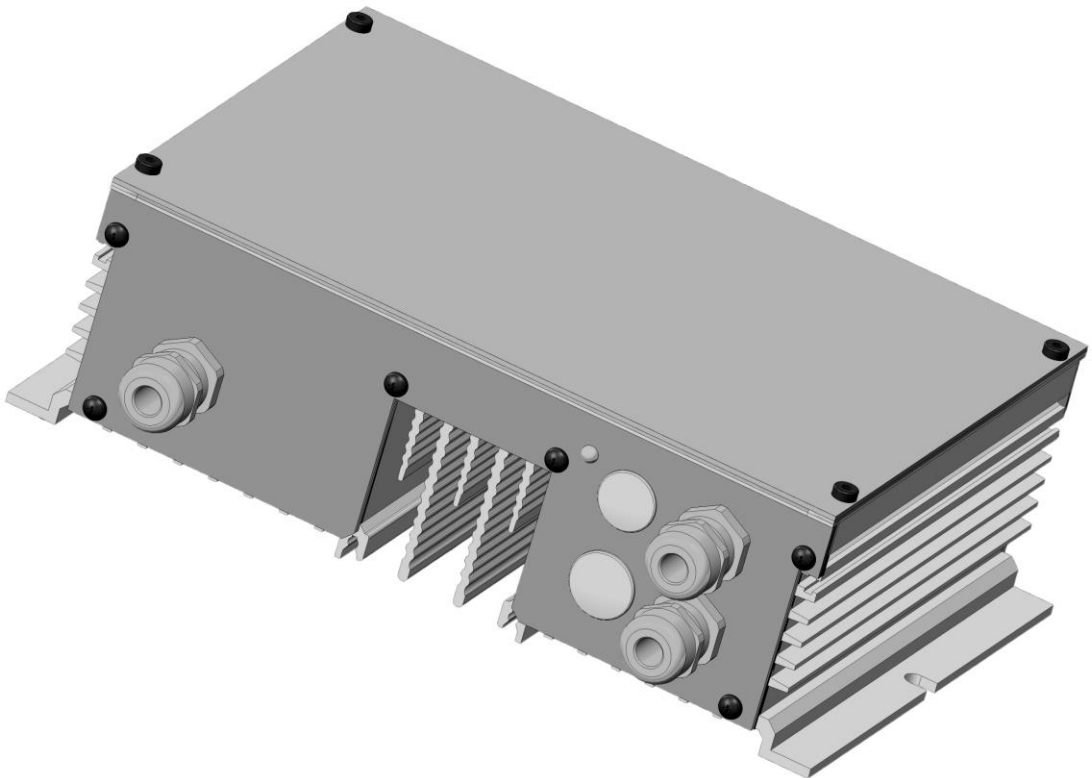


**BA-EKE 1.04 – 03/2020**

**EKE 10-0070-5E-IM**



**Warning**

Before installing and commissioning the EC-Controller, you must read all safety instructions and warnings carefully including all the warning labels attached to the equipment. Make sure that the warning labels are kept in a legible condition and replace missing or damaged labels.



NICOTRA Gebhardt reserves the right to change without notice.

**Information is also available from:**

Nicotra Gebhardt GmbH  
Gebhardtstraße 19-25  
74638 Waldenburg  
Germany

Phone: +49 (0)7942 / 101 - 0  
E-Mail: [info.ng.de@regalbeloit.com](mailto:info.ng.de@regalbeloit.com)  
URL: [www.nicotra-gebhardt.com](http://www.nicotra-gebhardt.com)

## Definitions and Warnings



### **Warning**

For the purpose of this documentation and the product warning labels, "Warning" indicates that death, severe personal injury or substantial damage to property can result if proper precautions are not taken.



### **Caution**

For the purpose of this documentation and the product warning labels, "Caution" indicates that minor personal injury or material damage can result if proper precautions are not taken.



### **Note**

For the purpose of this documentation, "Note" indicates important information relating to the product or highlights part of the documentation for special attention.

### **Qualified personnel**

For the purpose of this Instruction Manual and product labels, a "Qualified person" is someone who is familiar with the installation, mounting, start-up and operation of the equipment and the hazards involved.

He or she must have the following qualifications:

- Trained and authorized to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety procedures.
- Trained in the proper care and use of protective equipment in accordance with established safety procedures.
- Trained in rendering first aid.

### **Use for intended purpose only**

The equipment may be used only for the application stated in the manual and only in conjunction with devices and components recommended and authorized by Nicotra Gebhardt GmbH.

## Approvals



### **European Low Voltage Directive**

The EC-Controller complies to the requirements of the Low Voltage Directive 2006/95 EC.

### **European EMC Directive**

The EC-Controller is supplied exclusively in connection with products of the company Nicotra Gebhardt. The unit is fully integrated in the corresponding products or will be delivered together with the products. After correct installation it complies to the requirements of the EMC directive, according to the EMC product standard for electrical drives with variable speed EN 61800-3.

## Safety Instructions

The following warnings, cautions and notes are provided for your safety and as a means of preventing damage to the product or components at the connected machines. This section lists warnings, cautions and notes, which apply generally when handling the Nicotra Gebhardt EC-Controller, classified as **General, Transport & Storage, Commissioning, Operation and Repair**.

**Specific warnings, cautions and notes** that apply to particular activities are listed at the beginning of the relevant chapters and are repeated or supplemented at critical points throughout these sections.

**Please read the information carefully, since it is provided for your personal safety and will also help prolong the service life of your EC-Controller and the equipment you connect to it.**

### General



#### Warnings

This equipment contains dangerous voltages and controls potentially dangerous rotating mechanical parts. Non-compliance with these warnings or failure to follow the instructions contained in this manual can result in loss of life, severe personal injury or serious damage to property.

Only suitable qualified personnel should work on this equipment, and only after becoming familiar with all safety notices, installation, operation and maintenance procedures contained in this manual. The successful and safe operation of this equipment is dependent upon its proper handling, installation, operation and maintenance.

Children and the general public must be prevented from accessing or approaching the equipment!

#### Risk of electric shock!

The DC link capacitors remain charged after mains supply has been switched off. It is not permissible to open the equipment until 10 minutes after the mains supply has been removed.



#### Caution

This equipment may only be used for the purpose specified by the manufacturer. Unauthorized modifications and the use of spare parts and accessories that are not sold or recommended by the manufacturer of the equipment can cause fires, electric shocks and injuries.



#### Notes

Keep these operating instructions within easy reach of the equipment and make them available to all users. Whenever measuring or testing has to be performed on live equipment suitable electronic tools should be used.

Before installing and commissioning, please read these safety instructions and warnings carefully and all the warning labels attached to the equipment.

Make sure that the warning labels are kept in a legible condition and replace missing or damaged labels.

## Transport & Storage



Warning

### Warning

Correct transport, storage, erection and mounting, as well as careful operation and maintenance are essential for proper and safe operation of the equipment.



Caution

### Caution

Protect the inverter against physical shocks and vibration during transport and storage. Also be sure to protect it against water (rainfall) and excessive temperatures.

## Commissioning



Warning

### Warnings

Work on the device/system by **unqualified** personnel or failure to comply with warnings can result in severe personal injury or serious damage to material.

Only suitably qualified personnel trained in the setup, installation, commissioning and operation of the product should carry out work on the device/system.

### This equipment must be grounded.

The following terminals can carry dangerous voltages even if the *EC-Controller* is inoperative:

- the power supply terminals L1, N
- the motor terminals U, V, W

## Operation



Warning

### Warnings

The EC-Controller operates at high voltages.

Certain parameter settings may cause the inverter to restart automatically after an input power failure.

The MaxSpeed Parameter must be accurately configured for motor overload protection to operate correctly.

## Repair



Warning

### Warning

Repairs on equipment may only be carried out by Nicotra Gebhardt.

Before opening the equipment for access, disconnect the power supply and **wait for at least 5 minutes until the DC-link capacitor is completely discharged!**

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## 1 Overview

### 1.1 General Information

The Nicotra Gebhardt EC-Controller EKE10-0070-5E-IM is an inverter for controlling the speed of motor-impeller-units with BLDC or induction motors (IM).

Due to its sensorless field oriented control algorithm the motors are driven in any duty point at the optimum field angle. This always results in good efficiency.

The EC-Controller provides active Power Factor Correction (PFC) and inverter and motor overload protection. The EC-Controller EKE10-0070-5E-IM can be used in both stand-alone applications as well as in large fan systems using the integrated network interface (Modbus RTU) for controlling and monitoring purposes.

### 1.2 Features

#### 1.2.1 Main Characteristics

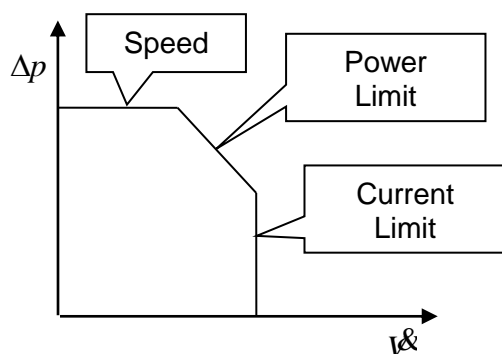
- Supply voltage 230Vac  $\pm 10\%$
- Easy installation and commissioning
- Simple cable connection with cage clamps
- Integrated network interface (Modbus RTU)
- Sensorless Airflow Control
- Integrated analogue-/digital interface (3x programmable analog/digital inputs, 2x programmable dry contacts)

#### 1.2.2 Performance

- Sensorless field oriented speed control
- Acceleration and deceleration ramp
- High efficiency
- up to 2000W input power (depending on cooling)
- Power Factor  $> 98\%$
- Harmonic currents  $< 8\%$  THD (integrated active PFC)

#### 1.2.3 Protection

- Mains voltage monitoring (Brown-out)
- Overload and overheat protection controller
- Impeller blocking protection
- Adjustable maximum speed according to the impeller size
- Safe Operating Area (speed, power and current limitation according to the selected fan type)





## 2 Installation



**Warning**

### Warnings

Work on the device/system by unqualified personnel or failure to comply with warnings can result in severe personal injury or serious damage to material.

Only suitably qualified personnel trained in the set-up, installation, commissioning and operation of the product should carry out work on the device/system.

### **This equipment must be grounded.**

The following terminals can carry dangerous voltages even if the EC-Controller is inoperative:

- the power supply terminals L1, N
- the motor terminals U, V, W

## 2.1 Ambient Operating Conditions

### Protection Class

IP 54

### Humidity Range

90% Non-condensing

### Altitude

If the inverter is to be installed at an altitude > 1000m, derating is required.

### Shock

Do not drop the inverter or expose it to sudden shock.

### Vibration

Do not install the inverter in an area where it is likely to be exposed to constant vibration.

### Installation



**Warning**

### Warnings

The device is designed to be exposed partly to the fan air stream with maximum medium temperature of 40°C to achieve full power load at all fan sizes.

Alternatively, a forced cooling can be realized in any other way, for instance by additional blower. Otherwise, if the operating conditions cause overheating, the controller would automatically perform self-derating to operate at the allowed temperature limit, indicating warning "Temperature derating".

Do not cover the device during operation!

## 2.2 Mechanical Dimensions

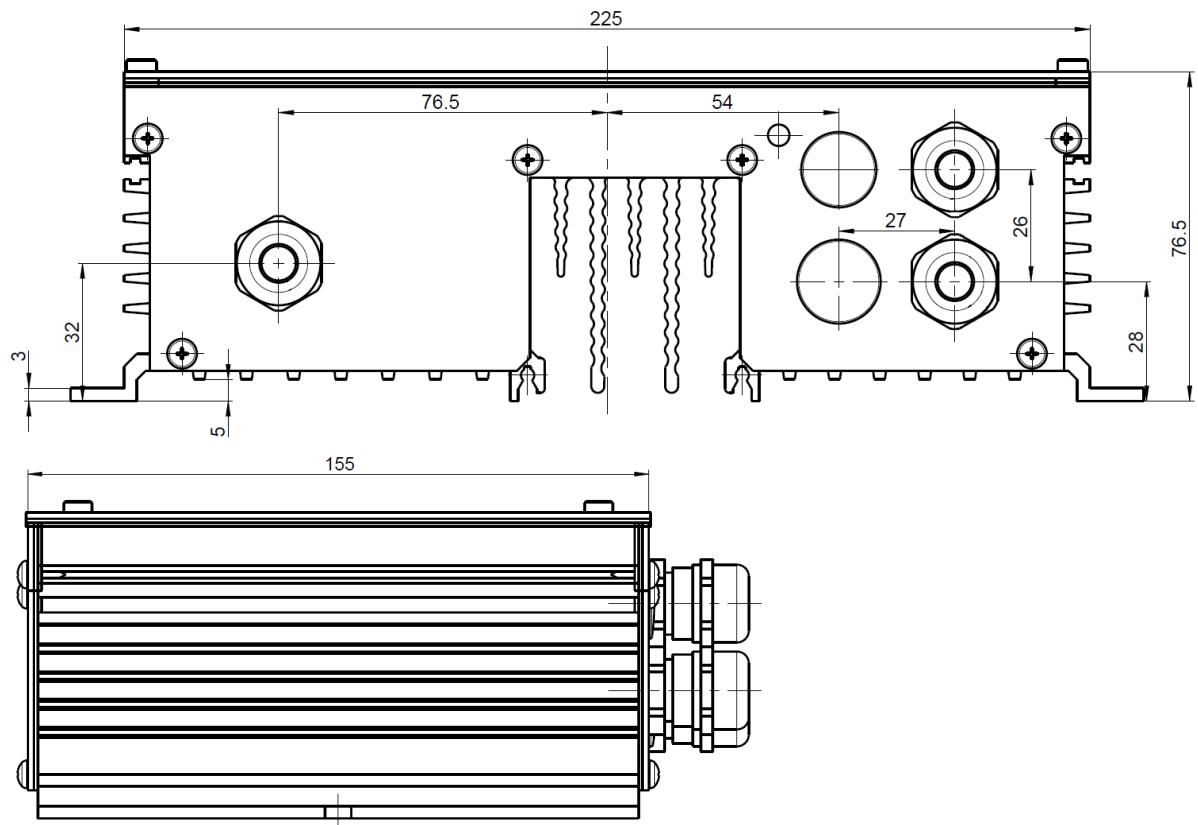


Figure 1: Device dimensions

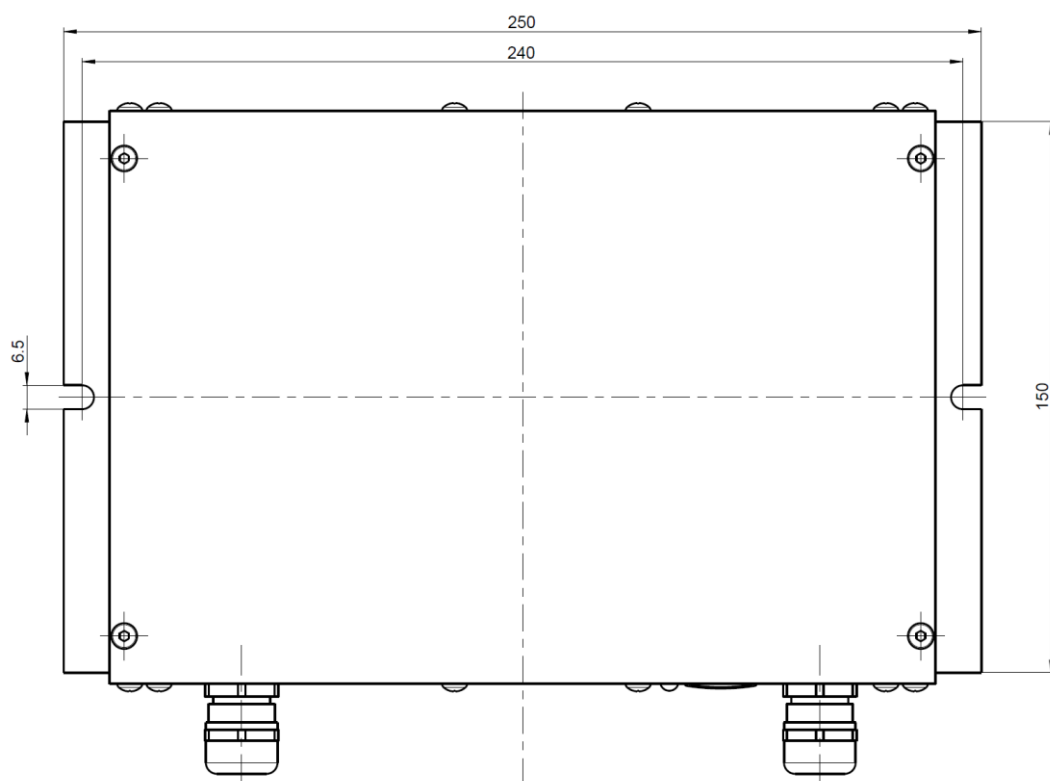


Figure 2: Drill pattern

## 2.3 Optional Fan

The EKE10 provides the possibility to mount an additional fan if the cooling may not be enough inside the application.

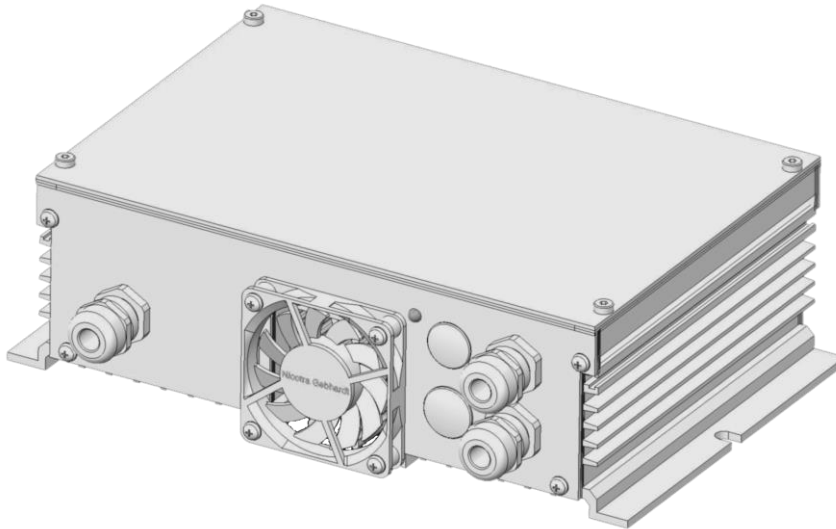


Figure 3: EKE10 with optional fan mounted

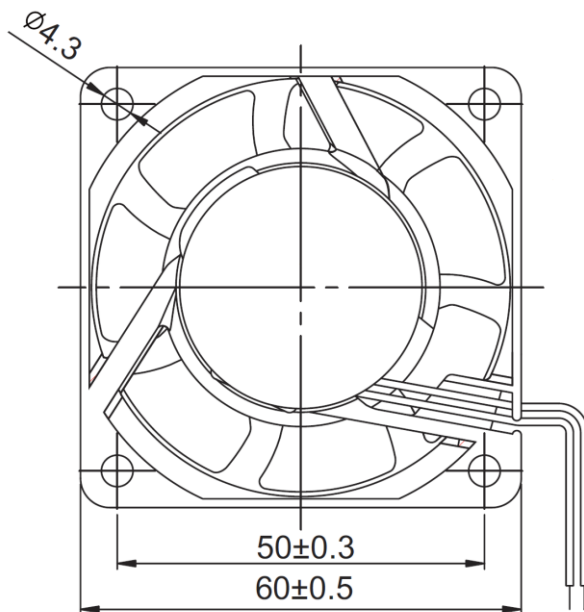


Figure 4: Required fan size



### Note

It is recommended to use a fan with minimum 25 m<sup>3</sup>/h (15 cfm).

When using a 230 Vac supplied fan, the power can be taken from EKE10 power connector X1 using one cable gland.

If the fan cooling is not sufficient, the device will perform automatic derating.

## 2.4 Overview Connectors and Operating Elements

### 2.4.1 Connectors

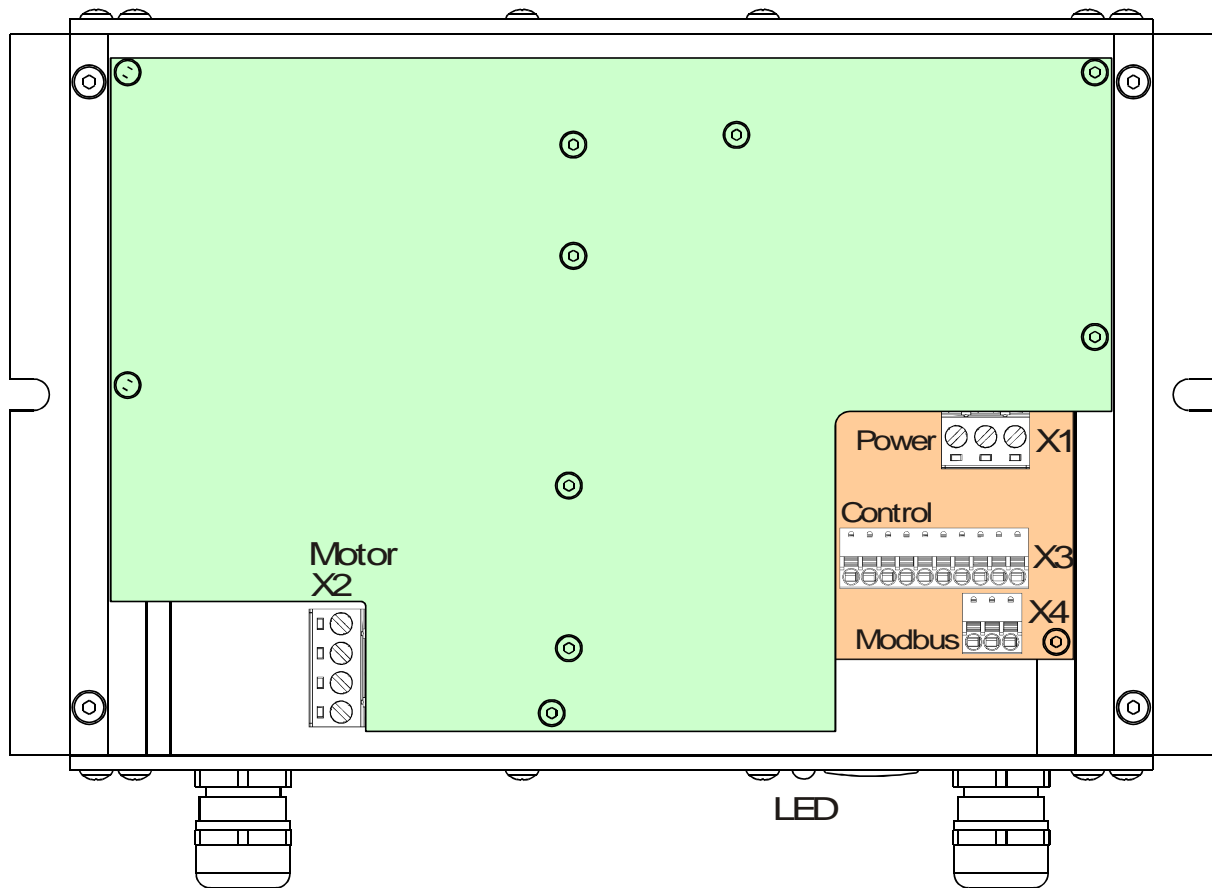


Figure 5: Connector overview

## 2.4.2 DIP Switches

The interface PCB provides DIP switches for fan selection purpose and to enable special functions.

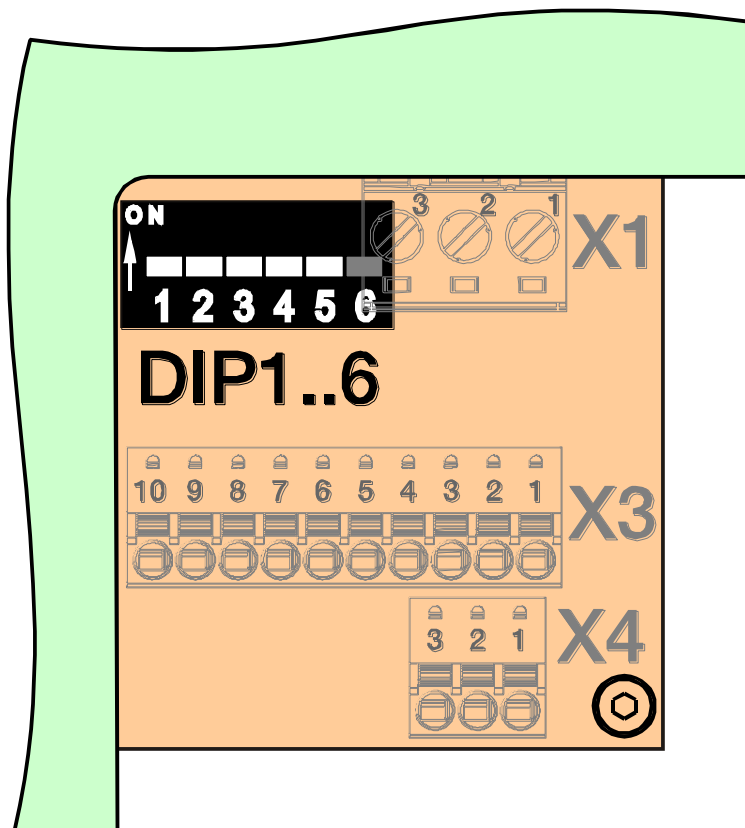


Figure 6: Position of DIP switches

Position	DIP	Additional Conditions	Function
1..5		DIP6 OFF	Fan selection
6		<b>This switch must be OFF during normal operation!</b>	
		<ul style="list-style-type: none"> <li>Analogue input <b>less than 50%</b></li> <li>Power-ON</li> </ul>	Reset to factory default.
		<ul style="list-style-type: none"> <li>Analogue input <b>more than 50%</b></li> <li>Power-ON</li> </ul>	Trigger motor identification

Table 1: DIP switches for fan selection and special functions

	<b>Note</b> All DIP adjustments will become valid even after power-ON.
--	---

## 2.4.3 Status LED

To indicate the device status the EKE10 provides a dual colour LED (red and green):

Status LED	Function	Indication	State
Green	Ready	slow flashing (1s period)	Device ready (speed= 0)
		ON	Device ready (speed>0)
		fast flashing (0,1s period)	Loading of motor parameters
Yellow (green and red together)	Warning	OFF	no warning
		ON (motor n>0)	Device is working at limit (voltage, current, power)
		slow flashing (1s period)	Warning temperature high
	Motor identification	fast flashing (0,1s period)	Motor identification in progress
Red	Software update	ON (motor n=0)	Software update initialized
	Software update	Periodical flashing (1s period, 3x flash)	Software update in progress
		OFF	no error
		ON	Error
		slow flashing (1s period)	Internal communication error
Red	Green	Wink	changing red-green flashing (1s period)
			„Wink“ command received

**Table 2: Status indication**

## 2.5 Assembling



**Warning**

### Warnings

Work on the device/system by unqualified personnel or failure to comply with warnings can result in severe personal injury or serious damage to material.

Only suitably qualified personnel trained in the set-up, installation, commissioning and operation of the product should carry out work on the device/system.

### This equipment must be grounded.

The following terminals can carry dangerous voltages even if the EC-Controller is inoperative:

- the power supply terminals L1, N
- the motor terminals U, V, W

Before opening the equipment for access, disconnect the power supply and **wait for at least 5 minutes until the DC-link capacitor is completely discharged!**

### 2.5.1 Working Steps

1. Preparation of the device	<p>If the EKE10 is not delivered pre-mounted on a fan it must be mounted on a grounded conducting metal plate.</p> <p>To open the device unfasten the 4 screws on top lid.</p>
2. Insertion of cable	<p>The device is partly equipped with cable glands</p> <p>If these glands are not enough it is possible to add more using the holes removing the blind plugs</p> <p>When shield motor cable is used, the plastic gland must be exchanged by an EMI gland to connect the shield properly with device ground.</p>
3. Connection	See Chapter 2.3
4. Adjustment of DIP switches	See Chapter 3.3
5. Check ground connection	<p><b>This equipment must be grounded.</b></p> <p>Check if the protective earth wire of mains and motor cable is connected properly.</p>
6. Close cover	Close the device with the top lid using the 4 screws.

**Table 3: Working steps for device mounting**

## 2.6 Electrical Installation



Warning

### Warning

**The inverter must always be grounded.** If the inverter is not grounded correctly, extremely dangerous conditions may arise within the inverter, which could be potentially fatal. Make sure that the grounding connection between PCB and basic housing part is applied correctly!

To ensure the safe operation of the equipment, it must be installed and commissioned by qualified personnel in full compliance with the warnings laid down in these operating instructions.

Take particular note of the general and regional installation and safety regulations regarding work on dangerous voltage installations (e.g. EN50178), as well as the relevant regulations regarding the correct use of tools and personal protective equipment (PPE).

After electrical wiring and DIP-switch setting the housing needs to be closed before the mains is switched on.

In case a permanent magnet synchronous motor (PMSM) is connected, the motor wires and the EKE10 itself can carry **dangerous voltage due to back EMF** when motor is turning by air pressure. Make sure to **prevent the motor from revolving** during installation or maintenance work is in progress.

All terminals and PCB parts can carry dangerous voltages even if the inverter is inoperative; **wait 5 minutes to allow the unit to discharge** after switching off before the housing is being opened.

The following terminals can carry dangerous voltages even if the EC-Controller is inoperative:

- - the power supply terminals L1, N
- - the motor terminals U, V, W



Warning

### Warning

The EKE10 contains no fuse! It needs to be protected by a sufficient external fuse (slow characteristic) inserted to the L supply wire.

Fuses and cable cross section must be chosen carefully according to the power consumption and number of connected devices.

Motor cable must not be switched or removed during operation!



Warning

### Warning

High leakage current!

When using the EKE10 inside an application the device has to be connected to protective ground by additional wire.



## 2.6.1 Pin Assignment

### 2.6.1.1 Power Connector X1

Type	Pin	Name	Function
Screw or cage clamp maximum 2,5mm <sup>2</sup> (13 AWG)	1	PE	Protective earth
	2	N	Neutral N
	3	L	Phase L

**Table 4: Power connection with X1**

### 2.6.1.2 Motor Connector X2

Type	Pin	Name	Function
Screw or cage clamp maximum 2,5mm <sup>2</sup> (13 AWG)	1	PE	Protective earth
	2	U	Motor phase U
	3	V	Motor phase V
	4	W	Motor phase W

**Table 5: Motor connection with X2**

### 2.6.1.3 Interface Connector X3

Typ3	Pin	Name	Function
Screw or cage clamp maximum 1,3 mm <sup>2</sup> (16 AWG)	1	GND	Ground
	2	ADIN1	Analogue/digital input 1 (Speed set point 0..10V)
	3	+10V	+10V output
	4	OUT2B	dry contact 2 (running indication)
	5	OUT2A	dry contact 2 (running indication)
	6	OUT1B	dry contact 1 (error indication)
	7	OUT1A	dry contact 1 (error indication)
	8	ADIN3	Analogue/digital input 3 (not preconfigured)
	9	ADIN2	Analogue/digital input 2 (not preconfigured)
	10	GND	Ground

**Table 6: Interface connection with X3**

### 2.6.1.4 Modbus RTU Interface X4

Type	Pin	Name	Funktion
Screw or cage clamp maximum 1,3 mm <sup>2</sup> (16 AWG)	1	GND	Ground
	2	Net A	Bus A
	3	Net B	Bus B

**Table 7: Modbus interface connection with X4**

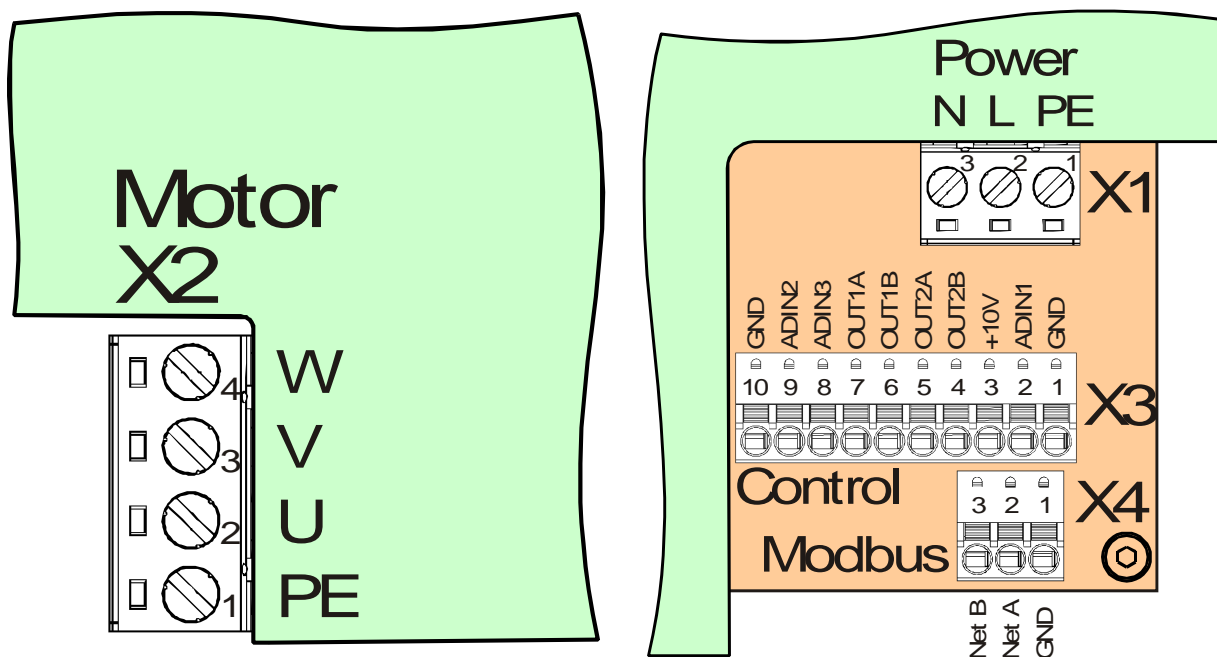


Figure 7: Configuration of connectors

## 2.6.2 Application Examples

### 2.6.2.1 Connection of Power and Motor

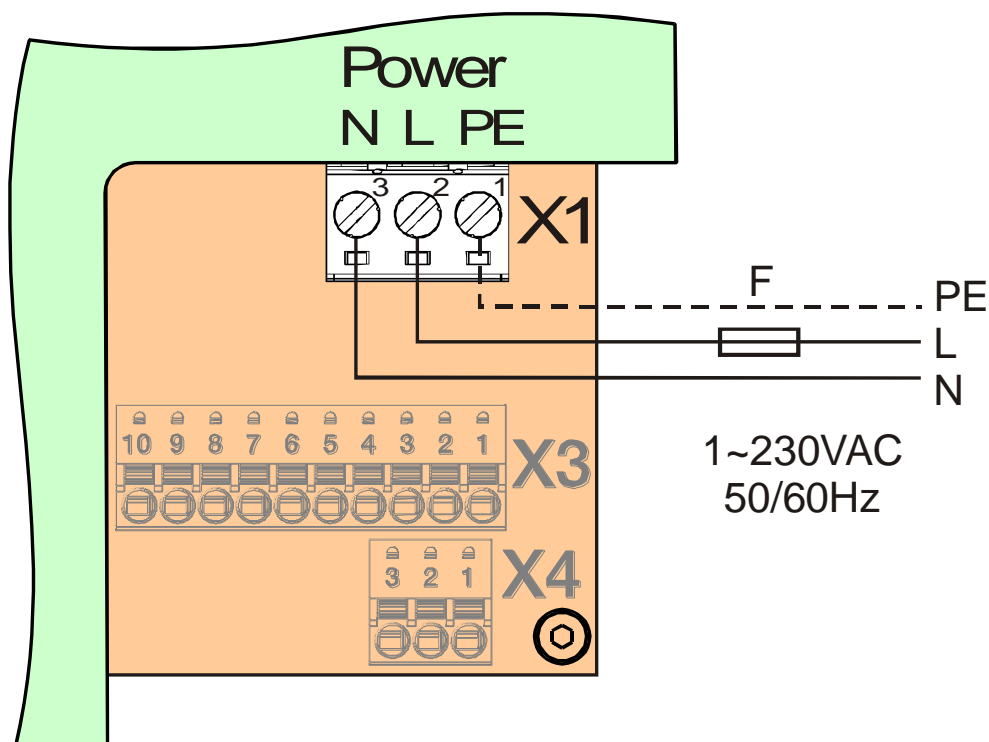
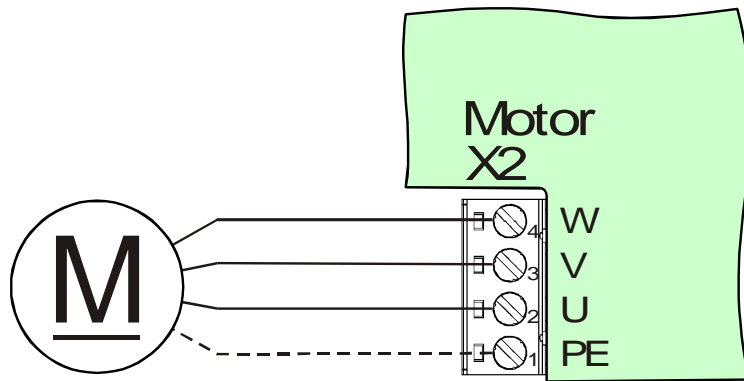


Figure 8: Mains connection



**Figure 9: Motor connection**

## 2.6.2.2 Analogue Interface

The analogue interface can be operated by two ways:

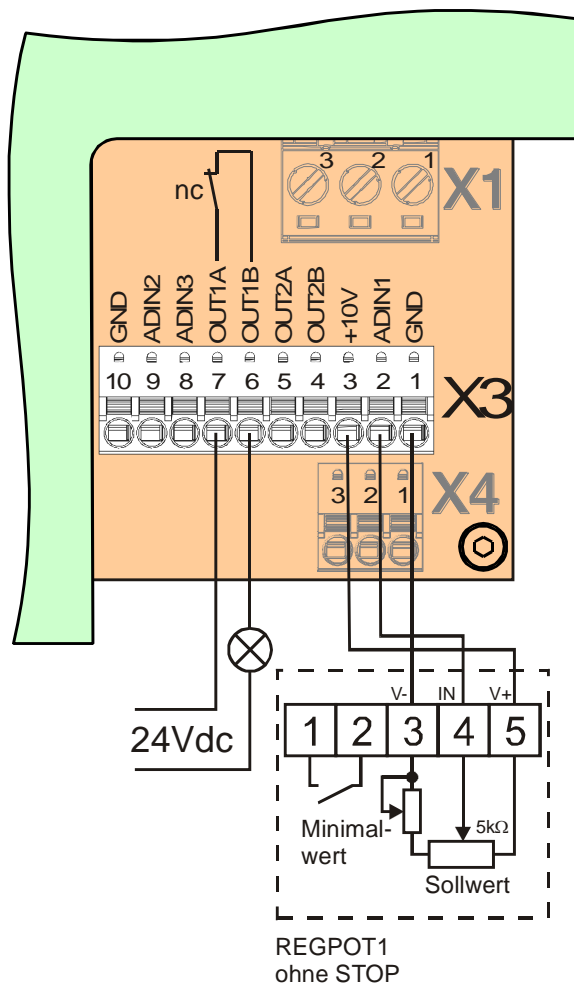
- External voltage 0..10 Vdc
- Potentiometer (using the 10Vdc source of the EKE10)



**Caution**

### Caution

When using external voltage signal, the voltage must not exceed the limits given at the Technical Data page.



**Figure 10: Connection of a potentiometer**

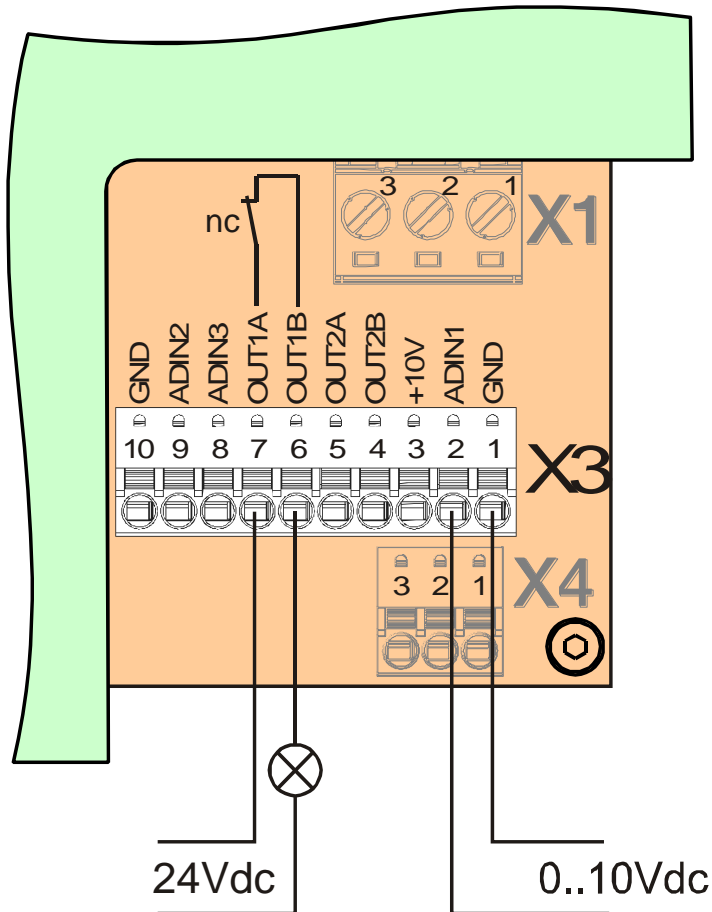


Figure 11: Speed control by external voltage signal

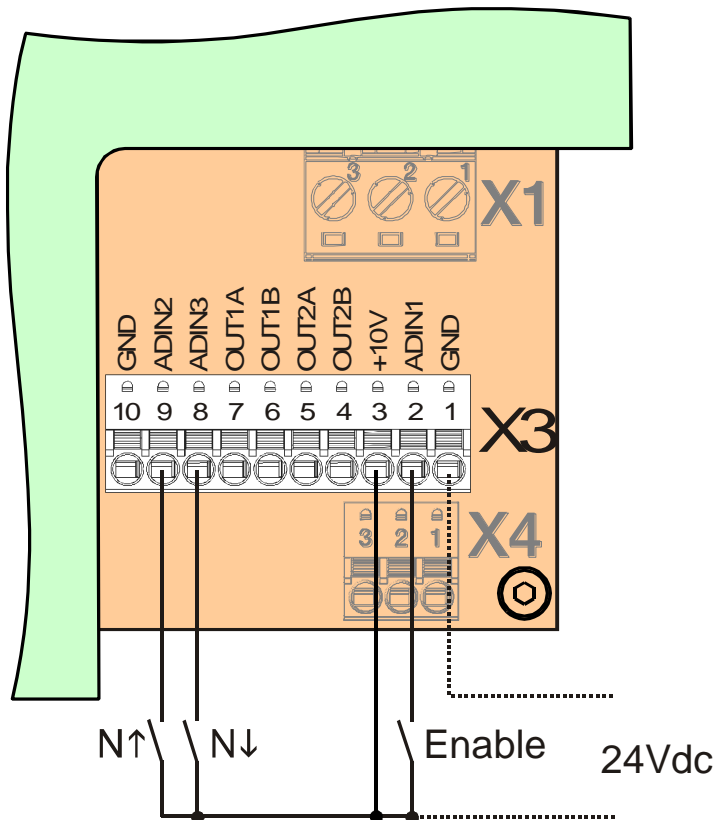


Figure 12: Touch mode, all 3 inputs configured as digital input

## 2.6.2.3 Modbus RTU Interface

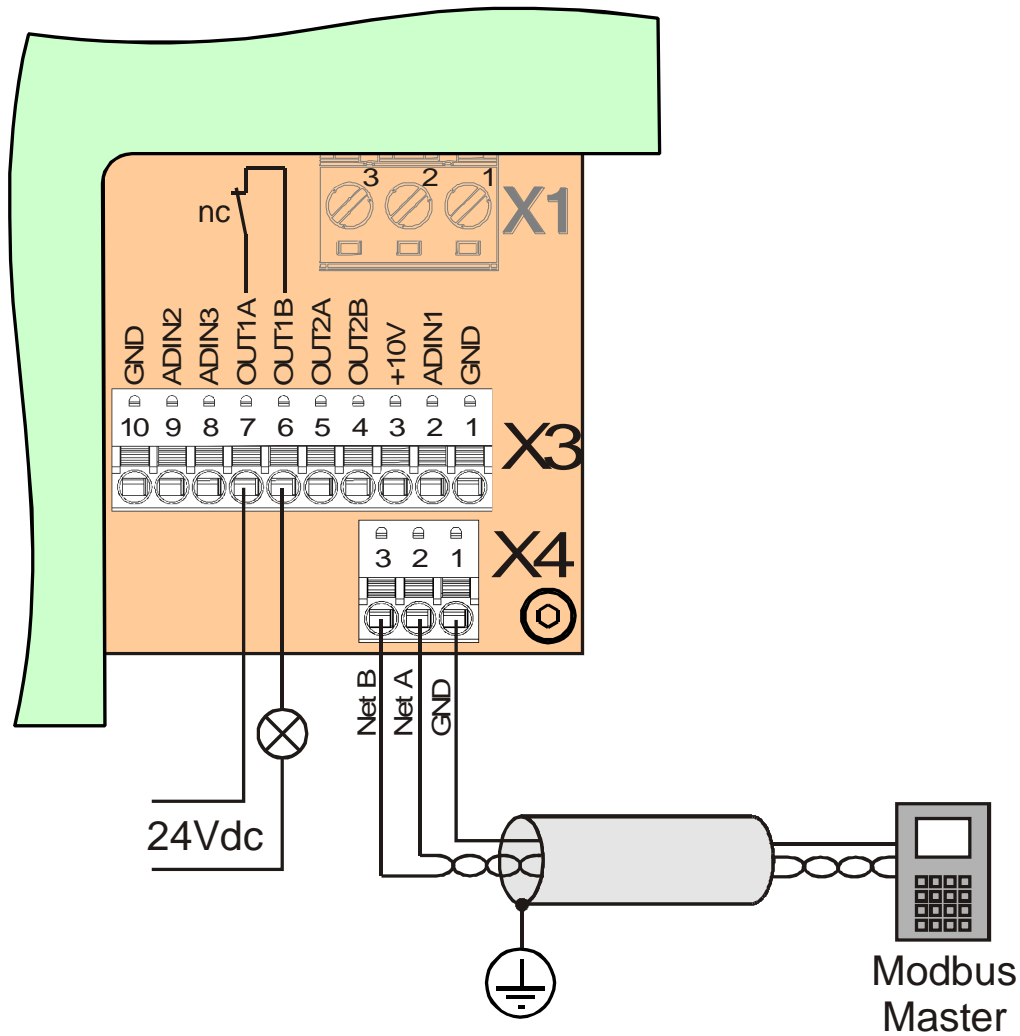


Figure 13: Operation in Modbus mode



**Note**

Using the Modbus interface to monitor operating parameters is possible also in analogue mode.

## 2.6.3 Wiring Guidelines

In standard case the fan will be delivered with an unshielded motor cable commonly used for power wiring of the motor close to the converter.

### 2.6.3.1 Installation Directly to the Fan Housing

Using the original motor cable is intended for standard applications, where the location conditions allow the mechanical assembling of the controller EKE10 close or directly to the fan.

The following terms of conditions should be followed for proper and save operation of the fan (see **Fehler! Verweisquelle konnte nicht gefunden werden.**):

1. Fan and controller should both be mounted on the same electrical conducting wall or chassis (ground plane).
2. Keep all cables close to the fan or ground plane.
3. Keep the motor cable as short as possible.
4. Motor cable should be separated from other cables (mains supply, control) to prevent EMI from cross-talking between motor cable and the other cables.
5. Do not install motor cable in parallel to other cables, these cables should cross under right angle.

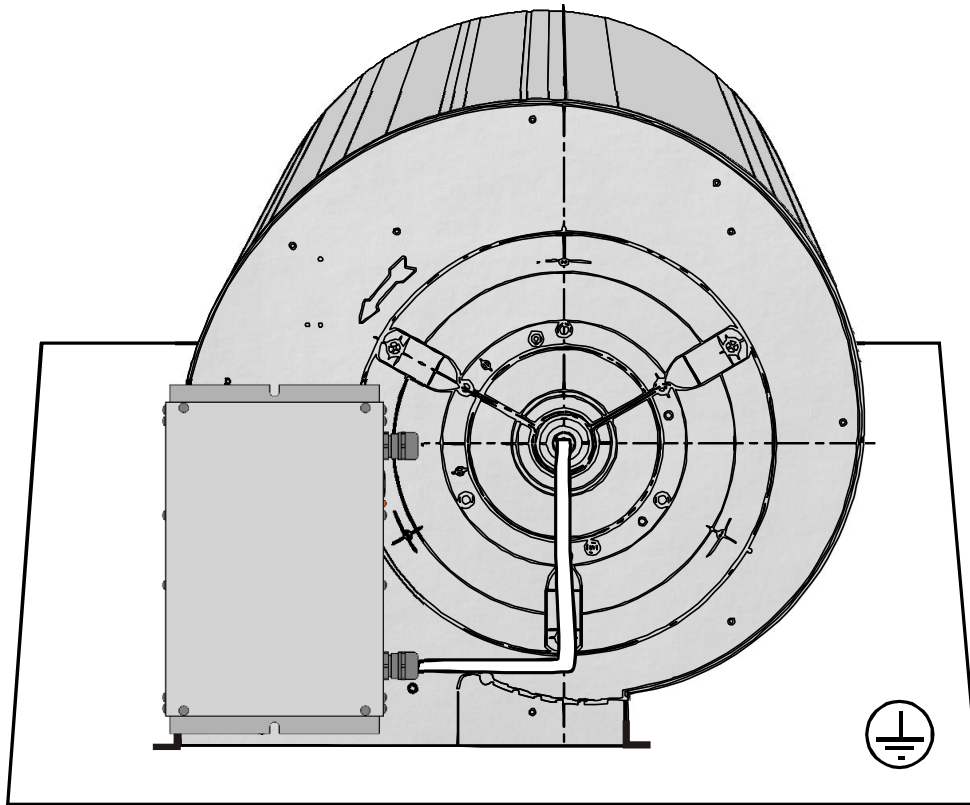


Figure 14: Mounting and wiring of EKE10 directly to the fan

## 2.6.3.2 Installation with Long Motor Cable



**Warning**

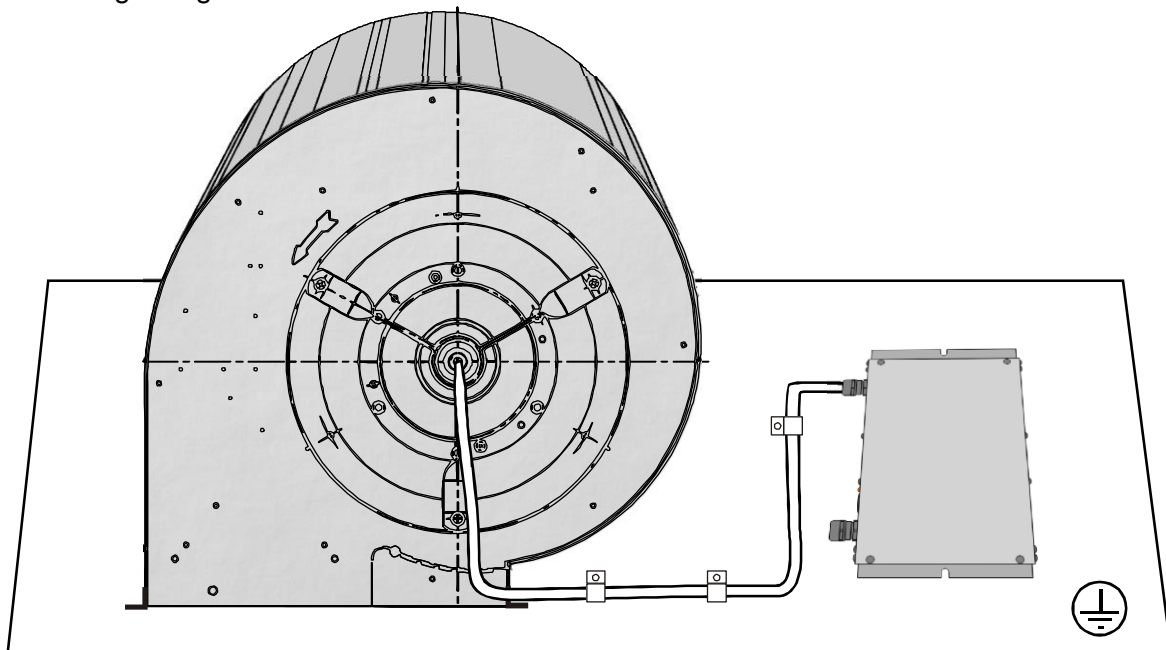
### **Warning**

Risk of electrical shock!

All motor wires will carry high voltages when the controller is powered.

In applications where the motor cable is not long enough, the motor cable can be extended under the following conditions (see Figure ):

1. Use optional metal junction box mounted directly to the motor shaft (therefore the fan has to be ordered with the available junction box option).
2. Keep the motor cable as short as possible, **up to 5 m maximum**.
3. Use **shielded** cables.
4. Fan and controller should both be mounted on the same electrical conducting wall or chassis (ground plane).
5. Keep all cables close to the fan or ground plane.
6. Motor cable should be separated from other cables (mains supply, control) to prevent EMI from cross-talking between motor cable and the other cables.
7. Do not run motor cable in parallel to other cables, these cables should cross under right angle.



**Figure 15: Mounting and wiring of EKE10 far from fan**

## 3 Commissioning



Warning

### Warning

**The inverter must always be grounded.** If the inverter is not grounded correctly, extremely dangerous conditions may arise within the inverter, which could be potentially fatal. Make sure that the grounding connection between PCB and basic housing part is applied correctly!

To ensure the safe operation of the equipment, it must be installed and commissioned by qualified personnel in full compliance with the warnings laid down in these operating instructions.

Take particular note of the general and regional installation and safety regulations regarding work on dangerous voltage installations (e.g. EN50178), as well as the relevant regulations regarding the correct use of tools and personal protective equipment (PPE).

After electrical wiring and DIP-switch setting the housing needs to be closed before the mains is switched on.

All terminals and PCB parts can carry dangerous voltages even if the inverter is inoperative; **wait 5 minutes to allow the unit to discharge** after switching off before the housing is being opened.



Warning

### Warning

Certain inverter parameter settings may cause the motor to start automatically after mains connection.

The type setting must be done correctly to protect motor from overload.

### 3.1 Reset to Factory Default


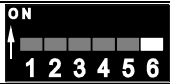
Step	Setting	Action
1		Switch OFF device  Wait at least <b>5 minutes</b> before proceeding with next steps.
2		Unfasten 4 screws to open the top lid.
3		Switch DIP6 to position ON
4	Analogue input open	Input voltage at ADIN1 must be <b>less than 50%</b> of maximum value.
5		Close housing with top lid and fasten the 4 screws.
6		Switch on power supply voltage
7		Switch OFF device  Wait at least <b>5 minutes</b> before proceeding with next steps.
8		Unfasten 4 screws to open the top lid.
9		Switch DIP6 to position OFF
10		Close housing with top lid and fasten the 4 screws.
11		Switch on power supply voltage

Table 8: Working steps to reset the device to factory default



## 3.2 Motor Identification

The EKE10 is able to identify the motor parameters (stator resistance, inductance, rotor resistance) by itself during an identification run.

For the preinstalled fans it is already done and the parameters are stored.

A new identification should be performed when:

- using an unknown motor is intended
- the stored parameters give no sufficient result (starting problems, bad efficiency)

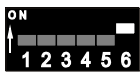



### Warning

Motor identification requires that the motor is running for several minutes.

For a successful identification it is important not to interrupt the identification process. This is indicated by status LED.

### 3.2.1 Identification of stored Motor Types

Step	Setting	Action
1		Switch OFF device  Wait at least <b>5 minutes</b> before proceeding with next steps.
2		Unfasten 4 screws to open the top lid.
3		Switch DIP6 to position ON
4	Analogue input supplied with voltage signal	Input voltage at ADIN1 must be <b>higher than 50%</b> of maximum value. This can be done by the following measures: <ul style="list-style-type: none"> <li>• Potentiometer totally opened</li> <li>• connect 10 Vcd from external source to ADIN1</li> <li>• bridge 10V output to ADIN1</li> </ul>
5		Close housing with top lid and fasten the 4 screws.
6		Switch on power supply voltage
7	<b>Motor identifikation in progress!</b> <ul style="list-style-type: none"> <li>• Process takes app. 2..3 minutes</li> <li>• Motor will be started during identification process</li> <li>• LED indicates the process (fast yellow flashing)</li> </ul>	
8		Switch OFF device  Wait at least <b>5 minutes</b> before proceeding with next steps.
9		Unfasten 4 screws to open the top lid.
10		Switch DIP6 to position OFF
11		Set the analogue input back to original connection and level, if necessary
12		Close housing with top lid and fasten the 4 screws.
13		Switch on power supply voltage

**Table 9: Working steps to identify stored motor types**

## 3.2.2 Create and Identify 3<sup>rd</sup> Party Motor



### Note

The position 0 of the motor table is intended to be occupied with 3<sup>rd</sup> party motor because this position is not used for preinstalled motors:

- Permanent Magnet Synchronous Machines (PMSM)
- Induction Machine (IM)

After creation of new motor the EKE10 will perform motor identification automatically.

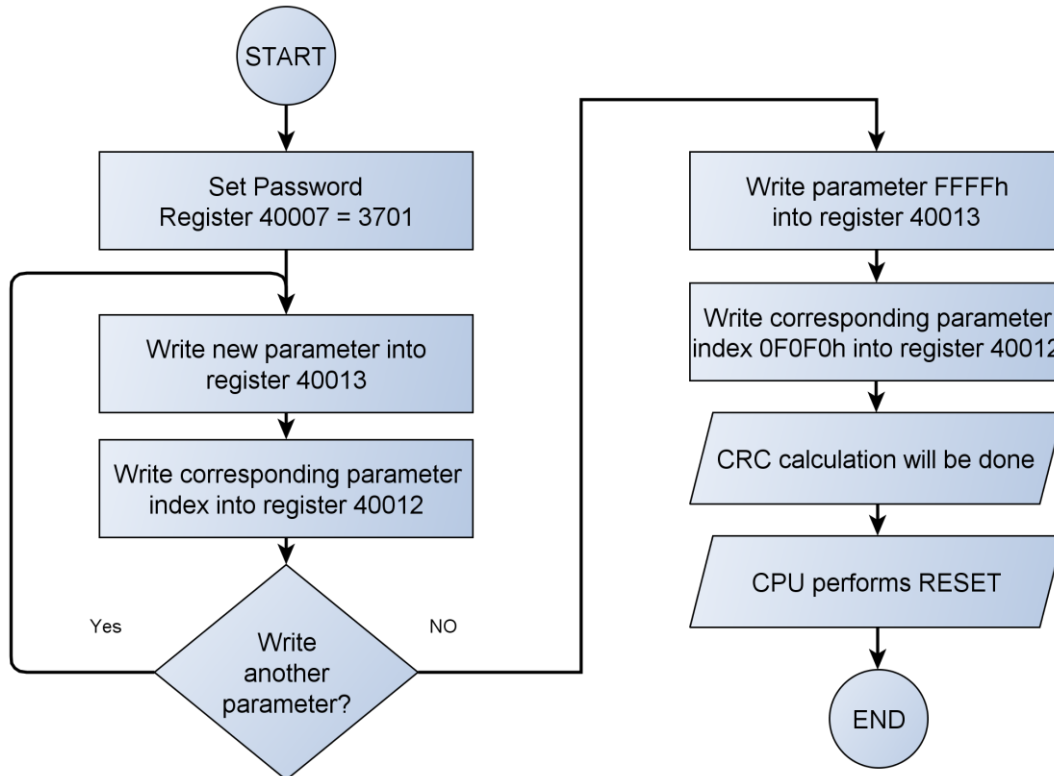


Figure 16: Steps to program motor parameters to table position 0

Parameter Index Register 40012	Motor Parameter Register 40013	Range	Unit	Remark
1	Speed limit	250...10000	rpm	
2	Power limit	200...2000	W	
3	Motor current limit	100...8000	mA	
4	Motor type	0/1/ 8/9	0: IM 1: PMSM	8: not identified 9: not identified
5	Number of pole pairs	1...16	Pole pairs	
6	L <sub>s_d</sub>	0...65000 (6,5H)	100 µH	Stator inductance d-Axis
7	L <sub>s_q</sub>	0...65000 (6,5H)	100 µH	Stator inductance q- Axis
8	R <sub>Rotor</sub>	0...65000 (650 Ω)	10 mΩ	Rotor resistance only at IM, otherwise 0
9	R <sub>Stator</sub>	1...65000 (650 Ω)	10 mΩ	Stator resistance
10	Magnetic Flux	0...65000 (65 Vs)	mVs	PMSM: calculated IM: $\Phi = \sqrt{(2/3)} \cdot U_n / f_n$
11	Magnetizing current	0...8000	mA	PMSM: 0 IM: calculated

Table 10: Motor parameters

Calculated during motor identification

## 3.3 Fan Selection



Warning

### Warning

Choose the correct fan type with care, otherwise overload or damage of motor and controller can result.

Number	DIP1..DIP5	Fan Type	Number	DIP1..DIP5	Fan Type
0		free (configurable)	16		TZP 04-0215-EC
1		DDMB 7/7	17		
2		DDMB 9/7 + DDMB 9/7T	18		
3		free (DDMB 9/7T)	19		
4		DDMB 9/9	20		RZP 11-200-EC
5		DDMB 9/9T	21		RZP 11-225-EC
6		DDMB 10/8	22		RZP 11-250-EC
7		DDMB 10/10	23		RZP 11-280-EC
8		DDMB 10/10 (high power)	24		RZP 11-315-EC
9		DDMB 12/9	25		
10		DDMB 12/12	26		
11		DDMB 10/8 (high speed)	27		
12			28		
13			29		
14			30		
15			31		

Table 11: DIP adjustment for fan selection

## 3.4 Analogue/Digital Inputs

### 3.4.1 Configuration of Inputs

The three analogue/digital inputs of the EKE10-0070-5E-IM are based on the same hardware and can be configured as analogue or digital input.

The following functions can be configured:

- Analogue speed set point
- Enable (START/STOP)
- Activate fixed speed set points
- Manipulate speed set point by a percent value
- Touch function (digital speed set point) – “Speed UP” and “Speed DOWN”
- Reset errors

#### 3.4.1.1 Programming of Input Function



##### Note

All inputs will **always** be added together to calculate the speed set point.  
 $n\Sigma$ : added speed set point values from other inputs

Register Value	Function	Description	Properties
0	analogue	Analogue input	$n = \text{Analogue value}\% \cdot \text{maximum speed} + n\Sigma$
1	digital	Enable	START at DI = High
2	digital	Fix speed 1	$n = \text{FIX1}\% \cdot \text{maximum speed} + n\Sigma$
3	digital	Fix speed 2	$n = \text{FIX2}\% \cdot \text{maximum speed} + n\Sigma$
4	digital	Factor	$n = n\Sigma \cdot \text{FIX1}\%$
5	digital	Touch Speed UP	Low-High-transition $\Delta n = + \text{FIX2}\% \cdot \text{maximum speed} / 10$
6	digital	Touch Speed DOWN	Low-High-transition $\Delta n = - \text{FIX2}\% \cdot \text{maximum speed} / 10$
7	digital	Change direction	$n = -n\Sigma$
8	digital	Reset error	High-active
15	none	Input deactivated	Input will not be used for set point calculation

Table 12: Configuration of Inputs with register Config\_ADIN

#### 3.4.1.2 Bit Assignment Register 40023 (Config\_ADIN)

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Status				Config ADIN3				Config ADIN2				Config ADIN1			
0	E3	E2	E1	X	X	X	X	X	X	X	X	X	X	X	X
X	X	X	X	1	1	1	1	1	1	1	1	0	0	0	0

Table 13: Bit assignment Config\_ADIN register 40023

##### Default setting:

ADIN1: Analogue input (register value=0)  
 ADIN2: Input deactivated (register value =15)  
 ADIN3: Input deactivated (register value =15)



##### Note

In case more than one inputs are configured as Enable, all of this inputs are linked with AND. To start the motor all of this inputs need to be activated (HIGH).

## 3.4.2 Characteristic of Analogue Inputs

Analogue Input	Motor Operation	Remark
0-0,5 V	Stop	
0,5-10 V	Motor runs according to the analogue signal value	under notice of the programmed minimum speed
10 V	Motor runs at maximum speed	

Table 14: Characteristic of analogue inputs

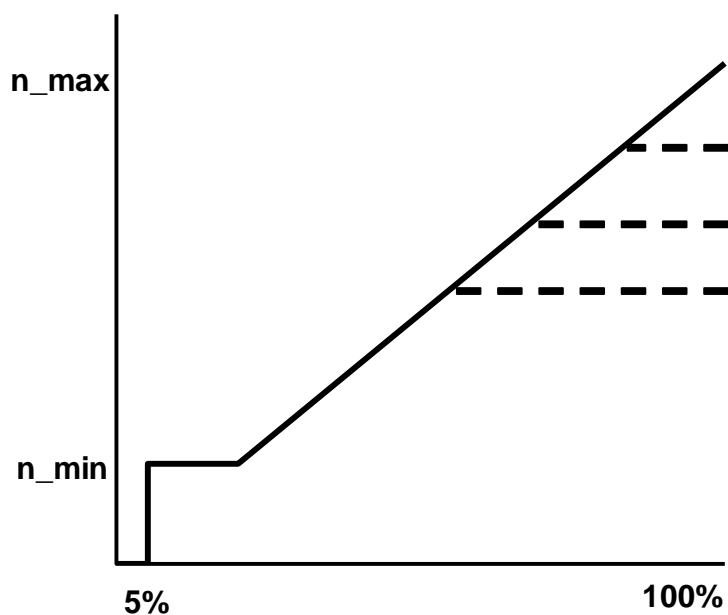


Figure 17: Characteristic of analogue inputs



### Note

The maximum speed can further be reduced by internal limits due to protection functions, depending on selected fan type and duty point.

## 3.4.3 Configuration of Outputs

The EKE10 provides two programmable digital outputs, OUT1 and OUT2.

### 3.4.3.1 Programming of the Output Functions



#### Caution

The dry contacts are solid state relays (Photo-MOS) with 30Vcd maximum voltage. When using external supply, the voltage must not exceed the limits given at the Technical Data page. Otherwise the relays may be destroyed.



#### Note

The speed impulse function can only be programmed to one output. If programmed to both outputs, only OUT2 will be used.

Register Value	Description	Properties
0	Output OFF	Output stays always OFF (open)
1	Error output signal	Low-active Closed: no error Open: error
2	Running signal $N > N_{min}$	$N_{min} = \text{rpm}$
3	Running signal $N = N_{set}$	Tolerance 5%
4	Speed impulse	1 impulse per motor revolution (50% High, 50% Low)
5	Output ON	Output stays always ON (closed)

**Table 15: Configuration of outputs with register Config\_OUT**

## 3.4.3.2 Bit Assignment Register 40024 (Config\_OUT)

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
								Config OUT2				Config OUT1			
0	0	0	0	0	0	0	0	X	X	X	X	X	X	X	X
X	X	X	X	X	X	X	X	0	0	1	0	0	0	0	1

**Table 16: Bit assignment Config\_OUT register 40024**

### Default setting:

OUT1: Error signal

OUT2: Running signal  $N > N_{min}$

## 3.4.4 Important Modbus Registers for Interface Configuration

Register	Name	Range	Default Value
40007	Password	0..65535	3701
40023	Config_ADIN	0..65535	4080 (0x0FF0)
40024	Config_OUT	0..65535	33 (0x0021)
40025	FIX1	0..2000 (0..200%)	500 (50%)
40026	FIX2	0..2000 (0..200%)	800 (80%)

**Table 17: Modbus registers for configuration of interface**

## 3.5 Change Motor PWM Frequency

The EKE10 inverter is set to 10 kHz PWM frequency by factory default.

This can be changed if the application requires it, for instance when:

- EMI is important in the application
  - Lower switching frequency causes less disturbance
  - Set pulse frequency according to meet motor filter design
- Improved efficiency is required
  - Reduction of switching losses
  - Increase maximum output power at free convection cooling
- Motor noise cannot be accepted



### Notes

Lower PWM frequency can cause higher noise level due to the fact that the frequency is shifted to human hearing range.

Changing of PWM frequency is only possible when motor is stopped.

## 3.6 Error Handling

Code	Name	Latch <sup>1</sup>	Stop <sup>2</sup>	Entering Condition
<b>Errors</b>				
1	Motor error	X	X	Motor parameter invalid or motor identification fails
2	Motor error	X	X	Over current output module
4	DC-link LOW error	X	X	Internal power supply defective
8	Mains brownout error		X	Mains voltage low
16	EEPROM error			Internal memory error
32	DC-link HIGH error	X	X	Internal power supply defective
64	Over temperature error	X	X	Overload or cooling too low
128	Communication error			Control board defective
1024	Rotor blocked	X	X	Fan blocked
<b>Status Information</b>				
256	Current limit			Controller operates at current limit
512	Power limit			Controller operates at power limit
2048	Constant Airflow error			No CAF table stored
4096	Temperature derating			Controller operates at temperature limit
8192	DC link undervoltage			DC-link warning level exceeded
16384	Speed limit			Motor cannot reach set speed

**Table 18: Error description**

<sup>1</sup> Latched error codes keep valid even when the motor is stopped. The driver must be reset or restarted. Unlatched errors will disappear automatically after the error condition is no longer valid and the motor will resume to operate without interaction.

<sup>2</sup> Motor and fan are stopped.



## 4 Technical Data

### 4.1 Electrical Characteristics

	Value	Unit	Comments
Nominal operating voltage	230 (+/-10%)	V	
Input frequency	50/60	Hz	
Rated input power	2000	W	
Rated input current	8,7	A	cos $\varphi$ =0,99
Efficiency	>94	%	at rated power
Power factor (cos $\varphi$ )	>0,98		at rated power
Total harmonic distortion current (THDC)	<8	%	at rated power
Recommended fuse	16	A	slow characteristic

Table 19: Elektrical characteristics

### 4.2 Performance Characteristics

	Value	Unit	Comments
Speed control accuracy	< $\pm 1$	%	related to maximum speed
Set point resolution	1	rpm	
Pulse frequency	10	kHz	adjustable in range 4...15 kHz
Output frequency range	0..500	Hz	
Over temperature stop threshold	85	°C	referenced to internal power device
Over temperature restart threshold	80	°C	referenced to internal power device
Derating threshold	75	°C	referenced to internal power device
Serial Interface	Modbus RTU (RS485) see chapter 4.5 for details		
Protection features	SOA-speed/power/current limitation, DC-Link voltage low, overload, temperature, impeller lock-up, brownout		
Analogue/Digital Input	Analogue	0..10	Vdc continuous or PWM
	Digital	24	Vdc Absolute maximum rating: -30...+30 Vdc
Potentiometer supply voltage	10	Vdc	Current limited to 30mA (@ 0V)
Dry contacts	voltage	24	Vac/dc potential free
	current	50	mA Absolute maximum rating: 30 Vdc, 100mA

Table 20: Performance

### 4.3 Mechanical Characteristics

	Value	Unit	Comments
Dimensions (w x h x d)	250 x 78 x 155	mm	
Masse	2,5	kg	
Minimum motor power wire gauge	0,75	mm <sup>2</sup>	
Maximum common motor cable length	1,25	m	original common motor cable (unshielded)
Maximum extended cable length	5	m	shielded
Cable gland holes	4 x M20, 1x M16		may vary
Power supply connector	Cage Clamp, maximum 2,5mm <sup>2</sup>		alternative screw clamp
Motor power connector	Cage Clamp, maximum 2,5mm <sup>2</sup>		alternative screw clamp
Communication connector	Cage Clamp, maximum 1,5mm <sup>2</sup>		alternative screw clamp

Table 21: Mechanical characteristics

### 4.4 Ambient Conditions

	Value	Unit	Comments
Storage temperature	-40...+70	°C	
Operating temperature	-10...+40	°C	
Operating altitude	<1000	m	above sea level <sup>3</sup>
Protection level	IP54		

Table 22: Ambient conditions

<sup>3</sup> Altitude derating of maximum operating temperature: -2°C per 300m (1000ft) over 1000m (3000ft)

## 4.5 Modbus RTU Specification

### 4.5.1 Protocol

Interface	Modbus RTU with RS485
Supported baud rates	9600, 19200, 38400, 57600 baud
Supported parities	none, odd, even
Data bits	8
Stop bits	1
Address range	1..247 (programmable via Modbus)
Supported function codes	03 – Read output register
	04 – Read input register
	06 – Write single output register
	16 – Write multiple output register

**Table 23: General Modbus protocol parameters**

## 4.5.2 Register

### 4.5.2.1 Input Register

No.	Name	Range	Remark
30001	Error code / status		
30002	Operation mode	0 = Modbus 1 = Analogue 2 = Constant Airflow 3 = Process Control	Default: 1
30003	Fan type	0..31	Depending on switch DIP1-5 (binary coded)
30004	Current speed	0..10000 rpm	
30005	Current power	0..2500 W	
30006	Speed set value	0..10000 rpm	Default: 0 rpm
30007	Speed limit	250..10000 rpm	Depending on fan type
30008	Power limit	100..2500 W	Depending on fan type
30009	Limit of motor current	100..10000/√2 mA	Depending on fan type
30010	Analogue input value 1 (ADIN1)	0..1000 (0..100%)	10V = 1000 = 100%
30011	Temperature power module	0..100°C	
30012	DC link voltage	0..500 V	
30013	DC link current	0..8000 mA	
30014	Supply voltage	0..1	1: in range 0: out of range or PFC OFF
30015	Motor current	0..8000 mA	
30016	Temperature CPU	0..100°C	
30017	DSP Diagnostic		internal use
30018	Duty point motor voltage	0..1000 ‰	
30019	Proportional part	0..100	Default: 0
30020	Integrating part	1..30	Default: 0
30021	Sampling rate	5..30	Default: 0
30022	Controller set point	0..65535	Default: 0
30023	K-Factor	0..1000	Depending on fan type
30024	Sensor range	1000..5000	Default: 1000
30025	0-point adjustment	0..1000	Default: 0
30026	Sensor max-point adjustment	500..1000	Default: 1000
30027	Sensor value	0..sensor range	
30028	Firmware Version	100	(1.0.0)
30029	RSP Data (error memory)	0..65535	internal use
30030	EEPROM Data	0..255	internal use
30031	ratedFlux_VpHz	1..65535 [0,001..65V/Hz]	internal use
30032	Mag_Curr_A	0..8000mA	internal use
30033	Ls_H	1..65535 [0,0001..6,5H]	internal use
30034	Lhf_H	1..65535 [0,0001..6,5H]	internal use
30035	Rr_Ohm	0..65535 [0,00..650 Ohm]	internal use
30036	Rs_Ohm	1..65535 [0,01..650 Ohm]	internal use
30037	DSP Appl. Status	0..7	internal use
30038	CtrlErrorCode	0..255	internal use
30039	UserErrorCode	0..255	internal use
30040	EstErrorCode	0..255	internal use
30041	Status_ADIN	0..65535	Default: 4080 (0x0FF0)
30042	Status_OUT	0..65535	Default: 33 (0x21)
30043	FIX1	0..2000 (0..200%)	Default: 500 (50%)
30044	FIX2	0..2000 (0..200%)	Default: 800 (80%)
30045	DSP Flash Offset		internal use
30046	DSP Flash Wert		internal use
30047	DSP Flash Kommando		internal use
30048	Set point Constant Air flow controller		
30049	Minimum air flow (user)		
30050	Maximum air flow (user)		
30051	Minimum air flow (absolute)		
30052	Maximum air flow (absolute)		
30053	Minimum speed		
30054	PWM frequency motor	4000..15000 Hz	Default: 10000 Hz
30055	Rotating direction	[1   0]	1: clockwise


			0: counter clockwise
30057	Analogue input value 2 (ADIN2)	0..1000	1000 = 10V
30058	Analogue input value 3 (ADIN3)	0..1000	1000 = 10V

**Table 24: Modbus input register**

## 4.5.2.2 Output Register

No.	Name	Range	Default
40001	Set status	2 = wink 9 = store configuration register 10 = reset interface controller 11 = reset error 13 = initialise firmware update DSP	0
40002	Operation mode	0 = Modbus 1 = Analogue 2 = Constant Airflow 3 = Process Control	1
40003	Modbus speed setpoint	0..10000 rpm	0
40004	New Modbus address	1..247	153
40005	New baud rate	9600 baud 19200 baud 38400 baud 57600 baud	57600
40006	New parity	0: none 1: odd 2: even	even
40007	Password	0..65535	3701 (fixed)
40008	write EEPROM value	0..255	
40009	Speed limit	250..10000 rpm	Depending on fan type
40010	Power limit	100..2500 W	Depending on fan type
40011	Motor current limit	100..8000 mA	Depending on fan type
40012	Set new fan limit address	0..65535	internal use
40013	Set new fan limit value	0..65535	internal use
40014	Proportional part	0..100	1
40015	Integrating part	0..30	1
40016	Sampling rate	5..30	5
40017	Controller Setpoint	0..65535	0
40018	Sensor range	1000..5000	1000
40019	0-point adjustment	0..1000	0
40020	Max-point adjustment	500..1000	1000
40021	RSP data address (error memory)	0..65535	internal use
40022	read EEPROM address	0..1023	internal use
40023	Config_ADIN	0..65535	4080 (0x0FF0)
40024	Config_OUT	0..65535	33 (0x0021)
40025	FIX1	0..2000 (0..200%)	500 (50%)
40026	FIX2	0..2000 (0..200%)	800 (80%)
40027	DSP Command	0..65535	
40028	DSP Value	0..65535	
40029	DSP Flash Offset	0..65535	
40030	DSP Flash Value	0..65535	
40031	DSP Flash Command	0..65535	
40032	Set point Constant Air flow controller	100..10000 m³/h	100 m³/h
40033	Minimum air flow (user)	100..10000 m³/h	100
40034	Maximum air flow (user)	100..10000 m³/h	10000
40035	Minimum speed	250..10000 rpm	250
40036	PWM frequency motor	4000..15000 Hz	10000 Hz
40037	Rotating direction	1: clockwise 0: counter clockwise	1

**Table 25: Modbus output register**

 Needs to set password before writing

## 5 Electro-Magnetic Compatibility (EMC)

### 5.1 EMC Evaluation Basics

All manufacturers / assemblers of electrical apparatus which “performs a complete intrinsic function and is placed on the market as a single unit intended for the end user” must comply with the EMC directive 2004/108/EG.

The motor controller EKE10-0070-5E-IM is supplied exclusively in connection with products of the company Nicotra Gebhardt. The unit is fully integrated in the corresponding products or will be delivered together with the products. After correct installation it complies to the requirements of the EMC directive 2004/108/EG, according to the EMC product standard for electrical drives with variable speed EN 61800-3.

### 5.2 EMC Evaluation

#### 5.2.1 Electromagnetic Interference and Immunity

The equipment has been evaluated using a construction according to Figure .

With the construction according to Figure the equipment has been able to meet the quasi-peak requirements of Category 1.

**Note**

In a residual environment the product can cause high frequency radiation, which makes it necessary to implement suitable counter measures.

#### 5.2.2 Compliance with Harmonics Regulations

From 1st January 2001 all electrical apparatus covered by the EMC Directive will have to comply with EN 61000-3-2 "Limits for harmonic current emissions (equipment input  $\leq 16A$  per phase)". Due to the integrated PFC (Power Factor Controller) the EC-Controller complies with the harmonics emissions specification EN 61000-3-2. The specification of THD values complies with the EMC Product Standard for Power Drive Systems EN 68100-3.

## 6 Notes