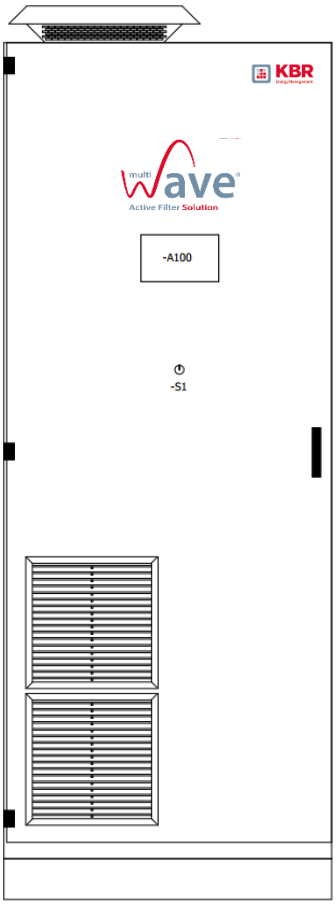
Operating instructions hardware

multiwave active Gen. 3



27259_EDEBDA0304-2422-1_EN_multiwave active Gen. 3
Revision 09

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Revision list

Revision	Name / Date	Chapter	Changes
09	Jco, JF / 2019-05-03	All	Update all versions ACF, PCS, 3W, 4W
08	JF / 2017-12-05	7.3, 2.2, 5.3.2	Table 7.2, addition PCS
07	JF / 2015-06-16	All	Warning symbol
06	BLL, Ktz/ 2014-02-18	7	Stromwandler, Beschreibung der digitalen E/A
05	JF / 2014-02-13	All	Layout and small changes
04	JF / 2013-11-28	All	Layout and small changes
03	BLL / 2013-07-25	All	Approval
02	JF / 2013-05-28	All	New document
01	BD / 2012-12-01	All	Draft

Table of contents

1 Information on this document

The text can include abbreviations. The first time each abbreviation appears, the designation will be written out in full and the abbreviation will follow in parentheses.
Example: IGBT Power Unit (IPU).

1.1 Scope

This document describes the hardware of the product series multiwave active.

1.2 Associated documents

Document No.	Document
27259 EDEBDA0304-2422-1	Operating instruction EN multiwave active Gen.3 Software
EDEBDA0309-3621-1_EN	Operating Instructions Touch Panel Santino 7.0 (Garz & Fricke)

Table 1: Associated documents

1.3 Symbols used in this document

The following symbols are used in these instructions:

WARNING: Indicates a significant risk of severe injury or death. Failure to observe these notes can result in severe injury or death.

NOTICE: Indicates a risk to the device or other property belonging to the owner/operator. In addition, a risk of serious injury or death cannot be ruled out.

Fire hazard

Tipping hazard

This notice contains important information for the correct use of the active filter.

2 General safety notes

Please read the operating instructions prior to installation. The operating instructions explain how to operate the product safely. The notes listed below warn of possible sources of danger and provide information on the correct use of the active filter. Priority must be given to the respectively applicable, recognized regulations pertaining to the technology, as well as the accident prevention regulations and, if applicable, internal regulations in the most up-to-date version.

Important notes:

NOTICE: Any persons performing work on the device must be sufficiently qualified based on their professional knowledge and experience and must be familiar with these operating instructions. In terms of these instructions or the warnings on the product itself, qualified persons are persons who are familiar with the installation, assembly, commissioning and operation of the product and who have the qualifications required for their job, such as training and instruction / authorization to switch on and off, ground and label circuits and equipment/systems in accordance with safety engineering standards, training or instruction in accordance with safety engineering standards in the care and use of appropriate safety equipment, training in first aid. In the event of incorrect operation or misuse, there are dangers to life and limb, to the device and other property of the operator and to the function of the device. The device may only be used in accordance with its intended use.
Unauthorized and improperly performed work on the device and, in particular, tampering with system-internal protection functions are prohibited!

NOTICE: Any persons who configure settings on the device, commission it or change its settings at a later date must be sufficiently qualified, meaning that they have successfully completed a product-specific training program.

NOTICE: It must be ensured that the secondary circuit of the current transformer is short-circuited before working on current transformer circuits. The current transformer circuit must under no circumstances be operated when it is open as this can lead to property damage and personal injury.

NOTICE: Because the voltage in the DC link capacitor can exceed 1000 V, a discharge time of 20 min must be observed before working on the system. Once this time has elapsed, the absence of voltage must be verified using a suitable measuring instrument. Failure to do so can lead to death or serious injuries.

WARNING: For your own safety, please observe the locally valid standards and regulations as well as the recognized regulations of the technology. Failure to observe these notes can result in severe injury or death.

NOTICE: These operating instructions have been created with great care; however, KBR cannot assume any liability for the freedom from errors of the operating instructions or for damage resulting from the use of the manual. We will strive to fix any errors that we become aware of as quickly as possible.

2.1 Intended use

Intended use

- The multiwave active is an electronic grid filter. Its role is to feed fundamental and harmonic currents to improve the voltage quality in electrical AC voltage grids.
- The multiwave active devices may only be operated by specially trained personnel. Any persons performing work on the device must be sufficiently qualified based on their professional knowledge and experience and must be familiar with these operating instructions.
- Qualified persons are persons who are familiar with the installation, assembly, commissioning and operation of the product and who have the qualifications required for their job, such as training and instruction / authorization to switch on and off, ground and label circuits and equipment/systems in accordance with safety engineering standards, training or instruction in accordance with safety engineering standards in the care and use of appropriate safety equipment, training in first aid.
- It must only be possible for authorized persons to come into contact with, to access and to intervene with the multiwave active – i.e. the cabinet door is to be kept closed and locked. The key to the room/cabinet may only be available to authorized persons.
- The devices may only be operated with the cabinet doors closed.
- The devices may only be operated if they have been installed correctly.
- Correct installation includes both the attachment and state of the cabinet, as well as the electrical connection and electrical protection.
- The multiwave active may only be used for the function described in this document.
- Interventions in the hardware and software are not permitted.
- The multiwave Active is designed for the environmental conditions described in this document and may only be operated under these conditions.

2.2 Improper use

Improper use

- Use for purposes other than that described above is not permitted.
- All warranties and liabilities become void in the event of violations.

3 Technical data

3.1 Standards

The product complies with the following standards and directives:

Standard description	Standards
Electromagnetic compatibility	EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6, EN 61000-4-8, EN 61000-4-11, EN 61000-6-2, EN 61000-6-2, EN 61000-6-4 and EN 55011
Safety requirements	EN 62477-1, EN 60664-1, IEC 60364-6
Low-voltage switchgear and controlgear assemblies	EN 61439-1, EN 61439-2
Electronic equipment for use in power installations	EN 50178
Protection class	IP20 in accordance with EN 60529 (air-cooled)
Approval marks: CE mark	2006/95/EC

Table 2: Standards

3.2 Technical data 3-wire

Technical data	multiwave floor cabinet							
Nominal voltage	400 V (max. 480 V) ± 10 %				690 V (max. 800 V on request) ± 10 %			
Nominal frequency	50 / 60 Hz							
Peak current	2x rated current							
Connection	3-phase + PE, neutral conductor connection not required (network topology: TN, TT, IT)							
Compensation	Outer conductors balanced and unbalanced (positive and negative sequence)							
Filter function	1st … 51st harmonic (50 Hz) // 1st … 41st harmonic (60 Hz) All harmonics can be filtered simultaneously							
Additional functions	Dynamic reactive power compensation Active and reactive power balancing (up to 100 % of rated current) Voltage stabilization via Q(U)-control Flicker compensation							
AC voltage	400 V				690 V			
Number of IPU modules	1	2	3	4	1	2	3	4
Rated current	125 A	250 A	375 A	500 A	125 A	250 A	375 A	500 A
Neutral current	-	-	-	-	-	-	-	-
Compensation power	87 kvar	174 kvar	261 kvar	348 kvar	150 kvar	300 kvar	450 kvar	600 kvar
Weight (approx.)	340 kg	460 kg	580 kg	700 kg	340 kg	460 kg	580 kg	700 kg
Expendability	Up to a maximum of 5 cabinets (1.7 Mvar, 2.5 kA)				Up to a maximum of 5 cabinets (3 Mvar, 2.5 kA)			
Power losses	< 2.5 % of compensation power maximum, < 2.2 % in typical operation, < 0.4 % idle mode < 100 W standby				< 2.1 % of compensation power maximum, < 1.8 % in typical operation, < 0.4 % idle mode < 100 W standby			
Switching frequency	10 kHz (low loss design)							
Control	Internal control computer with two digital signal processors							
Device setup and display	Via touch panel with graphic display, internal web server (TCP/IP) und PC, SD-card or Anybus-interface (fieldbus interface)							
Response time	<< 1 ms							
Interfaces	Ethernet (TCP/IP) Various field buses via optical Anybus modules (e.g. Profibus, Modbus TCP) 4x digital outputs: 250 VAC (3 A) / 110 VDC (0,7 A) / 24 VDC (1 A), isolated and parameterized for status messages 4x digital inputs: 24 VDC (10 mA), parameterized for external control and parameter set selection							
Current transformer	Either 2-phase or 3-phase current measurement, xx/5 A or xx/1 A (parameterized) Current transformers are not included, 5 VA, class 1 or better recommended							
Inverter	3-Level-IGBT with voltage link (DC film capacitors)							
Colouring	RAL 7035 light grey							
Dimensions (approx. W x D x H)	800 x 600 x 2000 mm + 200 mm Base							
Cooling	Air cooling with speed-controlled fans							
IP protection degree	IP 20, optional IP 54							
Ambient conditions	Maximum ambient temperature without derating: 40 °C Recommended ambient temperature for continuous operation: < 25 °C Minimum operating temperature: 0 °C, relative humidity: maximum 95 % Transport / storage: -20 °C … 70 °C							
Over voltage category	CAT III, 1000 V							
EMC class	EN 55011, class A1 (industrial environment)							
Standards	EN 50178, EN 61439-1, EN 61439-2, EN 61000-6-2, EN 61000-6-4, EN 55011							

Table 3 Technical Data 3-wire

3.3 Technical data 4-wire

Technical data	multiwave wall cabinet		multiwave floor cabinet				
Nominal voltage	400 V (max. 415 V) ± 10 %						
Nominal frequency	50 / 60 Hz						
Peak current	2x rated current						
Connection	3-phase + PE + N / PEN, neutral conductor connection mandatory (network topology: TN)						
Compensation	Outer conductors balanced and unbalanced (positive and negative sequence) with neutral conductor (zero sequence)						
Filter function	1st … 51st harmonic (50 Hz) // 1st … 41st harmonic (60 Hz) All harmonics can be filtered simultaneously						
Additional functions	Dynamic reactive power compensation Active and reactive power balancing (negative sequence up to 60 %, zero sequence up to 100 % of rated current) Voltage stabilization via Q(U)-control Flicker compensation Neutral conductor relief						
AC voltage	400 V						
Number of IPU modules	1	2	1	2	3	4	5
Rated current	60 A	120 A	60 A	120 A	180 A	240 A	300 A
Neutral current	180 A	360 A	180 A	360 A	540 A	720 A	900 A
Compensation power	42 kvar	82 kvar	42 kvar	82 kvar	125 kvar	166 kvar	208 kvar
Weight (approx.)	152 kg	196 kg	275 kg	335 kg	395 kg	455 kg	515 kg
Expendability	Up to a max. of 2 modules		Up to a maximum of 5 modules (208 kvar, 300 A)				
Power losses	< 2.6 % of compensation power maximum, < 2.3 % in typical operation, < 0.7 % idle mode, < 100 W standby						
Switching frequency	20 kHz (low loss design)						
Control	Internal control computer with two digital signal processors						
Device setup and display	Via touch panel with graphic display, internal web server (TCP/IP) und PC, SD-card or Anybus-interface (fieldbus interface)						
Response time	<< 1 ms						
Interfaces	Ethernet (TCP/IP) Various field buses via optical Anybus modules (e.g. Profibus, Modbus TCP) 4x digital outputs: 250 VAC (3 A) / 110 VDC (0,7 A) / 24 VDC (1 A), isolated and parameterized for status messages 4x digital inputs: 24 VDC (10 mA), parameterized for external control and parameter set selection						
Current transformer	3-phase current measurement, xx/5 A or xx/1 A (parameterized) Current transformers are not included, 5 VA, class 1 or better recommended						
Inverter	3-Level-IGBT with voltage link (DC electrolytic capacitors)						
Colouring	RAL 7035 light grey						
Dimensions (approx. W x D x H)	800 x 600 x 1200 mm		800 x 600 x 2000 mm + 100 mm Base				
Cooling	Air cooling with speed-controlled fans						
IP protection degree	IP 20, optional IP 54						
Ambient conditions	Maximum ambient temperature without derating: 40 °C Recommended ambient temperature for continuous operation: < 25 °C Minimum operating temperature: 0 °C, relative humidity: maximum 95 % Transport / storage: -20 °C … 70 °C						
Over voltage category	CAT III, 300 V						
EMC class	Standard EN 55011, class A1 (industrial environment), optional: class B (residential environment)						
Standards	EN 50178, EN 61439-1, EN 61439-2, EN 61000-6-2, EN 61000-6-4, EN 55011						

Table 4 Technical data 4-wire

4 General information

4.1 The five safety rules

Prior to any work, the following rules are to be complied with:

1. Disconnect
2. Secure against reconnection
3. Ensure no voltages are present
4. Ground and short-circuit
5. Cover or shield any adjacent live parts

4.2 Inadvertent startup

If the active filter is connected to the grid, the device can be started/stopped via digital commands (MIO), fieldbus commands and via the touch panel:

- Disconnect the unit from the grid and any DC voltage sources if avoiding an inadvertent startup is necessary to ensure personal safety
- Always switch the main switch to OFF if you want to avoid an inadvertent startup

4.3 Product identification and nameplate

The nameplate is in the cabinet door. Prior to installation and commissioning, ensure that the specified technical data follows your grid connection properties.

4.3.1 Nameplate

Figure 1: Nameplate

Number	Designation
1	Manufacturer logo
2	Product identification
3	Year of assembly
4	Order number
5	Degree of protection
6	Nominal (rated) current
7	Operating voltage
8	Control voltage
9	Standards
10	Country of manufacture
11	Manufacturer address and CE mark

Table 5: Nameplate designation

4.3.2 Product identification

multiwave active	300	- 400	- 4	- XX
1)	2)	3)	4)	5)

Number	Designation
1	Product
2	Nominal AC current
3	Nominal value of the AC operating voltage
4	Four-wire device (with N-conductor compensation)
5	Other: IP54 – increased degree of protection 2xMIO – Two separate measurement points SO – other deviations, e.g. color

Table 6: Product designation

5 Overview of functions

5.1 General

The multiwave active is an Active Filter who is used for improving the quality of the grid voltage. This improvement is achieved through the electronically regulated compensation/filtering of the reactive power (fundamental, unbalanced or distortion reactive power). In their grid, active filters act as a regulated current source which allows electricity to be fed into the grid at any frequency, in any phase orientation and at any amplitude. Displacement reactive power, harmonics and asymmetries are actively compensated via the principle of elimination. With the four-wire version, this is also possible in the neutral conductor.

Typical fields of application are grids with:

- High harmonic loads
- Harmonic currents on the neutral conductor
- Unbalanced loads
- Rapidly changing loads
- Flicker loads

5.2 Active Filter – Operating principle

The multiwave Active Filter is a regulated current source. It generates a compensation current out of phase with the harmonics emitted on the load side. This eliminates the harmonics in the direction of the grid. In addition, fundamental oscillation currents can also be fed in, which compensates for inductive or capacitive displacement reactive power. It is also possible to balance the conductor currents.

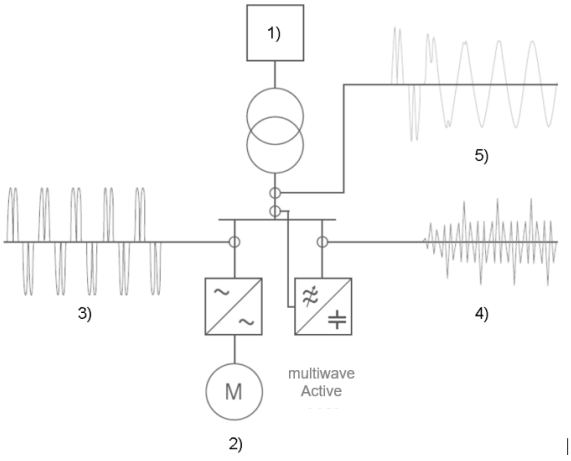


Figure 2: Operating principle

Number	Designation
1	Grid
2	Load
3	Load current
4	Compensation current
5	Grid current

Table 7: Operating principle designation

6 Layout

6.1 System cabinet

This section describes the main components of the Active Filter.

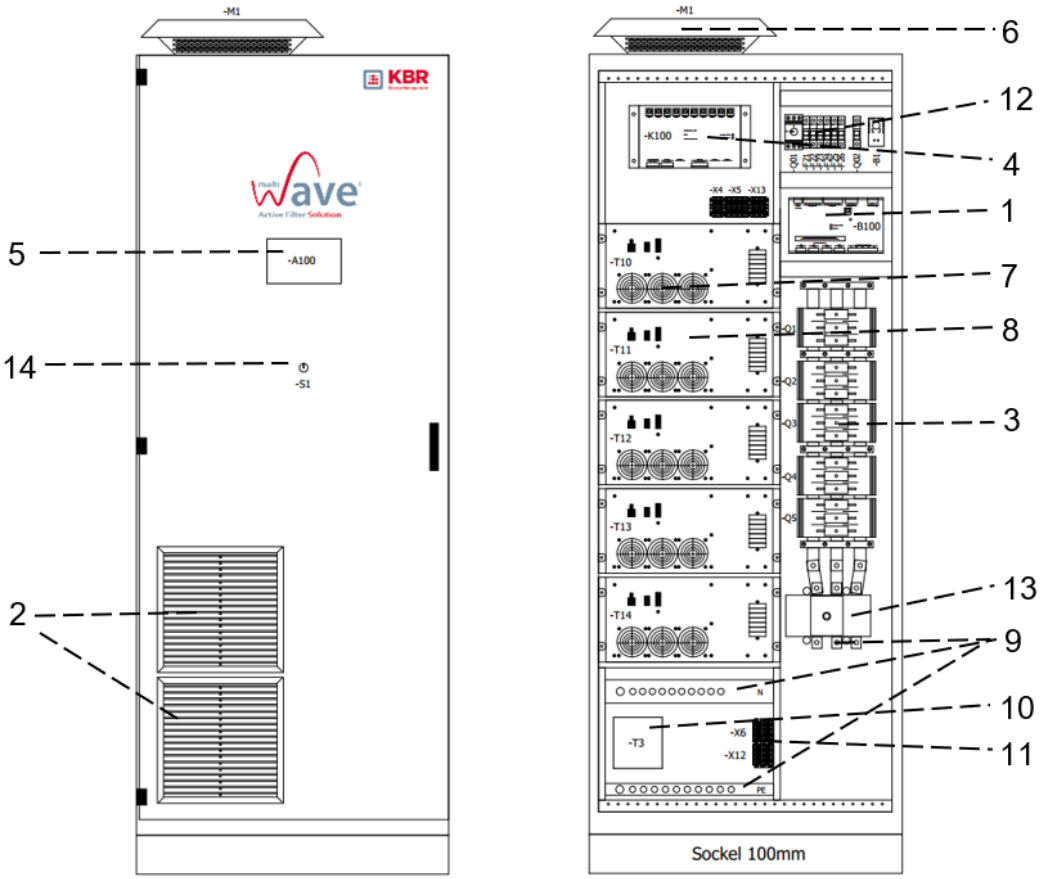
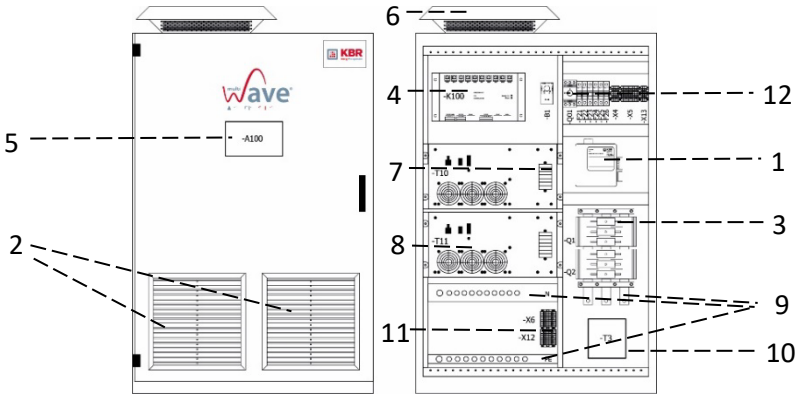


Figure 3: Main components



Number	Designation
1.	Measurement and I/O module (MIO)
2.	Air intake
3.	NH 000 fuse switch disconnector
4.	Control computer (CCU)
5.	Touch panel
6.	Roof fan
7.	Fans for power modules (IGBT module)

8.	IGBT power module (IPU)
9.	Grid connection / busbar
10.	24 V DC power supply
11.	Terminal strip
12.	Overcurrent protective devices (miniature circuit breakers)
13.	Main switch (optional)
14.	Control voltage switch (optional)

Table 8: Main components designation

6.2 Main components

6.2.1 IGBT Power Unit (IPU)

The power modules (IPU) consist of an IGBT converter with DC link capacitors including all EMC and ripple filter circuits. The overcurrent protection devices for line protection are arranged on the outside of the IPU modules in the control cabinet. The function of the IPU is to generate the compensation current.

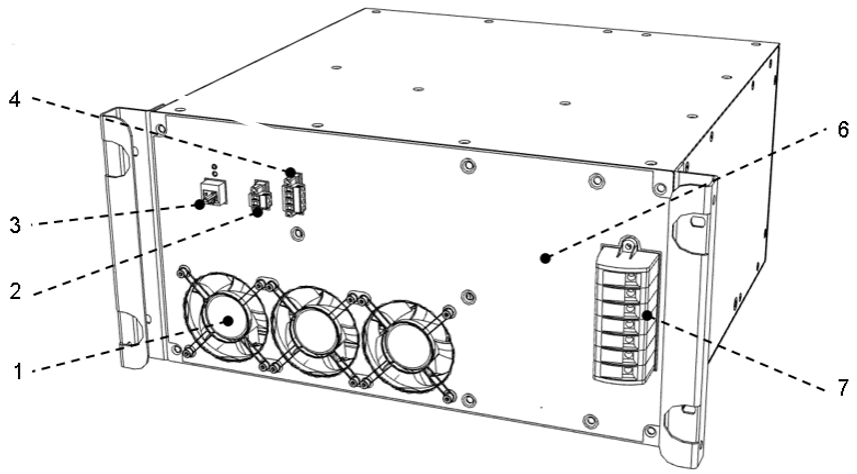


Figure 4: IGBT power unit (IPU) 60 A

Number	Designation
1	3x fans 24 V DC, can be replaced
2	24 V DC, control voltage monitoring
3	DSC connection (RJ45 – CAT5 cable)
4	24 V DC control voltage, 10 A
6	Main contactor 24 V DC, can be replaced (behind front panel)
7	Power connections L1, L2, L3, 3 x N, PE, 60 A

Table 9: IGBT power unit (IPU) 60 A

6.2.2 Control computer (CCU)

The CCU processes the measurement and control tasks with the help of a digital signal processor. The CCU has the functions of communication, measurement, control, protection and control of the power units. The operating state of the computer is signalized via LEDs. There are 3 LEDs on the front panel that signalize the 24 V supply, the 3.3 V voltage and the status/errors.

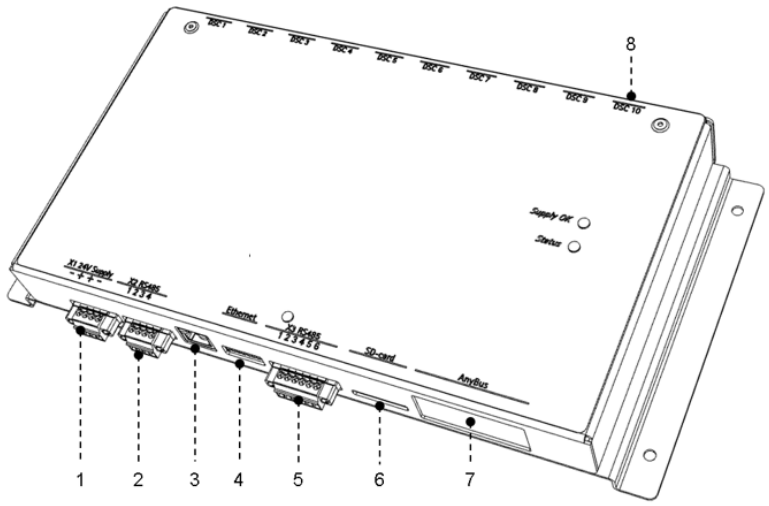


Figure 5: Control computer unit CCU

Number	Designation
1	X1 - 24 V DC control voltage, 1 A
2	X2 – RS485 interface (for touch panel only)
3	TCP/IP connection (RJ45 – CAT5 cable)
4	DIP switch for X3
5	X3 - RS485 interface (can be configured via DIP switch)
6	Slot for SD card
7	Slot for HMS Anybus module (fieldbus interface)
8	10x DSC connections (RJ45 - CAT5 cable)

Table 10: Control computer unit CCU designation

6.2.3 SD card

The control computer of the system has an SD card that can be inserted into or removed from the corresponding slot when the system is deactivated. In addition to the programs for operating the system, this memory card also contains all configured parameters.
These can be edited offline via a text editor, e.g. to set the system configuration parameters (hardware configuration) or to make general basic settings, e.g. to preset the parameter sets.

Note: All parameter settings via touch panel or Java applet are also stored on the SD card (online).

NOTICE: Parameter changes which are made directly in the text files of the SD card are not checked for plausibility. Incorrect changes can lead to malfunctions or even to irreversible hardware damage - therefore, changes may only be made by authorized personnel. The manufacturer's warranty will become void in the event of unauthorized manipulation of data on the SD card.

NOTICE: Only SD cards approved for use in the filter are permitted. If unauthorized SD cards are used, the long-term stability of the system cannot be guaranteed.

The SD cards approved for use are:

- SanDisk, 2 GB, HC, class 4
- SanDisk, 4 GB, HC, class 4
- SanDisk, 16 GB, HC, class 4
- Hama, R10, 2 GB, class 4

6.2.4 Measurement and input/output module (MIO)

Separate module for measuring line voltages and currents. Furthermore, the digital inputs and outputs as well as the ambient temperature measurement system are housed in this module. If required, one or more MIOs can also be positioned outside of the control cabinet system close to the current transformers. The connection to the control computer is established via a standard network cable or, for longer distances, via fiber-optic cables (additional fiber-optic converters required). If you would like an external connection, please contact our service department.

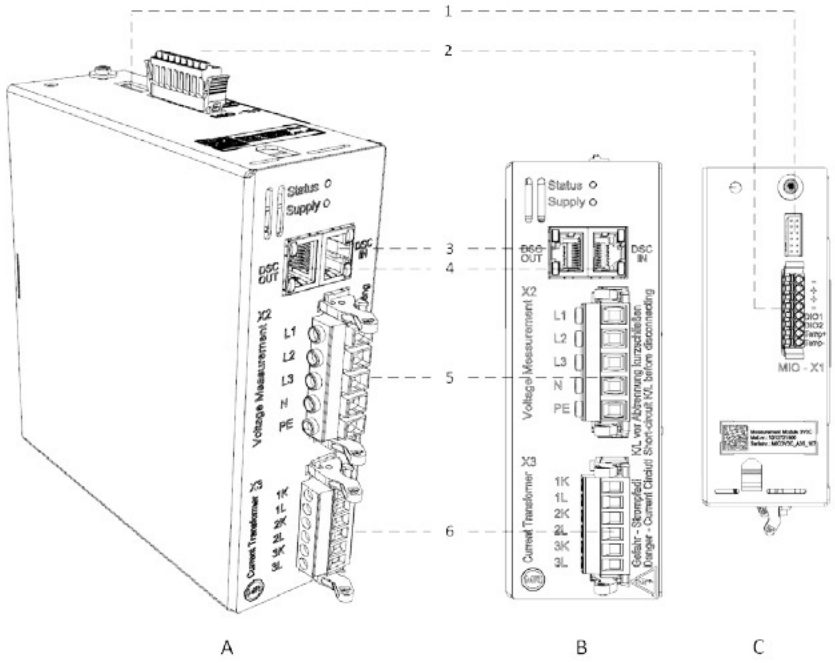


Figure 6: Measurement- and in-/output-module (MIO3V3C). View A: Trimetisch, View B: Front, View C: Top

Number	Designation
1	Four electrically isolated current inputs Measurement with high-precision A/D converter Switchable: 1 A / 5 A Overload capacity: up to 100 A for 1 second
2	Electrically isolated digital inputs and outputs 4x digital in 4x digital out
3	DSC connection (RJ45 – CAT5 cable)
4	Connection for an additional temperature measurement system
5	AC grid measurement voltage up to 1,000 V with increased overvoltage protection (CAT III)
6	24 V DC control voltage

Table 11: Measurement and input/output module (MIO) designation

6.2.5 Terminal strip X6
The terminal strip X6 is used for connecting the external current transformer. The connections can be bridged with the terminal.

6.2.6 Control Voltage switch S1 (optional)
The control voltage switch in the cabinet door is for switching the system's internal 230 V control power supply on.

6.2.7 24 V DC power supply unit T3
The 24 V DC, 40 A power supply transforms and rectifies the AC control voltage to 24 V DC.

6.2.8 Overcurrent protective devices for internal main and auxiliary circuits
The overcurrent protective devices for the internal AC main circuits (Q1 ... Q5) protect the IPUs in the event of a fault. These overcurrent protective devices comprise NH000 80 A/AC 500 V gG (max. power loss per NH fuse P_N = 7.5 W).
The control cabinet system includes a motor protective switch (Q01) for protecting the AC control circuits. Q01 protects the AC control voltage supply of the 24 V DC power supply unit.
The miniature circuit breakers F21 through F26 are used to protect the individual 24 V DC loads.

6.2.9 Touch panel (HMI)
The multiwave Active can be operated via the touch panel (Human Machine Interface - HMI) installed in the control cabinet door. The device can also be operated in the same way via a web server and Ethernet interface. Refer to the software manual for details.

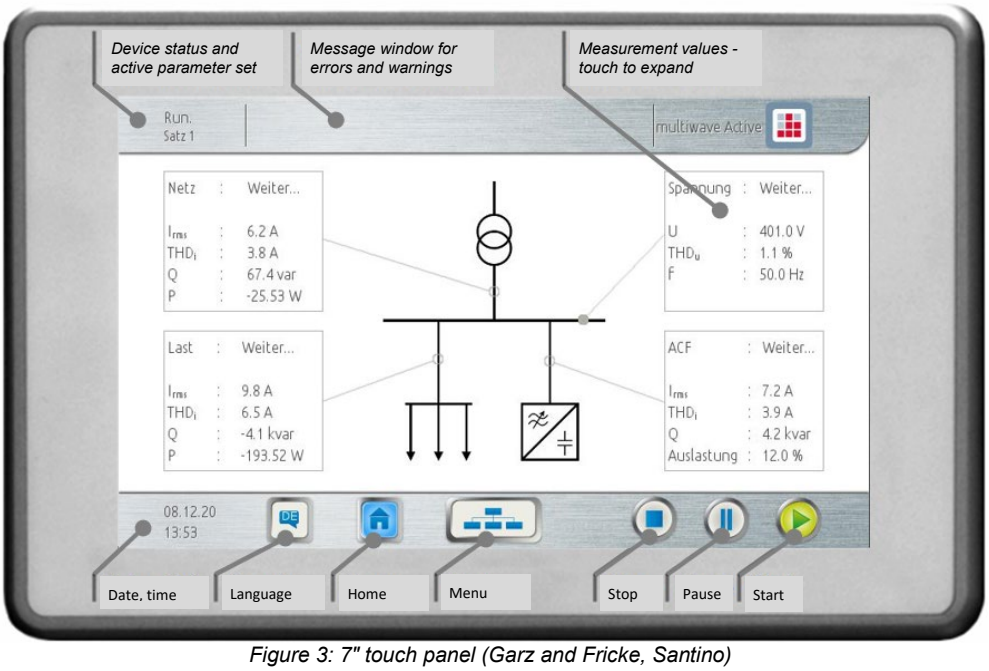


Figure 3: 7" touch panel (Garz and Fricke, Santino)

6.2.10 AC grid connection X0
The AC interfaces of the IGBT power units (IPU) are connected to the busbar of the cabinet. Connection to the AC grid is established via the marked connection points on terminal X0. When establishing this connection, please refer to the information in the corresponding chapter.

6.3 Compatibility with passive compensation systems

Unchoked compensation systems may ***not*** be operated in the same grid section as the multiwave Active filter with activated filter function.
Compensation systems must be choked with at least p = 7%. Here, it must be noted that the harmonics, that are compensated by the active filter, must be above the tuning frequencies of the passive compensation system. With tuned filter circuits, additional precautions must be taken to prevent interactions between passive and active filters. Contact the service department for further information.

6.4 Communication architecture

6.4.3 Internal communication architecture

Internal communication is via Distributed Synchronous Control® (DSC), which is responsible for real-time communication between the components. The CCU is connected to the MIOs, IPUs and other CCUs via the 10 available DSC ports. The hardware connection is made via RJ45 plugs.

The multiwave Active is operated via the touch panel. The touch panel and the CCU communicate via an RS485 interface.

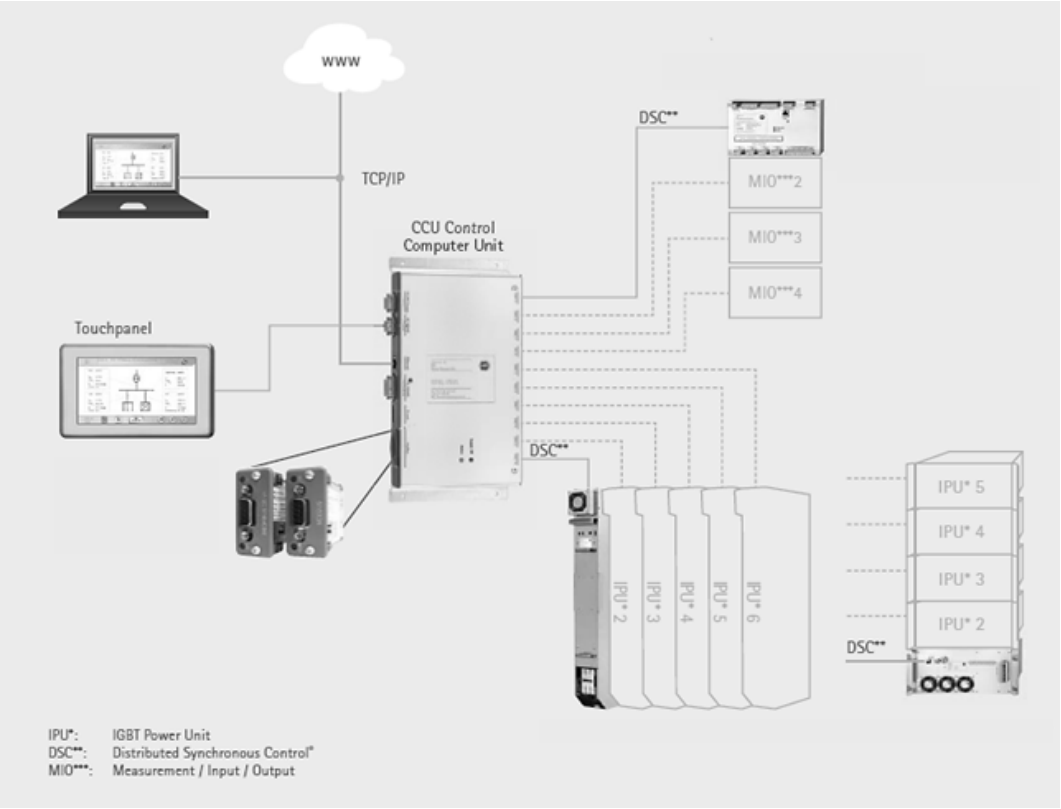


Figure 8: Internal communication architecture

6.4.4External communication architecture

A TCP/IP Ethernet interface is installed on the CCU for external communication. The internal web server of the multiwave active can be accessed via this interface. In this case, operation is performed via the web interface of the active filter. As an option, the multiwave Active can be extended with an Anybus module. This enables connection to a wide variety of bus systems, such as PROFIBUS. The bus systems that are available via the Anybus slot are not included in the standard scope of delivery. Contact your customer service agent for the procurement and software-side integration of an Anybus module.

The following Anybus modules are available:

- Modbus RTU
- PROFIBUS DP-V I
- Modbus TCP

Figure 9: External communication architecture: optional Anybus plug-in module (example: RS232)

6.5 Control process – closed loop / open loop

The active filter can be operated in two measurement transducer circuit versions:

Closed loop control process:

The current transformers are arranged upstream of the electrical connection point of load and filter in the direction of the superordinate grid. This arrangement enables the filter to measure its own effect in the grid (feedback) and thus to correct internal and external interference (e.g. inaccuracies in the current transformer). This is a closed-loop control circuit, see figure in the lower left. The advantage of this process is the high level of control accuracy and flexible adaptation to changed load conditions. Very large grid sections with many different loads can be compensated for since only one measurement, for example, is necessary at the feed-in of the distribution

Open loop control process:

The current transformers are arranged upstream of the individual load. Here, the filter operates as a power source in "controlled operation", i.e. it only measures the load current and feeds the opposing harmonic currents or fundamental oscillation into the grid. There is no feedback (open loop) of the effect, so this process is directly dependent on the fault of the converter, see figure below, right.

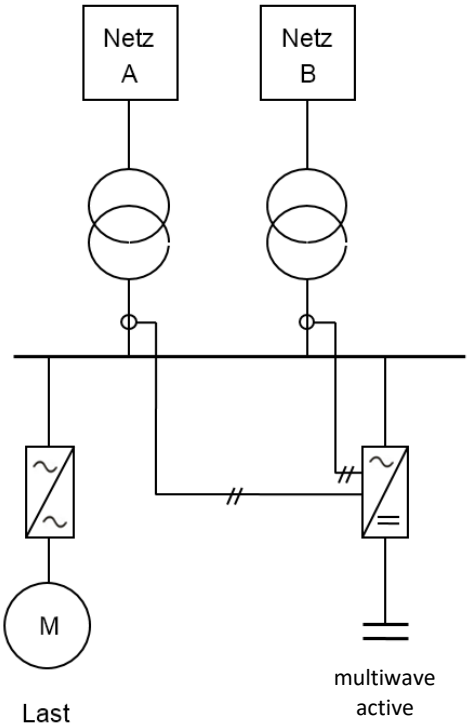
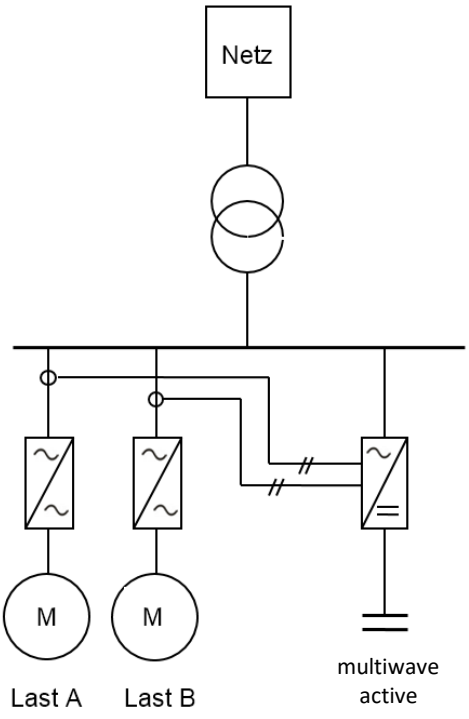


Figure 10: Closed loop



Open loop

7 Installation

This chapter includes mechanical and electrical installations.

WARNING: Danger to life due to short circuits and electric shock. Only perform work when no voltages are present.

NOTE: The individual dimensions, weights and design details may vary depending on the version ordered. Please check the individual technical data based on the supplied wiring manual

7.1 Transport and storage conditions

Before unpacking the active filter we recommend that it is placed as close to the installation location as possible in order to avoid transport-related damage. Please use the delivery packaging provided by KBR.

7.1.1 Removing the transport protection

Before removing the transport protection, please make sure that the packaging is not damaged, that the delivery is complete and that any shock indicators present have not been triggered.
Furthermore, it must be noted for transport purposes that the system with packaging can weigh up to 600 kg.

NOTE: Damaged packaging may indicate improper transportation that has also caused damage inside the unit.

7.1.2 Lifting and transport

The weight must be taken into consideration during lifting and transport. The cabinet system may only be moved with lifting gear approved for this purpose. Only use the transport lugs on the top of the cabinet system as suspension points. When lifting with a cable hoist, the cable hoist angle must be at least 60°.

NOTE: The control cabinet may only be transported in an upright position.
Please note that the system may be top-heavy.

WARNING: Please ensure that the control cabinet is placed on a stable surface and that no loads or forces cause the active filter to tip over.

Designation	Value	Note
Weight load	Min. 4570 N or min. load bearing capacity 600 kg	Select suitable lifting gear
Cable hoist angle	Min. 60°	

Table 12: Selection of suitable lifting gear

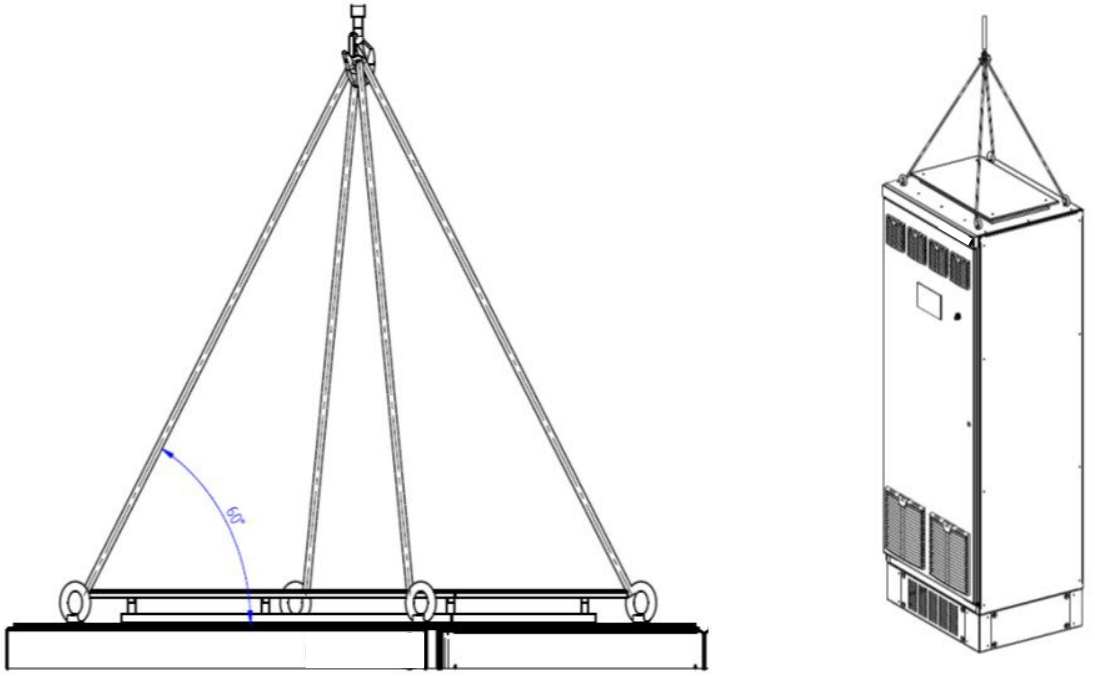


Figure 11: Transport example with cable hoist

7.2 Mechanical dimensions

7.3.1 Standard version

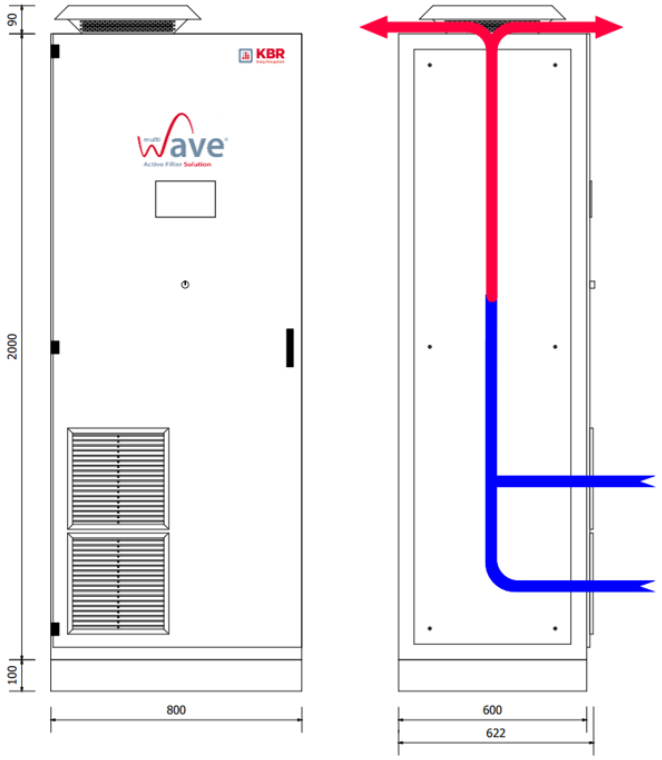


Figure 12: Cabinet: Dimensions with 100 mm base

7.3.2 Floor area

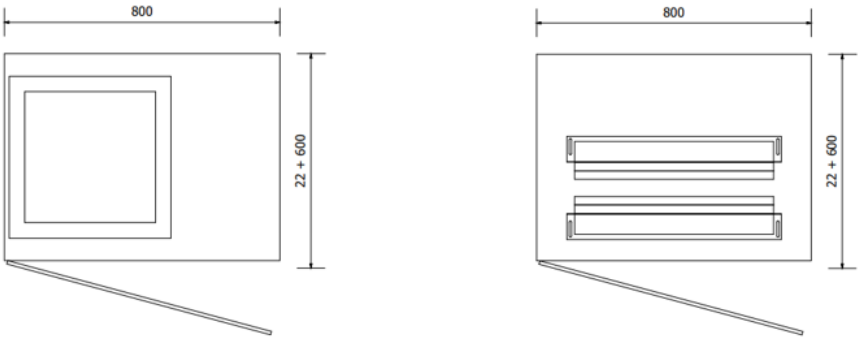


Figure 13: Cabinet: View from above and from below

7.3 Ambient conditions

Vibration test	EN 60068-2-6
Relative humidity during operation	Max. 95% (IEC 721-3-3; Class 3K3, non-condensing)
Ambient temperature at full output current	Max. 40 °C (short-term t <2 h)
Ambient temperature at full output current	Max. 35 °C (t >24 hours)
Recommended ambient temperature	25 °C (annual mean value)
Minimum ambient temperature during operation	0 °C
Temperature during storage/transport	-20 to +70 °C
Max. altitude above MSL without reduction	2000 m

Table 13: Ambient conditions

7.3.1 Operating voltages when used at altitudes > 2,000 m

Due to the limited insulation resistance, the permissible operating voltages are reduced as the altitude increases:

Altitude above MSL in m	Umax	Overvoltage category
Up to 2,000	1.1 pu	CAT III, 300 V
Up to 3,000	1.1 pu	CAT II, 300 V

Table 14: Permissible operating voltages for use at altitudes > 2,000 m

The maximum installation altitude without a reduction of the output power is 2,000 m. If operated at altitudes above 2,000 m, the overvoltage category changes from CAT III to CAT II. The operator is responsible for selecting and installing suitable overvoltage arresters at the connection point.

7.3.2 Power reduction for use at altitudes > 2,000 m

The cooling effect of the system reduces with increased altitude. For this reason, a thermal reduction of the output power is to be expected at an altitude of more than 2,000 m:

Altitude above MSL in m	Pressure	I_N in A at θmax = 35 °C	I_N in A at θmax = 25 °C
Up to 2,000	800 hPa	60	60
Up to 3,000	700 hPa	50	60

Table 15: Power reduction for use at altitudes > 2000 m

The power is only reduced automatically when monitored components reach the individually permissible operating temperature.

7.4 Setup/cooling

Only set up the system on a firm, stable foundation, considering locally permissible loads. The cabinet is designed for mounting on an open double floor. If the mounting location does not have a double floor, then an optional base with a height of 200 mm is required.

NOTICE: In both cases, ensure sufficient ventilation to dissipate the power loss.

The cooling air flow necessary depends on the number of installed power modules, the operating conditions and the load changes. The following table specifies the maximum air flow rate required per model:

Product versions	Maximum thermal power loss at P_N, U_N	Cooling air flow rate
multiwave active 060-400-4	1,100 W	500 m³/h
multiwave active 120-400-4	2,200 W	1,000 m³/h
multiwave active 180-400-4	3,200 W	1,500 m³/h
multiwave active 240-400-4	4,300 W	2,000 m³/h
multiwave active 300-400-4	5,500 W	2,500 m³/h

Table 16: Cooling air requirement

7.5 Clearances to walls / other systems

The system must be positioned such that the minimum clearance to walls, ceilings and other devices is complied with:

Side	Rear panel	Ceiling
----	----	200 mm

Table 17: Minimum clearances

Please also ensure that there is a clear space for the swivel range of the door.

The installation area is to be selected in accordance with the Technical Rules for Workplaces to ensure that all requirements are met.

7.6 Cooling

The active filter is cooled via forced airflow. The axial fans integrated into the IPUs draw the ambient air in via the air inlet grille in the lower part of the control cabinet door and force the heated exhaust air out through the cover plate. See figures in 7.2 Mechanical dimensions.

NOTICE: Ensure that the air inlet openings are not blocked or soiled. The air for cooling may not contain any conductive or corrosive gases.
Ensure that no filter mats are installed over the air intake openings. If there are, this will reduce the necessary air flow and can cause the system to reduce its output power.

8 Electrical connection

Overview of the connection points and integrated devices:

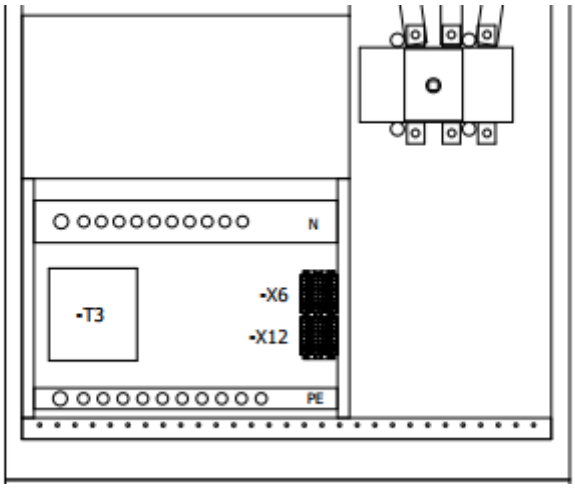


Figure 44: multiwave Active connection points and integrated devices

Designation	Description
X0	Grid connection (L1; L2; L3; N; PE)
X6	Current transformer terminals
X12	Communications lines MIO
T3	24 V DC power supply unit

Table 18: Connection points and integrated devices designation

8.1 Connecting the system

The system is equipped with busbar connection X0 and terminal strip X6 for the current transformers, and X12 for the communication lines.

8.1.1 AC grid connection X0

Prior to connection, ensure that all fuse switch disconnectors Q1 to Q5 are open and switch S1 (optional) is set to the "OFF" position.

WARNING: Only open the fuse switch disconnectors in a load-free state.

Grid connection X0 is located in the lower right-hand area of the cabinet. The connection is protected against contact behind a plastic cover.

Work is to be performed in the following sequence:

- Open fuse switch disconnectors Q1 to Q5
- Remove the protection against contact
- Open the cable entry
- Insert the cables
- Connect the cables at the connection point, torque: M10=40 Nm, M12=70 Nm
- Install the cable retainer
- Seal the cable entry
- Mount the protection against contact

WARNING: When connecting the power cables to the active filter, the overcurrent protection devices (Q1..5) and Q01 must be open. After operating the active filter, a discharge period of 20 minutes must be observed to ensure that the DC link capacitor has discharged to safe voltages. The absence of voltage must be ensured before work may be carried out on the grid connection. Failure to observe these notes can result in severe injury or death.

The protective conductor and, if necessary, the neutral conductor (PE/N) must also be connected to the corresponding connections on X0. The minimum cross section is to be in accordance with the respective regulations.

WARNING: The neutral conductor (N) must always be rated to withstand 3x the phase conductor current. If this is not possible, this neutral conductor current must be monitored.

WARNING: The phase orientation is to be checked. The protective conductor (PE) must be connected to the PE copper rail. Observe the separation of the PE and N conductors in a TN-S grid.

8.1.2 AC grid supply lines

The multiwave active must be fused on the grid side by means of suitable fuses or a circuit breaker. When selecting the fuses and cable dimensions, the ambient conditions, the harmonic content, load change cycles and the type of installation must be considered.

Fuse replacements must be documented so they can be tracked.

To ensure that the grid supply to the active filter is not overloaded due to the skin effect, it is recommended that the supply lines be rated to withstand at least 1.2 x the rated current. To simplify installation, we recommend the use of single cables that are laid parallel to each other.

The non-binding recommendations are listed in the tables below, considering the relevant standards (e.g. IEC 60364-5-52) and, if applicable, differing types of application and installation. The final choice of the cable cross-section is the responsibility of the operator or the installation company, considering the applicable directives and guidelines:

Product versions	AC current [Aeff]	Recommended preliminary fuse [A]	Recommended conductor cross section per phase and protective [mm²]	Recommended conductor cross section neutral [mm²]
multiwave active 060-400-4	60	100	3x 35 / 16	3x 35 oder 1x150
multiwave active 120-400-4	120	200	3x 95 / 50	3x 95 oder 2x150
multiwave active 180-400-4	180	315	3x 150 / 70	3x 150 oder 2x240
multiwave active 240-400-4	240	400	3x 240 / 120	3x 240 oder 4x150
multiwave active 300-400-4	300	400	3x 240 / 120	3x 240 oder 4x150

Table 19: Recommended AC line dimensioning and preliminary fuses

8.1.3 IPU short-circuit protection

The power units (IPUs) are fused on the AC side with NH000 80A gG fuses. Only fuse links of the same type may be used. An external short-circuit limiting overcurrent protection device, such as a circuit breaker or fuse links must be installed to protect the busbar and the supply lines. The expected short-circuit current must not exceed the current carrying capacity of the busbar of 39 kA / 1s.

NOTE: Fuse links may only be replaced by links of the same rated data, the respective type is to be found in the parts list of the circuit manual.

8.2 Current transformers

The correct positioning and assignment of the grid-side current transformers as well as the correct direction of current flow is decisive for the correct function of the system, see section 6.8, Control process. The assignment of the current transformers to the measurement inputs can be changed via parameterization of the software. Details on this can be found in the respective software operating instructions.

8.2.1 Selection and configuration of the current transformers

At least three current transformers each for phases L1, L2, and L3 in a four-wire installation are necessary. Multiple current measurements of the same phase within a connected electrical grid can be internally added up to create a single measurement, whereby all four current inputs of the first MIO or other optional MIOs are used.

8.2.2 Specification of the current transformers

When installing the current transformers, it must be ensured that the technical data satisfies the following requirements:

Characteristic	Specification of the current transformer
Accuracy class	1.0 (or better)
Primary current	Must be selected based on the maximum occurring current (including harmonics and transients).
Secondary current	1 A or 5 A
Output power	Minimum 5 VA

Table 20: Current transformer specification

The output power of the current transformer is to be calculated based on the cable length / cross section of the current transformer circuit and the input load of the multiwave Active of 0.5 VA. The cable should be rated to withstand at least twice the continuous rated secondary current of the current transformer at ambient temperature.

8.2.3 Connection of the current transformers

The external current transformers are to be connected via terminal strip X6 on the multiwave Active.

WARNING: The secondary circuit of the current transformer must always be short-circuited during installation work. The secondary current circuit may not be opened under any circumstances. Failure to observe these notes can result in severe injury or death.

It must be ensured that the assignment of the current transformers corresponds to the phase assignment of the voltage measurement. It must be ensured that k and l are not reversed.

NOTE: If the k and l connections of the current transformers are reversed, the current signal can be inverted by entering a negative primary current in the software settings of the corresponding MIO current measurement input.

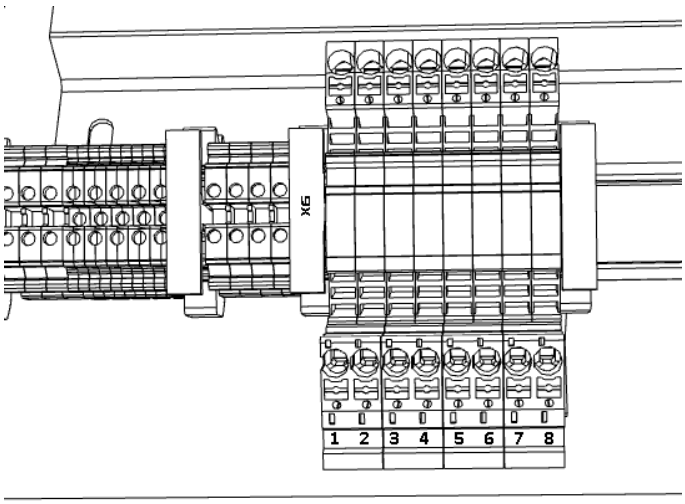


Figure 15: Current transformer terminals for connecting the external current transformers

Connection terminals for current transformers X6	Standard assignment – 4-wire
X6:01	k (L1)
X6:02	l (L1)
X6:03	k (L2)
X6:04	l (L2)
X6:05	k (L3)
X6:06	l (L3)

Table 21: Connection terminals for current transformers

8.3 Digital inputs and outputs

The digital inputs and outputs (DI/DO) are connected directly to the terminal X12. The functions of the individual DI/DOs are configured via software. Details are to be found in the respective software operating instructions.

Digital outputs	MIO terminal	Digital inputs	MIO terminal
230 V (optional +24 VDC)	1	COM	3
N (optional 0 VDC	2	NO	4
		NC	5

Table 22: Terminal assignment of the digital inputs and outputs (DI/DO)

Please ensure compliance with the following rated data of the digital inputs and outputs.

- Rated data of the digital outputs (DO) – Configured as floating relay contacts:
  250 V AC (10 A) / 24 V DC (10 A)
- Rated data of the digital inputs (DI) – configured as 230 V:
- Optional: optocoupler 24 V DC (10 mA)

9 Commissioning and operation

Prior to commissioning, please check:

- That grid connections L1, L2, L3 and the correct copper rail connections are connected.
- That the current transformers are connected to the correct terminals. The installation location, phase assignment and direction of current flow are also to checked for correctness.

The system is configured, commissioned and operated via the touch panel in the front door.

9.1 Closing fuse switch disconnectors Q1...Qn

Once all the aforementioned checks have been successfully completed, the main fuses Q1 to Qn can be closed.

9.2 Closing protective switch Q01

Actuating the motor protective switch Q01 switches on the auxiliary circuits across the control transformer and the 24 V DC power supply unit.

Check that:

- The control computer starts correctly
- The 24 V DC control voltage supply functions correctly
- The fans start correctly
- The optional touch panel lights up and functions

9.3 Touch panel

The touch panel can be used to easily set parameters, check operating states, and display the measured data and system state during operation.
System and filter settings are selected in the menu structure. For commissioning, configure every single sub-items of the menus SYSTEM and CONTROL. Only start the system once this has been completed.

WARNING: Incorrect configuration can lead to instability and errors as well as damage to the electrical system.

10 Maintenance

10.1 Maintenance information

Regular maintenance work in accordance with the maintenance schedule is necessary to ensure that the system has a long service life. Furthermore, the filter system must be cleaned regularly.

WARNING: Maintenance work may only be carried out if the multiwave Active is electrically disconnected. Electrostatic discharges are to be avoided because the power electronics are sensitive. Dust, and conductive dust in particular, can destroy the power electronics. Failure to observe these notes can result in severe injury or death.

The warranty will become void in the event of non-compliance or the maintenance measures being performed incorrectly.

In each case, inspections – such as those listed in section 10.2 – are to be performed at intervals of a maximum of 12 months.

10.2 Maintenance schedule

The system must be disconnected in accordance with the 5 safety rules prior to performing any maintenance work. The following checks are to be performed annually:

- General visual inspection
- Check replacement parts and accessories to ensure they are complete and in good condition
- Clean the system interior and exterior to remove heavy soiling, check connections, ensure secure positioning of screws and retighten them at contact points
- Examination of the switching devices for smoke traces and soiling
  Examination of the system for smoke traces and formation of creepage paths
- Check the overvoltage protective devices for actuation and secure positioning
- Check the function of the fans and clean if necessary; under extreme conditions (permanent operation at maximum temperature and power), the fans must be replaced every 2-3 years, under moderate conditions every 5 years.
- Examine the DC link capacitors. These are to be replaced after 5-10 years depending on the operating conditions.
- Clean the ventilation openings in the compensation cabinet, check filter mats (if installed) and replace if necessary
- Check the function and recommission the system.

If defects are found, the cause is to be identified and the affected components replaced. Dust in the control cabinet is to be removed appropriately.

Perform maintenance and care work at shorter intervals if the system is installed in a harsh environment.

10.2.1 Type of Touch panel internal battery

The touch panel Santino 7.0 have a backup battery for the display (time and date) which has a life of more than 10 years. When replacing these devices, only use the following types:

Battery manufacturer	Type
Camelion	CR1220
Renata	CR1220 MFR
Alpha 3 Manufacturing Ltd.	YOBCR1220
Keystone	1220
Maxell	CR1220

Table 23: Santino 7.0 battery types

10.2.2 Replacing the touch panel battery

- The battery is situated on the main board, see figure below.
- The SD card must be removed prior to replacement.
- The device should only be opened by a technically instructed person.

If different battery types are installed, there is a risk of damage to the touch panel.

Observe the user guide of the manufacturer Garz and Fricke. See Associated documents.

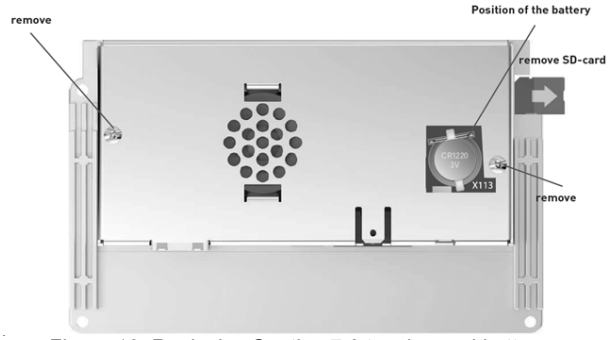


Figure 16: Replacing Santino 7.0 touch panel battery

There is a risk of explosion if the battery is replaced with an incorrect type. Replace the battery only with a lithium battery of the same or equivalent type recommended by Garz & Fricke GmbH. Entsorgen Sie verbrauchte CMOS-Batterien nicht im Hausmüll.

Dispose of the battery in accordance with local regulations for the disposal of these special materials (e.g. at collection points for the disposal of batteries).

11 Disassembly and disposal

11.1 Service life

The systems have a planned service life of 10 years in continuous operation. The mechanical equipment, e.g. contactors and fans, are subject to different loads depending on the ambient and grid conditions and may need to be replaced earlier. See Maintenance schedule.

11.2 Disassembly

Disassemble the system in the reverse order of the installation process.

11.3 Disposal

Separate the raw materials of the system according to disposal type and basic material. The components containing copper, such as the busbars and lines, can be recycled. The equipment, such as contactors, fuses, capacitors, regulators and terminals are to be disposed of as electronic waste. The components may not be disposed of as household waste, because they may contain small traces of heavy metals due to leaded solder or halogen compounds and PVC. The system housing and the mounting plates can be recycled as metal waste