BECKER

VARIAIR UNIT

Operating Instructions

Frequency converters
VAU 4/4
VAU(w) 7.5/3
VAU 11-22/3

28100241500 01/17

Contents

1 General information

1.1 Notes relating to the documentation

The following information explains how to navigate through the documentation. Read these instructions carefully. They contains important information for operating the frequency converter (VAU). We assume no liability for any damage resulting from non-observance of these instructions.

These instructions form part of the product and apply exclusively to the VAU series (**V**ARI**A**IR **U**NIT) of Gebrüder BECKER GmbH.

Make sure to hand these instructions to the plant operator to be readily available when required.

Store these instructions and all other applicable documents carefully to be readily available when required.

1.1.1 Warnings 4

The warnings refer to life-threatening dangers. Serious injuries possibly resulting in death may occur.

Each warning consists of the following elements:

❶⚠ ❷**DANGER**
❸**Mortal danger from electric shock!** ❹**Death or serious injury!** ❺Disconnect the frequency converter from the voltage supply and protect it against re-activation.

Fig. 1: Structure of warnings

❶ - warning symbol
❷ - signal word
❸ - type and origin of the danger
❹ - potential consequence(s) of non-compliance
❺ - remedy

1.1.2 Warning symbols used

⚠ Danger (general)

⚠ Danger from electric shock and electrical discharge

⚠ Danger from hot surfaces!

1.1.3 Signal words

Signal words are used to identify the severity of the danger.

DANGER

Indicates a direct hazard with a high level of risk, which, if not avoided, will result in death or serious injury.

WARNING

Indicates a hazard with a moderate level of risk, which, if not avoided, will result in death or serious injury.

CAUTION

Indicates a hazard with a low level of risk, which, if not avoided, may result in minor or moderate injury or property damage.

1.1.4 Information notices

Information notices contain important instructions for the installation and trouble-free operation of the frequency converter. They must be complied with at all times. The information notices also point out that non-compliance may result in property or financial damages.

IMPORTANT INFORMATION

The frequency converter may only be assembled, operated, maintained or installed by trained and qualified personnel.

Fig. 2: Example of an information notice

1.2 Markings at the frequency converter

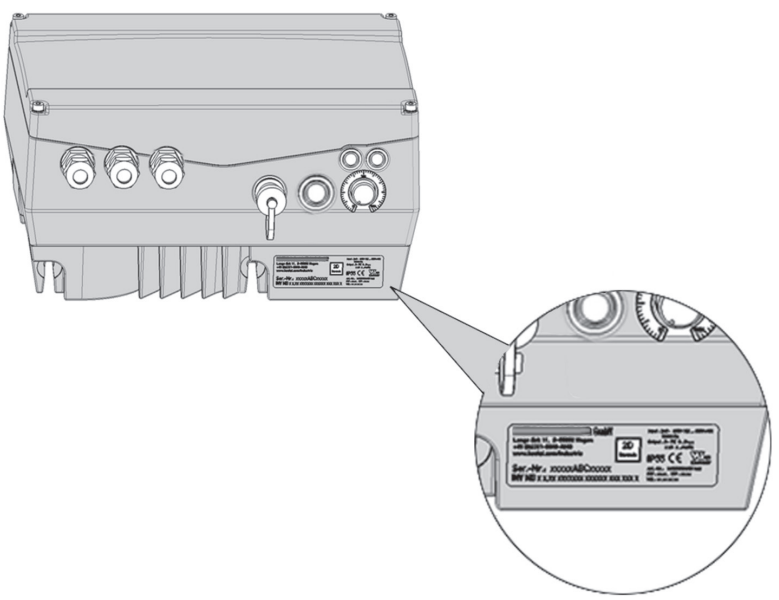


Fig. 3: Markings at the frequency converter

Signs and labels have been affixed to the frequency converter. These may not be altered or removed.

Symbol	Meaning
	Danger from electric shock and electrical discharge
	Danger from electric shock and electrical discharge. Wait two minutes (discharge time of the capacitors) after shut-down
	Additional earth connection

1.3 Qualified personnel

IMPORTANT INFORMATION

All work related to transport, installation and commissioning as well as maintenance must only be carried out by **qualified personnel** (comply with IEC 364 or CENELEC HD 384 or DIN VDE 0100 and IEC 664 or DIN VDE 0110 and national accident prevention regulations).

Qualified personnel in the meaning of these operating instructions are electricians who are familiar with the installation, assembly, commissioning and operation of the frequency converter and the related dangers. On account of their technical training they are further familiar with the relevant standards and regulations.

1.4 Intended use

IMPORTANT INFORMATION

▷ The frequency converter VAU is a device for speed control in three-phase rotary current motors.

▷ The frequency converter can be integrated in the motor (with the standard adapter plate) or fitted close to the motor (with the wall installation adapter plate).

▷ Frequency converters are components intended for installation in electrical systems or machinery.

▷ This frequency converter has not been approved for operation in explosive areas!

▷ When installed in machinery the commissioning of the frequency converters (i.e. commencing their intended use) is prohibited until it has been established that the machine meets the provisions of the Machinery Directive applicable at the time of commissioning, incl. the EMC Directive; EN60204 must be complied with.

▷ The harmonised standards of DIN EN 50178; VDE 0160:1998-04 must be applied to this frequency converter in conjunction with DIN EN 60439-1; VDE 0660-500:2005-01.

▷ The frequency converters meet the requirements of the EC Machinery Directive 2006/42/EC.

▷ The technical data and information on the connection conditions can be found on the rating plate and in these instructions and must always be adhered to.

▷ Repairs may only be carried out by authorised repair centres. Independent and unauthorised interventions may result in death, injury or property damage. This invalidates the warranty by Gebrüder BECKER GmbH.

▷ External mechanical loads, such as stepping onto the housing, are not permitted!

IMPORTANT INFORMATION

Using frequency converters in movable equipment amounts to an unusual ambient condition and is only permitted in accordance with the locally applicable standards and guidelines.

1.5 Responsibility

Electronic devices are not generally fail-safe. The installer and/or operator of the machine or plant is responsible for ensuring that the drive switches to a safe state if the device fails.

The “Electrical equipment of machines” section in DIN EN 60204-1; VDE 0113-1:2007-06, “Safety of machinery” describes the safety requirements for electrical control units. These are provided for the safety of people and machines and must be observed in order to retain the functional capability of the machine or plant.

An emergency stop feature does not necessary cause the power supply to the drive to be switched off. To avoid dangerous situations, it may be useful for individual drives to remain operational or for specific safety procedures to be initiated. The effectiveness of emergency stop measures is evaluated by means of a risk assessment for the machine or plant and its electrical equipment and is determined by selecting a circuit category according to DIN EN 13849 “Safety of machinery – Safety-related parts of control systems”.

1.6 CE marking

The CE marking confirms that the frequency converters meet the basic requirements of the following Directives:

▷ Directive on Electromagnetic Compatibility (Directive 2004/108/EC of the Council EN 61800-3:2004).

▷Low Voltage Directive (Directive 2006/95/EC of the Council EN 61800-5-1:2003).

1.7 Safety information

The following warnings, precautionary measures and information are provided for your safety and serve to prevent damage to the frequency converter and the components connected to it. This chapter contains warnings and information which apply in general to the handling of frequency converters. They are divided into general information, transport & storage and disassembly & disposal.

Specific warnings and comments which apply to specific activities can be found at the start of the appropriate chapters and are repeated or added to at various critical points in these chapters.

Please read this information carefully as it is provided for your personal safety and will also prolong the life of the frequency converter and connected devices.

1.7.1 General information

IMPORTANT INFORMATION

Carefully read these operating instructions and the warning signs affixed to the frequency converter prior to installation and commissioning. Make sure that all warning signs affixed to the frequency converter are legible; replace any missing or damaged signs.

They contain important information on the installation and operation of the frequency converter. In particular, note the information under "Important information". Gebrüder BECKER GmbH assumes no liability for damages arising from the non-compliance with these operating instructions.

These operating instructions form an integral part of the product. They apply exclusively to the frequency converters of the VAU series from Gebrüder BECKER GmbH.

Keep the operating instructions near the frequency converter to be easily accessible to all users.

The frequency converter can only be operated safely if the required ambient conditions found in chapter 3.2.1 have been met.

⚠ WARNING

Mortal danger from fire or electric shock!

Death or serious injury!

Always use the frequency converter as intended.

Do not modify the frequency converter.

Only use spare parts and accessories sold or recommended by the manufacturer.

During assembly, ensure adequate distance to adjacent components.

⚠ CAUTION

Risk of burns from hot surfaces!

Serious skin burns from hot surfaces!

The heat sinks and all other metal components may heat up to temperatures exceeding 70°C.

During assembly adequate distance must be maintained to adjacent components.

When working on the components provide for an adequate cooling-down period.

If necessary, install protection against accidental contact.

1.7.2 Transport and storage

Damage to property possible

Risk of damage to the frequency converter!

Risk of damage to the frequency converter from improper transport, storage, installation and assembly!

Transport the frequency converter properly in its original packaging.

Always store the frequency converter properly.

Only allow qualified personnel to carry out installation and assembly.

1.7.3 Notes for commissioning

Electrical connection

Frequency converters are equipment to be used in industrial high voltage systems and are operated with voltages which can cause serious injury or death upon contact.

Installation and work may only be carried out by **qualified electricians** with the equipment disconnected from the voltage supply. These individuals must always have access to the operating instructions which they must consistently adhere to.

⚠ DANGER

Mortal danger from to electric shock!

Death or serious injury!

Disconnect the frequency converter from the voltage supply and protect it against re-activation.

The following terminals may still carry dangerous currents even when the motor is not running:

- Supply terminals X1: L1, L2, L3
- Motor connection terminals X2: U, V, W
- Connection terminals X6, X7: Relay contacts for relays 1 and 2
- PTC/bimetallic switch connection terminals T1/ T2

IMPORTANT INFORMATION

- ▷ When working on live frequency converters, the applicable national accident prevention regulations (e.g. VBG 4) must be complied with.
- ▷ The local regulations pertaining to the installation of electrical systems and accident prevention regulations must be complied with.
- ▷ The electrical installation must be carried out in accordance with the relevant regulations (e.g. conductor cross sections, fuse protection, protective earth connection).
- ▷ If personal and fire protection are required during the use of the frequency converter, all-current sensitive RCDs of type B must be used (in accordance with DIN VDE 0160 and EN 50178). These provide reliable protection for the high frequency alternating currents and smooth and pulsating DC fault currents arising during frequency converter operation. Standard RCD devices of type A are not permitted.
- ▷ Only use permanently wired mains connections.
- ▷ Earth the frequency converter in accordance with DIN EN 61140; VDE 0140-1.
- ▷ Contact currents > 3.5 mA may occur in the VAU. In this case an additional protective earth conductor with the same cross section as the original earth conductor must be fitted In accordance with DIN EN 61800-5-1. The respective equipment instructions will provide information as to whether the equipment requires additional earthing. A second protective earth conductor can be connected below the mains supply (position marked with a mass symbol) on the outside of the device. A suitable M6x15 screw (4.0 Nm torque) is provided with the adapter plate.
- ▷ If different voltages levels are used (e.g. +24 V/230 V), crossing cable runs are not permitted under any circumstances! The operator must also ensure compliance with the applicable regulations (e.g. double or reinforced insulation according to DIN EN 61800-5-1)!
- ▷ The circuit boards contain highly sensitive MOS semiconductor elements which are particularly sensitive to static electricity. Conductor paths or components must therefore not be touched by hand or with metal objects. Only the screws of the terminal strips may be touched with insulated screwdrivers when connecting the cables.
- ▷ In a residential environment, this product can cause high-frequency interferences which might necessitate interference suppression measures!
- ▷ Information on EMC-compliant installation, such as shielding, earthing and cable routing, can be found in the documentation of the frequency converters. This information must always be complied with, even for frequency converters bearing the CE mark. The compliance with the limits required by EMC legislation is the responsibility of the plant or machine manufacturer.

1.7.4 Notes for operation

⚠ DANGER

Mortal danger from electric shock!

Death or serious injury!

Due to its charged capacitors, the equipment might still carry dangerous voltages for up to 2 minutes after being disconnected from the mains.

Contact with bare or unused terminals, conductors or equipment components may result in serious injury or death!

Therefore, the equipment may only be opened or the covers or control unit removed 2 minutes after the equipment has been disconnected from the mains.

Even with the motor at rest (e.g. due to electronic lock, blocked drive or short-circuited output terminals) the mains supply terminals, motor terminals and terminals for the brake resistance might carry dangerous voltages. A stopped motor does not imply electrical separation from the mains.

⚠ DANGER

Mortal danger from revolving mechanical parts!

Death or serious injury!

With certain configurations the converter may start automatically after activation from the mains.

Systems integrated into the frequency converters might need to be equipped with additional monitoring and protection devices in accordance with the respective applicable safety regulations, e.g. laws relating to technical operating equipment, accident prevention regulations etc.

Unauthorised removal of the required covers, improper use and incorrect installation or operation pose risk of serious injury or property damage.

All covers must remain closed during operation.

IMPORTANT INFORMATION

Observe the following instructions during operation:

- ▷ The frequency converter operates with high voltages.
- ▷ During the operation of electrical equipment, some of their parts are inevitably carrying dangerous voltages.
- ▷ Emergency stop devices according to DIN EN 60204-1; VDE 0113-1:2007-06 must remain operational during all operating modes of the control unit. Resetting the emergency stop devices must not lead to uncontrolled or undefined reactivation.
- ▷ To ensure safe disconnection from the mains, the mains cable must be completely disconnected from the frequency converter in a synchronous manner at all poles.
- ▷ For VAU 11-22/3 a pause of at least 1 to 2 min. must be observed between successive mains activations.
- ▷ Certain parameter settings may result in the frequency converter restarting automatically after a supply voltage failure.

Damage to property possible

If this information is not observed, the frequency converter could be damaged and destroyed during subsequent commissioning!

Observe the following instructions during operation:

▷ The motor parameters, especially the I2T settings, must be configured correctly to provide proper motor overload protection.

▷ The frequency converter features an internal motor overload protection. Motor overload protection can also be ensured via an external PTC/bimetallic switch.

▷ The frequency converter must not be used as an "emergency stop device" (see DIN EN 60204-1; VDE 0113-1:2007-06).

1.7.5 Maintenance and inspection

Frequency converters may only be maintained and inspected by trained electricians. Unless explicitly stated in these instructions, modifications of hardware and software may only be carried out by persons authorised by Gebrüder BECKER GmbH.

1.7.5.1 Cleaning of frequency converters

Frequency converters are maintenance-free if operated as intended. If the air contains dust, the cooling fins of the motor and frequency converter must be cleaned regularly.

1.7.5.2 Measuring the insulation resistance at the control terminals

An insulation test on the control board's input terminals is not permitted.

1.7.5.3 Measuring the insulation resistance at the power terminals

The power component of the VAU is tested with 1.9 kV during series testing.

Should the insulation resistance need to be measured during a system test, this can be done under the following conditions:

▷ An insulation test may only be carried out for the power component.

▷ To avoid excessively high voltages, all the connection cables of the VAU must be disconnected before testing,

▷ A 500 V DC insulation tester should be used.

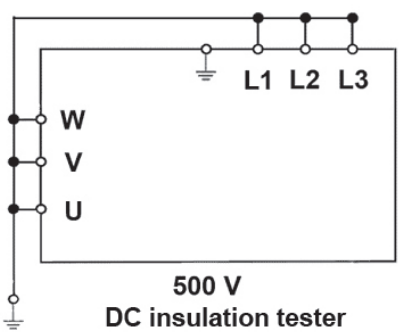


Fig. 4: Insulation test at the power component

1.7.5.4 Pressure test in a VAU

IMPORTANT INFORMATION

A pressure test is not permitted in a standard VAU.

1.7.6 Repairs

Damage to property possible

If this information is not observed, the frequency converter could be damaged and destroyed during subsequent commissioning!

▷ Repairs of the frequency converter may only be carried out by the Service department of Gebrüder BECKER GmbH.

DANGER

Mortal danger from to electric shock!

Death or serious injury!

Disconnect the frequency converter from the voltage supply and protect it against re-activation.

Due to its charged capacitors, the equipment might still carry dangerous voltages for up to 2 minutes after being disconnected from the mains.

Contact with bare or unused terminals, conductors or equipment components may result in serious injury or death!

Therefore, the equipment may only be opened or the covers or control unit removed 2 minutes after the equipment has been disconnected from the mains.

Related information signs affixed to the frequency converter must be observed.

Even with the motor at rest (e.g. due to electronic lock, blocked drive or short-circuited output terminals) the mains supply terminals, motor terminals and terminals for the brake resistance might carry dangerous voltages. A stopped motor does not imply electrical separation from the mains.

2 Frequency converter overview

2.1 Scope of delivery

Compare the scope of delivery of your product with that provided below.

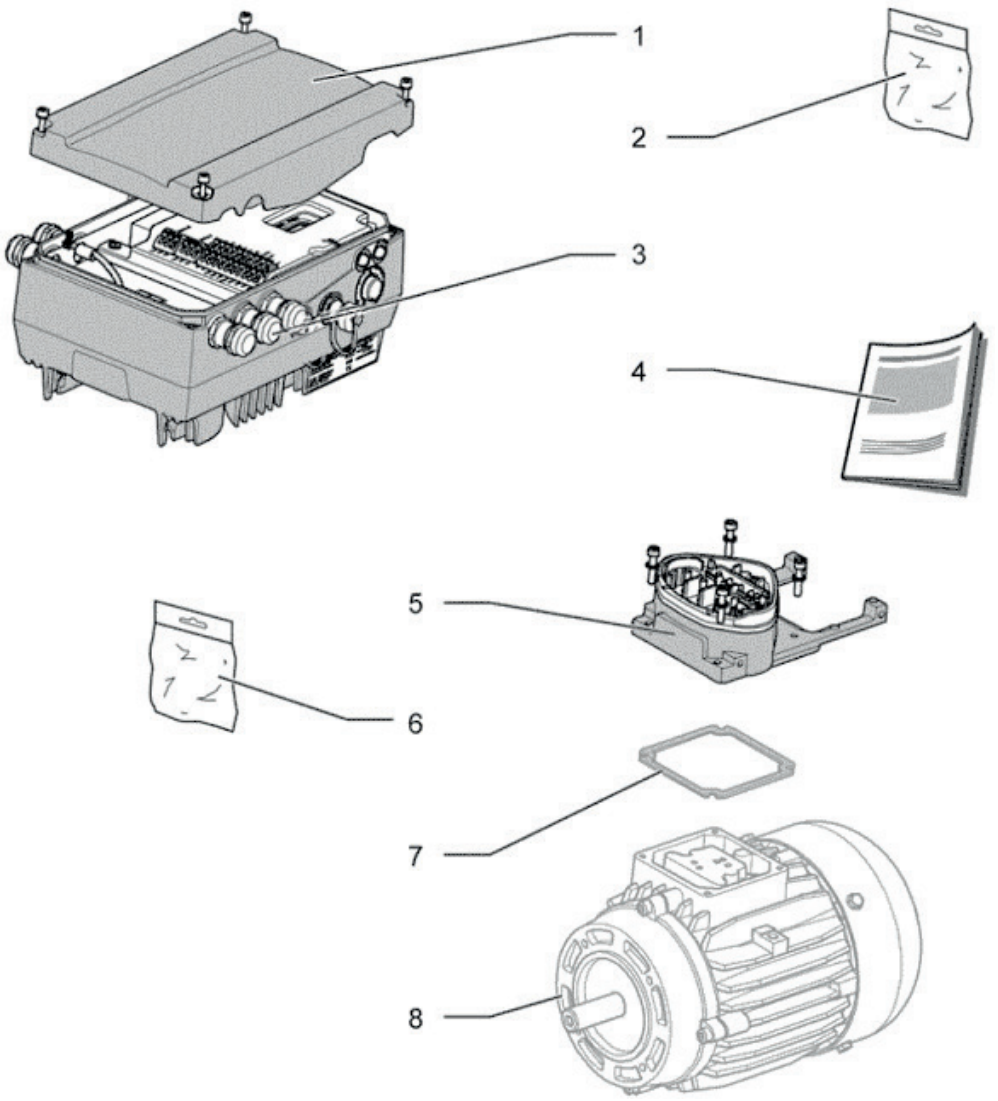


Fig. 5: Scope of delivery

Key			
1	Frequency converter (version)	5	Adapter plate with connection terminal (optional)
2	Poly bag containing fastening bolts	6	Poly bag containing connection material for terminal block (optional)
3	Cable glands	7	Seal (optional)
4	Operating instructions	8	Motor (not included in the scope of delivery)

2.2 Description of frequency converter VAU

The frequency converter VAU is a device for speed control in three-phase rotary current motors.

The frequency converter can be integrated in the motor (with the standard adapter plate) or fitted close to the motor (with the wall installation adapter plate).

The permitted ambient temperatures specified in the technical data (chapter 8) refer to operation at nominal load.

3 Installation

3.1 Safety information for installation

⚠ DANGER

Mortal danger from revolving mechanical parts!

Death or serious injury!

Disconnect the frequency converter from the voltage supply and protect it against re-activation.

Only allow installation by appropriately qualified personnel.

Only use personnel trained in assembly, installation, commissioning and operation.

Always earth the equipment in accordance with DIN EN 61140; VDE 0140, NEC and other relevant standards.

Mains connections must be permanently wired.

3.2 Installation requirements

3.2.1 Suitable ambient conditions

Conditions	Values
Altitude of the installation site:	up to 1000 m above MSL / more than 1000 m with reduced performance (1 % per 100 m) (max. 2000 m), see chapter 8.2
Ambient temperature:	-25 °C to +50 °C (different ambient temperatures may be possible in individual cases), see chapter 8.2
Relative humidity:	≤ 96%, condensation not permitted.
Resistance to vibration and shock:	DIN EN 60068-2-6 severity 2 (vibration from transport) DIN EN 60068-2-27 (vertical impact test) 2…200 Hz for sinusoidal vibrations.
Electromagnetic compatibility:	Immune to interference according to DIN EN 61800-3
Cooling:	Surface cooling: VAU 4/4 & VAU 7.5/3: free convection; VAU 7.5/3: optionally with integrated fan; VAU 11-22/3: with integrated fans. Water cooling: VAUw 7.5/3: with integrated water cooler

Table 1: Ambient conditions

Ensure that the housing type (protection class) is suitable for the operating environment:

- Ensure that the seal between the motor and the adapter plate is inserted correctly.
- All unused cable glands must be sealed.
- Check that the cover of the frequency converter is closed and bolted down with the following torque:
  ▷ VAU 4/4 & VAU 7.5/3 (4 x M4 x 28) 2 Nm,
  ▷ VAU 11-22/3 (4 x M6 x 28) 4 Nm.

Damage to property possible

Non-compliance may result in the loss of the protection class over time (particularly in respect to seals and optical fibres).

If circuit boards are being removed, the warranty is invalidated!

Mounting points and sealing surfaces must be kept free of paint for purposes of EMC and grounding!

3.2.2 Connection versions VAU 4/4 & VAU(w) 7.5/3

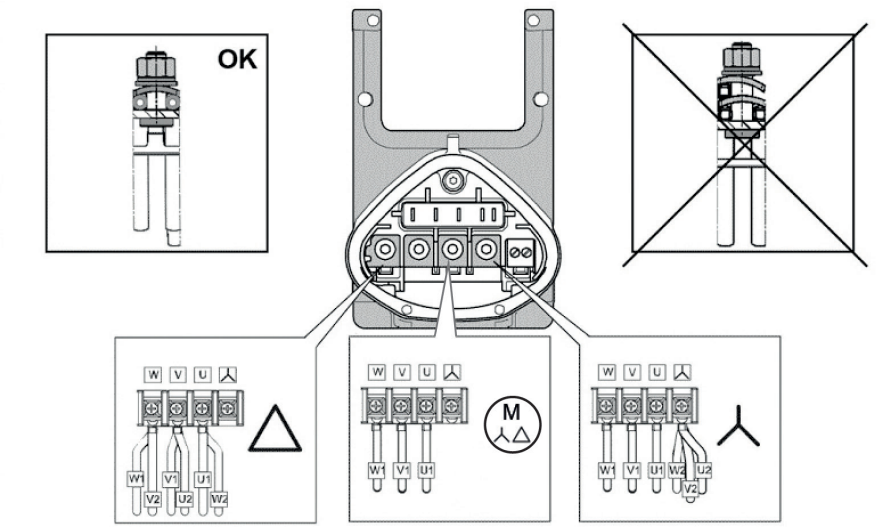


Fig. 6: Star or delta circuit for frequency converter integrated in the motor

DANGER

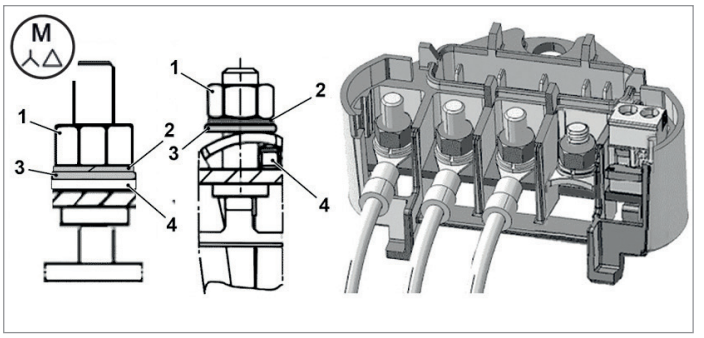
Mortal danger from to electric shock!

Death or serious injury!

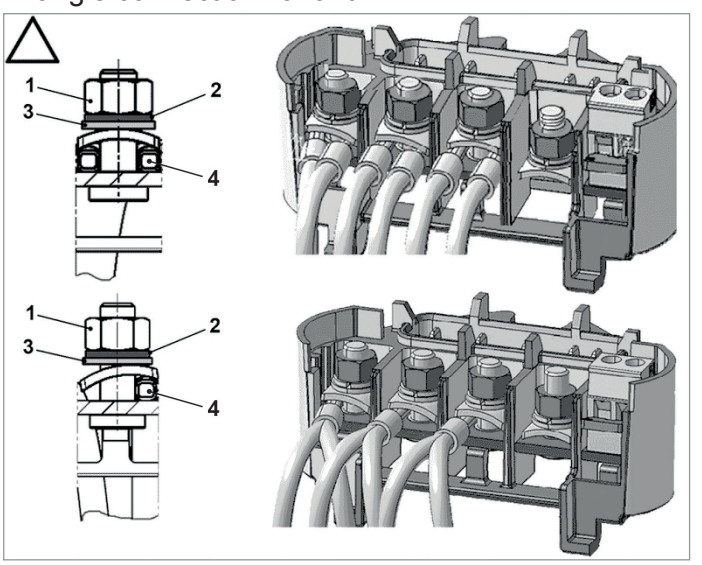
Disconnect the frequency converter from the voltage supply and protect it against re-activation.

Unused open cable ends in the motor terminal box must be insulated.

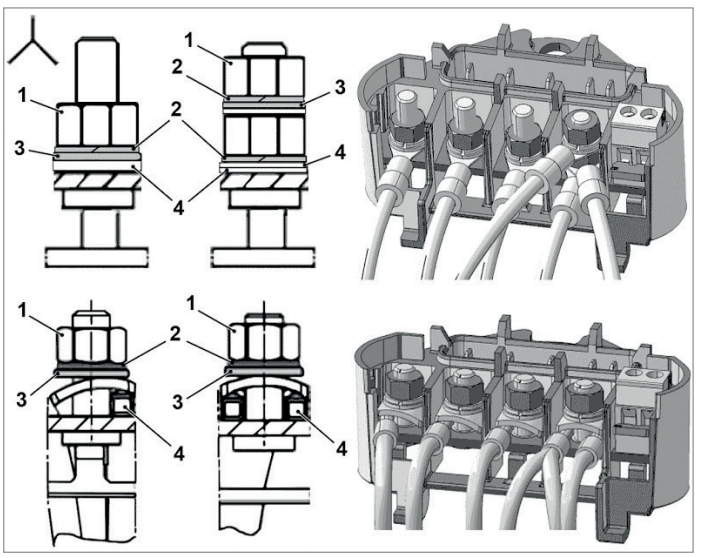
Connection version with 3 conductors (star/delta circuit already established in the motor)



Triangle connection variant



Star connection variant



Key			
1	Nut MA = 5Nm	3	Plain washer
2	Circlip	4	Cable lug / wire end sleeve

IMPORTANT INFORMATION

Regularly check that the nuts (1) are secure!

Damage to property possible

Risk of damage to the motor.

Correct phase assignment must be observed when connecting the frequency converter. Otherwise the motor may be overloaded.

The supplied assembly material can be used to connect both wire end sleeves and cable lugs. Fig. 6 shows the different connection options.

IMPORTANT INFORMATION

If the motor is fitted with a temperature sensor (PTC or bimetallic switch), this is connected to the T1 and T2 terminals (1).

Remove the bridging contact inserted for delivery purposes.

The cross section of the supply line must be designed according to the installation type and maximum permitted current. The contractor commissioning the device must ensure protection for the mains power line.

3.2.3 Connection version VAU 11-22/3

DANGER

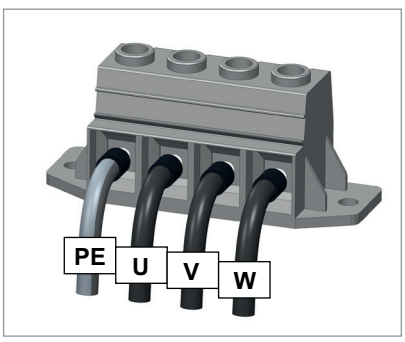
Mortal danger from to electric shock!

Death or serious injury!

Disconnect the frequency converter from the voltage supply and protect it against re-activation.

Unused open cable ends in the motor terminal box must be insulated.

Connection version with 3 conductors (star/delta circuit already established in the motor)



IMPORTANT INFORMATION

If the motor is fitted with a temperature sensor (PTC or bimetallic switch), this is connected to the T1 and T2 terminals (1).

Remove the bridging contact inserted for delivery purposes.

The cross section of the supply line must be designed according to the installation type and maximum permitted current. The contractor commissioning the device must ensure protection for the power line.

3.2.4 Short circuit and earth leakage protection

The frequency converter contains an internal short circuit and earth leakage protection.

3.2.5 Cabling instructions

The frequency converter includes a terminal block with control connections.

Control terminals (all VAU series)

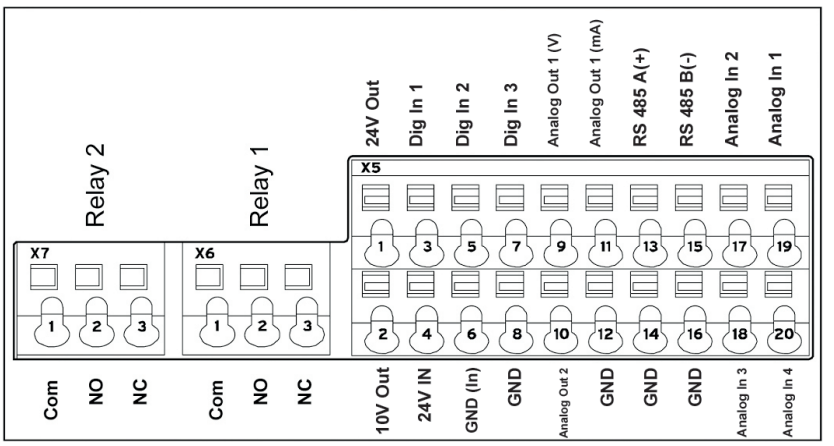


Fig. 7: Control terminals

all VAU series		
X5 – X7	Terminals:	Plug-in terminal connection with actuation lever (flat head screwdriver, max. width 2.5 mm)
	Connection cross section:	0.5 to 1.5 mm², single-wire, AWG 20 to AWG 14
	Connection cross section:	0.75 to 1.5 mm², fine-wired, AWG 18 to AWG 14
	Connection cross section:	0.5 to 1.0 mm², fine-wired (wire end sleeves with and without plastic collars)
	Length of stripped insulation:	9 to 10 mm

Table 2: Connection X5-X7

Power connections (VAU 4/4 & VAU(w) 7.5/3)

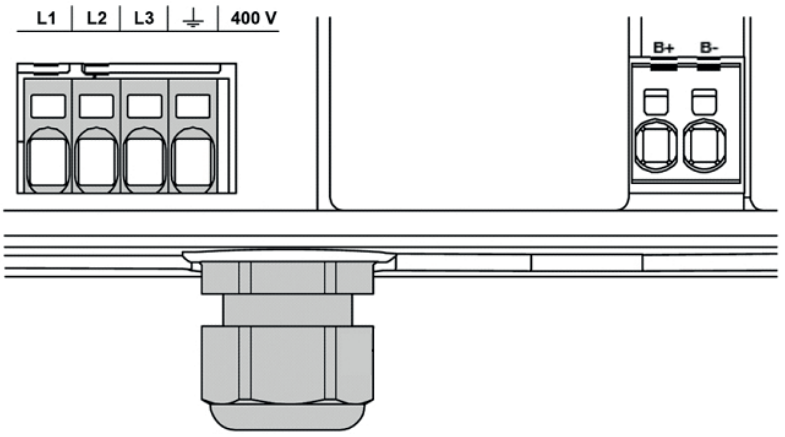


Fig. 8: Power connections 1

VAU 4/4 & VAU(w) 7.5/3		
X1 mains B+ B- brake resistance	The terminals for the supply cable are located inside the frequency converter. The VAU is equipped with terminals for connecting a brake resistor. The configuration may vary depending on the version.	
	Wire end sleeves with plastic collars and lugs are recommended.	
	Terminals:	Spring force connection (flat head screwdriver, max. width 2.5 mm)
	Conductor cross section, rigid	min. 0.2 mm² max. 10 mm²
	Conductor cross section, flexible	min. 0.2 mm² max. 6 mm²
	Conductor cross section, flexible with wire end sleeve without plastic collar	min. 0.25 mm² max. 6 mm²
	Conductor cross section, flexible with wire end sleeve with plastic collar	min. 0.25 mm² max. 4 mm²
	2 conductors of identical cross section, flexible with TWINAEH with plastic collar	min. 0.25 mm² max. 1.5 mm²
	Conductor cross section AWG/kcmil	min. 24 max. 8
	Length of stripped insulation:	15 mm
	Mounting temperature:	-5°C to +100°C

Table 3: Connection X1 (VAU 4/4 & VAU(w) 7.5/3)

Power connections (VAU 11-22/3)

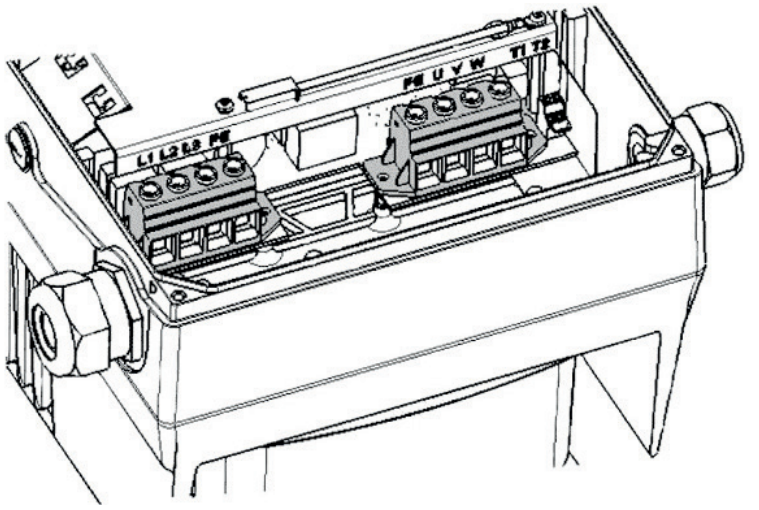


Fig. 9: Power connections 2

VAU 11-22/3		
X1 mains / X4 motor	The terminals for the supply cable are located inside the frequency converter. The configuration may vary depending on the version.	
	Wire end sleeves with plastic collars and lugs are recommended.	
	Torque min. 2.5 Nm / max. 4.5 Nm	
	Conductor cross section:	rigid min. 0.5 mm² / rigid max. 35 mm²
	Conductor cross section, flexible:	min. 0.5 mm² / max. 25 mm²
	Conductor cross section, flexible with wire end sleeves with plastic collar	min. 1 mm² max. 25 mm²
	Conductor cross section, flexible with wire end sleeves with plastic collar	min. 1.5 mm² max. 25 mm²
	Conductor cross section AWG / kcmil	min 20 max. 2
	2 conductors of identical cross section, rigid	min. 0.5 mm² max. 6 mm²
	2 conductors of identical cross section, flexible	min. 0.5 mm² max. 6 mm²
	2 conductors of identical cross section, flexible with AEH without plastic collar	min. 0.5 mm² max. 4 mm²
	2 conductors of identical cross section, flexible with TWINAEH with plastic collar	min. 0.5 mm² max. 6 mm²
	Length of stripped insulation:	18 mm
	AWG according to UL/CUL	min. 20 max. 2

Table 4: Connection X1 and X 4 (VAU 11-22/3)

3.2.6 Avoidance of electromagnetic interferences

Where possible use shielded cables for control circuits.

The shielding should be applied to the cable end with special care and without laying the wires across longer sections without shielding.

Ensure that no parasitic currents (compensating currents etc.) can flow across the shielding of the the analogue cable.

Route the control cables as far away as possible from the power cables. If necessary, separate power ducts should be used.

If cables do cross, an angle of 90° should be observed.

Upstream circuit elements, such as contactors and brake coils, or circuit elements operated via the outputs of the frequency converter must feature interference suppression. RC circuits are recommended for AC contactors. For DC contactors, free-wheeling diodes or varistors are usually used. These interference suppression devices are fitted directly to the contactor coils.

IMPORTANT INFORMATION

The power supply to a mechanical brake should be routed in a separate cable where possible.

Power connections between the frequency converter and motor should always be of shielded or reinforced design. The shielding must have large-area earthing at both ends! The use of EMC cable glands is recommended. These are not part of the scope of delivery.

Wiring suitable for EMC must generally be ensured.

3.3 Installation of a frequency converter integrated into the motor

3.3.1 Mechanical installation

3.3.1.1 Mechanical installation of the VAU 4/4 & VAU(w) 7.5/3

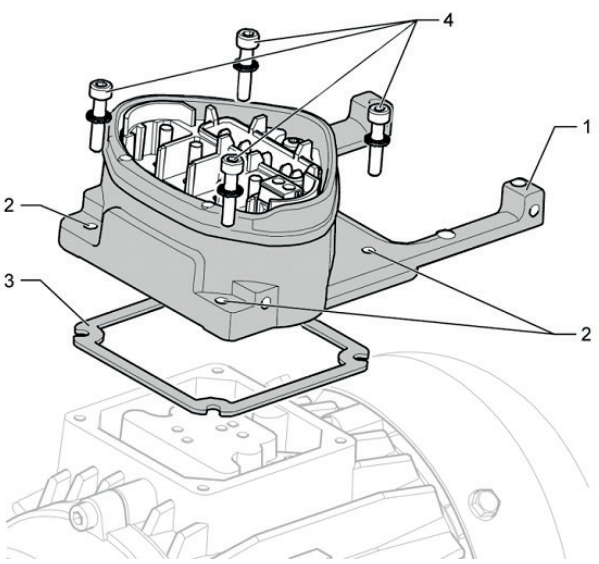


Fig. 10: Assembly sequence: Terminal box – adapter plate (VAU 4/4 & VAU 7.5/3)

Key			
1	Adapter plate	3	Seal
2	Drill holes	4	Fastening bolts

Proceed as follows to mechanically install the frequency converter:

1. Fit the seal (3).
2. Feed the motor supply cable past the connection terminal through the adapter plate (1) and screw it to the motor with the four fastening screws (4) and four spring elements (torque: 2.0 Nm).

IMPORTANT INFORMATION

When mounting the adapter plates, ensure that all four bolts, including the spring elements, are tightened to the appropriate torque (2 Nm)!

All contact points must be free of dirt/paint, otherwise a correct protective conductor connection cannot be ensured!

3. Attach the motor wires in the correct circuit, see also Fig. 6. (torque: 5.0 Nm). We recommend using insulated M5 ring cable lugs with a connection cross section of 4 to 6 mm^2.

IMPORTANT INFORMATION

When installing the motor wires, ensure that all bolts on the terminal board are fitted with the nuts provided even if the star point is not connected!

4. If present, wire the connection cable of the motor PTC/Klixxon to the T1 and T2 terminals (1) (torque: 0.6 Nm).

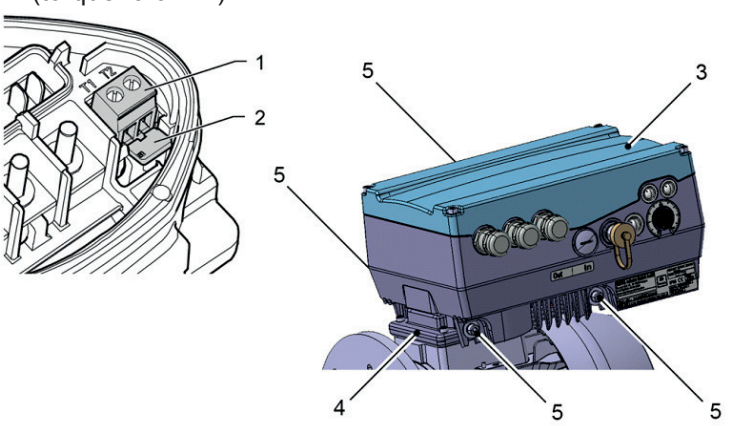


Fig. 11: Motor connection PTC/bimetallic switch

Key			
1	Temperature sensor terminals	4	Adapter plate
2	Bridge	5	Bolts
3	Frequency converters		

IMPORTANT INFORMATION

During assembly, ensure that the connection cables are not crushed!

IMPORTANT INFORMATION

If the motor is fitted with a temperature sensor, this is connected to the T1 and T2 terminals (1).

Remove the bridging contact (2) inserted for delivery purposes.

When the bridge is in place, the motor temperature will not be monitored!

5. Plug the frequency converter (3) onto the adapter plate (4) and fasten it evenly using the four lateral bolts (5) (VAU 4/4 & VAU 7.5/3) (torque: 4.0 Nm).

3.3.1.2 Mechanical connection of the water cooling of the VAUw 7.5/3

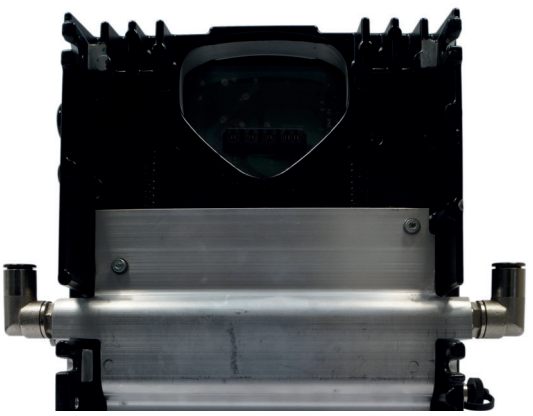


Fig. 12: Cooling water connections VAUw 7.5/3

IMPORTANT INFORMATION

Integrate the cooler at the frequency converter into your cooling circuit.

To ensure adequate cooling, the following conditions must be met:

▷ Coolant flow volume: 8l/ min

▷ Line pressure (coolant): 3-5 bar

▷ Temperature (coolant): 10-40 °C

Damage to property possible

Risk of damage to the aluminium cooler!

Risk of damage from incorrect coolant (e.g. tap water)!

Only use coolants meeting the guidelines of WN472 by Gebrüder BECKER GmbH. We recommend a mixture of 65% deionised water and 35% Glysantin G48 (anti-freeze agent).

3.3.1.3 Mechanical installation of the VAU 11-22/3

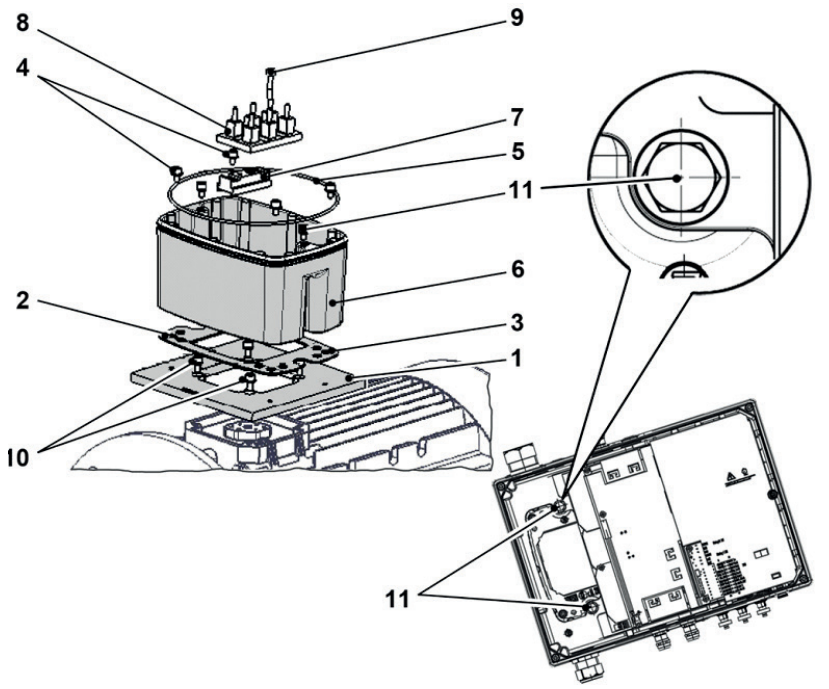


Fig. 13: Assembly sequence: Terminal box – adapter plate VAU 4/11-22/3

Key			
1	Adapter plate option (variant)	7	Junction plate heightening option
2	Holes depending on motor	8	Original terminal board (not included)
3	Seal	9	Extended screw option (for lt.
4	Retaining bolts with spring elements	10	Retaining bolts with spring elements option
5	O-ring seal	11	VAU/support fastening bolts
6	VAU/adapter plate support		

IMPORTANT INFORMATION

Correct sealing between the adapter plate and motor is of vital importance to comply with the protection class.

This is the sole responsibility of the commissioning contractor.

Please direct any queries to your usual contacts for Gebrüder BECKER GmbH.

Proceed as follows to mechanically install the frequency converter:

1. Fit the seal (3).
2. Screw the adapter plate (1) on to the motor with the four fastening bolts (10) and four spring elements (torque: M4 to 2.4 Nm, M5 to 5.0 Nm, M6 to 8.5 Nm).

IMPORTANT INFORMATION

When mounting the adapter plate (1), ensure that all four fastening bolts (10), including the spring elements, are tightened to the appropriate torque!

All contact points must be free of dirt/paint, otherwise a correct protective conductor connection cannot be ensured!

3. Attach the original junction plate (8) to the motor, using the optional terminal board height adjustment (7) and the optional extended bolts (9) if necessary.
4. Connect the four cables (PE, U, V, W) with the corresponding cross section (depending on the rating of the VAU in use) to the original terminal board (8).

IMPORTANT INFORMATION

The connecting cables (approx. 30 cm) needed for the wiring of the motor terminal board/VAU are not included in the scope of delivery!

Please ensure that the seal (3) sits perfectly!

5. Screw the support (6) to the adapter plate (1) with four fastening bolts (4) incl. the spring elements (torque: 5.0 Nm).
6. Feed the four cables (PE, U, V, W) through the VAUS support.

IMPORTANT INFORMATION

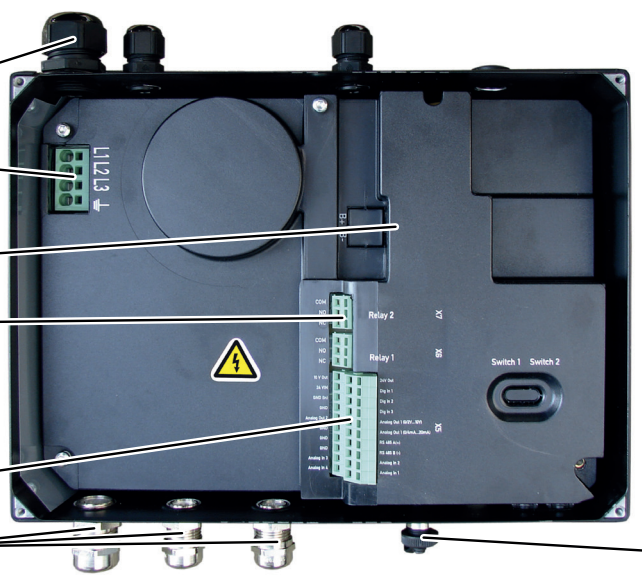
Please ensure that the O-ring seal (5) sits perfectly!

7. Carefully plug the frequency converter onto the support (6) and secure it evenly with two M8 bolts (11) (torque: max. 25.0 Nm).

3.3.2 Connection space

After opening the terminal box cover all connection terminals of the frequency converter can be found in the connection space.

VAU 4/4
VAU(w) 7.5/3



Cable gland (1)

Mains cable connection
L1, L2, L3, PE

Brake module connection

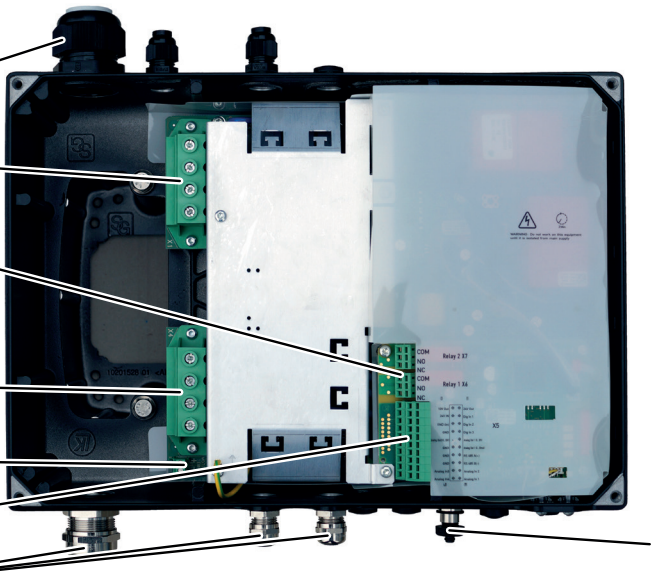
Relay
Rel.2: Collective fault message (standard)
Rel.1: Collective operating message (standard)

Control terminal

EMC - cable gland (2)

RS485-interface
Connection socket for:
- PC (KombiTool)
- manual control unit (MMI)

VAU 11-22/3



3.3.3 Power connection

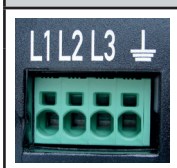
3.3.3.1 Power connection of the VAU 4/4 & VAU(w) 7.5/3

1. Unscrew the four bolts from the housing cover of the frequency converter and remove the cover.
2. Detach the earthing cable from the housing cover in the process.
3. Feed the mains supply cable through the cable gland (1).

IMPORTANT INFORMATION

The cable gland provides strain relief, and the PE connection cable must be connected in a leading fashion (considerably longer)!

4. Connect the cables to the terminals as follows:

	Terminals	Connection
	L1, L2, L3	Mains supply phase L1, L2, L3
	PE	Mains supply protective conductor PE

IMPORTANT INFORMATION

When connecting a brake resistance to an optional brake module, cables with shielding and double insulation must be used!

3.3.3.2 Power connection of the VAU 11-22/3

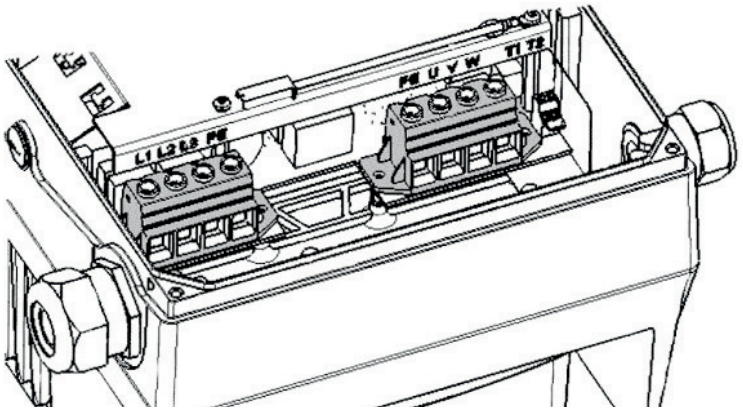


Fig. 16: Power connection (VAU 11-22/3)

1. Unscrew the four bolts from the housing cover of the frequency converter and remove the cover.
2. Detach the earthing cable from the housing cover in the process.
3. Guide the mains connection cable through the cable screw connection (1).

IMPORTANT INFORMATION

The cable gland provides strain relief, and the PE connection cable must be connected in a leading fashion (considerably longer)!

4. Connect the cables with the terminals as follows:

400 V connection			
L1	L2	L3	PE

The protective conductor must be connected to the "PE" contact.

Terminal no.	Designation	Assignment
1	L1	Mains phase 1
2	L2	Mains phase 2
3	L3	Mains phase 3
4	PE	Protective conductor

Table 5: Mains connection assignment X1

Terminal no.	Designation	Assignment
1	PE	Protective conductor
2	U	Motor phase 1
3	V	Motor phase 2
4	W	Motor phase 3

Table 6: Motor connection assignment X4

3.3.4 Brake resistance connections (VAU 4.4 & VAU(w) 7.5/3 only)

Terminal no.	Designation	Assignment
1	B+	Connection for brake resistance (+)
2	B -	Connection for brake resistance (-)

Table 7: Connection assignment for brake resistance

3.3.5 Control connections

1. Feed the required control cable through the cable glands (2) into the housing.
2. Connect the control cables according to the figure and/or table. Use shielded control cables.
3. Place the cover onto the housing of the frequency converter and bolt it tight to the following torque:

Size.	Torque
VAU 4/4 & VAU 7.5/3	2 Nm (4 x M4 x 28)
VAU 11-22/3	4 Nm (4 x M6 x 28)

Table 8: Tightening torques

Connection terminals of the bottom row of the double row terminal block:

	Terminal	Connection
	10V Out	Int. power supply
	24V IN	ext. voltage supply
	GND (In)	Mass (ext. voltage supply)
	GND	Ground
	Analogue Out 2 (0V...10V)	analogue voltage output 2
	GND	Mass
	GND	Mass
	GND	Mass
	Analogue In 3	analogue input 3
	Analogue In 4	analogue input 4

Table 9: Connection assignment for control connections (bottom row)

Connection terminals of the upper row of the double row terminal block:

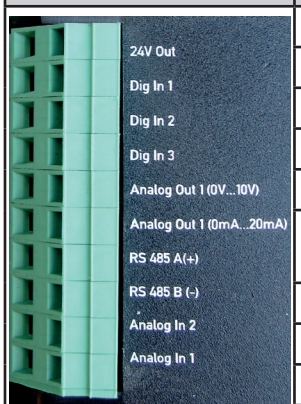
	Terminal	Connection
	24V Out	int. power supply
	Dig In 1	Digital input 1 - release (start/stop)
	Dig In 2	Digital input 2
	Dig In 3	Digital input 3
	Analogue Out 1 (0V...10V)	analogue voltage output 1
	Analogue Out 1 (0mA...20mA)	analogue current output 1
	RS 485 A(+)	Serial RS485 interface cable A
	RS 485 B(-)	Serial RS485 interface cable B
	Analogue In 2	analogue input 2
	Analogue In 1	analogue input 1

Table 10: Connection assignment for control connections (upper row)

3.3.6 Relays

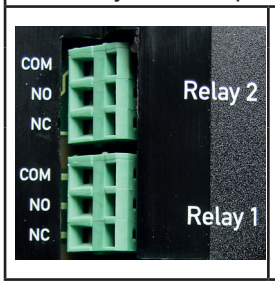
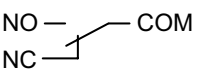
Operation		Description	
The relays can be parametrised with different functions (see chapter 5)			
		Relay 1 SBM	Collective operating message (standard) Device stopped: COM - NC Device rotates with a speed > 0: COM - NO
		Relay 2 SSM	Collective fault message (standard) COM - NC Fault-free operation: COM - NO Fault:

Table 11: Relay connection assignment

Damage to property possible

All control voltages are related to a common reference potential (GND).

24V can be picked up from the corresponding terminals.

The current total must not exceed 100 mA (see chapter 8 - technical data).

3.3.7 RS485 interface

The RS485 interface is of two-wire design in accordance with EIA RS485 (data cables A and B) and enables the communication with the frequency converter.

The interface is networkable in accordance with the above-mentioned standard in a network of up to 31 nodes.

The transmission rate and node address can be configured via corresponding parameters.

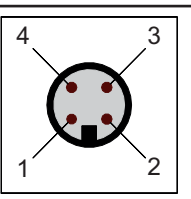
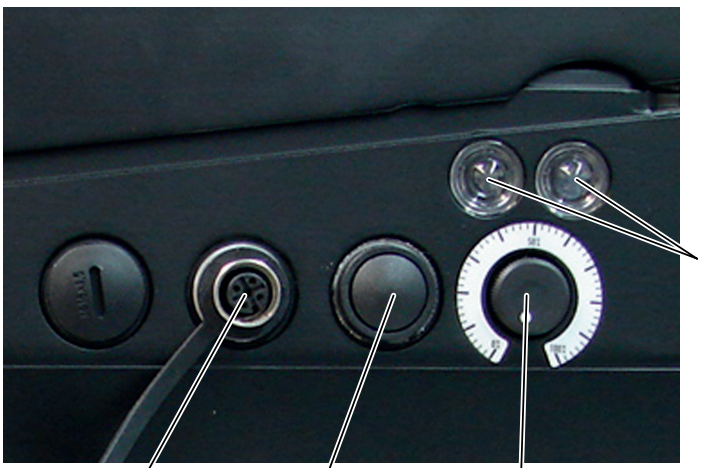
Connector assignment M12:	M12	Description	
	1	24V	 Stift (Bus-In)
	2	RS 485 A(+)	
	3	GND	
	4	RS 485 B(-)	

Table 12: Connector assignment M12

3.4 Local operation and display

The local operation of the equipment is via the control panel as shown in the figure.



Using the potentiometer the current setpoint can be increased or reduced with the aid of the scale.

The acknowledgement key can be used to acknowledge a fault.

The two LEDs indicated the current converter state.

Table of the **LED flash code**

Red LED	Green LED	State
○	●	Operation
✳	●	with optional BUS module:BUS operation (active BUS connection)
●	✳	**Fault** - for additional information see chapter 6.2
✳	✳	with optional BUS module: BUS module is operational
○	✳	Initialisation
Key: ○ **LED off,** ● **LED on,** ✳ **LED flashes,** ✳ **LED flashes rapidly**		

Fault see → chapter 6.2 - **Table of possible error messages**
→ read **KombiTool** P1011...1014
→ Display of **manual control unit (MMI)**

3.5 Optional accessories

The optionally available **manual control unit MMI** (order no.: 79630100115) is a diagnosis and service tool and used for the communication with the frequency converter.

It provides e.g. the following functions: Display/change of various parameters, error display (last 20) with error number and description, control (setpoint specification), saving, deleting and transferring parameter records.

3.6 Installation of a wall-mounted frequency converter

3.6.1 Suitable installation location for wall mounting

Make sure that the installation location for wall mounting a VAU meets the following conditions:

- ▷ The frequency converter must be mounted on a firm level surface.
- ▷ The frequency converter may only be mounted on non-flammable surfaces.
- ▷ There must be clearance of 200 mm around the frequency converter to ensure free convection.

The figure below shows the assembly dimensions and the required clearances for installing the frequency converter.

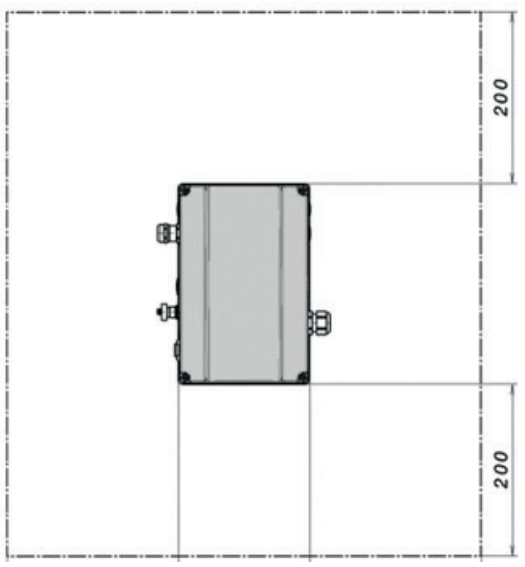


Fig. 17:

For the "wall mounting" version, the cable length between the motor and VAU must not exceed 5 m. Only use a shielded cable with the required cross section. A PE connection (below terminal board of the wall adapter) must be established.

3.6.2 Mechanical installation

1. Open the motor connection box.

IMPORTANT INFORMATION

The cable gland provides strain relief, and the PE connection cable must be connected in a leading fashion (considerably longer)!

2. Use suitable EMC glands to connect the shielded motor cable to the motor connection box!
   Ensure that the shielding has sound (large area) contact!
3. Connect the prescribed PE connection in the motor connection box!
4. Close the motor connection box.

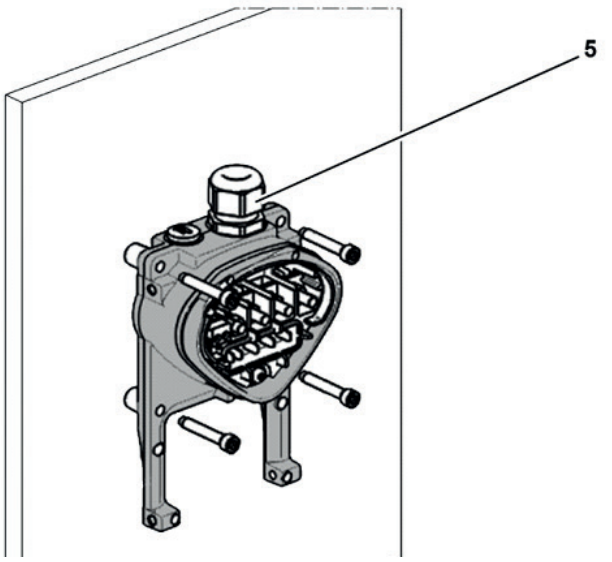


Fig. 18: Attaching the adapter plate to the wall

Key	
5	Cable gland

IMPORTANT INFORMATION

The frequency converter may not be installed without an adapter plate!

- ▷ Find a position which matches the required ambient conditions described in the chapter 3.2.
- ▷ To achieve optimum self-convection of the frequency converter, ensure that the (EMC) gland (1) points upwards during installation.
- ▷ If there is no additional ventilation for the VAU (optional for size VAU 7.5/3), only vertical installation is permitted.

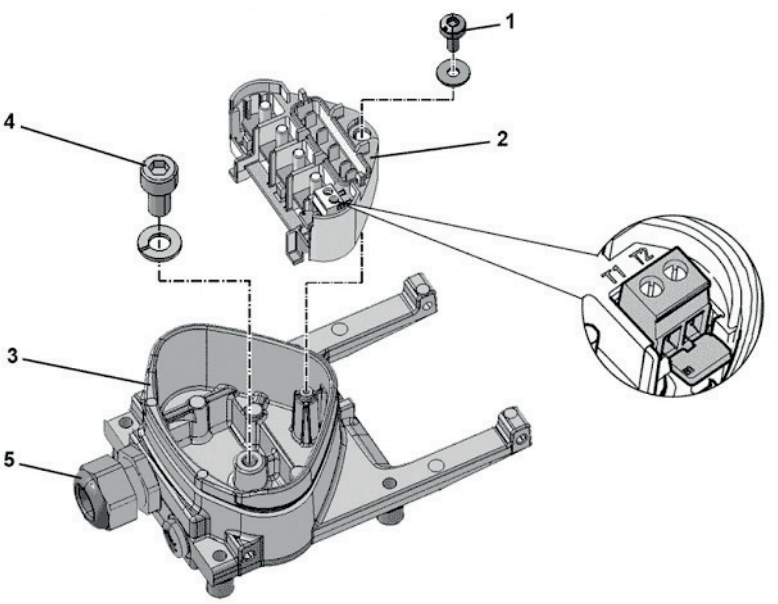


Fig. 19: Wiring

Key			
1	Bolt	4	PE connection
2	Contact plate	5	Cable gland
3	Adapter plate		

1. Release the screw (1) to remove the contact plate (2) from the adapter plate (3). The (M6x15) PE connection (4) is located below the contact plate.
2. Feed the connection cable from the motor through the integrated EMC gland (5) to the adapter plate (3).
3. This PE connection (torque: 4.0 Nm) must be connected with the same earth potential as the motor. The cross section of the equipotential bonding cable must correspond to at least the cross section of the mains supply cable.
4. Refit the contact plate (2) in the adapter plate (3).
5. Fasten the contact plate (2) using the bolt (1) (torque: 1.2 Nm).

INFORMATION

After fastening the contact plate (2), ensure that it is float-mounted.

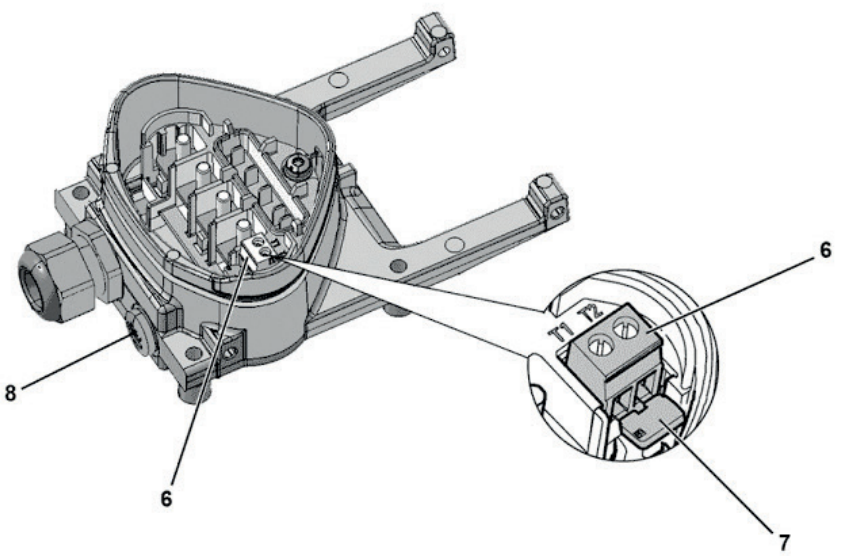


Fig. 20: Removal of the short circuit bridge

Key			
6	Temperature sensor terminals	8	Dummy gland
7	Bridge		

6. Wire the motor cable to contacts U, V, W (and the star point in some cases) in the connection terminal as described in the chapter 3.2.2. Use cable lugs (M5) for the purpose.
7. Before connecting any existing motor PTC/bimetallic switch to the T1 and T2 terminals (6), remove the pre-assembled short-circuit bridge (7).

IMPORTANT INFORMATION

The motor PTC/bimetallic switch carries potential after connecting the VAU. It must therefore be connected using a separate cable insulated against the motor cable.

To this end replace the dummy gland (8) with a suitable standard gland and route both ends to T1 and T2 (6).

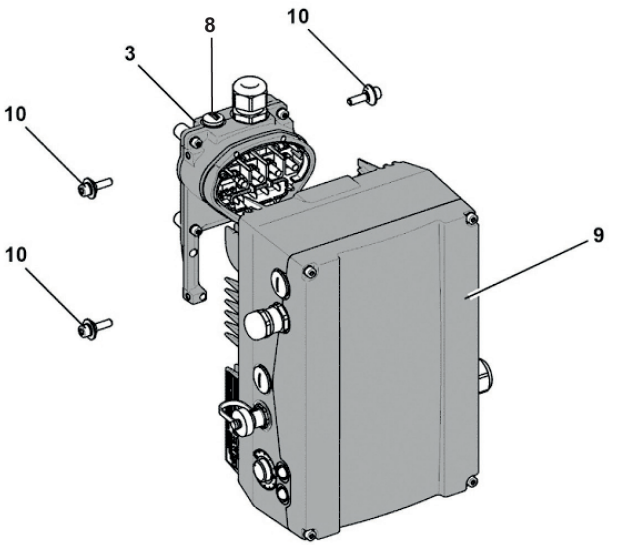


Fig. 21: Placing the frequency converter

Key			
3	Adapter plate	9	Frequency converters
8	Dummy gland	10	Bolts

8. Position the frequency converter (9) on the adapter plate (3) so that the collar of the adapter dips into the opening on the floor of the heat sink.
9. Attach the frequency converter (9) to the adapter plate (3) using the bolts (10) provided (torque: 4.0 Nm).

3.6.3 Power connection

The power connections are made as described in chapter 3.3.

3.6.4 Brake chopper

The brake connections are made as described in chapter 3.3.

3.6.5 Control connections

The control connections are made as described in chapter 3.3.

4. Commissioning

4.1 Safety information for commissioning

Damage to property possible

If this information is not observed, the frequency converter could be damaged and destroyed during subsequent commissioning!

Commissioning may only be performed by qualified personnel. Safety precautions and warnings must always be complied with.

⚠ DANGER

Mortal danger from to electric shock!

Death or serious injury!

Make sure that the power supply provides the correct voltage and is designed for the required current.

Use suitable circuit breakers with the prescribed nominal current between the mains and the frequency converter.

Use suitable fuses with appropriate current values between the mains and frequency converter (see chapter 8).

The frequency converter must be earthed together with the motor in accordance with regulations. Non-compliance may result in serious injury.

4.2 General information

The converter is not equipped with a mains switch and is therefore always carrying voltage once connected to the mains supply.

If the voltage supply is connected to the converter, it is ready for operation

within a few moments. During this state the converter can be configured to the application requirements, i.e. parametrised.

In the delivery state the converter is already parametrised for the customer-specific application. If necessary, application-specific parameter records can be obtained from the respective responsible national agency (see chapter 10 Service).

A detailed description of each parameter is provided in chapter 5.

The motor may only be started via a release signal after the parameters have been configured by qualified personnel.

IMPORTANT INFORMATION

Some parameters only take effect after the mains voltage is re-activated. In this case the frequency converter must be disconnected from the power supply for at least 60 seconds.

With certain parameter settings it is possible that the device starts immediately after activating the mains voltage.

INFORMATION

The parametrisation of the frequency converter can also be carried out with only small voltages, e.g. before installing the frequency converter on the motor.

To this end the frequency converter features a 24 V small voltage input (terminal X5: 24 V IN & Ground IN) to supply the electronics without mains voltage needing to be connected. The converter indicates an error based on the missing mains voltage.

4.2.1 KombiTool

The KombiTool is the parametrisation and diagnosis software for the frequency converters approved by Gebrüder BECKER GmbH.

The communication between the computer and the frequency converter must take place via a suitable interface converter.

The KombiTool is not included in the scope of delivery but can be ordered if required. For further information please contact your responsible national agency.

4.3 Basic configuration

The supplied frequency converter has always been parametrised with a basic configuration.

This includes in particular all regulator settings and regulator characteristics, temperature, speed and other limit values and the basic electrical alignment between the frequency converter and motor.

It is therefore essential that the frequency converter is only operated with the device type for which it has been supplied. Otherwise please contact qualified service personnel.

4.3.1 Pressure/vacuum mode

For the equipment to operate correctly with the application, it must be configured accordingly whether the equipment operates in pressure or vacuum mode.

Some equipment types can only be operated as pressure or vacuum equipment, whereas in other equipment the application depends on the equipment connection port selected.

In both cases it must be ensured that the configured operating mode matches the actual application in order to prevent damage to the equipment.

The operating mode for the equipment is selected through corresponding parametrisation.

4.3.2 Operating mode

The operating mode largely determines the equipment behaviour in the application.

Unless specified differently by the user, the equipment is preconfigured for the operating mode of speed-controlled operation.

This can be changed through corresponding parametrisation.

4.3.2.1 Speed-controlled operation

In speed-controlled operation the speed with which the equipment is to be operated is specified directly as a setpoint. The equipment indexes this speed and maintains it even if the operating point of the application changes.

4.3.2.2 Sensorless control (internal control)

With the sensorless control a process variable, e.g. pressure or vacuum, can be directly controlled without having to be measured by a sensor.

With correct parametrisation the frequency converter can calculate the process variable from internal variables and adjust them in line with the specified value.

For delivery the necessary characteristic parameters have already been configured in accordance with the equipment type used.

With pressure or vacuum control the (relative) pressure difference can be set directly as a positive value for either pressure or vacuum operation.

4.3.2.3 Process control (sensor-guided PID control)

For the process control a corresponding sensor must be connected to the analogue input.

The physical type of the process variable only depends on the type of sensor used.

The setpoint is specified as percentage value related to the maximum measuring value of the sensor used.

Caution: If an absolute pressure sensor is used for control in vacuum operation, the corresponding measured value might need to be inverted for correct control behaviour.

When using the process controller the control parameters might need to be adjusted to the behaviour of the controlled system if the control behaviour is not satisfactory using the preset values. The process controller has been designed as a PID controller.

4.3.3 Setpoint origin

The setpoint for the speed, the sensorless control or process control can be set in different ways, e.g. via an analogue input or the RS485 interface.

Which way is chosen for a specific application must be configured with the corresponding parameter for the main setpoint origin.

Unless specified differently by the user, the internal potentiometer is chosen as main setpoint origin.

4.3.4 Start/stop origin (release)

The release of the equipment for starting the ramp-up and for shut-down can also be issued in different ways (e.g. digital input or RS485 interface). Which way will be used is determined by the parameter of the start/stop origin.

Unless specified differently by the user, digital input 1 is configured as start/stop origin.

4.4 Block diagram

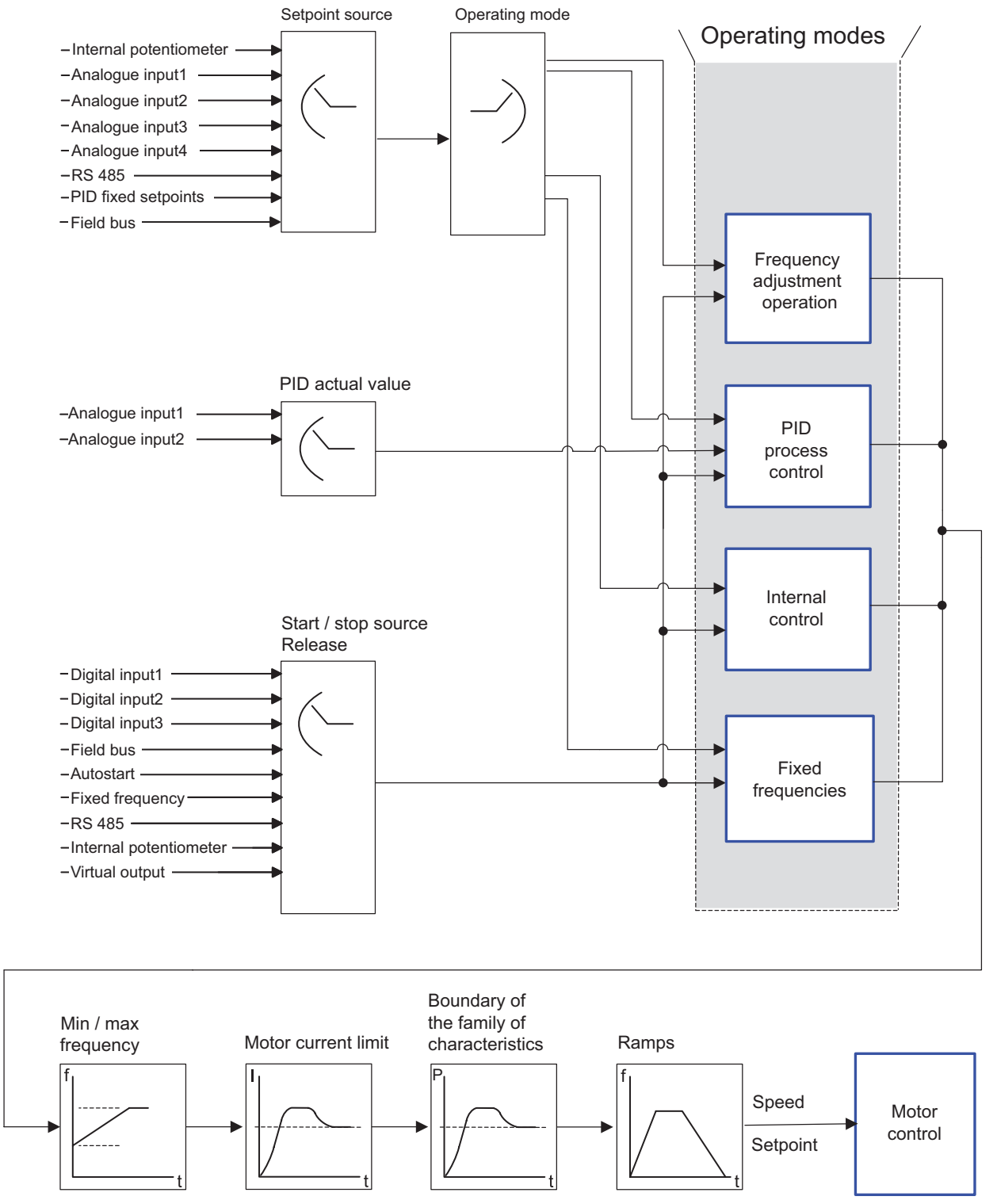
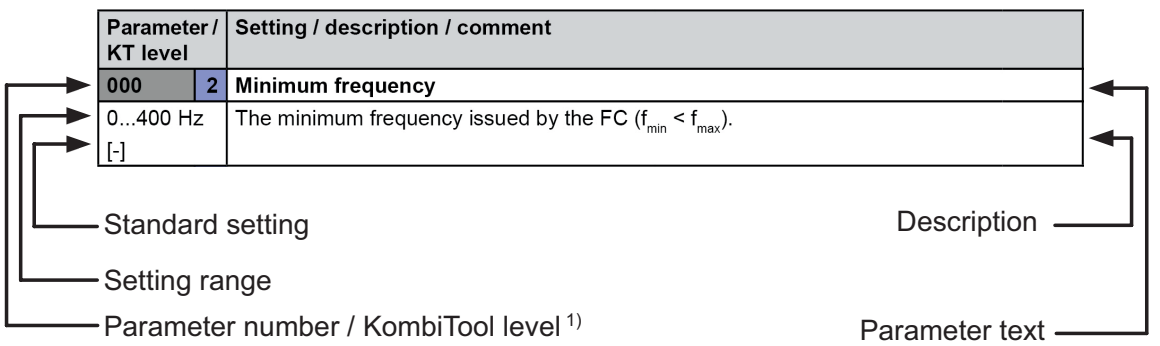


Fig. 22: General structure of target value generation

5 Parametrisation

Parameter availability

With access through different password levels different parameters are visible and can be parametrised via the KombiTool. The table below (chapter 5.1) lists all parameters.



1) KombiTool level (KT level)

Level 0 - Basic (basic parameters are displayed)
Level 2 - Professional (customer parameters are displayed and can be modified)
Level 3 - Professional Pro (all relevant parameters are displayed and can be modified)

5.1 Parameter description

The abbreviation FC will be used for the frequency converter below.

Parameter / KT level	Setting / description / comment
000 **2**	**Minimum frequency**
0...400 Hz [-]	The minimum frequency issued by the FC (f_{min} < f_{max}).
001 **2**	**Maximum frequency**
5...400 Hz [-]	The maximum frequency issued by the FC (f_{max} > f_{min}).
003/ 048 **2**	**Braking time** (brake ramp 1 / brake ramp 2)
0.1...1000 s [-]	Time period from f_{max} (see P001) to stoppage
004/ 049 **2**	**Ramp-up time** (acceleration ramp 1 / acceleration ramp 2)
0.1...1000 s [-]	Time period from stoppage to f_{max} (see P001)

Parameter / KT level		Setting / description / comment
005	**2**	**Main setpoint origin**
0...12 [0]		Determines the source from which the setpoint will be read. 0 = internal potentiometer 1 = analogue input 1 2 = analogue input 2 3 = MMI 4 = serial interface RS-485 (USS or SAS protocol) 6 = motor potentiometer 7= sum of analogue inputs 1 and 2 8 = PID fixed value (see parameters P83 & P127-133) 9 = field bus 10 = analogue input 3 11 = analogue input 4 12 = PLC (internal)
006	**2**	**Actual value origin** for sensor-guided PID control
0...2 [0]		Selection of the input source from which the actual value for the PID process controller is imported: 0 = analogue input 1 1 = analogue input 2 2 = PLC (internal)
007	**2**	**Main start/stop origin ➡ for release**
0...14 [0]		Selection of the source for SW release. 0 = digital input 1 1 = digital input 2 2 = digital input 3 3 = PLC (internal) 4 = analogue input 1 5 = analogue input 2 6 = field bus 7 = serial interface RS-485 (USS or SAS protocol) 9 = autostart 10 = fixed frequency release 11 = internal potentiometer 0% Off / > 0.5% On 13 = MMI 14 = virtual output
008	**2**	**Operating mode**
0...5 [0]		Selection of the operating mode 0 = speed-controlled operation 1 = sensor-guided PID controller 2 = fixed frequency 3 = sensorless (internal) pressure control 5 = PLC (internal)

Parameter / KT level		Setting / description / comment	
009/ 010 011/ 012 013/ 014 015	**2**	**Fixed frequency 1...7**	**➡ P008**
0...400 Hz [0]		The fixed frequency is set dependent on the switching pattern at the digital inputs 1 – 3. This mode must be selected in parameter 008. Change to fixed frequency via digital inputs: DigIN. 1 ➡ Fixed frequency 1: P009 DigIN. 2 ➡ Fixed frequency 2: P010 DigIN. 1 & DigIN. 2 ➡ Fixed frequency 3: P011 DigIN. 3 ➡ Fixed frequency 4: P012 DigIN. 3 & DigIN. 1 ➡ Fixed frequency 5: P013 DigIN. 3 & DigIN. 2 ➡ Fixed frequency 6: P014 DigIN. 3 & DigIN. 2 & DigIN. 1 ➡ Fixed frequency 7: P015	
022/ 031	**2**	**Filter time** (analogue input 1 / analogue input 2)	
0.02…1.00 s [0.02]		Time constant in seconds for input filter	
023/ 032	**2**	**Backlash** (analogue input 1 / analogue input 2)	
0...100 % [0]		Backlash as percentage of the final range value	
025/ 034	**2**	**Input type** (analogue input 1 / analogue input 2)	
1; 2 [1]		Change of the analogue input between voltage or current input: 1: Voltage input; 2: Current input	
026/ 035	**2**	**% min. value** (analogue input 1 / analogue input 2)	
0...100 % [0]		Defines the **minimum** value of the analogue input as percentage of the final range value: Example: **0**…10V or **0**…20mA ➡ **0%**…100% **2**…10V or **4**…20mA ➡ **20%**…100%	
027/ 036	**2**	**% max. value** (analogue input 1 / analogue input 2)	
0...100 % [0]		Defines the **maximum** value of the analogue input as percentage of the final range value: Example: 0…**10V** or 0…**20mA** ➡ 0%…**100%** 2…**10V** or 4…**20mA** ➡ 20%…**100%**	
037	**2**	**PID controller** (KP: P share)	
0...100 [1]		Proportional amplification of the PID controller	
038	**2**	**PID controller** (KI: I share)	
0...100 1/s [1]		Amplification factor of the integral share of the PID controller	
039	**2**	**PID controller** (KD: D share)	
0...100 s [0]		Amplification factor of the differential share of the PID controller	

Parameter / KT level		Setting / description / comment	
042/ 162	**2**	**Function** (analogue output 1 / analogue output 2)	
0...54 [5]		Signal selection at the analogue output: 0= signal is specified by the PLC (internal) 1 = U_d (intermediate circuit voltage) 2 = U_N (mains voltage) 3 = U_{Motor} (motor voltage) 4 = I_{Motor} (motor current) 5 = f_{ACT} (ACTUAL frequency) 8 = IGBT temperature 9 = inside temperature 10 = analogue input 1 11 = analogue input 2 12 = f_{TARGET} (TARGET frequency) 50 = P_d (intermediate circuit power) 51 = analogue input 3 52 = analogue input 4 53 = value from BECKERfunction 54 = dp_{ACT} (calculated ACTUAL pressure)	
043/ 163	**2**	**Minimum value** (analogue output 1 / analogue output 2)	➡ **P080** ➡ **P164**
-10000... 10000 [0]		Minimum value related to the selected process variable displayed at the analogue output as 0V (or 4mA). Example: **0**..10V (**min**ValueAOut .. maxValueAOut)	
050	**2**	**Ramp selection**	
0...6 [0]		Ramp selection: 0 = brake ramp 1 and acceleration ramp 1 1 = brake ramp 2 and acceleration ramp 2 2 = selection via digital input 1 3 = selection via digital input 2 4 = selection via digital input 3 5 = selection via PLC (internal) 6 = virtual output ➡ The following applies to the selection via digital inputs: 0 signal corresponds to brake ramp 1 and acceleration ramp 1 1 signal corresponds to brake ramp 2 and acceleration ramp 2	
051	**3**	**MOP step range**	➡ **P141**
0...100 % [0]		Step range of the motor potentiometer as percentage related to f_{max} (MAX frequency).	

Parameter / KT level		Setting / description / comment	
053	**2**	**Acknowledgement function**	
0...3 [0]		Selection of the source for fault acknowledgement: **Note**: Acknowledgement via button at the frequency converter is always possible 0 = no acknowledgement via digital input 1 = digital input 1 2 = digital input 2 3 = digital input 3	
054	**2**	**Automatic acknowledgement** (automatic restart after fault)	➡ **P109**
0...1000 s [0]		Activation of automatic acknowledgement 0 = no automatic acknowledgement 1-1000 = time (in seconds) after which the fault is automatically reset	
062/ 065	**2**	**Function** (relay 1 / relay 2)	
0...59 [19 / 10]		Selection of the process variable which causes the relay to be switched on or off if the limit value is exceeded or fallen below: 1 = U_d (intermediate circuit voltage) 2 = U_N (mains voltage) 3 = U_{Motor} (motor voltage) 4 = I_{Motor} (motor current) 5 = f_{ACT} (ACTUAL frequency) 8 = IGBT temperature 9 = inside temperature 10 = fault (switches ON during fault) **collective fault message** 11 = inverted fault (switches OFF during fault) 13 = digital IN 1 14 = digital IN 2 15 = digital IN 3 18 = ready 19 = operation (switches ON if speed > 0) **collective operating message** 50 = current limit active 51 = target frequency reached 52 = target value cannot be reached (control deviation) 53 = analogue IN 1 > limit value 1 ➡ (relay 1: P63 / P64 relay 2: P66 / P67) 54 = analogue IN 2 > limit value 2 ➡ (relay 1: P165 / P166 relay 2: P171 / P172) 55 = analogue IN 3 > limit value 3 ➡ (relay 1: P167 / P168 relay 2: P173 / P174) 56 = analogue IN 4 > limit value 4 ➡ (relay 1: P169 / P170 relay 2: P175 / P176) 57 = function 53, 54, 55 or 56 active 58 = fault or function 57 active 59 = output limit active (temperature protection)	
063/ 066	**2**	**Activation threshold** (relay 1 / relay 2)	
0...10000 [0]		Activation threshold related to the selected process variable for relay function 1, 2, 3, 4, 5, 8, 9, 53 (value specified in physical units: A, V, Hz, °C)	

Parameter / KT level		Setting / description / comment
064/ 067	**2**	**Shut-down threshold** (relay 1 / relay 2)
0...10000 [0]		Shut-down threshold related to the selected process variable for relay function 1, 2, 3, 4, 5, 8, 9, 53 (value specified in physical units: A, V, Hz, °C)
068	**2**	**IGBT fan temperature**
40...200 °C [60]		IGBT temperature threshold °C for fan activation.
069	**2**	**Internal temperature ON activation threshold for fan**
40...200 °C [60]		Internal temperature threshold °C for fan activation.
070/ 071 072/ 073 074	**2**	**Technology parameters 1 / 2 / 3 / 4 / 5**
-32768... 32768 [0]		separately documented dependent on firmware version
075/ 076 077/ 078 079	**3**	**Technology parameters 6 / 7 / 8 / 9 / 10**
-32768... 32768 [0]		separately documented dependent on firmware version
080/ 164	**2**	**Maximum value** (analogue output 1 / analogue output 2)
-10000... 10,000 [-]		Maximum value related to the selected process variable displayed at the analogue output as 10V (or 20mA). Example: 0..**10**V (minValueAOut .. **max**ValueAOut)
081	**2**	**Start protection** ➡ **P007**
0...8 [0]		Selection of the start-up behaviour with SW release parameter 007: 0 = immediate start with high signal at start input of controller release 1 = start only with rising flank at start input of controller release (re-activation protection) 2 = digital input 1 activates this function 3 = digital input 2 activates this function 4 = digital input 3 activates this function 6 = PLC (internal) 7 = analogue input 1 8 = analogue input 2
082	**2**	**PID inverted**
0; 1 [0]		Inverts the actual value of the PID process controller: (important for absolute pressure sensor in vacuum range) 0 = not inverted 1 = PID ACTUAL value is inverted

Parameter / KT level		Setting / description / comment	
083	**2**	**PID fixed setpoint**	**➡ P005**
0...100 % [0]		Fixed setpoint specification for the PID process controller ➡ must be selected in P005 (8 = PID fixed setpoint)	
084	**2**	**PID standby time**	
0...1000 s [0]		Waiting period till the standby function is activated	
085	**2**	**PID standby hysteresis**	
0...50 % [0]		Condition for waking up the PID controller from the stand-by function. (control difference greater than set value)	
086	**2**	**Motor current limit** (% value of the nominal motor current)	
0...250 % [-]		If this limit is exceeded, the speed is reduced	
087	**2**	**Motor current limit** (time during which overcurrent is permissible)	
0...100 s [-]		If this limit is exceeded, the speed is reduced	
094/ 096	**2**	**Energizing delay** (relay 1 and 2)	
0...99 s [1]			
095/ 097	**2**	**De-energizing delay** (relay 1 and 2)	
0...99 s [1]			
098	**0**	**USS/SAS address**	
0...31 [0]		Device address for USS/SAS bus operation	
099	**2**	**Field bus address**	
0...31 [0]		when using the optional field bus module, e.g. CANOpen	
100	**2**	**Field bus baud rate**	
0...8 [2]		0 = 9600, 1 = 19200, 2 = 38400, 3 = 57600, 4 = 115200;	CanOpen 0 = 1MBit, 1 = 800kBit, 2 = 500kBit, 3 = 250kBit, 4 = 125kBit, 5 = 100kBit, 6 = 50kBit, 7 = 20kBit, 8 = 10kBit

Parameter / KT level		Setting / description / comment
102	**0**	**Bus timeout (USS timeout)**
0...100 s [0]		Maximum time between two USS telegrams (RS485) / BUS timeout in seconds. If the main setpoint origin (P005) and/or the main start/stop origin (P007) have been set to RS485 and a value greater than 0 has been entered, the frequency converter expects a telegram at the RS485 interface in a time interval not exceeding the specified value or it changes to a fault state. If a value of 0 is entered, the telegram traffic will not be monitored.
109	**2**	**Automatic acknowledgement** (numbers) ➡ **P054**
0...500 [0]		The maximum number of automatic acknowledgements can be selected. ➡ 0 means unlimited automatic acknowledgements possible
110	**0**	**USS /SAS baud rate** (RS485 interface)
0...3 [0]		0 = 9600 baud, 1 = 19200 baud, 2 = 38400 baud, 3 = 57600 baud
112/ 113 **114/ 115** **116/ 117** **118/ 119**	**2**	**Process data out 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10**
0...49 [-]		Actual bus value no. 3 ➡ see process value table (actual values) Actual bus value no. 4 Actual bus value no. 5 Actual bus value no. 6 Actual bus value no. 7 Actual bus value no. 8 Actual bus value no. 9 Actual bus value no. 10
120/ 121 **122**	**2**	**Inversion** (digital input 1 / digital input 2/ digital input 3)
0; 1 [0]		Inversion of digital input 1 ➡ 0 is not inverted, 1 is inverted Inversion of digital input 2 ➡ 0 is not inverted, 1 is inverted Inversion of digital input 3 ➡ 0 is not inverted, 1 is inverted
124/ 125	**3**	**External fault 1 / external fault 2**
0...5 [0]		Frequency converter enters fault / fault indication 0 = from PLC (internal) 1 = fault via digital input 1 2 = fault via digital input 2 3 = fault via digital input 3 5 = fault via virtual digital output 1

Parameter / KT level		Setting / description / comment	
127/ 128 129/ 130 131/ 132	**2**	**PID fixed setpoint 2 / 3 / 4 / 5 / 6 / 7**	**➡ P005**
0...100 % [0]		PID fixed setpoint specification 2 / 3 / 4 / 5 / 6 / 7 for the PID process controller (must be selected in parameter 005)	
133	**2**	**PID fixed setpoint mode**	
0...2 [2]		Selection of the PID fixed setpoints used 0 = PID fixed setpoint 1 (digital input 1) 1 = PID fixed setpoint 1 - 3 (digital input 1, 2) 2 = PID fixed setpoint 1 - 7 (digital input 1, 2, 3)	
134/ 135 136/ 137	**2**	**Process data in 3 / 4 / 5 / 6**	
3...6 [-]		Actual bus value no. 3 ➡ see process value table (actual values) Actual bus value no. 4 Actual bus value no. 5 Actual bus value no. 6	
139	**3**	**MOP digital input**	
0...7 [3]		Input sources for setpoint origin of motor potentiometer: 0 = digital input 1 increases + digital input 2 reduces the setpoint 1 = digital input 1 increases + digital input 3 reduces the setpoint 3 = digital input 2 increases + digital input 3 reduces the setpoint 6 = analogue input 1 increases + analogue input 2 reduces the setpoint 7 = PLC (internal)	
140	**3**	**MOP response time**	
0.02...1000 s [0.3]		Response time to permanent pressing of the motor potentiometer input sources	
141	**3**	**MOP step time**	**➡ P051**
0.02...1000 s [0.04]		Cycle time with which the setpoint is increased or reduced by the step range configured in parameter 51	
142	**3**	**MOP reference memory**	
0; 1 [0]		Activates the storage of the motor potentiometer setpoint (and thus also the loading of this saved stepoint as start value after power ON): 0 = storage disabled 1 = storage enabled	
143	**3**	**MOP stored value**	
0...100 % [0]		Memory for motor potentiometer setpoint ➡ if the motor potentiometer setpoint was not changed for 2 seconds and differs from the setpoint saved last, this value is saved!	
144	**2**	**PID maximum setpoint**	
0...100 % [100]		PID setpoint limit ➡ The PID setpoint from the setpoing origin is limited to this setpoint.	

Parameter / KT level		Setting / description / comment
150	**3**	**Converter type**
0...10000 [101]		Only written by BECKER to define the converter in the KombiTool
151	**2**	**Hardware status**
0...10000 [1]		Only written by BECKER to define the parameter record in the KombiTool
152	**2**	**Software status**
0...10000 [1]		Only written by BECKER to define the parameter record in the KombiTool
153	**0**	**Parameter record ID**
0...10000 [-]		Only written by BECKER to define and ID for the parameter record
154	**2**	**Alternative setpoint origin**
0...11 [0]		Determines the source from which the target value is to be read. 0 = internal potentiometer 1 = analogue input 1 2 = analogue input 2 3 = manual control unit (MMI) 4 = serial interface RS-485 (USS or SAS protocol) 5 = PLC (internal) 8 = PID fixed value (see parameters P83 & P127-133) 10 = analogue input 3 11 = analogue input 4
155	**2**	**Alternative start/stop origin ➡ for release**
0...11 [0]		Selection of the source for SW release: 0 = digital input 1 1 = digital input 2 2 = digital input 3 3 = PLC (internal) 4 = analogue input 1 5 = analogue input 2 7 = serial interface RS-485 (USS or SAS protocol) 9 = autostart 10 = fixed frequency release 11 = internal potentiometer 0% Off / > 0.5% On

Parameter / KT level		Setting / description / comment
156/ 157	**2**	**Function** (digital input 2 / digital input 3)
0...10 [0]		Additional functions for digital inputs 2 and 3 **Caution**: Digital inputs 2 and 3 must not be parametrised with an identical function! Switching level: Low < 5V / High > 15V 0 = additional function disabled 1 = change to setpoint origin 2 (P154) + start/stop origin 2 (P155) 2 = change to pressure (0V) / vacuum (24) 3 = Control change (according to P008) (0V) / speed-controlled operation (24V) 4 = change to fixed frequency operating mode 5 = change to emergency operation ➡ Setpoint origin internal potentiometer, release of digital input 1 and speed-controlled operation 6 = alarm 1 24V: Alarm trigger ➡ FC enters fault, fault indication 7 = alarm 2 24V: Alarm trigger ➡ FC enters fault, fault indication 8 = stop via ramp 9 = immediate stop (zero current) 10 = value from BECKERfunction
158/ 160	**2**	**Input type** (analogue input 3 / analogue input 4)
1; 2 [1]		Change of the analogue inputs between voltage or current input: 1 = voltage input 2 = current input
159/ 161	**2**	**% min. value** (analogue input 3 / analogue input 4)
0...100 % [0]		Specifies the minimum value of the analogue inputs 3+4 as a percentage of the range Example: **0**…10V or **0**…20mA ➡ **0%**…100% **2**…10V or **4**…20mA ➡ **20%**…100% **Note**: % max. value: 100% with 10V / 20mA (z.B. 10V at A_{in} ➡ stepoint f_{max} 100Hz)
162	**2**	**Function** (analogue output 2) ➡ **P042**
163	**2**	**Minimum value** (analogue output 2) ➡ **P043**
164	**2**	**Maximum value** (analogue output 2) ➡ **P080**
165/ 171	**2**	**Limit value analogue input 2: Act**ivation threshold (relay 1 / relay 2)
0...10000 [0]		Activation threshold related to the selected process variable (specify value in physical units : mA, V (0…20mA / 0…10V)) see parameters 62 / 65 relay function: 54
166/ 172	**2**	**Limit value analogue input 2: De**activation threshold (relay 1 / relay 2)
0...10000 [0]		Deactivation threshold related to the selected process variable (specify value in physical units : mA, V (0…20mA / 0…10V)) see parameters 62 / 65 relay function: 54

Parameter / KT level		Setting / description / comment
167/ 173	**2**	**Limit value analogue input 3: Act**ivation threshold (relay 1 / relay 2)
0...10000 [0]		Deactivation threshold related to the selected process variable (specify value in physical units : mA, V (0…20mA / 0…10V)) see parameters 62 / 65 relay function: 55
168/ 174	**2**	**Limit value analogue input 3: De**activation threshold (relay 1 / relay 2)
0...10000 [0]		Deactivation threshold related to the selected process variable (specify value in physical units : mA, V (0…20mA / 0…10V)) see parameters 62 / 65 relay function: 55
169/ 175	**2**	**Limit value analogue input 4: Act**ivation threshold (relay 1 / relay 2)
0...10000 [0]		Deactivation threshold related to the selected process variable (specify value in physical units : mA, V (0…20mA / 0…10V)) see parameters 62 / 65 relay function: 56
170/ 176	**2**	**Limit value analogue input 4: De**activation threshold (relay 1 / relay 2)
0...10000 [0]		Deactivation threshold related to the selected process variable (specify value in physical units : mA, V (0…20mA / 0…10V)) see parameters 62 / 65 relay function: 56
177	**2**	**Pressure / vacuum mode**
0;1 [0]		Selection of pressure or vacuum 0 = pressure; 1 = vacuum
178	**2**	**Minimum pressure**
0 . . . 1 0 0 0 mbar [0]		(potentiometer full left deflection) in the operating mode sensorless control or with minimum control voltage.
179	**2**	**Maximum pressure**
0 . . . 1 0 0 0 mbar [-]		(potentiometer full right deflection) in the operating mode sensorless control or with maximum control voltage.
180/ 181 182	**2**	**Pressure/temperature characteristic** (K0 / K1 / K2)
-1000... 1000 W/Hz [-]		Temperature limit
183/ 184 185	**2**	**Vacuum/temperature characteristic** (K0 / K1 / K2)
-1000... 1000 W/Hz [-]		Temperature limit

Parameter / KT level		Setting / description / comment
186	**2**	**Temperature limit/time**
0...32767 s [30]		max. time for exceeding the temperature limit
187/ 188 **189/ 190** **191/ 192**	**3**	**Values for pressure characteristics** (K1 / K2 / K3 / K4 / K5 / K6)
[-]		for operating mode internal control in pressure operation
193/ 194 **195/ 196** **197/ 198**	**3**	**Values for vacuum characteristics** (K1 / K2 / K3 / K4 / K5 / K6)
[-]		for operating mode internal control in vacuum operation
201	**2**	**Function** (virtual output)
0...19 [-]		Selection of the process variable which causes the virtual output to be switched on or off if the limit value is exceeded or fallen below (0=disabled) 1 = U_d (intermediate circuit voltage) 2 = U_N (mains voltage) 3 = U_{Motor} (motor voltage) 4 = I_{Motor} (motor current) 5 = f_{ACT} (ACTUAL frequency) 8 = IGBT temperature 9 = inside temperature 10 = fault (switches during fault / collective fault message) 11 = inverted fault (switches OFF during fault) 12 = limit stage release 13 = digital input 1 14 = digital input 2 15 = digital input 3 17 = ready for operation 18 = ready 19 = operation (collective operational message)
202	**2**	**Minimum value** (virtual output)
-10000... 10000 [0]		Activation threshold of the virtual output related to the selected process variable (specify value in physical units: A, V, Hz, °C)
203	**2**	**Maximum value** (virtual output)
-10000... 10000 [0]		Deactivation threshold of the virtual output related to the selected process variable (specify value in physical units: A, V, Hz, °C)
204	**2**	**Activation delay** (virtual output)
0...99 s [1]		

Parameter / KT level		Setting / description / comment
205	**2**	**Deactivation delay** (virtual output)
0...99 s [1]		
218-237	**3**	**Technology parameters** (11-30)
-32768... 32768 [0]		separately documented dependent on firmware version
1011 **1012** **1013** **1014**	**2**	**Error group 1** **Error group 2** **Error group 3** **Error group 4**
0...32768		see chapter 6.2 (error messages)
1038	**2**	**Operating hours**
0...32768 hours		
1039	**2**	**Power ON counter**
0...32768		
1040	**2**	**Consumption**
0... kWh		

Table 13: Parameter overview

5.2 Diagnostic parameters

The following diagnostic parameters can be read via the KombiTool.

Parameter number	Unit	KombiTool name ► Diagnosis	Description
1000	Hz	**f actual**	Actual frequency
1001	V	**u motor**	Motor voltage
1002	A	**i motor**	Motor current
1003	°C	**hybrid temperature**	
1004	V	**ud intermediate circuit**	Intermediate circuit voltage
1005	Hz	**f target controller**	Target frequency of the current controller
1006	V	**u mains**	Mains voltage
1007	A	**id intermediate circuit**	intermediate circuit current
1008	°C	**Internal temperature**	
1011	1	**Error group 1**	Chapter 6.2
1012	1	**Error group 2**	Chapter 6.2
1013	1	**Error group 3**	Chapter 6.2
1014	1	**Error group 4**	Chapter 6.2
1015	1	**Digital IN all**	Status of all digital inputs
1016	V	**Analogue IN1**	Analogue input 1
1017	V	**Analogue IN2**	Analogue input 2

1019	Hz	**f target input**	Target frequency of the setpoint origin
1020	%	**PID actual**	Actual value process controller
1021	%	**PID target**	Process controller setpoint
1022	V	**Analogue OUT1**	Analogue output 1
1023	W	**P intermediate circuit**	Intermediate circuit power
1024	V	**Analogue IN3**	Analogue input 3
1025	V	**Analogue IN4**	Analogue input 4
1026	V	**Analogue OUT2**	Analogue output 2
1027	W	**P temp. limit**	max. power of the temperature limitation
1028	s	**Temp. limit counter**	Temperature limitation counter
1030	rpm	**n mech. motor**	Motor speed
1031	Nm	**M motor**	Motor torque
1032	W	**P motor**	Motor rating
1035	W	**Ptarget int. calc.**	calculated power for the internal pressure control
1038	hours	**Operating hours**	
1039	1	**Power ON counter**	
1040	kWh	**Consumption**	
1041	1	**Status Rel.1 Rel.2**	Status of relay 1 and 2

Table 14: Diagnostic parameters

6. Error detection and removal

DANGER

Mortal danger from to electric shock!

Death or serious injury!

Disconnect the equipment from the voltage supply and protect it against re-activation.

If damaged parts or components need replacing, only replace with original parts.

Danger from electric shock and electrical discharge. Wait two minutes (discharge time of the capacitors) after shut-down

6.1 List of errors and system faults

In case of an error the frequency converter shuts down. The corresponding error numbers can be found in the flashing code table below (chapter 6.2) or in the PC tool.

IMPORTANT INFORMATION

Error messages can only be acknowledged once the error has been remedied!

Error messages can be acknowledged as follows:

- ▷ digital input (programmable)
- ▷ via the KombiTool (P1011...1014)
- ▷ via the MMI (manual control unit)
- ▷ automatic acknowledgement
- ▷ switch equipment off and back on
- ▷ via field bus (CANOpen, Profibus DP, EtherCAT)

6.2 Table of possible error messages

In case of a fault (red LED constantly lit) the error is indicated via an extended flashing code of the green LED.

The green LED flashes briefly 1-10 times. At the end of the flashing code there is a pause of 5 seconds before the code is repeated. The following table contains an overview:

Error group		Error no. KombiTool				
LED			MMI	Name	Description	Cause
1x	1	4096	13	Cable break Analogue In 1 (4..20mA / 2 - 10V)	Current or voltage below the lower limit of analogue input 1	Cable break, faulty or disconnected external sensor
	1	8192	14	Cable break Analogue In 2 (4..20mA / 2 - 10V)	Current or voltage below the lower limit of analogue input 2	Cable break, faulty external sensor
	1	32768	16	Alarm 1 System error	Customer-specific error via function of the digital inputs	dependent on application
	2	1	17	Alarm 2 System error	Customer-specific error via function of the digital inputs	dependent on application
	2	64	23	External fault 1	The parametrised error input (digital input) is active	
	2	128	24	External fault 2	The parametrised error input (digital input) is active	
2x	3	1	32	Trip IGBT	Protection of the IGBT module against overcurrent has been triggered	Short circuit in the motor or motor feed line / controller settings
	3	128	39	Overcurrent	Maximum output current of the converter exceeded	Insufficient cooling / low motor speed and high torque / switching frequency too high / ramp times too low / brake not released
3x	2	2	18	FC overtemperature	Internal temperature too high	Insufficient cooling, low motor speed and high torque, switching frequency too high.
	3	8	35	Motor overtemperature	Motor temperature monitoring with PTC/bimetallic switch has tripped	Motor overload (e.g. high torque at low speed) / ambient temperature too high
	3	64	38	IGBT module overtemperature	Power module / IGBT module overtemperature	Insufficient cooling, low speed and high torque, switching frequency too high
	3	256	40	Frequency converter overtemperature	Internal temperature too high	Insufficient cooling, low speed and high torque, switching frequency too high / permanent overload
4x	3	16	36	Mains failure		A phase is missing / mains voltage has been disrupted
	3	2048	43	Ground leak	Ground leak during a motor phase	Insulation fault
	3	8192	45	Motor connection disrupted	No motor current in spite of control through FC	No motor connected or motor not connected correctly.

Key: ☀ **LED flashes,** ☀ **LED flashes rapidly**

Error group / LED		Error no. KombiTool	MMI	Name	Description	Cause
5x	2	16	21	Bus timeout	Setpoint specification via bus No response from bus node or MMI/PC	Bus line interruption
	2	32	22	Max. automatic acknowledgements	The number of maximum automatic acknowledgements (1.182) was exceeded	
6x	1	16384	15	Blockage	Motor blocked	mechanical fault or overload
7x	3	1024	42	I^2t motor protection shut-down	The internal I^2t motor protection has tripped	Permanent overload
	4	2	49	Overload	Max. overload of the frequency converter exceeded for more than 60 sec.	
8x	3	2	33	Intermediate circuit overvoltage	The maximum intermediate circuit voltage has been exceeded	Feedback by motor in generator mode / mains voltage too high / faulty setting of controller / brake resistance not connected or faulty / ramp times too short
	3	4	34	Undervoltage of intermediate circuit	The minimum intermediate circuit voltage has not been reached	Mains voltage too low / mains connection faulty
9x	1	1	1	24V undervoltage	Supply voltage for the application is less than 15V	24V supply overload
	1	2	2	24V overvoltage	Supply voltage for the application is greater than 31V	Internal 24V supply is NOK or external supply is not NOK
	1	1024	11	System error	No voltage is present at the consumer	Operation with 24 V without mains supply

Key: LED flashes, LED flashes rapidly

Error group		Error no. KombiTool				
LED			MMI	Name	Description	Cause
			3	System error	Contact BECKER for this fault	
			4	System error	Contact BECKER for this fault	
			5	System error	Contact BECKER for this fault	
			6	System error	Contact BECKER for this fault	
			7	System error	Contact BECKER for this fault	
	1	128	8	Internal application	The internal communication is faulty	EMC interference
			9	System error	Contact BECKER for this fault	
10x			12	System error	Contact BECKER for this fault	
			19	System error	Contact BECKER for this fault	
			20	System error	Contact BECKER for this fault	
			25	System error	Contact BECKER for this fault	
			37	System error	Contact BECKER for this fault	
			41	System error	Contact BECKER for this fault	
			44	System error	Contact BECKER for this fault	
			50	System error	Contact BECKER for this fault	
	1	512	10	Parameter distributor	The internal distribution of parameters during initialisation failed	Parameter set is incomplete
	3	16384	46	Motor parameters	Plausibility check for motor parameters failed	Parameter record NOK
	3	32768	47	Frequency converter parameters	Plausibility check for frequency converter parameters failed	Parameter record NOK
	4	1	48	Rating plate data	No valid motor rating plate data	Motor rating plate data not yet entered (delivery state)
Key: **LED flashes,** **LED flashes rapidly**						

Table 14: Overview of possible error messages

7. Disassembly and disposal

7.1 Disassembly of the frequency converter

DANGER

Mortal danger from to electric shock!

Death or serious injury!

Disconnect the frequency converter from the voltage supply and protect it against re-activation.

Danger from electric shock and electrical discharge. Wait two minutes (discharge time of the capacitors) after shut-down

1. Open drive the cover of the frequency converter.
2. Detach the cables at the terminals.
3. Remove all cables.
4. Remove connection bolts between frequency converter and adapter plate.
5. Remove frequency converter.

7.2 Information for correct disposal

Dispose of frequency converter, packaging and replaced parts in accordance with the regulations of the country in which the frequency converter has been installed.

The frequency converter may not be disposed of with household waste.

8. Technical data

8.1 General data

Description / installation size	VAU 4/4	VAU(w) 7.5/3	VAU 11-22/3			
Typical motor power to be connected [kW] (4 pole asynchronous motor)	4	7.5	11	15	18.5	22
Ambient temperature [° C]	- 25 (non condensing) to + 50 (without derating)					
Mains voltage [V]	3~ 400 – 15 % … 480 +10 % [1)]					
Mains frequency [Hz]	47 to 63					
Mains configurations	TN / TT					
Mains current [A]	7.9	14.8	23.2	28.2	33.2	39.8
FC output current, eff. [A] [I_N at 8 kHz / 400 V]	9.5	17.8	28.0	34.0	40.0	48.0
Min. brake resistance [Ω]	50	50	-			
Maximum overload	150 % of nominal current for 60 sec					130 %
Switching frequency [kHz]	4, 8, 16, (factory setting 8)					
Rotating field frequency [Hz]	0 - 400					
Protective function	Over- and undervoltage, I^2t limitation, short circuiit, motor/frequency converter temperature, tilt protection, blocking protection					
Recommendations for LS switches [2)]	C 16	C 25	C 63			
	Property C = line safety switch					
	Caution: The cross section of the supply line must be designed according to the installation type and maximum permitted current. The contractor commissioning the device must ensure protection for the mains power line.					
Dimensions [L x W x H] mm	270 x 189 x 140	307 x 223 x 181 VAU**w** (307x223x155)	414 x 294 x 232			
Weight incl. adapter plate [kg]	5.0	8.7	21.0			
Protection type [IPxy]	65		55			
EMC	immunity according to DIN EN 61800-3 Interference emission: 1st environment category C2 Interference immunity: 2nd environment					
Vibration resistance (DIN EN 60068-2-6)	50 m/s²; 5…200 Hz					
Shock resistance (DIN EN 60068-2-27)	300 m/s²					

Table 14: Technical data (subject to technical modifications)

[1] supply reduction of approx. 50 % possible (reduced output power)

[2)] For the exact information on the pre-fuse for individual devices, please refer to the device data sheet or the operating instructions of the device.

Inputs/outputs	Description
Digital inputs 1 – 3	- Switching level low < 5 V / high > 15 V - I_{max} (at 24 V) = 3 mA - R_{in} = 8.6 kOhm
Analogue inputs 1 – 4	- In +/- 10 V or 0 – 20 mA - In 2 – 10 V or 4 – 20 mA - 10-bit resolution - Tolerance +/- 2 % Voltage input: - R_{in} = 10 kOhm Current input: - Working resistance = 500 Ohm
Relays 1, 2	Alternating contact (NO/NC/COM) Maximum switching power - with resistive load (cos φ = 1): 5 A at ~ 230 V or = 30 V - with inductive load (cos φ = 0.4 and L/R = 7 ms): 2 A at ~ 230 V or = 30 V Maximum response time: 7 ms ± 0.5 ms Service life: 100,000 switching cycles
Analogue output 1 (current)	- Short-circuit proof - I_{out} = 0.. 20 mA - Working resistance = 500 Ohm - Tolerance +/- 2 %
Analogue output 1 (voltage)	- Short-circuit proof - U_{out} = 0..10 V - Imax = 10 mA - Tolerance +/- 2 %
Voltage supply 24 V	- Auxiliary voltage U = 24 V DC - Short-circuit proof - I_{max} = 100 mA - External supply of 24 V possible
Voltage supply 10 V	- Auxiliary voltage U = 10 V DC - Short-circuit proof - I_{max} = 30 mA

Table 15: Interface specification

The frequency converters include the option of connecting motor temperature monitoring (PTC/bimetallic switch).

8.2 Derating of output power

Frequency converters of the VAU series have two integrated PTC resistors as standard which monitor both the heat sink temperature and the internal temperature. As soon as a permissible IGBT temperature of 95°C or a permissible internal temperature of 85°C is exceeded, the frequency converter shuts down.

With the exception of the 22kW controller (VAU 11-22/3 130%), all frequency converters of type VAU are designed for an overload of 150% for 60sec (every 10min).

Reductions in the ability to handle overload and/or its duration should be taken into account in the following circumstances:

- ▷ A switching frequency permanently set too high >8 kHz (load-dependent).
- ▷ A permanently increased heat sink temperature, caused by a blocked air flow or a thermal blockage (soiled cooling ribs).
- ▷ Depending on the type of assembly, permanently excessive ambient temperature.

The respective max. output values can be determined from the following characteristic curves.

8.2.1 Derating due to increased ambient temperature

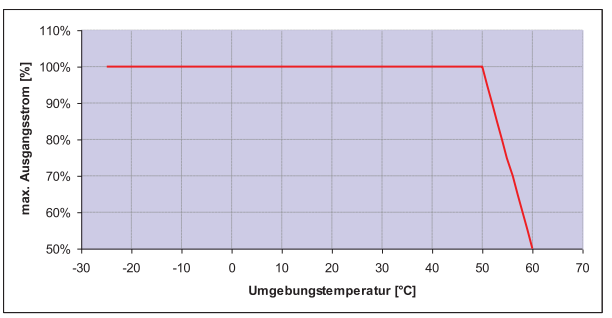


Fig. 23: Derating for frequency converter mounted on motor (all sizes)

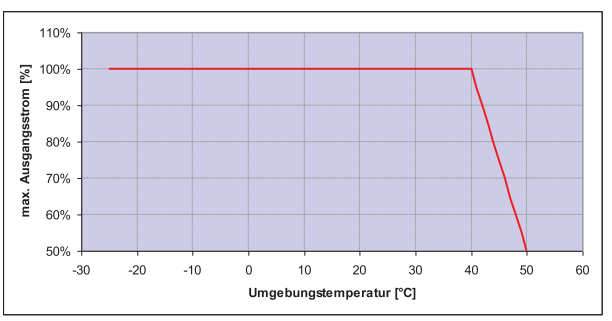


Fig. 24: Derating for wall-mounted frequency converters (VAU 4/4 & VAU 7.5/3)

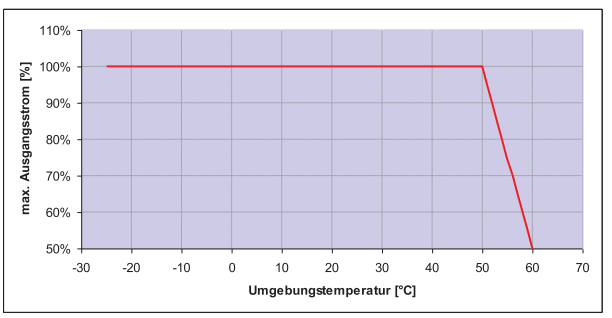


Fig. 25: Derating for wall-mounted frequency converters (VAU 7.5/3 with fan option and VAU 11-22/3)

8.2.2 Derating due to installation altitude

The following applies to all VAU frequency converters:

- ▷ No reduction in performance is required in S1 mode up to 1000m above MSL.
- ▷ A reduction in performance of 1% for every 100 m is required from 1000m to 2000m. Overvoltage category 3 is observed!
- ▷ Overvoltage category 2 should be observed from 2000 m to 4000 m because of the lower air density!

In order to observe the overvoltage category:

- ▷ use an external overvoltage protection in the supply cable of the VAU.
- ▷ reduce the input voltage. Contact the Service department of Gebrüder BECKER GmbH.

The respective max. output values can be determined from the following characteristic curves.

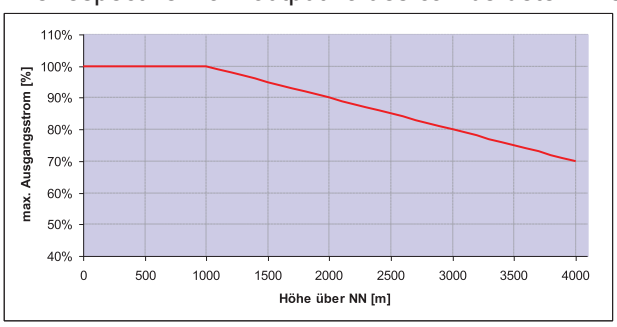


Fig. 26: Derating of maximum output current as a result of installation altitude

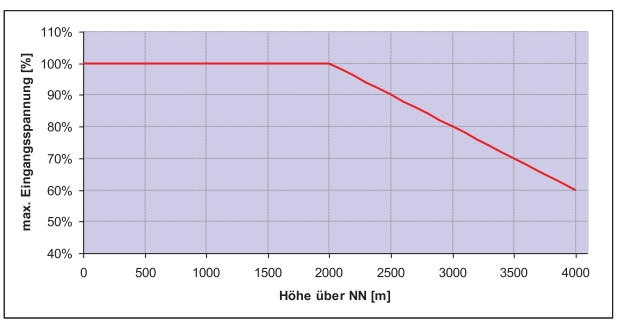


Fig. 27: Derating of maximum input voltage as a result of installation altitude

8.2.3 Derating due to cycle frequency

The following diagram shows the output current dependent on the switching frequency. To limit the heat loss in the frequency converter, the output current must be reduced.

Note: The switching frequency is not reduced automatically!

The max. output values can be determined from the following characteristic curve.

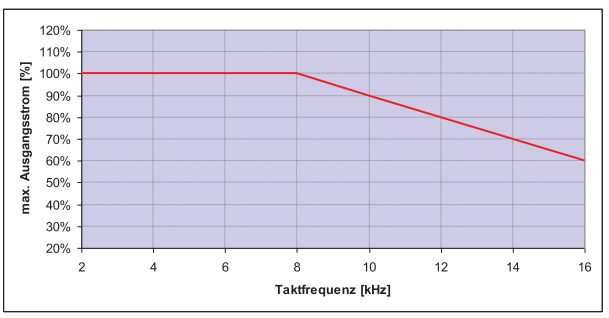


Fig. 28: Derating of maximum output current as a result of switching frequency

9. Approvals, standards and guidelines

9.1 EMC limit classes

Please note that EMC limit classes are only reached if the standard switching frequency of 8 kHz is complied with.

Depending on the installation material used and/or extreme ambient conditions, it might be necessary to use additional sheath wave filters (ferrite rings). If the device is wall-mounted, the length (max. 3 m) of the shielded motor cables (with large surfaces at both ends) may not exceed the permissible limits.

Wiring suitable for EMC also requires that EMC glands be used on both sides (frequency converter and motor).

INFORMATION

In a residential environment this product can cause high-frequency interference requiring interference suppression measures.

9.2 Classification according to IEC/EN 61800-3

The generic standard defines test procedures and severity levels for every environment in the frequency converter category which have to be complied with.

Definition of environment

First environment (residential, commercial and industrial area):

All “areas” which are directly supplied by a public low-voltage connection, such as:

- ▷ residential area, e.g. houses, apartments etc.
- ▷ retail area, e.g. shops, supermarkets
- ▷ public institutions, e.g. theatres, stations
- ▷ outside areas, e.g. petrol stations and parking areas
- ▷ light industry, e.g. workshops, laboratories, small businesses

Second environment (industry):

Industrial environments with their own supply network separated from the public low-voltage supply by a transformer.

9.3 Standards and directives

The following specifically apply:

- ▷ Directive on Electromagnetic Compatibility (Directive 2004/108/EC of the Council EN 61800-3:2004).
- ▷ Low Voltage Directive (Directive 2006/95/EC of the Council EN 61800-5-1:2003)

9.4 UL approval

9.4.1 UL specification (English version)

Maximum Ambient Temperature (without models Suffix S10):

Electronic	Adapter	Ambient	Suffix
INV MB 4 2.2	ADP MB WDM	45° C	-
INV MB 4 3.0	ADP MB WDM	40° C	-
INV MB 4 4.0	ADP MB WDM	35° C	-
INV MC 4 5.5	ADP MC WDM	40° C	Gx0
INV MC 4 7.5	ADP MC WDM	35° C	Gx0
INV MC 4 9.2	ADP MC WDM	20° C	Gx0
INV MC 4 5.5	ADP MC WDM	55° C	Gx1
INV MC 4 7.5	ADP MC WDM	50° C	Gx1
INV MC 4 9.2	ADP MC WDM	50° C	Gx1
INV MC 4 5.5	ADP MC WDM	50° C	Gx2
INV MC 4 7.5	ADP MC WDM	45° C	Gx2
INV MC 4 9.2	ADP MC WDM	45° C	Gx2
INV MD 4 11.0	ADP MD WDM	55° C	-
INV MD 4 15.0	ADP MD WDM	50° C	-
INV MD 4 18.5	ADP MD WDM	40° C	-
INV MD 4 22.0	ADP MD WDM	35° C	-
INV MD 4 28.0	ADP MD WDM	10° C	-

Maximum ambient temperature (with suffix S10):

Electronic	Adapter	Ambient	Suffix
INV MC 4 5.5	ADP MC WDM	40° C	S10
INV MC 4 7.5	ADP MC WDM	35° C	S10

Required Markings

Enclosure intended for use with field-installed conduit hubs, fittings or closure plates UL approved in accordance to UL514B and CSA certified in accordance to C22.2 No. 18, environmental Type 1 or higher.

The VAU INV MC 4 with suffix S10 is for use in Pollution Degree 2 only.

Internal Overload Protection Operates within 60 seconds when reaching 150 % of the Motor Full Load Current

Suitable for use on a circuit capable of delivering not more than 5 kA rms symmetrical amperes, 230 Volts for INV Mx 2 or 480 Volts for INV Mx 4, maximum when protected by fuses.

“Warning” – Use fuses rated 600 V/30 A for INV MB 4 only.

“Warning” – Use fuses rated 600 V/30 A for INV MC 4 only.

“Warning” – Use fuses rated 600 V/70 A for INV MD 4 only.

Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the Manufacturer Instructions, National Electrical Code and any additional local codes.

All wiring terminals marked to indicate proper connections for the power supply, load and control circuitry.

The tightening, torque to connect the motor terminals, is 26.55 IB/in (size A to C) and 5.31 lb/in to connect the PTC (in all sizes).

Instruction for operator and servicing instructions on how to mount and connect the products using the intended motor connection adapter, please see chapter 3 in the operating manual.

Use 75° C copper wires only.

Drives do not provide over temperature sensing. For use in Pollution degree 2 only (only for model S10).

For Mx 4 used in Canada: TRANSIENT SURGE SUPPRESSION SHALL BE INSTALLED ON THE LINE SIDE OF THIS EQUIPMENT AND SHALL BE RATED 277 V (PHASE TO GROUND), 480 V (PHASE TO PHASE), SUITABLE FOR OVERVOLTAGE CATEGORY III, AND SHALL PROVIDE PROTECTION FOR A RATED IMPULSE WITHSTAND VOLTAGE PEAK OF 2.5 kV

Maximum Surrounding Temperature (sandwich version):

Electronic	Overall heatsink dimensions	Surrounding	Suffix
INV MB 4 2.2	(200x40x250) mm	60° C	Gx3
INV MB 4 3.0	(200x40x250) mm	60° C	Gx3
INV MB 4 4.0	(200x40x250) mm	60° C	Gx3
INV MC 4 5.5	(216x83x300) mm	65° C	Gx3
INV MC 4 7.5	(216x83x300) mm	65° C	Gx3
INV MD 4 11.0	to be defined	to be defined	Gx3
INV MD 4 15.0	to be defined	to be defined	Gx3
INV MD 4 18.5	to be defined	to be defined	Gx3
INV MD 4 22.0	to be defined	to be defined	Gx3

CONDITIONS OF ACCEPTABILITY:

Use - For use only in complete equipment where the acceptability of the combination is determined by Underwriters Laboratories Inc.

1. These drives are incomplete in construction and have to be attached to an external heatsink in the end-use. Unless operated with the heatsink as noted in item 2 of the conditions of acceptability below, temperature test shall be conducted in the end-use.
2. Temperature test was conducted with drive installed on aluminum heatsink, overall dimensions and ribs shape as outlined below:
3. Suitability of grounding for the combination of drive and heatsink needs to be verified in accordance with the end-use standard.
4. Temperature test was not conducted on models INV MD 4. Suitability of drive - heatsink combination shall be determined by subjecting to temperature test in the end-use.

Required Markings

Internal Overload Protection Operates within 60 seconds when reaching 150 % of the Motor Full Load Current.

Suitable for use on a circuit capable of delivering not more than 5 kA rms symmetrical amperes, 230 Volts for INV Mx 2 or 480 Volts for INV Mx 4, maximum when protected by fuses.

“Warning” – Use fuses rated 600 V/30 A for INV MB 4 only.

“Warning” – Use fuses rated 600 V/30 A for INV MC 4 only.

“Warning” – Use fuses rated 600 V/70 A for INV MD 4 only.

Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the Manufacturer Instructions, National Electrical Code and any additional local codes.

All wiring terminals marked to indicate proper connections for the power supply, load and control circuitry.

Instruction for operator and servicing instructions on how to mount and connect the products using the intended motor connection adapter, please see chapter 3 in the operating manual.

Use 75° C copper wires only.

Drives do not provide over temperature sensing.

For use in Pollution degree 2 only.

For Mx 4 used in Canada: TRANSIENT SURGE SUPPRESSION SHALL BE INSTALLED ON THE LINE SIDE OF THIS EQUIPMENT AND SHALL BE RATED 277 V (PHASE TO GROUND), 480 V (PHASE TO PHASE), SUITABLE FOR OVERVOLTAGE CATEGORY III, AND SHALL PROVIDE PROTECTION FOR A RATED IMPULSE WITHSTAND VOLTAGE PEAK OF 2.5 kV

9.4.2 Homologation CL (Version en française)

Température ambiante maximale (sans modèles suffixe S10):

Électronic	Adaptateur	Ambiante	Suffixe
INV MB 4 2.2	ADP MB WDM	45° C	-
INV MB 4 3.0	ADP MB WDM	40° C	-
INV MB 4 4.0	ADP MB WDM	35° C	-
INV MC 4 5.5	ADP MC WDM	40° C	Gx0
INV MC 4 7.5	ADP MC WDM	35° C	Gx0
INV MC 4 9.2	ADP MC WDM	20° C	Gx0
INV MC 4 5.5	ADP MC WDM	55° C	Gx1
INV MC 4 7.5	ADP MC WDM	50° C	Gx1
INV MC 4 9.2	ADP MC WDM	50° C	Gx1
INV MC 4 5.5	ADP MC WDM	50° C	Gx2
INV MC 4 7.5	ADP MC WDM	45° C	Gx2
INV MC 4 9.2	ADP MC WDM	45° C	Gx2
INV MD 4 11.0	ADP MD WDM	55° C	-
INV MD 4 15.0	ADP MD WDM	50° C	-
INV MD 4 18.5	ADP MD WDM	40° C	-
INV MD 4 22.0	ADP MD WDM	35° C	-
INV MD 4 28.0	ADP MD WDM	10° C	-

Température environnante maximale (avec suffixe S10):

Électronic	Adaptateur	Ambiante	Suffixe
INV MC 4 5.5	ADP MC WDM	40° C	S10
INV MC 4 7.5	ADP MC WDM	35° C	S10

Mentions requises

Boîtier prévu pour une utilisation avec entrées de conduit filetées installées sur le terrain, raccords ou plaques d'obturation approuvées UL conformément à UL514B et certifiées CSA conformément à C22.2 No. 18, étiquetage environnemental de type 1 ou plus.

Le variateur VAU INV MC 4 avec le suffixe S10 est exclusivement conçu pour une utilisation en environnement de degré de pollution 2.

La protection interne contre les surcharges se met en marche en l'espace de 60 secondes une fois 150 % du courant nominal du moteur atteints.

Convient pour une utilisation sur un circuit capable de livrer pas plus de 5 kA ampères symétriques rms, 230 volts pour INV Mx 2 ou 480 volts pour INV Mx 4 maximum en cas de protection par fusibles.

« Avertissement » – Utiliser des fusibles d'une valeur nominale de 600 V/30 A pour INV MB 4 uniquement.

« Avertissement » – Utiliser des fusibles d'une valeur nominale de 600 V/30 A pour INV MC 4 uniquement.

« Avertissement » – Utiliser des fusibles d'une valeur nominale de 600 V/70 A pour INV MD 4 uniquement.

La protection intégrée contre les courts-circuits à semi-conducteur n'assure pas la protection du circuit de dérivation. Le circuit de dérivation doit être protégé conformément aux instructions du fabricant, au code national d'électricité et à tout autre code local additionnel.

Toutes les bornes de câblage avec repères pour les connexions correctes pour l'alimentation électrique, la charge et les circuits de commande.

Le couple de serrage pour la connexion des bornes du moteur est de 26,55 lb/in (taille A à C) et de 5,31 lb/in pour la connexion CTP (toutes les tailles).

Pour les instructions destinées à l'opérateur et les instructions de service relatives au montage et à la connexion des produits à l'aide de l'adaptateur de connexion du moteur prévu à cet effet, voir les chapitres 3 contenus dans le Manuel d'utilisation.

Utiliser uniquement des câbles en cuivre 75° C.

Les entraînements ne permettent pas la détection de surtempérature.

Réservé exclusivement à une utilisation en environnement de pollution de degré 2 (seulement pour le modèle S10).

Concernant le Mx 4 utilisé au Canada : LA SUPPRESSION DE TENSION TRANSITOIRE DOIT ÊTRE INSTALLÉE CÔTÉ LIGNE DE CET ÉQUIPEMENT ET AVOIR UNE VALEUR NOMINALE DE 277 V (PHASE-TERRE), 480 V (PHASE-PHASE), EN COMPATIBILITÉ AVEC LA CATÉGORIE DE SURTENSION III, ET DOIT OFFRIR UNE PROTECTION CONTRE UN PIC DE TENSION ASSIGNÉE DE TENUE AUX CHOCS DE 2,5 kV

Température environnante maximale (version sandwich):

Électronic	Dimensions hors tout du dissipateur	Environnante	Suffixe
INV MB 4 2.2	(200x40x250) mm	60° C	Gx3
INV MB 4 3.0	(200x40x250) mm	60° C	Gx3
INV MB 4 4.0	(200x40x250) mm	60° C	Gx3
INV MC 4 5.5	(216x83x300) mm	65° C	Gx3
INV MC 4 7.5	(216x83x300) mm	65° C	Gx3
INV MD 4 11.0	to be defined	to be defined	Gx3
INV MD 4 15.0	to be defined	to be defined	Gx3
INV MD 4 18.5	to be defined	to be defined	Gx3
INV MD 4 22.0	to be defined	to be defined	Gx3

CONDITIONS D'ACCEPTABILITÉ:

Utilisation - Réservé à une utilisation dans un équipement complet pour lequel l'acceptabilité de la combinaison est déterminée par Underwriters Laboratories Inc.

1. Ces entraînements sont incomplets et doivent être raccordés à un dissipateur externe en utilisation finale. Sauf en cas d'utilisation avec dissipateur comme mentionné au point 2 des conditions d'acceptabilité ci-dessous, il est conseillé d'effectuer un test de température en utilisation finale.
2. Le test de température a été effectué avec un entraînement installé sur un dissipateur en aluminium, dimensions hors tout et forme d'ailettes comme indiqué ci-dessous.

3. La possibilité de mise à la terre de la combinaison entraînement et dissipateur doit être vérifiée conformément à la norme d'utilisation finale.
4. Le test de température n'a pas été conduit sur les modèles INV MD 4. Déterminer si la combinaison entraînement - dissipateur est appropriée à l'aide d'un test de température en utilisation finale.

Mentions requires

La protection interne contre les surcharges se met en marche en l'espace de 60 secondes une fois 150 % du courant nominal du moteur atteints.

Convient pour une utilisation sur un circuit capable de livrer pas plus de 5 kA ampères symétriques rms, 230 volts pour INV Mx 2 ou 480 volts pour INV Mx 4 maximum en cas de protection par fusibles.

« Avertissement » – Utiliser des fusibles d'une valeur nominale de 600 V/30 A pour INV MB 4 uniquement.

« Avertissement » – Utiliser des fusibles d'une valeur nominale de 600 V/30 A pour INV MC 4 uniquement.

« Avertissement » – Utiliser des fusibles d'une valeur nominale de 600 V/70 A pour INV MD 4 uniquement.

La protection intégrée contre les courts-circuits à semi-conducteur n'assure pas la protection du circuit de dérivation. Le circuit de dérivation doit être protégé conformément aux instructions du fabricant, au code national d'électricité et à tout autre code local additionnel.

Toutes les bornes de câblage avec repères pour les connexions correctes pour l'alimentation électrique, la charge et les circuits de commande.

Pour les instructions destinées à l'opérateur et les instructions de service relatives au montage et à la connexion des produits à l'aide de l'adaptateur de connexion du moteur prévu à cet effet, voir les chapitres 3 contenus dans le Manuel d'utilisation.

Utiliser uniquement des câbles en cuivre 75° C.

Les entraînements ne permettent pas la détection de surtempérature.

Réservé exclusivement à une utilisation en environnement de pollution de degré 2.

Concernant le Mx 4 utilisé au Canada: LA SUPPRESSION DE TENSION TRANSITOIRE DOIT ÊTRE INSTALLÉE CÔTÉ LIGNE DE CET ÉQUIPEMENT ET AVOIR UNE VALEUR NOMINALE DE 277 V (PHASE-TERRE), 480 V (PHASE-PHASE), EN COMPATIBILITÉ AVEC LA CATÉGORIE DE SURTENSION III, ET DOIT OFFRIR UNE PROTECTION CONTRE UN PIC DE TENSION ASSIGNÉE DE TENUE AUX CHOCS DE 2,5 kV

10 Information for maintenance and service

VAU frequency converters are maintenance-free with correct operation. Please also note the "general data" in chapter 8.1.

If the frequency converter is operated in dusty air, the cooling surfaces must be cleaned regularly. Any air inlet filters used in the control cabinet must also be cleaned or replaced regularly.

For repairs please contact your responsible national agency.

If a frequency converter is sent for repair, no warranty will be given for any add-on components, such as mains cables, potentiometer, external displays etc.!

Please remove all non-original parts from the frequency converter.

All ducts carrying cooling water must be drained (purge with compressed air).