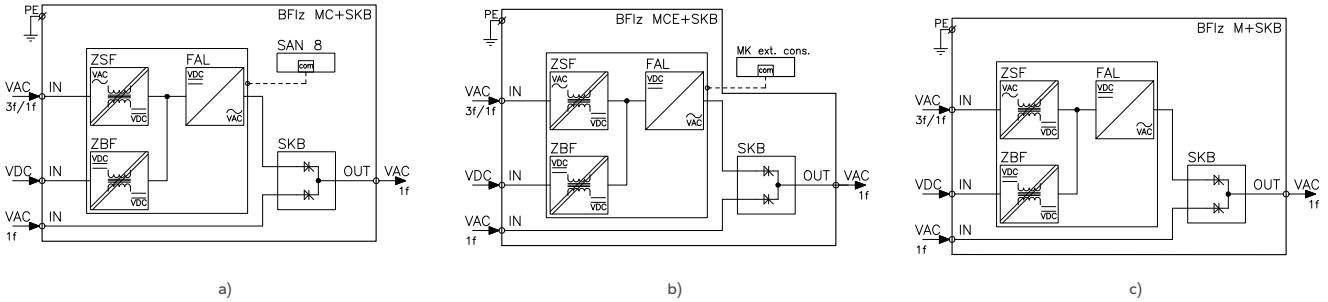
CUSTOM INVERTERS

In the case of atypical or special requirements related to the design, parameters of devices, formal requirements or standards applicable in a given region of the world. Inverters produced by APS Energia SA are designed in accordance with the project requirements. Special designs constitute a huge percent of solutions designed and manufactured by APS Energia SA.

MODULAR DESIGN INVERTERS

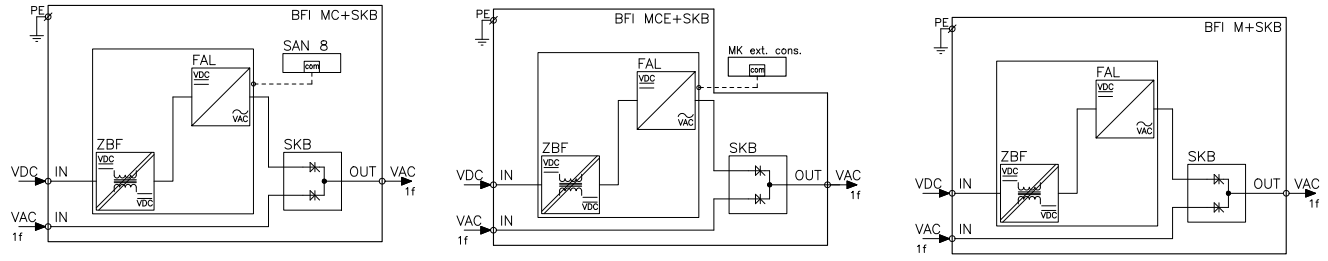
THE INVERTER MODULE INTENDED FOR AUTONOMOUS OPERATION WITH GALVANIC ISOLATION AT THE AC AND DC SUPPLY VOLTAGE SIDE.

This chapter presents single-phase type BFIz / BFI inverters in a form of 19" module of standard 6U height. They are adapted for mounting in industrial cabinets. The main task of an inverter is to continuously supply loads with the AC guaranteed voltage.



a) b) c)

Fig. 46 Block diagram of the BFIz type inverter module with a power supply unit and the SKB type bypass:
a) with a built-in console; b) with an external MK console; c) without a console.



a) b) c)

Fig. 47. Block diagram of the BFI type inverter module with the SKB bypass:
a) with a built-in console; b) with an external MK console; c) without a console.

The BFIz+SKB inverter module is supplied by the basic AC network voltage, the DC voltage, as well as the AC reserve network voltage (the automatic bypass supply voltage – this is a standard solution used to increase the reliability of the system). On the other hand, the BFI+SKB inverter module is supplied from the DC voltage and a reserve AC network voltage. By standard, the inverter module is equipped with a SAN 8 inverter operating parameters control system. Modules with a built-in SAN 8 console belong to the MC modules family.

(Fig. 46 a), modules with an external MK console belong to the MCE modules family (Fig. 46 b), while the modules without the SAN 8 console are a part of the M modules family (Fig. 46 c).

The inverter's power supply (mains converter) converts the basic alternating current into direct current necessary to supply the inverter, and ensures galvanic isolation of the network from the inverter's circuits at the same time.

The battery power supply (battery converter) converts the DC supply voltage into direct current necessary to supply the inverter, and ensures galvanic isolation of the battery from the inverter's circuits at the same time.

The inverter converts direct current into alternating current of the value accordant with the order (by standard, 230 V AC). The galvanic isolation of the inverter's input voltage from AC and DC supply voltages of the inverter is ensured by high-frequency isolating transformers located in the mains converter or the battery converter of the inverter.

The BFIz / BFI modules may be equipped with the SKB automatic bypass system.

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

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10kVA FOR AUTONOMOUS OPERATION

Rated output voltage 230 V AC*

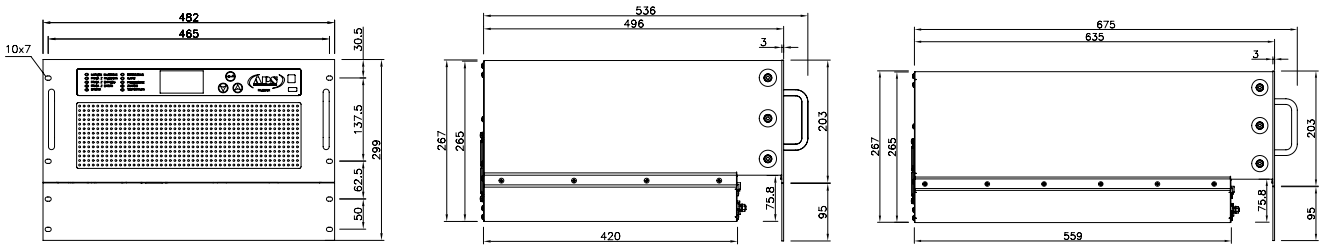
Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions****
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1S 24/230 MC**+SKB 1***	M5
		3×400 or 230	BFIz 1S 24/230 MC**+SKB 1***	
7.5	60	-	BFI 7.5S 60 / 230 MC**+SKB 7.5***	
1 / 2 / 2.5	110 / 220	-	BFI 1S 110 / 230 MC**+SKB 1***	M3
		3×400 or 230	BFIz 1S 110 / 230 MC**+SKB 1***	
3 / 3.5 / 5	110	-	BFI 3S 110 / 230 MC**+SKB 3***	M5
		3×400 or 230	BFIz 3S 110 / 230 MC**+SKB 3***	
7.5 / 10		-	BFI 7.5S 110 / 230 MC**+SKB 7.5***	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1S 220 / 230 MC**+SKB 1***	M3
		3×400 or 230	BFIz 1S 220 / 230 MC**+SKB 1***	
7.5 / 10		-	BFI 7.5S 220 / 230 MC**+SKB 7.5***	M5
7.5		3×400 or 230	BFIz 7.5S 220 / 230 MC**+SKB 7.5***	
10		3×400	BFIz 10S 220 / 230 MC**+SKB 10***	

* – possible options: 220 / 230 / 240 V AC;

** – possible options: M / MC / MCE;

*** – a module without the SKB bypass is available as an option;

**** – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).



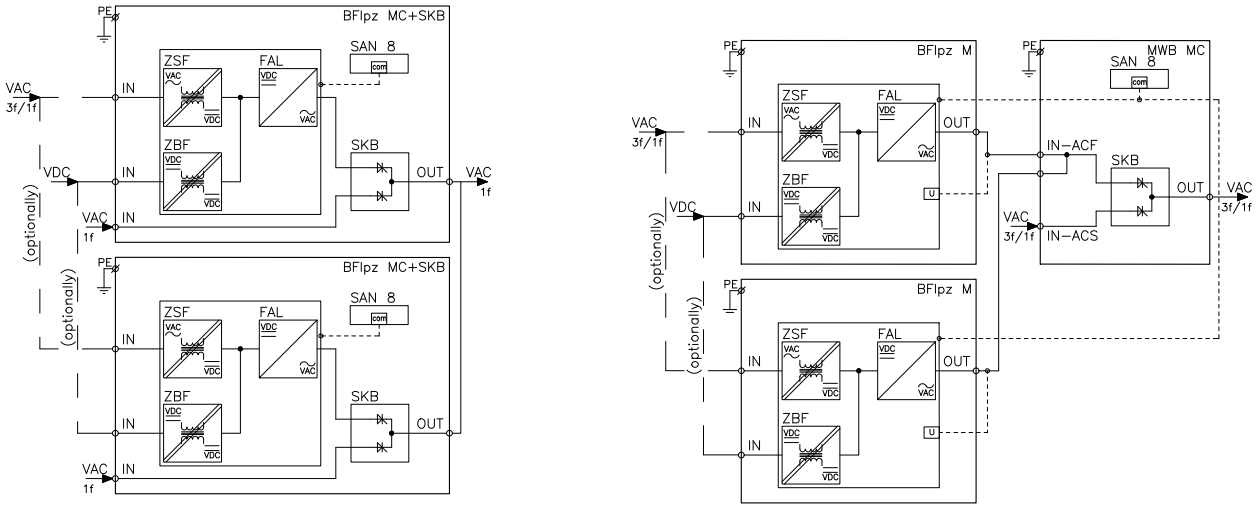
a) b) c)

Fig. 48. Views with dimensions of the BFIz / BFI type inverter module (option):
a) front view in the M3 and M5 enclosure; b) left-side view in the M3 enclosure; c) left-side view in the M5 enclosure.

THE INVERTER MODULE INTENDED FOR PARALLEL OPERATION WITH GALVANIC ISOLATION AT THE AC AND DC SUPPLY VOLTAGE SIDE

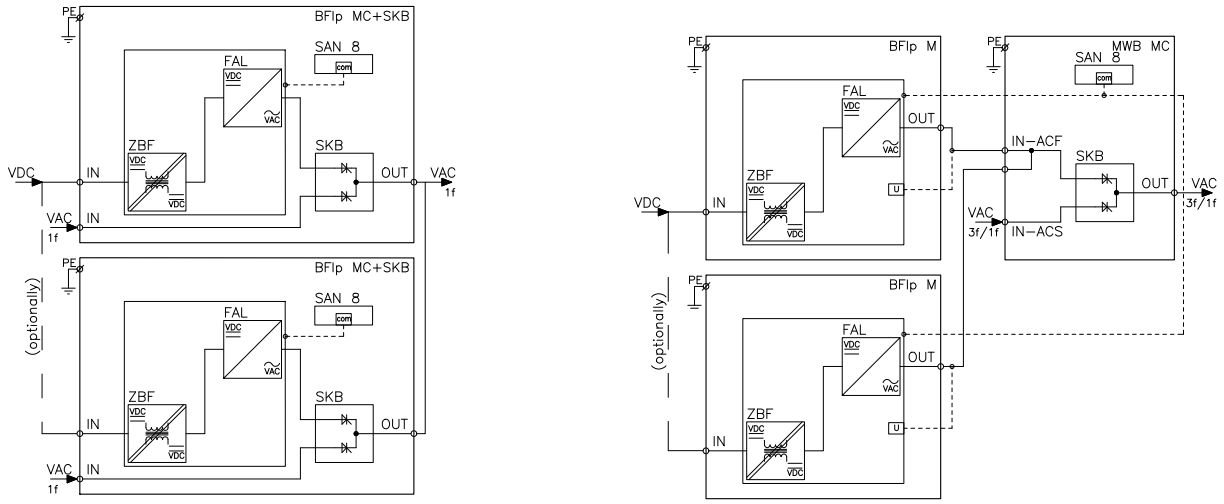
This chapter presents single-phase type BFIp / BFIpz inverters in a form of 19" module of standard 6U height. They are adapted for mounting in industrial cabinets. The main task of an inverter is to continuously supply loads with the AC guaranteed voltage.

The BFIp / BFIpz inverter module is intended for parallel operation with an inverter of the same type. This allows increasing the output power of the system or obtaining redundancy for the components of "1+1" system.



a) b)

Fig. 49. Block diagram of the inverter module for parallel operation with the BFIpz power supply unit. Possible configurations:
a) two autonomous SKB type bypasses, a console built in the inverter module; b) a common SKB type bypass, a console built in the MWB module.



c) d)

Fig. 50. Block diagram of the BFIp type inverter module for parallel operation. Possible configurations:
a) two autonomous SKB type bypasses, a console built in the inverter module; b) a common SKB type bypass, a console built in the MWB module.

Systems consisting of two inverter modules operating in parallel are available in the following configurations:

1. Two modules – Fig. 49 a), Fig. 50 a):
   - Module 1 – inverter + automatic bypass:BFIpz / BFIp xxx MC + SKB
   - Module 2 – inverter + automatic bypass:BFIpz / BFIp xxx MC + SKB

2. Three modules – Fig. 49 b), Fig. 50b):
   - Module 1 – inverter 1: BFIpz / BFIp xxx M
   - Module 2 – inverter 2: BFIpz / BFIp xxx M
   - Module 3 – a module that integrates parallel operation of inverters + automatic bypass: MWB xx MC.

In configuration 1 – the BFIpz+SKB inverter module is supplied by the basic AC network voltage, DC voltage, as well as the AC reserve network voltage (the automatic bypass supply voltage – this is a standard solution used to increase the reliability of the system) (Fig. 49 a). On the other hand, the BFIp+SKB inverter module is supplied from DC voltage and a reserve AC network voltage (Fig. 50 a).

In configuration 2 – the BFIpz inverter module is supplied by voltage of the basic AC network and DC voltage – Fig. 49 b), while the BFIp inverter module is supplied from DC voltage (Fig. 50 b). The MWB modules is supplied by voltage of the AC reserve network (the automatic bypass's supply voltage – this is a standard solution used to increase the system's reliability), as well as output voltages of inverters (Fig. 49 b, Fig. 50 b).

By standard, the module is equipped with the SAN 8 inverter operating parameters control system. Modules with a built-in SAN 8 console belong to the MC modules family.

The inverter's power supply (mains converter) converts the basic alternating current into direct current necessary to supply the inverter, and ensures galvanic isolation of the network from the inverter's circuits at the same time.

The battery power supply (battery converter) converts the DC supply voltage into direct current necessary to supply the inverter, and ensures galvanic isolation of the battery from the inverter's circuits at the same time.

The inverter converts direct current into alternating current of value necessary according to the order. The galvanic isolation of the inverter's input voltage from AC and DC supply voltages of the inverter is ensured by high-frequency isolating transformers located in the mains converter or the battery converter of the inverter.

The BFIp / BFIpz modules may be equipped with the SKB automatic bypass system.

Inverters and automatic bypasses in configuration 1 operate as MASTER / SLAVE, and do not require any additional synchronising systems.

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

Note: the MWB type bypass system module is described in chapter "MODULAR DESIGN STATIC SWITCHES".

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10kVA FOR PARALLEL OPERATION

Rated output voltage 230 V AC*

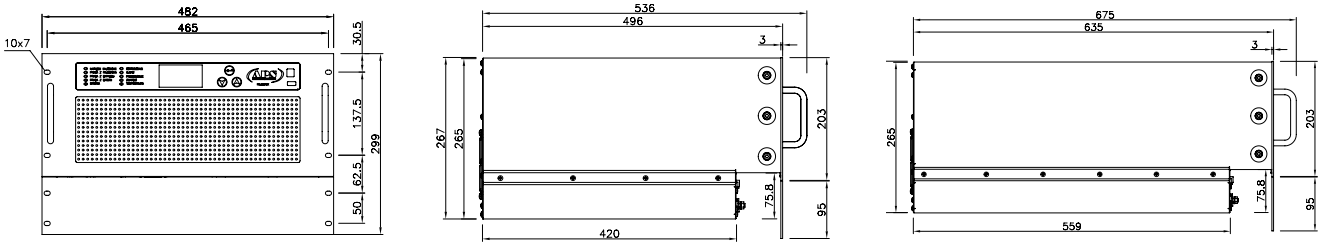
Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions****
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFIp 1S 24/230 MC**+SKB 1***	M5
		3×400 or 230	BFIpz 1S 24/230 MC**+SKB 1***	
7.5	60	-	BFIp 7.5S 60 / 230 MC**+SKB 7.5***	
1 / 2 / 2.5	110 / 220	-	BFIp 1S 110 / 230 MC**+SKB 1***	M3
		3×400 or 230	BFIpz 1S 110 / 230 MC**+SKB 1***	
3 / 3.5 / 5	110	-	BFIp 3S 110 / 230 MC**+SKB 3***	M5
		3×400 or 230	BFIpz 3S 110 / 230 MC**+SKB 3***	
7.5 / 10		-	BFIp 7.5S 110 / 230 MC**+SKB 7.5***	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFIp 1S 220 / 230 MC**+SKB 1***	M3
		3×400 or 230	BFIpz 1S 220 / 230 MC**+SKB 1***	
7.5 / 10		-	BFIp 7.5S 220 / 230 MC**+SKB 7.5***	M5
7.5		3×400 or 230	BFIz 7.5S 220 / 230 MC**+SKB 7.5***	
10		3×400	BFIz 10S 220 / 230 MC**+SKB 10***	

* – possible options: 220 / 230 / 240 V AC;

** – possible options: M / MC / MCE;

*** – a module without the SKB bypass is available as an option;

**** – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).



a) b) c)

Fig. 51. Views with dimensions of the BFIpz / BFIp MC type inverter module (option):
a) front view in the M3 and M5 enclosure; b) left-side view in the M3 enclosure; c) left-side view in the M5 enclosure.

THE INVERTER MODULE FOR AUTONOMOUS OPERATION WITH 50 Hz ISOLATING TRANSFORMER

This chapter presents the single-phase or three-phase BFIz / BFI type inverters in a form of 19" module of standard 6U height cooperating with 50 Hz isolating transformers. They are adapted for mounting in industrial cabinets. The main task of an inverter is to continuously supply loads with the AC guaranteed voltage.

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).

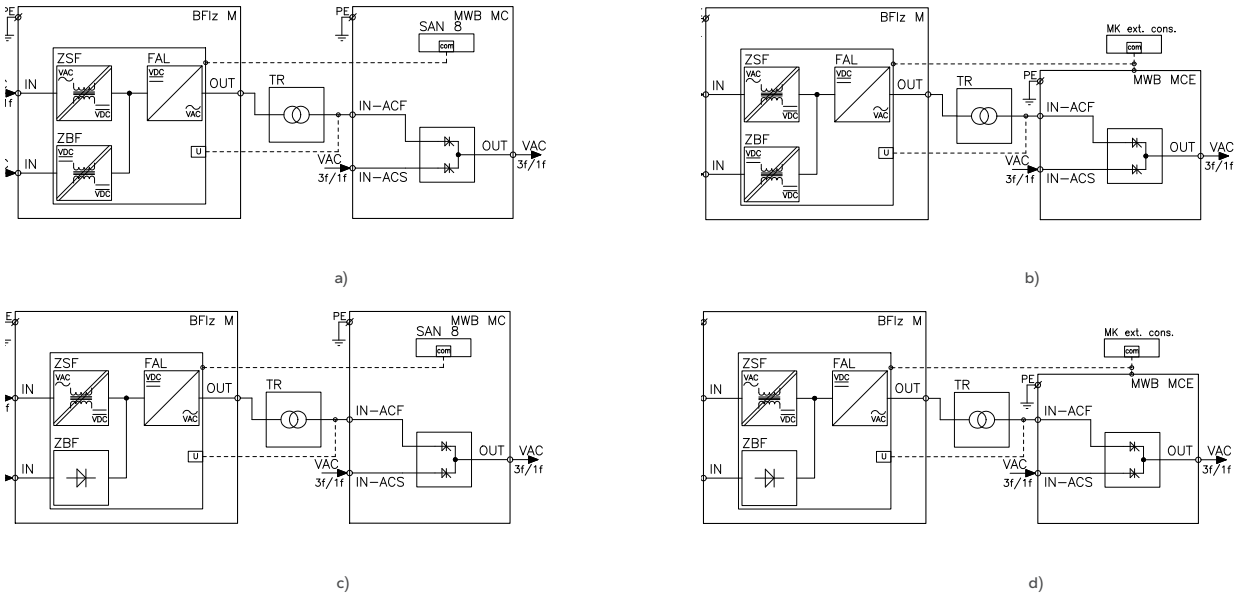


Fig. 52. Block diagram of the BFIz type inverter module with a power supply unit and the MWB module. Possible configurations:
a) power supply unit, battery converter, built-in console; b) power supply unit, battery converter, external MK console;
c) power supply unit, diode in the DC power supply circuit, built-in console; d) power supply unit, diode in the DC power supply circuit, external MK console.

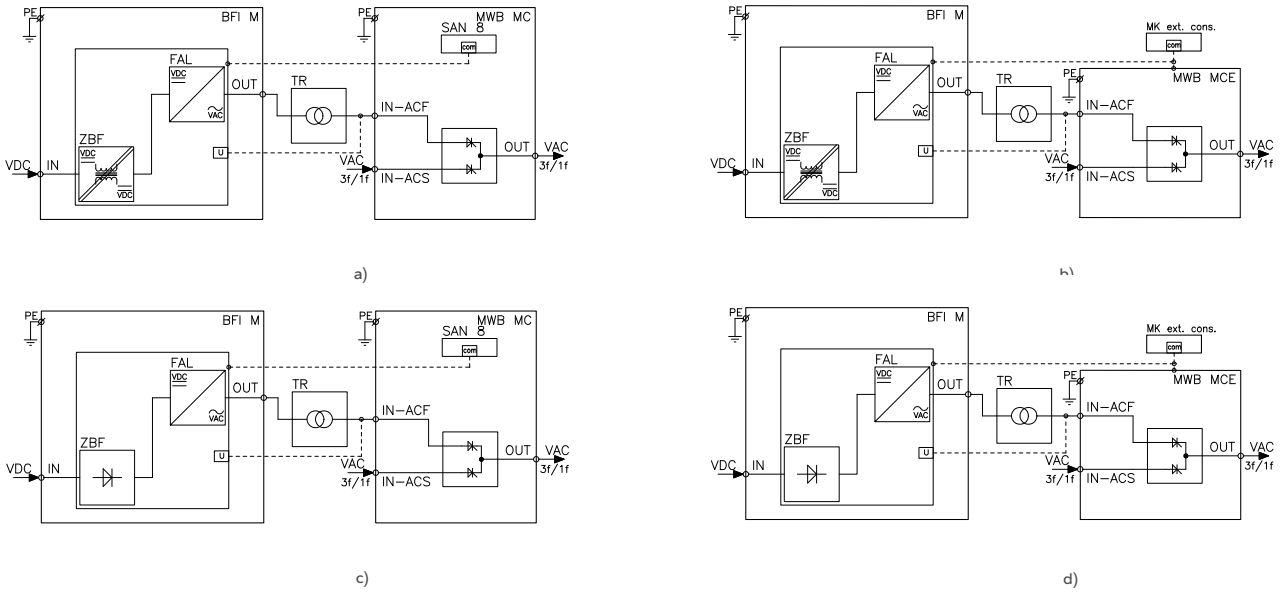


Fig. 53. Block diagram of the BFI type inverter module with the MWB module. Possible configurations:
a) battery converter, built-in console; b) battery converter, external MK console;
c) diode in the DC power supply circuit, built-in console; d) diode in the DC power supply circuit, external MK console.

The BFIz inverter module is supplied by voltage of the basic AC network and DC battery voltage (Fig. 52), while the BFI inverter module is supplied only by DC voltage (Fig. 53). The MWB module is supplied by voltage of the AC reserve network, as well as the inverter's output voltage adapted to the client's requirements by the transformer. This transformer provided isolation from supply voltage, and constitutes an ideal protection against penetration of the constant component to the loads in the case of a failure of the inverter. By standard, the MWB module is equipped with the SAN 8 inverter operating parameters control system. The MWB modules with a built-in console belong to the MC modules family, while the modules with an external MK console are a part of the MCE modules family. The BFIz / BFI modules without a controller belong to the M modules family.

The inverter's power supply (mains converter) converts the basic mains voltage into direct current necessary to supply the inverter, and ensures galvanic isolation of the mains from the inverter's circuits at the same time.

The battery power supply is available in two versions dependent on various parameters such as: overload, short-circuit, or the most important of those parameters: reliability.

1. High frequency DC/DC converter;
2. Cut-off diode.

1. The high frequency DC/DC converter (battery converter) converts the DC supply voltage into direct current necessary to supply the inverter, and ensures galvanic isolation of the battery from the inverter's circuits at the same time.

2. The diode is incorporated in series into the DC power supply circuit. The task of the diode is to provide DC power voltage to the inverter's circuits, and block penetration of the intermediate voltage of the inverter to DC supply voltage at the same time.

The system including a diode on the battery power supply circuit instead of a battery converter (Fig. 52 c, d, and Fig. 53 c, d) is characterised by a greater reliability due to a lack of processing on the DC circuit.

Due to the fact that the inverter in such a configuration is unable to autonomously obtain 230 V AC or 3×400 V AC rated voltage on its output, it always cooperates with the 50 Hz adapting transformer of appropriate voltage switch.

The galvanic isolation of the inverter and the basic AC power supply from DC voltage is ensured by a 50 Hz transformer (from the inverter's side) and a high-frequency transformer (at the side of the power supply unit).

The inverter converts direct current into alternating current adapted via the transformer to the value accordant with the order (by standard, 230 V or 3×400 V AC).

The MWB module may be equipped with the SKB automatic bypass system.

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

Note: the MWB type bypass system module is described in chapter "MODULAR DESIGN STATIC SWITCHES".

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10kVA FOR AUTONOMOUS OPERATION IN COOPERATION WITH 1-PHASE TRANSFORMER 230 V / 230 V 50 Hz – AS PER FIG. 52 A, B, AND FIG. 53 A, B

Inverter module's rated output voltage – 230 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1S 24/230 M	M5
		3×400 or 230	BFIz 1S 24/230 M	
7.5	60	-	BFI 7.5S 60 / 230 M	
1 / 2 / 2.5	110 / 220	-	BFI 1S 110 / 230 M	M3
		3×400 or 230	BFIz 1S 110 / 230 M	
3 / 3.5 / 5	110	-	BFI 3S 110 / 230 M	M5
		3×400 or 230	BFIz 3S 110 / 230 M	
7.5 / 10		-	BFI 7.5S 110 / 230 M	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1S 220 / 230 M	M3
		3×400 or 230	BFIz 1S 220 / 230 M	
7.5 / 10		-	BFI 7.5S 220 / 230 M	M5
7.5		3×400 or 230	BFIz 7.5S 220 / 230 M	
10		3×400	BFIz 10S 220 / 230 M	

* – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10kVA FOR AUTONOMOUS OPERATION IN COOPERATION WITH 1-PHASE TRANSFORMER 115 V / 230 V 50 Hz – AS PER FIG. 52 C, D, AND FIG. 53 C, D

Inverter module's rated output voltage – 230 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1S 24/115 M	M5
		3×400 or 230	BFIz 1S 24/115 M	
7.5	60	-	BFI 7.5S 60 / 115 M	
1 / 2 / 2.5	110 / 220	-	BFI 1S 110 / 115 M	M3
		3×400 or 230	BFIz 1S 110 / 115 M	
3 / 3.5 / 5	110	-	BFI 3S 110 / 115 M	M5
		3×400 or 230	BFIz 3S 110 / 115 M	
7.5 / 10		-	BFI 7.5S 110 / 115 M	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1S 220 / 115 M	
		3×400 or 230	BFIz 1S 220 / 115 M	
7.5 / 10		-	BFI 7.5S 220 / 115 M	
7.5		3×400 or 230	BFIz 7.5S 220 / 115 M	
10		3×400	BFIz 10S 220 / 115 M	

* – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 3-PHASE INVERTER MODULES 1 ÷ 10kVA FOR AUTONOMOUS OPERATION IN COOPERATION WITH 3-PHASE TRANSFORMER 3×240 V / 3×400 V 50 Hz – AS PER FIG. 52 A, B, AND FIG. 53 A, B

Inverter module's rated output voltage – 3×240 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 /	24 / 48 / 60	-	BFI 1T 24/240 M	M5
		3×400 or 230	BFIz 1T 24/240 M	
7.5	60	-	BFI 7.5T 60 / 240 M	
1 / 2 / 2.5	110 / 220	-	BFI 1T 110 / 240 M	
		3×400 or 230	BFIz 1T 110 / 240 M	
3 / 3.5 / 5	110	-	BFI 3T 110 / 240 M	
		3×400 or 230	BFIz 3T 110 / 240 M	
7.5 / 10		-	BFI 7.5T 110 / 240 M	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1T 220 / 240 M	
		3×400 or 230	BFIz 1T 220 / 240 M	
7.5 / 10		-	BFI 7.5T 220 / 240 M	
7.5		3×400 or 230	BFIz 7.5T 220 / 240 M	
10		3×400	BFIz 10T 220 / 240 M	

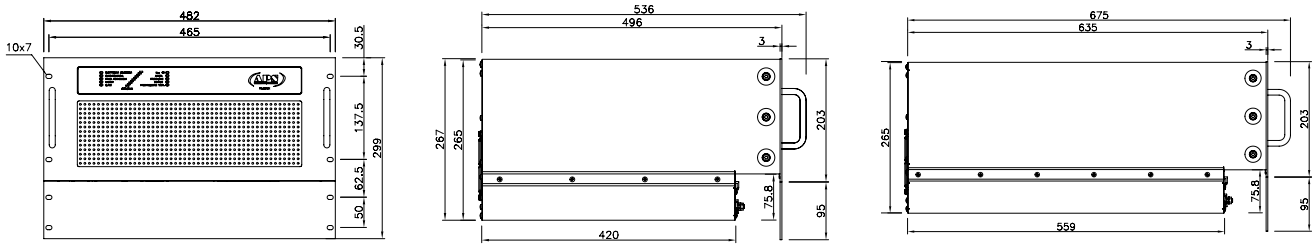
* – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 3-PHASE INVERTER MODULES 1 ÷ 10kVA FOR AUTONOMOUS OPERATION IN COOPERATION WITH 3-PHASE TRANSFORMER 3×110 V / 3×400 V 50 Hz – AS PER FIG. 52 C, D, AND FIG. 53 C, D

Inverter module's rated output voltage – 3×110 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1T 24/110 M	M5
		3×400 or 230	BFIz 1T 24/110 M	
7.5	60	-	BFI 7.5T 60 / 110 M	
1 / 2 / 2.5	110 / 220	-	BFI 1T 110 / 110 M	
		3×400 or 230	BFIz 1T 110 / 110 M	
3 / 3.5 / 5	110	-	BFI 3T 110 / 110 M	
		3×400 or 230	BFIz 3T 110 / 110 M	
7.5 / 10		-	BFI 7.5T 110 / 110 M	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1T 220 / 110 m	
		3×400 or 230	BFIz 1T 220 / 110 M	
7.5 / 10		-	BFI 7.5T 220 / 110 M	
7.5		3×400 or 230	BFIz 7.5T 220 / 110 M	
10		3×400	BFIz 10T 220 / 110 M	

* – M5 (6U): 482×267×635. (W×H×D).



a) b) c)

Fig. 54. Views with dimensions of the BFIz / BFI M type inverter module:
a) front view in the M3 and M5 enclosure; b) left-side view in the M3 enclosure; c) left-side view in the M5 enclosure.

THE INVERTER MODULE FOR PARALLEL OPERATION WITH 50 Hz ISOLATING TRANSFORMER

This chapter presents the single-phase or three-phase BFIpz / BFIp type inverters in a form of 19" module of standard 6U height cooperating with 50 Hz isolating transformers. They are adapted for mounting in industrial cabinets. The main task of an inverter is to continuously supply loads with the AC guaranteed voltage.

The BFIpz / BFIp inverter module is intended for parallel operation with an inverter of the same type. This allows increasing the output power of the system or obtaining redundancy for the components of "1+1" system.

The BFIpz / BFIp M inverter modules cooperate with the MWB module and transformers, which, apart from providing galvanic isolation, also adapt output voltages of inverter modules to appropriate values. The MWB module contains special LC filters, which are responsible for high quality of the inverter's voltage, and the Static Switch system (optionally).

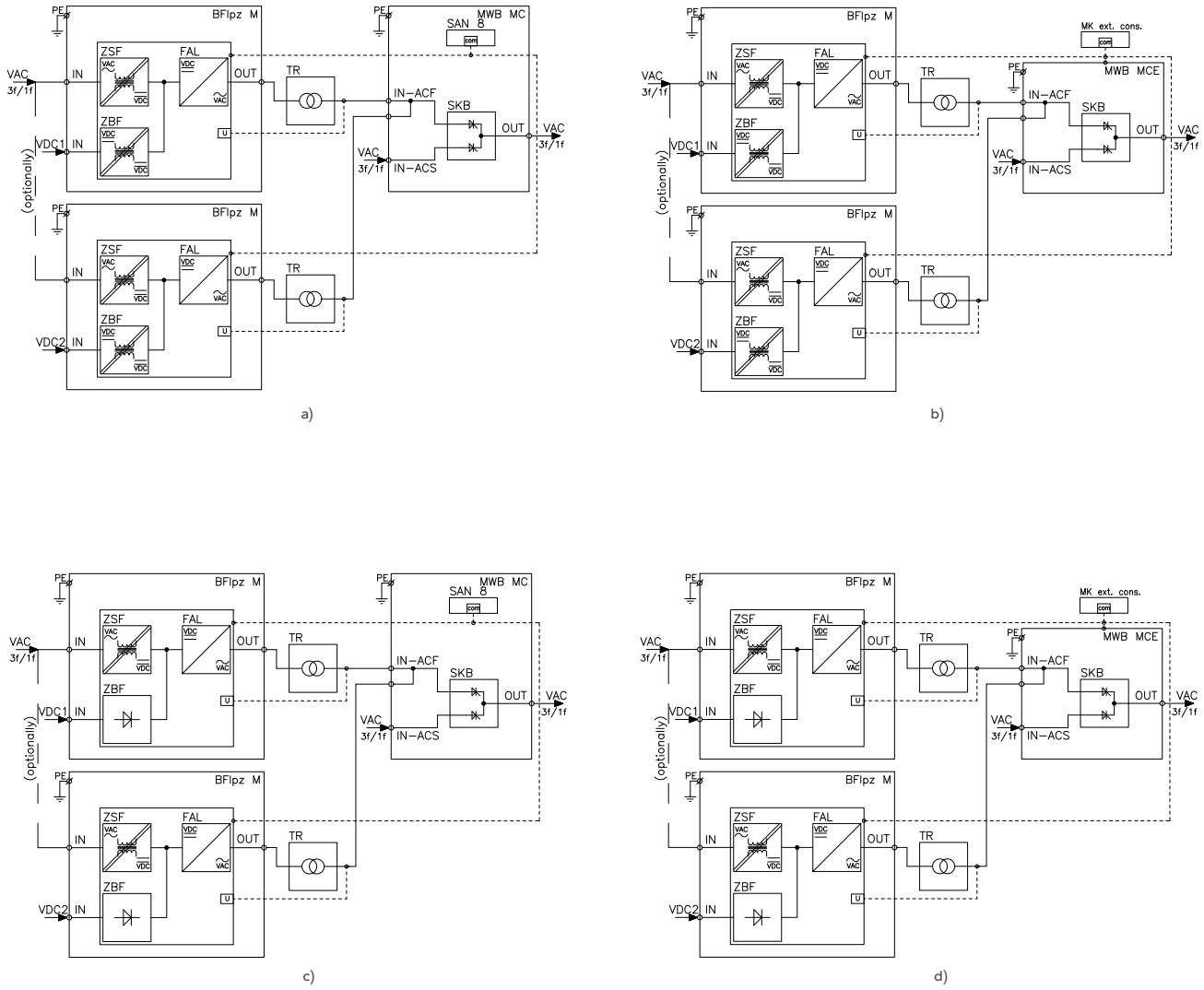


Fig. 55. Block diagram of the inverter modules for parallel operation with the BFIpz power supply unit and the MWB module. Possible configurations:
a) power supply unit, battery converter, built-in console; b) power supply unit, battery converter, external MK console;
c) power supply unit, diode in the DC power supply circuit, built-in console; d) power supply unit, diode in the DC power supply circuit, external MK console.

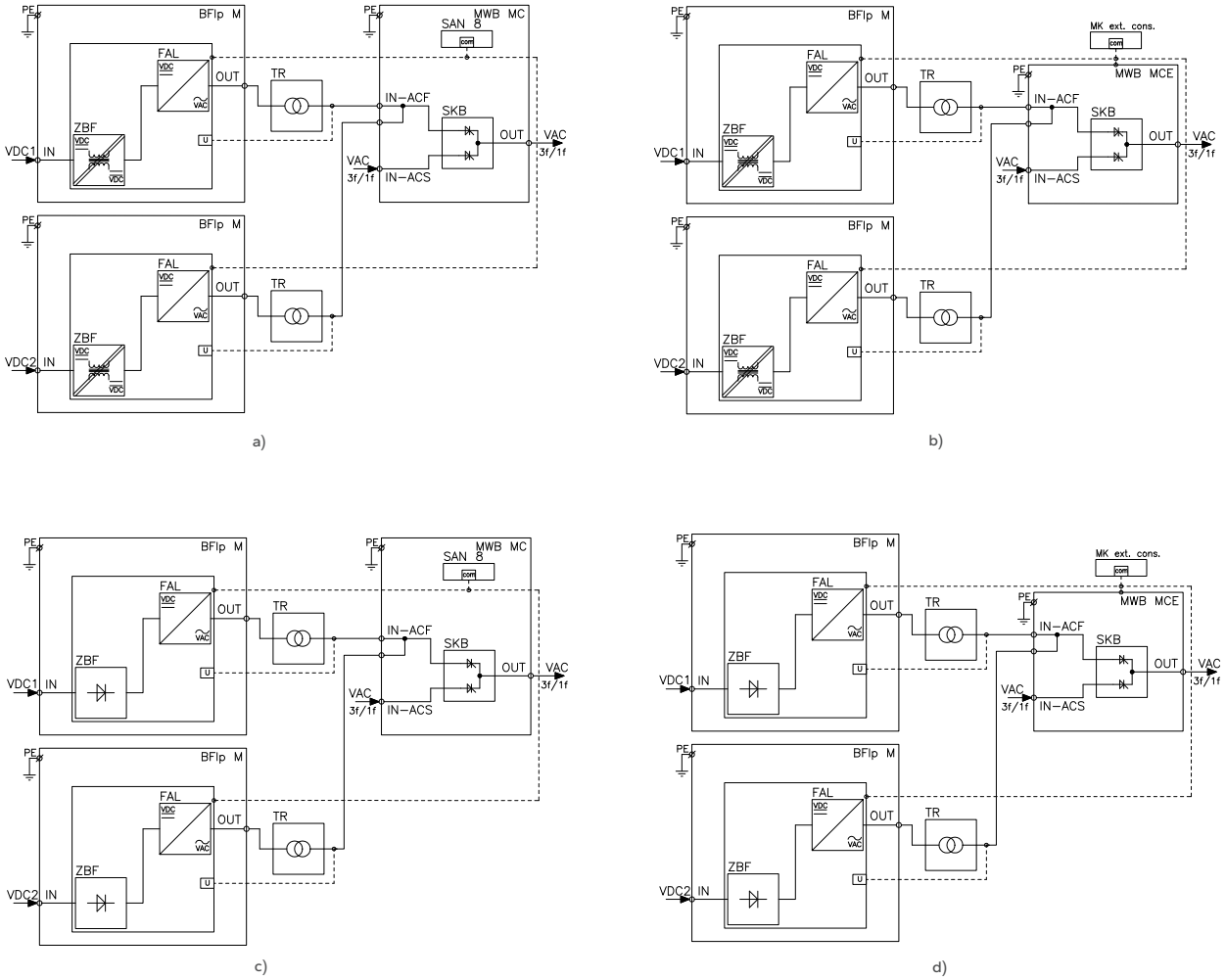


Fig. 56. Block diagram of the BFIp type inverter modules for parallel operation and the MWB module. Possible configurations:
a) battery power supply, built-in console; b) battery power supply, external MK console;
c) diode in the DC power supply circuit, built-in console; d) diode in the DC power supply circuit, external MK console.

The BFIpz inverter module is supplied by voltage of the basic AC network and DC battery voltage (Fig. 55), while the BFIp inverter module is supplied only by DC voltage (Fig. 56). The MWB module is supplied by the reserve AC network, and has two inputs to which output voltages (adapted to the client's requirements) of inverters are applied by transformers. The transformers provide isolation from supply voltages and constitute an ideal protection against penetration of the constant component to the loads in the case of a failure of the inverter. The MWB type inverters parallel operation integrating module is equipped with the SAN 8 system that controls the operating parameters of the inverters. The MWB module with a built-in console belong to the MC modules family (Fig. 56 a, c), while the modules with an external MK console are a part of the MCE modules family (Fig. 56 b, d). The BFIpz / BFIp modules without a controller belong to the M modules family.

The inverter's power supply (mains converter) converts the basic mains voltage into direct current necessary to supply the inverter, and ensures galvanic isolation of the mains from the inverter's circuits at the same time.

The battery power supply is available in two versions dependent on various parameters such as: overload, short-circuit, or the most important of those parameters: reliability.

1. High frequency DC/DC converter
   (Fig. 55 a, b, and Fig. 56 a, b);
2. Cut-off diode (Fig. 55 c, d, and Fig. 56 c, d).

1. The high frequency DC/DC converter (battery converter) converts the DC supply voltage into direct current necessary to supply the inverter, and ensures galvanic isolation of the battery from the inverter's circuits at the same time.

2. The diode is incorporated in series into the DC power supply circuit. The task of the diode is to provide DC power voltage to the inverter's circuits, and block penetration of the intermediate voltage of the inverter to DC supply voltage at the same time.

The system including a diode on the battery power supply circuit instead of a battery converter (Fig. 55 c, d, and Fig. 56 c, d) is characterised by a greater reliability due to a lack of processing on the DC circuit.

Due to the fact that the inverter in such a configuration is unable to autonomously obtain 230 V AC or 3×400 V AC rated voltage on its output, it always cooperates with the 50 Hz adapting transformer of appropriate voltage switch.

The galvanic isolation of the inverter and the basic AC power supply from DC voltage is ensured by a 50 Hz transformer (from the inverter's side) and a high-frequency transformer (at the side of the power supply unit).

The inverter converts direct current to alternating current adapted by the transformer to the value necessary according to the order.

The MWB module may be equipped with the SKB automatic bypass system.

Inverters in this configuration operate as MASTER / SLAVE, and do not require additional synchronising systems.

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

Note: the MWB type bypass system module is described in chapter "MODULAR DESIGN STATIC SWITCHES."

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10kVA FOR PARALLEL OPERATION IN COOPERATION WITH 1-PHASE TRANSFORMER 230 V / 230 V 50 Hz – AS PER FIG. 55 A, B, AND FIG. 56 A, B

Inverter module's rated output voltage – 230 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFIp 1S 24/230 M	M5
		3×400 or 230	BFIpz 1S 24/230 M	
7.5	60	-	BFIp 7.5S 60 / 230 M	
1 / 2 / 2.5	110 / 220	-	BFIp 1S 110 / 230 M	M3
		3×400 or 230	BFIpz 1S 110 / 230 M	
3 / 3.5 / 5	110	-	BFIp 3S 110 / 230 M	M5
		3×400 or 230	BFIpz 3S 110 / 230 M	
7.5 / 10		-	BFIp 7.5S 110 / 230 M	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFIp 1S 220 / 230 M	M3
		3×400 or 230	BFIpz 1S 220 / 230 M	
7.5 / 10		-	BFIp 7.5S 220 / 230 M	M5
7.5		3×400 or 230	BFIpz 7.5S 220 / 230 M	
10		3×400	BFIpz 10S 220 / 230 M	

* – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10kVA FOR PARALLEL OPERATION IN COOPERATION WITH 1-PHASE TRANSFORMER 115 V / 230 V 50 Hz – AS PER FIG. 55 C, D, AND FIG. 56 C, D

Inverter module's rated output voltage – 115 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFIp 1S 24/115 M	M5
		3×400 or 230	BFIpz 1S 24/115 M	
7.5	60	-	BFIp 7.5S 60 / 115 M	
1 / 2 / 2.5	110 / 220	-	BFIp 1S 110 / 115 M	M3
		3×400 or 230	BFIpz 1S 110 / 115 M	
3 / 3.5 / 5	110	-	BFIp 3S 110 / 115 M	M5
		3×400 or 230	BFIpz 3S 110 / 115 M	
7.5 / 10		-	BFIp 7.5S 110 / 115 M	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFIp 1S 220 / 115 M	M5
		3×400 or 230	BFIpz 1S 220 / 115 M	
7.5 / 10		-	BFIp 7.5S 220 / 115 M	
7.5		3×400 or 230	BFIpz 7.5S 220 / 115 M	
10		3×400	BFIpz 10S 220 / 115 M	

* – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 3-PHASE INVERTER MODULES 1 ÷ 10kVA FOR PARALLEL OPERATION IN COOPERATION WITH 3-PHASE TRANSFORMER 3×240 V / 3×400 V 50 Hz – AS PER FIG. 55 A, B, AND FIG. 56 A, B

Inverter module's rated output voltage – 3×240 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFIp 1T 24/240 M	M5
		3×400 or 230	BFIpz 1T 24/240 M	
7.5	60	-	BFIp 7.5T 60 / 240 M	
1 / 2 / 2.5	110 / 220	-	BFIp 1T 110 / 240 M	
		3×400 or 230	BFIpz 1T 110 / 240 M	
3 / 3.5 / 5	110	-	BFIp 3T 110 / 240 M	
		3×400 or 230	BFIpz 3T 110 / 240 M	
7.5 / 10		-	BFIp 7.5T 110 / 240 M	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFIp 1T 220 / 240 M	
		3×400 or 230	BFIpz 1T 220 / 240 M	
7.5 / 10		-	BFIp 7.5T 220 / 240 M	
7.5		3×400 or 230	BFIpz 7.5T 220 / 240 M	
10		3×400	BFIpz 10T 220 / 240 M	

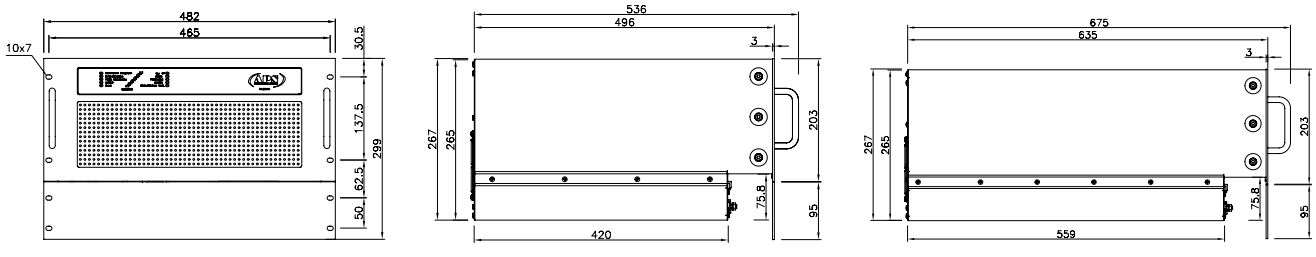
* – M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 3-PHASE INVERTER MODULES 1 ÷ 10kVA FOR PARALLEL OPERATION IN COOPERATION WITH 3-PHASE TRANSFORMER 3×110 V / 3×400 V 50 Hz – AS PER FIG. 55 C, D, AND FIG. 56 C, D

Inverter module's rated output voltage – 3×110 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFIp 1T 24/110 M	M5
		3×400 or 230	BFIpz 1T 24/110 M	
7.5	60	-	BFIp 7.5T 60 / 110 M	
1 / 2 / 2.5	110 / 220	-	BFIp 1T 110 / 110 M	
		3×400 or 230	BFIpz 1T 110 / 110 M	
3 / 3.5 / 5	110	-	BFIp 3T 110 / 110 M	
		3×400 or 230	BFIpz 3T 110 / 110 M	
7.5 / 10		-	BFIp 7.5T 110 / 110 M	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFIp 1T 220 / 110 m	
		3×400 or 230	BFIpz 1T 220 / 110 M	
7.5 / 10		-	BFIp 7.5T 220 / 110 M	
7.5		3×400 or 230	BFIpz 7.5T 220 / 110 M	
10		3×400	BFIpz 10T 220 / 110 M	

* – M5 (6U): 482×267×635. (W×H×D).

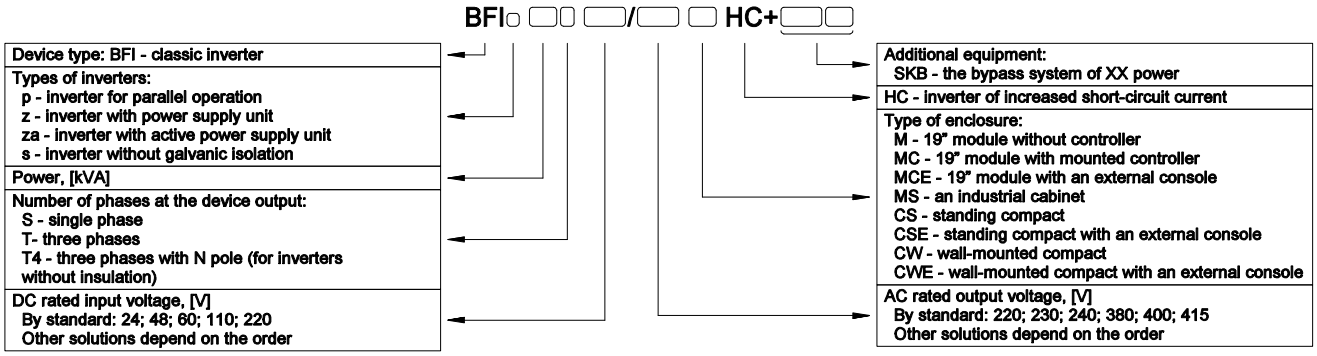


a) b) c)

Fig. 57. Views with dimensions of the BFIpz / BFIp M type inverter module:
a) front view in the M3 and M5 enclosure; b) left-side view in the M3 enclosure; c) left-side view in the M5 enclosure.

INVERTER MODULE OF INCREASED SHORT-CIRCUIT CURRENT

METHOD OF DESIGNATION OF THE BFI HC TYPE INVERTERS OF INCREASED SHORT-CIRCUIT



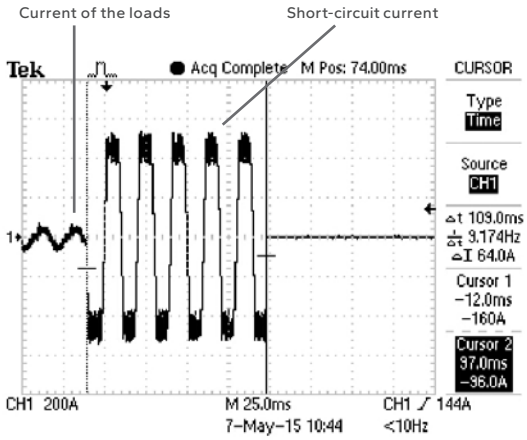
The HC version BFIz / BFI inverter modules create a family of devices, which, contrary to standard inverter modules, are characterised by increased operating parameters:

- higher multiplication crest factor (from 3:1 to 5:1),
- high short-circuit currents at the inverter's output (3×In to 9×In).

Significantly higher-than-standard short-circuit current parameters ensure highly selective tripping of protection in inverter-supplied distribution board. A high resistance to overload characteristic for the HC inverters is useful when supplying loads of high starting currents (e.g., electric motors) without increasing the power of the inverter itself, thus reducing the costs and impacting the overall dimensions of the inverter. High crest factor is particularly important in the case of supplying pulse loads.

The BFIz / BFI / BFIpz / BFIp HC inverter module may cooperate with the MWB module and transformer to provide galvanic isolation and adapt the inverter module 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).

Note: the MWB type bypass system module is described in chapter "MODULAR DESIGN STATIC SWITCHES."



Oscillogram of the programmed current and the duration of short-circuit of the inverter

SERIES TYPE: 1-PHASE HC INVERTER MODULES 1 ÷ 10kVA

Rated output voltage 230 V AC*

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions****
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1S 24/230 MC** HC +SKB 1***	M5
		3×400 or 230	BFIz 1S 24/230 MC** HC+SKB 1***	
7.5	60	-	BFI 7.5S 60 / 230 MC** HC+SKB 7.5***	
1 / 2 / 2.5	110 / 220	-	BFI 1S 110 / 230 MC** HC+SKB 1***	M3
		3×400 or 230	BFIz 1S 110 / 230 MC** HC+SKB 1***	
3 / 3.5 / 5	110	-	BFI 3S 110 / 230 MC** HC+SKB 3***	M5
		3×400 or 230	BFIz 3S 110 / 230 MC** HC+SKB 3***	
7.5 / 10		-	BFI 7.5S 110 / 230 MC** HC+SKB 7.5***	
3 / 3.5 / 5	220	-	BFI 3S 220 / 230 MC** HC+SKB 3***	M3/M5*****
		3×400 or 230	BFIz 3S 220 / 230 MC** HC+SKB 3***	
7.5 / 10		-	BFI 7.5S 220 / 230 MC** HC+SKB 7.5***	M5
7.5		3×400 or 230	BFIz 7.5S 220 / 230 MC** HC+SKB 7.5***	
10		3×400	BFIz 10S 220 / 230 MC** HC+SKB 10***	

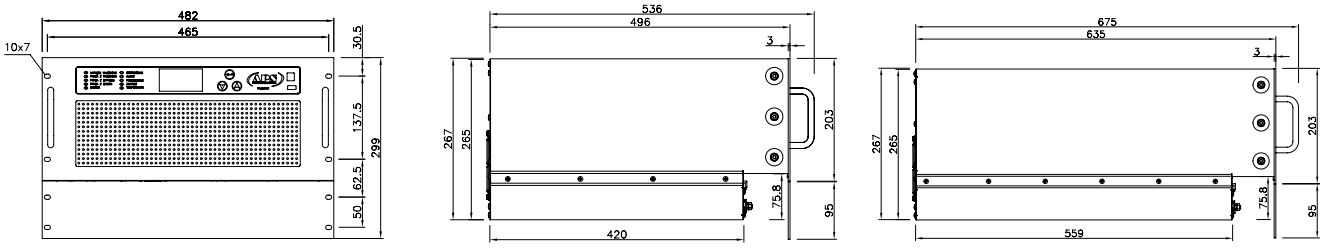
* – possible options: 220 / 230 / 240 V AC;

** – possible options: M / MC / MCE;

*** – a module without the SKB bypass is available as an option;

**** – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D);

***** – M3 or M5 module, depending on the short-circuit current value



a) b) c)

Fig. 58. Views with dimensions of the BFIz / BFI MC HC type inverter module:
a) front view in the M3 and M5 enclosure; b) left-side view in the M3 enclosure; c) left-side view in the M5 enclosure.

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10kVA IN COOPERATION WITH 1-PHASE TRANSFORMER 230 V / 230 V 50 Hz – AS PER FIG. 52 A, B, AND FIG. 53 A, B

Inverter module's rated output voltage – 230 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1S 24/230 M HC	M5
		3×400 or 230	BFIz 1S 24/230 M HC	
7.5	60	-	BFI 7.5S 60 / 230 M HC	
1 / 2 / 2.5	110 / 220	-	BFI 1S 110 / 230 M HC	M3
		3×400 or 230	BFIz 1S 110 / 230 M HC	
3 / 3.5 / 5	110	-	BFI 3S 110 / 230 M HC	M5
		3×400 or 230	BFIz 3S 110 / 230 M HC	
7.5 / 10		-	BFI 7.5S 110 / 230 M HC	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1S 220 / 230 M HC	M3
		3×400 or 230	BFIz 1S 220 / 230 M HC	
7.5 / 10		-	BFI 7.5S 220 / 230 M HC	M5
7.5		3×400 or 230	BFIz 7.5S 220 / 230 M HC	
10		3×400	BFIz 10S 220 / 230 M HC	

* – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10kVA IN COOPERATION WITH 1-PHASE TRANSFORMER 115 V / 230 V 50 Hz – AS PER FIG. 52 C, D, AND FIG. 53 C, D

Inverter module's rated output voltage – 115 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1S 24/115 M HC	M5
		3×400 or 230	BFIz 1S 24/115 M HC	
7.5	60	-	BFI 7.5S 60 / 115 M HC	
1 / 2 / 2.5	110 / 220	-	BFI 1S 110 / 115 M HC	M3
		3×400 or 230	BFIz 1S 110 / 115 M HC	
3 / 3.5 / 5	110	-	BFI 3S 110 / 115 M HC	M5
		3×400 or 230	BFIz 3S 110 / 115 M HC	
7.5 / 10		-	BFI 7.5S 110 / 115 M HC	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1S 220 / 115 M HC	M5
		3×400 or 230	BFIz 1S 220 / 115 M HC	
7.5 / 10		-	BFI 7.5S 220 / 115 M HC	
7.5		3×400 or 230	BFIz 7.5S 220 / 115 M HC	
10		3×400	BFIz 10S 220 / 115 M HC	

* – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 3-PHASE INVERTER MODULES 1 ÷ 10kVA IN COOPERATION WITH 3-PHASE TRANSFORMER 3×240 V / 3×400 V 50 Hz – AS PER FIG. 52 A, B, AND FIG. 53 A, B

Inverter module's rated output voltage – 3×240 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1T 24/240 M HC	M5
		3×400 or 230	BFIz 1T 24/240 M HC	
7.5	60	-	BFI 7.5T 60 / 240 M HC	
1 / 2 / 2.5	110 / 220	-	BFI 1T 110 / 240 M HC	
		3×400 or 230	BFIz 1T 110 / 240 M HC	
3 / 3.5 / 5	110	-	BFI 3T 110 / 240 M HC	
		3×400 or 230	BFIz 3T 110 / 240 M HC	
7.5 / 10		-	BFI 7.5T 110 / 240 M HC	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1T 220 / 240 M HC	
		3×400 or 230	BFIz 1T 220 / 240 M HC	
7.5 / 10		-	BFI 7.5T 220 / 240 M HC	
7.5		3×400 or 230	BFIz 7.5T 220 / 240 M HC	
10		3×400	BFIz 10T 220 / 240 M HC	

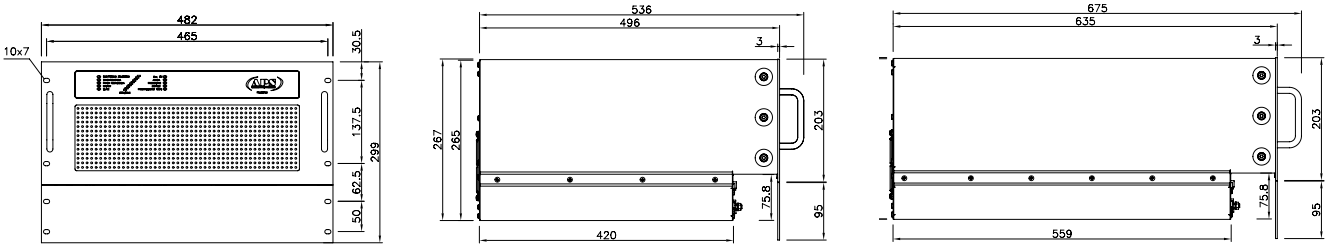
* – M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 3-PHASE INVERTER MODULES 1 ÷ 10kVA IN COOPERATION WITH 3-PHASE TRANSFORMER 3×110 V / 3×400 V 50 Hz – AS PER FIG. 52 C, D, AND FIG. 53 C, D

Inverter module's rated output voltage – 3×110 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1T 24/110 M HC	M5
		3×400 or 230	BFIz 1T 24/110 M HC	
7.5	60	-	BFI 7.5T 60 / 110 M HC	
1 / 2 / 2.5	110 / 220	-	BFI 1T 110 / 110 M HC	
		3×400 or 230	BFIz 1T 110 / 110 M HC	
3 / 3.5 / 5	110	-	BFI 3T 110 / 110 M HC	
		3×400 or 230	BFIz 3T 110 / 110 M HC	
7.5 / 10		-	BFI 7.5T 110 / 110 M HC	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1T 220 / 110 m HC	
		3×400 or 230	BFIz 1T 220 / 110 M HC	
7.5 / 10		-	BFI 7.5T 220 / 110 M HC	
7.5		3×400 or 230	BFIz 7.5T 220 / 110 M HC	
10		3×400	BFIz 10T 220 / 110 M HC	

* – M5 (6U): 482×267×635. (W×H×D).



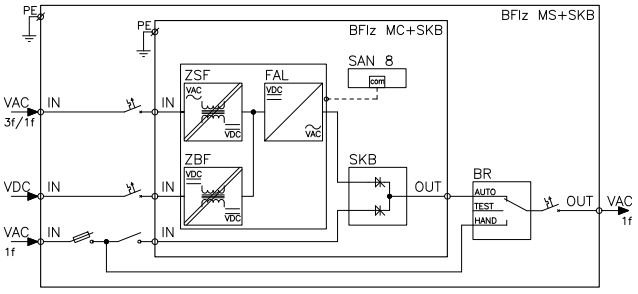
a) b) c)

Fig. 59. Views with dimensions of the BFIz / BFI M type inverter module:
a) front view in the M3 and M5 enclosure; b) left-side view in the M3 enclosure; c) left-side view in the M5 enclosure.

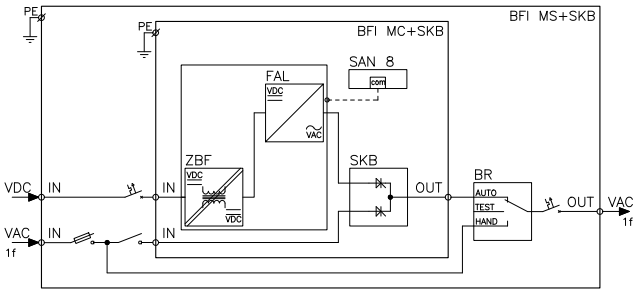
INVERTERS BUILT IN A CABINET

THE INVERTER CABINET FOR AUTONOMOUS OPERATION

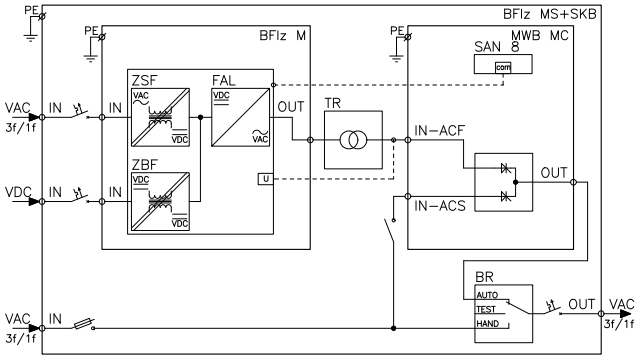
This chapter presents the BFIz / BFI type inverters in a form of 19" industrial cabinet for installation on a substrate. The main task of an inverter is to continuously supply loads with the AC guaranteed voltage.



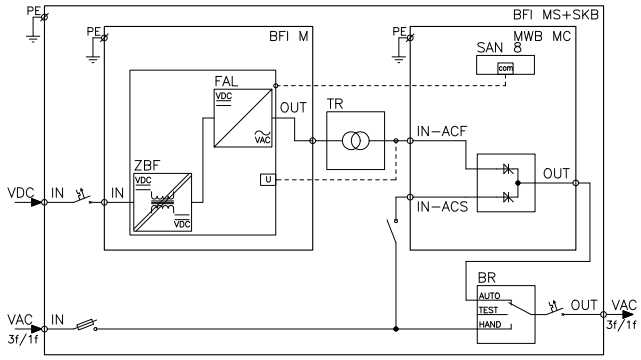
a)



b)



c)



d)

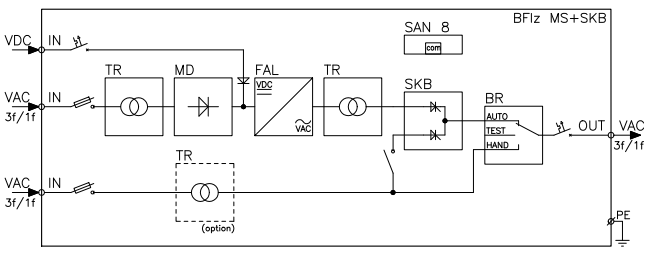
Fig. 60 a) and b) present a standard solution for single-phase module inverters in an industrial cabinet.

Description of the inverter module is provided in chapter "The inverter module intended for autonomous operation with galvanic isolation at the AC and DC supply voltage side."

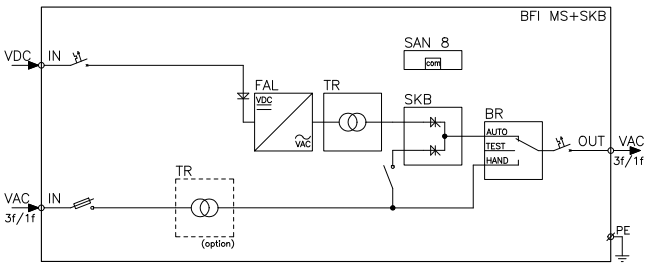
Fig. 60 c) and d) present a standard solution for single-phase or three-phase module inverters with a 50 Hz transformer in an industrial cabinet.

Description of the inverter module is provided in chapter "The inverter module for autonomous operation with a 50 Hz isolating transformer."

Fig. 60. Block diagram of a cabinet with an inverter module:
a) the BFIz type with the SKB bypass; b) the BFI type with the SKB bypass;
c) the BFIz type with a 50 Hz transformer and the MWB module; d) the BFI type with a 50 Hz transformer and the MWB module.



a)



b)

Fig. 61. Block diagram of the inverter cabinet in a free design:
a) the BFIz type with the SKB bypass; b) the BFI type with the SKB bypass.

Fig. 61 a) and b) present a standard solution for single-phase or three-phase inverters in a free design in an industrial cabinet.

The BFIz+SKB inverter cabinet is supplied by the basic AC network voltage, DC voltage, as well as the AC reserve network voltage (the automatic bypass supply voltage – this is a standard solution used to increase the reliability of the system). On the other hand, the BFI+SKB inverter cabinet is supplied from DC voltage and a reserve AC network voltage. By standard, the inverter cabinet is equipped with the SAN 8 inverter operating parameters control system.

Fig. 61 a) presents an inverter with a power supply unit consisting of a 12-impulse transformer and a 12-impulse diode rectifier. Application of the transformer ensures galvanic isolation of DC supply voltage from the AC network, and adapts the AC supply to the needs of the inverter, which depend on the value of the DC power supply. The 12-impulse transformer may also be used to improve the THD value of the current drawn from the mains. Application of a diode rectifier significantly increases reliability of the power supply and desensitises the inverter to any disturbances in the voltage or the frequency of the mains. Apart from the diode, there are no automatics or power electronics elements in the DC power supply circuit, which guarantees certain and continuous switch of the inverter to battery operation in the case of drop or break of the mains.

The inverter converts direct current into alternating current adapted via the transformer to the value accordant with the order (by standard, 230 V or 3×400 V AC).

The BFIz / BFI systems installed in cabinets may be equipped with the SKB automatic bypass system.

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

ADDITIONAL OPTIONS

- Active power supply (sinusoidal current draw);
- Active filter in the AC power supply (improves THDi);
- Automatic bypass;
- 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 INVERTER CABINETS 1 ÷ 150kVA FOR AUTONOMOUS OPERATION

Rated output voltage 230 V AC*

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Min. dimensions of the enclosure [W×D×H**], [mm]
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1S 24/230 MS+SKB 1***	600×800×2,000
		3×400 or 230	BFIz 1S 24/230 MS+SKB 1***	
7.5 / 10	60	-	BFI 7.5S 60 / 230 MS+SKB 7.5***	
		3×400 or 230	BFIz 7.5S 60 / 230 MS+SKB 7.5***	
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10 / 12.5 / 15 / 20	110 / 220	-	BFI 1S 110 / 230 MS+SKB 1***	
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10		3×400 or 230	BFIz 1S 110 / 230 MS+SKB 1***	
12.5 / 15 / 20		3×400	BFIz 12.5S 110 / 230 MS+SKB 12.5***	
25 / 30 / 40	110	-	BFI 25S 110 / 230 MS+SKB 25***	1,200×800×2,000
		3×400	BFIz 25S 110 / 230 MS+SKB 25***	
50 / 60		-	BFI 50S 110 / 230 MS+SKB 50***	1,800×800×2,000
		3×400	BFIz 50S 110 / 230 MS+SKB 50***	
25 / 30 / 40	220	-	BFI 25S 220 / 230 MS+SKB 25***	600×800×2,000
		3×400	BFIz 25S 220 / 230 MS+SKB 25***	800×800×2,000
50 / 60 / 75		-	BFI 50S 220 / 230 MS+SKB 50****	1,200×800×2,000
		3×400	BFIz 50S 220 / 230 MS+SKB 50***	1,400×800×2,000
100 / 120		-	BFI 100S 220 / 230 MS+SKB 100***	1,800×800×2,000
		3×400	BFIz 100S 220 / 230 MS+SKB 100***	
140 / 150		-	BFI 140S 220 / 230 MS+SKB 140***	2,400×800×2,000
		3×400	BFIz 140S 220 / 230 MS+SKB 140***	

* – possible options: 220 / 230 / 240 V AC;

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

*** – a cabinet without the SKB bypass is available as an option;

SERIES TYPE: 3-PHASE INVERTER CABINETS 1 ÷ 400kVA FOR AUTONOMOUS OPERATION

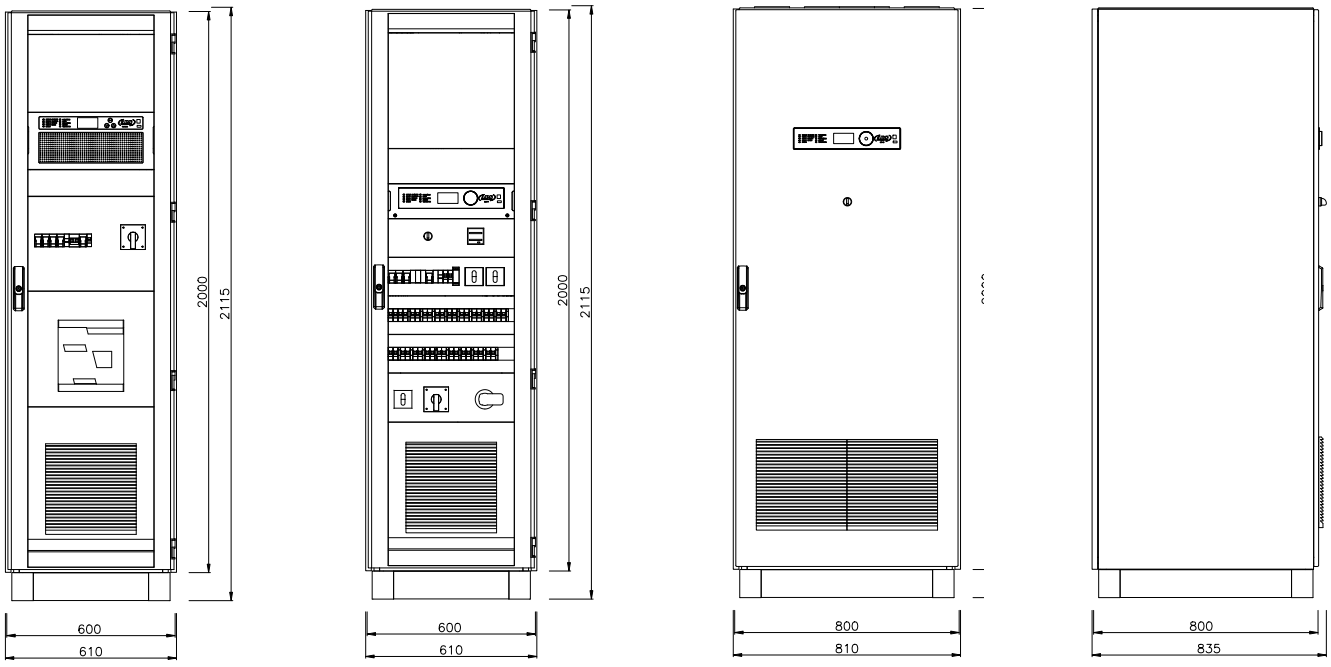
Rated output voltage 3×400 V AC*

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Min. dimensions of the enclosure [W×D×H**], [mm]
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1T 24/400 MS+SKB 1***	600×800×2,000
		3×400 or 230	BFIz 1T 24/400 MS+SKB 1***	
7.5 / 10	60	-	BFI 7.5T 60 / 400 MS+SKB 7.5***	
		3×400 or 230	BFIz 7.5T 60 / 400 MS+SKB 7.5***	
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10 / 12.5 / 15 / 20 / 25 / 30 / 35 / 40	110 / 220	-	BFI 1T 110 / 400 MS+SKB 1***	
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10		3×400 or 230	BFIz 1T 110 / 400 MS+SKB 1***	
12.5 / 15 / 20		3×400	BFIz 12.5T 110 / 400 MS+SKB 12.5***	
25 / 30 / 35 / 40		3×400	BFIz 25T 110 / 400 MS+SKB 25***	800×800×2,000
50 / 60 / 75	110	-	BFI 50T 110 / 400 MS+SKB 50***	1,200×800×2,000
		3×400	BFIz 50T 110 / 400 MS+SKB 50***	1,400×800×2,000
50 / 60	220	-	BFI 50T 220 / 400 MS+SKB 50***	600×800×2,000
50		3×400	BFIz 50T 220 / 400 MS+SKB 50***	800×800×2,000
75		-	BFI 75T 220 / 400 MS+SKB 75***	
60 / 75		3×400	BFIz 60T 220 / 400 MS+SKB 60***	1,400×800×2,000
100 / 120 / 140 / 150		-	BFI 100T 220 / 400 MS+SKB 100***	1,200×800×2,000
100 / 120		3×400	BFIz 100T 220 / 400 MS+SKB 100***	1,600×800×2,000
160		-	BFI 160T 220 / 400 MS+SKB 160***	1,400×800×2,000
140 / 150 / 160		3×400	BFIz 140T 220 / 400 MS+SKB 140***	2,000×800×2,000
180 / 200		-	BFI 180T 220 / 400 MS+SKB 180***	1,800×800×2,000
180 / 200 / 220 / 250		3×400	BFIz 180T 220 / 400 MS+SKB 180***	3,000×800×2,000
220 / 250		-	BFI 220T 220 / 400 MS+SKB 220***	2,000×800×2,000
300 / 350		-	BFI 300T 220 / 400 MS+SKB 300***	3,000×800×2,000
300		3×400	BFIz 300T 220 / 400 MS+SKB 300***	3,600×800×2,000
400		-	BFI 400T 220 / 400 MS+SKB 400***	3,200×800×2,000

* – possible options: 3×380 / 3×400 / 3×415 V AC;

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

*** – a cabinet without the SKB bypass is available as an option;



a) b) c) d)

Fig. 62. Views with dimensions of the BFIz / BFI type inverter cabinet:
a) 600×800×2,000 cabinet (modular design) – front view; b) 600×800×2,000 cabinet (free design) – front view;
c) 800×800×2,000 cabinet (free design) – front view; d) cabinet of depth of 800 mm – left-side view.

THE INVERTER CABINET FOR PARALLEL OPERATION

This chapter presents the BFIpz / BFIp type inverters in a form of 19" industrial cabinet. They are intended for installation on a substrate. The main task of an inverter is to continuously supply loads with the AC guaranteed voltage.

The BFIpz / BFIp inverter is intended for parallel operation with an inverter of the same type. This allows increasing the output power of the system or obtaining redundancy for the components of "1+1" system.

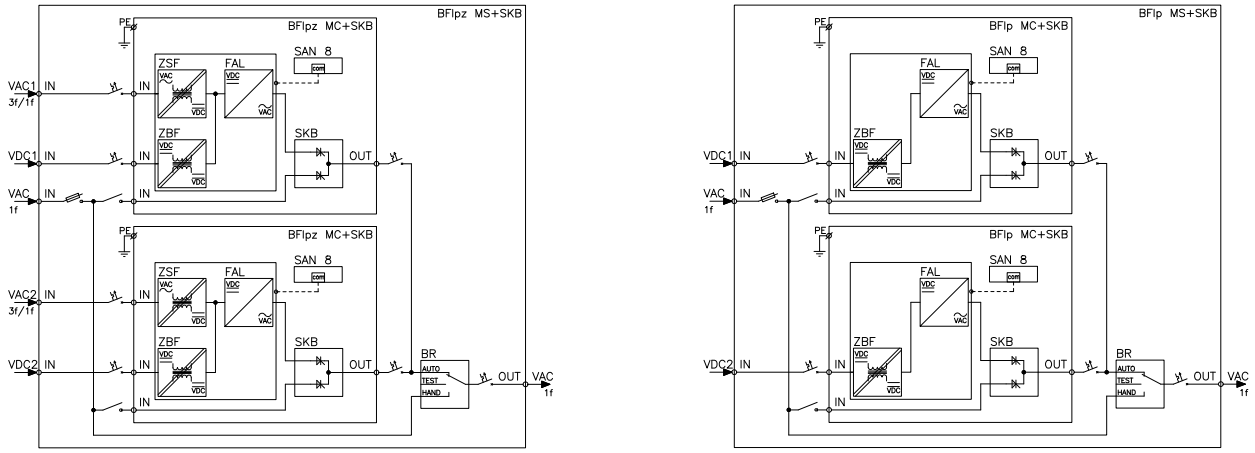


Fig. 63. Block diagram of the inverter cabinet consisting of the BFIpz/BFIp type inverter modules for parallel operation of max. module power up to 10kVA with the SKB type bypass (1-phase solution). Possible configurations:
a) a system of two BFIpz modular inverters with own bypasses; b) a system of two BFIp modular inverters with own bypasses.

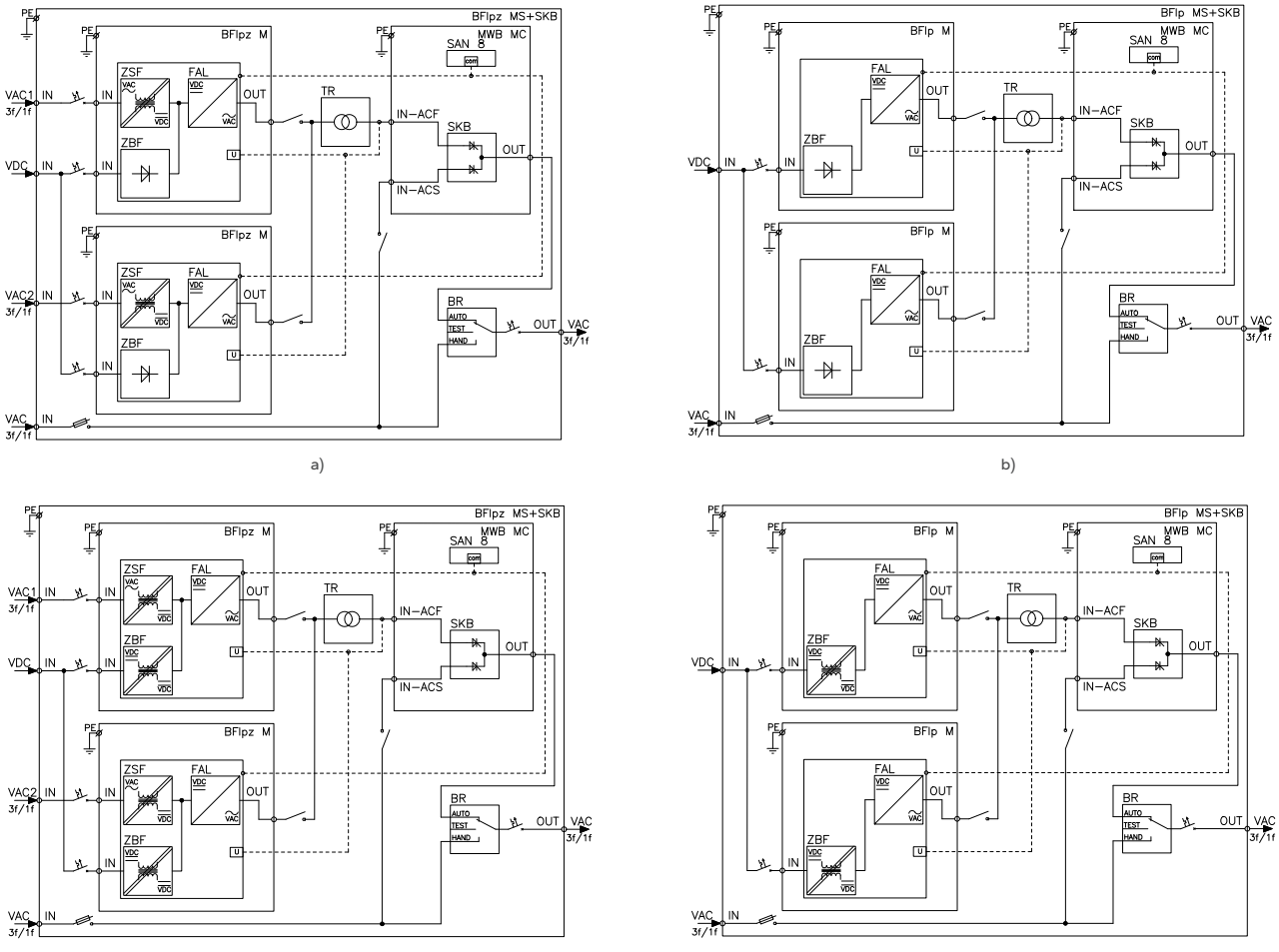


Fig. 64. Block diagram of the inverter cabinet consisting of the BFIpz / BFIp type inverter modules for parallel operation of max. module power up to 10kVA with the SKB type bypass and a common transformer (1-phase or 3-phase solution). Possible configurations:
a) a diode in the DC power supply circuit of the BFIpz type inverter module; b) a diode in the DC power supply of the BFIp type inverter module; c) a battery converter at the DC power supply of the BFIpz type inverter module; d) a battery converter at the DC power supply of the BFIp inverter module.

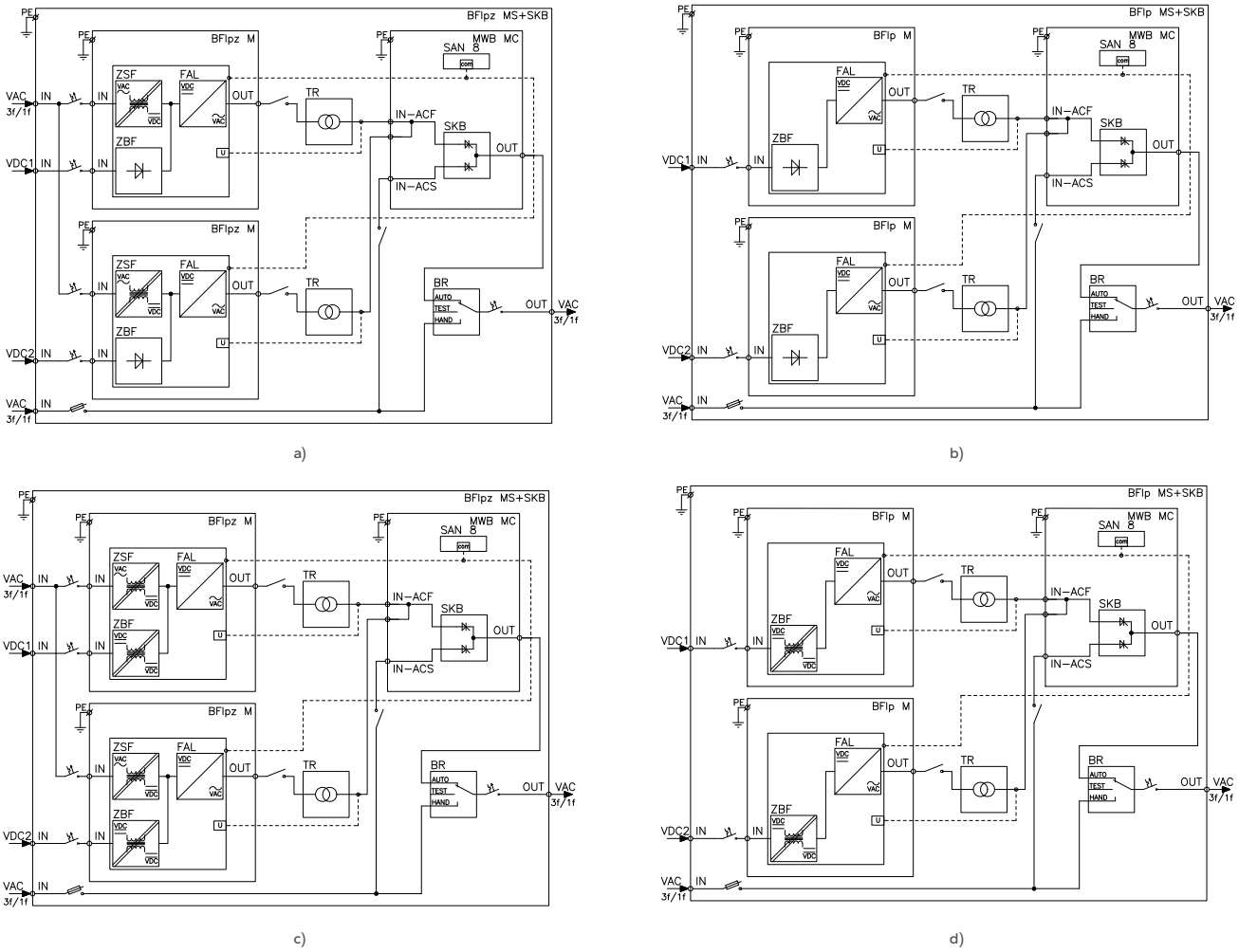


Fig. 65. Block diagram of the inverter cabinet consisting of the BFIpz / BFIp type inverter modules for parallel operation of max. module power up to 10kVA with the SKB type bypass and own transformers (1-phase or 3-phase solution). Possible configurations:

a) a diode in the DC power supply circuit of the BFIpz type inverter module; b) a diode in the DC power supply of the BFIp type inverter module;
c) a battery converter at the DC power supply of the BFIpz type inverter module; d) a battery converter at the DC power supply of the BFIp inverter module.

Fig. 63 – Fig. 66 present standard solutions for parallel operation of single-phase or three-phase modular inverters incorporated in industrial cabinets. The cabinet, which consists of inverter modules operating in parallel, is available in the following configurations:

1. Two modules – Fig. 63:

- Module 1 and Module 2 – inverter + automatic bypass:BFIpz / BFIp xxx MC + SKB
  Maximum power of the inverter module: 10kVA.

2. Three modules – Fig. 64, Fig. 65:

- Module 1 and Module 2 – inverter: BFIpz / BFIp xxx M
- Module 3 – a module that integrates parallel operation of inverters + automatic bypass: MWB xx MC
  Maximum power of a single inverter module: 10kVA.

3. "n" modules – Fig. 66:

- Module from 1 to "n" – inverter: BFIpz / BFIp xxx M
- The SKB automatic bypass system
  Maximum power of a single inverter module: 15kVA.Maximum number of modules for parallel operation: "n" = 16.

In configuration 1 – the BFIpz+SKB inverter module is supplied by the basic AC network voltage, DC voltage, as well as the AC reserve network voltage (the automatic bypass supply voltage – this is a standard solution used to increase the reliability of the system). The BFIp+SKB inverter module is supplied from DC voltage and a reserve AC network voltage.

Inverters and automatic bypasses in configuration 1 operate as MASTER / SLAVE, and do not require any additional synchronising systems.

In configuration 2 and 3 – the BFIpz inverter module is supplied from the basic AC network voltage and the DC voltage. On the other hand, the BFIp inverter module is supplied by the DC voltage. The SKB bypass in the MWB module (Fig. 64, Fig. 65) and the SKB bypass (Fig. 66) are supplied from the AC reserve network voltage (the automatic bypass supply voltage – this is a standard solution used to improve the reliability of the system), as well as output voltages of the inverters.

The cabinet (or module) is equipped with the SAN 8 inverter operating parameters control system.

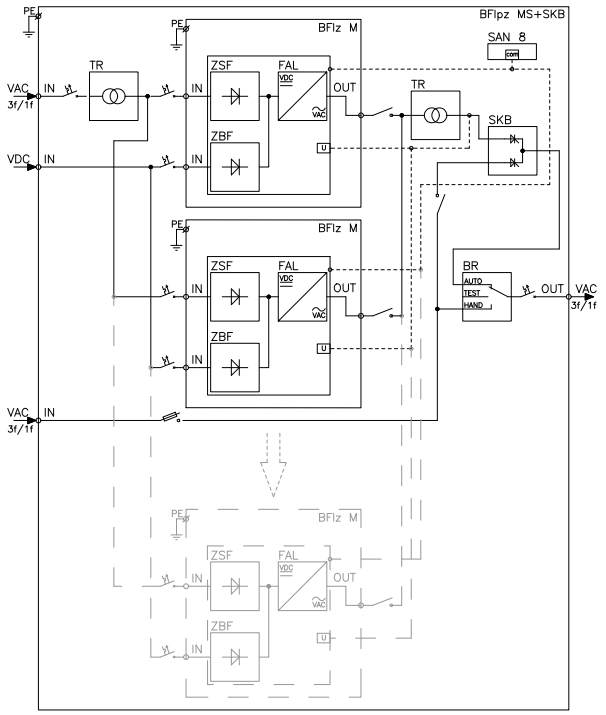


Fig. 66. Block diagram of the inverter cabinet consisting of the BFIpz type inverter modules for parallel operation of max. module power up to 15kVA with the SKB type bypass.

A system with "n" module inverters with a common bypass (1-phase or 3-phase solutions).

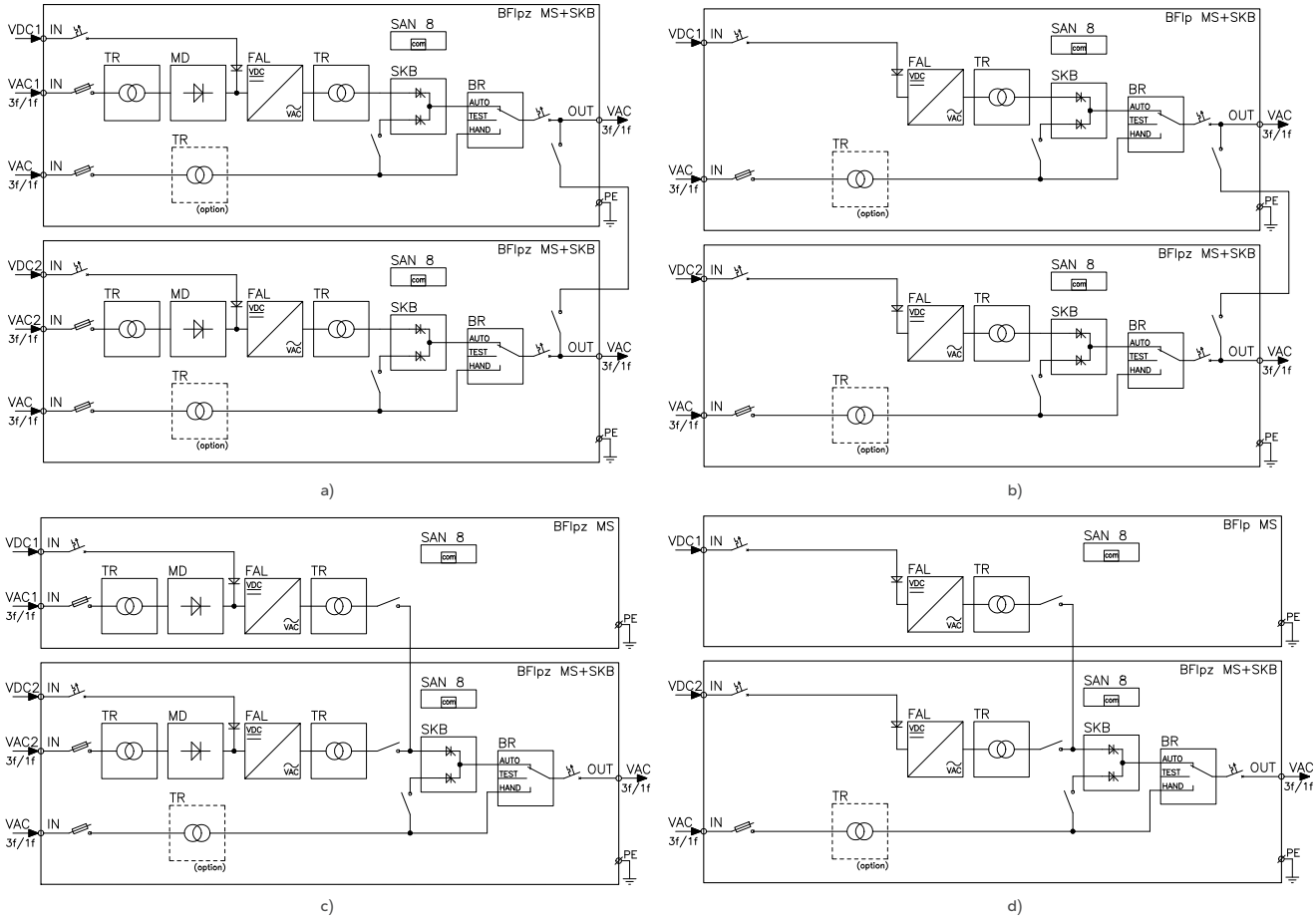


Fig. 67. Block diagram of the BFIpz / BFIp type inverter cabinets in a free design for parallel operation with the SKB type bypass. Possible configurations:
a) a parallel system of two BFIpz inverters with own bypasses; b) a parallel system of two BFIp inverters with own bypasses;
c) a parallel system of two BFIpz inverters with a single common bypass; d) a parallel system of two BFIp inverters with a single common bypass.

The inverter's power supply (mains and battery) is available in two versions dependent on various parameters such as: overload, short-circuit, or the most important of those parameters: reliability.

a) High-frequency converter (AC/DC for the power supply unit and DC/DC for the battery power supply);

b) Cut-off diode.

a.1. The high-frequency AC/DC converter (mains converter) transforms the AC supply voltage into direct voltage necessary to supply the inverter, and provided galvanic isolation of the mains from the inverter's circuits at the same time (Fig. 63 a; Fig. 64 a, c; Fig. 65 a, c).

a.2. The high frequency DC/DC converter (battery converter) transforms the DC supply voltage into direct current necessary to supply the inverter, and ensures galvanic isolation of the battery from the inverter's circuits at the same time (Fig. 63; Fig. 64 c, d; Fig. 65 c, d).

b.1. The diode is incorporated in series into the DC power supply circuit. The task of the diode is to provide DC power voltage to the inverter's circuits, and block penetration of the intermediate voltage of the inverter to DC supply voltage at the same time (Fig. 64 a, b; Fig. 65 a, b; Fig. 66).

b.2. The diode is incorporated in series into the AC power supply circuit. The task of the diode is to convert the AC power voltage to the DC voltage and feed it to the inverter's circuits, and preventing the intermediate voltage of the inverter from penetrating into the AC power supply at the same time (Fig. 66).

A system having a cut-off diode instead of the converter (Fig. 64 a, b; Fig. 65 a, b; Fig. 66) in the power circuit is characterised by a greater reliability due to the lack of processing in the AC and DC circuits.

Due to the fact that the inverter in the configuration presented in Fig. 64 – Fig. 66 is unable to autonomously obtain 230 V AC or 3×400 V AC rated voltage on its output, it always cooperates with a 50 Hz adapting transformer of appropriate voltage switch.

The galvanic isolation of the inverter and the basic AC power supply from DC voltage is ensured by a 50 Hz transformer (from the inverter's side) and a high-frequency transformer (at the side of the power supply unit, if it is used).

Fig. 67 presents a standard parallel operation solution for single-phase or three-phase inverters in a free design in an industrial cabinet.

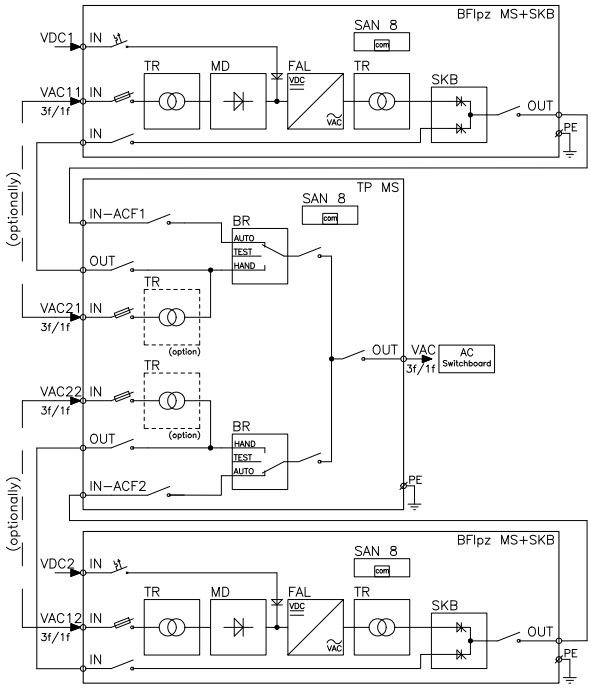
The BFIpz+SKB inverter cabinet is supplied by the basic AC network voltage, DC voltage, as well as the AC reserve network voltage (the automatic bypass supply voltage). The BFIp+SKB inverter module is supplied from the DC voltage and the reserve AC network voltage. By standard, the inverter cabinet is equipped with the SAN 8 inverter operating parameters control system.

Fig. 67 a, b) presents an inverter with a power supply unit consisting of a 12-impulse transformer and a 12-impulse diode rectifier. Application of the transformer ensures galvanic isolation of DC supply voltage from the AC network, and adapts the AC supply to the needs of the inverter, which depend on the value of the DC power supply. The 12-impulse transformer may also be used to improve the THD value of the current drawn from the mains. Application of a diode rectifier significantly increases reliability of the power supply and desensitises the inverter to any disturbances in the voltage or the frequency of the mains. Apart from the diode, there are no automatics or power electronics elements in the DC power supply circuit, which guarantees certain and continuous switch of the inverter to battery operation in the case of drop or break of the mains.

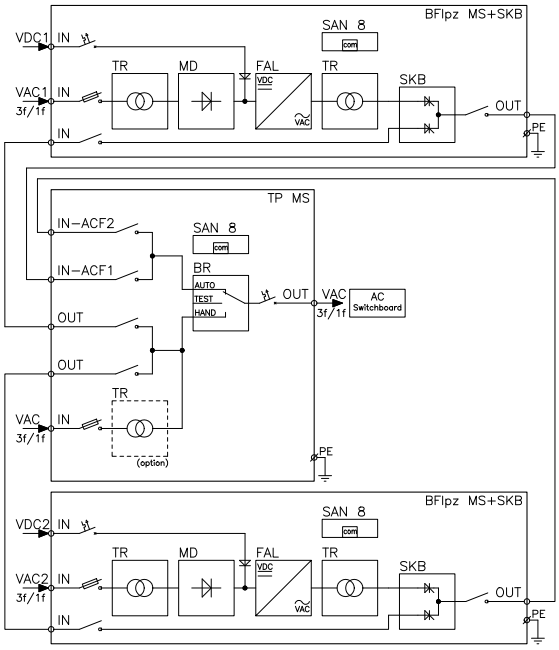
Fig. 68 presents a parallel operation solution of the inverters using an additional TP cabinet, which allows connecting inverters into the parallel operation mode. Such a solution allows easy servicing of the inverters (it is possible to completely disconnect the inverter from the TP cabinet), and facilitates the connection process (the instruments in the TP cabinet create a synoptic board that presents the design of connections between the elements of the system in a graphical manner). Usually, the TP cabinet also contains a maintenance (or an automatic and maintenance) bypass, and, optionally, a transformer in the bypass's circuit.

The inverter converts direct current into alternating current adapted via the transformer to the value accordant with the order (by standard, 230 V or 3×400 V AC).

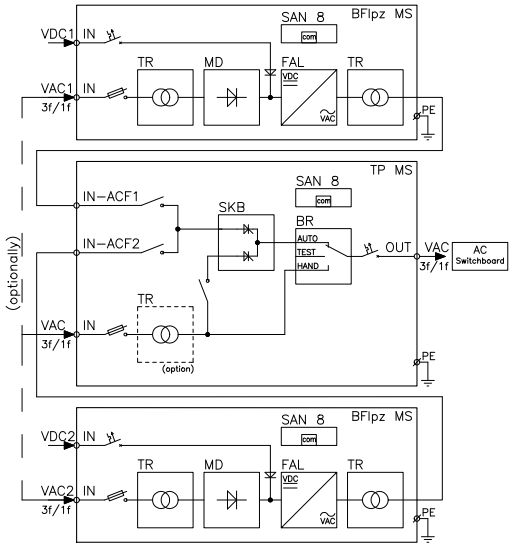
The industrial cabinet is cooled by a forced air circulation via redundant roof fans. Moreover, each module is cooled by fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, significantly increasing their lifetime.



a)



b)



c)

Fig. 68. Block diagram of the BFIpz type inverter cabinets in a free design for parallel operation with the SKB type bypass and the TP type distribution board. Possible configurations:

a) a parallel system of two BFIpz inverters with own SKB and maintenance bypasses – two AC reserve power supplies in the TP cabinet;

b) a parallel system of two BFIpz inverters with own SKB bypasses and a single common maintenance bypass – a single common AC reserve power supply in the TP cabinet;

c) a parallel system of two BFIpz inverters with a common SKB and maintenance bypass in the TP cabinet – a single common reserve AC power supply in the TP cabinet.

The TP type switchboard is a cabinet used to safely connect inverter cabinets and manoeuvre the instruments and links of the entire system.

It may contain an automatic and maintenance bypass, as well as additional option, such as a guaranteed voltage distribution boards and measuring panels. The series type of the TP cabinets is presented in the further part of the chapter.

ADDITIONAL OPTIONS

- Active power supply (sinusoidal current draw);
- Active filter in the AC power supply (improves THDi);
- Automatic bypass;
- 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 INVERTER CABINETS 1 ÷ 20kVA FOR PARALLEL OPERATION AS PER FIG. 63 – FIG. 65

Rated output voltage 230 or 3×400 V AC*

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Min. dimensions of the enclosure [W×D×H**], [mm]
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFIp 1S 24/230 MS+SKB 1***	600×800×2,000
		3×400 or 230	BFIpz 1S 24/230 MS+SKB 1***	
7.5 / 10	60	-	BFIp 7.5S 60 / 230 MS+SKB 7.5***	
		3×400 or 230	BFIpz 7.5S 60 / 230 MS+SKB 7.5***	
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10 / 12.5 / 15 / 20	110 / 220	-	BFIp 1S 110 / 230 MS+SKB 1***	
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10		3×400 or 230	BFIpz 1S 110 / 230 MS+SKB 1***	
12.5 / 15 / 20		3×400	BFIpz 12.5S 110 / 230 MS+SKB 12.5***	

* – possible options: 220 / 230 / 240 / 3×380 / 3×400 / 3×415 V AC;

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

*** – a cabinet without the SKB bypass is available as an option;

SERIES TYPE: 1-PHASE AND 3-PHASE INVERTER CABINETS 7.5 ÷ 240kVA FOR PARALLEL OPERATION AS PER FIG. 66

Rated output voltage 230 or 3×400 V AC*

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Min. dimensions of the enclosure [W×D×H**], [mm]
7.5 ÷ 20	110	3×400	BFIz 7.5T 110 / 400 MS+SKB 7.5***	600×800×2,000
30 ÷ 45			BFIz 30T 110 / 400 MS+SKB 30***	1,200×800×2,000
50 ÷ 65			BFI 50T 110 / 400 MS+SKB 50***	2,000×800×2,000
70 ÷ 90			BFIz 70T 110 / 400 MS+SKB 70***	3,000×800×2,000
95 ÷ 120			BFI 95T 110 / 400 MS+SKB 95***	3,600×800×2,000
10 ÷ 20	220		BFIz 10T 220 / 400 MS+SKB 10***	600×800×2,000
25 ÷ 45			BFIz 25T 220 / 400 MS+SKB 25***	800×800×2,000
50 ÷ 90			BFIz 50T 220 / 400 MS+SKB 50***	1,400×800×2,000
100 ÷ 135			BFIz 100T 220 / 400 MS+SKB 100***	2,000×800×2,000
150 ÷ 180			BFIz 150T 220 / 400 MS+SKB 150***	3,000×800×2,000
195 ÷ 240			BFI 195T 220 / 400 MS+SKB 195***	3,600×800×2,000

* – possible options: 220 / 230 / 240 / 3×380 / 3×400 / 3×415 V AC;

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

*** – a cabinet without the SKB bypass is available as an option;

SERIES TYPE: 1-PHASE AND 3-PHASE INVERTER CABINETS 1 ÷ 400kVA FOR PARALLEL OPERATION AS PER FIG. 67 AND 68

Rated output voltage 230 or 3×400 V AC*

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Min. dimensions of the enclosure [W×D×H**], [mm]
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFIp 1T 24/400 MS+SKB 1***	600×800×2,000
		3×400 or 230	BFIpz 1T 24/400 MS+SKB 1***	
7.5 / 10	60	-	BFIp 7.5T 60 / 400 MS+SKB 7.5***	
		3×400 or 230	BFIpz 7.5T 60 / 400 MS+SKB 7.5***	
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10 / 12.5 / 15 / 20 / 25 / 30 / 35 / 40	110 / 220	-	BFIp 1T 110 / 400 MS+SKB 1***	
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10		3×400 or 230	BFIpz 1T 110 / 400 MS+SKB 1***	
12.5 / 15 / 20		3×400	BFIpz 12.5T 110 / 400 MS+SKB 12.5***	
25 / 30 / 35 / 40			BFIpz 25T 110 / 400 MS+SKB 25***	800×800×2,000
50 / 60 / 75	110	-	BFIp 50T 110 / 400 MS+SKB 50***	1,200×800×2,000
		3×400	BFIpz 50T 110 / 400 MS+SKB 50***	1,400×800×2,000
50 / 60	220	-	BFIp 50T 220 / 400 MS+SKB 50***	600×800×2,000
50		3×400	BFIpz 50T 220 / 400 MS+SKB 50***	800×800×2,000
75		-	BFIp 75T 220 / 400 MS+SKB 75***	
60 / 75		3×400	BFIpz 60T 220 / 400 MS+SKB 60***	1,400×800×2,000
100 / 120 / 140 / 150		-	BFIp 100T 220 / 400 MS+SKB 100***	1,200×800×2,000
100 / 120		3×400	BFIpz 100T 220 / 400 MS+SKB 100***	1,600×800×2,000
160		-	BFIp 160T 220 / 400 MS+SKB 160***	1,400×800×2,000
140 / 150 / 160		3×400	BFIpz 140T 220 / 400 MS+SKB 140***	2,000×800×2,000
180 / 200		-	BFIp 180T 220 / 400 MS+SKB 180***	1,800×800×2,000
180 / 200 / 220 / 250		3×400	BFIpz 180T 220 / 400 MS+SKB 180***	3,000×800×2,000
220 / 250		-	BFIp 220T 220 / 400 MS+SKB 220***	2,000×800×2,000
300 / 350		-	BFIp 300T 220 / 400 MS+SKB 300***	3,000×800×2,000
300		3×400	BFIpz 300T 220 / 400 MS+SKB 300***	3,600×800×2,000
400		-	BFIp 400T 220 / 400 MS+SKB 400***	3,200×800×2,000

* – possible options: 220 / 230 / 240 / 3×380 / 3×400 / 3×415 V AC;

** – add the height of the pedestal to the height of the device: by standard, 100 mm; the dimension of the enclosure may be increased in the case of use of a transformer in the bypass circuit;

*** – a cabinet without the SKB bypass is available as an option;

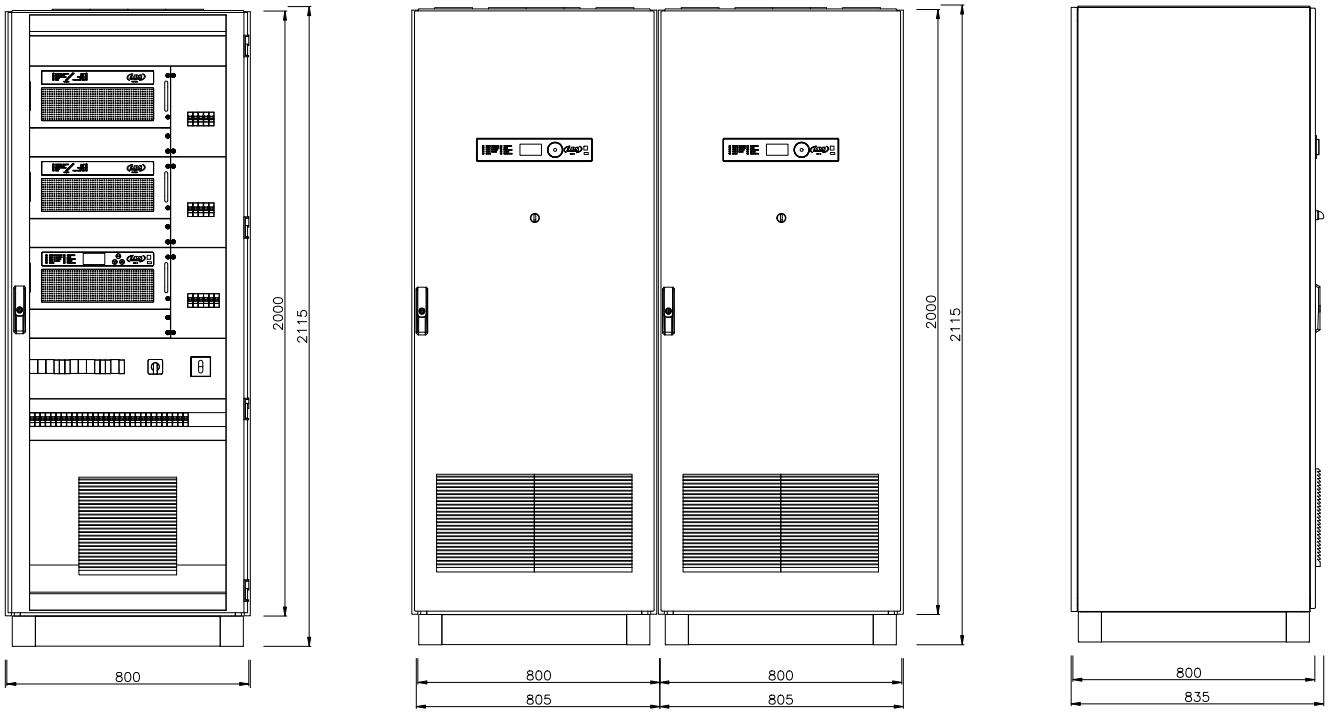
SERIES TYPE: 1-PHASE AND 3-PHASE TP CABINETS FOR COOPERATION WITH INVERTER CABINETS (INDUSTRIAL CABINETS – AS PER FIG. 68)

Rated output voltage 230 or 3×400 V AC*

Power, [kVA]	Optionally, a transformer in the bypass circuit	Example type	Min. dimensions of the enclosure [W×D×H**], [mm]
1 ÷ 25	Yes	TP 1	600×800×2,000
30 ÷ 50		TP 30	800×800×2,000
60 ÷ 100		TP 60	1,200×800×2,000
110 ÷ 250		TP 110	1,600×800×2,000
260 ÷ 400		TP 260	2,200×800×2,000

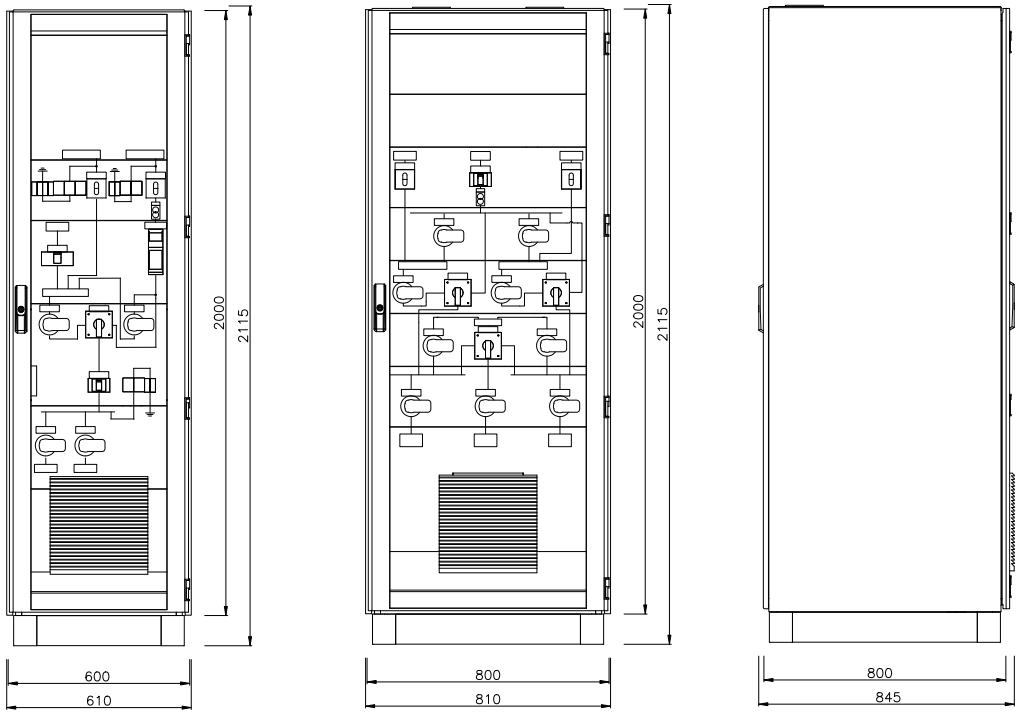
* – possible options: 220 / 230 / 240 / 3×380 / 3×400 / 3×415 V AC;

** – add the height of the pedestal to the height of the device: by standard, 100 mm; the dimension of the enclosure may be increased in the case of use of a transformer in the bypass circuit;



a) b) c)

Fig. 69. Views with dimensions of the BFIpz / BFIp type inverter cabinet:
a) 800×800×2,000 cabinet (modular design) – front view; b) (2×800)×800×2,000 cabinet (free design) – front view;
c) a cabinet of depth of 800 mm – left-side view.



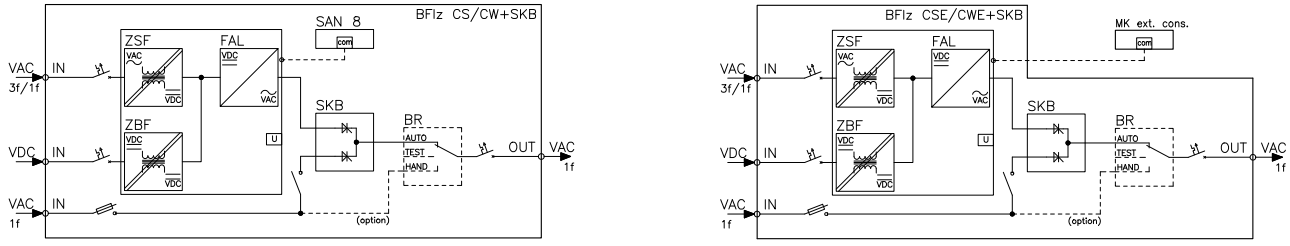
a) b) c)

Fig. 70. Views with dimensions of the TP type 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.

COMPACKT DESIGN INVERTERS

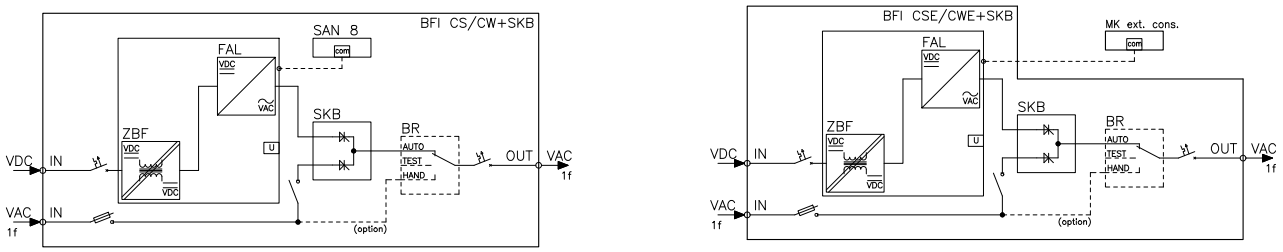
THE INVERTER COMPACT INTENDED FOR AUTONOMOUS OPERATION WITH GALVANIC ISOLATION AT THE AC AND DC SUPPLY VOLTAGE SIDE

This chapter presents single-phase type BFIz / BFI inverters 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 an inverter is to continuously supply loads with the AC guaranteed voltage.



a) b)

Fig. 71. Block diagram of the BFIz type inverter compact with a power supply unit and the SKB type bypass: a) with a built-in console; b) with an external MK console.



a) b)

Fig. 72. Block diagram of the BFI type inverter compact with the SKB bypass: a) with a built-in console; b) with an external MK console.

The BFIz+SKB inverter compact is supplied by the basic AC network voltage, the DC voltage, as well as the AC reserve network voltage (the automatic bypass supply voltage – this is a standard solution used to increase the reliability of the system). On the other hand, the BFI+SKB inverter compact is supplied from the DC voltage and a reserve AC network voltage. By standard, the inverter compact is equipped with a SAN 8 inverter operating parameters control system. Compacts with a built-in SAN 8 console are presented in Fig. 71 a) and Fig. 72 a), compacts with an external MK console are presented in Fig. 71 b) and Fig. 72 b).

The inverter's power supply (mains converter) converts the basic alternating current into direct current necessary to supply the inverter, and ensures galvanic isolation of the network from the inverter's circuits at the same time.

The battery power supply (battery converter) converts the DC supply voltage into direct current necessary to supply the inverter, and ensures galvanic isolation of the battery from the inverter's circuits at the same time.

The inverter converts direct current into alternating current of value according to the order. The galvanic isolation of the inverter's input voltage from AC and DC supply voltages of the inverter is ensured by high-frequency isolating transformers located in the mains converter or the battery converter of the inverter.

The BFIz / BFI compacts may be equipped with the SKB automatic bypass system and a maintenance bypass uninterrupted switch.

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

- Active filter (sinusoidal power draw);
- Automatic bypass;
- Maintenance bypass;
- Isolating input transformer;
- Special designs;
- Protection of circuits at the input and the output (standard);
- Built-in output circuits distribution board;
- 1-phase power supply.

SERIES TYPE: 1-PHASE INVERTER COMPACTS 1 ÷ 10kVA FOR AUTONOMOUS OPERATION

Rated output voltage 230 V AC*

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions**
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1S 24/230 CS***+SKB 1****	CW1
		3×400 or 230	BFIz 1S 24/230 CS***+SKB 1****	
7.5	60	-	BFI 7.5S 60 / 230 CS***+SKB 7.5****	
1 / 2 / 2.5	110 / 220	-	BFI 1S 110 / 230 CS***+SKB 1****	CS6 / CW6
		3×400 or 230	BFIz 1S 110 / 230 CS***+SKB 1****	
3 / 3.5 / 5	110	-	BFI 3S 110 / 230 CS***+SKB 3****	CW1
		3×400	BFIz 3S 110 / 230 CS***+SKB 3****	
7.5 / 10		-	BFI 7.5S 110 / 230 CS***+SKB 7.5****	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1S 220 / 230 CS***+SKB 1****	CS6 / CW6
		3×400 or 230	BFIz 1S 220 / 230 CS***+SKB 1****	
7.5 / 10		-	BFI 7.5S 220 / 230 CS***+SKB 7.5****	CW1
		3×400	BFIz 7.5S 220 / 230 CS***+SKB 7.5****	

* – possible options: 220 / 230 /240 V AC;

** – CS6: 500×(2×700)×250; CW1: 800×1,000×300; CW6: 500×700×250. (W×H×D);

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

*** – a compact without the SKB bypass is available as an option.

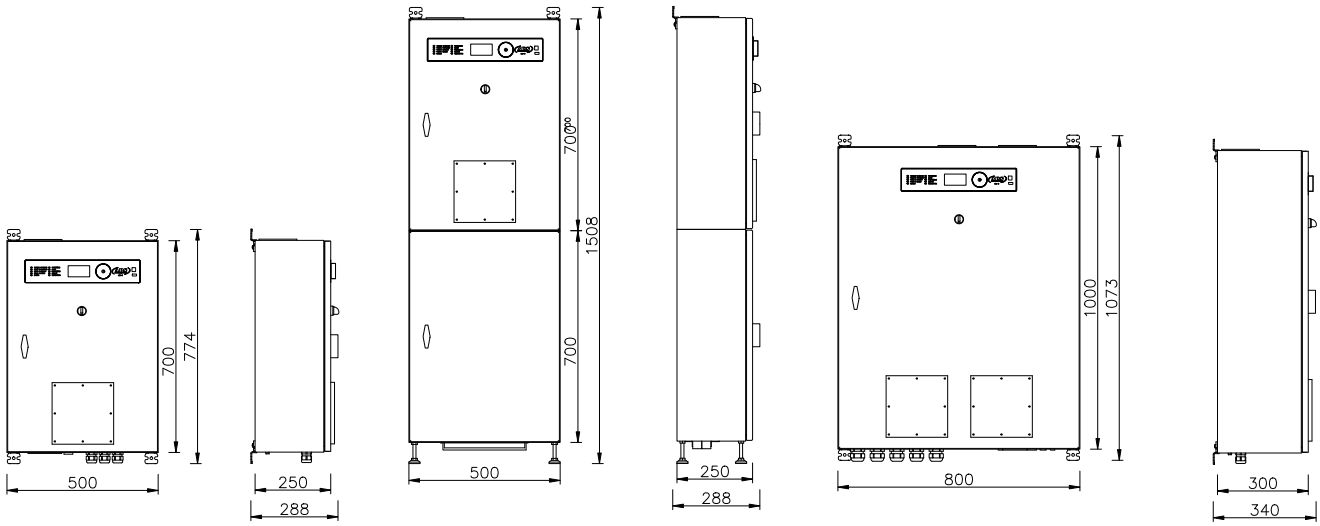


Fig. 73. Views with dimensions of the BFIz / BFI type inverter compact:
a) CW6 compact – front view; b) CW6 compact – left-side view; c) CS6 compact – front view;
d) CS6 compact – left-side view; e) CW1 compact – front view; f) CW1 compact – left-side view.

THE INVERTER COMPACT INTENDED FOR PARALLEL OPERATION WITH GALVANIC ISOLATION AT THE AC AND DC SUPPLY VOLTAGE SIDE

This chapter presents single-phase type BFIpz / BFIp inverters 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 an inverter is to continuously supply loads with the AC guaranteed voltage.

The BFIpz / BFIp inverter compact is intended for parallel operation with an inverter of the same type. This allows increasing the output power of the system or obtaining redundancy for the components of "1+1" system.

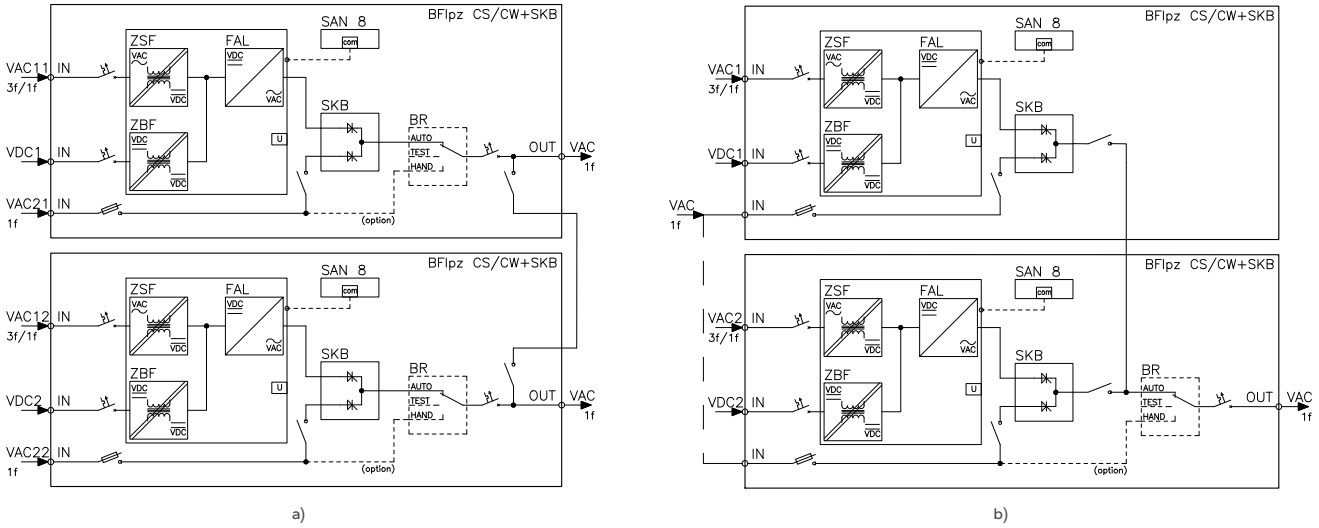


Fig. 74. Block diagram of the BFIpz inverter compact for parallel operation with a power supply unit and the SKB type bypass. Possible configurations: a) two autonomous maintenance bypass switches, a built-in console; b) a common maintenance bypass switch, a built-in console.

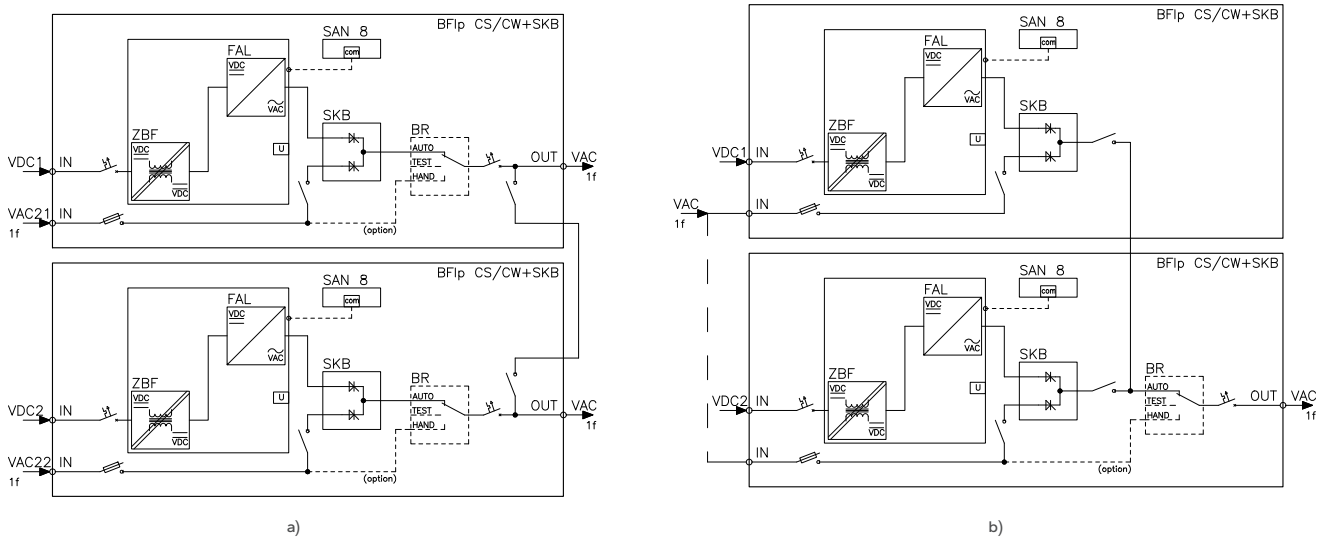


Fig. 75. Block diagram of the BFIp type inverter compact for parallel operation with the SKB type bypass. Possible configurations: a) two autonomous maintenance bypass switches, a built-in console; b) a common maintenance bypass switch, a built-in console.

The BFIpz inverter compact is supplied by the basic AC network voltage, the DC voltage, as well as the AC reserve network voltage (the automatic bypass supply voltage – this is a standard solution used to increase the reliability of the system). On the other hand, the BFIp inverter compact is supplied from the DC voltage and a reserve AC network voltage. By standard, the compact is equipped with the SAN 8 inverter operating parameters control system.

The inverter's power supply (mains converter) converts the basic alternating current into direct current necessary to supply the inverter, and ensures galvanic isolation of the network from the inverter's circuits at the same time.

The battery power supply (battery converter) converts the DC supply voltage into direct current necessary to supply the inverter, and ensures galvanic isolation of the battery from the inverter's circuits at the same time.

The inverter converts direct current into alternating current of value according to the order. The galvanic isolation of the inverter's input voltage from AC and DC supply voltages of the inverter is ensured by high-frequency isolating transformers located in the mains converter or the battery converter of the inverter.

The BFIpz / BFIp compacts may be equipped with the SKB automatic bypass system and a maintenance bypass uninterrupted switch.

Inverters and automatic bypasses in this configuration operate as MASTER / SLAVE, and do not require additional synchronising systems.

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

- Active filter (sinusoidal power draw);
- Automatic bypass;
- Maintenance bypass;
- Isolating input transformer;
- Special designs;
- Protection of circuits at the input and the output (standard);
- Built-in output circuits distribution board;
- 1-phase power supply.

SERIES TYPE: 1-PHASE INVERTER COMPACTS 1 ÷ 10kVA FOR PARALLEL OPERATION

Rated output voltage: 230 V AC*

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions**
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFIp 1S 24/230 CS***+SKB 1****	CW1
		3×400 or 230	BFIpz 1S 24/230 CS***+SKB 1****	
7.5	60	-	BFIp 7.5S 60 / 230 CS***+SKB 7.5****	
1 / 2 / 2.5	110 / 220	-	BFIp 1S 110 / 230 CS***+SKB 1****	CS6 / CW6
		3×400 or 230	BFIpz 1S 110 / 230 CS***+SKB 1****	
3 / 3.5 / 5	110	-	BFIp 3S 110 / 230 CS***+SKB 3****	CW1
		3×400	BFIpz 3S 110 / 230 CS***+SKB 3****	
7.5 / 10		-	BFIp 7.5S 110 / 230 CS***+SKB 7.5****	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFIp 1S 220 / 230 CS***+SKB 1****	CS6 / CW6
		3×400 or 230	BFIpz 1S 220 / 230 CS***+SKB 1****	
7.5 / 10		-	BFIp 7.5S 220 / 230 CS***+SKB 7.5****	CW1
		3×400	BFIpz 7.5S 220 / 230 CS***+SKB 7.5****	

* – possible options: 220 / 230 /240 V AC;

** – CS6: 500×(2×700)×250; CW1: 800×1,000×300; CW6: 500×700×250. (W×H×D);

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

*** – a compact without the SKB bypass is available as an option.

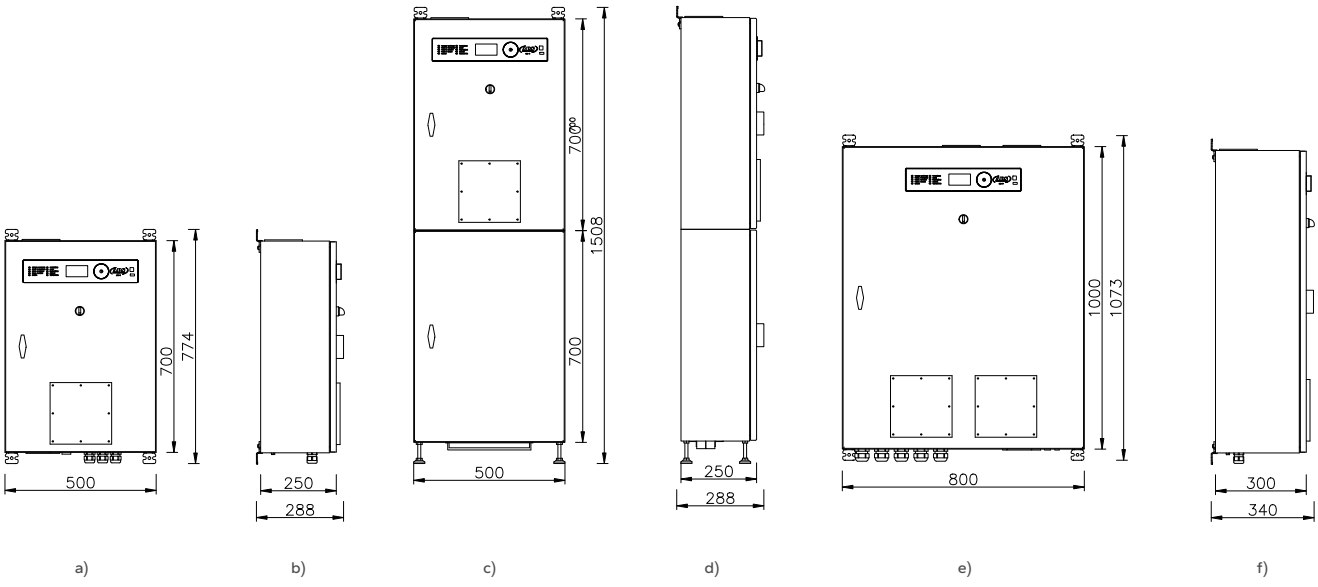


Fig. 76. Views with dimensions of the BFIpz / BFIp type inverter compact:
a) CW6 compact – front view; b) CW6 compact – left-side view; c) CS6 compact – front view;
d) CS6 compact – left-side view; e) CW1 compact – front view; f) CW1 compact – left-side view.

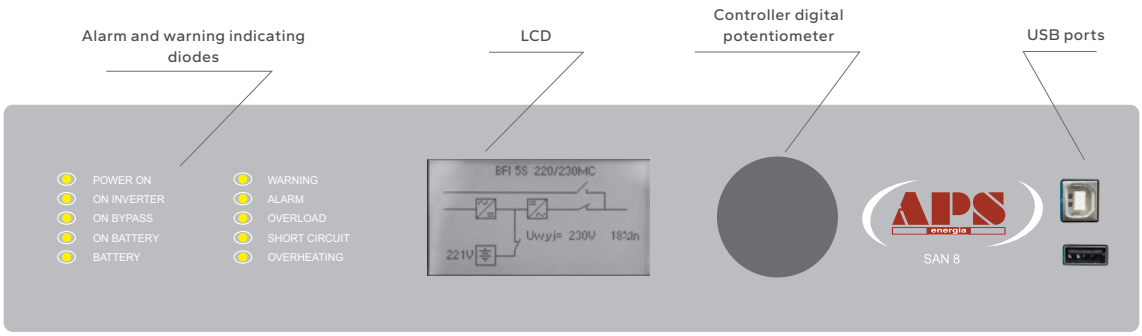
SAN 8 EXTERNAL COMMUNICATION – ALTERNATING CURRENT SYSTEMS

The inverters and converters are equipped with an extensive communication system with the user and master systems – HMI (Human Machine Interface).

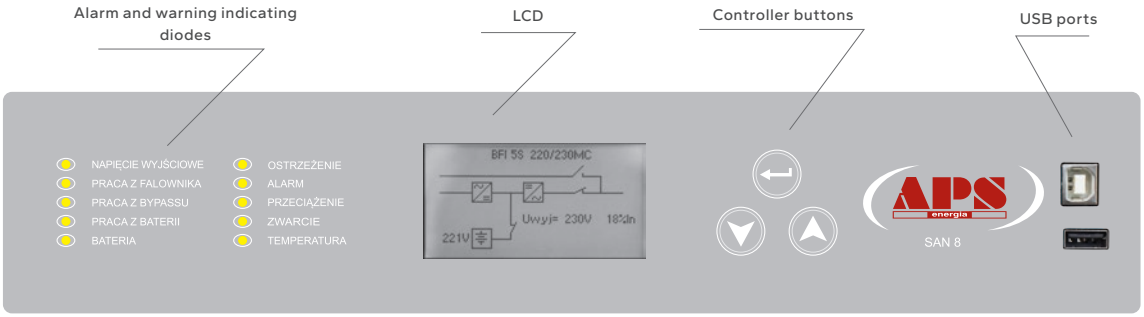
THE COMMUNICATION SYSTEM CONSISTS OF:

1. A local user panel consists of indicator diodes, an LCD screen for displaying messages and reading parameters, as well as a digital potentiometer and cursors used to navigate the console menu.
2. A set of potential-free relay contacts for I/O binary signals.
3. External communication links. Data transmission is possible via RS485, USB (archive buffers readout), and Ethernet ports.

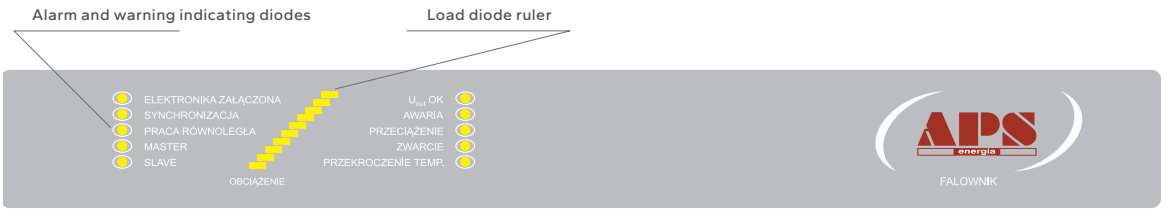
LOCAL USER PANEL



View of the console with a digital potentiometer



View of a console with navigation cursors



View of the console without a display, for modules in multi-module systems and with a separate controller

SAN 8 MEASURED PARAMETERS:

Output current, phase L1	Power factor
Output current, phase L2	Output current, phase L1 percentage
Output current, phase L3	Output current, phase L2 percentage
L1 phases output voltage	Output current, phase L3 percentage
L2 phases output voltage	Battery's voltage (UPS)
L3 phases output voltage	Battery current (UPS)
L1 phases input voltage	Battery operation autonomy time (UPS)
L2 phases input voltage	Battery's charge (UPS)
L3 phases input voltage	Charge percentage value (UPS)
Ambient temperature	Apparent power
Active power	

SIGNALLED SAN 8 ALARMS INCLUDING DESCRIPTION ON THE LCD SCREEN:

Collective alarm	Power supply failure
Warning	Battery converter failure
Internal error	Rectifier failure
Inverter short circuit	Low battery voltage
Overload	No battery charging
Inverter supplied operation	Battery discontinuity
Bypass supplied operation	maintenance bypass on
Battery supplied operation	Output voltage drop
Basic power supply failure	No synchronization
Inverter failure	Ambient temperature out of tolerance
Bypass failure	Inverter temperature
Battery failure	No reserve network power supply

INTEGRATED RS485, USB, ETHERNET COMMUNICATION INTERFACES

RS485 LINK

RS485 is a wired interface used in industrial networks. The basic advantage of data transmission via RS485 bus bar is resistance to external distortions (e.g., caused by inductive devices, such as electric motors). The RS485 standard allows to connect many transmitters and loads (up to 32). The range of this standard is approx. 1,200 m.

The RS485 link of the device features APS6000, Modbus RTU, IEC 60870-5-103 transmission protocols. They allow reading a complete set of data from the device.

By use of an external converter, it is possible to transmit data in the Profibus DP protocol.

USB LINK

In the APS Energia SA devices, the USB link is used to copy archive logs saved during operation.

The USB port (A) is used to connect mass memory (USB flash drive).

The USB port (B) operating in the mass memory mode; after connecting it to a PC, it is shown as an additional drive.

ETHERNET LINK

Ethernet (IEEE 802.3) is the most commonly used technology in local networks (LAN). This interface allows connecting the device to a local computer network in the facility, and thus easily read data even from several stations at the same time.

The Ethernet interface may be designed in to ways:

1. A link incorporated into a controller with an implemented Modbus TCP, SNMP protocol;
2. An additional converter may provide transmission in one of the following protocols:
   - IEC 61850 (APS SAN KP1 converter)
   - SNMP (AGENT- APS2 converter)
   - Modbus TCP (external converter)

Storage of events and states of the operation of the device and an SD memory card.

An internal memory card stores data saved in the events buffer and the archive buffer. Lack of a card makes saving logs impossible and is indicated on the display by "SD" symbol.

BFI AND BFIz INVERTERS: INPUT BINARY SIGNALS – CONTROL:

Fire-fighting switch (EPO)
START/STOP inverter switch
Reserve
ATSE

The USB type port (A)

The USB type port (B) sends archive data directly to a PC

BFI AND BFIz INVERTERS: OUTPUT BINARY SIGNALS:

8 STANDARD SIGNALS:	8 ADDITIONAL SIGNALS (SELECTABLE):
1. Alarm	1. Basic power supply failure
2. Warning	2. Inverter failure
3. Inverter supplied operation	3. No bypass power supply
4. Bypass supplied operation	4. Battery failure
5. Overload	5. Power supply failure
6. Battery supplied operation	6. Battery converter failure
7. Low battery voltage	7. No battery charging
8. maintenance bypass on.	8. Rectifier failure
	9. Battery discontinuity
	10. Drain deactivation
	11. Output voltage drop
	12. No sync
	13. ATSE power supply
	14. Ambient temperature out of tolerance
	15. Inverter overheating
	16. tripping of the fire-fighting switch