

ACTIVE and ACTIVE Cube

Installation manual - Cold Plate
Frequency Inverter 230V / 400V



General points on the documentation

This documentation is valid for the frequency inverter series ACT and ACU in "Cold Plate" variant (type designation ACT xxx-xxx C, ACU xxx-xxx C).

The "Cold Plate" variant differs from the frequency inverter series ACT and ACU described in the instructions only as regards the design of the heat sink. The installation instructions complement the documentation by the information relating to the variant details. For all other instructions and information, in particular the safety instructions, refer to the instructions included in the scope of supply.

The documentation and additional information can be requested via your local representation of the company BONFIGLIOLI.

The following pictograms and signal words are used for the purposes of the present documentation:



Danger

Danger refers to an immediate threat. Non-compliance with the precaution described may result in death, serious injury or material damage.



Warning

Warning refers to a possible threat. Non-compliance with the warning may result in death, serious injury or material damage.



Caution

Caution refers to an indirect threat. Non-compliance may result in personal or material damage.

Attention

Attention refers to a possible operational behavior or an undesired condition that can occur in accordance with the reference text.

Note

Note and the related text provide useful information which supplements the corresponding part of the documentation.



Warning: The specifications and instructions contained in the documentation must be complied with strictly during installation and commissioning. Only qualified staff who has read the documentation and, in particular, the safety instructions carefully is allowed to carry out installation or commissioning work or to operate the frequency inverters. The term „Qualified Staff“ refers to anybody who is familiar with the installation, assembly, commissioning and operation of the frequency inverter and has the proper qualification for the job.

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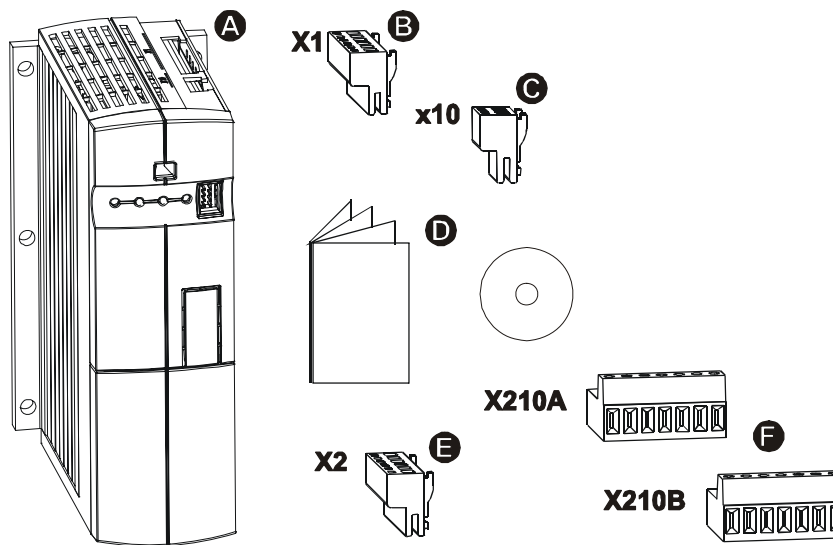
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1 Scope of Supply for Devices in "Cold Plate" Variant

The scope of supply of the "Cold Plate" variant differs from the scope defined in the operating instructions as regards the heat sink design and the standard fixtures which are not required in this variant.

1.1 ACT/ACU 201 (up to 3.0 kW) and ACT/ACU 401 (up to 4.0 kW)

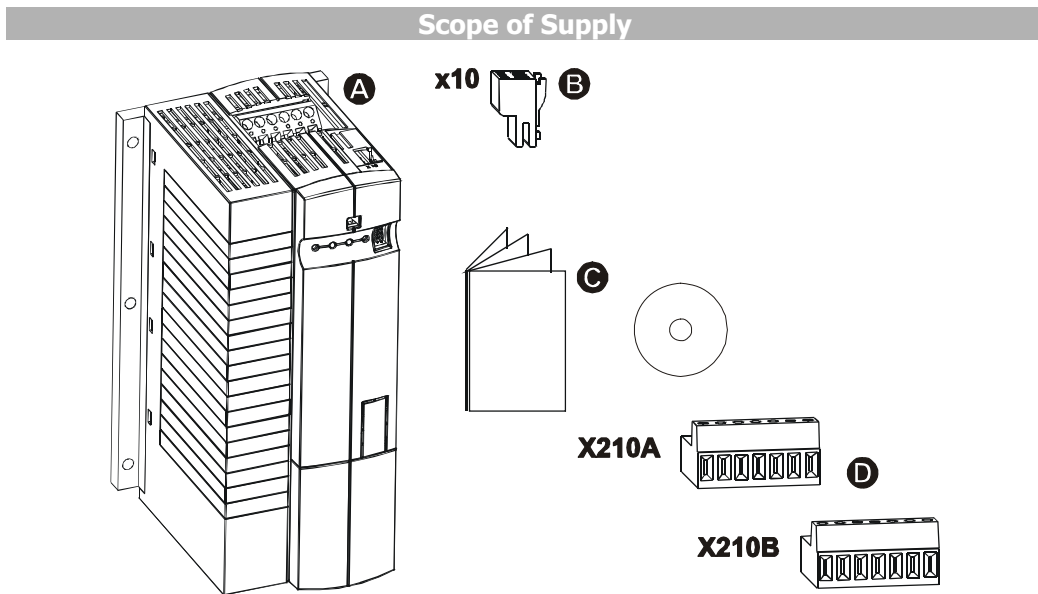
Scope of Supply



Scope of supply	
A	Frequency inverter
B	Terminal bar X1 (Phoenix ZEC 1,5/ST7,5) Plug-in terminals for mains connection and DC networking
C	Terminal bar X10 (Phoenix ZEC 1,5/3ST5,0) Plug-in terminals for relay output
D	Instructions and installation instructions for the device in "Cold Plate" variant, CD ROM with manuals
E	Terminal bar X2 (Phoenix ZEC 1,5/ST7,5) Plug-in terminal for braking resistor and motor connection
F	Control terminals X210A / X210B (Wieland DST85/RM3,5) Plug-in terminal for connection of control signals

Note: Immediately check the goods received for quality, quantity and type. Obvious defects such as exterior damage of the packing and/or the unit must be notified to the sender within seven days for insurance reasons.

1.2 ACT/ACU 201 (4.0 to 9.2 kW) and ACT/ACU 401 (5.5 to 15.0 kW)

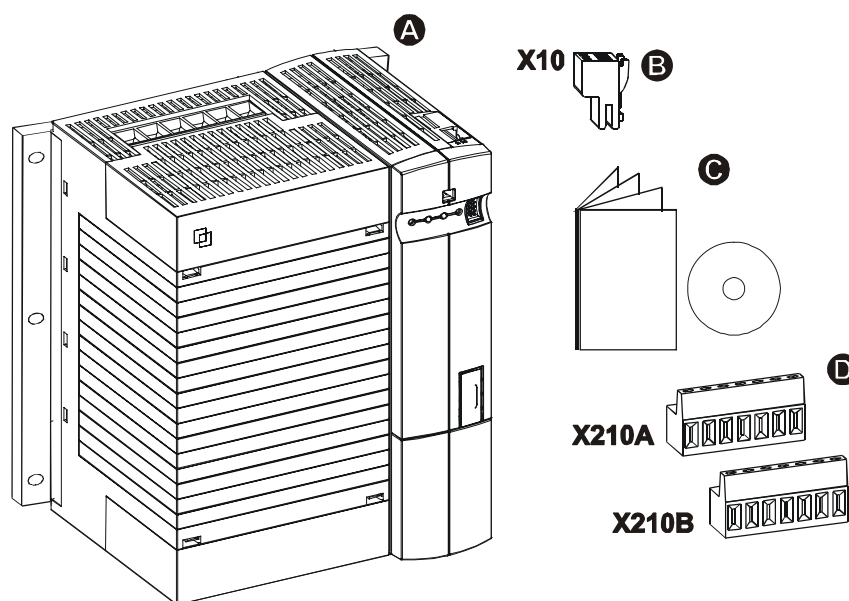


Scope of supply	
A	Frequency inverter
B	Terminal bar X10 (Phoenix ZEC 1,5/3ST5,0) Plug-in terminals for relay output
C	Instructions and installation instructions for the device in "Cold Plate" variant, CD ROM with manuals
D	Control terminal X210A / X210B (Wieland DST85/RM3,5) Plug-in terminal for connection of control signals

Note: Immediately check the goods received for quality, quantity and type. Obvious defects such as exterior damage of the packing and/or the unit must be notified to the sender within seven days for insurance reasons.

1.3 ACT/ACU 401 (18.5 to 30.0 kW)

Scope of Supply



Scope of supply

A	Frequency inverter
B	Terminal bar X10 (Phoenix ZEC 1,5/3ST5,0) Plug-in terminals for relay output
C	Instructions and installation instructions for the device in "Cold Plate" variant, CD ROM with manuals
D	Control terminal X210A / X210B (Wieland DST85/RM3,5) Plug-in terminal for connection of control signals

Note: Immediately check the goods received for quality, quantity and type. Obvious defects such as exterior damage of the packing and/or the unit must be notified to the sender within seven days for insurance reasons.

2 Technical data

The following tables contain the technical data of the frequency inverter series ACT and ACU in the "Cold Plate" variant. The recommended motor shaft output applies to the corresponding nominal voltage of the frequency inverter according to the instructions at a switching frequency of 2 kHz. The weights and dimensions differ from the data listed in the instructions. The dimensions are valid for the frequency inverter without plug-in terminals and with cold plate in the "Cold Plate" device variant. For the other technical data refer to the enclosed instructions.

2.1 ACT/ACU 201 (0.55 to 3.0 kW, 230 V)

Type designation								
ACT/ACU 201			-05	-07	-09	-11	-13	-15
Motor-side output								
Recommended motor shaft output	P	kW	0.55	0.75	1.1	1.5	2.2	3.0
Mechanical								
Dimensions	HxWxD	mm	190x82x140			250x85x140		
Weight (approx.)	m	kg	1.2			1.6		
Type of protection	-	-	IP20 (EN60529)					
Installation position	-	-	vertical					
Environmental conditions								
Energy dissipation (at 2 kHz switching frequency)	P	W	43	53	73	84	115	170
Coolant temperature	Tn	°C	0 ... 40 (3K3 DIN IEC 721-3-3)					

2.2 ACT/ACU 201 (4.0 to 9.2 kW, 230 V)

Type designation						
ACT/ACU 201			-18	-19	-21	-22
Motor-side output						
Recommended motor shaft output	P	kW	4.0	5.5	7.5	9.2
Mechanical						
Dimensions	HxWxD	mm	250x125x144		250x150x144	
Weight (approx.)	m	kg	2.2		3.1	
Type of protection	-	-	IP20 (EN60529)			
Installation position	-	-	vertical			
Environmental conditions						
Energy dissipation (at 2 kHz switching frequency)	P	W	200	225	310	420
Coolant temperature	Tn	°C	0 ... 40 (3K3 DIN IEC 721-3-3)			

2.3 ACT/ACU 401 (0.55 to 4.0 kW, 400 V)

Type designation										
ACT/ACU 401			-05	-07	-09	-11	-12	-13	-15	-18
Motor-side output										
Recommended motor shaft output	P	kW	0.55	0.75	1.1	1.5	1.85	2.2	3.0	4.0
Mechanical										
Dimensions	HxWxD	mm	190x82x140				250x85x140			
Weight (approx.)	m	kg	1.2				1.6			
Type of protection	-	-	IP20 (EN60529)							
Installation position	-	-	vertical							
Environmental conditions										
Energy dissipation (at 2 kHz switching frequency)	P	W	40	46	58	68	68	87	115	130
Coolant temperature	Tn	°C	0 ... 40 (3K3 DIN IEC 721-3-3)							

2.4 ACT/ACU 401 (5.5 to 15.0 kW, 400 V)

Type designation							
ACT/ACU 401			-19	-21	-22	-23	-25
Motor-side output							
Recommended motor shaft output	P	kW	5.5	7.5	9.2	11.0	15.0
Mechanical							
Dimensions	HxWxD	mm	250x125x144			250x150x144	
Weight (approx.)	m	kg	2.2			3.1	
Type of protection	-	-	IP20 (EN60529)				
Installation position	-	-	vertical				
Environmental conditions							
Energy dissipation (at 2 kHz switching frequency)	P	W	145	200	225	240	310
Coolant temperature	Tn	°C	0 ... 40 (3K3 DIN IEC 721-3-3)				

2.5 ACT/ACU 401 (18.5 to 30.0 kW, 400 V)

Type designation					
ACT/ACU 401			-27	-29	-31
Motor-side output					
Recommended motor shaft output	P	kW	18.5	22.0	30.0
Mechanical					
Dimensions	HxWxD	mm	250x225x171		
Weight (approx.)	m	kg	8.0		
Type of protection	-	-	IP20 (EN60529)		
Installation position	-	-	vertical		
Environmental conditions					
Energy dissipation (at 2 kHz switching frequency)	P	W	420	470	750
Coolant temperature	Tn	°C	0 ... 40 (3K3 DIN IEC 721-3-3)		

3 Range of application



Warning: During operation, the heat sink can reach a temperature of up to 75 °C. Do not touch the heat sink during operation. The heat sink may be hot even some time after the frequency inverter was switched off.

The "Cold Plate" variant enables installation of the frequency inverter on suitable surfaces which have sufficient thermal conductivity to dissipate the heat developing during the operation of the frequency inverter.

This enables the use of the frequency inverter in the following applications:

- Installation in a housing, where a high type of protection is required but the volume of the housing limits thermal compensation.
- Use in highly polluted cooling air affecting the function and service life of the fan.
- Use of several frequency inverters in limited space conditions, e.g. installation of frequency inverters on a liquid-cooled plate (sum cooler).
- Direct assembly on (or in) a machine case, with parts of the machine constructions taking over the cooling function.

Note: Frequency inverters with a continuous output >15 kW require an improvement of the efficiency of the heat sink by means of suitable fans, liquid cooling or other measures improving the cooling capacity of the heat sink.

4 Thermal properties of the heat sink

The heat in the frequency inverter due to the energy dissipation of the electronic components (rectifier and IGBT) must be dissipated to a heat sink via the cold plate of the frequency inverter.

The capacity to dissipate this heat mainly depends on the size of the heat sink surface, the ambient temperature and the heat transmission resistance. An increase of the heat transmission rate can only be realized to a certain extent by increasing the surface of the heat sink. An additional increase of the heat dissipation by increasing the heat sink is not possible.

The frequency inverter should be mounted with the cold plate on a heat sink with the lowest thermal resistance possible.

4.1 Thermal resistance

The thermal resistance R_{th} is calculated from the difference between the maximum heat sink temperature and the ambient temperature, referred to the energy dissipation of the frequency inverter. The ambient temperature to be considered refers to the immediate environment of the frequency inverter.

$$R_{th} = \frac{T_{k\ max} - T_u}{P_v}$$

Max. permissible heat sink temperature of the frequency inverter	$T_{k\ max} = 75\ ^\circ\text{C}$
Ambient temperature of the cold plate of the frequency inverter	$T_u = 35\ ^\circ\text{C}$
Difference between the maximum heat sink temperature and the ambient temperature ($T_{k\ max} - T_u$)	$\Delta T = 40\ \text{K}$
Energy to be dissipated by the heat sink	$P_v =$ depends on type

Note: During installation, the following items must be considered in order to minimize the thermal resistance:

- The installation surface must at least be as large as the cold plate surface.
- The contact surface must be plane and have a good thermal conductivity.
- The thermal limits of the frequency inverter and the cold plate must be considered when determining the dimensions.

For the max. permissible thermal resistance R_{th} and the device-specific energy dissipation P_v , refer to the following table. The thermal resistance R_{th} is given in the unit Kelvin per Watt (K/W). Additionally, the thermal radiation of the frequency inverter is indicated.

4.1.1 ACT/ACU 201 (0.55 to 3.0 kW, 230 V)

Type designation								
ACT/ACU 201			-05	-07	-09	-11	-13	-15
Motor-side output								
Recommended motor shaft output	P	kW	0.55	0.75	1.1	1.5	2.2	3.0
Mains-side input								
Nominal voltage	U	V	230					
Energy dissipation, heat sink [2 kHz]	P_v	W	43	53	73	84	115	170
Energy dissipation, interior	$P_{v\text{int}}$	W	12	15	18	21	25	31
Thermal resistance								
Thermal resistance	R_{th}	K/W	0.93	0.75	0.55	0.48	0.35	0.24
Mechanical								
Dimensions	HxWxD	mm	190x82x140			250x85x140		
Heat sink	HxW	mm	170x82			230x85		
$T_{k\text{max}} - T_U$	ΔT	K	40					

4.1.2 ACT/ACU 201 (4.0 to 9.2 kW, 230 V)

Type designation						
ACT/ACU 201			-18	-19	-21	-22
Motor-side output						
Recommended motor shaft output	P	kW	4.0	5.5	7.5	9.2
Mains-side input						
Nominal voltage	U	V	230			
Energy dissipation, heat sink [2 kHz]	P_v	W	200	225	310	420
Energy dissipation, interior	$P_{v\text{int}}$	W	35	48	61	68
Thermal resistance						
Thermal resistance	R_{th}	K/W	0.20	0.18	0.13	0,10
Mechanical						
Dimensions	HxWxD	mm	250x125x144		250x150x144	
Heat sink	HxW	mm	230x125		230x150	
$T_{k\text{max}} - T_U$	ΔT	K	40			

4.1.3 ACT/ACU 401 (0.55 to 4.0 kW, 400 V)

Type designation										
ACT/ACU 401			-05	-07	-09	-11	-12	-13	-15	-18
Motor-side output										
Recommended motor shaft output	P	kW	0.55	0.75	1.1	1.5	1.85	2.2	3.0	4.0
Mains-side input										
Nominal voltage	U	V	400							
Energy dissipation, heat sink [2 kHz]	P_v	W	40	46	58	68	68	87	115	130
Energy dissipation, interior	$P_{v\text{int}}$	W	12	15	18	20	21	25	31	35
Thermal resistance										
Thermal resistance	R_{th}	K/W	1.0	0.87	0.69	0.59	0.59	0.46	0.35	0.31
Mechanical										
Dimensions	HxWxD	mm	190x82x140				250x85x140			
Heat sink	HxW	mm	170x82				230x85			
$T_{k\text{max}} - T_U$	ΔT	K	40							

4.1.4 ACT/ACU 401 (5.5 to 15.0 kW, 400 V)

Type designation							
ACT/ACU 401			-19	-21	-22	-23	-25
Motor-side output							
Recommended motor shaft output	P	kW	5.5	7.5	9.2	11.0	15.0
Mains-side input							
Nominal voltage	U	V	400				
Energy dissipation, heat sink [2 kHz]	P_v	W	145	200	225	240	310
Energy dissipation, interior	$P_{v\text{int}}$	W	48	61	68	81	107
Thermal resistance							
Thermal resistance	R_{th}	K/W	0.24	0.18	0.16	0.15	0.11
Mechanical							
Dimensions	HxWxD	mm	250x125x144			250x150x144	
Heat sink	HxW	mm	230x125			230x150	
$T_{k\text{max}} - T_U$	ΔT	K	40				

4.1.5 ACT/ACU 401 (18.5 to 30.0 kW, 400 V)

Type designation					
ACT/ACU 401			-27	-29	-31
Motor-side output					
Recommended motor shaft output	P	kW	18.5	22.0	30.0
Mains-side input					
Nominal voltage	U	V	400		
Energy dissipation, heat sink [2 kHz]	P_v	W	420	470	750
Energy dissipation, interior	$P_{v\ int}$	W	160	175	265
Thermal resistance					
Thermal resistance	R_{th}	K/W	0.08	0.07	0.05
Mechanical					
Dimensions	HxWxD	mm	250x225x171		
Heat sink	HxW	mm	230x225		
$T_{k\ max} - T_U$	ΔT	K	40		

The thermal resistance values and the technical data referring to the cooling concept of the "Cold Plate" variant indicated in the above table apply in the following conditions:

- no airflow
- clearance of approx. 300 mm above and below as well as 100 mm on both the left and right side of the frequency inverter
- The energy dissipation values are valid for a switching frequency of 2 kHz. The energy dissipation values are also valid for the other switching frequencies, as at these operating points, the output current is reduced. For the output current reduction to be considered, refer to the chapter "Technical Data" in the instructions.

4.2 Fan and liquid cooling

The size of the heat sinks can be reduced if fans are installed or a liquid cooling system is used in addition to the "Cold Plate" technology.

The size of the heat sink can be reduced proportionally to the increase in the flow rate of the cooling medium.

In the following a fan cooling system is described as an example. For calculating the maximum permissible heat resistance $R_{th\ enforced}$ for cooling by means of a fan, a proportionality factor is introduced. This factor describes the increase of the max. permissible thermal resistance at increasing flow rate of the cooling air.

The max. permissible thermal resistance $R_{th\ enforced}$ for enforced air cooling can be calculated as follows:

$$R_{th\ enforced} = \frac{R_{th}}{\alpha}$$

R_{th} : max. permissible thermal resistance with free circulation of air; calculate according to the formula for R_{th} in the previous chapter or use the value indicated in the table, α : proportionality factor

The relation is shown, as an example, in the following table for the ACT401-27 frequency inverter.

Thermal resistance for enforced air cooling			
R_{th} [K/W]	V_{air} [m/s]	α	$R_{th\ enforced}$ [K/W]
0.08	0	1	0.08
0.08	1	0.65	0.12
0.08	2	0.45	0.18
0.08	4	0.28	0.29
0.08	6	0.20	0.40

5 Application notes

- Note the operating diagrams for power reductions (derating) in the instructions.
- The temperature of the cold plates of the frequency inverters must not exceed $T_{kmax} = 75\text{ °C}$ for a nominal power of 0.55...3.0 kW and $T_{kmax} = 70\text{ °C}$ for a nominal power of 4.0...18.5 kW.
- Additional power losses $P_{v\ int}$ are dissipated as heat into the interior of a control cabinet. These losses may amount to 30% of the total energy dissipation and must be considered in the calculation of the volume of the control cabinet. The values are listed in the tables in chapter "Thermal resistance".
- If several frequency inverters or other heat-producing devices are mounted on a common heat sink (sum cooler), the losses of all devices must be added up. Calculate the max. permissible thermal resistance R_{th} using the formula (chapter "Thermal resistance").
- The contact surface of the heat sink must at least be as large as the contact surface of the cold plate of the frequency inverter.
- The contact surfaces of the heat sink and the cold plate of the frequency inverter must be plane.
- Black anodized heat sinks are particularly suitable. If free convection is guaranteed, these heat sinks have a thermal resistance which is 5...10% lower than that of untreated heat sinks.

6 Mechanical installation

The frequency inverters in the "Cold Plate" variant are designed for installation on surfaces which comply with the specifications listed in these installation instructions. During installation, both the installation and the safety instructions as well as the device specifications must be complied with.



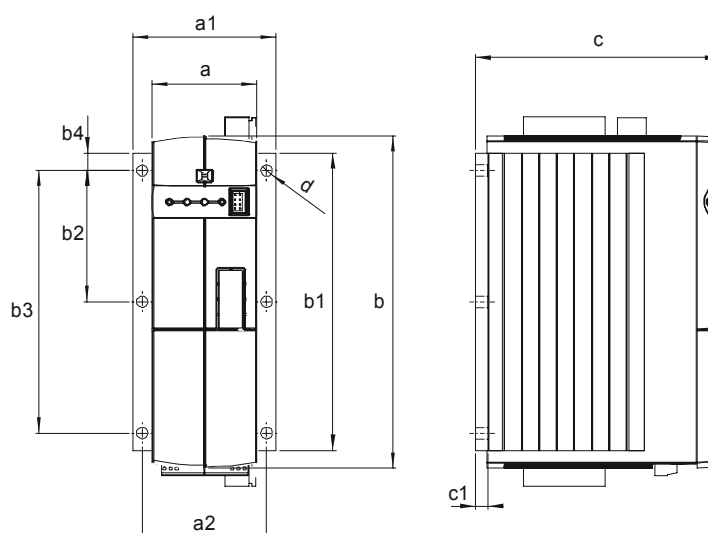
Warning: To avoid serious physical injuries or considerable damage to property, only qualified persons may work on the devices. Qualified means people who are acquainted with the erection, assembly, commissioning and operation and have corresponding qualifications for their activity. Read both documents carefully before carrying out the work and follow the safety instructions.



Warning: The frequency inverters meet the IP20 protection requirements only if the covers and connection terminals are installed properly. The units may not be put into operation before that.

6.1 ACT/ACU 201 (up to 3.0 kW) and ACT/ACU 401 (up to 4.0 kW)

Installation "Cold Plate" variant



Dimensions in mm

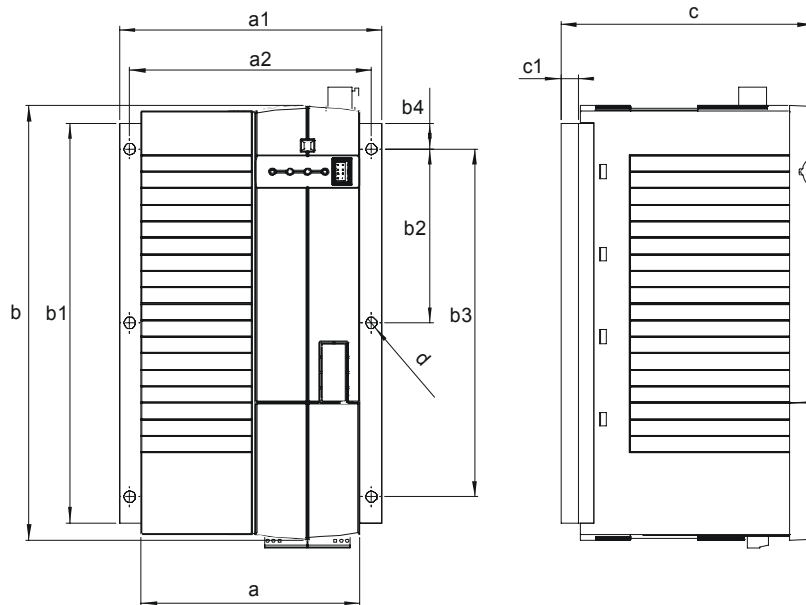
Frequency inverter		a	b	c	d
ACT/ACU 201	0.55 ... 1.1 kW	60	190	140	Ø 6.6
	1.5 ... 3.0 kW	60	250	140	Ø 6.6
ACT/ACU 401	0.55 ... 1.5 kW	60	190	140	Ø 6.6
	1.85 ... 4.0 kW	60	250	140	Ø 6.6

Installation dimensions in mm

Frequency inverter		a1	a2	b1	b2	b3	b4	c1
ACT/ACU 201	0.55 ... 1.1 kW	82	71	170	75	150	10	7
	1.5 ... 3.0 kW	85	71	230	75	190	10	70
ACT/ACU 401	0.55 ... 1.5 kW	82	71	170	75	150	10	7
	1.85 ... 4.0 kW	85	71	230	75	190	10	70

6.2 ACT/ACU 201 (4.0 to 9.2 kW) and ACT/ACU 401 (5.5 to 15.0 kW)

Installation "Cold Plate" variant



Dimensions in mm

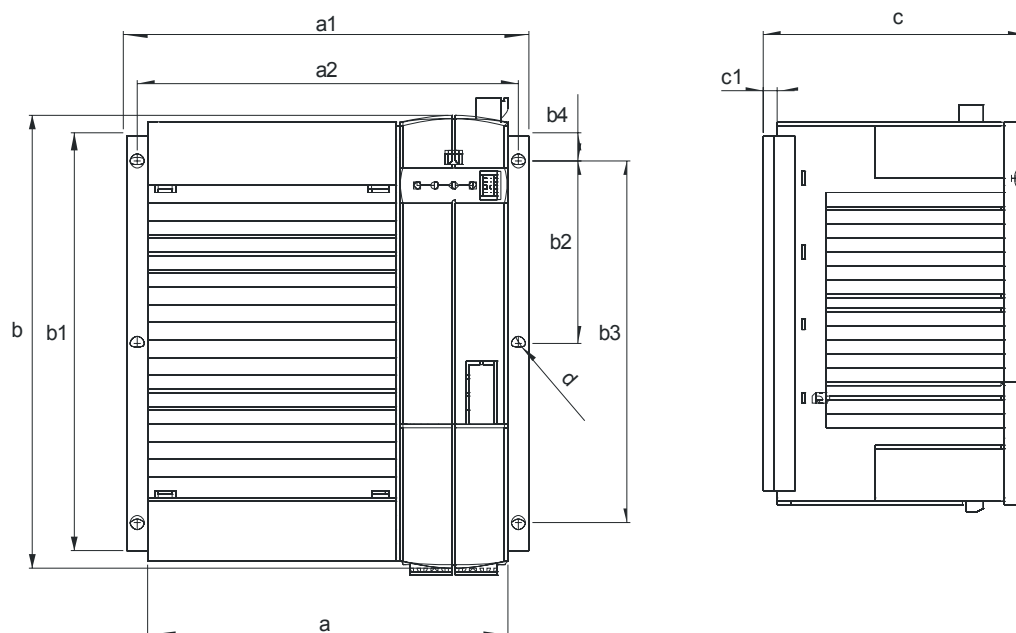
Frequency inverter		a	b	c	d
ACT/ACU 201	4.0 ... 5.5 kW	100	250	144	Ø 6.6
	7.5 ... 9.2 kW	125	250	144	Ø 6.6
ACT/ACU 401	5.5 ... 9.2 kW	100	250	144	Ø 6.6
	11.0 ... 15.0 kW	125	250	144	Ø 6.6

Installation dimensions in mm

Frequency inverter		a1	a2	b1	b2	b3	b4	c1
ACT/ACU 201	4.0 ... 5.5 kW	125	113	230	100	200	15	10
	7.5 ... 9.2 kW	150	138	230	100	200	15	10
ACT/ACU 401	5.5 ... 9.2 kW	125	113	230	100	200	15	10
	11.0 ... 15.0 kW	150	138	230	100	200	15	10

6.3 ACT/ACU 401 (18.5 to 30.0 kW)

Installation "Cold Plate" variant



Dimensions in mm

Frequency inverter		a	b	c	d
ACT/ACU 401	18.5 ... 30.0 kW	200	250	171	Ø 6.6

Installation dimensions in mm

Frequency inverter		a1	a2	b1	b2	b3	b4	c1
ACT/ACU 401	18.5 ... 30.0 kW	225	212.5	230	100	200	15	8

6.4 Installation



Caution: Mount the units, allowing for sufficient clearance of at least 300 mm above and below the frequency inverter and 100 mm on both sides of the unit.

- For fixing the frequency inverter, drill 6 threaded holes M6 in the installation surface. For the installation dimensions, refer to the above illustrations.
- Clean the contact surfaces of the cold plate and the heat sink.
- Apply a thin and uniform film of heat conducting paste on the cold plate.

Note: The heat conducting paste compensates the roughness of the contact surfaces and thus the heat transmission resistance between the cold plate and the heat sink. In this way, the cooling efficiency is increased.

- Mount the frequency inverter vertically on the heat sink using 6 M6 bolts. The bolts must have a minimum length of 20 mm. Tighten all bolts uniformly.

Note: The maximum tightening torque of the fixing bolts in a typical construction is 3.4 Nm.

After the mechanical installation continue with the electrical installation according to the instructions. Comply with the safety instructions provided there.

7 Temperature Monitoring

The operation of the frequency inverter and the connected load is continuously monitored. The monitoring functions as well as the corresponding limit values are to be parameterized depending on the specific application. If the limits are set below the switch-off limit of the frequency inverter, a warning message can be triggered and, provided that appropriate measures are taken, an error switch-off can be avoided. After commissioning of the frequency inverter, the thermal operating conditions of the frequency inverter can be monitored:

- The heat sink temperature and the interior temperature can be displayed in the actual value menu. For detailed information, refer to the operating instructions, chapter "Actual values of the frequency inverter".
- Alarm limits can be set up in order to trigger alarms indicating a temperature increase of the heat sink or the control cabinet interior and in order to avoid an error switch-off of the frequency inverter.
By default, these two limits are set to -5 °C. This means that an alarm is triggered if the maximum heat sink or interior temperature minus 5 °C is reached. For detailed information, refer to the operating instructions, chapter "Temperature".
- When the maximum heat sink temperature or the maximum interior temperature (minus the alarm limit) is reached, an alarm message is triggered. The red LED flashes and the message "WARN" is displayed in the control unit. The warning message can be output via a digital control output. For detailed information, refer to the operating instructions, chapters "Error and warning behavior" and "Warning status".

Note: The switch-off limits of the frequency inverter are 80 °C for the heat sink temperature and 65 °C for the interior temperature.



Bonfiglioli has been designing and developing innovative and reliable power transmission and control solutions for industry, mobile machinery and renewable energy applications since 1956.

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