UNINTERRUPTIBLE POWER SUPPLY SYSTEMS

ON THE ENERGY MARKET FOR 30 YEARS

INVERTER MODULES CATALOGUE

MODULAR DESIGN INVERTERS

An inverter is a basic element of guaranteed power supply systems. An inverter converts direct current (DC) into alternating current (AC). The purpose of the guaranteed power supply systems in the industry is supplying critical loads which require uninterruptible 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 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 catalogue presents the BFI type inverters in a form of 19" modules. The are adapted to be installed in the industrial cabinets.

The inverters feature two independent power supply inputs:

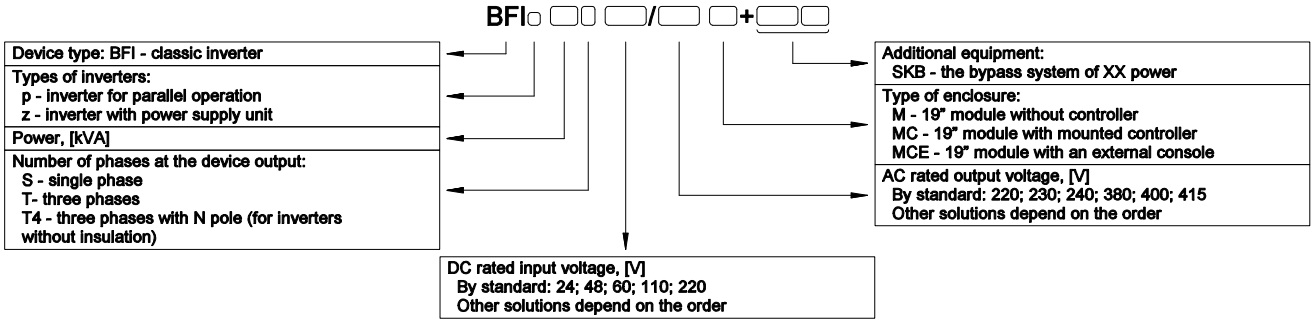
1) primary (mains) – the AC input [single- or three-phase], and

2) reserve – DC input. The 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 uniterruptile power supply field.

BFIz inverters are used mainly in UPSs and central or local guaranteed power supply systems.

DESIGNATION METHOD OF THE BFI TYPE INVERTERS



THE BFI TYPE INVERTER CHARACTERISTICS

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

Main characteristics:

- 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 inductive or capacitive loads);
- high short-circuit current factor ranges 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;

View of the inverter module

- data transmission protocol selection: Modbus RTU, IEC 60870-5-103;
- short-circuit protection;
- parallel operation with current equality; possible parallel operation of inverters to increase power or reliability (n+1 type redundancy);
- SAN 8 microprocessor monitoring of the entire system.

THE BFI TYPE INVERTERS – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS

PARAMETER		VALUE
INVERTER'S AC POWER SUPPLY (mains)*		
Input voltage:	single-phase	220 / 230 / 240 V
	three-phase	380 / 400 / 415 V
Input voltage tolerance		+10 % to -15 %
Input voltage frequency		50/60 Hz
Input voltage frequency tolerance		±10 %
INVERTER'S DC POWER SUPPLY		
Input voltage		24 / 48 / 60 / 110 / 220 V
Input voltage tolerance		±20 %*
BYPASS POWER SUPPLY (backup mains)**		
Input voltage:	single-phase	220 / 230 / 240 V
	three-phase	380 / 400 / 415 V
Input voltage tolerance		±15 %
Input voltage frequency		50/60 Hz
Input voltage frequency tolerance		±10 %
INVERTER'S AC OUTPUT		
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
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."

GENERAL INFORMATION

Fig. 1 presents the most common solution: the BFIz type inverter works with the Static Switch system. This cooperation may take place in the "on-line" or "offline" mode. In the online operation mode, the primary 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 backup mains. In the offline operation mode, the primary power supply of the Static Switch system is the AC backup mains power supply, while the reserve power supply function is provided by the inverter output voltage. The BFIz inverter systems, both with (Fig. 1) and without (Fig. 2) a bypass system, may operate in a parallel configuration to increase 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.

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

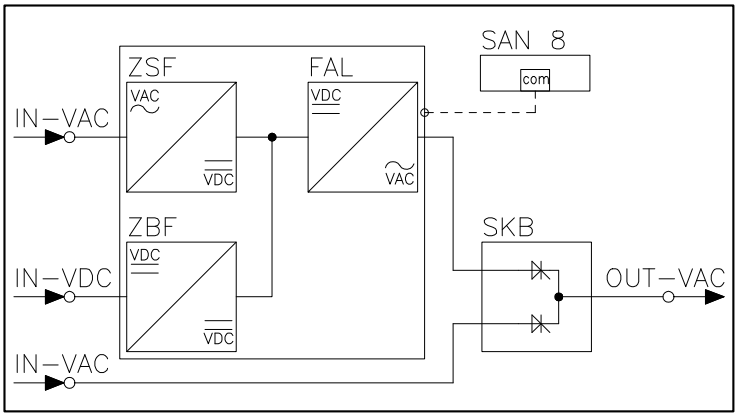


Fig. 1. General block diagram of the BFIz type inverter system with the power supply unit and the SKB type bypass

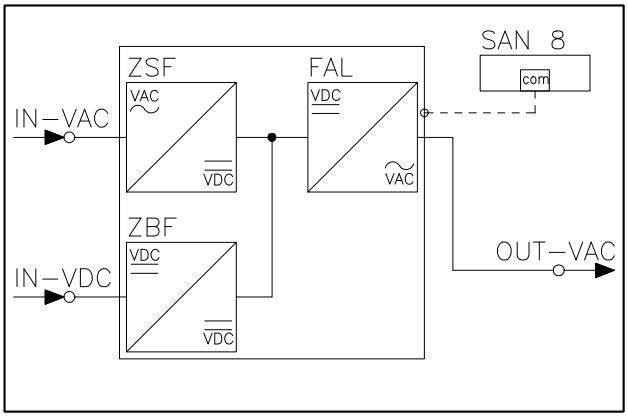


Fig. 2. General block diagram of the BFIz type inverter system with the power supply unit

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-ACS – AC supply from the grid

com – communication

MD – diode bridge

OUT – output

SAN 8 – console

SKB – automatic bypass

TR – 50 Hz transformer

U – voltage measurement

VAC – AC voltage

VDC – DC voltage

ZBF – inverter's power supply from DC voltage

ZSF – inverter's power supply from AC voltage

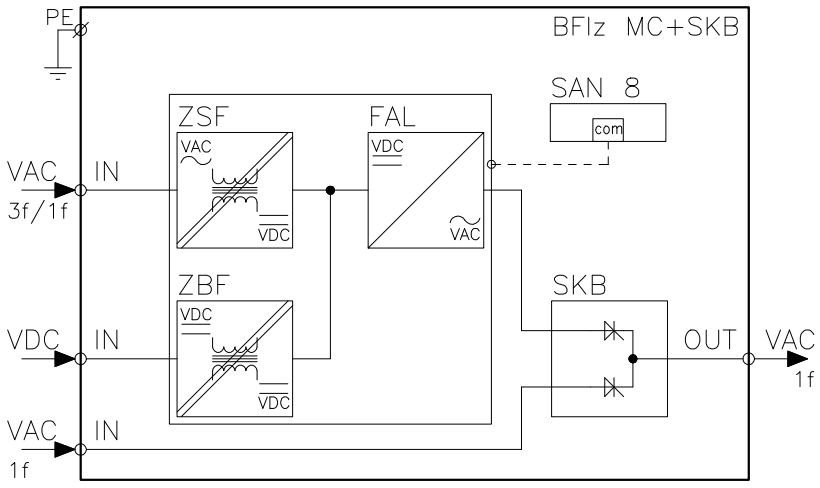
AVAILABLE INVERTER OPTIONS

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: 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.
Automatic bypass	The microprocessor bypass system (the internal system of connections with the SKB type static connector) ensuring uninterruptible (<5 ms), automatic switching of loads to supply from a backup mains 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.
Parallel operation	Two or more inverters may operate on a single guaranteed AC voltage bus. The control algorithm of the inverters ensures output voltages synchonisation of particular inverters and even power distribution.

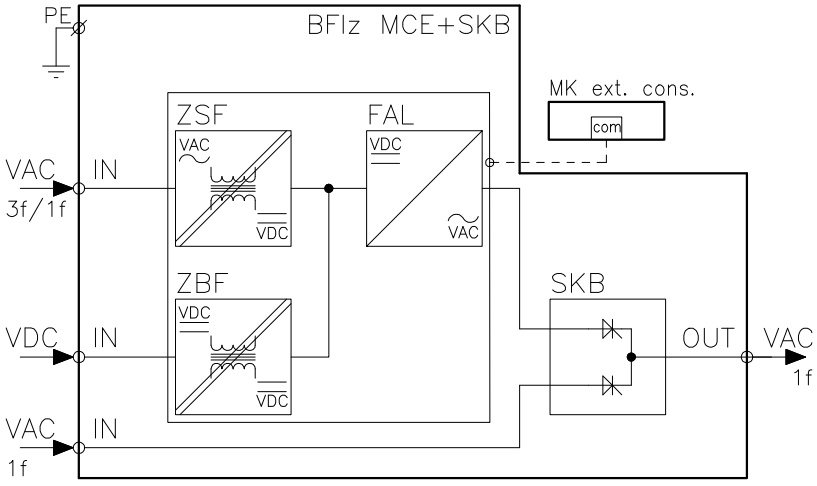
TECHNICAL SOLUTIONS AND SERIES TYPES

THE INVERTER MODULE DESIGNED FOR AUTONOMOUS OPERATION WITH GALVANIC ISOLATION AT THE AC AND DC SUPPLY VOLTAGE

Autonomous operation of the system is based on a configuration with a single inverter or with one inverter and one bypass.



a)



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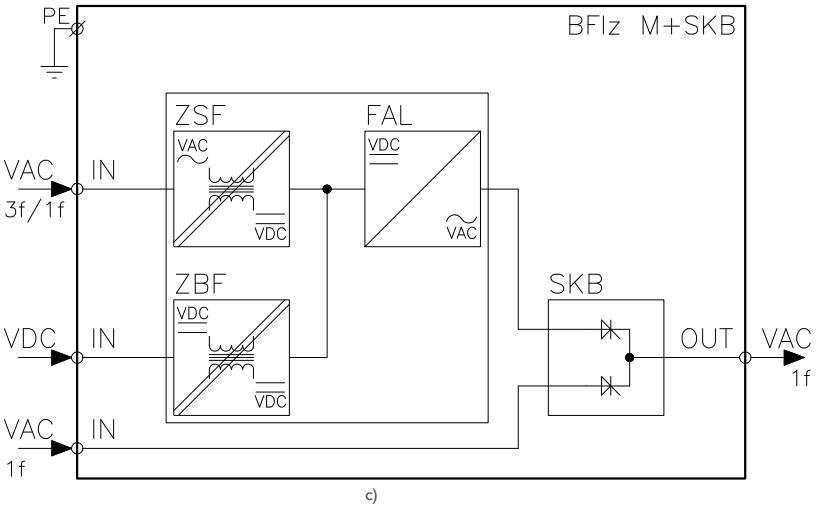
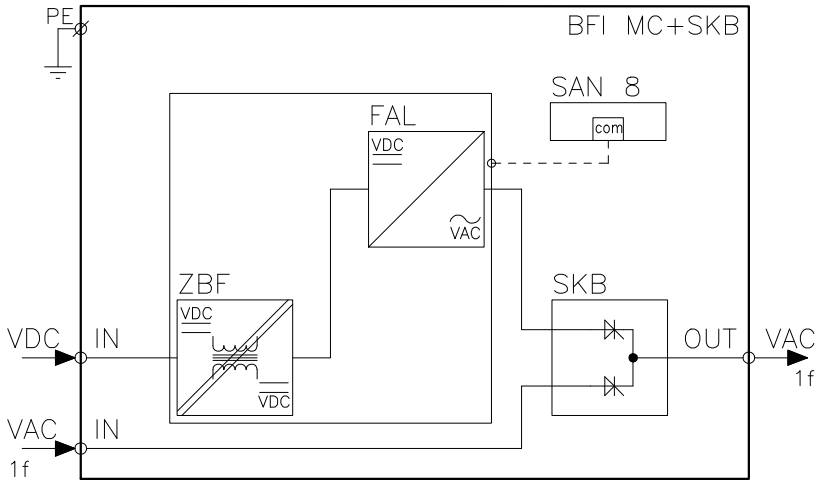
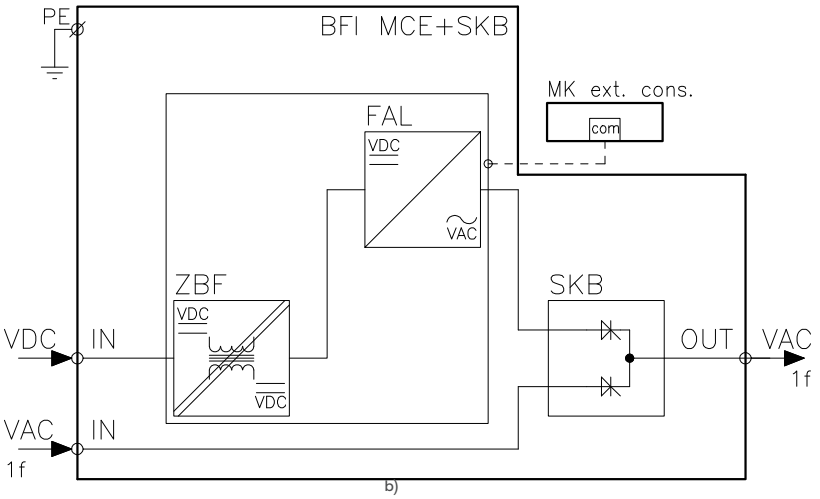


c)

Fig. 3. 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)



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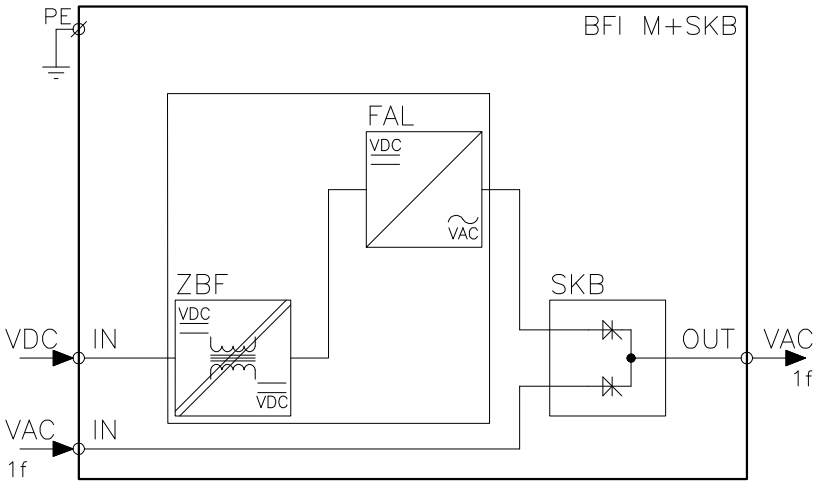


c)

Fig. 4. Block diagram of the BFI type inverter module with the SKB type bypass:
a) with a built-in console; b) with an external MK console; c) without a console.

By standard, the BFIz / BFI type inverter module is equipped with a SAN 8 inverter operating parameters control system. The modules with a built-in SAN 8 console belong to the MC modules family (Fig. 3 a, Fig. 4 a), the modules with an external MK console belong to the MCE modules family (Fig. 3 b, Fig. 4 b), and the modules without the SAN 8 console are a part of the M modules family (Fig. 3 c, Fig. 4 c).
The inverter's power supply unit (Fig. 3) converts the mains AC voltage into DC voltage necessary to supply the inverter, and ensures galvanic isolation of the grid from the inverter's circuits at the same time.
The battery power supply unit (Fig. 3, Fig. 4) converts the DC supply voltage into DC voltage necessary to supply the inverter, and ensures galvanic isolation of the battery from the inverter's circuits at the same time.
The inverter converts DC voltage into AC voltage of the value according to 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 in the battery converter of the inverter.
The BFIz / BFI modules may be equipped with the SKB automatic bypass system.
Each module cooled by multiple fans. Fans RPM's can be easily adjusted by the device's internal temperature, that significantly increases their lifetime.

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

Rated output voltage 230 V AC*

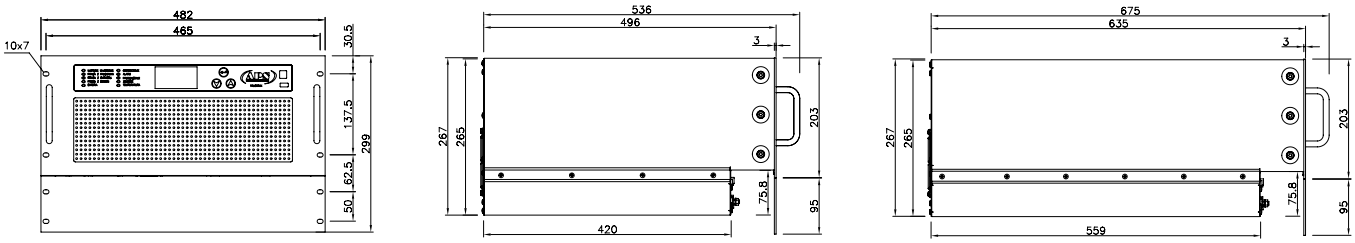
Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions****
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1S 24/230 MC**+SKB 1***	M5
		3×400 or 230	BFIz 1S 24/230 MC**+SKB 1***	
7.5	60	-	BFI 7.5S 60/230 MC**+SKB 7.5***	
1 / 2 / 2.5	110 / 220	-	BFI 1S 110/230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

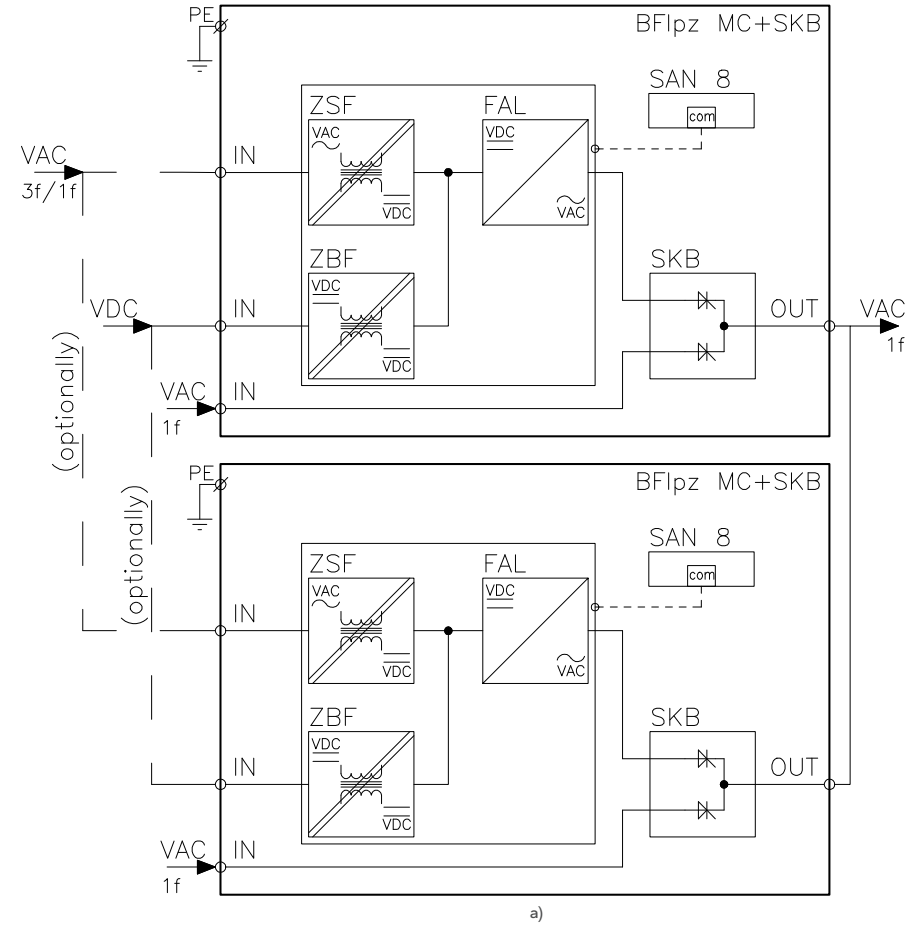


a) b) c)

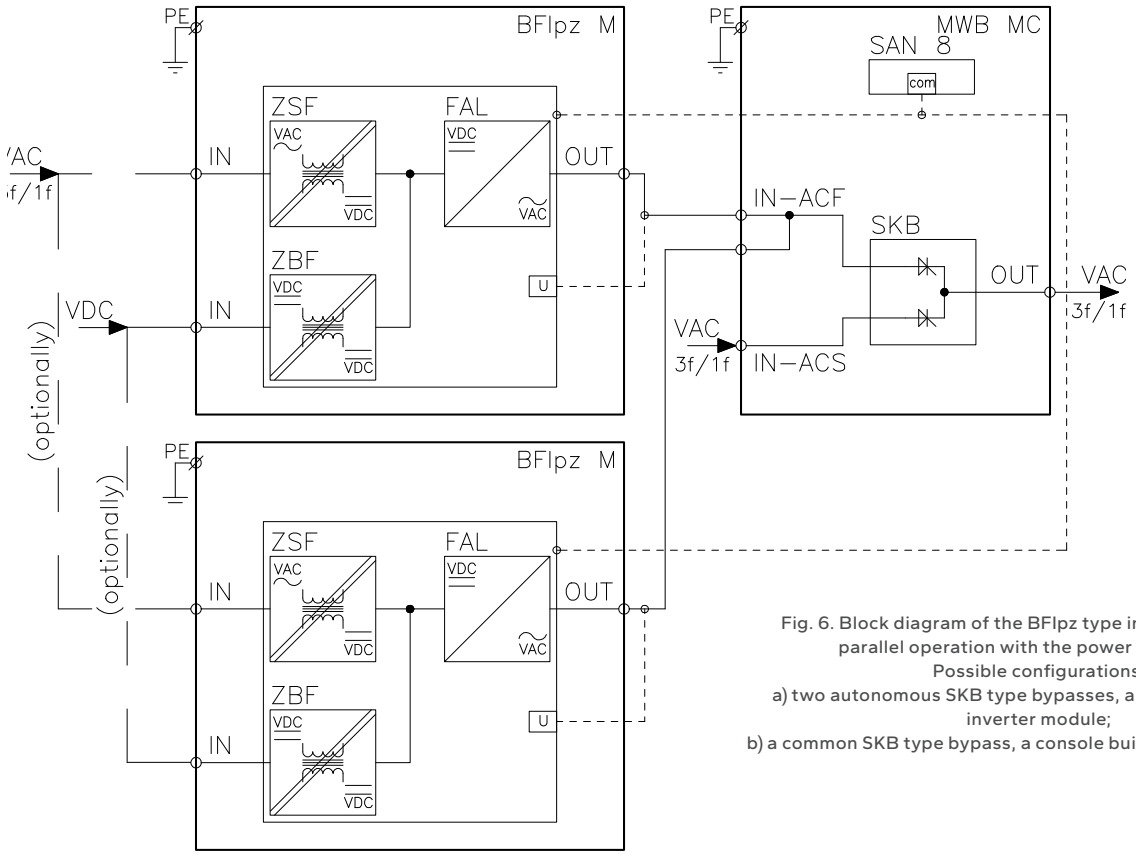
Fig. 5. Views with dimensions of the BFIz / BFI inverter module (option):
a) front view in the M3 and M5 enclosure; b) left-side view in the M3 enclosure; c) left-side view in the M5 enclosure.

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

The parallel operation mode of the inverters is an extension of the inverter's autonomous operation mode (see chapter "The inverter module designed for autonomous operation with galvanic isolation at the AC and DC supply voltage side").
The BFIp / BFIpz inverter module is intended for parallel operation with an inverter of the same type. This allows for output power increase or for obtaining redundancy for the components of "1+1" system.



a)



b)

Fig. 6. Block diagram of the BFIpz type inverter module for parallel operation with the 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.

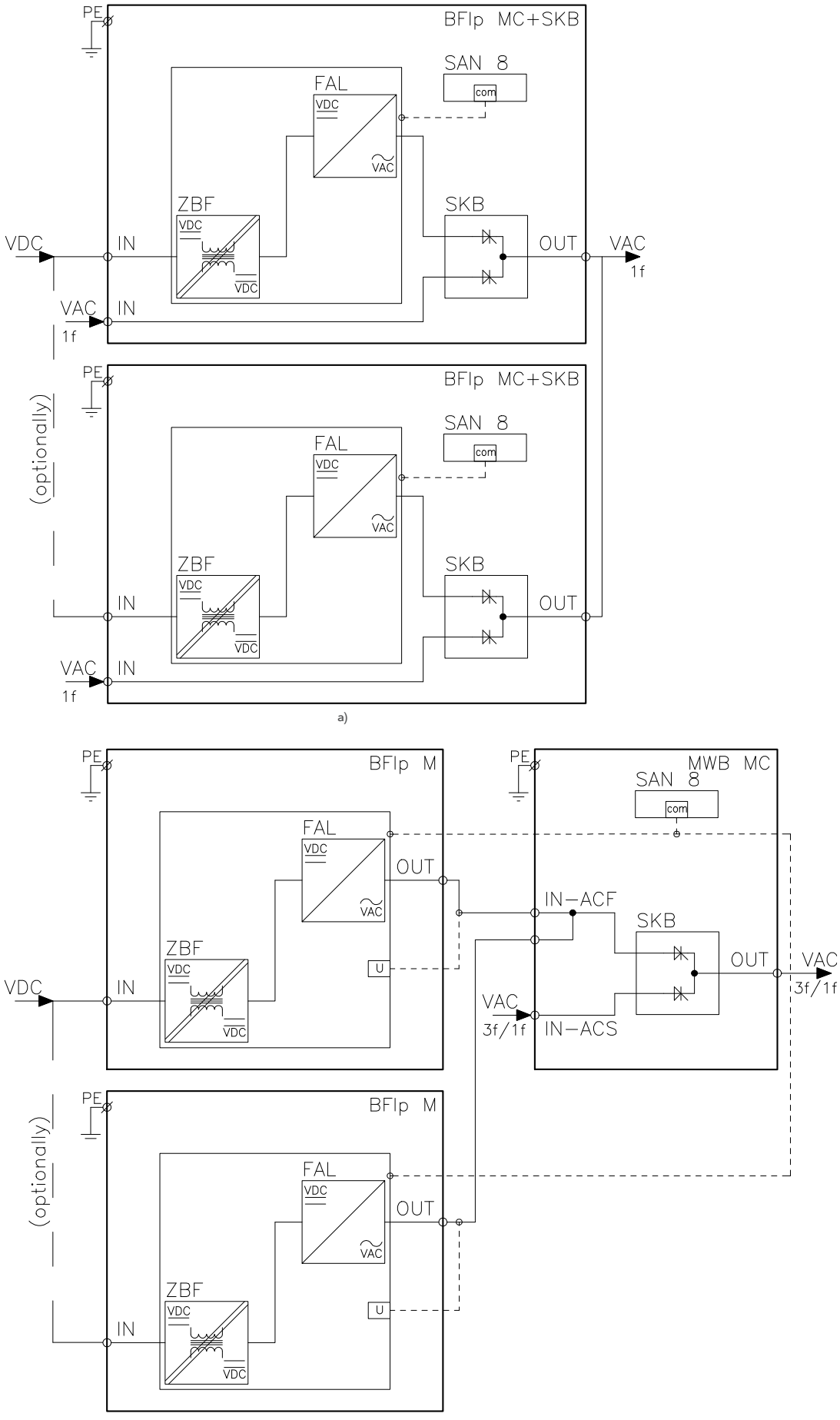


Fig. 7. Block diagram of the BFIp type inverter module for parallel operation. Possible configurations:
a) two autonomous SKB type bypasses, a console built in the inverter module; b) a common SKB type bypass, a console built in the MWB module.

Systems consisting of two inverter modules operating in parallel are available in the following configurations:
1. Two modules – Fig. 6 a), Fig. 7 a):
   a. Module 1 – inverter + automatic bypass: BFIpz / BFIp xxx MC + SKB
   b. Module 2 – inverter + automatic bypass: BFIpz / BFIp xxx MC + SKB

2. Three modules – Fig. 6 b), Fig. 7 b):
   a. Module 1 – inverter 1: BFIpz / BFIp xxx M
   b. Module 2 – inverter 2: BFIpz / BFIp xxx M
   c. 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 mains AC voltage, DC voltage, as well as the backup mains AC voltage (the automatic bypass supply voltage – this is a standard solution used to increase the reliability of the system) (Fig. 6 a). Moreover, the BFIp+SKB inverter module is supplied from DC voltage and a backup mains AC voltage (Fig. 7 a).
In configuration 2 – the BFIpz inverter module is supplied by voltage of the mains AC voltage and DC voltage – Fig. 6 b), while the BFIp inverter module is supplied from DC voltage (Fig. 7 b). The MWB module is supplied by voltage of the AC backup mains (the automatic bypass's supply voltage – this is a standard solution used to increase the system's reliability), as well as inverters output voltages (Fig. 6 b, Fig. 7 b).

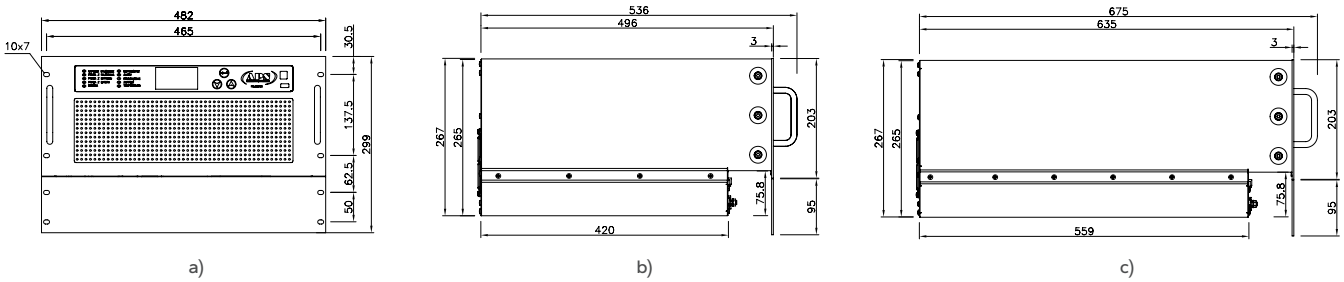
By standard, the MWB module is equipped with the SAN 8 inverter operating parameters control system. Modules with a built-in SAN 8 console belong to the MC modules family.
The inverter's power supply unit converts the basic AC voltage into DC voltage necessary to supply the inverter, and ensures galvanic isolation of the power grid from the inverter's circuits at the same time.
The battery power supply unit converts the DC supply voltage into necessary DC voltage to supply the inverter, and ensures galvanic isolation of the battery from the inverter's circuits at the same time.
The inverter converts DC voltage into AC voltage 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 in the inverter's battery converter.
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 multiple fans. Each module cooled by multiple fans. Fans RPM's can be easily adjusted by the device's internal temperature, that significantly increases their lifetime.
Note: the MWB module including a bypass system is described in chapter "MWB module."

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. 8. 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

Autonomous operation of the system is based on a configuration with a single inverter or with one inverter and one bypass.
The BFIz / BFI inverter module cooperates with the MWB module and 50 Hz 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 (optional).

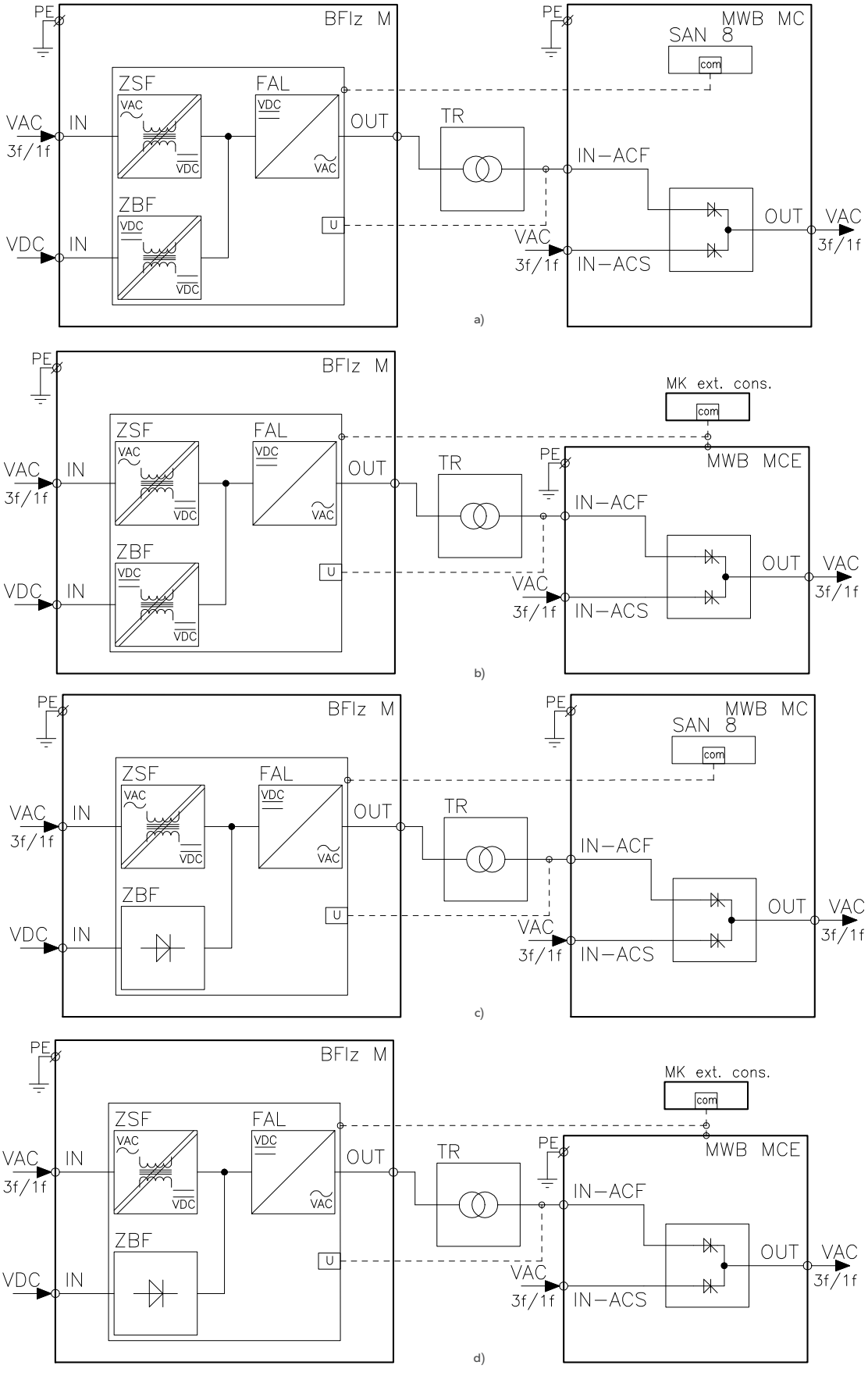


Fig. 9. Block diagram of the BFIz type inverter module with a power supply unit and the MWB module. Possible configurations:
a) power supply unit, battery converter, built-in console; b) power supply unit, battery converter, external MK console;
c) power supply unit, diode in the DC power supply circuit, built-in console; d) power supply unit, diode in the DC power supply circuit, external MK console.

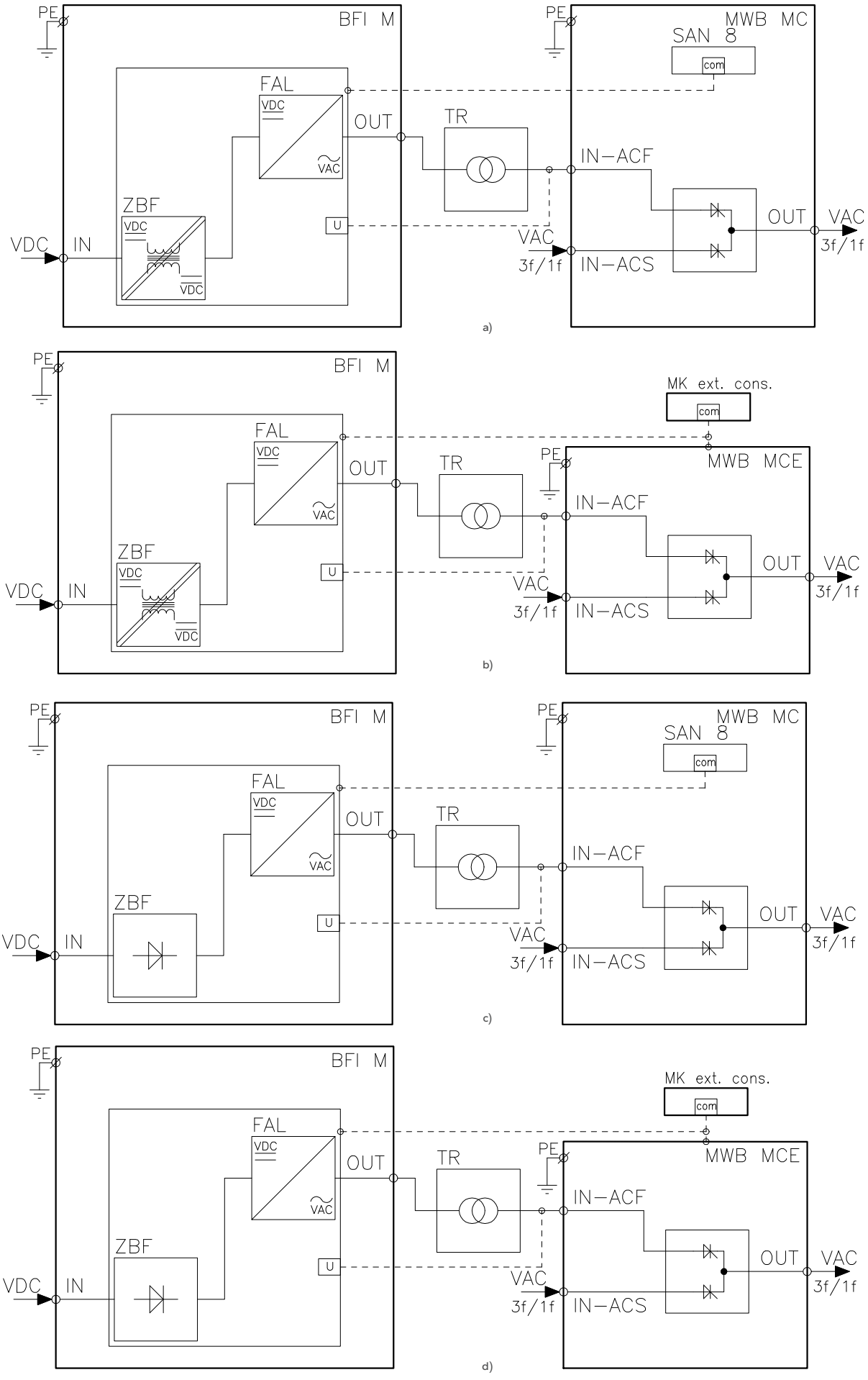


Fig. 10. Block diagram of the BFI type inverter module with the MWB module. Possible configurations:
a) battery converter, built-in console; b) battery converter, external MK console;
c) diode in the DC power supply circuit, built-in console; d) diode in the DC power supply circuit, external MK console.

The BFIz inverter module is powered by the mains AC voltage and DC battery voltage (Fig. 9), while the BFI inverter module is supplied only by DC voltage (Fig. 10). The MWB module is supplied by voltage of the AC backup mains, as well as the inverter's output voltage adapted to the client's requirements by the transformer. This transformer provides isolation from supply voltage, and is an ideal protection against constant component permeation of the loads in the case of an inverter's failure. 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 the part of the MCE modules family. The BFIz / BFI modules without a controller belong to the M modules family.
The inverter's power supply unit converts the mains AC voltage into DC voltage 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 unit is available in two versions depending 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 the required direct current 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 intermediate voltage permeation of the inverter to DC supply voltage at the same time.
The system includes a diode in the battery power supply circuit instead of a battery converter (Fig. 9 c, d, and Fig. 10 c, d) and is characterised by a greater reliability because of non-processing action 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 dedicated voltage switch.
The galvanic isolation of the inverter and the AC mains power supply from DC voltage is ensured by a 50 Hz transformer (from the inverter's side) and a high-frequency transformer (on the side of the power supply unit).
The inverter converts DC voltage into AC voltage adapted via the transformer to the value accordingly to the 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 multiple fans. Fans RPM's can be easily adjusted by the device's internal temperature, that significantly increases their lifetime.
Note: the MWB module including a bypass system is described in chapter "MWB module."

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10 kVA FOR AUTONOMOUS OPERATION COOPERATING WITH A 1-PHASE 230 V / 230 V 50 Hz TRANSFORMER – AS PER FIG. 9 A, B, AND FIG. 10 A, B

230 V AC rated output power

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	

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

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10 kVA FOR AUTONOMOUS OPERATION COOPERATING WITH A 1-PHASE 115 V / 230 V 50 Hz TRANSFORMER – AS PER FIG. 9 C, D, AND FIG. 10 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 ÷ 10 kVA FOR AUTONOMOUS OPERATION COOPERATING WITH A 3-PHASE 3×240 V / 3×400 V 50 Hz TRANSFORMER – AS PER FIG. 9 A, B, AND FIG. 10 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	

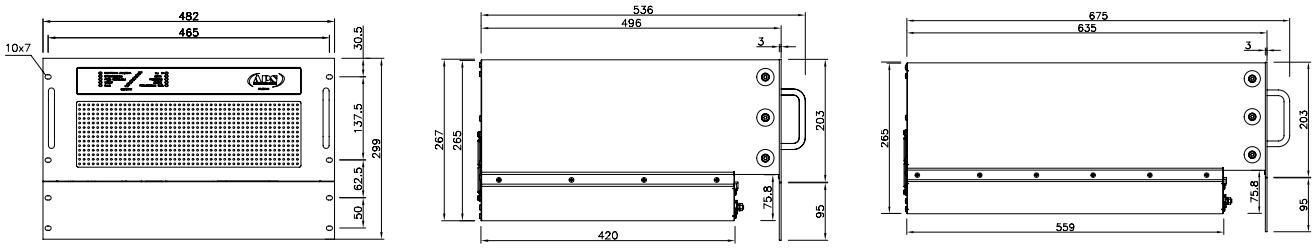
* – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 3-PHASE INVERTER MODULES 1 ÷ 10 kVA FOR AUTONOMOUS OPERATION COOPERATING WITH A 3-PHASE 3×110 V / 3×400 V 50 Hz TRANSFORMER – AS PER FIG. 9 C, D, AND FIG. 10 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 220/110M	
		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).

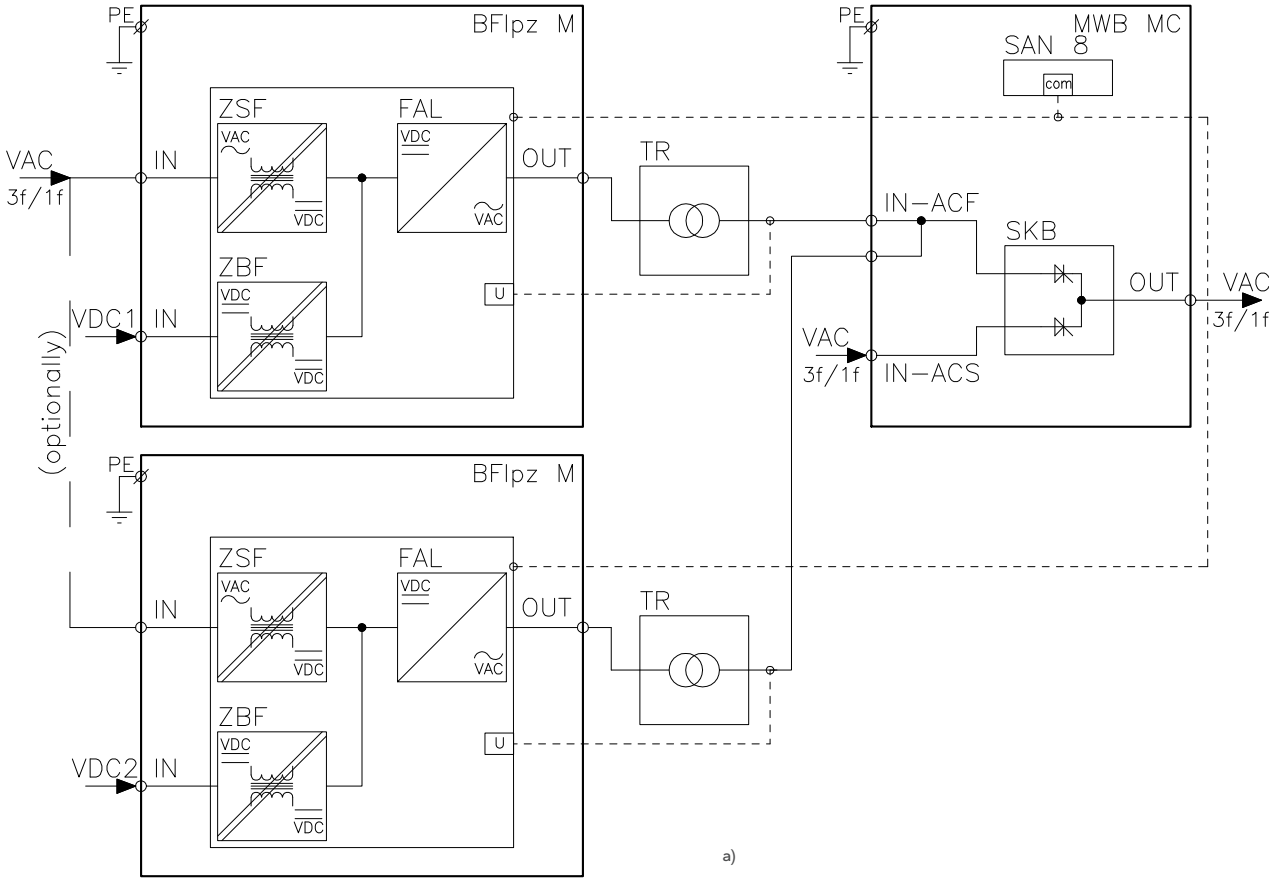


a) b) c)

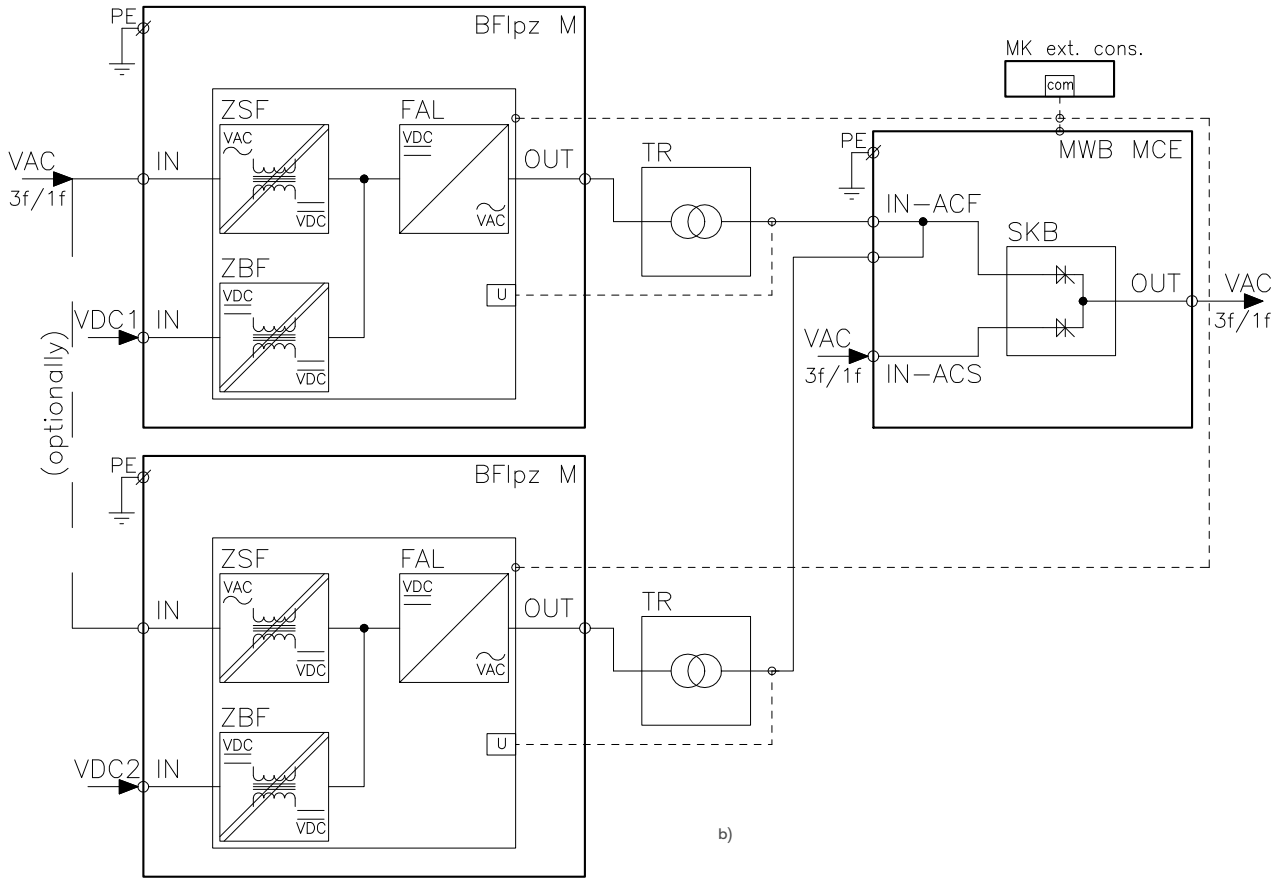
Fig. 11. Views with dimensions of the BFIz / BFI M type inverter module:
a) front view in the M3 and M5 enclosure; b) left-side view in the M3 enclosure; c) left-side view in the M5 enclosure.

THE INVERTER MODULE FOR PARALLEL OPERATION WITH 50 Hz ISOLATING TRANSFORMER

The parallel operation mode of the inverters is an extension of the inverter's autonomous operation mode (see chapter "The inverter module for autonomous operation with 50 Hz isolating transformer").
The BFIp / BFIpz inverter module is intended for parallel operation with an inverter of the same type. This allows for an output power incease or for obtaining redundancy for the components of "1+1" system.
The BFIp / BFIpz M inverter modules cooperate with the MWB module and 50 Hz 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).



a)



b)

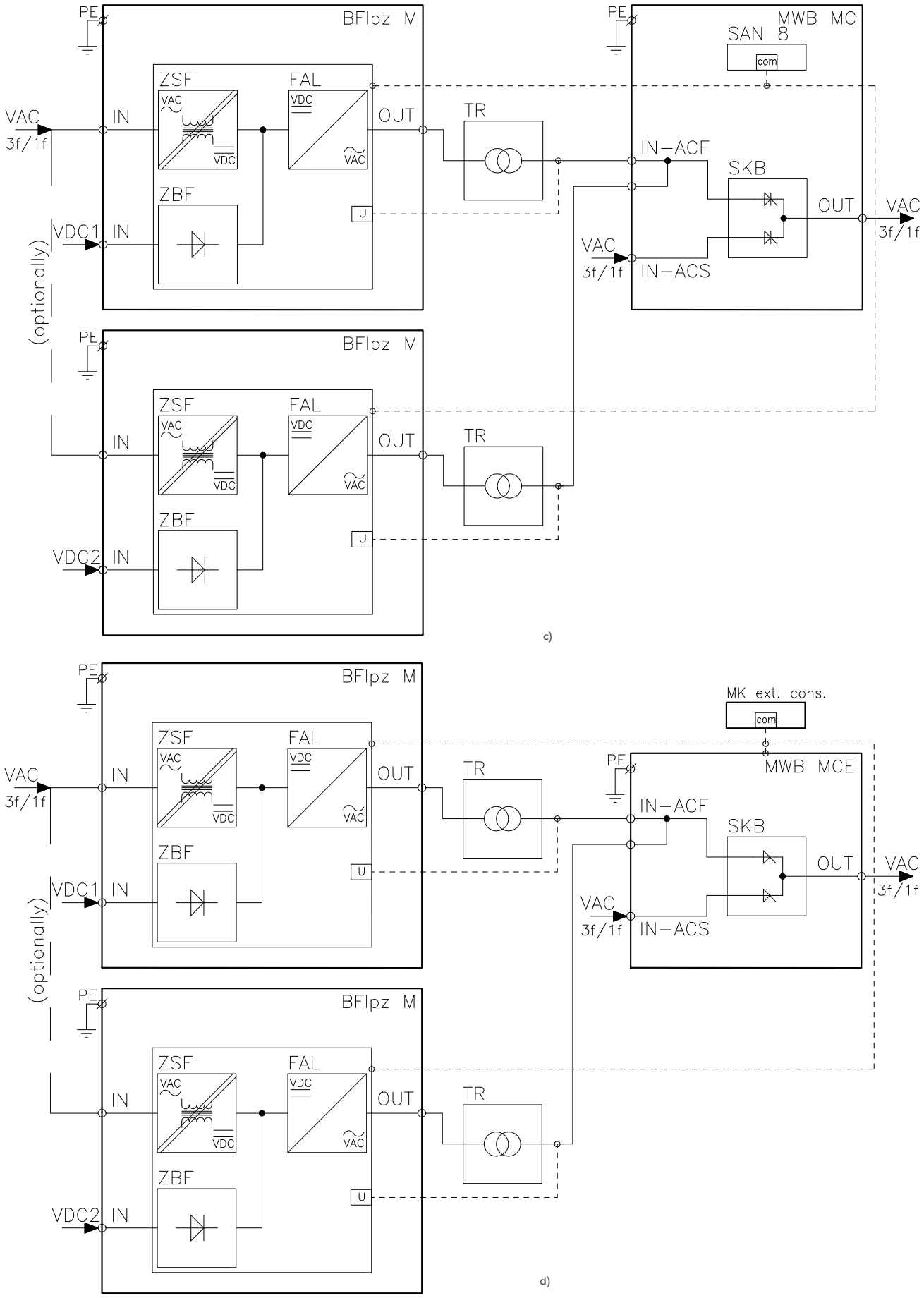
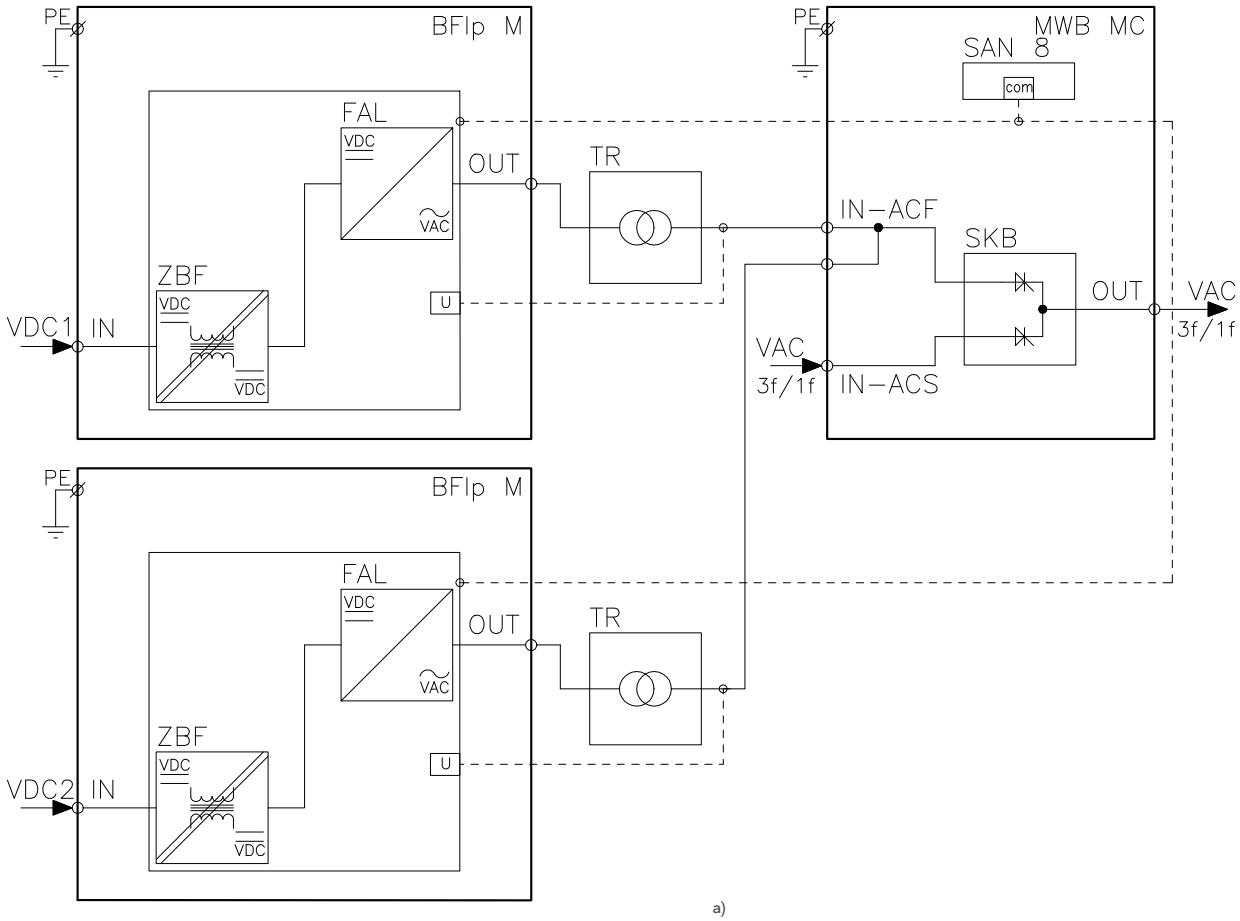
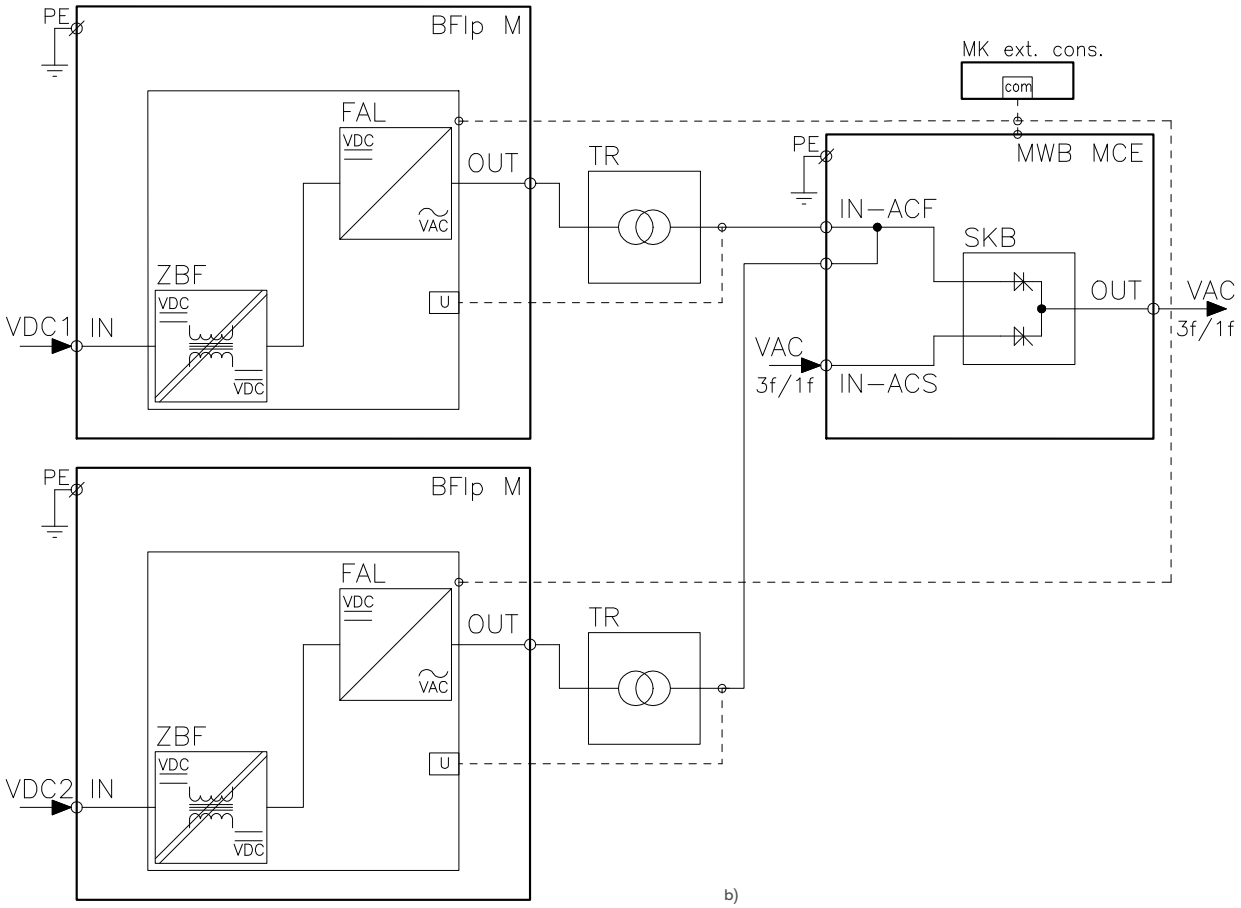


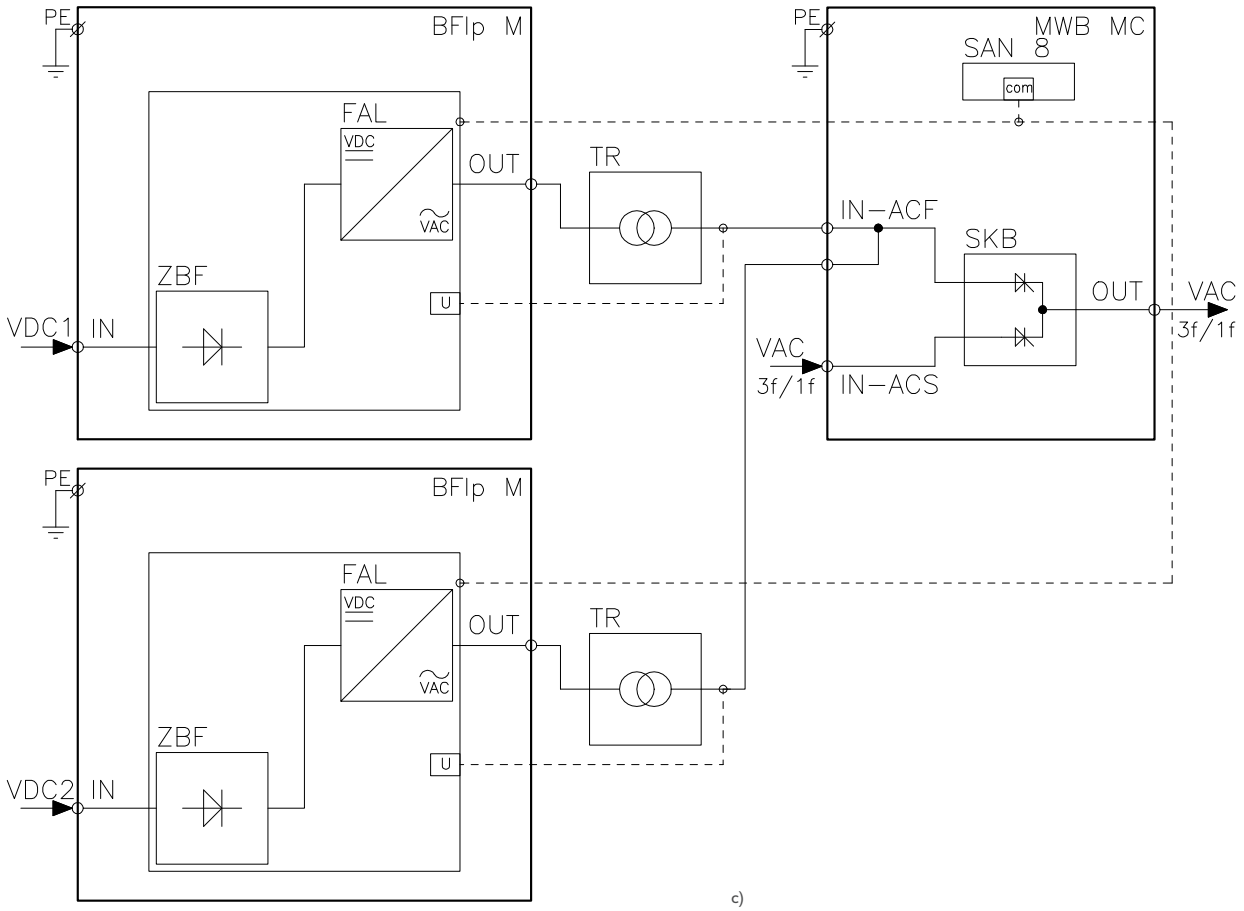
Fig. 12. Block diagram of the inverter modules for parallel operation with the BFIpz power supply unit and the MWB module. Possible configurations:
a) power supply unit, battery converter, built-in console; b) power supply unit, battery converter, external MK console;
c) power supply unit, diode in the DC power supply circuit, built-in console; d) power supply unit, diode in the DC power supply circuit, external MK console.


PE
BFIp M
FAL
VDC
VAC
OUT
TR
ZBF
VDC
U
VDC1 IN
VDC2 IN
PE
MWB MC
SAN 8
com
IN–ACF
SKB
OUT
VAC
3f/1f
VAC
3f/1f
IN–ACS

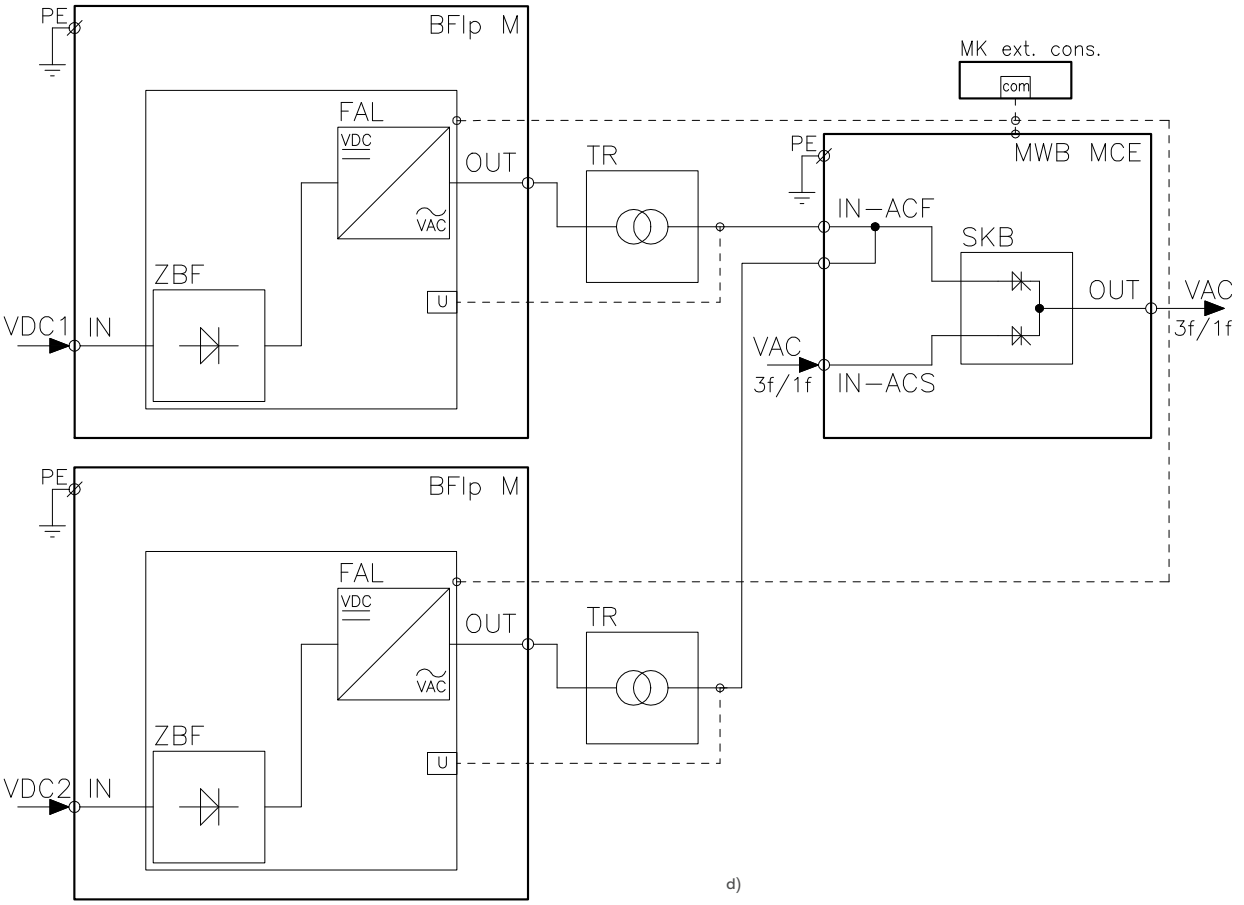
a)


PE
BFIp M
FAL
VDC
VAC
OUT
TR
ZBF
VDC
U
VDC1 IN
VDC2 IN
MK ext. cons.
com
PE
MWB MCE
IN–ACF
SKB
OUT
VAC
3f/1f
VAC
3f/1f
IN–ACS

b)



c)



d)

Fig. 13. 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 mains AC voltage and DC battery voltage (Fig. 12), while the BFIp inverter module is supplied only by DC voltage (Fig. 13). The MWB module is supplied by the backup mains AC voltage, 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 is an ideal protection against constant component permeation to the loads in the case of an inverter's failure. The inverters parallel operation integrating module of MWB type 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. 13 a, c), while the modules with an external MK console are a part of the MCE modules family (Fig. 13 b, d). The BFIp / BFIpz modules without a controller belong to the M modules family.

The inverter's power supply unit converts the mains AC voltage into DC voltage 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 unit is available in two versions dependent on various parameters such as: overload, short-circuit, or the most important: reliability.

1. High frequency DC/DC converter (Fig. 12 a, b, and Fig. 13 a, b);
2. Cut-off diode (Fig. 12 c, d, and Fig. 13 c, d).

1. The high frequency DC/DC converter (battery converter) converts the DC supply voltage into needed DC voltage 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 intermediate voltage permeation of the inverter to DC supply voltage at the same time.

The system includes a diode on the battery power supply circuit instead of a battery converter (Fig. 12 c, d, and Fig. 13 c, d) and is characterised by a greater reliability because of non-processing action 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 dedicated voltage switch.

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

The inverter converts DC voltage to AC voltage 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 multiple fans. Fans RPM's can be easily adjusted by the device's internal temperature, that significantly increases their lifetime.

Note: the MWB module including a bypass system is described in chapter "MWB module."

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10 kVA FOR PARALLEL OPERATION COOPERATING WITH A 1-PHASE 230 V / 230 V 50 Hz TRANSFORMER – AS PER FIG. 12 A, B, AND FIG. 13 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 ÷ 10 kVA FOR PARALLEL OPERATION COOPERATING WITH A 1-PHASE 115 V / 230 V 50 Hz TRANSFORMER – AS PER FIG. 12 C, D, AND FIG. 13 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	
		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 ÷ 10 kVA FOR PARALLEL OPERATION COOPERATING WITH A 3-PHASE 3×240 V / 3×400 V 50 Hz TRANSFORMER – AS PER FIG. 12 A, B, AND FIG 13 A, B

Inverter module's rated output voltage – 3x240 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	

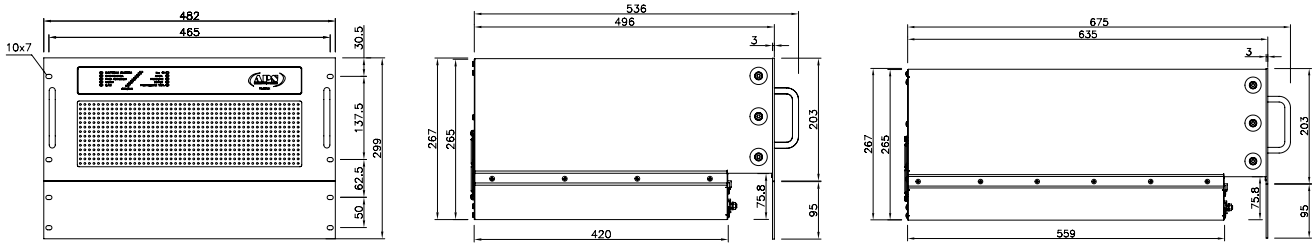
* – M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 3-PHASE INVERTER MODULES 1 ÷ 10 kVA FOR PARALLEL OPERATION COOPERATING WITH A 3-PHASE 3×110 V / 3×400 V 50 Hz TRANSFORMER – AS PER FIG. 12 C, D, AND FIG. 13 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).

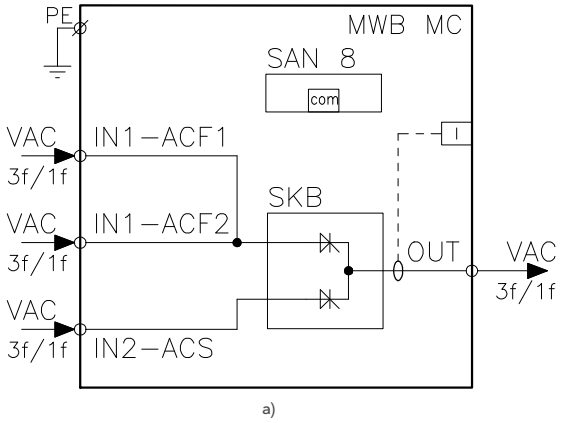


a) b) c)

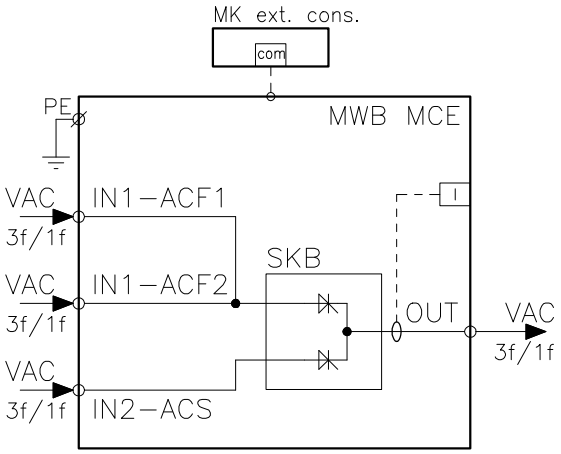
Fig. 14. Views with dimensions of the BFIpz / BFIp M type inverter module:
a) front view in the M3 and M5 enclosure; b) left-side view in the M3 enclosure; c) left-side view in the M5 enclosure.

MWB MODULE

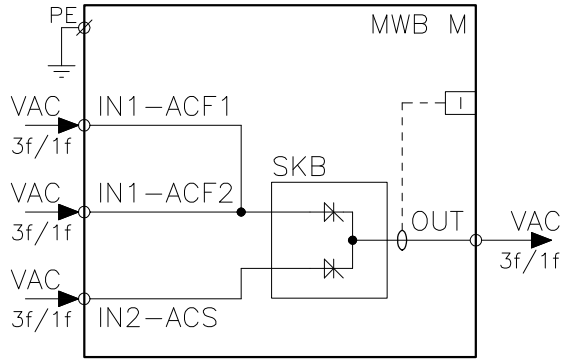
The MWB module is a device that integrates parallel operation of inverter modules. This module may cooperate with single- or three-phase inverters. The main function of the MWB module is enabling simple and safe connection of two inverters for parallel operation. It features two inputs, to which output voltages of inverters and communication buses with inverters are connected. By standard, this module also includes a SAN 8 controller, and, optionally, a Static Switch automatic bypass.
The MWB type module, presented in Fig. 15, has special LC filters responsible for high quality of the voltage and, optionally, may have an automatic bypass system.
The MWB modules with a built-in SAN 8 console belong to the MC modules family (Fig. 15 a), the modules with an external MK console are a part of the MCE modules family (Fig. 15 b), while the modules without a console belong to the M modules family (Fig. 15 c).
Each module is cooled by multiple fans. Fans RPM's can be easily adjusted by the device's internal temperature, that significantly increases their lifetime.



a)



b)



c)

Fig. 15. Block diagram of the MWB type static connector:
a) with a built-in console; b) with an external MK console; c) without a console.

KEY OF THE ABBREVIATIONS USED IN THE DIAGRAMS IN THE CHAPTER	
BR – maintenance bypass	com – communication
I – current measurement	OUT – output
IN – power supply	SAN 8 – console
IN-ACF – AC supply from the inverter	SKB – automatic bypass
IN-ACS – AC supply from the grid	VAC – AC voltage

DESIGNATION METHOD OF THE MWB TYPE MODULES WITH AUTOMATIC BYPASS SYSTEM WHICH ALLOWES INVERTERS PARALLEL OPERATION

MWB ☐☐ ☐ ☐

Device type: **MWB - bypass module that enables parallel operation of inverters**
Power, [kVA]
Number of phases at the device output: **S - single phase (L)** **S2 - single phase (L+N or L1+L2)** **T - three phases (L1, L2, L3)** **T4 - three phases (L1, L2, L3, N)**
AC rated voltage, [V] **By standard: 220; 230; 240; 380; 400; 415** **Other solutions depend on the order**
Type of enclosure: **M - 19" module without controller** **MC - 19" module with mounted controller** **MCE - 19" module with an external console**

* – means a configuration of thyristor switches in the SKB system:

S – a single-phase system. Thyristors switch only L phase voltages. N neutral cables are permanently connected.

S2 – a single- or two-phase system. Thyristors switch L and N voltages in a single-phase system or L1 and L2 in a two-phase system.

T – a three-phase system. Thyristors switch only L1, L2, L3 phase voltages. N neutral cables are permanently connected.

T4 – a three-phase system. Thyristors switch L1, L2, L3, and N phase voltages.

The MWB module views

THE CHARACTERISTICS OF THE MWB MODULE:

- operation in the wide load cos φ range;
- high resistance to overload and difficult operating conditions;
- a built-in synoptic panel, indicating operation and power lines status;
- high efficiency;
- advanced communication between the user and the device: keyboard, control console with LCD, indicating LEDs, application of all binary signals to potential-free relay contacts;
- data archiving and events buffer on SD card;
- RS485, USB and Ethernet integrated communication interfaces;
- data transmission protocol selection: Modbus RTU, IEC 60870-5-103;
- SAN 8 microprocessor monitoring of the entire system.

A version with a built-in Static Switch system:

- a microprocessor control system;
- an advanced power lines voltage parameters analysis algorithm;
- quick switching within the range (0 to 10 ms depending on the synchronisation of voltages);
- a possibility to select the primary or secondary line;
- a possibility to block automatic return to the primary line;
- a possibility to manually switch power supply between the lines;
- selection of the primary line return mode in the case of cessation of the cause of the switch (or an option to remain on the secondary line).

TECHNICAL CHARACTERISTIC – standard parameters

PARAMETER	VALUE
AC* INPUT, NO. 1, NO. 2	
Input voltage:	220 / 230 /240 / 3×380 / 3×400 / 3×415 V
Input voltage tolerance	+10 % to -15 %
Input voltage frequency	50 Hz
Input voltage frequency tolerance	± 10 %
AC OUTPUT	
Output voltage:	220 / 230 / 240 / 3×380 / 3×400 / 3×415 V
Output voltage tolerance	+10 % to -15 %
Output voltage frequency	50 Hz
Output voltage frequency tolerance	± 10 %
Overload indication	In
The time of switching to reserve power supply	5 ms
Overload capacity	1.1×In long-term <1.25×In within 10 min <1.5×In within 60 s >1.5×In within 1 s
Short-circuit strength	10×In within 20 ms
Cos φ range	from -1.0 to 1.0
Inverter efficiency	>99%
Available menu language versions	PL | EN | CZ | RU
OPERATING ENVIRONMENT	
Operating temperature (EN 50178 class 3k3)	+5 to +40°C*
Storage temperature (EN 50178 class 1k4)	-25 to +55°C*
Humidity (EN 50178 class 3k3)	5 to 85 % (non-condensing)*
Access to the device	operation and maintenance from the front*
Cable entry	from the bottom
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.

STATIC SWITCH SYSTEM SWITCHING CHARACTERISTICS

The oscillogram in Fig. 16 presents an uninterruptible (<5 ms) switching of the microprocessor bypass system (SKB) to supplying loads from the AC backup line in the case of damage to the main AC power line. There is a maintenance bypass switch at the output of this Static Switch system.

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

This characteristic is default for both SKB and MWB system.

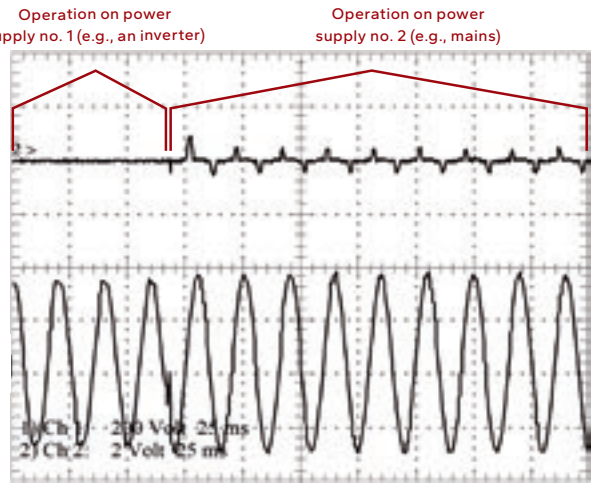


Fig. 16. Switching of the SKB system from line no. 1 (e.g., an inverter) to the voltage of the line no. 2 (e.g., mains), where:
Ch1 – system output voltage
Ch2 – current drawn from the mains

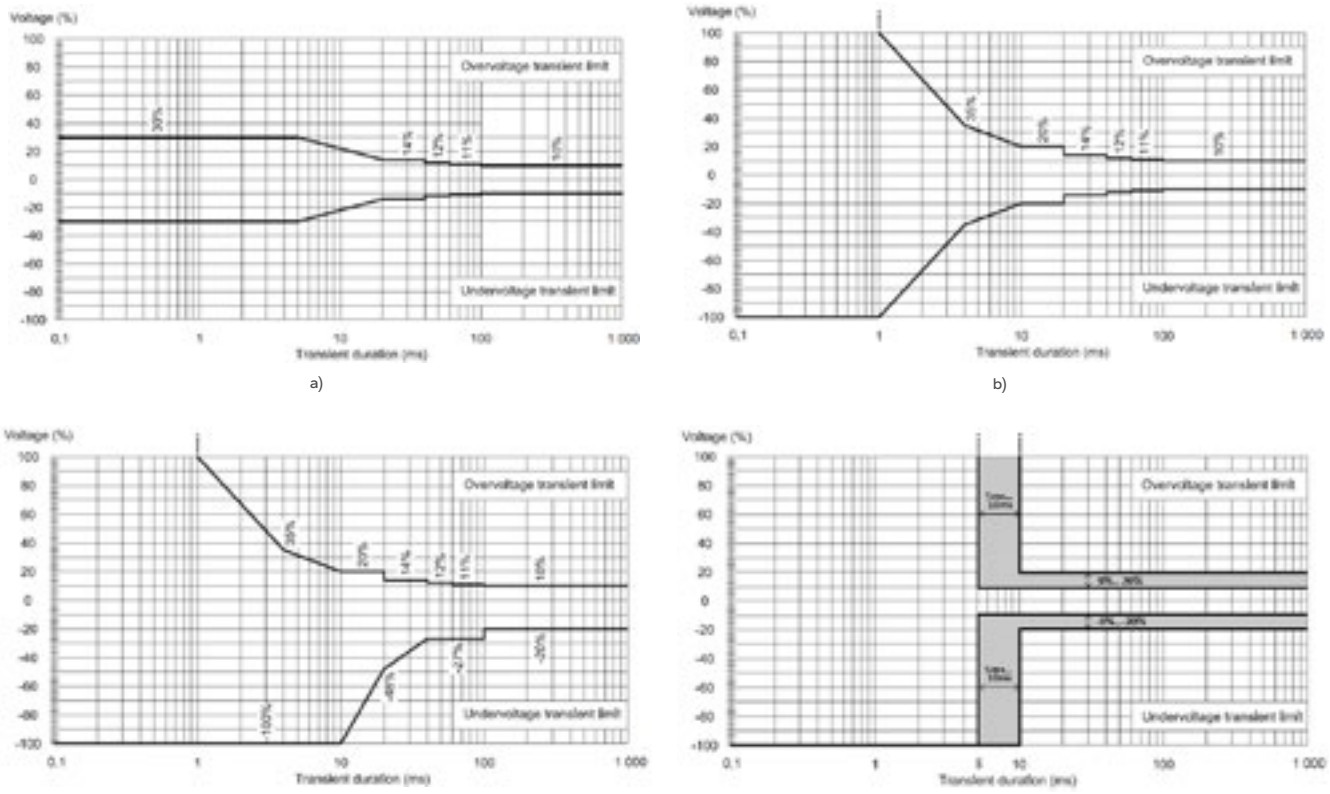


Fig. 17. Line voltage fault characteristics:
a) the APS4 type; b) as per EN62040 – 3 Class 1; c) EN62040 – 3 Class 2; d) EN62040 – 3 Class 3.

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

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

* – possible options: see table "TECHNICAL CHARACTERISTICS – standard parameters" in the "MWB MODULE" chapter;
** – M3 (6U): 482×267×496; (W×H×D);
*** – possible options: M / MC / MCE.

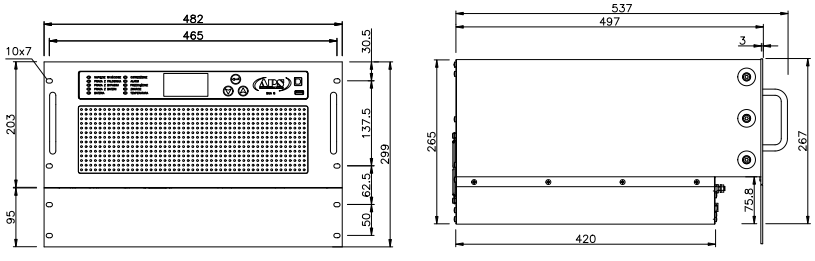


Fig. 18. Views with the dimensions of the MWB module:
a) front view; b) left-side view.

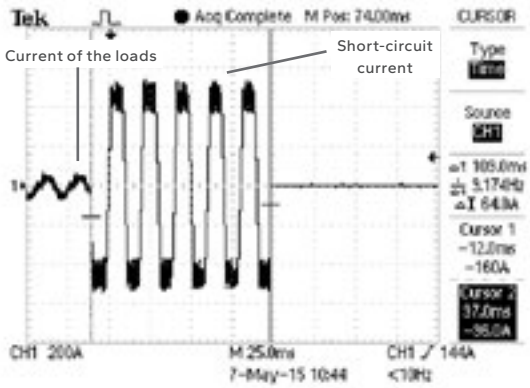
INVERTER MODULE OF INCREASED SHORT-CIRCUIT CURRENT

DESIGNATION METHOD OF THE BFI HC TYPE INVERTERS

BFI□ □□ □□/□ □ HC+□□

- Device type: BFI - classic inverter
- Types of inverters:
  - p - inverter for parallel operation
  - z - inverter with power supply unit
- Power, [kVA]
- Number of phases at the device output:
  - S - single phase
  - T- three phases
  - T4 - three phases with N pole (for inverters without insulation)
- DC rated input voltage, [V]
  - By standard: 24; 48; 60; 110; 220
  - Other solutions depend on the order
- Additional equipment:
  - SKB - the bypass system of XX power
- HC - inverter of increased short-circuit current
- Type of enclosure:
  - M - 19" module without controller
  - MC - 19" module with mounted controller
  - MCE - 19" module with an external console
- AC rated output voltage, [V]
  - By standard: 220; 230; 240; 380; 400; 415
  - Other solutions depend on the order

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



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

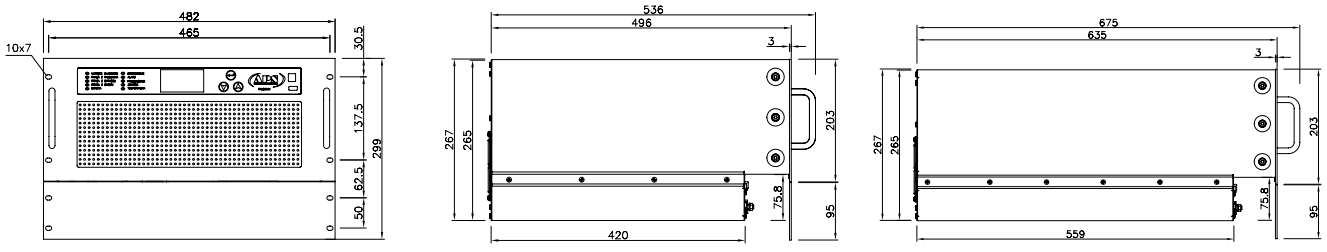
The BFIz / BFI / BFIpz / BFIp HC inverter module may cooperate with the MWB module and transformer to provide galvanic isolation and adapt the inverter module output voltage to required value. The MWB module contains special LC filters, which are responsible for high quality of the inverter's voltage, and the Static Switch system (optionally).
Note: the MWB type bypass system module is described in chapter "MWB module."

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

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. 19. 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 HC INVERTER MODULES 1 ÷ 10 kVA COOPERATING WITH A 1-PHASE 230 V / 230 V 50 Hz TRANSFORMER – AS PER FIG. 9 A, B, AND FIG. 10 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 HC INVERTER MODULES 1 ÷ 10 kVA COOPERATING WITH A 1-PHASE 115 V / 230 V 50 Hz TRANSFORMER – AS PER FIG. 9 C, D, AND FIG. 10 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 HC INVERTER MODULES 1 ÷ 10 kVA COOPERATING WITH A 3-PHASE 3×240 V / 3×400 V 50 Hz TRANSFORMER – AS PER FIG. 9 A, B, AND FIG. 10 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	

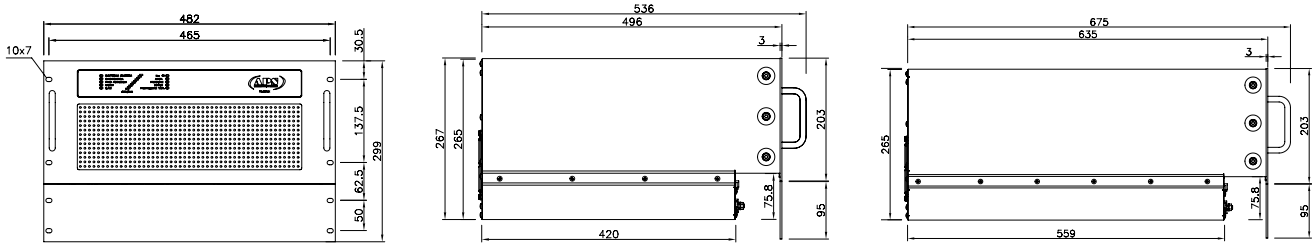
* – M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 3-PHASE HC INVERTER MODULES 1 ÷ 10 kVA COOPERATING WITH A 3-PHASE 3×110 V / 3×400 V 50 Hz TRANSFORMER – AS PER FIG. 9 C, D, AND FIG. 10 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. 20. 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.

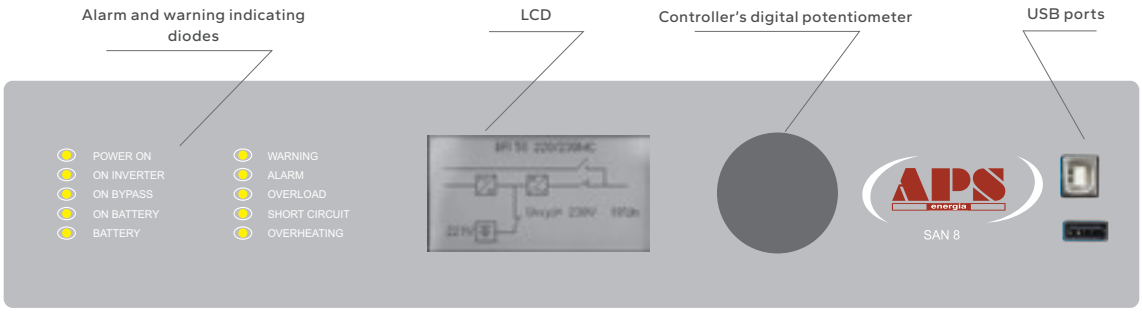
SAN 8 EXTERNAL COMMUNICATION – ALTERNATING CURRENT SYSTEMS

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

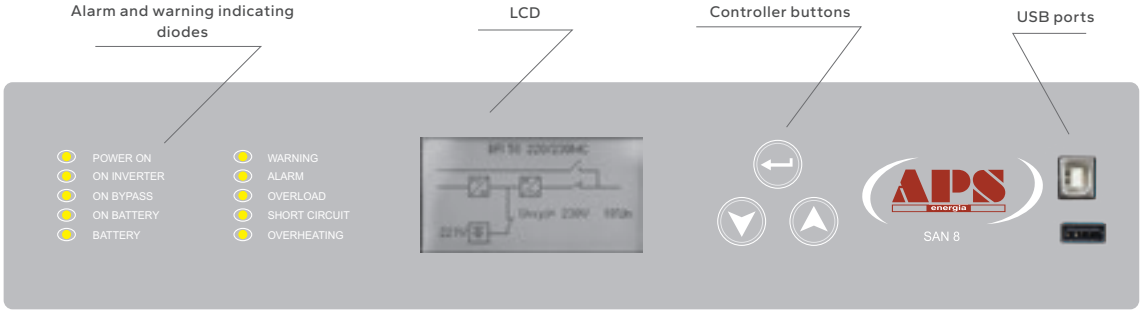
THE COMMUNICATION SYSTEM CONSISTS OF:

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 logs readout), and Ethernet ports.

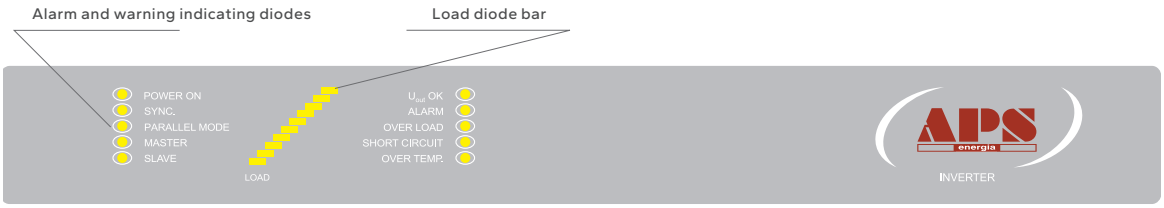
LOCAL USER PANEL



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

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.

BFI AND BFIz INVERTERS: INPUT BINARY SIGNALS* – CONTROL:

Emergency power off switch (EPO)
START/STOP inverter switch
ATSE
Spare

* - signals depend on inverter type and have to be agree with the manufacturer.

The USB type port (A)

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

SIGNALLED SAN 8 ALARMS INCLUDING DESCRIPTION ON THE LCD SCREEN:

General alarm	Power supply failure
Warning	Battery converter failure
Internal error	Rectifier failure
Inverter short circuit	Low battery voltage
Overload	No battery charging
Inverter operation	Battery circuit open
Bypass operation	Maintenance bypass on
Battery operation	No output voltage
Mains power supply failure	No synchronization
Inverter failure	Ambient temperature out of range
Bypass failure	Inverter temperature
Battery failure	Backup mains failure

ETHERNET CONNECTOR (AN OPTION INVOLVING USE OF AN EXTERNAL CONTROLLER)

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: OUTPUT BINARY SIGNALS:

8 STANDARD SIGNALS:	8 ADDITIONAL SIGNALS (SELECTABLE):
1. Alarm	1. Mains power supply failure
2. Warning	2. Inverter failure
3. Inverter operation	3. Bypass mains failure
4. Bypass operation	4. Battery failure
5. Overload	5. Power supply failure
6. Battery operation	6. Battery converter failure
7. Low battery voltage	7. No battery charging
8. Maintenance bypass on	8. Rectifier failure
	9. Battery circuit open
	10. Output switch off
	11. No output voltage
	12. No synchronization
	13. ATSE tripping
	14. Ambient temperature out of range
	15. Inverter overheating
	16. Emergency power off switch tripping

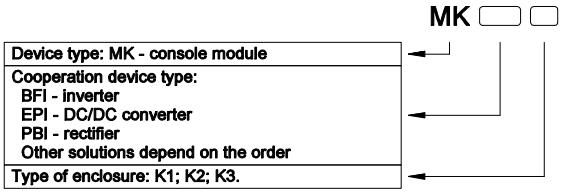
THE MK BFI TYPE EXTERNAL CONSOLE

One of the equipment options for modules is the console (display).
Depending on the console location or its absence, the modules are broken down into:

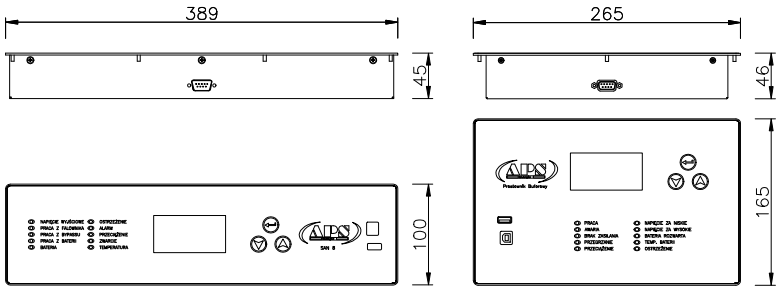
- Devices with a built-in console (with display) – designated as the MC type modules;
- Devices with an external console (with display) – designated as the MCE type modules;
- Devices without a console (with display) – designated as the M type modules.

An external console is used mainly in the industrial cabinet systems containing modular devices. In case of such systems, where it is necessary to quickly and easily access information about the device's state, you may use the MK BFI type external console. If it is possible to open the door to access the console or the door is glazed, you may use the MC type modules with a built-in console.
There are two types of external consoles: MK BFI K1 and MK BFI K2. These versions feature different overall dimensions (Fig. 21).
The MK BFI consoles may be produced in a version which, after appropriate installation on the cabinet's door, allows for obtaining a higher IP rating, up to IP 54. IP rating must be provided when placing an order.

DESIGNATION METHOD OF THE MK TYPE EXTERNAL CONSOLES



View of the MK type portable console



a) b)

Fig. 21. Views of the MK type portable consoles:
a) K1 console; b) K2 console.

USE OF MODULAR DESIGN INDUSTRIAL INVERTERS

Modular design inverters are intended for installation in industrial cabinets. They may constitute:

- a basis of the BFIz / BFI MS type multi-module inverter system;
- a part of an uninterruptible power supply (UPS) system;
- a part of AC or DC distribution board.

The devices may operate autonomously and/or in parallel (on its own or in connection with MWB module).

Installation of an inverter module in a 19'' industrial cabinet creates a compact design optimised in terms of operating conditions.

Use of an inverter module within the system ensures:

- Conversion of direct current to alternating current;
- Stabilisation of parameters regardless of fluctuations in the mains;
- Maintenance of correct power supply parameters for critical devices;
- Backup power supply during interruptions;
- Compensation of disturbances and high quality of the power supply;
- Voltage and frequency quality adjustment;
- Synchronisation with the power grid;
- Protection of loads against short-circuits and overloads;
- Ability to control and monitor output parameters.

The inverter modules are exceptionally versatile devices used in various systems that require conversion and adjustment of electrical energy. Below are the main areas in which they are used:

- Drive systems and industrial engine control;
- Renewable energy sources systems;
- Uninterruptible power supply (UPS) systems;
- Transport and traction;
- HVAC (Heating, Ventilation, and Air Conditioning);
- Power systems and electric grid management;
- Water and sewage systems.

Use of inverter modules in uninterruptible power supply (UPS) systems is thoroughly described in chapter "UPS SYSTEMS" of the APS Energia S.A. production catalogue.

APS Energia SA
ul. Strużańska 14
05-126 Stanisławów Pierwszy

NIP: 125-11-78-954
KRS: 0000346520
+48 (22) 762 00 00
aps@apsenergia.pl
www.apsenergia.pl