AMKASYN
Device description
Servo Drives KE/KW
Compact Power Supplies KE, KES, KEN
Compact Inverters KW, KWD

Version: 2023/11
Part no.: 28932

Translation of the "Original Dokumentation"

AMKmotion

MEMBER OF THE ARBURG FAMILY

Imprint

Name: PDK_028932_KEKW_Hardware_en

Version:

Version 2023/11		
Chapter / Topic	**Change**	**Initials**
	AMKmotion Design	LeS
Technical data inverters KW/KWD	foot note 1: firmware version added for Non Dual Use classification	LeS

Previous version: 2021/39

Product version:

Product	Firmware version (Part no.)	
KE/KW series	Siehe Validity of device description auf Seite 3.	

Reservation: We reserve the right to modify the content of the documentation as well as the delivery options for the product.

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For fast and reliable troubleshooting, you can help us by informing our Customer Service about the following:

- Type plate data for each unit
- Software version
- Device configuration and application
- Type of fault/problem and suspected cause
- Diagnostic messages (error messages)

E-mail service@amk-motion.com

Internet address: www.amk-motion.com

Validity of device description

The device description is valid for the following hardware version numbers and firmware versions.

In KE/KW modules with smaller version numbers and older firmware version numbers, it is possible that not all contents described in this document are available.

Hardware revisions

Compact power supplies

Module	Rev. status	AMK part no.
KEN 5	3.24	E793
KEN 5-F	3.24	E923
KEN 5-0N	1.03	E1054
KEN 5-FN	1.03	E1055
KEN 5-S10	1.03	E1200
KEN 10	3.24	E816
KEN 10-F	3.24	E924
KE 10 *	---	---
KEN 20-0N	1.00	E1234
KE 20	3.23	E717
KE 20-F	3.23	E928
KE 20-0EU	1.04	E1037
KES 20	3.26	E944
KES 20-0EU	1.07	E984
KE 40	3.25	E718
KE 40-0EU	1.04	E1038
KES 40-0EU	1.06	E985
KEN 60 * (KE 60-S4)	3.24	E892
KE 60	3.25	E719
KE 60-0EU	1.04	E1039
KES 60	3.26	E833
KES 60-0EU	1.06	E986
KEN 120	3.23	E781
KE 120	4.14	E856
KE 120-0EU	1.04	E1040
KES 120	4.05	E834
KES 120-0EU	1.04	E987
KE 180-0EU	1.11	E1060
KES 180-0EU	1.11	E1061

Compact inverters

Module	Rev. status	AMK part no.
KW 2	3.25	E765
KW 2-F	3.25	E910
KW 2-0N	3.24	E764
KW 3	3.23	E815
KW 4-F	3.23	E942
KW 5	3.23	E767
KW 5-0N	3.23	E766
KW 6-F	3.24	E943
KW 8	3.24	E813
KW 8-0N	3.24	E814
KW 9-F	3.25	E925
KW 10	3.25	E768
KW 20	3.26	E769
KW 40	3.27	E770
KW 60	3.27	E771
KW 100	4.05	E855
KW 150	1.08	E988
KW 200	1.08	E989
KWD 1	3.25	E759
KWD 1-F	3.25	E914
KWD 1-0N	3.25	E762
KWD 2	3.25	E760
KWD 2-F	3.25	E915
KWD 2-0N	3.25	E763
KWD 4-F	3.24	E916
KWD 5	3.24	E818

* Please contact the AMK sales team to inquire about availability or alternative modules.

Firmware versions

Compact power supply

Controller card	Firmware version
KE-E03	KER3_304_1303_204405
KE-E10 / -E11 (KExx-xEx)	KE_404_1829_207248
KE-N02	KEN_102_1438_205360

Content

1 About this documentation

1.1 Keeping this document

This document must permanently be available and readable at the place where the product is in use. If the product is used at another place or changed the owner, the document must be passed on.

1.2 Target group

Any person who is entitled and intends to carry out one of the following works must read, understand, and observe this documentation.

- Transportation and storage
- Unpacking and installation
- Projecting
- Connection
- Parameterisation and startup
- Testing and maintenance
- Service and repair
- Decommissioning and disposal

1.3 Purpose

The documentation at hand describes the functional safety of the KW-R07 / -R17 controller cards.
It is intended to qualify the user to parameterise and command safety functions.

This documentation is addressed to any person who handles the product. It gives information about the following topics.

- Safety messages which are absolutely necessary to take care of during handling the product.
- Product identification
- Projecting, planning, and dimensioning of the application
- Environmental conditions for storage, transportation, and operation
- Installation
- Electrical connections
- Startup and operation
- Maintenance, repair, exchange and diagnosis
- Exchange and diagnosis
- Decommissioning and disposal
- Technical data and conformity with standards

1.4 Display conventions

Display	Meaning
	This symbol points to parts of the text to which particular attention should be paid.
ID0815 'parameter text' 1234 'diagnostic message'	Parameter names, e.g. ID2 'SERCOS cycle time' Diagnostic message, e.g. 1110 'Warning brake transistor'
0x	0x followed by a hexadecimal number, e.g. 0x500A
'Name'	Calling up the 'Delete PLC program' function for example.
'bold'	Menu items and buttons in a software or on a control unit, for example. Click the **'OK'** button in the **'Options'** menu to call up the 'Delete PLC program' function.
>Input variables<	A variable that is entered in the operator interface.

1.5 Appendant documents

Standards and guidelines

Name	Title
EG Richtlinie Niederspannung 2014/35/EU	Low voltage directive
EG Richtlinie EMV 2014/30/EU	EMC directive

Certificates

Name	Title
Z10 16 12 23303 008	TÜV certificate; power output stage enable for protection against restart
Certificate of Compliance 1441318	CSA certificate; KE/KW modules, switch on components, cooling plates

Device descriptions

AMK part-no.	Title
25240	Brake resistor AR45
26891	Brake resistor AR1000
26892	Brake resistor AR4000
29881	Controller cards KW-R03 / -R03P / -R04
200043	Liquid-cooled cold plate KW-CP
200776	Brake resistor AR140
202393	Fan-cooled cold plate KW-LK
202744	Controller cards KW-R06 / -R16 / -R07 / -R17
204918	Controller cards KW-R24(-R) / -R25 / -R26 / -R27
203422	Main contactor
203423	Mains choke
203424	Mains filter
203425	Upstream mains choke
204027	Supplementary filter AF-FE1
204382	Additional capacity AE-ZK6

Functional descriptions

AMK part-no.	Title
25786	Diagnostic messages
204979	Software description AIPEX PRO V3 (PC software for startup and parameterization)
203704	Parameter descriptionKW-R06 / -R16 / -R07 / -R17, KE (CAN / Ethernet), KW-R24(-R) / -R25 / -R26 / -R27
203771	Software description ATF - AMK Tool Flasher (PC software for firmware update)
203878	Function descriptions (functions of the controller firmware)
204539	Initial startup KE/KW

2 For your safety

2.1 Design of safety information

Any safety information is configured as follows:

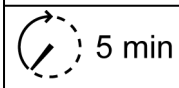
⚠ SIGNAL WORD	
	**Type and source of risk** Consequence(s) of non-observance **Steps to prevent:** • ...

2.2 Classes of hazard

Safety and warning messages are graduated into classes of hazard (according to ANSI Z535). The class of hazard defines the potential risk of harm and is described by a single word, if the safety information is ignored. The signal word is followed by a safety alert symbol (ISO 3864, DIN EN ISO 7010). In accordance with ANSI Z535, the following signal words are used to define the class of hazard.

Safety alert symbol and signal word	Class of hazard and its meaning
⚠ DANGER	DANGER indicates a hazardous situation which, if not avoided, **will** result in death or serious injury
⚠ WARNING	WARNING indicates a hazardous situation which, if not avoided, **could** result in death or serious injury
⚠ CAUTION	CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, **could** result in minor or moderate injury
NOTICE	NOTICE is used to address preventions to avoid material damage, but not related to personal injury.

2.3 Used safety symbols

Safety symbol	Meaning
	Warning of a danger!
	Warning against dangerous electrical voltage!
	Warning against dangerous electrical voltage! It will last up to 5 minutes until the energy storage is discharged after it has been electrically disconnected.
	Warning against hot surface
	Warning against crushing

2.4 General safety notes

Generally there is a danger from electrical drives because of improper use, uncontrollable movements due to defective components, software errors, handling errors, errors in the installation and with components, errors because of environmental influences, and from touching current-carrying parts.

2.4.1 For your safety

⚠ DANGER	
	**Danger to life from touching electrical connections!** Electrical terminals and connectors carry voltages that may cause death or serious injury upon contact. The teminals of the DC circuit capacitors (UZP, UZN) on the front panel of the device may retain hazardous DC voltage for up to 5 minutes after switching off the device! In OFF state, the LED indicators on the device front panels do not indicate the voltage status of the terminals. **Steps to prevent:** • Provide shock-hazard protection • Prior to any work on the device: Turn off the main switch to disconnect the power supply, and secure switch against being turned on again. • Wait at least 5 minutes for components to discharge. • Connection or disconnection of terminals is only allowed if they are free of voltage. • Measure the terminals voltage to verify that the terminal is de-energized. One suitable measuring point is the DC bus between the UZP and UZN terminals. • If the PE connection between the modules is open, avoid touching the casing since dangerous voltages may be present. During the proper operation of the KE/KW modules there is an earth leakage current of more than 3.5 mA. In this case, the standard requires that the devices be firmly connected to PE. The PE conductor must have a cross section of at least 10 mm^2. • Do not connect, disconnect and/or install the electrical lines (terminal cables, plugs, sockets) and optional modules until they have been electrically de-energized.

2.4.2 Avoiding material damage

NOTICE	
Material Damage!	**Electronic components could be destroyed through static discharge!** Therefore touching of the electrical connections (e. g. signal and power supply cable or option and controller cards) must be avoided. Otherwise you can be damaged the components when touching by static discharge. **Steps to prevent:** • Avoid touching electrical connections and contacts. • During handling the electronic component discharge yourself by touching PE. • Pay attention to the ESD-notes (electrostatic discharge).

2.5 Requirements for the personnel and their qualification

Any work performed on AMKmotion products should be carried out only by trained and authorized technicians.

Technicians must:

- Carry out mechanical and electrical work which are described in this documentation, e. g. when mounting and connecting devices
- Regard any documentation that accompanies the products, in order to work safely and without fault with the products
- Know about the potential hazards and realize them
- Be familiar with the basic functions and interrelationships of the system
- Be familiar with the controller principles to put the drive system into operation
- Have knowledge and the authority to switch electrical circuits and devices on and off, to earth and mark them
- Regard specifically local safety requirements

Repair and work on devices that require them being opened may be carried out only by technicians authorised by AMK. Unauthorised opening of the modules means the loss of the warranty.

2.6 Intended use

The AMKASYN KE/KW modules are used to control AMKmotion servo motors, and are designed as installation devices of the safety class 1 (in accordance with EN 61800-5-1). They need to be installed in a closed, well-sized switch cabinet (IP 54) with a fixed connection. The fed-in air must be dry and free of electrically conductive dust, fibres, gases and vapours. If necessary, suitable filters should be used or other protective measures need to be taken.

No other loads except for synchronous or asynchronous servo motors may be connected to the AMKmotion inverters.

The protection against direct contact has to be ensured with the switch cabinet.

The AMKASYN series is designed for use in commercial applications.

Other norms apply for the use in private areas. Additional filter measures may have to be taken by the user for this.

Only components certified for use by AMKmotion may be connected to the interfaces.

The manufacturer / operator of the system is liable for any damage resulting from improper use.

2.7 Directives, laws, standards and certificates

AMKmotion products have been constructed using the "State of the Art" and are safe to operate. AMKmotion issues an EU declaration of conformity for each of its products in which the standards and guidelines relevant for the product are listed. AMKmotion also designates the products with the CE mark which signifies conformity to the standards. Since these standards are listed in the Official Journal of the EU, it can be assumed through their application that the product meets the basic safety and health requirements of the harmonization regulation, the so-called presumption of conformity applies.

Prior to starting up a machine in which the AMKmotion products have been installed, the machine manufacturer has to ensure that the currently valid EC machinery directive and all other regulations, laws, standards and guidelines relevant for the machine are observed.

2.7.1 EC/EU declaration of conformity - CE mark

The AMKASYN KE/KW series was designed and manufactured in compliance with the EC/EU Directive on low-voltage equipment and EMC.

EC/EU declaration of conformity: See chapter 'Certificates'

2.7.2 TÜV certificate - EF power output stage enable

KW compact inverters with integrated EF safety function are certified to protect against restart.

The integrated EF safety function used to protect against restart is certified in accordance with EN ISO 13849-1 (Cat.4, PL e) and EN 954-1, Cat.4.

TÜV certificate: See chapter 'Certificates'

2.7.3 Certificate of compliance – CSA INTERNATIONAL

The products listed in the Certificate (LINK) are eligible to bear the CSA Mark shown with adjacent indicators ‘C’ and ‘US’.

The ‘C’ and ‘US’ indicators adjacent to the CSA Mark signify that the product has been evaluated to the applicable CSA and ANSI/UL Standards, for use in Canada and the U.S., respectively. This ‘US’ indicator includes products eligible to bear the ‘NRTL’ indicator. NRTL, i.e. National Recognized Testing Laboratory, is a designation granted by the U.S. Occupational Safety and Health Administration (OSHA) to laboratories which have been recognized to perform certification to U.S. Standards.

CSA certificate: See chapter 'Certificates'

2.8 EMC legal regulations and norms

When installed according to specification, the KE/KW device combinations comply with the maximum permissible values of the EMC product standard (acc. to EN 61800-3 'Adjustable speed electrical power drive systems' for Power Drive Systems intended for use in the second environment [industrial applications], category C3). Additional discrete filter components need to be installed for use in the first environment (household applications). This must be done in prior consultation with AMK; system measurements have to be performed on-site.

The EMC measurements were carried out specially on a model drive system with 1 KE and 4 KW modules with various motor cable lengths. The results are not universally applicable to every system. For this reason, the user is required to conduct on-site EMC tests to verify CE conformity.

2.9 Safety rules

In particular on drive systems, the instructions pertaining to safety and the following five safety rules have to be kept in the specified sequence:

1. Switch off electrical circuits (also electronic and auxiliary circuits).
2. Secure against being switched on again.
3. Determine that there is no voltage.
4. Ground and short circuit.
5. Cover or close off neighboring parts that are under voltage.

Reverse the measures taken in reverse order after completing the work.

2.10 Prerequisite for safe operation with the drive system

- The electricity, mechanical movements and high temperatures in electrical drive systems present hazards that can result in fatal injuries and material damage. These hazards are present while starting up and operating the unit, and also during servicing or maintenance work.
- Personnel must have read and understood the safety instructions before installing and operating the unit. In the documentation included with the product, the usage warnings pertain to direct hazards and must therefore be followed directly when operating or handling the unit by the operator.
- Compliance with all of the instructions given in the documentation included with the product will ensure safe and fault-free operation of the unit and is a prerequisite for asserting warranty claims.
- AMK Arnold Müller GmbH & Co. KG shall not be held liable for any damages ensuing from using the unit in a manner contrary to the intended use, from faulty installation or from using the unit beyond the specified operating characteristics and conditions.
- Do not start the system in which the AMK products are installed (begin of intended use) until you can determine that all relevant standards, laws and directives have been complied with.

2.11 Safety devices

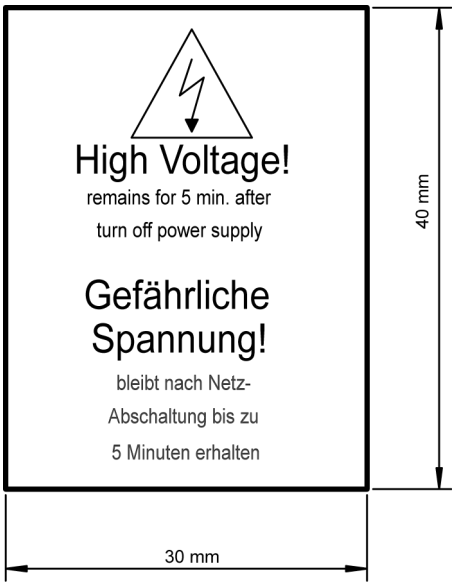
The KE/KW modules must be installed such that personnel cannot contact them directly or indirectly, as stipulated by IEC 60364-4-41 (EN 60204-1, EN 50178). The units must be earthed and connected to an overcurrent protection device.

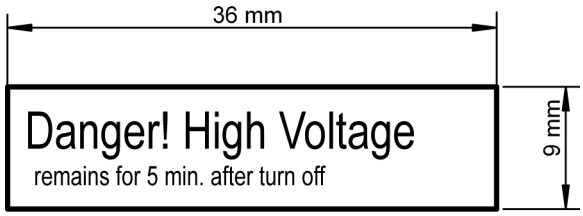
AC/DC surge protectors can be used. These are not adequate for protecting personnel against electric shocks from the operating current of ≤ 30mA, because the rated surge current in the KE/KW drive system can exceed 30 mA. Only surge protectors with the following specifications are suitable:

- Type B in acc. with IEC 60755 A2, AC/DC surge protector (in acc. with EN 50178 section 5.2.11.2) (e.g., type F 804 from ABB Stotz-Kontakt GmbH)
- Operating current ≥ 300mA (no operator protection!)
- Response delay ≥ 40 ms
- Surge current resistance ≥ 3000A

2.12 Safety and warning signs

The following safety and warning signs are found on the modules:





2.13 Warranty

- All information in the documents accompanying the product must be complied with for a safe and trouble-free operation.
- The assertion of warranty claims is excluded if the information in the documents is not observed completely.
- Hardware and firmware may not be modified except by personnel authorized by AMKmotion and after consultation with AMKmotion.
- The company AMKmotion GmbH + Co KG is not liable for damages from unintended use, incorrect installation or operation, exceeding rated values and non-observance with the environmental conditions.

3 Transport and storage

3.1 Transport

- The servo inverters may only be transported in their original packaging.
- Shocks during transport must be prevented.
- Check the components for signs of transport damage after their arrival. Do not install and operate any damaged components.

NOTICE	
Material Damage!	**Electronic components could be destroyed through static discharge!** Therefore touching of the electrical connections (e. g. signal and power supply cable or option and controller cards) must be avoided. Otherwise you can be damaged the components when touching by static discharge. **Steps to prevent:** • Avoid touching electrical connections and contacts. • During handling the electronic component discharge yourself by touching PE. • Pay attention to the ESD-notes (electrostatic discharge).

3.2 Storage conditions

- Ambient temperature: -25 °C and +75 °C
- Maximum relative humidity: 95 %
- Maximum height: 2000 m above sea level
- Protect the devices against condensation.
- Store in the original packaging.
- Clean, dry, protected against weather conditions
- Protected against sudden temperature and humidity changes
- Protected against salt fog, industrial fumes, corroding liquids, vermin and mildew.
- Storage period of up to one year under conditions in accordance with EN 61800-2.

3.3 Note for electrolytic capacitors - reforming

If the electrolytic capacitors of the converters are not in operation, because the device is in storage or the machine is switched off, the residual current behaviour is changed at next restart. The residual current is the leakage current which is very high after switch on dc voltage and decreases to nominal after approximately 5 minutes. The longer time the electrolytic capacitor is voltage-free the higher is the leakage current which can destroy the converter. After 2 years without voltage supply the converters (power supply, inverters) must be connected to mains voltage and electronic voltage for 1-2 hours (Converter ON [UE=1] and Controller enable OFF [RF=0]) to reform the capacitors, means to reduce the leakage current to nominal value. After that, the converters can be stored again.

4 Product overview

4.1 Ordering data

KE with ACC bus interface

Designation	Ordering no.
KEN 5	E793
KEN 5-F	E923
KE 10	--
KEN 10	E816
KEN 10-F	E924
KE 20	E717
KE 20-F	E928
KES 20	E944
KE 40	E718
KEN 60 (KE 60-S4)	E892
KE 60	E719
KES 60	E833
KEN 120	E781
KE 120	E856
KES 120	E834

KE with real-time Ethernet interface

Designation	Ordering no.
KE 20-0EU	E1037
KES 20-0EU	E984
KE 40-0EU	E1038
KES 40-0EU	E985
KE 60-0EU	E1039
KES 60-0EU	E986
KE 120-0EU	E1040
KES 120-0EU	E987
KE 180-0EU	E1060
KES 180-0EU	E1061

KE without fieldbus interface

Designation	Ordering no.
KEN 5-0N	E1054
KEN 5-FN	E1055
KEN 5-S10	E1200
KEN 20-0N	E1234

KW

Designation	Ordering no.
KW 2	E765
KW 2-F	E910
KW 2-0N	E764
KW 3	E815
KW 4-F	E942
KW 5	E767
KW 5-0N	E766
KW 6-F	E943
KW 8	E813
KW 8-0N	E814
KW 9-F	E925
KW 10	E768
KW 20	E769
KW 40	E770
KW 60	E771
KW 100	E855
KW 150	E988
KW 200	E989

KWD

Designation	Ordering no.
KWD 1	E759
KWD 1-F	E914
KWD 1-0N	E762
KWD 2	E760
KWD 2-F	E915
KWD 2-0N	E763
KWD 4-F	E916
KWD 5	E818

4.2 Basics on servo drive system

Configuration and function

A servo drive system consists of a compact power supply and compact inverters with built-in or integrated controller cards. A servo motor is connected to each compact inverter.
The compact power supply provides the DC bus for supplying power to the compact inverter.
The main purpose of the compact inverter is to regulate current for the servo motor. The servo motor converts electrical energy into mechanical energy.

The integrated encoder system in the servo motor supplies the cyclical position feedback values of the servo motor to the controller card in real-time. The controller card then uses the cyclical position feedback value to calculate the current speed of the servo motor.

The controller card adjusts the position, speed and current of the servo motor based on the operating mode.

Servo drive systems are generally used in applications which demand dynamic performance, precision, full stall torque and compact motors with high power density.

Power supply

The compact power supply units are connected to the mains supply via two isolated input terminals (charging circuit and mains connection). Compact power supply units without fieldbus interface have no separate charging circuit and they are connected to the mains supply via terminal X01 (mains connection). The DC bus capacitors are charged by the internal charging device. They supply power in dynamic operation and absorb generative brake energy.

Power is supplied by way of the mains filter, main contactor and mains choke. The mains filter is integrated into several compact power supply units. The main contactor and mains choke must always be installed externally (exception: Siehe 'Accessories components - overview' auf Seite 91.).

A mains filter limit electrical interference in the range of 150 kHz to 30 MHz that electronic devices transfer into the public power grid. In addition, they improve the electromagnetic compatibilities of the devices in the face of interferences from the electricity network.

The mains choke reduces circuit feedback (harmonics) and improves the power factor of the connected compact power supply units.

The logic supply is fed in via an external, buffered power supply unit.
This makes it possible to perform controlled braking in the event of mains failure.

Regenerative energy and feedback

A servo motor creates regenerative energy during braking, which is fed back into the DC DC bus. This regenerative energy is available to motorically running servo motors that are connected to the same DC bus. Excess generative energy within the DC bus is fed back by the compact power supply into the public mains. If the compact power supply is not equipped for regenerative feedback or the mains supply fails, feedback will not be possible. For such cases, an external brake resistor must be connected to the compact power supply, which is used to convert the excess energy into heat. The AMK compact power supply units are equipped with an internal brake transistor with a control unit and terminals for connecting an external brake resistor with temperature monitoring. The brake resistor needs to be selected application-specific depending on the occurring generative energy.

4.3 Product description

AMKASYN servo inverters KE/KW

The intelligent servo inverter KE/KW opens a whole new dimension in power density. It enables control cabinets to be designed extremely compact and often integrated directly into the machine. This saves both time and space. This is achieved by so-called cold plate technology. The AMKASYN servo inverter is available in liquid and air-cooled versions.

The KE/KW series of devices includes supply and inverter modules. The modular system design provide a maximum in flexibility. The customer only requires the components necessary for his application. Access to all parameters is provided with the real time bus system ACC, based on CANopen or EtherCAT. In addition, connection assembly groups for profibus, the SERCOS interface and a range of real-time Ethernet protocol delivers end-to-end communication on all levels. This in turn makes the system open to all common standards. Standard functions such as position control, positioning and electronic gearing are included in the basic device.

4.3.1 Products, options, accessories

The AMK drive and controller modular system is a sophisticated system with optimally compatible modules in a modular, open architecture for innovative, integrated automation solutions.

The modular system offers all of the components you need for your automation solution.

AMKAMAC PLC operator control units

with touch screen or keyboard

AMKAMAC PLC controllers

Drive-integrated PLC on the controller card in the inverter

Drive-integrated PLC as optional card in the inverter

Cabinet controller

Compact controller with touch screen or keyboard

AMKASYN inverter
Compact power supply
Compact inverter
Compact double inverter
Compact frequency inverter

AMKASYN optional cards
Various fieldbuses
I/O optional cards
PLC for motion control
Encoder interfaces

DYNASYN servo motors
Different models, power classes and cooling types

Decentralised servo solutions
AMKASMART iX and iC
AMKASMART IDT4, iDT5 and iDP7

Engineering tools and accessories
AIPEX PRO software tool with integrated technology libraries
Manual operating panel
PC-AMK connection cable

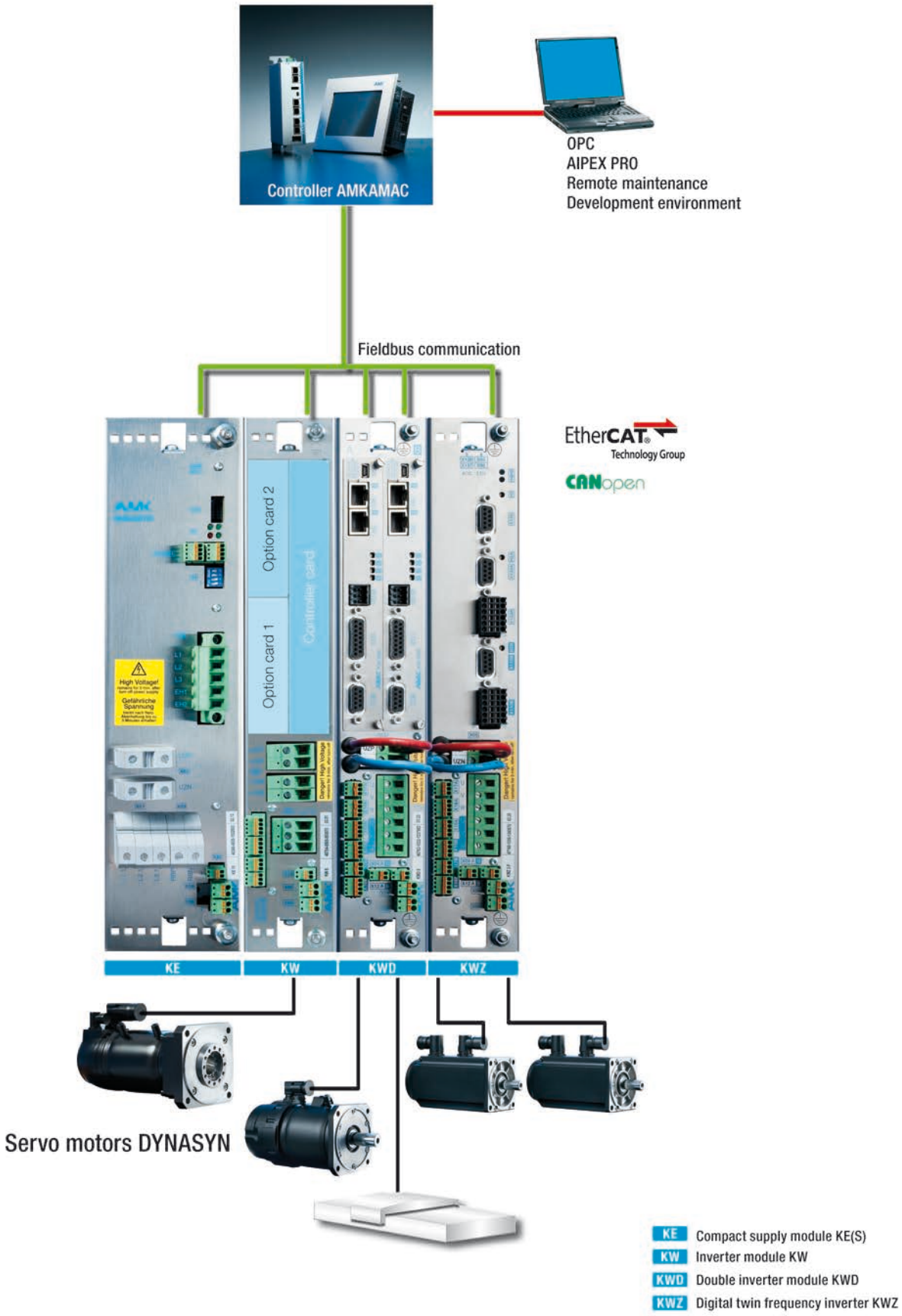
Cooling systems
Liquid cooling plates
Air cooling plates
Integrated air cooling systems

Controller cards
Various fieldbuses

Accessories
Upstream mains choke
Mains choke
Mains filter
Mains contactor
EMI suppressor
Brake resistor
I/O terminal via fieldbus

4.3.2 Display of product in system

The overview shows a possible AMK system structure. A higher level AMKAMAC controller exchanges data with the connected AMK modules via a fieldbus. The modular structure makes it possible to supply power to several compact inverters using a single compact power supply.
The AMKAMAC controller can be accessed over an Ethernet.


Controller AMKAMAC
OPC
AIPEX PRO
Remote maintenance
Development environment
Fieldbus communication
EtherCAT Technology Group
CANopen
Option card 2
Option card 1
Controller card
KE
KW
KWD
KWZ
Servo motors DYNASYN
KE Compact supply module KE(S)
KW Inverter module KW
KWD Double inverter module KWD
KWZ Digital twin frequency inverter KWZ

4.4 Product names and type codes

A label on the front of the devices identify the modules:

Device type	AMK part no.-serial no.	Revision no.

Device type = module name xx-yy

AMKASYN Compact Power Supply KE / KEN / KES

KE KEN KES	**xxx**	**-**	**x**	**y**	**z**
|	|		|	|	|
|	|		|	UPS
|	|		|	0: no UPS
|	|		|	U: with DC bus UPS [1]
|	|		Communication	
|	|		0: ACC bus [2]	
|	|		E: Real-time Ethernet	
|	|		N: no fieldbus communication	
|	|	Cooling		
|	|	0: coldplate		
|	|	F: integrated air cooling		
|	|	S: special model		
|	Nominal power			

Device type

KE: compact power supply with feedback

KEN: compact power supply without feedback

KES: compact power supply with sine feedback

1) Modules with UPS only available with Ethernet
2) Modules with ACC bus only available without UPS

AMKASYN Compact Inverter KW / KWD

KW KWD	**xxx**	**-**	**x**	**y**
|	|		|	|
|	|		|	Power output stage enable
|	|		|	0: with power output stage enable
|	|		|	N: no power output stage enable
|	|	Cooling		
|	|	0: coldplate		
|	|	F: integrated air cooling		
|	|	S: special model		
|	Nominal power			

Device type

KW: compact inverter

KWD: compact double inverter

AMKASYN Compact Two-Axes Inverter KWZ

KWZ	xxx	-	x	y
|	|		|	|
|	|		|	Cooling
|	|		|	0: coldplate
|	|		|	F: integrated air cooling
|	|	Communication		
|	|	0: ACC bus		
|	|	EC: EtherCAT		
|	Nominal power			

Device type

KWZ: compact two-axes inverter

(see separate description PDK_201603_KEKW_Hardware_KWZ)

AMKASYN V/f Compact Frequency Inverter KWF

KWF	xx	-	x	y
|	|		|	|
|	|		|	Power output stage enable
|	|		|	0: with power output stage enable
|	|		|	N: no power output stage enable
|	|	Communication		
|	|	0: ACC bus		
|	Nominal power			

Device type

KWF: compact frequency inverter

(see separate description PDK_200302_KEKW_Hardware_KWF)

A type plate containing the following information can also be found on the right side of the modules:

- Manufacturer, address
- Product group, device type
- Serial no., version no.
- Technical Data
- Permitted ambient temperature, protection class
- Conformity, certificates and CE marking

Siehe 'Type plates' auf Seite 24.

4.5 Type plates

4.5.1 Type plate KE / KEN / KES

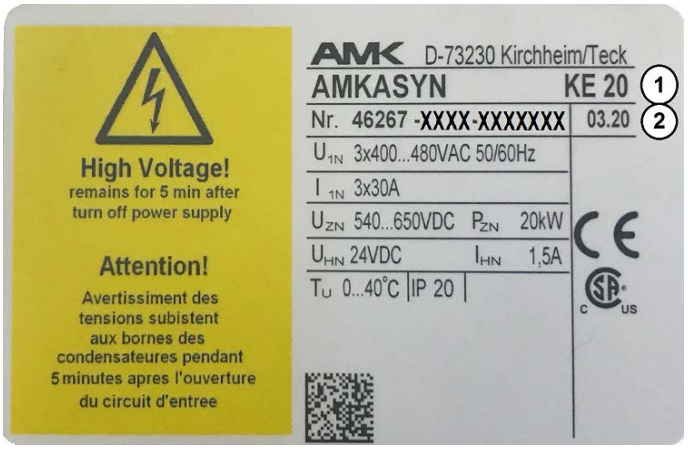


Illustration based on a KE 20 as an example: Content and scope can differ

Legend:

Abbreviation	Designation
Nr.	Serial number (part no. – calendar week + year – consecutive number)
1	Type designation
2	Revision
U_{1N}	Rated input voltage
f_{1N}	Input frequency
I_{1N}	Rated input current
U_{ZN}	Rated output voltage
P_{ZN}	Rated output power
U_{HN}	Supply voltage 24 VDC for electronic
I_{HN}	Rated current for 24 VDC (without I/O)
T_U	Permissible ambient temperature
IP	Type of protection according to EN 60529

4.5.2 Type plate KW / KWD

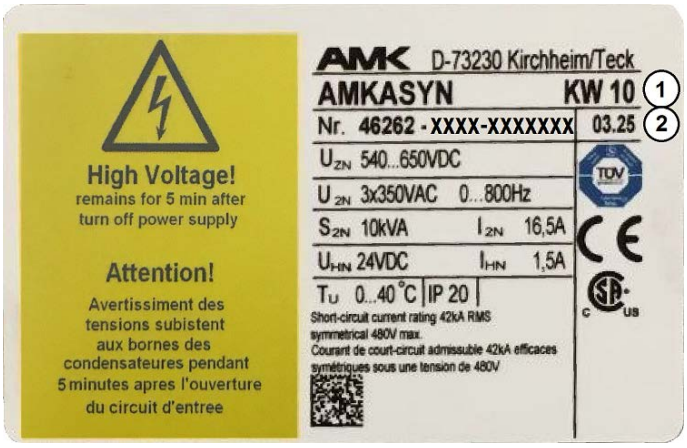


Illustration based on a KW10 as an example: Content and scope can differ

Legend:

Abbreviation	Designation
Nr.	Serial number (part no. – calendar week + year – consecutive number)
1	Type designation
2	Revision
U_{ZN}	Rated input voltage
U_{2N}	Rated output voltage
f_{2N}	Output frequency
S_{2N}	Rated output power
I_{2N}	Rated output current
U_{HN}	Supply voltage 24 VDC for electronic
I_{HN}	Rated current for 24 VDC (without I/O)
T_U	Permissible ambient temperature
IP	Type of protection according to EN 60529

4.6 Technical data

4.6.1 General technical data

Rated voltage: **3 x 400 VAC, 47 ... 63 Hz**

KE, KES; the mains power supply must be feedback-capable. Check for possible limitations when using a generator as an emergency power supply.

The short-circuit power must be interpreted according to standard EN 61800-3 as follows:

Legend

Short-circuit power in VA

Number of power supply units depending on transformer feeder

Rated power of the KE/ KEN/ KES systems

Mains supply KE / KEN / KES: Network operation requirements acc. to EN 61800-2 section 4.3.2.1 and EN 60204-1 section 4.3.2	**Mains form: TN-S (4-conductor), TN-C, TN-C-S, TT (4-conductor)** A symmetrical three-phase power supply is required, earthed at neutral point. The max. permitted voltage imbalance is 3%. **Rated current 3 x 400 VAC ... 3 x 480 VAC, 47 ... 63 Hz** Operating range: 3 x 400 VAC -20 % ... 3 x 480 VAC +10 %, 47 ... 63 Hz 3 x 320 VAC ... 3 x 528 VAC, 47 ... 63 Hz The system may not be operated outside this range. With mains voltages of less than 3 x 380 VAC, the system remains operational; the specified values for the operating point 3 x 400 VAC however are no longer achieved. **Mains form: IT** A symmetrical three-phase power supply is required, high impedance earthed at neutral point or not earthed. The max. permitted voltage imbalance is 3%. **Rated current 3 x 400 VAC ... 3 x 440 VAC, 47 ... 63 Hz** Operating range: 3 x 400 VAC -20 % ... 3 x 440 VAC +10 %, 47 ... 63 Hz 3 x 320 VAC ... 3 x 484 VAC, 47 ... 63 Hz The system may not be operated outside this range. With mains voltages of less than 3 x 380 VAC, the system remains operational; the specified values for the operating point 3 x 400 VAC however are no longer achieved.
Reference potential:	PE, switching GND of low-voltage circuits is connected internally to the frame ground.
Power supply unit for supply voltage:	24 VDC ± 15 %, ripple max. 5%, with integrated switch-on current limitation. Connect the 0 V potential to the PE.
Max. permissible values for radio interference voltages acc. to EN 61800-3:	in acc. with section 6.3.2 table 11 and table 12 (An external filter is required for KEN 5-S10, KEN 20-0N,KES 20, KES 40, KE-/ KEN-/ KES 60, KE-/ KEN-/ KES 120 and KE-/ KES180!)
Short Circuit Current Rating (SCCR):	42 kA
Ambient conditions	Acc. to EN 61800-2
Protection class as per EN 60529:	IP 20, degree of soiling 2
Storage/Shipping temperature:	- 25 °C to +75 °C
Ambient temperature:	+5 °C to +40 °C
Cooling temperature:	Must be maintained at below 40 °C.
Relative humidity:	5 % to 85 %, without condensation
Installation altitude:	Up to 1000 m above sea level. If installed at elevations of 1000 m to max. 2000 m above sea level, the nominal data has to be lowered by 1 % per 100 m.
Shock resistance:	15 g for 11 ms acc. to EN 60068-2-27
Vibration resistance:	1 g at 10 - 150 Hz acc. to EN 60068-2-6
Pollution degree:	2 acc. to EN 61800-5-1
Overvoltage category:	III (up to 2000 m above see level) acc. to EN 61800-5-1
EMC:	second environment, category C3 acc. to EN 61800-3 Places of the second environment are industrial areas and technical areas of buildings fed from a dedicated transformer. Devices of the second environment have no direct connection to a low voltage network that also supplies residential buildings. Category C3 devices with a rated voltage less than 1000 V, for use in the second environment.

Signal voltage for binary inputs/outputs acc. to VDI 2880

The signal voltage must be supplied by an external power supply unit. The power supply unit must feature potential separation acc. to EN 50178 Section 5.3 (safe electrical separation) and radio interference suppression acc. to EN 55011 Cl. A and B. The 0 V potential of the power supply unit should be earthed with the central switch cabinet PE.

Binary input signals in the basic device

Signal voltage:	24 VDC $_{ext.}$ relative to 0 V_{ext}
Max. permissible values 1 signal:	min. 13 V / 2 mA, max. 30.2 V / 115 mA
Max. permissible values 0 signal:	min. -3 V / 0 mA, max. 5 V / 15 mA
Min. duration BI (signal):	> 2 ms
Min. duration EF/EF2 (signal):	> ca. 50µs Siehe 'Reaction time EF safety function' auf Seite 191.

Binary outputs in the basic device

Output voltage:	24 VDC $_{ext.}$, relative to 0 V_{ext}
Rated output current:	0.1 A

A suppressor for inductive loads is integrated.

Insulation voltage

The insulation of the I/O interfaces is performed acc. to EN 50178 and tested at 500 VDC. Connectors X08, X09, X21, X22, X25, X236 and X237 are part of the circuits that are safely isolated from the mains circuit supply acc. to EN 50178 Section 5.2.

4.6.2 Technical data - compact power supply

4.6.2.1 KE without fieldbus connection

Nominal data	Terminal	KEN 5-FN	KEN 5-0N	KEN 5-0N with mains choke ALN 17	KEN 5-S10	KEN 20-0N
Input voltage (power supply)	X01	3 x 400 VAC, 47...63 Hz				
Input current (power supply)		12 A				30 A
Input voltage (logic supply)	X08 X07	24 VDC ±15 %				
Input power (logic supply)		5 W				6 W
Efficiency		approx. 99 %				
Power factor λ		0.6		0.9	0.6	approx. 0,92
Output power	X02	5 kW		7.5 kW	5 kW	20 kW [1)]
Max. output power		10 kW for 10 s		15 kW for 10 s	10 kW for 10 s	40 kW for 10 s
Output voltage (information: Siehe 'DC bus voltage' auf Seite 184.)		540 VDC				
Output current		9.25 A (at 540 VDC)		13.75 A (at 540 VDC)	9.25 A (at 540 VDC)	37 A (at 540 VDC)
Regenerative feedback		no				
Braking transistor	X03	Integrated, short-circuit proof				
Brake threshold		800 VDC				
External brake resistor		min. 47 Ohm				min. 27 Ohm
Max. generative power		13 kW				24 kW
Protective/ monitoring functions		protection system - charging resistor, short circuit external braking resistor, excess temperature heat sink and external brake resistor				
Fieldbus connection		no				
Interference filter (EN 61800-3, table 11)		Integrated			External	
Charging circuit		Integrated			-	Integrated
Main contactor		External				
Cooling		Integrated	External air or liquid cold plate			
Max. cold plate or ambient temperature		40 °C				
Module width		55 mm				
Weight		3 kg	2.5 kg			3 kg

1) In applications of decentralized drives or compact inverters with a module width 55 mm reduces the output power to 15 kW.

4.6.2.2 KE with fieldbus connection

Nominal data	Terminal	KEN 5	KEN 5-F
Input voltage (power supply)	X07	3 x 400 VAC, 47...63 Hz	
Input current (power supply)	X07	13 A	
Input voltage (logic supply)	X08 X09	24 VDC	
Input power (logic supply)	X08 X09	20 W	22 W
Efficiency		approx. 99 %	
Power factor λ		approx. 0,55	
Output power	X02	5 kW	
Max. output power	X02	10 kW for 60 s	
Output voltage (information: Siehe 'DC bus voltage' auf Seite 184.)	X02	540 VDC	
Output current	X02	9,5 A (at 540 VDC)	
Regenerative feedback		no	
Max. generative power (regenerative feedback)		-	
Braking transistor		Integrated	
Brake threshold		800 VDC	
Shutdown threshold of the DC bus overvoltage		850 VDC	
Shutdown threshold of the DC bus undervoltage		SEEP value typically 385 VDC parametrization with ID32837 'DC bus voltage monitoring'	
External brake resistor	X03	Rev. 1.00: min. 33 Ohm Rev. 1.01 and higher: min. 22 Ohm	
Protective/ monitoring functions		Line overcurrent (I^2t), protection system - charging resistor, Short circuit external braking resistor, Excess temperature heat sink and external brake resistor	
Fieldbus connection	X236 X237	ACC bus	
Interference filter (EN 61800-3, table 11)		Integrated	
Charging circuit, main contactor		Integrated	
Cooling		External air or liquid cold plate	Integrated
Max. cold plate or ambient temperature		40 °C	
Module width		55 mm	
Weight		3 kg	

Nominal data	Terminal	KEN 10	KEN 10-F	KE 10
Input voltage (power supply)	X07	3 x 400 VAC, 47...63 Hz		-
Input current (power supply)	X07	15 A		-
Input voltage (power supply) (charging circuit)	X01 X20	- -	- -	3 x 400 VAC, 47...63 Hz
Input current (power supply)	X01	-	-	15 A
Input voltage (logic supply)	X08 X09	24 VDC		
Input power (logic supply)	X08 X09	20 W	22 W	7,5 W
Efficiency		approx. 99 %		
Power factor λ		approx. 0,9		
Output power	X02	10 kW		
Max. output power	X02	20 kW for 60 s		
Output voltage (information: Siehe 'DC bus voltage' auf Seite 184.)	X02	540 VDC		
Output current	X02	19 A (at 540 VDC)		
Regenerative feedback		no		Line-synchr. block feedback
Max. generative power (regenerative feedback)		-		20 kW for 60 s
Braking transistor		Integrated		
Brake threshold		800 VDC		
Shutdown threshold of the DC bus overvoltage		850 VDC		
Shutdown threshold of the DC bus undervoltage		SEEP value typically 385 VDC parametrization with ID32837 'DC bus voltage monitoring'		
External brake resistor	X03	Rev. 1.00: min. 33 Ohm Rev. 1.01 and higher: min. 22 Ohm		min. 20 Ohm
Protective/ monitoring functions		Line overcurrent (I^2t), Protection system - charging resistor, Short circuit external braking resistor, Excess temperature heat sink and external brake resistor		
Fieldbus connection	X236 X237	ACC bus		
Interference filter (EN 61800-3, table 11)		Integrated		
Charging circuit, main contactor		Integrated		External
Cooling		External air or liquid cold plate	Integrated	External air or liquid cold plate
Max. cold plate or ambient temperature		40 °C		
Module width		55 mm		85 mm
Weight		3 kg		4.2 kg

Nominal data	Terminal	KE 20-F	KE 20	KE 20-0EU	KES 20	KES 20-0EU
Input voltage (power supply) (charging circuit)	X01 X20	3 x 400 VAC, 47...63 Hz				
Input current (power supply)	X01	30 A				
Input voltage (logic supply)	X08 X09	24 VDC				
Input power (logic supply)	X08 X09	17 W	7,5 W			
Efficiency		approx. 99 %			approx. 98 %	
Power factor λ		approx. 0,9			> 0,98	
Output power	X02	20 kW [1]				
Max. output power	X02	40 kW for 60 s			40 kW for 10 s	
Output voltage (information: Siehe 'DC bus voltage' auf Seite 184.)	X02	540 VDC			regulated 650 VDC (max. 720 VDC)	
Output current	X02	37 A (at 540 VDC)			31 A (at 650 VDC)	
Regenerative feedback		Line-synchronous block feedback			Sine-shaped line current during feed-in and feedback	
Max. generative power (regenerative feedback)		40 kW for 60 s			40 kW for 10 s	
Braking transistor		Integrated				
Brake threshold		800 VDC				
Shutdown threshold of the DC bus overvoltage		850 VDC				
Shutdown threshold of the DC bus undervoltage		SEEP value typically 385 VDC parametrization with ID32837 'DC bus voltage monitoring'				
External brake resistor	X03	min. 20 Ohm				
Protective/ monitoring functions		Line overcurrent (I^2t), protection system - charging resistor, Short circuit, external braking resistor, Excess temperature, heat sink and external brake resistor				
Fieldbus connection	X236 X237	ACC bus		-	ACC bus	-
	X85 X86	-	-	Real-time Ethernet	-	Real-time Ethernet
Interference filter (EN 61800-3, table 11)		Integrated			External	
Cooling		Integrated	External air and liquid cold plate			
Charging circuit, main contactor		External				
Max. cold plate or ambient temperature		40 °C				
Module width		86 mm	85 mm			
Weight		4.2 kg				

1) In applications of decentralized drives or compact inverters with a module width of 55 mm reduces the output power to 17 kW.

Nominal data	Terminal	KE 40	KE 40-0EU	KES 40-0EU
Input voltage (power supply) (charging circuit)	 X01 X20	3 x 400 VAC, 47...63 Hz		
Input current (power supply)	 X01	60 A		
Input voltage (logic supply)	X08 X09	24 VDC		
Input power (logic supply)	X08 X09	9 W		
Efficiency		approx. 99 %		approx. 98 %
Power factor λ		approx. 0,9		> 0,98
Output power	X02	40 kW		
Max. output power	X02	80 kW for 60 s		80 kW for 10 s
Output voltage (information: Siehe 'DC bus voltage' auf Seite 184.)	X02	540 VDC		regulated 650 VDC (max. 720 VDC)
Output current	X02	74 A (at 540 VDC)		62 A (at 650 VDC)
Regenerative feedback		Line-synchronous block feedback		Sine-shaped line current during feed-in and feedback
Max. generative power (regenerative feedback)		80 kW for 60 s		80 kW for 10 s
Braking transistor		Integrated		
Brake threshold		800 VDC		
Shutdown threshold of the DC bus overvoltage		850 VDC		
Shutdown threshold of the DC bus undervoltage		SEEP value typically 385 VDC parametrization with ID32837 'DC bus voltage monitoring'		
External brake resistor	X03	min. 8 Ohm		
Protective/ monitoring functions		Line overcurrent (I^2t), protection system - charging resistor, Short circuit, external braking resistor, Excess temperature, heat sink and external brake resistor		
Fieldbus connection	X236 X237	ACC bus	-	-
	X85 X86	-	Real-time Ethernet	Real-time Ethernet
Interference filter (EN 61800-3, table 11)		Integrated		External
Cooling		External air or liquid cold plate		
Charging circuit, main contactor		External		
Max. cold plate or ambient temperature		40 °C		
Module width		170 mm		
Weight		8 kg		

Nominal data	Terminal	KEN 60 (KE 60-S4)	KE 60	KE 60-0EU	KES 60	KES 60-0EU
Input voltage (power supply) (charging circuit)	X01 X20	3 x 400 VAC, 47...63 Hz				
Input current (power supply)	X01	90 A				
Input voltage (logic supply)	X08 X09	24 VDC				
Input power (logic supply)	X08 X09	15 W				
Efficiency		approx. 99 %			approx. 98 %	
Power factor λ		approx. 0,9			> 0,98	
Output power	X02	60 kW				
Max. output power	X02	120 kW for 60 s			120 kW for 10 s	
Output voltage (information: Siehe 'DC bus voltage' auf Seite 184.)	X02	540 VDC			regulated 650 VDC (max. 720 VDC)	
Output current	X02	112 A (at 540 VDC)			92 A (at 650 VDC)	
Regenerative feedback		-	Line-synchronous block feedback		Sine-shaped line current during feed-in and feedback	
Max. generative power (regenerative feedback)		-	120 kW for 60 s		120 kW for 10 s	
Braking transistor		Integrated				
Brake threshold		800 VDC				
Shutdown threshold of the DC bus overvoltage		850 VDC				
Shutdown threshold of the DC bus undervoltage		SEEP value typically 385 VDC parametrization with ID32837 'DC bus voltage monitoring'				
External brake resistor	X03	min. 8 Ohm				
Protective/ monitoring functions		Line overcurrent (I^2t), protection system - charging resistor, Short circuit, external braking resistor, Excess temperature, heat sink and external brake resistor				
Fieldbus connection	X236 X237	ACC bus	ACC bus	-	ACC bus	-
	X85 X86	-	-	Real-time Ethernet	-	Real-time Ethernet
Interference filter (EN 61800-3, table 11)		External				
Charging circuit, main contactor		External				
Cooling		External air and liquid cold plate				
Max. cold plate or ambient temperature		40 °C				
Module width		170 mm				
Weight		8 kg				

Nominal data	Terminal	KEN 120	KE 120	KE 120-0EU	KES 120	KES 120-0EU
Input voltage (power supply) (charging circuit)	X01 X20	3 x 400 VAC, 47...63 Hz				
Input current (power supply)	X01	180 A				
Input voltage (logic supply)	X08 X09	24 VDC				
Input power (logic supply)	X08 X09	15 W				
Efficiency		approx. 99 %			approx. 98 %	
Power factor λ		approx. 0,9			> 0,98	
Output power	X02 X06	120 kW				
Max. output power	X02	200 kW for 60 s			200 kW for 10 s	
Output voltage (information: Siehe 'DC bus voltage' auf Seite 184.)	X02	540 VDC			regulated 650 VDC (max. 720 VDC)	
Output current	X02	112 A (at 540 VDC)			92 A (at 650 VDC)	
	X06	225 A (at 540 VDC)			185 A (at 650 VDC)	
Regenerative feedback		-	Line-synchronous block feedback		Sine-shaped line current during feed-in and feedback	
Max. generative power (regenerative feedback)		-	200 kW for 60 s		200 kW for 10 s	
Braking transistor		2 x Integrated	Integrated			
Brake threshold		800 VDC				
Shutdown threshold of the DC bus overvoltage		850 VDC				
Shutdown threshold of the DC bus undervoltage		SEEP value typically 385 VDC parametrization with ID32837 'DC bus voltage monitoring'				
External brake resistor	X03	2 x min. 8 Ohm	min. 8 Ohm			
Protective/ monitoring functions		Line overcurrent (I^2t), protection system - charging resistor, Short circuit, external braking resistor, Excess temperature, heat sink and external brake resistor				
Fieldbus connection	X236 X237	ACC bus	ACC bus	-	ACC bus	-
	X85 X86	-	-	Real-time Ethernet	-	Real-time Ethernet
Interference filter (EN 61800-3, table 11)		External				
Charging circuit, main contactor		External				
Cooling		Coldplate, external air* or liquid cold plate (* Note derating)			Coldplate, external Liquid cold plate	
Max. cold plate or ambient temperature		40 °C				

Nominal data	Terminal	KEN 120	KE 120	KE 120-0EU	KES 120	KES 120-0EU
Module width		255 mm				
Weight		16 kg				

Nominal data	Terminal	KE 180-0EU	KES 180-0EU
Input voltage (power supply) (charging circuit)	 X01 X20	3 x 400 VAC, 47...63 Hz	
Input current (power supply)	 X01	270 A	
Input voltage (logic supply)	X08 X09	24 VDC	
Input power (logic supply)	X08 X09	36 W	
Efficiency		ca. 99 %	ca. 98 %
Power factor λ		approx. 0.90	> 0.98
Output power	X02 X06	180 kW	
Max. output power	X02	320 kW for 60 s	320 kW for 10 s
Output voltage (information: Siehe 'DC bus voltage' auf Seite 184.)	X02	540 VDC	regulated 650 VDC (max. 720 VDC)
Output current	max. (X02 + X06)	333 A (at 540 VDC) (180 kW)	277 A (at 650 VDC) (180 kW)
	X02	max. 112 A (at 540 VDC)	max. 92 A (at 650 VDC)
	X06	max. 333 A (at 540 VDC)	max. 277 A (at 650 VDC)
Regenerative feedback		Line-synchronous block feedback	Sine-shaped line current during feed-in and feedback
Max. generative power (regenerative feedback)		320 kW for 60 s	320 kW for 10 s
Braking transistor		Integrated	
Brake threshold		800 VDC	
Shutdown threshold of the DC bus overvoltage		850 VDC	
Shutdown threshold of the DC bus undervoltage		SEEP value typically 385 VDC parametrization with ID32837 'DC bus voltage monitoring'	
External brake resistor	X03	min. 5.4 Ohm (max. 150 A at 800 V)	
Max. generative power (brake resistor; time depends on resistor type)	X03	120 kW for 60 s	
Protective/ monitoring functions		Line overcurrent (I^2t), protection system - charging resistor, Short circuit, external braking resistor, Excess temperature, heat sink and external brake resistor	
Fieldbus connection	X85 X86	Real-time Ethernet	Real-time Ethernet
Interference filter (EN 61800-3, table 11)		External	
Charging circuit, main contactor		External	
Cooling		Coldplate, external liquid cold plate	

Nominal data	Terminal	KE 180-0EU	KES 180-0EU
Max. cold plate or ambient temperature		40 °C	
Module width		425 mm	
Weight		18 kg	

For compact power supplies and compact inverters with a module width of 425 mm, cold plates KW-CP680 (AMK part no. O708), KW-CP510 (AMK part no. O706) respectively KW-CP510R (AMK part no. O707) must be exclusively used with a **revision from 2.03 on**!

4.6.3 Technical data - compact inverter

The following nominal data apply: 3 x 400 VAC, 50/60 Hz for an input voltage on the CI, 540 VDC for a DC bus voltage and 350 VAC for a motor rated voltage.

Nominal data of the compact inverters is valid for vertical installation:

Nominal data	Terminal	KW 2 KW 2-F	KW 3	KW 4-F	KW 5
Input voltage (UZP, UZN) (Power supply)	X05	540 VDC (max. 720 VDC)			
Input current at 540 VDC (Power supply)	X05	3.8 A	5.6 A	7.6 A	9.3 A
Shutdown threshold of the DC bus voltage		850 VDC			
Supply voltage (Logic supply)	X08 X09	24 VDC			
Input power (Logic supply)		12 W (+2.5 W / Option)			
Efficiency		ca. 98 %			
Control procedure/switch frequency		PWM 8 kHz			
Output frequency [1] **KW-R03(P) / KW-R04** **KW-R05 / -R06 / -R16 / -R07 / -R17 /-R24(-R) / -R25 / -R26 / -R27**	X04	0 - 800 Hz 0 - 1200 Hz			
Output voltage	X04	0 - 350 VAC (sine-shaped output current)			
Output rated power at 3 x 350 VAC	X04	2 kVA	3 kVA	4 kVA	5 kVA
Output rated current I_N	X04	3.3 A	5 A	6.6 A	8.25 A
Peak output current I_{max} [2]	X04	6.6 A	10 A	13.2 A	16.5 A
Max. time **Peak output current. I_{max}**	X04				
Output frequency f_{out} > 1 Hz		10 s			
Output frequency f_{out} ≤ 1 Hz		0.5 s			
Protective/ monitoring functions		Motor over-current / short-circuit / short-to-ground, Excess temperature - heat sink / motor - current overload after I^2t			
Cooling		KW x = External air or liquid cold plate KW x-F = Integrated air cooling			
Max. cold plate or ambient temperature		40 °C			
Module width		55 mm			
Weight		3 kg			

Nominal data	Terminal	KW 6-F	KW 8	KW 9-F	KW 10
Input voltage (UZP, UZN) (Power supply)	X05	540 VDC (max. 720 VDC)			
Input current at 540 VDC (Power supply)	X05	11.4 A	15 A	16.8 A	18.5 A
Shutdown threshold of the DC bus voltage		850 VDC			
Supply voltage (Logic supply)	X08 X09	24 VDC			
Input power (Logic supply)		13 W (+2.5 W / option)			
Efficiency		ca. 98 %			
Control procedure/switch frequency		PWM 8 kHz			
Output frequency [1] **KW-R03(P) / KW-R04** **KW-R05 / -R06 / -R16 / -R07 / -R17 /-R24(-R) / -R25 / -R26 / -R27**	X04	0 - 800 Hz 0 - 1200 Hz			
Output voltage	X04	0 - 350 VAC (sine-shaped output current)			
Output rated power at 3 x 350 VAC	X04	6 kVA	8 kVA	9 kVA	10 kVA
Output rated current I_N	X04	9.9 A	13.2 A	14.9 A	16.5 A
Peak output current I_{max} [2]	X04	19.8 A	26.4 A	29.7 A	33 A
Max. time **Peak output current. I_{max}**	X04				
Output frequency f_{out} > 1 Hz		10 s			
Output frequency f_{out} ≤ 1 Hz		0.5 s			
Protective/ monitoring functions		Motor over-current / short-circuit / short-to-ground, Excess temperature - heat sink / motor - current overload after I^2t			
Cooling		KW x = External air or liquid cold plate KW x-F = Integrated air cooling			
Max. cold plate or ambient temperature		40 °C			
Module width		55 mm		86 mm	85 mm
Weight		3 kg		4.2 kg	

Nominal data	Terminal	KW 20	KW 40	KW 60
Input voltage (UZP, UZN) (Power supply)	X05	540 VDC (max. 720 VDC)		
Input current at 540 VDC (Power supply)	X05	37 A	74 A	112 A
Shutdown threshold of the DC bus voltage		850 VDC		
Supply voltage (Logic supply)	X08	24 VDC		
Input power (Logic supply)	X09	13 W (+2.5 W / option)		17 W (+2.5 W / option)
Efficiency		ca. 98 %		
Control procedure/switch frequency		PWM / 8 kHz		
Output frequency [1] **KW-R03(P) / KW-R04** **KW-R05 / -R06 / -R16 / -R07 / -R17 /-R24(-R) / -R25 / -R26 / -R27**	X04	0 - 800 Hz 0 - 1200 Hz		
Output voltage	X04	0 - 350 VAC (sine-shaped output current)		
Output rated power at 3 x 350 VAC	X04	20 kVA	40 kVA	60 kVA
Output rated current I_N	X04	33 A	66 A	99 A
Peak output current I_{max} [2]	X04	66 A	132 A	198 A
Max. time **Peak output current. I_{max}**	X04			
Output frequency f_{out} > 1 Hz		10 s		
Output frequency f_{out} ≤ 1 Hz		0,5 s		
Output frequency f_{out} > 0,4 Hz			10 s	
Output frequency f_{out} ≤ 0,4 Hz			≤ 720 V = 1 s 800 V = 0,5 s	
Output frequency f_{out} > 0,8 Hz				10 s
Output frequency f_{out} ≤ 0,8 Hz				≤ 720 V = 1 s 800 V = 0,5 s
Protective/ monitoring functions		Motor over-current / short-circuit / short-to-ground, Excess temperature - heat sink / motor - current overload after I^2t		
Cooling		External air * or liquid cold plate * Observe derating		
Max. cold plate or ambient temperature		40 °C		
Module width		85 mm	170 mm	
Weight		4.2 kg	8 kg	

Nominal data	Terminal	KW 100	KW 150	KW 200
Input voltage (UZP, UZN) (Power supply)	X05	540 VDC (max. 720 VDC)		
Input current at 540 VDC (Power supply)	max. (X05 + X06)	187 A	280 A	370 A
	X05	max. 112 A	max. 112 A	max. 112 A
	X06	max. 187 A -	- max. 370 A	- max. 370 A
Shutdown threshold of the DC bus voltage		850 VDC		
Supply voltage (Logic supply)	X08 X09	24 VDC		
Input power (Logic supply)		33 W (+2.5 W / option)	50 W (+2.5 W / option)	50 W (+2.5 W / option)
Efficiency		ca 98 %		
Control procedure/switch frequency		PWM / 8 kHz		
Output frequency [1] **KW-R03(P) / KW-R04** **KW-R05 / -R06 / -R16 / -R07 / -R17 /-R24(-R) / -R25 / -R26 / -R27**	X04	0 - 800 Hz 0 - 1200 Hz		
Output voltage	X04	0 - 350 VAC (sine-shaped output current)		
Output rated power at 3 x 350 VAC	X04	100 kVA	150 kVA	200 kVA
Output rated current I_N	X04	165 A	247 A	330 A
Peak output current I_{max} [2]	X04	272 A	495 A	561 A
Max. time **Peak output current. I_{max}**	X04			
Output frequency f_{out} > 1,5 Hz		7.3 s		
Output frequency f_{out} ≤ 1,5 Hz		≤ 650 V = 0,65 s 800 V = 0,15 s		
Output frequency f_{out} > 10 Hz			10 s	7.3 s
Output frequency f_{out} ≤ 10 Hz			0.05 s	0.05 s
Protective/ monitoring functions		Motor over-current / short-circuit / short-to-ground, Excess temperature - heat sink / motor - current overload after I^2t		
Cooling		External air * or liquid cold plate * Observe derating	External liquid cold plate	
Max. cold plate or ambient temperature		40 °C		
Module width		255 mm	425 mm	425 mm
Weight		16 kg	20 kg	25 kg

For compact power supplies and compact inverters with a module width of 425 mm, cold plates KW-CP680 (AMK part no. O708), KW-CP510 (AMK part no. O706) respectively KW-CP510R (AMK part no. O707) must be exclusively used with a **revision from 2.03 on**!

Nominal data	Terminal	KWD 1 KWD 1-F	KWD 2 KWD 2-F	KWD 4-F	KWD 5
Input voltage (UZP, UZN) (Power supply)	X05	540 VDC (max. 720 VDC)			
Input current at 540 VDC (Power supply)	X05	3.8 A	7.6 A	15.2 A	19 A
Shutdown threshold of the DC bus voltage		850 VDC			
Supply voltage (Logic supply)	X08 X09	24 VDC			
Input power (Logic supply)		24 W			
Efficiency		approx. 98%			
Control procedure/switch frequency		PWM / 8 kHz			
Output frequency [1] **KW-R03(P) / KW-R04** **KW-R05 / -R06 / -R16 / -R24(-R) / -R25 / -R26**	X04	0 - 800 Hz 0 - 1200 Hz			
Output voltage	X04 A/B	0 - 350 VAC (sine-shaped output current)			
Output rated power at 3 x 350 VAC	X04 A/B	2 x 1 kVA	2 x 2 kVA	2 x 4 kVA	2 x 5 kVA
Output rated current I_N	X04 A/B	2 x 1.65 A	2 x 3.3 A	2 x 6.6 A	2 x 8.25 A
Peak output current I_{max} [2]	X04 A/B	2 x 3.3 A	2 x 6.6 A	2 x 13.2 A	2 x 16.5 A
Max. time **Peak output current I_{max}**	X04 A/B				
Output frequency f_{out} > 1 Hz		10 s			
Output frequency f_{out} ≤ 1 Hz		0.5 s			
Protective/ monitoring functions		Motor over-current / short-circuit / short-to-ground, Excess temperature - heat sink / motor - current overload after I^2t			
Cooling		KW x = External air or liquid cold plate KW x-F = Integrated air cooling			
Max. cold plate or ambient temperature		40 °C			
Module width		55 mm			
Weight		3 kg			

1) Valid for devices with firmware versions beginning up from V2.12 2018/03:

V/f-operation:	Output frequency max. 599 Hz
Closed control loop operation:	Speed setpoint values are limited to 30000 rpm. The actual speed value is monitored for the maximum speed of 30000 rpm. Actual speed values are detected above 30000 rpm. The drive generates the error 2319 'n > nmax 'and runs down.

2) The max. duration of power output current I_{max} is lowered in DC operation (moving on block/stop). The limit speed between normal and DC operation can be defined using the following formula.

$$n\ [RPM] = \frac{f\ [Hz]}{\text{pole pairs motor}} \cdot 60$$

Additional information: Note on application No. AP 2008_05-1d

The maximum duration of peak output current I_{max} is based on twice the output power of the inverter. The maximum duratin of power current output t_{max} can be calculated for any output current. The I^2t constant is c = 30 at t_{max} = 10 s and c = 1.5 at t_{max} = 0.5 s.

$$t_{max} = \frac{k}{\left(\frac{I_{max}}{I_N}\right)^2 - 1}$$

Formula: Any I^2t constant c

$$k = \left[\left(\frac{I_{max}}{I_N}\right)^2 - 1\right] \cdot t_{max}$$

Additionally, the evaluation of the temperature of the rear panel of the module and the temperature model (KW-R06) provide the best possible protection for the module in DC operation (moving on block) and during cyclic overload with simultaneous high basic load.

4.7 Views KE

4.7.1 Module overview

KE with ACC bus interface

Module width	Module name	Dimensions
55 mm	KEN 5, KEN 10, KEN 5-F, KEN 10-F	Siehe 'Front view KE: module width 55 mm and 85 mm' auf Seite 44.
85 mm	KE 10, KE 20, KES 20 KE 20-F	Siehe 'Front view KE: module width 55 mm and 85 mm' auf Seite 44.
170 mm	KE 40, KE 60, KEN 60 (KE 60-S4), KES 60	Siehe 'Front view KE: module width 170 mm' auf Seite 45.
255 mm	KE 120, KEN 120, KES 120	Siehe 'Front view KE: module width 255 mm' auf Seite 46.

KE with real-time Ethernet interface

Module width	Module name	Dimensions
85 mm	KE 20-0EU, KES 20-0EU	Siehe 'Front view KE-0EU: module width 85 mm' auf Seite 50.
170 mm	KE 40-0EU, KES 40-0EU KE 60-0EU,KES 60-0EU	Siehe 'Front view KE-0EU: module width 170 mm' auf Seite 51.
255 mm	KE 120-0EU, KES 120-0EU	Siehe 'Front view KE-0EU: module width 255 mm' auf Seite 52.
425 mm	KE 180-0EU, KES 180-0EU	Siehe 'Front view KE-0EU: module width 425 mm' auf Seite 53.

KE without fieldbus interface

Module width	Module name	Dimensions
55 mm	KEN 5-0N, KEN 5-FN, KEN 5-S10 KEN 20-0N	Siehe 'Front view KEN xx-xN/S10: module width 55 mm' auf Seite 56.

4.7.2 KE with ACC bus interface

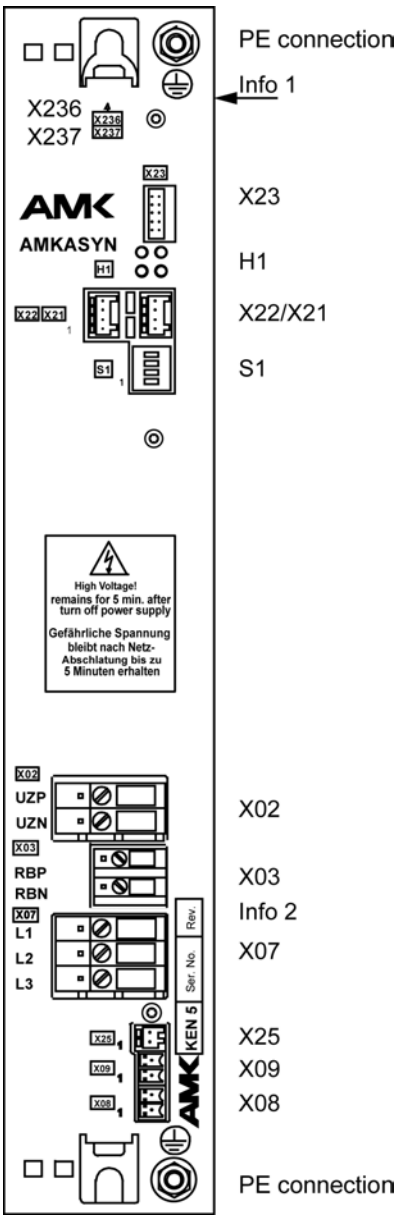
4.7.2.1 Connections

Connection	Use
A	Internal AMK service interface
H1	LED status indicator
Info 1	Lateral type plate
Info 2	Device type, serial no., hardware version
S1	DIP switch (device addressing and BUS transmission rate for ACC bus)
X01	Mains supply (external main contactor)
X02	DC bus
X03.1	External brake resistor
X03.2	External brake resistor
X06	DC bus
X07	Mains supply (main contactor integrated)
X08	Input for external 24 VDC supply
X09	Looping 24 VDC (total of max. five modules per group)
X20	Power supply to charging circuit, control for main contactor
X21	2 binary outputs
X22	2 binary inputs, 2 binary outputs
X23	Internal AMK service interface
X25	PTC thermistor for monitoring temperature of external components such as brake resistors and mains filters
X236/X237	ACC bus (Siehe 'Top view: compact power supply KE' auf Seite 47.)

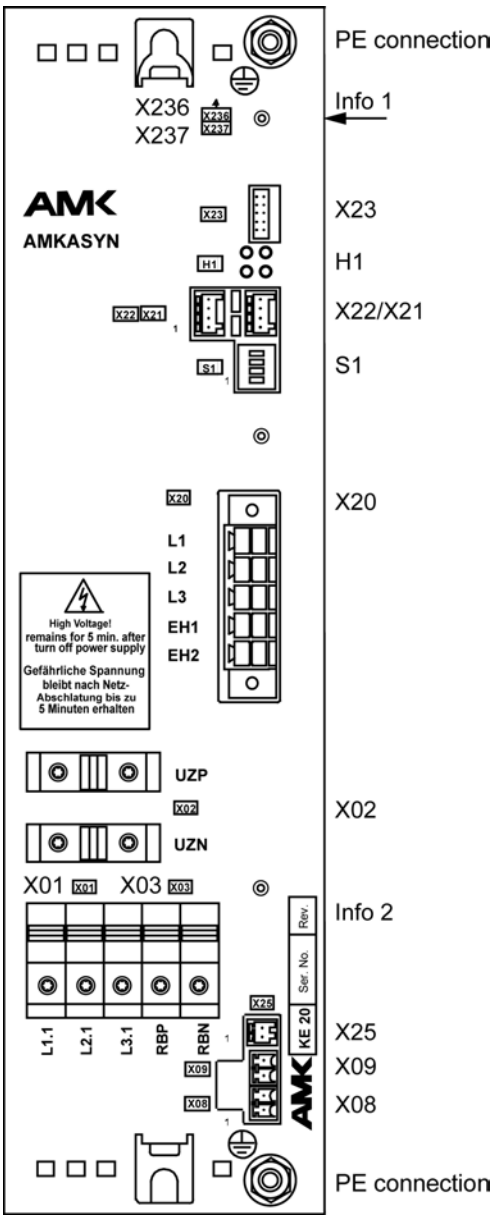
For a detailed description of the connections, refer to chapter 'Connection technology'.

4.7.2.2 Front view KE: module width 55 mm and 85 mm

Compact power supply
KEN 5, KEN 10, KEN 5-F, KEN 10-F

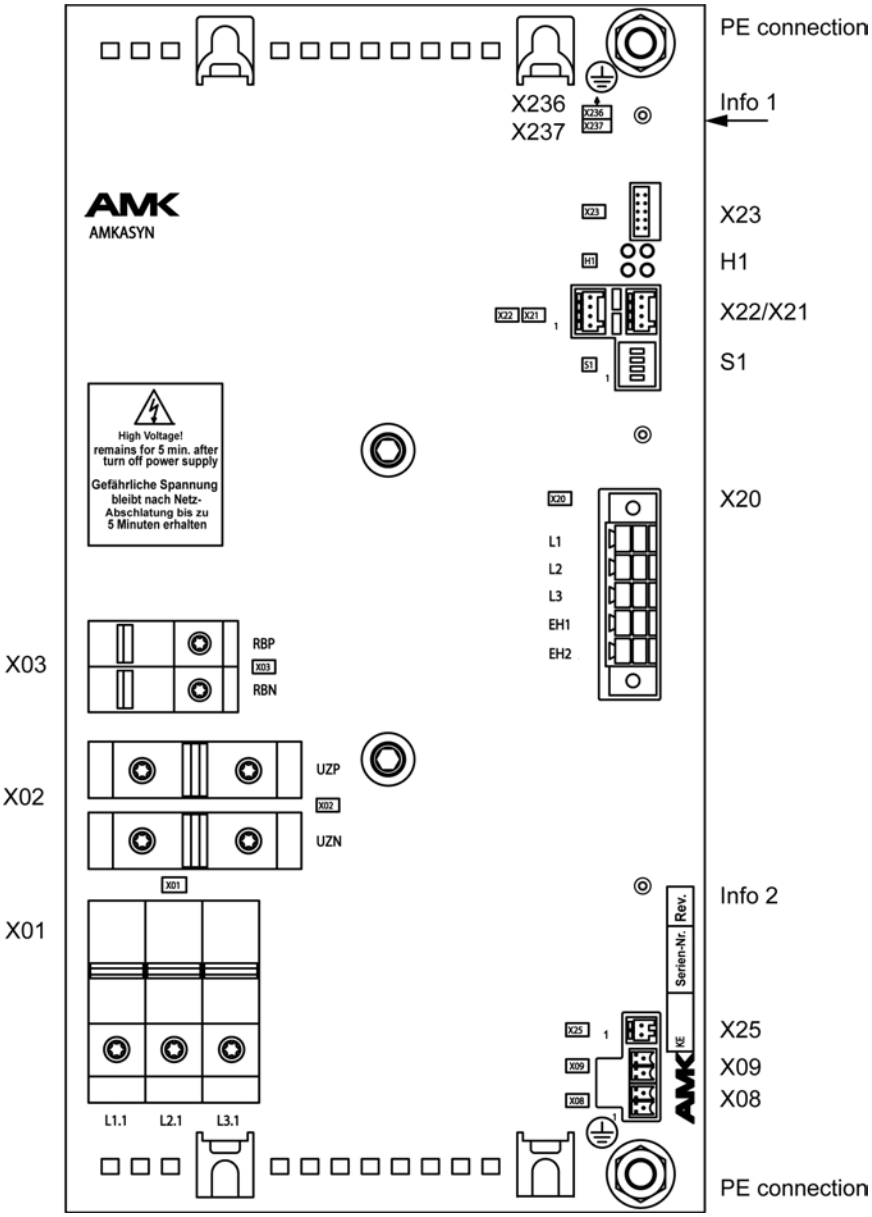


Compact power supply
KE 10, KE 20, KE 20-F, KES 20



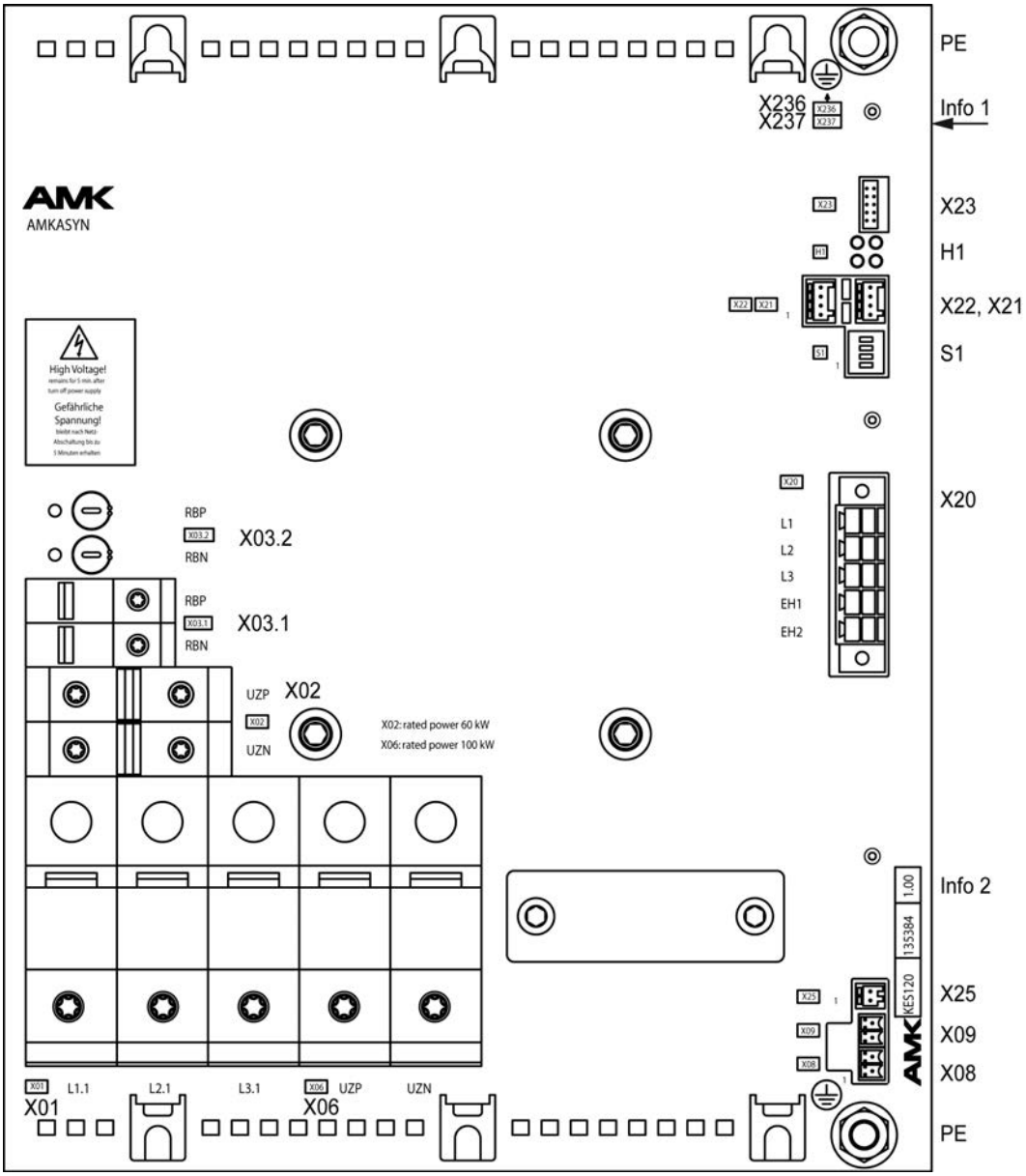
4.7.2.3 Front view KE: module width 170 mm

Compact power supply
KE 40, KE 60, KEN 60 (KE 60-S4), KES 60



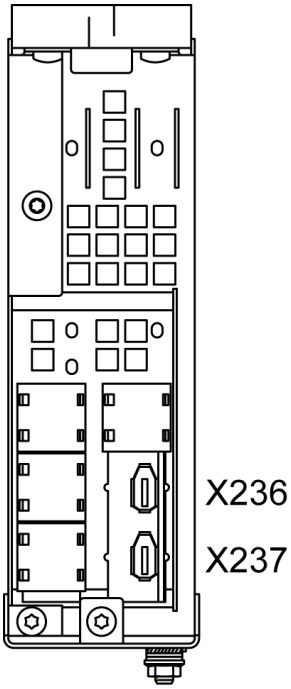
4.7.2.4 Front view KE: module width 255 mm

Compact power supply
KE 120, KEN 120[1)], KES 120



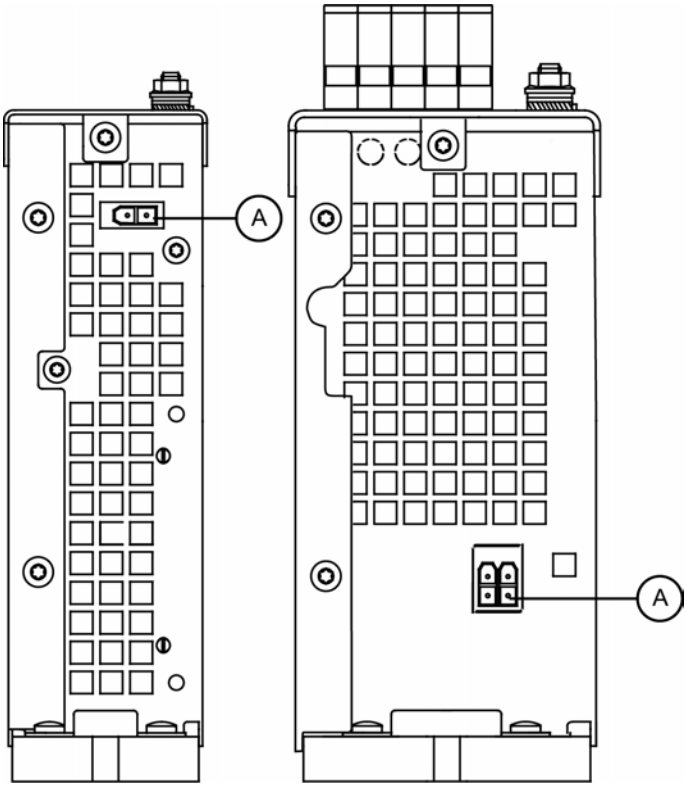
1) X03.2 is additionally equipped for KEN 120

4.7.2.5 Top view: compact power supply KE



Connection	Use
X236	ACC bus
X237	ACC bus

4.7.2.6 View from below: compact power supply



Connection	Use
A	Internal AMK service interface

4.7.3 KE with real-time Ethernet interface

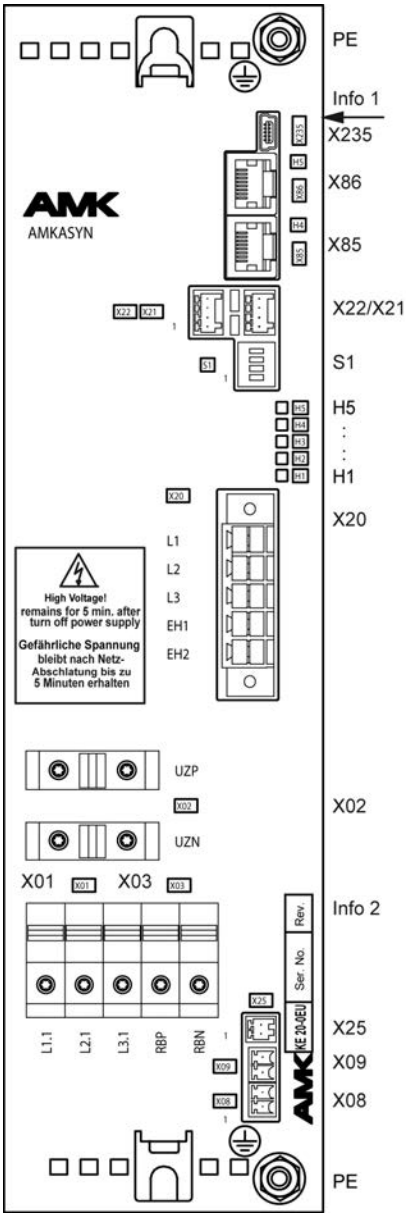
4.7.3.1 Connections

Connection	Use
A	Internal AMK service interface
H1 - H5	LED status indicator
Info 1	Lateral type plate
Info 2	Device type, serial no., hardware version
S1	DIP switch (device addressing)
X01	Mains supply (external main contactor)
X02	DC bus
X03.1	External brake resistor
X03.2	External brake resistor
X06	DC bus
X08	Input for external 24 VDC supply
X09	Looping 24 VDC (total of max. five modules per group)
X20	Power supply to charging circuit, control for main contactor
X21	2 binary outputs
X22	2 binary inputs, 2 binary outputs
X25	PTC thermistor for monitoring temperature of external components such as brake resistors and mains filters
X85	Real-time Ethernet IN
X86	Real-time Ethernet OUT
X235	MiniUSB interface for firmware update and parameterisation

For a detailed description of the connections, refer to chapter 'Connection technology'.

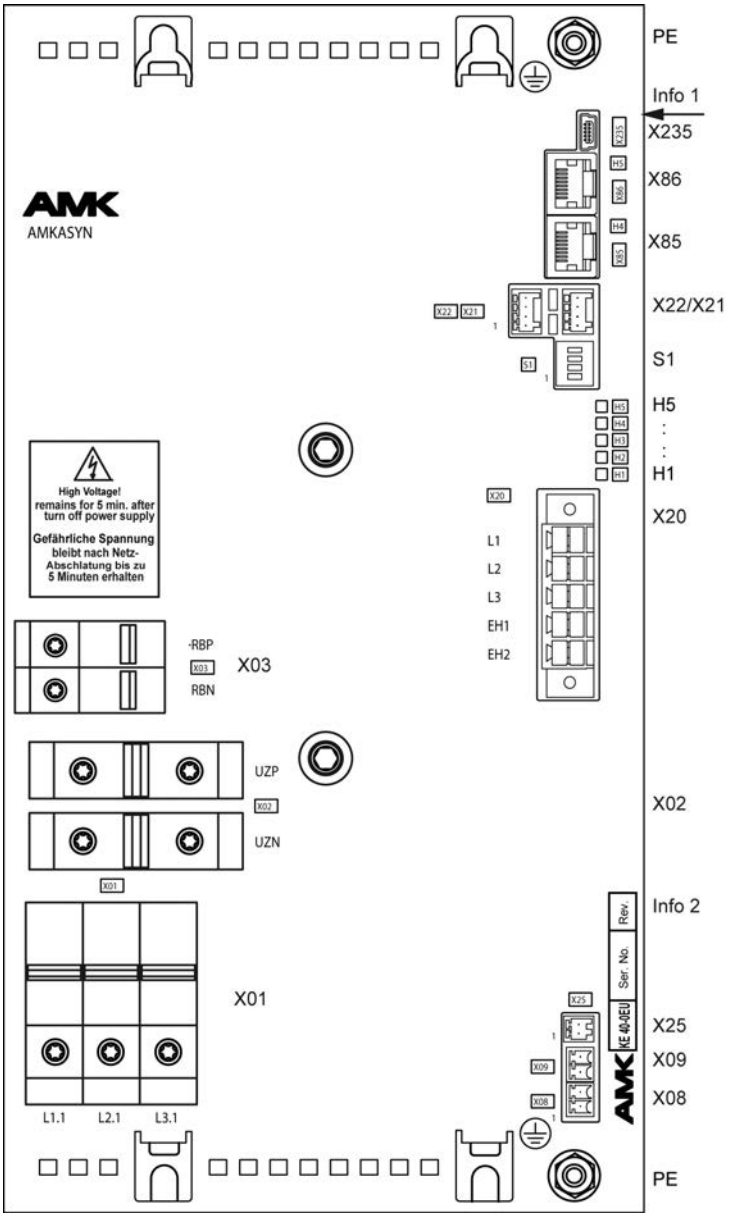
4.7.3.2 Front view KE-0EU: module width 85 mm

Compact power supply
KE 20-0EU, KES 20-0EU



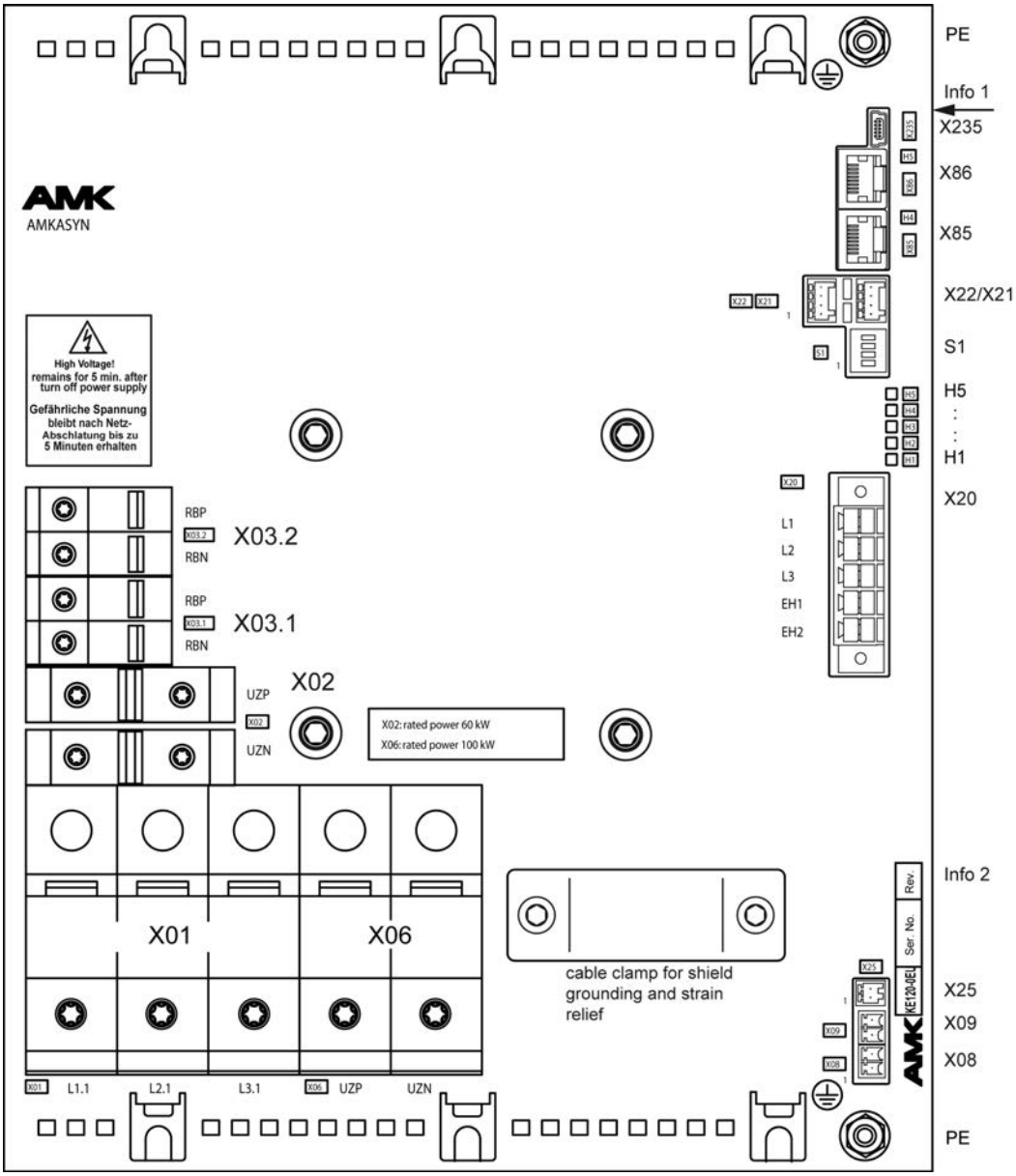
4.7.3.3 Front view KE-0EU: module width 170 mm

Compact power supply
KE 40-0EU, KES 40-0EU, KE 60-0EU, KES 60-0EU



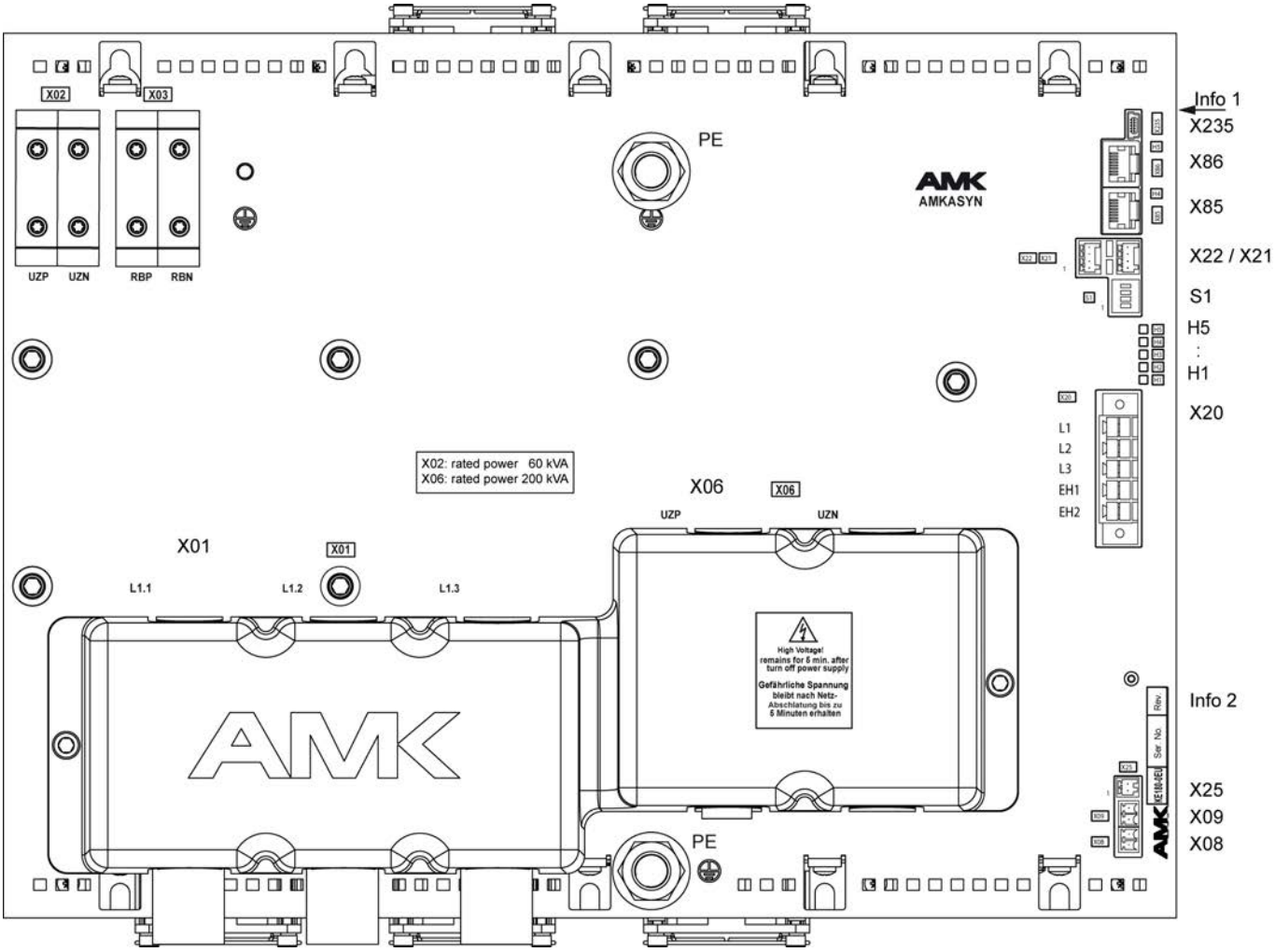
4.7.3.4 Front view KE-0EU: module width 255 mm

Compact power supply
KE 120-0EU, KES 120-0EU

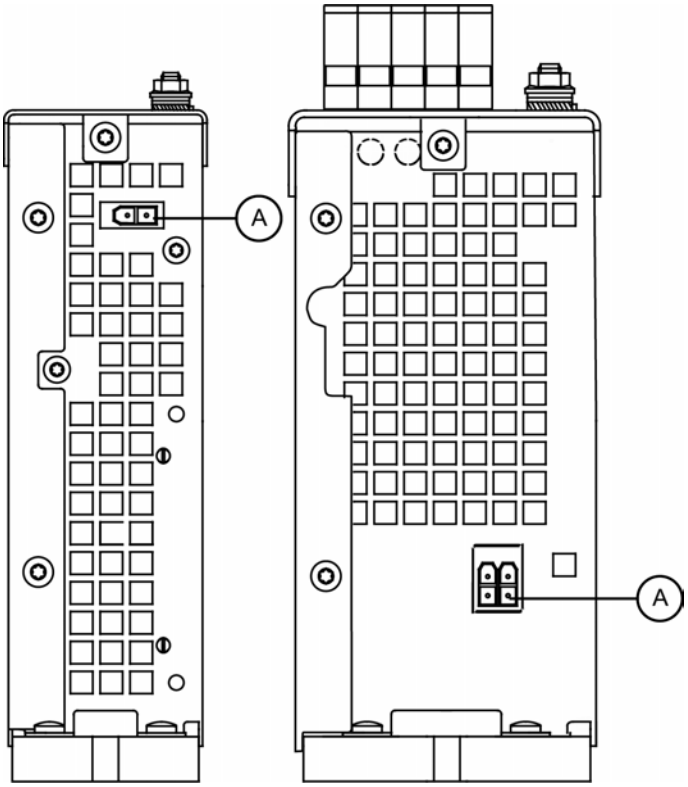


4.7.3.5 Front view KE-0EU: module width 425 mm

Compact power supply
KE 180-0EU, KES 180-0EU



4.7.3.6 View from below: compact power supply



Connection	Use
A	Internal AMK service interface

4.7.4 KE without fieldbus interface

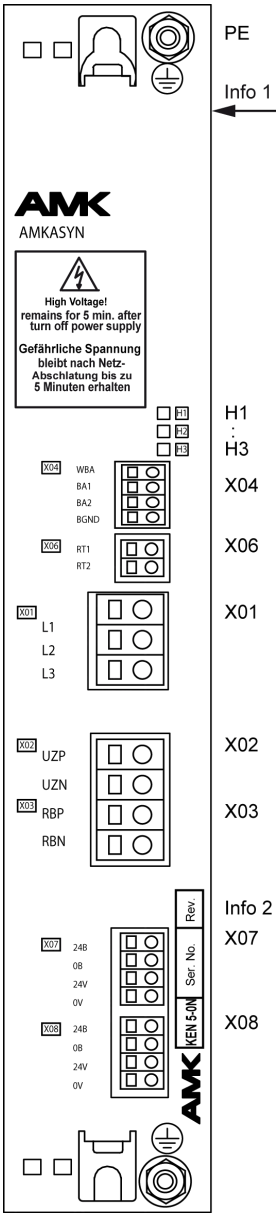
4.7.4.1 Connections

Connection	Use
H1 ... H3	LED status indicator
Info 1	Lateral type plate
Info 2	Device type, serial no., hardware version
X01	Mains supply (external main contactor)
X02	DC bus
X03	External brake resistor
X04	2 binary outputs
X06	PTC thermistor for monitoring temperature of external components such as brake resistors
X07	Looping 24 VDC
X08	Input for external 24 VDC supply

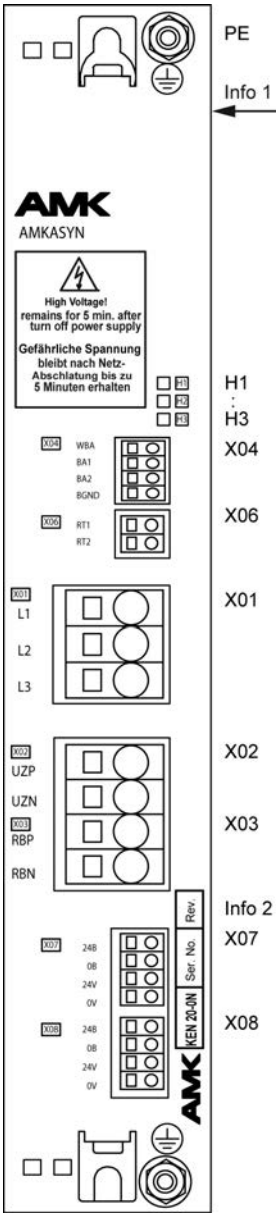
For a detailed description of the connections, refer to chapter 'Connection technology'.

4.7.4.2 Front view KEN xx-xN/S10: module width 55 mm

Compact power supply
KEN 5-0N, KEN 5-FN, KEN 5-S10



Compact power supply
KEN 20-0N



4.8 Views KW

4.8.1 Module overview

Module width	Module name	Front view
55 mm	KW 2, KW 3, KW 5, KW 8, KW 2-F, KW 4-F,KW 6-F	Siehe Front view KW: module width 55 mm and 85 mm auf Seite 58.
85 mm	KW 10, KW 20, KW 9-F	Siehe Front view KW: module width 55 mm and 85 mm auf Seite 58.
170 mm	KW 40, KW 60	Siehe Front view KW: module width 170 mm auf Seite 59.
255 mm	KW 100	Siehe Front view KW: module width 255 mm auf Seite 60.
425 mm	KW 150, KW 200	Siehe Front view KW: module width 425 mm auf Seite 61.
55 mm	KWD 1, KWD 2, KWD 5, KWD 1-F, KWD 2-F, KWD 4-F	Siehe Front view KWD: module width 55 mm auf Seite 62.

4.8.2 Connectors of compact inverters

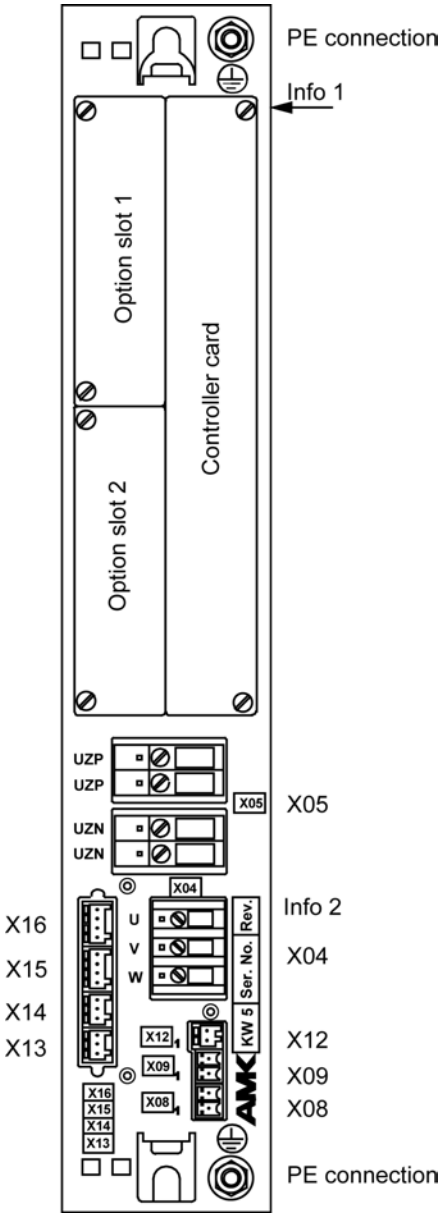
Connection	Use
A	Internal AMK service interface
Info 1	Lateral type plate
Info 2	Device type, serial no., hardware version
X04	Motor connection
X05	DC bus, DC bus routing (max. connected rating: 60 kVA)
X06	DC bus (max. connected rating: 100 kVA)
X08	Input for external 24 VDC supply
X09	Looping 24 VDC (total of max. five modules per group)
X12	PTC thermistor for monitoring temperature of motor
X13	Acknowledgment power output stage enable (transmission)
X14	Power output stage enable (transmission)
X15	Power output stage enable EF / EF2
X16	Acknowledgment of power output stage enable
X17	Power output stage enable EF EF2
X18	Power output stage enable transmission

With the double inverter KWD, the two axes are differentiated by A and B in the identification, e.g. X04A and X04B for two motor connections.

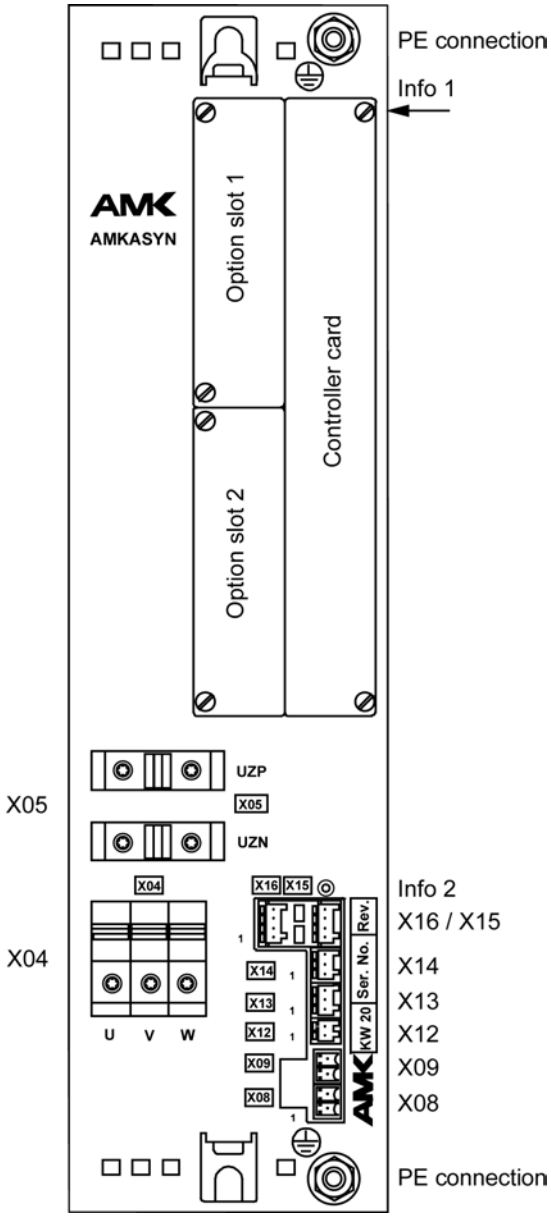
For a detailed description of the connections, refer to chapter 'Connection Technology'.

4.8.3 Front view KW: module width 55 mm and 85 mm

Compact inverter
KW 2, KW 3, KW 5, KW 8,
KW 2-F, KW 4-F, KW 6-F

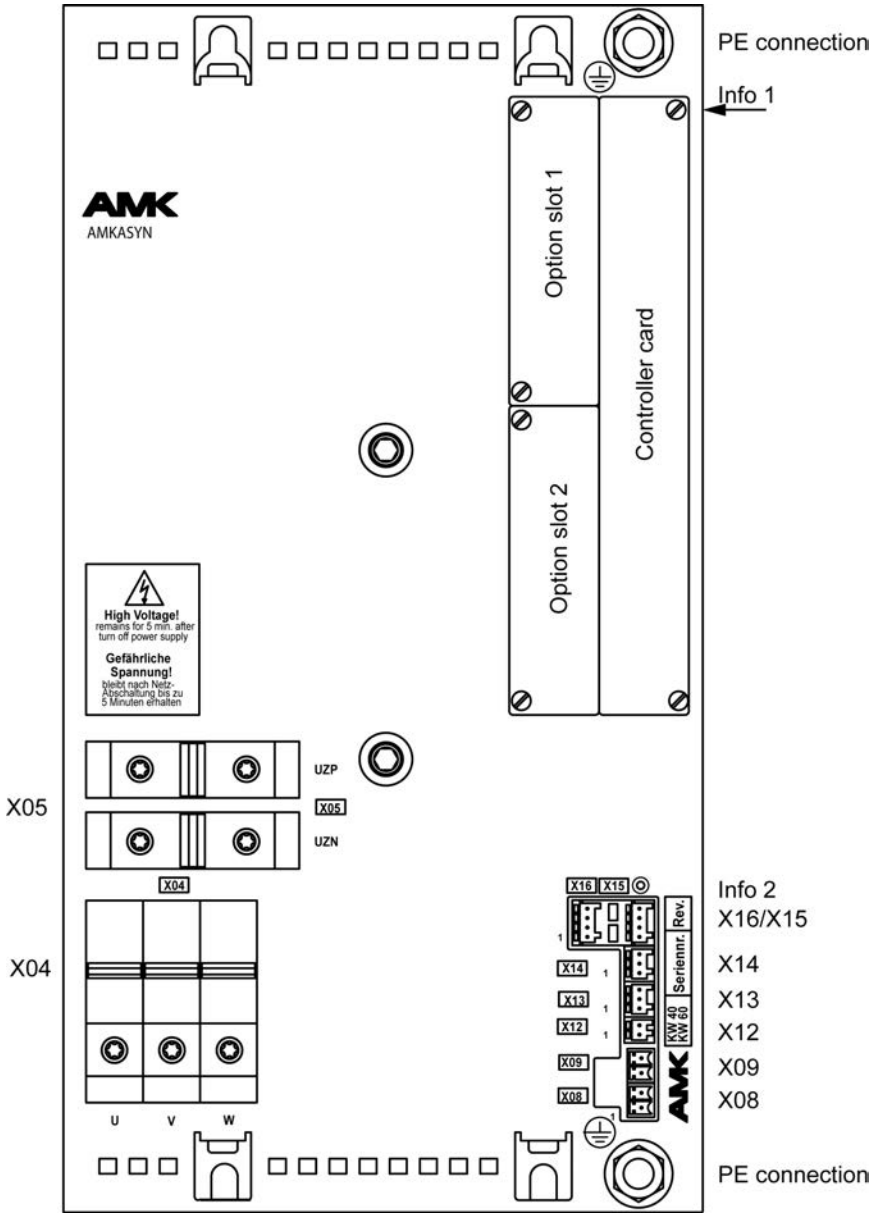


Compact inverter
KW 10, KW 20, KW 9-F



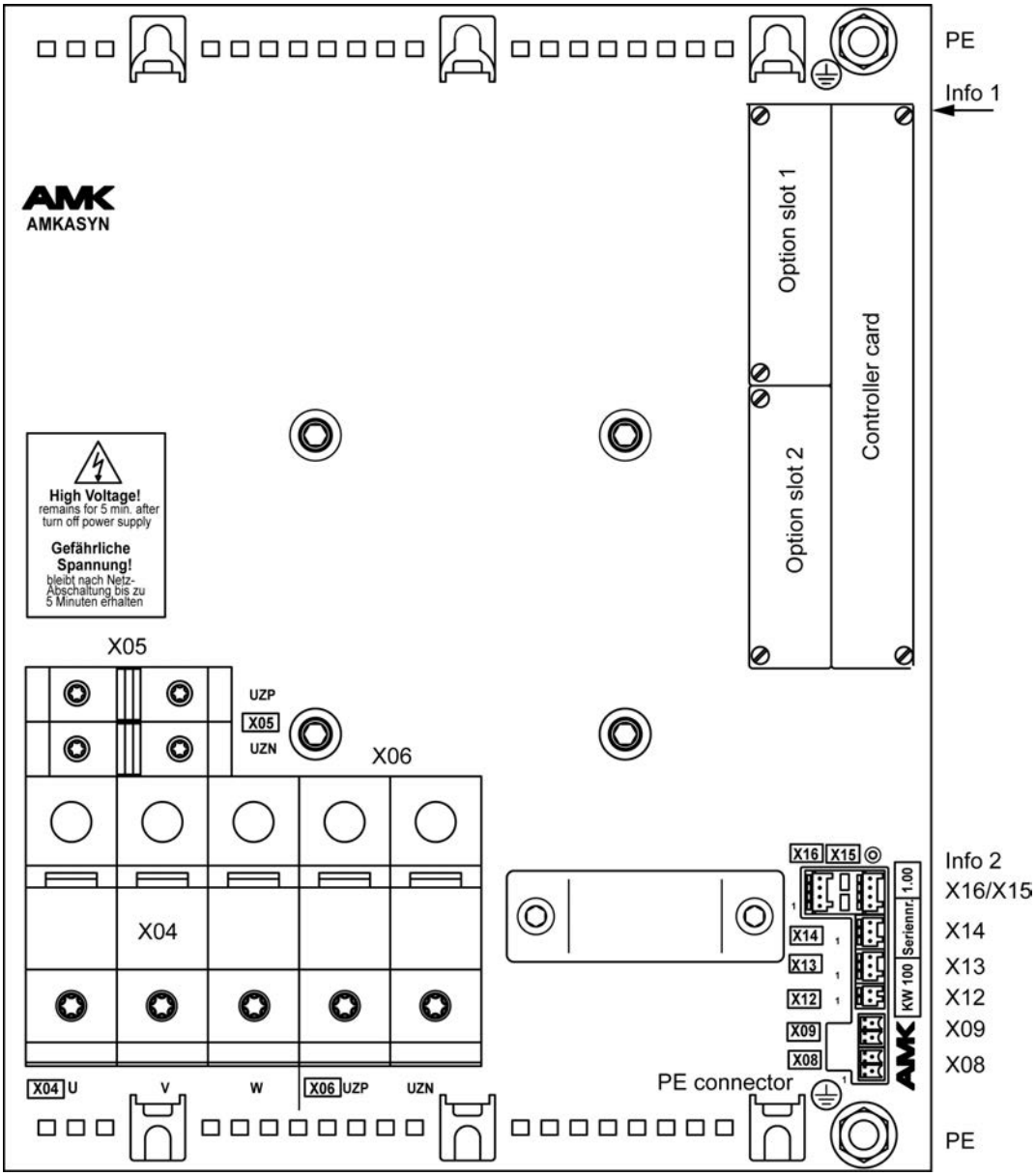
4.8.4 Front view KW: module width 170 mm

Compact inverter
KW 40, KW 60



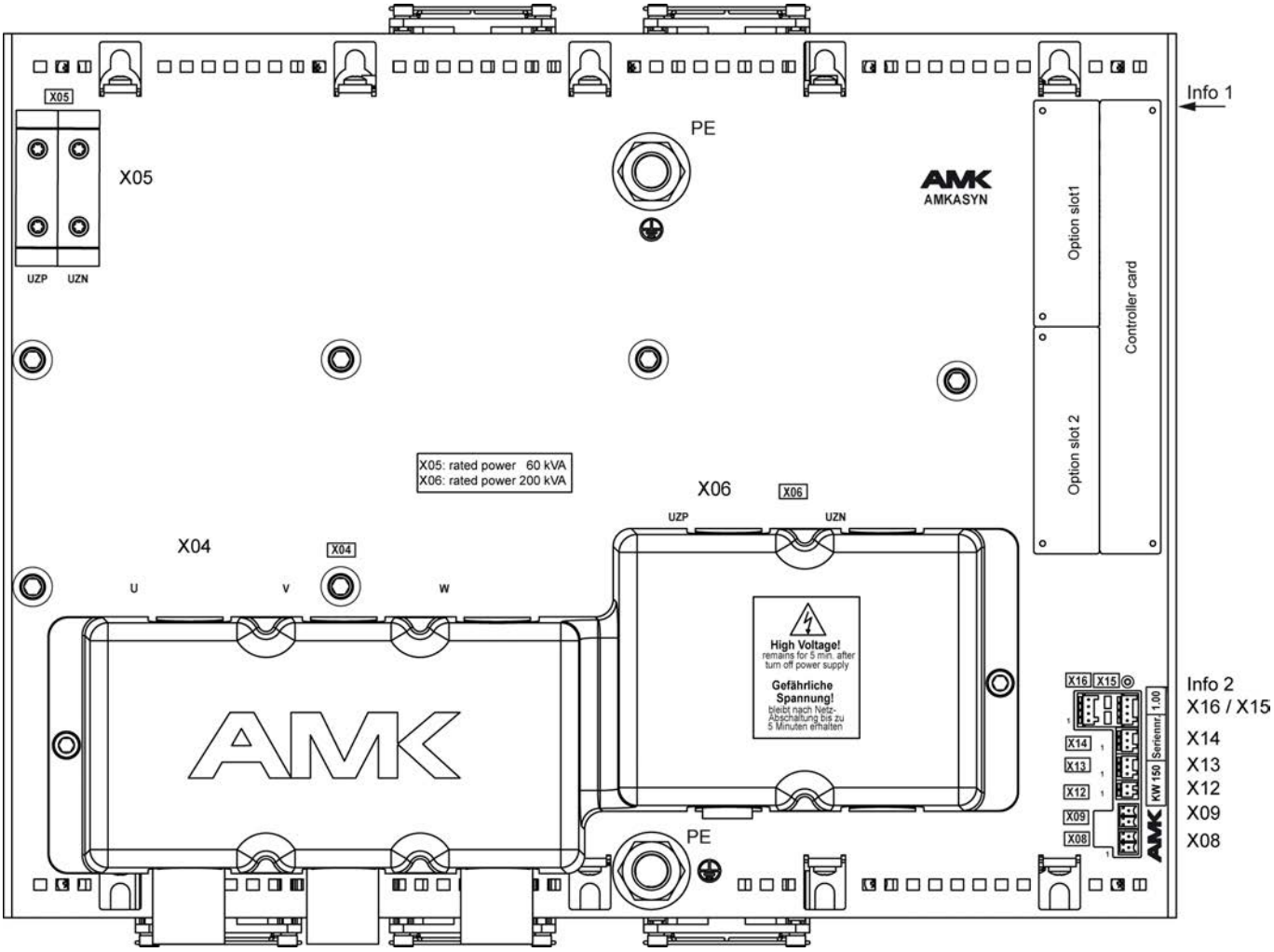
4.8.5 Front view KW: module width 255 mm

Compact inverter
KW 100



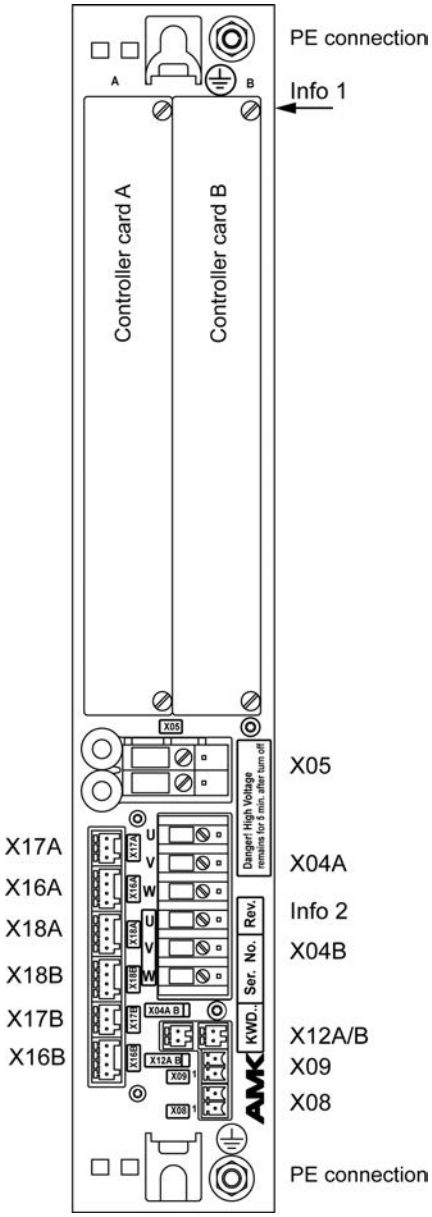
4.8.6 Front view KW: module width 425 mm

Compact inverter
KW 150, KW 200

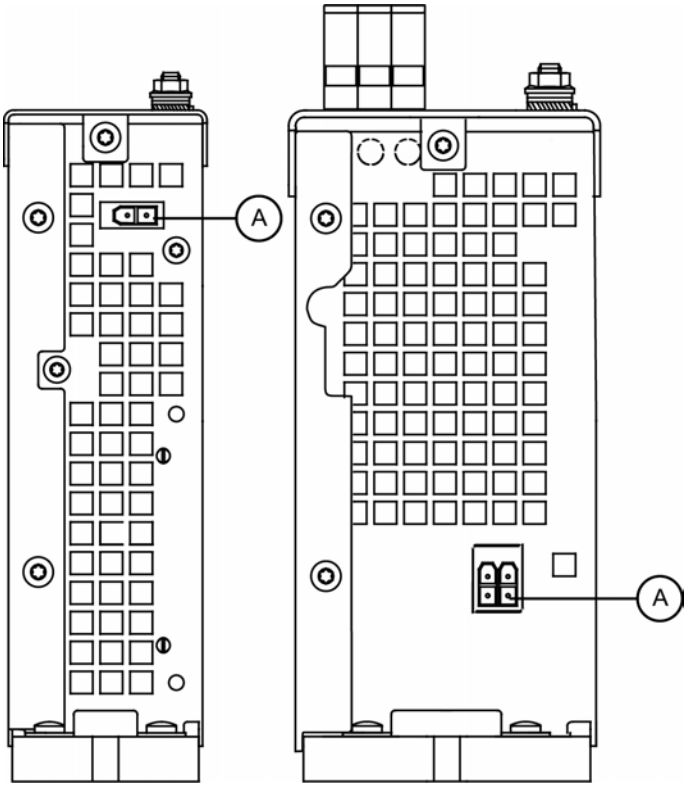


4.8.7 Front view KWD: module width 55 mm

Double inverter
KWD 1, KWD 2, KWD 5, KWD 1-F, KWD 2-F, KWD 4-F



4.8.8 View from below: compact inverter



Connection	Use
A	Internal AMK service interface

5 Projecting

5.1 Compatibility of controller cards

Device	Controller card												
	KW-R03	KW-R03P	KW-R04	KW-R05	KW-R06	KW-R07	KW-R16	KW-R17	KW-R24	KW-R24-R	KW-R25	KW-R26	KW-R27
KW2 KW2-F KW2-0N	■	■	■	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)
KW3	■	■	■	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)
KW4-F	■	■	■	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)
KW5 KW5-0N	■	■	■	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)
KW6-F	■	■	■	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)
KW8 KW8-0N	■	■	■	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)
KW 9-F	■	■	■	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)
KW 10	■	■	■	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)
KW 20	■	■	■	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)
KW 40	■	■	■	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)
KW 60	■	■	■	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)	■ 1)
KW 100	■	■	■	■ 2)	■ 2)	■ 2)	■ 2)	■ 2)	■ 2)	■ 2)	■ 2)	■ 2)	■ 2)
KW 150	-	-	-	■	■	■	■	■	■	■	■	■	■
KW 200	-	-	-	■	■	■	■	■	■	■	■	■	■
KWD 1 KWD 1-F KWD 1-0N	■	■	■	■ 1)	■ 1)	-	■ 1)	-	■ 1)	■ 1)	■ 1)	■ 1)	-
KWD 2 KWD 2-F KWD 2-0N	■	■	■	■ 1)	■ 1)	-	■ 1)	-	■ 1)	■ 1)	■ 1)	■ 1)	-
KWD 4-F	■	■	■	■ 1)	■ 1)	-	■ 1)	-	■ 1)	■ 1)	■ 1)	■ 1)	-
KWD 5	■	■	■	■ 1)	■ 1)	-	■ 1)	-	■ 1)	■ 1)	■ 1)	■ 1)	-

1) Compatibility from device version number 3.20
2) Compatibility from device version number 4.01

5.2 Notes on EMC-compatible switch cabinet construction

The EU Machine Directive requires the entire machine/system to comply with electromagnetic emissions limits (EMC). According to the Electromagnetic Compatibility Act ("EMV-Gesetz" in Germany), the system manufacturer and supplier bears the responsibility for the system's compliance with the maximum permissible values for electromagnetic emissions.

Here are some basic rules about the switch cabinet construction and wiring that help improve the EMC characteristics of the system:

- All machine and system parts (switch cabinet, switch cabinet doors, assembly panel, cooling back plate, PE bus bar, cable duct, machine bed, motor) have to be connected by short metallic connection with large contact surfaces or by stranded copper wire (for high frequency, low ohm, mixed as often as possible).
- Use metallic bare assembly panels and cable ducts.
- Contact points have to be bare and grease-free.
- Contact surfaces directly without lock washers etc.

- Power and signal cables need to be kept consistently separate from each other (minimum distance >20 cm), if necessary, install wide-surfaced, earthed separating sheets.
- Wire intersections should be done at right angles and at a distance.
- Avoid wire loops and lay out cables as close as possible to the reference potential PE (casing wall, metal. cable duct).
- Earth unassigned conductors.

- Always attach cable shields directly to casing inlets by flat shielding terminals, EMC-compliant cable screw connections or metal clamps.
- Shield connections by branch lines are not permitted.
- Fault-prone cables (motor cables, power cables, clocked electrical lines) should be kept as short as possible; always attach the cable shield at both ends to the reference potential PE.
- For sensitive process, control and sensor lines, use pair-stranded wiring with close-meshed, copper braided shield.

- Spatial separation of the sensors to modules with power electronics (converter, power supply unit, inductances, switching elements) and suitable wiring layout.
- The mains choke needs to be installed with a minimum distance of 80 mm to the Power supply/inverter module.
- In case there is not enough spatial separation (20 cm) between the shielded power cable and the cable of the filter load side and other fault-prone cables or components (motor cable, mains choke, contactor) a shielded line with shield support connected on both sides for the cable from the filter to the converter and if necessary, also shield the power cable in its course to the switch cabinet outlet (shield support connected on both sides).
- Switched inductances (contactors, solenoid valves) have to be interconnected with EMI suppressors.

EMC Filter (interference filters)

Due to the circuit principle, servo inverters generate radio interference voltages. The mains-borne interference levels remain below the legally permissible limits due to interference filters. Optimal performance of these filters is achieved only by proper, EMC-compliant installation, wiring, earthing and shielding. In the chapter 'Technical data - compact power supply' is specified, in which power supply an interference filter is integrated and to which power supply an external interference filter must be connected.

Siehe 'Mains filter AF' auf Seite 97.

5.3 Configuration of compact inverter KW

To determine the performance characteristics of the compact inverter KW, the maximum current drawn by the motor must be known.

Example:
DH10-40-4-I0F
Nominal current I_N: 15 A_{eff}
Maximum current (Imax): 50 A_{eff} for 3.6 Sekunden
Suitable inverter KW 20, rated output current I_N = 33 A, peak output current 66 A for 10 seconds
The inverter KW 20 provides sufficient power reserves for your application.

Optimised view:
Example:
A cycle consists of six second acceleration at 150% of the rated torque.
Stationary operation lasts for 50 seconds at 80% of the rated torque.
Braking lasts for six seconds at 150% of the rated torque.
Max. current (motor): 150 % I_N= 22.5 A
Stationary operation: 80 % of I_N=12 A
Effective value of current:
Suitable compact inverter KW10 (nominal current 16.5 A; max. current 33 A)

5.4 Configuration - compact power supply KE

Rough estimate:

Add all power ratings (kVA) of the compact inverter KW that will be connected to the compact power supply KE to be configured.
Select an appropriate compact power supply from the data sheets.

Example:
3 servo motors with P = 3 kW each in stationary operation
3 compact inverters KW5
KW 5 (5 kVA)+ KW 5 (5 kVA)+ KW 5 (5 kVA) = 15 kVA
Suitable compact power supply KE20
When using the rough estimate, you will receive a result that offers sufficient power reserves for your application.

Optimum configuration:

During configuration, please take into account the effective output and efficiency of the motors connected to the compact inverters KW.
With modular systems, you must observe the energy direction and concidence factor.

Example:
3 servo motors with P = 3 kW each in stationary operation; efficiency n=0.9
Max. 2 motors are operated for 50 seconds in stationary operation at one time.
When accelerating and braking, they require double the effective power for six seconds.

- Stationary operation:
  $P_{steady\ state} = \left(\frac{2 \cdot 3\ kW}{0,9}\right) = 6,67\ kW$
  Suitable compact power supply KE 10 (rated power 10 kW)
- Accelerating and braking each for six seconds:
  $P_{acceleration} = \left(\frac{2 \cdot 3\ kW \cdot 2}{0,9}\right) = 13,33\ kW$
  Suitable compact power supply KE 10 (max. output power 20 kW for 60 seconds)

- Effective value of output:

Suitable compact power supply KE 10 (rated power 10 kW)

5.5 DC bus capacity

DC bus capacity - compact power supply

	KEN 5 KEN 5-0N KEN 5-F KEN 5-FN KEN 5-S10	KEN 10 KEN 10-F	KE 10	KEN 20-0N	KE 20 KE 20-F	KE 20-0EU
C_Z [mF] internal	0.54	0.54	0.35	0.68	0.35	0.35
C_Z [mF] total	1.24	1.24	10.0	2.0	10.0	15.0
C_Z [mF] external	**0.7**	**0.7**	**9.65**	**1.32**	**9.65**	**14.65**

	KES 20 KES 20-0EU	KE 40	KE 40-0EU	KES 40-0EU	KEN 60 (KE 60-S4)	KE 60
C_Z [mF] internal	0.35	1.25	1.25	1.25	1.5	1.5
C_Z [mF] total	15.0	10.0	15.0	15	10.0	10.0
C_Z [mF] external	**14.65**	**8.75**	**13.75**	**13.75**	**8.5**	**8.5**

	KE 60-0EU	KES 60 KES 60-0EU	KEN 120	KE 120 KE 120-0EU	KES 120 KES 120-0EU
C_Z [mF] internal	1.5	1.5	2.5	2.5	2.5
C_Z [mF] total	15.0	15.0	20.0	20.0	20.0
C_Z [mF] external	**13.5**	**13.5**	**17.5**	**17.5**	**17.5**

	KE 180-0EU	KES 180-0EU
C_Z [mF] internal	4	4
C_Z [mF] total	20	20
C_Z [mF] external	**16**	**16**

DC bus capacity - compact inverter

	KW 2 KW 3 KW 5 KW 8	KW 2-F KW 4-F KW 6-F	KWD 1 KWD 2 KWD 5	KWD 1-F KWD 2-F KWD 4-F
C_Z [mF] internal	0.01	0.01	0.01	0.01

	KW 10	KW 20	KW 40	KW 60
C_Z [mF] internal	0.35	0.7	1.25	1.5

	KW 100	KW 150	KW 200
C_Z [mF] internal	2.5	4	5

5.5.1 Maximum DC Bus Capacity that can be Connected Externally to the KE

If the maximum external DC bus capacity permitted on the KE is exceeded. the charging of the DC bus cannot be terminated properly.

The DC bus capacity connected to the KE corresponds to the sum total of all capacities of the KW modules in the DC bus.

5.5.2 Inhibit Time for Control Signal UE (Converter ON)

To protect the charging device from thermal overload. a minimum inhibit time of 4 s has to be observed between two consecutive starting commands. The inhibit time T_S is calculated internally and is dependant on the capacity installed in the DC bus.

Inhibit time for devices < 120kW: T_S = 3 x (Sum C_Z [mF] of installed modules) in [s]
Inhibit time for devices ≥ 120kW: T_S = 4,5 x (Sum C_Z [mF] of installed modules) in [s]

The calculation of the inhibit time for devices ≥ 120kW will apply from the following hardware revision status.

Module	KEN 120	KE 120	KE 120-0EU	KES 120	KES 120-0EU
Rev. status	3.22	4.13	1.03	4.04	1.03
AMK part no.	E781	E856	E1040	E834	E987

Module	KE 180-0EU	KES 180-0EU
Rev. status	1.07	1.07
AMK part no.	E1060	E1061

For devices with an older hardware revision status will be applied with the following calculation.
Inhibit time: T_S = 3 x (Sum C_Z [mF] of installed modules) in [s]

By reading the parameter ID32903 'DC Bus on' you can evaluate. if the inhibit time has expired.
A DC Bus enable signal with a shorter time distance is not accepted and creates the diagnostic message 1047 'Inhibit time for UE'.

5.6 DC bus wiring

5.6.1 DC bus looping

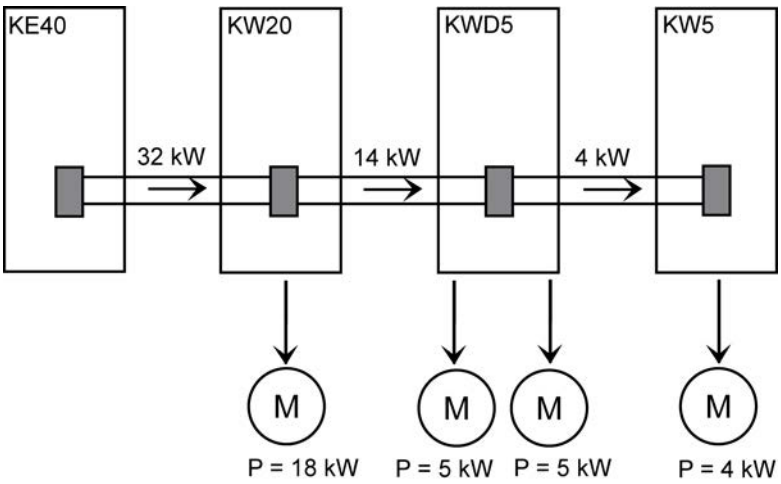
The connected rating of the KE/KW DC bus terminals is restricted. The limitation depends on the conductivity of the UZ terminals and the cross-section of the UZ connecting cable. The DC bus looping must be designed in that way, that the current load rating of the DC bus terminals and the DC bus cables cross section is exceeded at no place. The design has to be made application specific in consideration of the simultaneity factor with the expected loads in motor and generator operation mode. For the following it is provided that the inverters and the converters are sized to the application requirements and the simultaneity factor will be 1. The data about the maximum permitted connected load of the dc bus terminal excludes the rated power and the overload capacity of the converters.

Maximum connected load of the DC terminal

Module width	Terminal	Module name	Maximum permitted connected load of the DC bus terminal $P_{max, DC bus}$
55 mm	X02	KEN 5, KEN 5-F KEN 10, KEN 10-F	18 kW
	X02	KEN 5-0N, KEN 5-FN, KEN 5-S10	
	X05	KW 2, KW 3, KW 5, KW 8 KW 2-F, KW 4-F, KW 6-F KWD 1, KWD 2, KWD 5 KWD 1-F, KWD 2-F, KWD 4-F	
	X02	KEN 20-0N	35 kW
85 mm	X02	KE 10 KE 20, KE 20-F, KE 20-0EU, KES 20, KES 20-0EU	35 kW
	X05	KW 9-F KW 10, KW 20	

Module width	Terminal	Module name	Maximum permitted connected load of the DC bus terminal $P_{max, DC\ bus}$
170 mm	X02	KE 40, KE 40-0EU KES 40-0EU KEN 60 (KE 60-S4) KE 60, KE 60-0EU KES 60, KES 60-0EU	60 kW
	X05	KW 40, KW 60	
255 mm	X02 X06	KEN 120 KE 120, KE 120-0EU KES 120, KES 120-0EU	60 kW 100 KW
	X05 X06	KW 100	60 kW 100 KW
425 mm	X02 X06	KE 180-0EU, KES 180-0EU	60 kW 200 KW
	X05 X06	KW150, KW 200	60 kW 200 KW

Example 1: Device configuration with exemplary load



The following table shows how to check the load of each DC terminal:

Line		KE40	KW20	KWD5	KW5
1	**Maximum permitted connected load** of the DC bus terminal [kW] $P_{max, DC bus}$ (Values out of the prior table)	60	35	18	18
2	**Exemplary load** [kW] P(KE) = P(KW20) + P(KWD5) + P(KW5) 32 kW = 18 kW + 2 x 5 kW + 4 kW (Load values are exemplary designed)	32	18	2 x 5	4
3	**Module specific reserve capacity** of the DC bus terminal for looping [kW] **without** consideration of the prior modules Calculation: line 1 - line 2 Note: terminal has no overload, if $P_{max, DC bus}$ - exemplary load ≥ 0	60 - 32 = 28	35 - 18 = 17	18 - 2 x 5 = 8	18 - 4 = 14
4	**Maximum capacity reserve** of the DC bus terminal for looping [kW] with consideration of the prior modules Calculation: The exemplary load of the current modules (line 2) is subtracted from the capacity reserve of the prior module (line 4) Note: The terminal has no overload, if the calculated values ≥ 0	60 - 32 = 28	35 - 18 = 17	17 - 2 x 5 = 7	7 - 4 =3
5	**Real load** of the DC bus terminal for looping [kW]: Calculation: The real load of the DC bus terminal is the sum of the exemplary loads of the following modules (line 5) added to the exemplary load on the current module (line 2)	32	32 - 18 = 14	14 - 2 x 5 = 4	4 - 4 = 0
6	**Capacity reserve referred to the exemplary load** Calculation: capacity reserve (line 4) - real load of the DC bus terminal (line 5)	28	3	3	3

Summary of the results for this example:

The sum of the exemplary loads amounts 32 kW and can be supplied from KE40. The DC bus terminal at KW20 must absorb the 32 kW. The local motor needs 18 kW of the 32 kW input, 14 kW can be looped from the DC bus terminal to following modules. At maximum this terminal can loop 17 kW, so the is a capacity reserve of 3 kW.

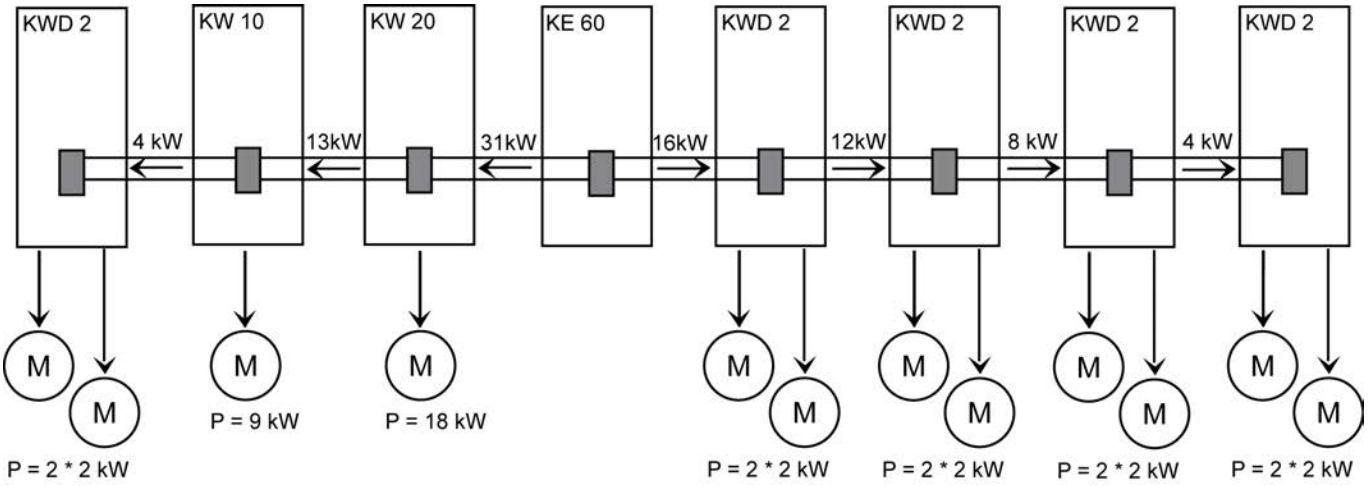
14 kW arrive at the KWD5 DC bus input terminal, the local motor needs 10 kW and therefor 4 kW are looped to the KW5. At the KW5 a capacyty reserve of 3 kW is available for a possible extension with a further module.

Example 2: Exceed of the maximum permitted connected load of the DC bus terminal

In this example the devices and the exemplary loads are selected in that way, that the DC bus terminals become overload if the DC bus is looped in a serial line through all modules. 2 possible solutions are presented following:

Solution 1:

The DC bus terminals of a KE module can be started from both sides. This makes it possible to evenly distribute the required output.

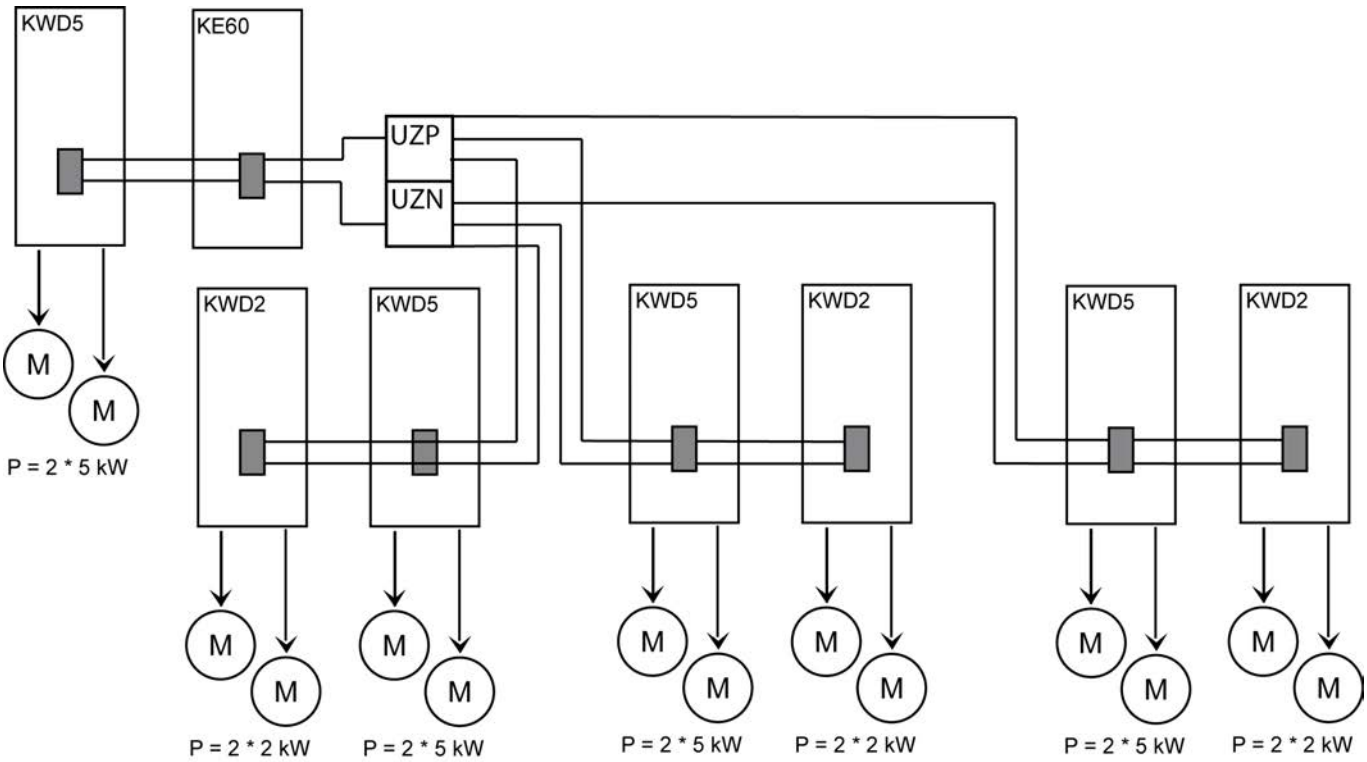


Line		KWD2	KW10	KW20	KE60	KWD2	KWD2	KWD2	KWD2
1	**Maximum permitted connected load** of the DC bus terminal [kW] $P_{max, DC bus}$ (Values out of the prior table)	18	35	35	60	18	18	18	18
2	**Exemplary load** [kW] P(KE) = P(KW20) + P(KWD5) + P (KW5) 32 kW = 18 kW + 2 x 5 kW + 4 kW (Load values are exemplary designed)	2 x 2	9	18	47	2 x 2	2 x 2	2 x 2	2 x 2
3	**Module specific reserve capacity** of the DC bus terminal for looping [kW] **without** consideration of the prior modules Calculation: line 1 - line 2 Note: terminal has no overload, if $P_{max, DC bus}$ - exemplary load ≥ 0	14	26	17	13	14	14	14	14
4	**Maximum capacity reserve** of the DC bus terminal for looping [kW] with consideration of the prior modules Calculation: The exemplary load of the current modules (line 2) is subtracted from the capacity reserve of the prior module (line 4) Note: The terminal has no overload, if the calculated values ≥ 0	4	8	17	13	14	10	6	2

Line		KWD2	KW10	KW20	KE60	KWD2	KWD2	KWD2	KWD2
5	**Real load** of the DC bus terminal for looping [kW]: Calculation: The real load of the DC bus terminal is the sum of the exemplary loads of the following modules (line 5) added to the exemplary load on the current module (line 2)	0	4	13	47	12	8	4	0
6	**Capacity reserve referred to the exemplary load** Calculation: capacity reserve (line 4) - real load of the DC bus terminal (line 5)	4	4	4	13	2	2	2	2

Solution 2:

Distribute the DC bus voltage radially via a terminal block to the compact inverter.



5.6.2 DC Bus Cable Sets

All KW modules up to module width 255 mm come standard with UZ cables that are longer than the length of the module itself.

The DC bus voltage is supplied to the KWD, KWZ and KWZ devices via integrated cable strands (UZP: red, UZN: blue, AWG 10). The length of the cables is selected to allow devices to be connected to an upstream 170 mm module.

NOTICE	
Material Damage!	**Material damage caused by incorrect assembly!** When connecting to a smaller, narrower module, the protruding cord may not be inserted into the KWD, KWZ or KWF module. That could cause damage to the cord's insulation.

In the table below you will also set DC bus connections between 55mm / 170 mm and 170mm / 425 mm devices.
Only use AMK UZ cable set!

AMK Part number	UZ cable set	Cable set length [mm]	Cable cross-section	Device connection	Max. continuous power rating
46621	KW-UZ 55	180	4 mm^2 AWG10	55 mm and 55 mm 55 mm and 85 mm 55 mm and 170 mm	18 kW
47546	KW-UZ 55/2	180	4 mm^2 AWG10	**only for KEN 5-xN /-S10:** 55 mm and 55 mm 55 mm and 85 mm	
46620	KW-UZ 85	44	10 mm^2 AWG6	85 mm and 85 mm	35 kW
46376	KE-UZ 170	114	10 mm^2 AWG6	170 mm and 85 mm	35 kW
46622	KW-UZ 170	114	25 mm^2 AWG2	170 mm and 170 mm	60 kW
46975	KE-UZ 255	350	25 mm^2 AWG2	255 mm and 170 mm	60 kW
47794	UZ 600	600	25 mm^2 AWG2	255 mm and 170 mm 425 mm and 255 mm 425 mm and 425 mm	60 kW
46908	KW-UZ 255	380	50 mm^2 AWG1/0	255 mm and 255 mm	100 kW
on request				425 mm and 255 mm 425 mm and 425 mm	200 kW

Combinations with KE 120

AMK Part number	UZ cable set	KEN 120 KE 120, KE 120-0EU KES 120, KES 120-0EU (255 mm)	KW100 (255 mm)	KW40, KW60 (170 mm)
46908	KW-UZ 255	Terminal X06	Terminal X06	
46622	KW-UZ 170	Terminal X02	Terminal X05	
46622	KW-UZ 170	Terminal X06		Terminal X05
47794	UZ 600	Terminal X06		Terminal X05

Combinations with KE 180

AMK Part number	UZ cable set	KE 180, KE 180-0EU KES 180, KES 180-0EU (425 mm)	KW100 (255 mm)	KW 150 (425 mm)	KW 200 (425 mm)
47794	UZ 600	Terminal X02	Terminal X05	Terminal X05	Terminal X05
on request		Terminal X05	Terminal X06	Terminal X06	Terminal X06

Extension of UZ cable set

Where required, KE/KW devices can also be positioned with a distance between them or on top of each other. The connection for DC bus voltage UZ must be kept as short as possible in this configuration (max. length: 1 m).

If it is not possible to route the DC bus cable separately from the signal lines, shielded cables must be used. The shield should be earthed on both sides using shielding terminals KP-SK. The maximum wire cross-section that can be connected to the DC bus terminals X02 and X05 must be selected for this extension cable.

Shielded single conductors with cross-sections up to 300 mm^2(type ÖLFLEX-FD 90 CY; black) are available from LAPP KABEL.

Recommendation: Labelling of lines to ensure correct allocation to UZP/UZN.

5.6.3 Connection to modules of the decentralised drive technology

In order to connect modules of the decentralised drive technology (iX, iDT) to the compact power supplies, special types of cables are necessary.

See document: device description Decentralized drive technology iC / iX / iDT5 (AMK part no. 203445)

5.7 Supply voltage 24 VDC

NOTICE	
Material Damage!	**Overload of the terminal and the internal circuit board!** The connected rating of the terminals X08, X09 is restricted. The terminals X08 or X09 are designed for a current of at most 8 A. **Steps to prevent:** • A looping of the 24 VDC supply voltage is permitted for a total of 5 modules at the most. • If more than 5 devices are installed, each group of five needs to be supplied separately with 24 VDC.

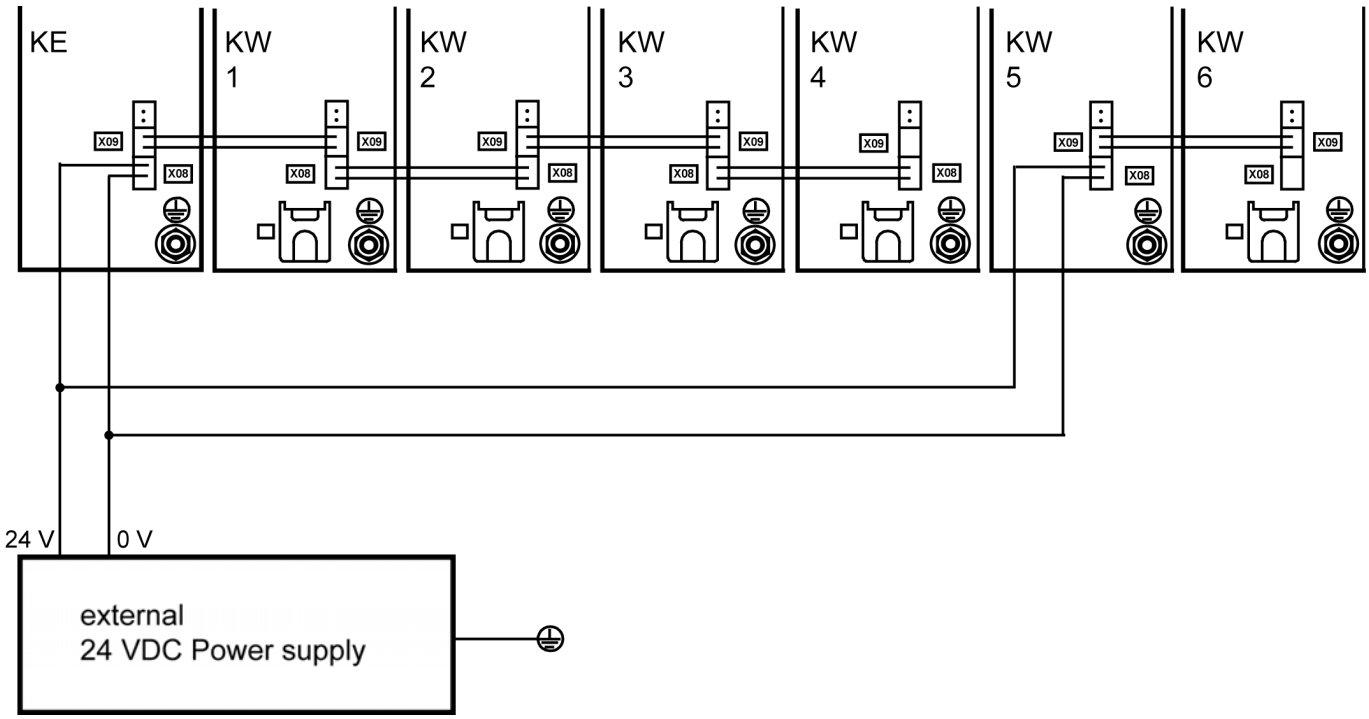
The 24 VDC supply voltage of the KE/KW system must be provided by an external power supply unit. A failure of the 24 VDC supply voltage lasting 10 ms causes a fault; the main contactor fails and the servo motors coast to stop. When using an uninterrupted power supply (UPS), the device logic is also supplied with power during a mains failure. This makes it possible to perform a controlled braking of the servo motors.

Prerequisite (power supply unit):

24 VDC ± 15% Power supply unit with potential separation according to VDE 0160.

Ripple max. 5%, with integrated switch-on current limitation.

The 0 V potential of the power supply unit should be earthed at the central PE.



5.8 Module cooling

NOTICE	
Material Damage!	**Material damage due to impure air!** If the fed-in air contains moisture, electrically conductive dust, fibres, gases, vapours ... short circuits can occur. **Steps to prevent:** • Use dehumidifiers and filters

In the case of cold plate modules, the power loss of the power electronics is discharged through the rear panel of the module. Liquid-cooled cold plates or heat sinks with an air-cooling system are available as cooling systems. The air cooling system is mainly suitable for devices with low rated power. If devices with higher rated power are operated air-cooled, the performance data may need to be reduced (derating).
Air-cooled modules with an integrated air-cooling system do not require an external cooling system.

The power loss of the electronics (controller card, internal power supply units, etc.) generates heat which can not be dissipated over the cooling back plate, but must be removed via the control cabinet cooling. The modules are equipped with an internal fan. Make sure sufficient air circulation is possible.
At least 100 mm of space must be free above and below the modules.

An air temperature of 0 °C - max. 40 °C on the bottom of the device is permitted.
The air temperature in the switch cabinet must be < 40 °C.
The temperature of the liquid- or air-cooled cold plate must be < 40 °C. Do not allow condensation to form.
It is recommended to maintain the temperature of the cold plate at a value $T_{ambient} < T_{cold\ plate} < 40$ °C by means of a cooling unit.

5.8.1 Power loss (configuration of cooling system)

Use the table to find the total power losses that must be dissipated over the cooling back plate as heat while the system is running. When running the KW modules in alternating operation, the coincidence factor must be factored in when calculating the power loss. The power losses of the power electronic are approximately linear to the rated current. Additionally the power losses of the electronics have to be removed with the cabinet cooling. The power losses of the electronic are nearly independently of the rated current.

5.8.1.1 Power loss with cold plate modules

The power losses are based on the operating point:

KW, KWD, KWZ:	$U_{DC\ bus}$ = 540 VDC, U_{Motor} = 3 x 350 VAC, f_{PWM} = 8 kHz
KE:	$U_{power\ supply}$ = 3 x 400 VAC, U_Z = 540 VDC
KES:	$U_{power\ supply}$ = 3 x 400 VAC, U_Z = 720 VDC, f_{PWM} = 8 kHz

Compact power supplies

Module	KEN 5	KEN 5-0N KEN 5-S10	KEN 10	KE 10	KEN 20-0N
Power loss at P_N [W]	25	25	40	70	75
Power loss of electronics [W]	25	10	25	15	15

Module	KE 20 KE 20-0EU	KES 20 KES 20-0EU	KE 40 KE 40-0EU	KES 40-0EU	KEN 60(KE 60-S4)
Power loss at P_N [W]	130	359	240	570	240
Power loss of electronics [W]	20	45	35	65	50

Module	KE 60 KE 60-0EU	KES 60 KES 60-0EU	KEN 120	KE 120 KE 120-0EU	KES 120 KES 120-0EU
Power loss at P_N [W]	350	876	520	780	1926
Power loss of electronics [W]	50	95	50	50	150

Module	KE 180-0EU	KES 180-0EU
Power loss at P_N [W]	1025	3500

Module	KE 180-0EU	KES 180-0EU
Power loss of electronics [W]	110	280

Compact inverters

Module	KW 2	KW 3	KW 5	KW 8	KW 10
Power loss at P_N [W]	30	43	80	128	200
Power loss of electronics [W]	17	18	20	23	40

Module	KW 20	KW 40	KW 60
Power loss at P_N [W]	333	590	950
Power loss of electronics [W]	50	100	130

Module	KW 100	KW 150	KW 200
Power loss at P_N [W]	8 kHz: 1800 4 kHz: 1250	8 kHz: 2900 4 kHz: 1900	8 kHz: 4000 4 kHz: 2500
Power loss of electronics [W]	150	250	330

Module	KWD 1	KWD 2	KWD 5
Power loss at P_N [W]	2 x 13	2 x 30	2 x 75
Power loss of electronics [W]	25	28	37

5.8.1.2 Power loss for air-cooled modules

The power losses are based on the operating point:

KW, KWD, KWZ: $U_{DC\ bus}$ = 540 VDC, U_{Motor} = 3 x 350 VAC, f_{PWM} = 8 kHz

KE: $U_{power\ supply}$ = 3 x 400 VAC, U_Z = 540 VDC

KES: $U_{power\ supply}$ = 3 x 400 VAC, U_Z = 720 VDC, f_{PWM} = 8 kHz

.

With modules that feature an integrated air-cooling system, the total power loss must be removed by the cabinet cooling.

Compact power supplies

Module	KEN 5-F	KEN 5-FN	KE 20-F
Power loss at P_N [W]	25	35	130
Power loss of electronics [W]	25	10	20
Power loss P_{Ges}	50	45	150

Compact inverters

Module	KW 2-F	KW 4-F	KW 6-F	KW 9-F
Power loss at P_N [W]	30	60	97	180
Power loss of electronics [W]	24	24	28	40
Power loss P_{Ges}	54	84	125	220

Module	KWD 1-F	KWD 2-F	KWD 4-F
Power loss at P_N [W]	2 x 13	2 x 30	2 x 60
Power loss of electronics [W]	28	28	30
Power loss P_{Ges}	54	88	150

5.8.2 Liquid cooling

5.8.2.1 Requirements for cooling circuit

When these requirements are fulfilled, the maximum permissible surface temperature of 40 °C is not exceeded when the power losses specified above are deducted:

- Closed water circuit
- Before starting the machine or system, the operator must check the cooling circuit for leaks in acc. with EN50178.
- Water flow quantity approx. 10 l/min
- Water pressure 1.5 bar (test pressure for plate 8 bar)
- Water temperature at inlet < 30 °C
  The user must take the necessary measures in the cooling circuit to ensure that the coolant does not cause the temperature of the cold plate to fall below the dew point. Do not allow condensation to form.

The following reference values are valid for the properties of the circulating water:

pH value 7 - 9

electr. conductivity < 300 mS/m

A corrosion inhibitor (e.g., Nalco 77381 made by Nalco Deutschland GmbH) must be added to the coolant. The dosage and other data on water quality can be found in the product data sheets from the inhibitor supplier.

The rear panel is made of an aluminium composite ALMgSi0.5.

Use the same type of material materials if possible for the water circuit.

5.8.2.2 Dew point table

NOTICE	
Material Damage!	**Material damage when dew forms!** Dew may result in electrical shorts. **Steps to prevent:** • Observe the dew point table! • Keep the switch cabinet doors closed when in operation! • Switch off the cooling circuit when the systems are idle! • Check the temperature of the coolant after longer downtimes (cold production plants)! • At high levels of humidity, it is recommended to use a dehumidifier!

The dew point table specifies at which surface temperature condensate forms. This depends on the temperature of the air and the relative humidity.

Dew point table in °C

Example: Ambient temperature: 32 °C, humidity: 60 %
The temperature of the cooling circuit may not be less than 23 °C, else condensate will form!

Ambient air temperature in °C	Dew point in °C at a relative humidity of										
	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%
2	-7.70	-6.26	-5.43	-4.40	-3.16	-2.48	-1.77	-0.98	-0.26	0.47	1.20
4	-6.11	-4.88	-3.69	-2.61	-1.79	-0.88	-0.09	0.78	1.62	2.44	3.20
6	-4.49	-3.07	-2.10	-1.05	-0.08	0.85	1.86	2.72	3.62	4.48	5.38
8	-2.69	-1.61	-0.44	0.67	1.80	2.83	3.82	4.77	5.66	6.48	7.32
10	-1.26	0.02	1.31	2.53	3.74	4.79	5.82	6.79	7.65	8.45	9.31
12	0.35	1.84	3.19	4.46	5.63	6.74	7.75	8.69	9.60	10.48	11.33
14	2.20	3.76	5.10	6.40	7.58	8.67	9.70	10.71	11.64	12.55	13.36
15	3.12	4.65	6.07	7.36	8.52	9.63	10.70	11.69	12.62	13.52	14.42
16	4.07	5.59	6.98	8.29	9.47	10.61	11.68	12.66	13.63	14.58	15.54
17	5.00	6.48	7.62	9.18	10.39	11.48	12.54	13.57	14.50	15.36	16.19
18	5.90	7.43	8.83	10.12	11.33	12.44	13.48	14.56	15.41	16.31	17.25
19	6.80	8.33	9.75	11.09	12.26	13.37	14.49	15.47	16.40	17.37	18.22
20	7.73	9.30	10.72	12.00	13.22	14.40	15.48	16.46	17.44	18.36	19.18
21	8.60	10.22	11.59	12.92	14.21	15.36	16.40	17.44	18.41	19.27	20.19
22	9.54	11.16	12.52	13.89	15.19	16.27	17.41	18.42	19.39	20.28	21.22
23	10.44	12.02	13.47	14.87	16.04	17.29	18.37	19.37	20.37	21.34	22.23
24	11.34	12.93	14.44	15.73	17.06	18.21	19.22	20.33	21.37	22.32	23.18
25	12.20	13.83	15.37	16.69	17.99	19.11	20.24	21.35	22.27	23.30	24.22
26	13.15	14.84	16.26	17.67	18.90	20.09	21.29	22.32	23.32	24.31	25.16
27	14.08	15.68	17.24	18.57	19.83	21.11	22.23	23.31	24.32	25.22	26.10
28	14.96	16.61	18.14	19.38	20.86	22.07	23.18	24.28	25.25	26.20	27.18
29	15.85	17.58	19.04	20.48	21.83	22.97	24.20	25.23	26.21	27.26	28.18
30	16.79	18.44	19.96	21.44	23.71	23.94	25.11	26.10	27.21	28.19	29.09
32	18.62	20.28	21.90	23.26	24.65	25.79	27.08	28.24	29.23	30.16	31.17
34	20.42	22.19	23.77	25.19	26.54	27.85	28.94	30.09	31.19	32.13	33.11
36	22.23	24.08	25.50	27.00	28.41	29.65	30.88	31.97	33.05	34.23	35.06
38	23.97	25.74	27.44	28.87	30.31	31.62	32.78	33.96	35.01	36.05	37.03
40	25.79	27.66	29.22	30.81	32.16	33.48	34.69	35.86	36.98	38.05	39.11
45	30.29	32.17	33.86	35.38	36.85	38.24	39.54	40.74	41.87	42.91	44.03
50	34.76	36.63	38.46	40.09	41.58	42.99	44.33	45.55	46.75	47.90	48.98

The interior of the switch cabinet forms the ambient of the KE/KW modules.

5.9 Maximum generative brake energy

Compact power supply units with regenerative feedback (KE/KES) can also feed back the maximum output power regeneratively into the mains supply.

The maximum generative power that can dissipated into an external brake resistor is limited. It is calculated based on the brake threshold (800 V in the DC bus) and the minimum possible brake resistance value that can be connected to the compact power supply.

Example:

How high is the maximum generative output that a KE 120 can dissipate into an external brake resistor?

The minimum possible value for a brake resistor to a KE 120 is 8 ohm.

Accordingly, max. 80 kW can be dissipated into an external brake resistor.

$$P_{max} = R \cdot \left(\frac{U}{R}\right)^2 = 8\ \Omega \cdot \left(\frac{800\ V}{8\ \Omega}\right)^2 = 80\ kW$$

5.10 Maximum available ACC bus length

Compact power supplies with ACC bus interface are connected using firewire cables.

The ACC bus is based on the CAN bus.

The cable length is based on the transfer rate and the number of nodes in use (CAN bus subscribers). To determine the max. cable length, all delay times must be converted into meters.

For a CAN-compliant cable, 5 ns corresponds to 1 m.

For cables that do not comply with the CAN standard, the maximum cable length can be reduced to 25 m.

When calculating the maximum cable length, it is necessary to initially estimate the maximum possible cable length in relation to the transfer rate.

Transfer rate	Max. cable length
1000 kBit/s	38 m
500 kBit/s	80 m
250 kBit/s	164 m
125 kBit/s	332 m

This table already includes the times for bus accesses by the transmitter and receiver.

The cable length is also reduced by the inductances and capacities of the CAN nodes. A length of 0.5 m must be deducted for each CAN node.

To determine the total cable length, you need to subtract the length of the CAN node from the maximum cable length specified in the table above. Example:

Example:

Transfer rate 500 kBit/s	80 m
15 KWs and 1 KE = 16 device at 0.5 m each	- 8 m
Max. bus length	72 m

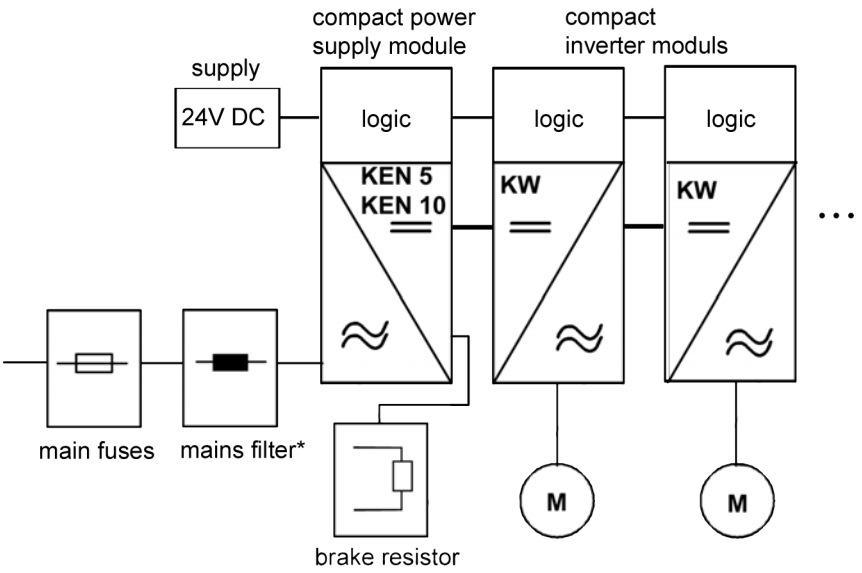
- All of the information above correspond to theoretical values and may be different in practice, in particular due to insufficient cables. Verify the aforementioned values by performing the applicable tests.
- The values above do not include any margin of error. Include a margin of error of at least 20% in your configuration.

6 System structure and accessories

6.1 System structure KEN 5 (-F, -xN, -S10), KEN 10(-F) and KEN 20-0N

System structure KEN 5 (-F) and KEN 10(-F)

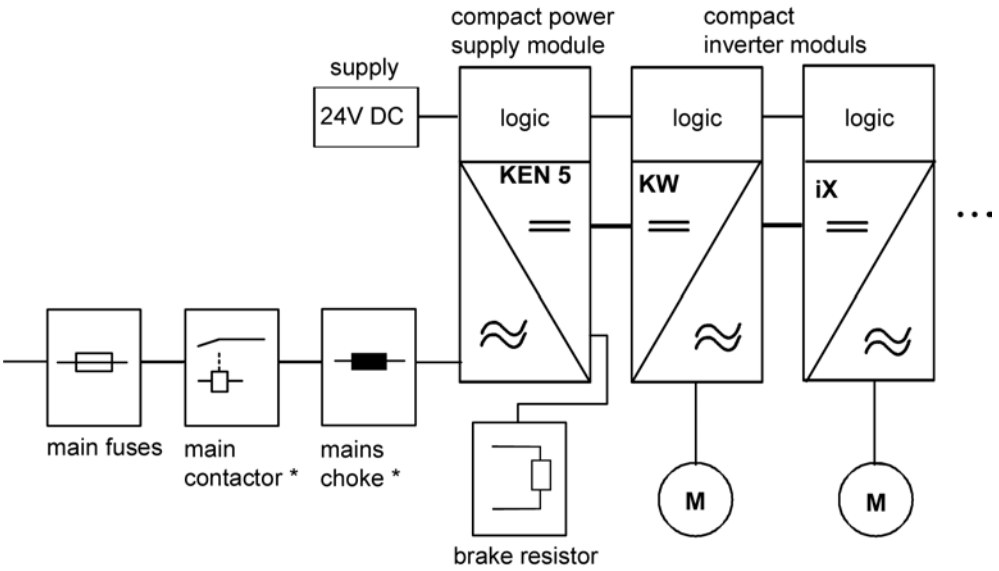
The image shows the system structure and the accompanying switch-on components when using a KEN 5(-F,) or a KEN 10(-F).



* The compact power supplies KEN 5 and KEN 5-F do not require an external mains choke.

System structure KEN 5-xN

The image shows the system structure and the accompanying switch-on components when using a KEN 5-xN.

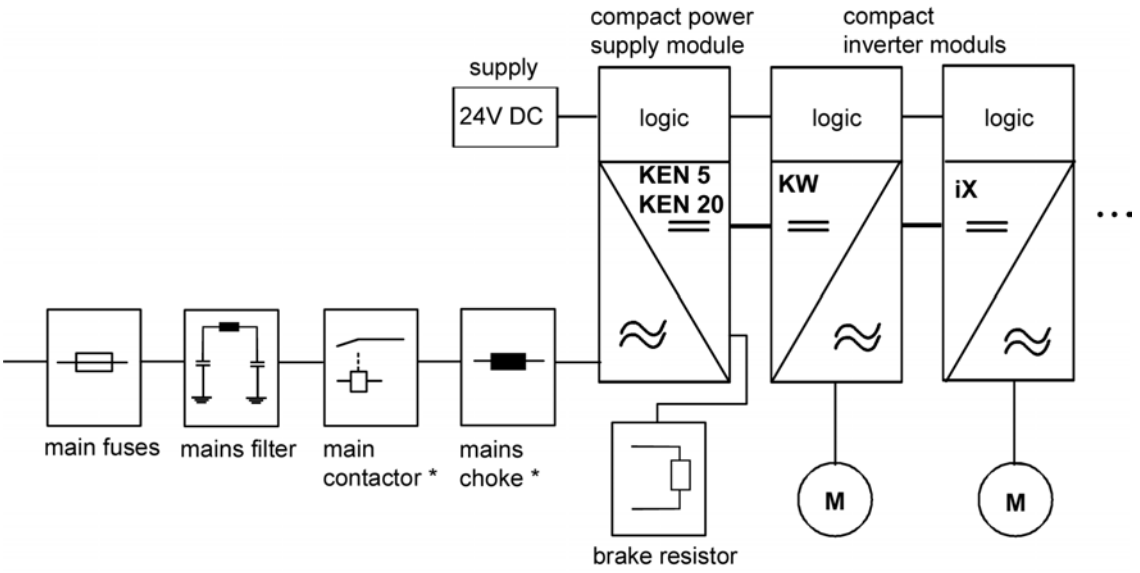


*) The compact power supplies KEN 5-xN has no opportunity to switch off the power supply voltage. When required use a external main contactor(EN 60204-1).

A mains choke can optionally be used with a KEN 5-0N.

System structure KEN 5-S10 and KEN 20-0N

The image shows the system structure and the accompanying switch-on components when using a KEN 5-S10 or KEN 20-0N.

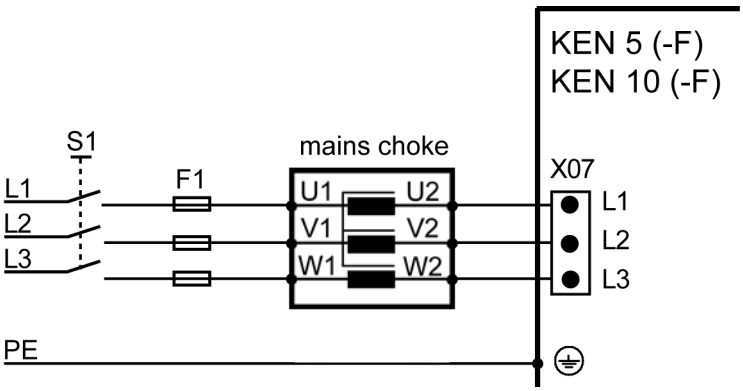


*) The compact power supplyies KEN 5-S10 and KEN 20-0N have no opportunity to switch off the power supply voltage. When required use a external main contactor (EN 60204-1).
A mains choke can optionally be used with a KEN 5-S10.

6.2 Switch-on components and mains supply KEN 5(-F, -xN, -S10), KEN 10(-F) and KEN 20-0N

KEN 5(-F) and KEN 10(-F)

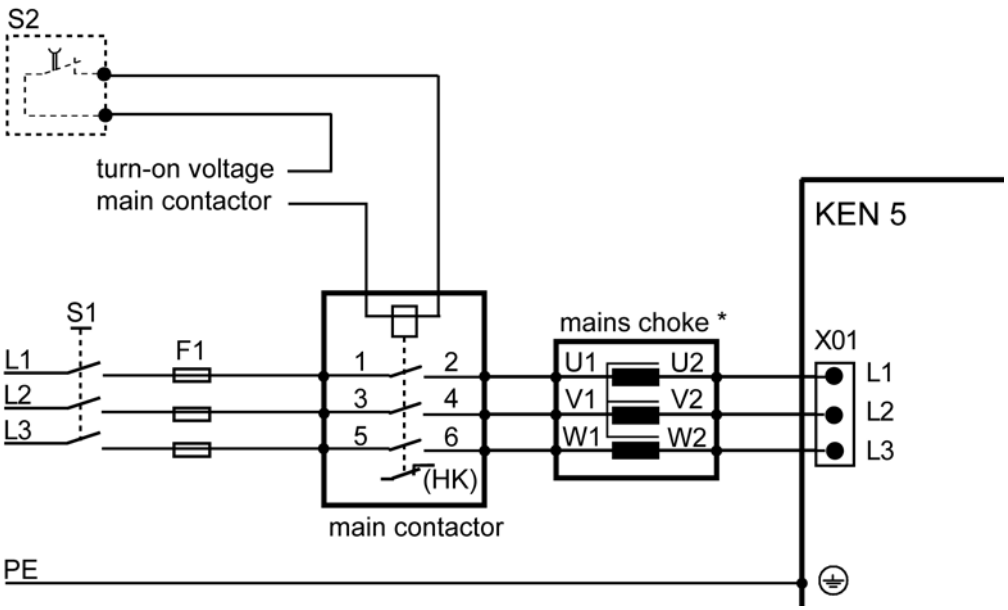
Power is supplied to the compact power supply unit via terminal X07.
The main contactor and mains filter are pre-installed on the module. A mains choke is only required for a KEN 10(-F).
After connecting the control signal UE (Converter on) and if the DC bus capacitors are loaded, the KE module closes the integrated main contactor.



Module name	Description	
L1, L2, L3, PE	Mains supply	
S1	Main contactor	
F1	Main fuse	
Mains choke	Reduction of induced distortion on the mains and improvement of power factor The compact power supply KEN 5(-F) does not require an external mains choke.	
	X01 -U1 -V1 -W1	Mains-side connection -line phase L1 -line phase L2 -line phase L3
	X02 -U2 -V2 -W2	Load-side connection -line phase L1 -line phase L2 -line phase L3
KEN	Compact power supply without feedback	
	X07 -L1, L2, L3	Mains supply (supply for DC bus)

KEN 5-0N and KEN 5-FN

Power is supplied to the compact power supply unit via terminal X01.
The mains filter is pre-installed on the module. A main contactor must be connected externally. A mains choke can optionally be used with a KEN 5-0N.
The switch voltage for the contactor (24V DC or 24V...230V AC, depending on contactor version) must be provided by the user.
The switch voltage for the main contactor is set on the protective conductor.
The DC bus is now directly fed from the line through the main contactor and mains choke.
If necessary, the user can externally interrupt the control of the main contactor (S2), e.g. to separate the drive system power-sided from the line in case of an emergency stop (for further information: Siehe 'Pulse diagram EMERGENCY STOP' auf Seite 186.).
The auxiliary contact HK (NC) allows the user to monitor the switch status of the main contactor.

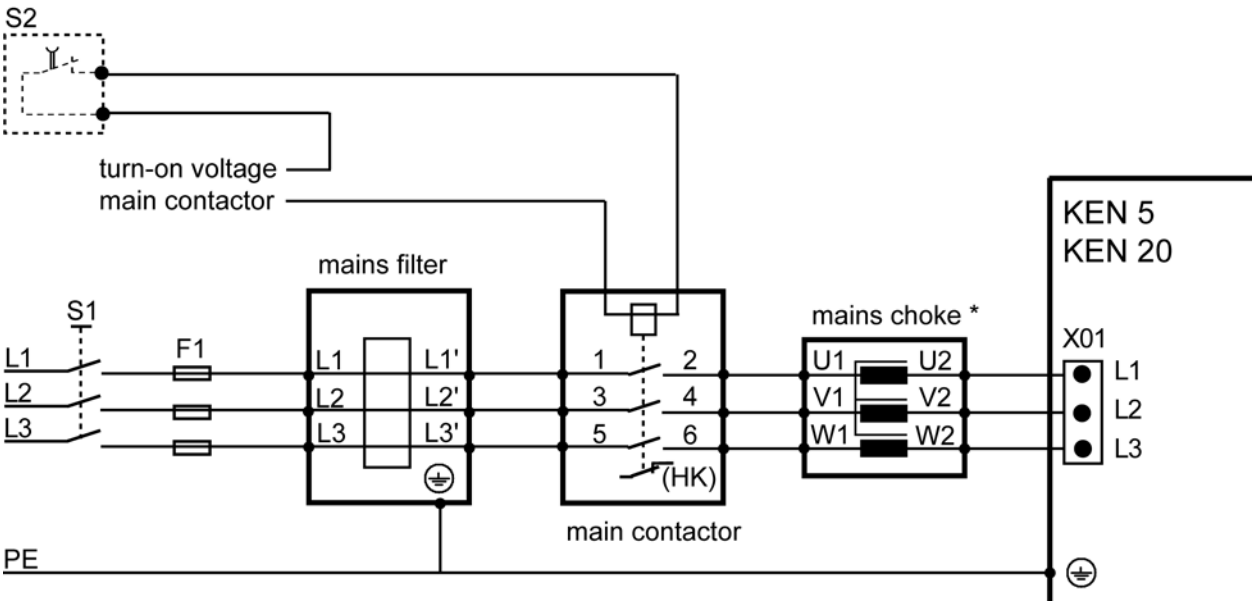


Module name	Description
L1, L2, L3, PE	Mains supply
S1	Main contactor
F1	Main fuse
S2	If necessary: External safety circuit for main contactor OFF

Module name	Description	
Main contactor		
	Main contacts -1 L1 -3 L2 -5 L3	Mains-side connection -line phase L1 -line phase L2 -line phase L3
	Main contacts -2 T1 -4 T2 -6 T3	Load-side connection -line phase L1 -line phase L2 -line phase L3
	HK (help contact)	Option for monitoring switch status
Mains choke	Reduction of induced distortion on the mains and improvement of power factor *Can optionally be used with a KEN 5-0N.	
	X01 -U1 -V1 -W1	Mains-side connection -line phase L1 -line phase L2 -line phase L3
	X02 -U2 -V2 -W2	Load-side connection -line phase L1 -line phase L2 -line phase L3
KEN	Compact power supply without feedback	
	X01 -L1, L2, L3	Mains supply (supply for DC bus)

KEN 5-S10 and KEN 20-0N

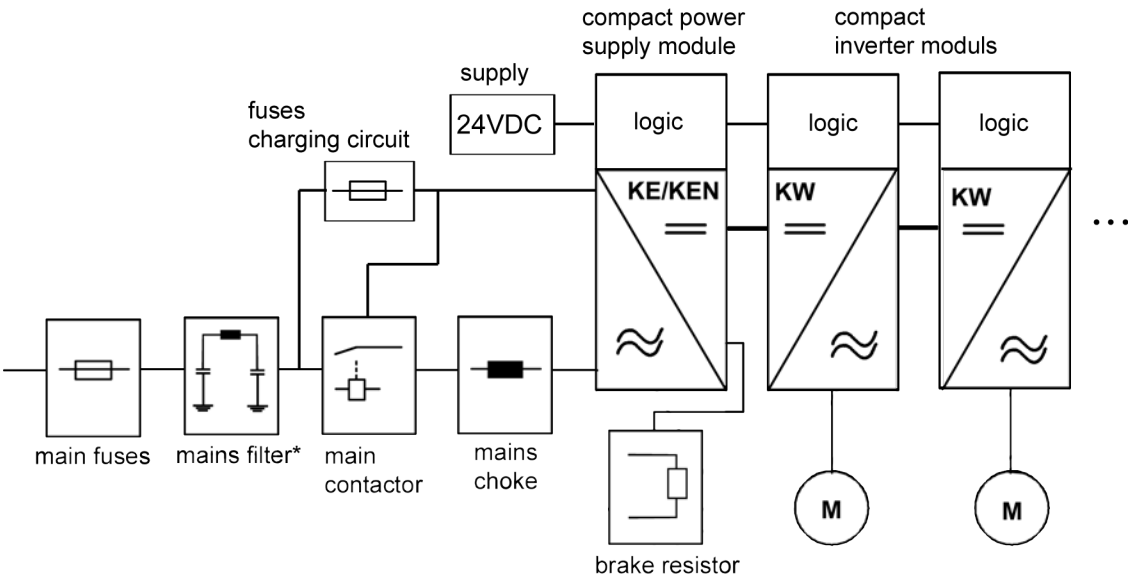
Power is supplied to the compact power supply unit via terminal X01.
The mains filter is required. The mains choke can optionally be used with a KEN 5-S10. A main contactor must be connected externally.
The switch voltage for the contactor (24V DC or 24V...230V AC, depending on contactor version) must be provided by the user.
The switch voltage for the main contactor is set on the protective conductor.
The DC bus is now directly fed from the line through the main contactor and mains choke.
If necessary, the user can externally interrupt the control of the main contactor (S2), e.g. to separate the drive system power-sided from the line in case of an emergency stop (for further information: Siehe 'Pulse diagram EMERGENCY STOP' auf Seite 186.).
The auxiliary contact HK (NC) allows the user to monitor the switch status of the main contactor.



Module name	Description	
L1, L2, L3, PE	Mains supply	
S1	Main contactor	
F1	Main fuse	
Mains filter	Compliance with the maximum permissible values for electromagnetic emissions	
	X01 -L1 -L2 -L3	Mains-side connection -line phase L1 -line phase L2 -line phase L3
	X02 -L1' -L2' -L3'	Load-side connection -line phase L1 -line phase L2 -line phase L3
S2	If necessary: External safety circuit for main contactor OFF	
Main contactor		
	Main contacts -1 L1 -3 L2 -5 L3	Mains-side connection -line phase L1 -line phase L2 -line phase L3
	Main contacts -2 T1 -4 T2 -6 T3	Load-side connection -line phase L1 -line phase L2 -line phase L3
	HK (help contact)	Option for monitoring switch status
Mains choke	Reduction of induced distortion on the mains and improvement of power factor *Can optionally be used with a KEN 5-S10.	
	X01 -U1 -V1 -W1	Mains-side connection -line phase L1 -line phase L2 -line phase L3
	X02 -U2 -V2 -W2	Load-side connection -line phase L1 -line phase L2 -line phase L3
KEN	Compact power supply without feedback	
	X01 -L1, L2, L3	Mains supply (supply for DC bus)

6.3 System structure KE (-F) and KEN

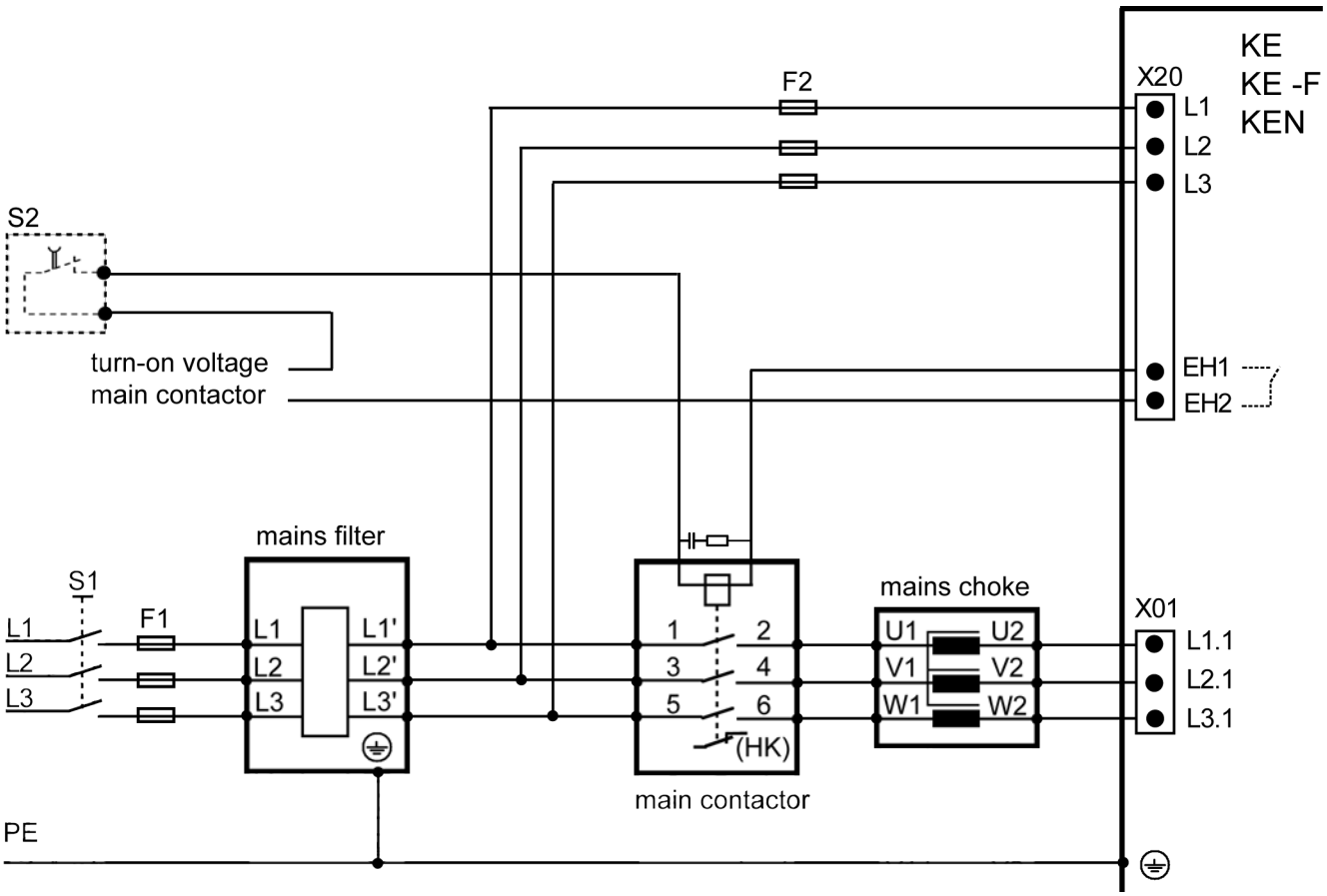
The image shows the system structure and the accompanying switch-on components when using a KE(-F) or a KEN.



* The compact power supply units KE 10, KE 20(-F), KE 40 requires no external mains filter.

6.4 Switch-on components in charging circuit and mains supply KE (-F, -0EU) and KEN

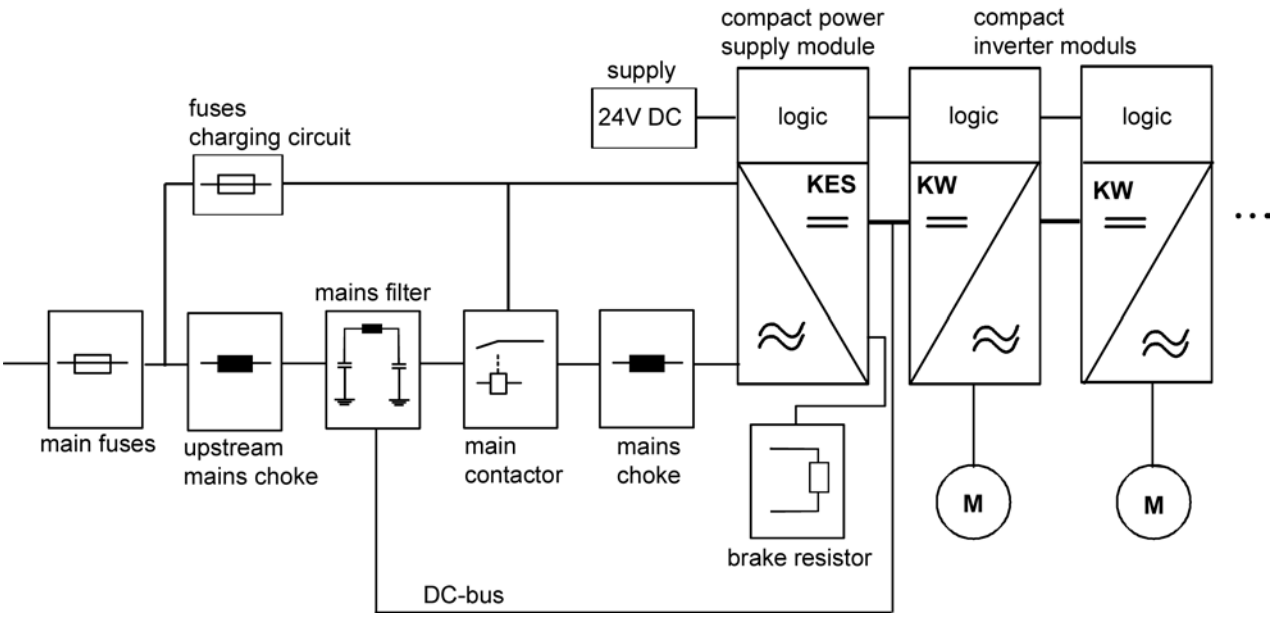
To supply power to the compact power supply, a main contactor with force-driven contact has to be installed; the contactor coil requires an EMI suppressor.
The switch voltage for the contactor (24V DC or 24V...230V AC, depending on contactor version) must be provided by the user.
After connecting the control signal UE (Converter on) and if the DC bus capacitors are loaded, the KE/KEN closes the switch contact for "Main contactor ON" (neutral NO contact, led through terminals EH1 / EH2 on plug X20).
The switch voltage for the main contactor is set on the protective conductor.
The DC bus is now directly fed from the line through the main contactor and mains choke; the charging circuit is switched off.
If necessary, the user can externally interrupt the control of the main contactor (S2), e.g. to separate the drive system power-sided from the line in case of an emergency stop (for further information: Siehe 'Pulse diagram EMERGENCY STOP' auf Seite 186.).
The auxiliary contact HK (NC) allows the user to monitor the switch status of the main contactor.
See following diagram.


KE
KE -F
KEN
X20
L1
L2
L3
F2
S2
turn-on voltage
main contactor
EH1
EH2
mains filter
S1
F1
L1
L2
L3
L1'
L2'
L3'
1
2
3
4
5
6
(HK)
main contactor
mains choke
U1
U2
V1
V2
W1
W2
X01
L1.1
L2.1
L3.1
PE

Module name	Description	
L1, L2, L3, PE	Mains supply	
S1	Main switch	
F1	Main fuse	
Mains filter	Compliance with the maximum permissible values for electromagnetic emissions The compact power supply units KE 10, KE 20(-F), KE 40 requires no external mains filter.	
	X01 -L1 -L2 -L3	Mains-side connection -line phase L1 -line phase L2 -line phase L3
	X02 -L1' -L2' -L3'	Load-side connection -line phase L1 -line phase L2 -line phase L3
S2	If necessary: External safety circuit for main contactor OFF	
F2	Fuse, charging circuit for DC bus	
Main contactor		
	Main contacts -1 L1 -3 L2 -5 L3	Mains-side connection -line phase L1 -line phase L2 -line phase L3
	Main contacts -2 T1 -4 T2 -6 T3	Load-side connection -line phase L1 -line phase L2 -line phase L3
	HK (help contact)	Option for monitoring switch status
Mains choke	Reduction of induced distortion on the mains and improvement of power factor	
	X01 -U1 -V1 -W1	Mains-side connection -line phase L1 -line phase L2 -line phase L3
	X02 -U2 -V2 -W2	Load-side connection -line phase L1 -line phase L2 -line phase L3
KE **KEN**	compact power supply with feedback compact power supply without feedback	
	X01 -L1.1, L2.1, L3.1	Mains supply (supply for DC bus)
	X20 -EH1, EH2 -L1, L2, L3	 -Switch contact, main contactor ON/OFF -Mains supply (supply for charging circuit of DC bus)

6.5 System structure KES

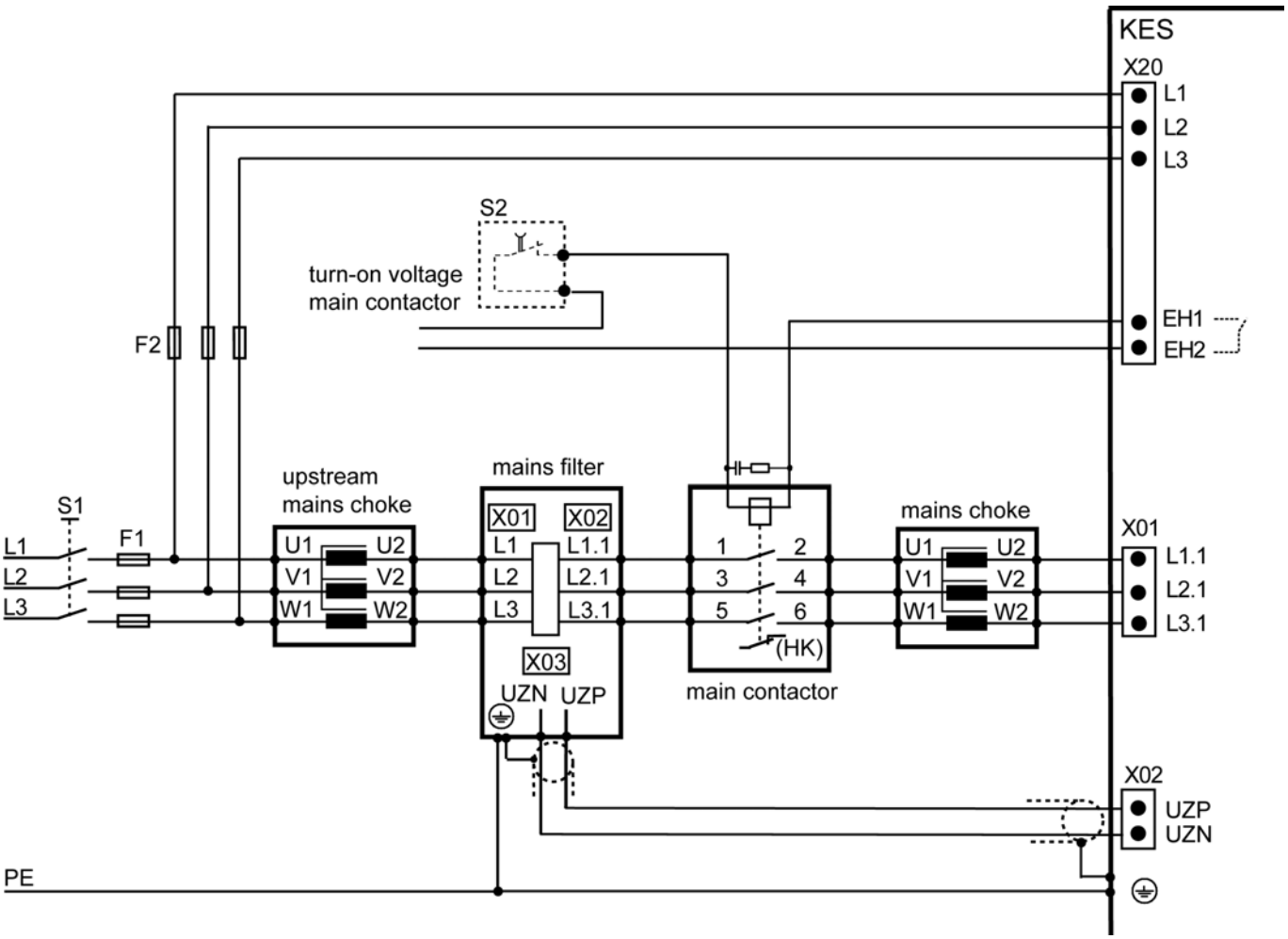
The image shows the system structure and the accompanying switch-on components when using a KES.



6.6 Switch-on components in charging circuit and mains supply KES

To supply power to the compact power supply, a main contactor with force-driven contact has to be installed; the contactor coil requires an EMI suppressor.
The switch voltage for the contactor (24V DC or 24V...230V AC, depending on contactor version) must be provided by the user-
After connecting the control signal UE (Converter on) and if the DC bus capacitors are loaded, the KES closes the switch contact for "Main contactor ON" (neutral NO contact, led through terminals EH1 / EH2 on plug X20).
The switch voltage for the main contactor is set on the protective conductor.
The DC bus is now directly fed from the line through the main contactor and mains choke, the charging circuit is switched off.
If necessary, the user can externally interrupt the control of the main contactor (S2), e.g. to separate the drive system power-side from the line in case of an emergency stop (for further information: Siehe 'Pulse diagram EMERGENCY STOP' auf Seite 186.).
The auxiliary contact HK (NC) allows the user to monitor the switch status of the main contactor.

NOTICE	
Material Damage!	**Material damage due missing DC bus wiring** If the DC bus of the KES not connected to the mains filter, the KES may be damaged and fail.


KES
X20
L1
L2
L3
EH1
EH2
S2
turn-on voltage
main contactor
F2
S1
F1
L1
L2
L3
upstream
mains choke
U1
U2
V1
V2
W1
W2
mains filter
X01
X02
L1
L2
L3
L1.1
L2.1
L3.1
X03
UZN
UZP
1
2
3
4
5
6
(HK)
main contactor
mains choke
U1
U2
V1
V2
W1
W2
X01
L1.1
L2.1
L3.1
X02
UZP
UZN
PE

Module name	Description	
L1, L2, L3, PE	Mains supply	
S1	Main switch	
F1	Main fuse	
F2	Fuse, charging circuit for DC bus	
Upstream mains choke	The upstream mains choke reduces the induced distortion on the mains in the 8 kHz range.	
	X01 -U1 -V1 -W1	Mains-side connection -line phase L1 -line phase L2 -line phase L3
	X02 -U2 -V2 -W2	Load-side connection -line phase L1 -line phase L2 -line phase L3
Mains filter	Compliance with the maximum permissible values for electromagnetic emissions	
	X01 -L1 -L2 -L3	Mains-side connection -line phase L1 -line phase L2 -line phase L3
	X02 -L1.1 -L2.1 -L3.1	Load-side connection -line phase L1 -line phase L2 -line phase L3
	X03 -UZP -UZN	Connecting DC bus -DC bus voltage (+) -DC bus voltage (-)
S2	If necessary: External safety circuit for main contactor OFF	
Main contactor		
	Main contacts -1 L1 -3 L2 -5 L3	Mains-side connection -line phase L1 -line phase L2 -line phase L3
	Main contacts -2 T1 -4 T2 -6 T3	Load-side connection -line phase L1 -line phase L2 -line phase L3
	HK (help contact)	Option for monitoring switch status
Mains choke	Reduction of induced distortion on the mains and improvement of power factor	
	X01 -U1 -V1 -W1	Mains-side connection -line phase L1 -line phase L2 -line phase L3
	X02 -U2 -V2 -W2	Load-side connection -line phase L1 -line phase L2 -line phase L3

Module name	Description	
KES	Compact power supply with sine feedback	
	X01 -L1.1, L2.1, L3.1	Mains supply (supply for DC bus)
	X02 -UZP -UZN	Connecting DC bus -DC bus voltage (+) -DC bus voltage (-)
	X20 -EH1, EH2 -L1, L2, L3	 -Switch contact, main contactor ON/OFF -Mains supply (supply for charging circuit of DC bus)

6.7 Accessories components - overview

The following table contains information on the accessories components and the accompanying AMK part no. for the respective compact power supply.

	KEN 5 **KEN 5-F**	**KEN 5-0N** **KEN 5-FN**	**KEN 5-S10**	**KEN 10** **KEN 10-F**	**KE 10**	**KEN 20-0N**
F1 (power) **F2 (charging circuit)**	16 A -	16 A -	16 A -	20 A -	20 A 10 A	32 A -
Upstream mains choke **AMK part number**	-	-	-	-	-	-
Mains choke **AMK part number**	-	ALN 12 [3] O911 ALN 17 [3] O742	ALN 12 [4] O911 ALN 17 [4] O742	ALN 17 O742	ALN 36 O726	ALN 36/1000 O727
Mains filter **AMK part number.**	-	-		-	-	AF 30 O840
Mains contactor **AMK part number**	-	mains contactor (EN 60204-1)		-	25 A 204297	mains contactor (EN 60204-1)
EMI suppressor **AMK part number**	-	-	-	-	-	-
Auxiliary contact **AMK part number**	-	-	-	-	-	-
Brake resistor **AMK part number**	AR 140 O746				AR4000-20-0 E591 AR4000-20-F E593	AR 140 O746

	KE 20-F KE 20 KE 20-0EU	KES 20 KES 20-0EU	KE 40 KE 40-0EU	KES 40-0EU	KEN 60 (KE 60-S4) KE 60 KE 60-0EU
F1 (power) **F2 (charging circuit)**	35 A 10 A	35 A 10 A	80 A 10 A	80 A 10 A	100 A 10 A
Upstream mains choke **AMK part number** **Upstream mains choke** **AMK part number**	-	ALNV 30-S [1] O828 ALNV 15-SI [2]O841	-	ALNV 90-S [1] O890 ALNV 45-SI-100 [2] O951	-
Mains choke **AMK part number** **Mains choke** **AMK part number**	ALN 36/1000 O727	ALN 30-S [1] O893 ALN 15-SI [2] O968 / O829	ALN 63 O728	ALN 90-S [1] O770 ALN 45-SI [2] O889	ALN 85 O729
Mains filter **AMK part number** **Mains filter** **AMK part number**	-	AF 45-SI [1] O927 AF 15-SI [2] O915	-	AF 60-SI [1] O940 AF 45-SI [2] O927	AF 90 O820
Mains contactor **AMK part number**	45 A 204298	45 A 204298	80 A 29297		90 A 29298
EMI suppressor **AMK part number**	-	-	AMK EMI suppressor 29300		
Auxiliary contact **AMK part number**	204300	204300	-	-	-
Brake resistor **AMK part number**	AR4000-20-0 E591 AR4000-20-F E593	AR4000-20-0 E591 AR4000-20-F E593	AR4000-8-0 E584 AR4000-8-F E585		

	KES 60 KES 60-0EU	KEN 120 KE 120 KE 120-0EU	KES 120 KES 120-0EU	KE 180-0EU	KES 180-0EU
F1 (power) **F2 (charging circuit)**	100 A 10 A	200 A 10 A	200 A 10 A	315 A 10 A	315 A 10 A
Upstream mains choke **AMK part number** **Upstream mains choke** **AMK part number**	ALNV 90-S 1) O890 ALNV 45-SI-100 2) O951	-	ALNV 180-S 1) O827/ O959 ALNV 60-SI 2) O894	-	ALNV 150-SI2)O944
Mains choke **AMK part number** **Mains choke** **AMK part number**	ALN 90-S 1) O770 ALN 45-SI 2) O889	ALN 180 O739	ALN 180-S 1) O771 / O958 ALN 60-SI 2) O790 / O942	ALN 270 1) O965 ALN 150-I 2) O885	i.p. ALN 150-SI 2) O943
Mains filter **AMK part number** **Mains filter** **AMK part number**	AF 90-S 1) O825 AF 45-SI 2) O927	AF 180 O821	AF 180-S 1) O812 AF 60-SI 2) O940	AF 300 O886	AF 270-S 2) O946
Mains contactor **AMK part number**	90 A 29298	230 A 200446		350 A i.p.	
EMI suppressor **AMK part number**	AMK EMI suppressor 29300	-		-	
Auxiliary contact **AMK part number**	-	-		-	
Brake resistor **AMK part number**	AR4000-8-0 E584 AR4000-8-F E585	AR4000-8-0 E584 AR4000-8-F E585		AR4000-8-0 E584 AR4000-8-F E585	

1) continuous operation
2) pulse operation
3) optional with KEN 5-0N
4) optional

6.7.1 Fuses

Excess-current protectors according to the requirements according to EN 60204-1. Fuses to protect the wiring, classification "gG" acc. DIN / VDE 0636.

Selection fuses

Fuse	KEN 5-F KEN 5	KEN 5-0N KEN 5-FN KEN 5-S10	KEN 10-F KEN 10	KE 10	KEN 20-0N
Input fuse					
Fuse	16 A	16 A	20 A	20 A	32 A
Terminal	X07	X01	X07	X01	X01
Charging circuit					
Fuse	-	-	-	10 A	-
Terminal	-	-	-	X20	-

Fuse	KE 20-F KE 20 KE 20-0EU	KES 20 KES 20-0EU	KE 40 KE 40-0EU	KES 40-0EU	KEN 60 (KE 60-S4) KE 60 KE 60-0EU
Input fuse					
Fuse	35 A	35 A	80 A	80 A	100 A
Terminal	X01	X01	X01	X01	X01
Charging circuit					
Fuse	10 A	10 A	10 A	10 A	10 A
Terminal	X20	X20	X20	X20	X20

Fuse	KES 60 KES 60-0EU	KEN 120 KE 120 KE 120-0EU	KES 120 KES 120-0EU	KE 180-0EU	KES 180-0EU
Input fuse					
Fuse	100 A	200 A	200 A	315 A	315 A
Terminal	X01	X01	X01	X01	X01
Charging circuit					
Fuse	10 A	10 A	10 A	10 A	10 A
Terminal	X20	X20	X20	X20	X20

6.7.2 Upstream mains choke ALNV

The upstream mains choke reduces the induced distortion on the mains in the 8 kHz range.
Upstream mains chokes are only required for KES compact power supply units.

Selection upstream mains choke

Upstream mains choke	KES 20 KES 20-0EU	KES 40-0EU	KES 60 KES 60-0EU	KES 120 KES 120-0EU
Type	ALNV 30-S [1]	ALNV 90-S [1]	ALNV 90-S [1]	ALNV 180-S [1]
AMK part number	O828	O890	O890	O827 / O959
Type	ALNV 15-SI [2]	ALNV 45-SI-100 [2]	ALNV 45-SI-100 [2]	ALNV 60-SI [2]
AMK part number	O841	O951	O951	O894

Upstream mains choke	KES 180-0EU
Type	ALNV 150-SI [2]
AMK part number	O944

1) Continuous operation
2) Pulse operation

Further Information: see device description Upstream mains choke (AMK part no. 203425)

6.7.3 Main contactor

To supply power to the compact power supply, a main contactor with force-driven contact has to be installed. The contactor coil requires an EMI suppressor. The control voltage for the contactor coil has to be provided externally. The switch status of the main contactor can be monitoring using the auxiliary contact HK (NC). The activation time of the main contactor must be < 150 ms; if not, the compact power supply generates a diagnostic message.

Selection main contactor

Contactor **EMI suppressor**	**KEN 5-0N** **KEN 5-FN** **KEN 5-S10**	**KE 10**	**KEN 20-0N**	**KE 20-F** **KE 20** **KE 20-0EU**	**KES 20** **KES 20-0EU**
Contactor					
Typ	main contactor (EN 60204-1)	25A 3P	main contactor (EN 60204-1)-	45A 3P	
AMK part number	-	204297	-	204298	
EMI suppressor					
AMK part number	not necessary	not necessary	not necessary	not necessary	
Auxiliary contact					
AMK part number	not necessary	not necessary	not necessary	204300	

Contactor **EMI suppressor**	**KE 40** **KE 40-0EU**	**KES 40-0EU**	**KEN 60** **(KE 60-S4)** **KE 60** **KE 60-0EU**	**KES 60** **KES 60-0EU**	**KEN 120** **KE 120** **KE 120-0EU**
Contactor					
Typ	80A 3P		90A 3 P		230A 3P
AMK part number	29297		29298		200446
EMI suppressor					
AMK part number	29300		29300		not necessary
Auxiliary contact					
AMK part number	not necessary		not necessary		not necessary

Contactor **EMI suppressor**	**KES 120** **KES 120-0EU**	**KE 180-0EU**	**KES 180-0EU**
Contactor			
Typ	230A 3P	350 A	
AMK part number	200446	204558	
EMI suppressor			
AMK part number	not necessary	not necessary	
Auxiliary contact			
AMK part number	not necessary	not necessary	

Further Information: see device description Main contactor (AMK part no. 203422)

The main contactor can also be supplied by the customer.
The configuration is then based on the rated voltage of the network (400V...480V AC, 50/60Hz) and the rated input current of the KE module in use.

6.7.4 Mains filter AF

A mains filter limit electrical interference in the range of 150 kHz to 30 MHz that electronic devices transfer into the public power grid. In addition, they improve the electromagnetic compatibilities of the devices in the face of interferences from the electricity network.

Selection mains filter for KE and KEN

Mains filter for	KEN 20-0N	KEN 60 (KE 60-S4) KE 60 KE 60-0EU	KEN 120 KE 120 KE 120-0EU	KE 180-0EU
Module name	AF 30	AF 90	AF 180	AF 300
AMK part number	O840	O820	O821	O886

Selection mains filter for KES

Mains filter for	KES 20 KES 20-0EU	KES 40-0EU	KES 60 KES 60-0EU	KES 120 KES 120-0EU
Continuous operation				
Module name	AF 45-SI	AF 60-SI	AF 90-S	AF 180-S
AMK part number	O927	O940	O825	O812
Pulse operation				
Module name	AF 15-SI	AF 45-SI	AF 45-SI	AF 60-SI
AMK part number	O915	O927	O927	O940

Mains filter for	KES 180-0EU
Pulse operation	
Module name	AF 270-S
AMK part number	O946

Further Information: see device description Mains filter (AMK part no. 203424)

6.7.5 Mains choke ALN

The mains chokes (ALN) recommended by AMK feature a higher saturation current and greater inductance that is optimised for AMK devices. They reduce the induced distortion on the mains (harmonics) and improve the power factor of the downstream device.

- The AMK mains chokes (ALN) switched up-stream is necessary.
- The mains choke needs to be installed with a minimum distance of 80 mm to the KE/KW module.

Selection mains choke for KE and KEN

	KEN 5-0N 1) **KEN 5-S10** 1)	**KEN 10** **KEN 10-F**	**KE 10**	**KEN 20-0N** **KE 20-F** **KE 20** **KE 20-0EU**
Type	ALN 12 / ALN 17	ALN 17	ALN 36	ALN 36 / 1000
AMK part number	O911 / O742	O742	O726	O727

	KE 40 **KE 40-0EU**	**KEN 60** **(KE 60-S4)** **KE 60** **KE 60-0EU**	**KEN 120** **KE 120** **KE 120-0EU**
Type	ALN 63	ALN 85	ALN 180
AMK part number	O728	O729	O739

	KE 180-0EU
Continuous operation	
Type	ALN 270
AMK part number	O965
Pulse operation	
Type	ALN 150-I
AMK part number	O885

1) mains choke optional

Selection mains chokes for KES

	KES 20 **KES 20-0EU**	**KES 40-0EU**	**KES 60** **KES 60-0EU**	**KES 120** **KES 120-0EU**
Continuous operation				
Type	ALN 30-S	ALN 90-S	ALN 90-S	ALN 180-S
AMK part number	O893	O770	O770	O771 / O958
Pulse operation				
Type	ALN 15-SI	ALN 45-SI	ALN 45-SI	ALN 60-SI
AMK part number	O968 / O829	O889	O889	O790 / O942

	KES 180-0EU
Continuous operation	
Type	i.p.
AMK part number	
Pulse operation	
Type	ALN 150-SI
AMK part number	O943

There are a range of mains chokes for continuous operation and pulse operation available for the **compact power supply KES**. The mains chokes for pulse operation have a reduced nominal current with higher overload capacity. In the event of an overload, both transmit the same power.

Further Information: see device description Mains choke (AMK part no. 203423)

6.8 Brake resistor

⚠ WARNING	
	**Risk of burns when touching hot surfaces!** The casing temperature, for example of the line filter, the choke or the brake resistor, can be more than 70 °C during and even after operation. Contact causes burns. **Steps to prevent:** • Make sure that the surfaces have cooled down before you touch. • Wear protective clothing such as gloves if hot parts need to be touched. • Fit a warning sign with warning hot surface. • Do not mount any flammable objects near the device.

NOTICE	
Material Damage!	**Fire hazard!** The brake resistor may overheat in general if: the rotational energy is not limited, a component in the power supply is defective or it is not installed properly. The cooling air through the brake resistor can reach temperatures of up to 200 °C. **Steps to prevent:** • The PTC thermistor in the brake resistor must be used for temperature monitoring. Connection to X25, evaluation in the power supply. • The brake resistor may not be installed in the air intake area for cooling electronic equipment. • Do not use any flammable materials in the direct vicinity of the brake resistor.

All compact power supplies feature an internal brake resistor used to dissipate excessive brake energy by way of an externally connected brake resistor.

In normal operation, the **KE and KES compact power supply** will feed the excessive brake energy back into the mains supply.

An external brake resistor (+ USV 24 VDC for the logic power supply X08/X09) is required to decelerate the drives in the event of mains failure.

The brake resistor needs to be selected based on the occurring brake energy.

Further information: Siehe 'Maximum generative brake energy' auf Seite 78.

Observe the rotational energy in the system. If this is greater than the max. pulse energy of the brake resistor, please contact AMK.

Compact power supply KEN 120

Two external brake resistors (AMK type AR 4000-8-F or AR 4000-8-0) with min. 8 Ohm can be connected to the KEN 120 compact power suppy. This results in a doubling of the max. generative power that can be dissipated by the brake resistors to 160 kW.

(Terminal name X03.01 and X03.02. The PTC thermistor for both brake resistors must be switched in series and connected to terminal X25.)

Selection brake resistors

Brake resistor	KEN 5 KEN 5-F	KEN 5-0N KEN 5-FN KEN 5-S10	KEN 10 KEN 10-F	KE 10	
Type	AR 140		AR 140	AR 4000-20-0	AR 4000-20-F
AMK part number	O746		O746	E591	E593

Brake resistor	KEN 20-0N	KE 20-F KE 20, KE 20-0EU KES 20, KES 20-0EU		KE 40 KE 40-0EU KES 40-0EU	
Type	AR 140	AR 4000-20-0	AR 4000-20-F	AR 4000-8-0	AR 4000-8-F
AMK part number	O746	E591	E593	E584	E585

Brake resistor	KEN 60 (KE 60-S4) KE 60, KE 60-0EU KES 60, KES 60-0EU		KEN 120 KE 120, KE 120-0EU KES 120, KES 120-0EU	
Type	AR 4000-8-0	AR 4000-8-F	AR 4000-8-0	AR 4000-8-F
AMK part number	E584	E585	E584	E585

Brake resistor	KE 180-0EU KES 180-0EU
Type	≥ 5.4 Ω
AMK part number	-

Further Information: see device descriptions Brake resistor AR140 (AMK part no. 200776) and Brake resistor AR4000 (AMK part no. 26892)

6.9 Liquid cooling system

All KE/KW series modules are designed for mounting on a cold plate with liquid cooling.
The coolant line is connected either on the right side (on the left side only at KW-CP 1000) or on the back using two G1/4" inner threads and the matching hose connections.

Cold plate	Technical Data
KW-CP 340(R)	Effective width 340 mm removable power approx. 1.5 kW
KW-CP 420R	Effective width 416 mm removable power approx. 1.9 kW
KW-CP 510(R)	Effective width 510 mm removable power approx. 2.3 kW
KW-CP 680(R) KW-CP 680(R)-V	Effective width 680 mm removable power approx. 3.0 kW
KW-CP 1000 *)	Effective width 1000 mm removable power approx. 3.0 kW
KW-CP 1035R	Effective width 1035 mm removable power approx. 3.0 kW

R coolant connection on the back
-V integrated stainless steel piping
*) not to be used for new applications

Depending on the module width, the KE/KW cold plate modules can be mounted on the cold plates according to the following table.
When you select the cold plate, you have to take into account the power losses to be removed.

Cold plate	AMK part no.	Module width / mm				
		55	85	170	255	425
KW-CP 340	O704	■	■	■	-	-
KW-CP 340R	O705	■	■	■	-	-
KW-CP 420R	O710	■	■	-	-	-
KW-CP 510	O706	■	■	■	■	■
KW-CP 510R	O707	■	■	■	■	■
KW-CP 680	O708	■	■	■	■	■
KW-CP 680R	O709	■	■	■	■	-
KW-CP 680-V	O782	■	■	■	■	-
KW-CP 680R-V	O783	■	■	■	■	-
KW-CP 1000	O717	■	■	■	■	-
KW-CP 1035R	O734	■	■	■	-	-

For compact power supplies and compact inverters with a module width of 425 mm, cold plates KW-CP680 (AMK part no. O708), KW-CP510 (AMK part no. O706) respectively KW-CP510R (AMK part no. O707) must be exclusively used with a **revision from 2.03 on**!

For more information: see device description Liquid-cooled cold plate KW-CP (AMK part no. 200043)

Use of own cold plates

Requirements on surface when using own cold plate with liquid cooling.

- Plate flatness: 0.1 mm
- Surface finish: 0.02 mm
- Ridges and bore holes should be carefully deburred.
- To make assembly easier, the threads M6 for the clamping bolts must in the centre for devices with a width of 170/255 mm must feature an inner bevel of approx. 45°/2 mm.

6.10 Air cooling system

For systems with no liquid cooling or where this cannot be used, the air-cooled cold plates (air cooling systems KW-LK xx) are available, on which the KE/KW series modules are mounted.

The air cooling system consists of a finned heat sink on which the base of the axial cooler is mounted. The heat is dissipated in the air which is blown through the cooling fins by a fan.

The fed-in air must be dry and free of electrically conductive dust, fibres, gases and vapours.

If necessary, suitable filters should be used or other protective measures need to be taken.

Air cooling system	Technical Data
KW-LK 110	Effective width 110 mm removable power approx. 120 W
KW-LK 250	Effective width 250 mm (220 mm with through-hole mounting) removable power approx. 600 W
KW-LK 400	Effective width 400 mm (370 mm with through-hole mounting) removable power approx. 900 W
KW-LK 500	Effective width 500 mm (470 mm with through-hole mounting) removable power approx. 1200 W

Depending on the module width, the KE/KW coldplate modules can be mounted on the cold plates according to the following table.

When you select the cold plate, you have to take into account the power losses to be removed and deratings.

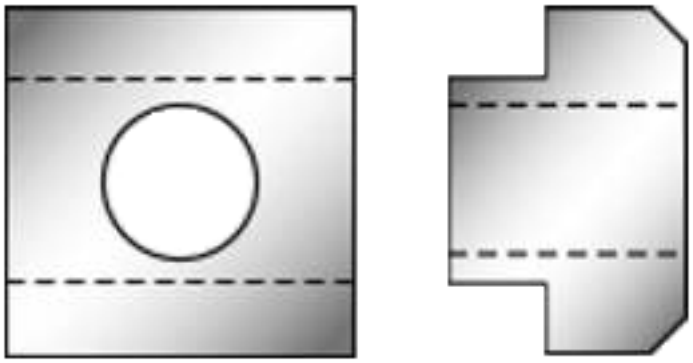
Air cooling system	AMK part no.	Module width / mm				
		55	85	170	255	425
KW-LK 110	O745	■	-	-	-	-
KW-LK 250	O743	■	■	■	-	-
KW-LK 400	O744	■	■	■ 1)	■ 1)	-
KW-LK 500	O802	■	■	■ 1)	■ 1)	-

1) max. 1 device per KW-LK 400, max. 2 devices per KW-LK 500; no more devices permitted

Derating and more information: see device description Fan-cooled cold plate KW-LK (AMK part no. 202393)

6.11 Slot nut D508

The cold plate features one T-slot (acc. to DIN 508) on the top and bottom used to mount the plate.
Slot nuts can be ordered under AMK part no. 18139. They feature an M6 inner thread for fastening screws M6 x 20.

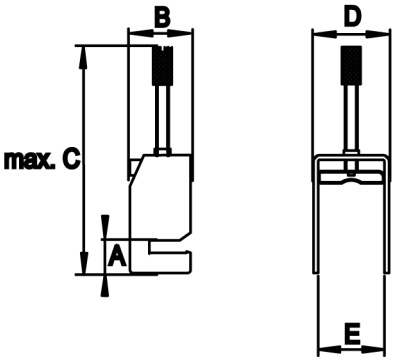


6.12 Shielding terminals

The KP-SK8 ... KP-SK35 shielding clamps are used for strain relief of the connection cable and for earthing the shield.
Further informations: Siehe 'Connection technology - shielding terminals' auf Seite 167.

Type	AMK part no.	Tightening torque
KP-SK 8	28503	0.6 Nm
KP-SK 14	28504	0.8 Nm
KP-SK 20	28505	0.8 Nm
KP-SK 35	28506	1.8 Nm

Dimensions - Shielding terminals



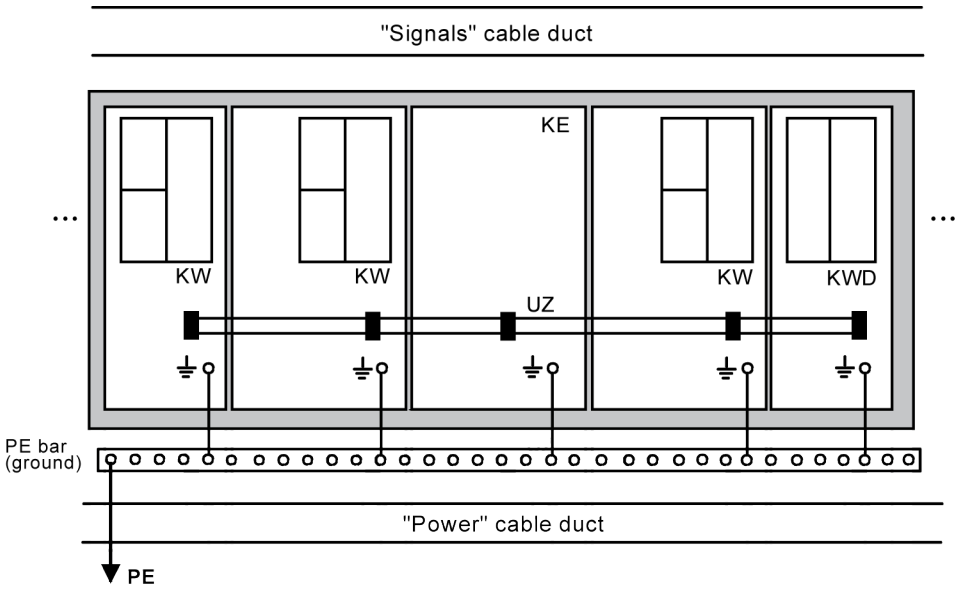
Type	Dimension in mm				
	A	B	C	D	E
KP-SK 8	6,5	19,5	48,7	12	9
KP-SK 14	6,5	19,5	59,3	17	14
KP-SK 20	6,5	19,5	75	24	21
KP-SK 35	6,5	20	106,5	40	36

7 Assembly

7.1 Arrangement of KE/KW modules in the switch cabinet

NOTICE	
Material Damage!	**Overload of DC bus cable and terminals!** The connected rating of the DC bus terminals is restricted based on the conductivity of the UZ terminals and the cross-section of the UZ connecting cable. **Steps to prevent:** • Do not exceed the maximum possible connected rating of the modules. • Siehe DC bus wiring auf Seite 68.

- The cold plate modules must be installed on a liquid- or air-cooled AL assembly plate.
- Modules with integrated air cooling must be mounted on an even surface that forms a closed air duct with the heat sink.
- Recommended installation position: vertical. Other installation positions are permitted upon prior consultation with AMK.
- Place the modules in a way that the signal and power cables are always kept separate from each other during wiring (distance > 20 cm).
- The compact inverter KW must be connected to the compact power supply KE in the order from the highest to lowest rated output. For improved power distribution and shorter DC lines, the KWs can be connected to the KE on both sides from the highest to the lower output.
- Avoid installing the system above devices that generate a lot of heat. The air inlet temperature on the KE/KW modules must be < 40°.
- A direct connection is permitted; sufficient space must be available for air circulation on the module casing above and below. Recommended distance: 100 mm.
- For multi-row mounting, we recommend a minimum distance of 100 mm between the module rows (1st row - 100 mm spacing - 2nd row - 100 mm spacing - 3rd row, etc.)



7.2 Installation of cold plate modules on the cooling system

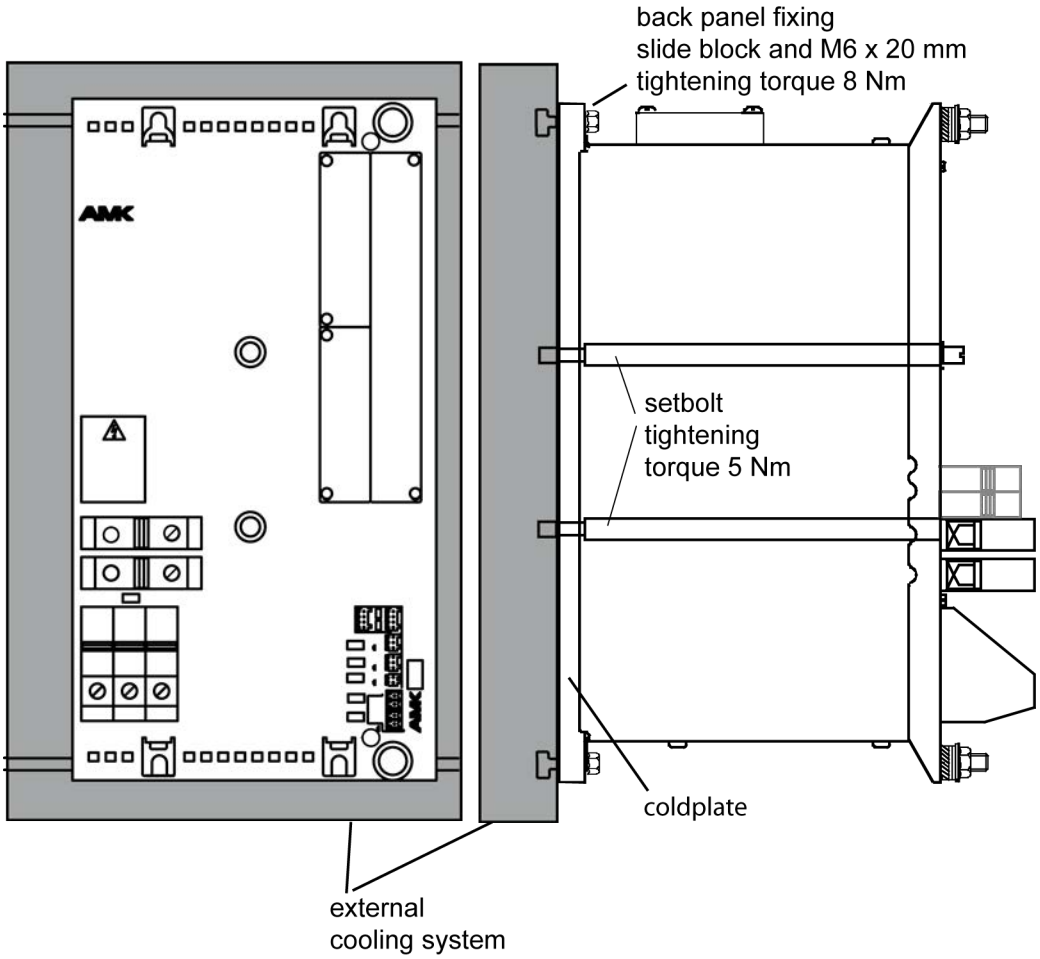
DANGER	
	**Risk of injury from crushing, cutting and hitting.** When transporting and mounting sharp-edged and / or heavy components, there is a risk of crushing, cutting and bruising of the persons involved. Suspended loads can fall down and people suffer fatal injuries. **Steps to prevent:** • Utilize suitable assembly and transport equipment, such as hoists and carriages. • Wear protective clothing, e.g. safety gloves and boots, during the assembly. • Use only appropriate tools during the assembly. • Make sure that there are no persons or body parts located under suspended loads during the transport or assembly. • Prevent catching and crushing by mechanical devices.

NOTICE	
Material Damage!	**Short circuit due to penetrating foreign objects or water** Foreign objects such as metal shavings, screws, etc. cause short circuits. In particular it needs to be prevented that water, e.g. condensation water, seeps in through the cooling units. A temporary forming of dew may only occur as long as the devices are out of operation. **Steps to prevent:** • The modules need to be protected against penetrating foreign objects or water. • When applying mains voltage, no dew may be present any longer.

The KE/KW modules are installed directly on the cooling system **without** heat transfer paste.

Note the following during assembly:

- The protective cardboard on the bearing face (cold plate) of the modules needs to be removed.
- The mounting surface for the modules must be clean and free of scratches.
- The cold plate features a T-slot on the top and bottom acc. to DIN 508 used to fasten the modules in place. The corresponding slot nuts with inner thread M6 for fastening screws M6 x 20 mm (AMK part no. 18139) must be inserted into these. Further information: Siehe 'Slot nut D508' auf Seite 104.
- There are screw threads on the cold plate for mounting the modules with clamping bolts 170/255/425 mm in width). The modules must be place on the lower stop angle and can be right-justified using the markings (above and below the T-slots). During assembly, the clamping bolts must first be fastened (tightening torque: 5 Nm / Tool: Allen size 4), followed by the top and bottom fastening screws. Tightening torque for mounting rear panel of modules: 8 Nm (Tool: Allen size 5)



7.3 Installation of modules with integrated air cooling

DANGER	
	**Risk of injury from crushing, cutting and hitting.** When transporting and mounting sharp-edged and / or heavy components, there is a risk of crushing, cutting and bruising of the persons involved. Suspended loads can fall down and people suffer fatal injuries. **Steps to prevent:** • Utilize suitable assembly and transport equipment, such as hoists and carriages. • Wear protective clothing, e.g. safety gloves and boots, during the assembly. • Use only appropriate tools during the assembly. • Make sure that there are no persons or body parts located under suspended loads during the transport or assembly. • Prevent catching and crushing by mechanical devices.

NOTICE	
Material Damage!	**Short circuit due to penetrating foreign objects or water** Foreign objects such as metal shavings, screws, etc. cause short circuits. In particular it needs to be prevented that water, e.g. condensation water, seeps in through the cooling units. A temporary forming of dew may only occur as long as the devices are out of operation. **Steps to prevent:** • The modules need to be protected against penetrating foreign objects or water. • When applying mains voltage, no dew may be present any longer.

Notes on assembly:

The modules must be mounted on an even surface that forms a closed air duct with the heat sink. On the air inlet and outlet, 60 mm of space must be kept free for air circulation. The fans are mounted to the air inlet on the lower end of the device. For multi-row installation, there must be at least 120 mm space (2 x 60 mm) between the module rows (1st row - 120 mm spacing - 2nd row -120 mm spacing - 3rd row, etc.). Between the rows air baffles could be provided so that the warm air is not sucked by the above device.

Mounting the rear panel: M6 x length min. 12 mm (2x)

Tightening torque for rear panel mounts: 8 Nm

8 Electrical connections

8.1 Wiring

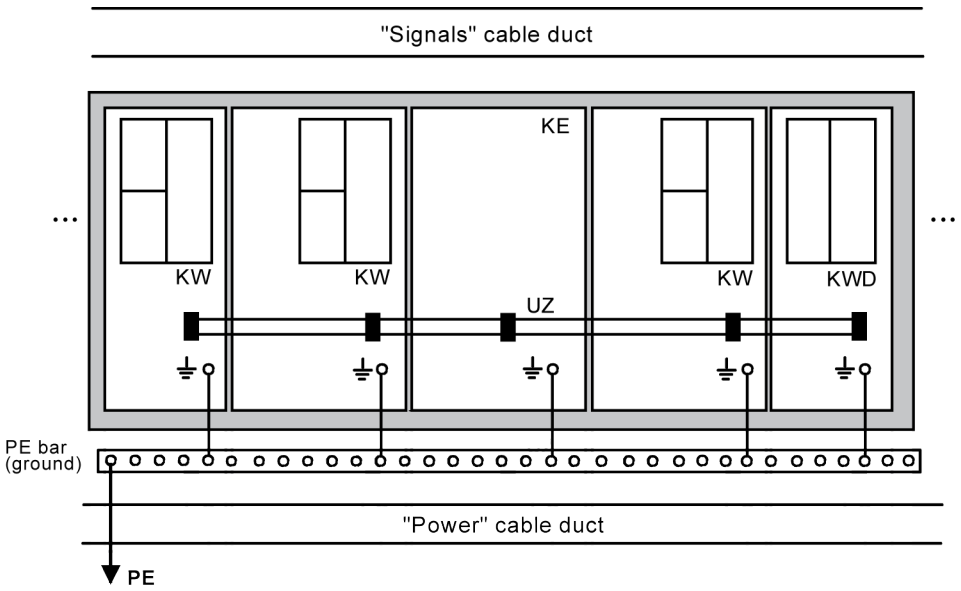
- The recommended connection diameters for cables are based on EN 60204-1, installation type C, ambient temperature ≤ 40°C.
- All signal lines must be run out the top of the devices (cable duct 'Signals'); all motor lines must be run through the bottom of the devices (cable duct 'Power'). Crossings of control and power cables must be performed at an angle of less than 90° and at a distance from each other.
- Motor and signal lines must be laid separately throughout the entire system (distance > 20 cm).
- Please refer to chapter 'Earthing' before switching the system on the first time: Further information: Siehe 'Earthing' auf Seite 110.
- Only devices, electrical elements, or wiring may be connected to the AMKSYN series signal interfaces that feature a "secure disconnection" of the connected circuits according to EN 50178.

For a certify CSAus unit you must observe following rules:

CSA C22.2 Tab.3, Cl. 3 and Tab. 31 on rather UL508C: Tab. 40.3, Copper, 75 °C
Use copper wires only
Use 75 °C minimum wire only

It is not allowed in both norms to be less the recommended cable cross section (AWG).

System mouniting KE/KW:



8.2 Earthing

⚠ DANGER

Danger to life from electrical shock!

In the event of an interruption to the PE connection, avoid touching the casing because life-threatening levels of voltage may be present!

Steps to prevent:

- EN 61800-5-1 requires that the devices be firmly connected on the power side.
- The PE conductor must have a cross-section of at least 10 mm^2 or must have a second PE connection with a cross-section at least equal to the mains feeder (cf. EN 61800-5-1).

Cross-section AC wire	Cross-section PE wire
≤ 10 mm^2	= 10 mm^2
10 ... 16 mm^2	= Cross-section AC wire
16 ... 35 mm^2	= 16 mm^2
≥ 35 mm2	≈ 1/2 x Cross-section AC wire

All AMKASYN casings are separate and should be connected to the earth using the shortest route possible (central PE bus bar switch cabinet). Throughout the entire system, the earth should be star-like in shape, extending from the central earthing point.

Connection PE bolts on casing: Siehe 'PE connection' auf Seite 113.

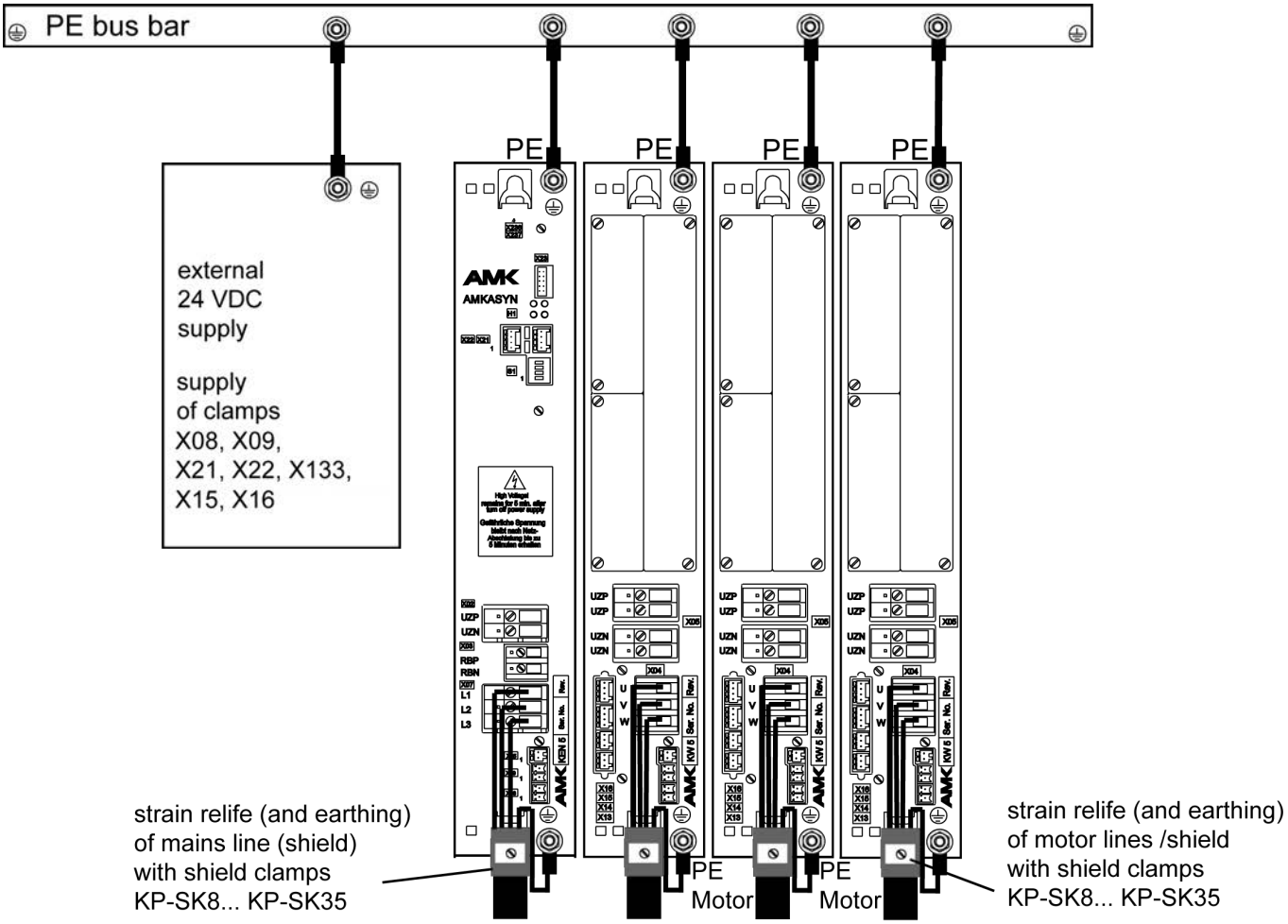
The cable and shield earthing that runs to the KE/KW modules must be strain-relieved and earthed via shielding terminal KP-SK8 - KP-SK35. Further information: Siehe 'Shielding terminals' auf Seite 104. and Siehe 'Connection technology - shielding terminals' auf Seite 167..

PE is the reference potential for internal power supply and voltage sensing purposes.

The 0V potential of the external power supply units for the power supply of binary inputs and outputs X21/X22/(X133) power output stage enable X15/X16 and power supply X08/X09 must be connected to the central PE bar.

For cables that are connected to D-sub connector, the shield is earthed internally via the metallised D-sub casing. Further information: Siehe 'Connection technology - D-SUB connector' auf Seite 166..

Installation, connection and earthing should be performed according to the applicable local regulations (e.g. EN 60204 Ch. 8 Protective earth conductor system, equipotential bonding).


PE bus bar
external
24 VDC
supply
supply
of clamps
X08, X09,
X21, X22, X133,
X15, X16
PE
PE
PE
PE
strain relife (and earthing)
of mains line (shield)
with shield clamps
KP-SK8... KP-SK35
PE
Motor
PE
Motor
strain relife (and earthing)
of motor lines /shield
with shield clamps
KP-SK8... KP-SK35

8.3 Motor power and encoder cable

Motor lines totalling up to 100 m can be connected to one AMKSYN compact power supply (with an internal or external AMK mains filter).
With a total motor line length of 100 m and above, faults may occur that overload the mains filter and cause damage to other network subscribers. The overall load can be calculated and appropriate countermeasures taken. Please contact AMK in this case.

An exception to this is made for the compact power supplies KEN 5-0N and KEN 5-FN. Motor lines totalling up to 25 m can be connected.

The motor line must be a shielded cable with tin-plate copper mesh. The cable shield on the motor and KW device side must be placed on the frame ground with a large contact surface. The cable shield is earthed on the inverter using the shielding terminal on the KW casing.

Further information:
Siehe 'Shielding terminals' auf Seite 104.
Siehe 'Connection technology - shielding terminals' auf Seite 167.

The following applies to all types of encoders:

The encoder cable shield has to be earthed on both sides: Via the round plug casing:

On the motor and via the metallic D-SUB casing on the converter.

Detailed Information for the encoder connection and the you will find in the document of the controller cards.

8.4 Connection technology KE with ACC bus or real-time Ethernet interface

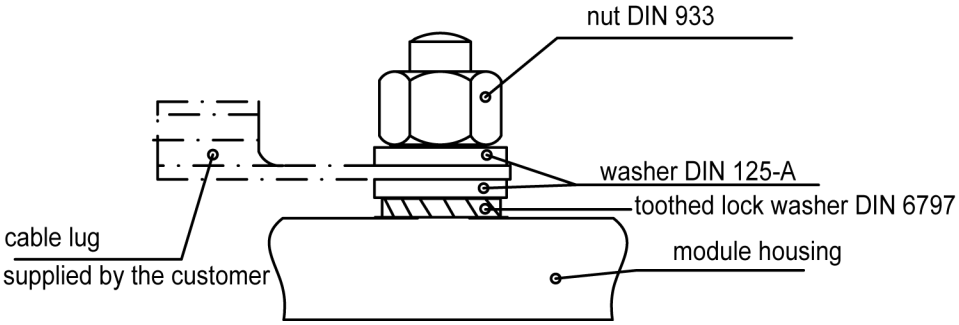
8.4.1 PE connection

⚠ DANGER	
	**Danger to life from electrical shock!** In the event of an interruption to the PE connection, avoid touching the casing because life-threatening levels of voltage may be present! **Steps to prevent:** • EN 61800-5-1 requires that the devices be firmly connected on the power side. • The PE conductor must have a cross-section of at least 10 mm^2 or must have a second PE connection with a cross-section at least equal to the mains feeder (cf. EN 61800-5-1). **Cross-section AC wire** / **Cross-section PE wire** ≤ 10 mm^2 / = 10 mm^2 10 ... 16 mm^2 / = Cross-section AC wire 16 ... 35 mm^2 / = 16 mm^2 ≥ 35 mm2 / ≈ 1/2 x Cross-section AC wire

Description:

The PE connection is a screw bolt on the module casing (see front view) for attaching PE lines and cable shields.

Configure as follows:



Connection:

Recommended cable type	1-wire, unshielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Ring cable lug

	Compact power supply			
	KEN 5, KEN 5-F KEN 10, KEN 10-F	**KE 10**	**KE 20-F KE 20, KE 20-0EU KES 20, KES 20-0EU**	**KE 40, KE 40-0EU KES 40-0EU**
Recommended wire cross-sections	10 mm² AWG 6			16 mm² AWG 4
Tightening torque	4 Nm	8 Nm	8 Nm	15 Nm

	Compact power supply		
	KEN 60 (KE 60-S4) KE 60, KE 60-0EU KES 60, KES 60-0EU	**KEN 120 KE 120, KE 120-0EU KES 120, KES 120-0EU**	**KE 180-0EU KES 180-0EU**
Recommended wire cross-sections	16 mm² AWG 4	50 mm² AWG 1/0	95 mm^2 kcmil 250
Tightening torque	15 Nm	15 Nm	12 Nm

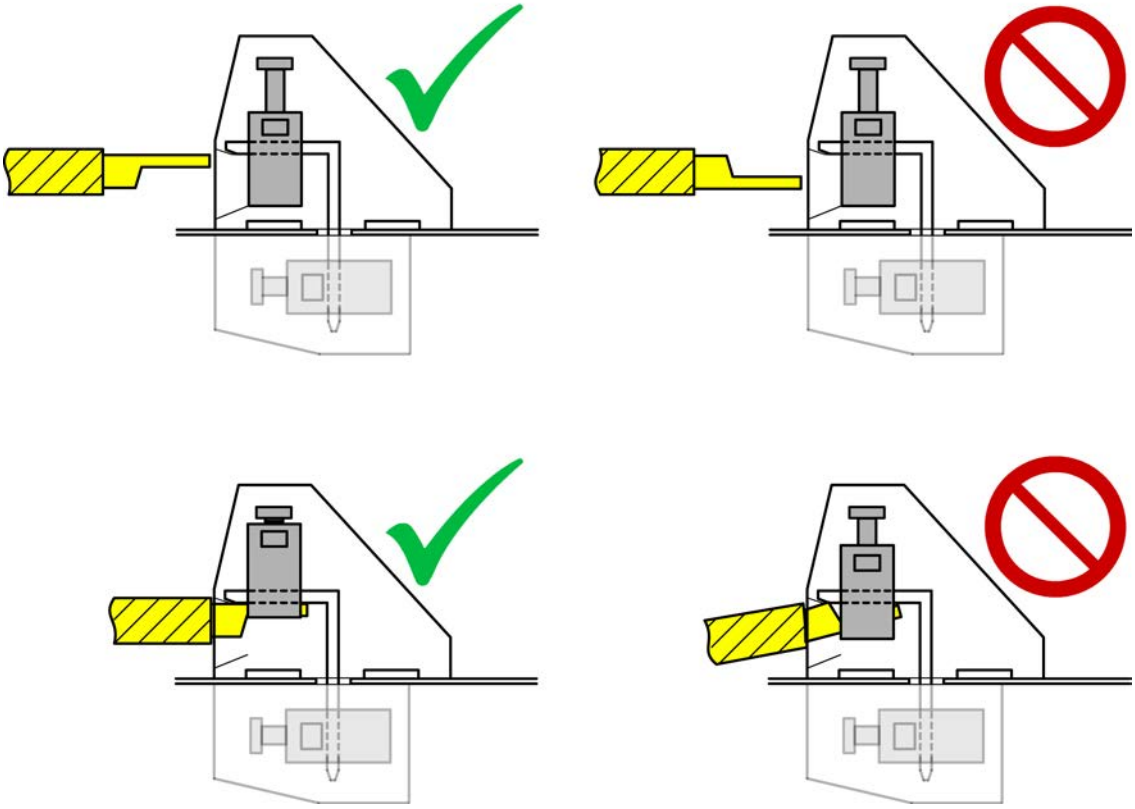
Note	Further information: Siehe 'Earthing' auf Seite 110.

8.4.2 Terminal connection technology

When using pin cable lugs please note!

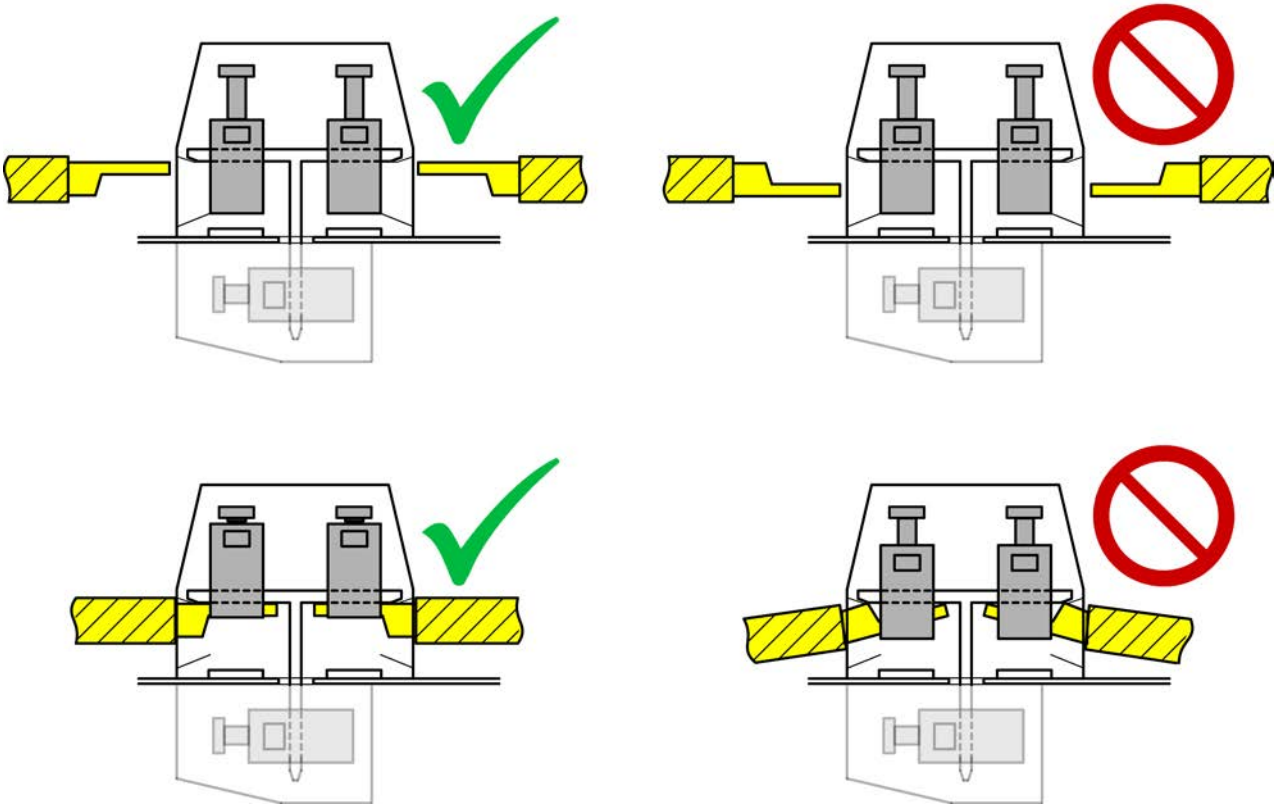
Terminal HDFKVxx

Connection	Description	Device
[X01]	Mains supply	KE 10 - KE 120
[X03]	External brake resistor	KE 10 - KE 120
[X06]	DC bus	KE 120



Terminal HDFKVxx - TWIN

Connection	Description	Device
[X02]	DC bus	KE 10 - KE 180
[X03]	External brake resistor	KE 180



8.4.3 [S1] DIP switch

8.4.3.1 KE with ACC bus interface

Using the DIP switch S1 on the KE, it is possible to change the ACC BUS baud rate and the ACC BUS subscriber address or activate and deactivate the ACC bus.

	Default value	Min/max
KE ACC bus baud rate	1000 kBd	125 kBd - 1000 kBd
KE ACC bus address	33	33 - 39
KE ACC bus	Active	Inactive

For more information or to change the default values:Siehe 'Changing the default settings' auf Seite 172.

8.4.3.2 KE with real-time Ethernet interface

Using the DIP switch S1 on the KE, it is possible to change the EtherCAT or VARAN bus subscriber address.

	Default value	Min/max
EtherCAT bus address	133	133 - 135

For more information or to change the default values:Siehe 'Changing the default settings' auf Seite 172.

8.4.4 [X01] mains supply

⚠ DANGER	
	**Danger to life from touching electrical connections!** Electrical terminals and connectors carry voltages that may cause death or serious injury upon contact. When the LEDs on the front panels are OFF, this does not indicate that the electrical terminals have been de-energized. **Steps to prevent:** • Prior to any work on the device: Observe the 5 safety rules. • Measure the terminal voltages. There may be no voltage present. • Plug and pull connections only when there is no voltage. • For devices that are connected to a DC bus, or generate it yourself, you need to consider the discharge times of the dc bus capacitors mentioned in the converter documentation • Before commencing work, the connections must be isolated from the voltage supply at both ends! (both ends mean: AC and DC bus supply side)

Description:
Mains supply over the main contactor K1 and mains choke ALN

Technical data:

- Mains voltage: 3 x 400 V, 50/60 Hz (symmetric three-phase power supply)
- Further information:Siehe ' General technical data' auf Seite 25.

Version:

Type	Pins
Up to KE 120: Screw terminal	3
KE 180: Thread bolt	3

Name [X01]	Connection
L1.1	Mains choke ALN (terminal U2)
L2.1	Mains choke ALN (terminal V2)
L3.1	Mains choke ALN (terminal W2)

Connection:

Recommended cable type	4-wire, unshielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Wire end ferrule with plastic sheath KEx 180: ring cable lug
Shield connection	If available, attach on both sides

	Compact power supply		
	KE 10	**KE 20, KE 20-0EU KES 20, KES 20-0EU**	**KE 40, KE 40-0EU KES 40-0EU**
Cross-section min./max.	0.5 mm² / 10 mm² AWG 20 / AWG 6		10 mm² / 25 mm² AWG 6 / AWG 2
Recommended wire cross-sections	2.5 mm² AWG 12	6 mm² AWG 8	16 mm² AWG 4
Cable stripping length	11 mm		19 mm
Tightening torque	1,5 - 1,8 Nm		4,0 - 4,5 Nm
Terminal	HDFKV10[1)]		HDFKV25[1)]

	Compact power supply	
	KEN 60 (KE 60-S4) KE 60, KE 60-0EU KES 60, KES 60-0EU	**KEN 120 KE 120, KE 120-0EU KES 120, KES 120-0EU**
Cross-section min./max.	10 mm^2 / 50 mm^2 AWG 6 / AWG 1/0	35 mm^2 / 95 mm^2 AWG 1 / AWG 1/0
Recommended wire cross-sections	35 mm^2 2) AWG 1	95 mm^2 AWG 4/0
Cable stripping length	24 mm	27 mm
Tightening torque	6 - 8 Nm	15 - 20 Nm
Terminal	HDFKV50 1)	HDFKV95 1)

	Compact power supply
	KE 180-0EU KES 180-0EU
Cross-section min./max.	- / 240 mm^2 - / kcmil 600
Recommended wire cross-sections	180 mm^2 (70 °C) kcmil 500
Cable stripping length	-
Tightening torque	15 Nm
Terminal	Thread bolt M12 3)

Note	1) When using pin cable lug: Siehe 'Terminal connection technology ' auf Seite 114. 2) To reach the limit values of the radio interference suppression, it may be necessary for modules KE 60, KEN 60 (KE 60-S4), KES 60 and higher with external mains filter and unfavourable cable layout and long cable lengths to use a shielded cable for the mains feeder in the switch cabinet. In this case, the cable shield has to be stranded on both sides. 3) When using 2 cables: Siehe 'Connection technology - connection bolts with 2 ring cable lugs' auf Seite 169.

8.4.5 [X02] DC bus

⚠ DANGER	
	**Danger to life from electric shock!** LED displays on the front, when indicating OFF, do not mean that the device terminals are voltage-free. After switching off the mains, the buffer capacitors for the DC bus can still have a charge and lead to a life-threatening DC voltage. **Steps to prevent:** • After switching off, expect a discharge time of at least 5 minutes. • Measure the voltage in the DC bus between the UZP / UZN terminals to ensure that the terminals are voltage-free.

Description:
The DC bus supplies DC power to the connected inverter modules.

Technical data:

- KE, KEN: 540 ... 650 VDC
- KES: regulated 650 VDC (max. 720 VDC)
- KEx 120, KEx 180: max. connection power 60 kW

Version:

Type	Pins
Screw terminal	2

Name [X02]	Connection
UZP	DC bus voltage (+)
UZN	DC bus voltage (-)

Connection:

Recommended cable type	2-wire, unshielded Use only AMK DC bus UZ cable sets. Further information: Siehe 'DC bus wiring' auf Seite 68.
Cable assembly	Wire end ferrule with plastic sheath
Shield connection	If available, attach on both sides

	Compact power supply		
	KEN 5-F KEN 5	**KEN 10-F KEN 10**	**KE 10 KE 20-F KE 20, KE 20-0EU KES 20, KES 20-0EU**
Cross-section min./max.	0.5 mm² / 4 mm² AWG 20 / AWG 12		0.5 mm² / 10 mm² AWG 20 / AWG 6
Recommended wire cross-sections	1.5 mm² AWG 14	4 mm² AWG 10	10 mm² AWG 6
Cable stripping length	9 mm		11 mm
Tightening torque	0,4 - 0,5 Nm		1,5 - 1,8 Nm
Terminal	Front 4-H-7,62-2		HDFKV10TWIN[1)]

	Compact power supply		
	KE 40, KE 40-0EU KES 40, KES 40-0EU	**KEN 60 (KE 60-S4) KE 60, KE 60-0EU KES 60, KES 60-0EU**	**KEN 120 KE 120, KE 120-0EU KES 120, KES 120-0EU**
Cross-section min./max.	4 mm² / 25 mm² AWG 10 / AWG 2		
Recommended wire cross-sections	16 mm² AWG 4	25 mm² AWG 2	25 mm² AWG 2
Cable stripping length	19 mm		
Tightening torque	4,0 - 4,5 Nm		
Terminal	HDFKV25TWIN[1)]		

	Compact power supply
	KE 180-0EU KES 180-0EU
Cross-section min./max.	4 mm² / 25 mm² AWG 10 / AWG 2
Recommended wire cross-sections	25 mm² AWG 2
Cable stripping length	19 mm
Tightening torque	4,0 - 4,5 Nm
Terminal	HDFKV25TWIN[1)]

Note	1) When using pin cable lug: Siehe 'Terminal connection technology ' auf Seite 114. A maximum length of 1 meter is permitted for the cable to connect the DC bus voltage when assembling the device with a distance between the modules. A 2-wire shielded cable might have to be used in order to limit interference radiation. In this case, the cable shield has to be stranded on both sides. (Use of longer cables only after consulting with AMK).

8.4.6 [X03] External brake resistor

⚠ DANGER	
	**Danger to life from touching electrical connections!** Electrical terminals and connectors carry voltages that may cause death or serious injury upon contact. When the LEDs on the front panels are OFF, this does not indicate that the electrical terminals have been de-energized. **Steps to prevent:** • Prior to any work on the device: Observe the 5 safety rules. • Measure the terminal voltages. There may be no voltage present. • Plug and pull connections only when there is no voltage. • For devices that are connected to a DC bus, or generate it yourself, you need to consider the discharge times of the dc bus capacitors mentioned in the converter documentation • Before commencing work, the connections must be isolated from the voltage supply at both ends! (both ends mean: AC and DC bus supply side)

Description:

An externally connected brake resistor converts excess brake energy into heat.

Controller and brake transistor are standard features on the compact power supply.

Technical data:

- Switch threshold at 800V UZP/UZN

Version:

Type	Pins
Screw terminal	2

Name [X03]	Connection
RBN	Connection for brake resistor
RBP	Connection for brake resistor

Connection:

Recommended cable type	2-wire, shielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Wire end ferrule with plastic sheath
Shield connection	Attached on both sides

	Compact power supply		
	KEN 5, KEN 5-F KEN 10, KEN 10-F	**KE 10 KE 20-F KE 20, KE 20-0EU KES 20, KES 20-0EU**	**KE 40, KE 40-0EU KES 40-0EU KEN 60 (KE 60-S4) KE 60, KE 60-0EU KES 60, KES 60-0EU**
Cross-section min./max.	0.25 mm² / 1.5 mm² AWG 24 / AWG 14	0.5 mm² / 10 mm² AWG 20 / AWG 6	0.5 mm² / 16 mm² AWG 20 / AWG 4
Recommended wire cross-sections	1.5 mm² AWG 14	6 mm² AWG 8	6 mm² AWG 8
Cable stripping length	14 mm	11 mm	16 mm
Tightening torque	0,5 - 0,6 Nm	1,5 - 1,8 Nm	2,0 - 2,3 Nm
Terminal	Front 2,5-H/SA5	HDFKV10[1)]	HDFKV16[1)]

	Compact power supply	
	KEN 120 **KE 120, KE 120-0EU** **KES 120, KES 120-0EU**	**KE 180-0EU** **KES 180-0EU**
Cross-section min./max.	0.5 mm² / 16 mm² AWG 20 / AWG 4	4 mm² / 25 mm² AWG 10 / AWG 2
Recommended wire cross-sections	6 mm² AWG 8	16 mm² AWG 6
Cable stripping length	16 mm	19 mm
Tightening torque	2,0 - 2,3 Nm	4,0 - 4,5 Nm
Terminal	HDFKV16[1)]	HDFKV25TWIN[1)]

Note	1) When using pin cable lug: Siehe 'Terminal connection technology ' auf Seite 114.

8.4.7 [X06] DC bus

⚠ DANGER	
	**Danger to life from electric shock!** LED displays on the front, when indicating OFF, do not mean that the device terminals are voltage-free. After switching off the mains, the buffer capacitors for the DC bus can still have a charge and lead to a life-threatening DC voltage. **Steps to prevent:** • After switching off, expect a discharge time of at least 5 minutes. • Measure the voltage in the DC bus between the UZP / UZN terminals to ensure that the terminals are voltage-free.

Description:

The DC bus supplies DC power to the connected inverter modules.

X06 is intended for connecting compact inverters from KW 100 upwards.

Technical data:

- Terminal is present only at KEx 120, KEx 180
- Max. connection power
  KEx 120: 100 kW
  KEx 180: 200 kW
- KE, KEN: 540 ... 650 VDC
- KES: controlled 650 VDC (max. 720 VDC)

Version:

Type	Pins
KEx 120: Screw terminal	2
KEx 180, KEx 240: Thread bolt	2

Name [X06]	Connection
UZP	DC bus voltage (+)
UZN	DC bus voltage (-)

Connection:

Recommended cable type	KEx 120: 2-wire, unshielded KEx 180 : Single wire, unshielded Use only AMK DC bus cable sets Further information: Siehe 'DC bus wiring' auf Seite 68.
Cable assembly	KEx 120: Wire end ferrule with plastic sheath KEx 180 : ring cable lug
Shield connection	If available, attach on both sides

	Compact power supply	
	KEN 120 **KE 120, KE 120-0EU** **KES 120, KES 120-0EU**	**KE 180-0EU** **KES 180-0EU**
Cross-section min./max.	35 mm² / 95 mm² AWG 1 / AWG 1/0	- / 240 mm^2 - / kcmil 600
Recommended wire cross-sections	50 mm² AWG 1/0	150 mm^2 kcmil 250
Cable stripping length	27 mm	-
Tightening torque	15 - 20 Nm	15 Nm
Terminal	HDFKV95[1)]	Thread bolt M12[2)]

Note	1) When using pin cable lug: Siehe 'Terminal connection technology ' auf Seite 114. 2) When using 2 cables: Siehe 'Connection technology - connection bolts with 2 ring cable lugs' auf Seite 169. A maximum length of 1 meter is permitted for the cable to connect the DC bus voltage when assembling the device with a distance between the modules. A 2-wire shielded cable might have to be used in order to limit interference radiation. In this case, the cable shield has to be stranded on both sides. (Use of longer cables only after consulting with AMK).

8.4.8 [X07] mains supply

⚠ DANGER	
	**Danger to life from touching electrical connections!** Electrical terminals and connectors carry voltages that may cause death or serious injury upon contact. When the LEDs on the front panels are OFF, this does not indicate that the electrical terminals have been de-energized. **Steps to prevent:** • Prior to any work on the device: Observe the 5 safety rules. • Measure the terminal voltages. There may be no voltage present. • Plug and pull connections only when there is no voltage. • For devices that are connected to a DC bus, or generate it yourself, you need to consider the discharge times of the dc bus capacitors mentioned in the converter documentation • Before commencing work, the connections must be isolated from the voltage supply at both ends! (both ends mean: AC and DC bus supply side)

Description:
Direct mains supply (KEN 10 via ALN mains choke); main contactor is integrated.

Technical data:
- Mains voltage: 3 x 400 V, 50/60 Hz (symmetric three-phase power supply)
- Further information: Siehe ' General technical data' auf Seite 25.

Version:

Type	Pins
Screw terminal	3

Name [X07]	Connection
L1.1	Mains choke ALN (terminal U2)
L2.1	Mains choke ALN (terminal V2)
L3.1	Mains choke ALN (terminal W2)

Connection:

Recommended cable type	4-wire, unshielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Wire end ferrule with plastic sheath
Shield connection	-

	Compact power supply	
	KEN 5	**KEN 10**
Cross-section min./max.	0.5 mm² / 4 mm² AWG 20 / AWG 12	
Recommended wire cross-sections	1.5 mm² AWG 14	2.5 mm² AWG 12
Cable stripping length	14 mm	
Tightening torque	0.5 - 0.6 Nm	
Terminal	FRONT 4-H-7.62-3	

8.4.9 [X08, X09] supply voltage 24 VDC

NOTICE	
Material Damage!	**Overload of the terminal and the internal circuit board!** The connected rating of the terminals X08, X09 is restricted. The terminals X08 or X09 are designed for a current of at most 8 A. **Steps to prevent:** • A looping of the 24 VDC supply voltage is permitted for a total of 5 modules at the most. • If more than 5 devices are installed, each group of five needs to be supplied separately with 24 VDC.

NOTICE	
Material Damage!	**Material damage caused by incorrect handling!** Mechanical damage to terminals! Disconnected signal lines. **Steps to prevent:** • The plug connectors are partially encoded. Do not push in with force. • Never pull on the cable, but rather on the connector casing. • For service purposes, use the control tap.

Description

For supplying the internal switched mode power supply and the fan.

X08: Connection 24 VDC supply voltage

X09: Looping of the voltage

Technical data

- 24 VDC ± 15% Power supply unit with potential separation according to VDE 0160.
- Ripple max. 5%, with integrated switch-on current limitation
- The 0 V potential of the power supply unit should be earthed at the central PE.

Version

Type	Pins	Class
Connector with spring connection	2	1-row pin strip

Assignment

[X08] / [X09]	Connection	Signal	Description
front view, device side X09 PIN 2 X09 PIN 1 X08 PIN 2 X08 PIN 1 	1	0 VDC	Connection 0 VDC logic supply
	2	24 VDC	Connection 24 VDC logic supply

Connection

Recommended cable type	2-wire, unshielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Flexible line or wire end ferrule without plastic sheath
Shield connection	-

	Complete KE/KW series
Cross-section min./max.	0.25 mm²/ 1.5 mm² AWG 24 / AWG 16
Recommended wire cross-sections	0.75 mm² AWG 18
Cable stripping length	9 mm
Terminal	FK-MCP 1,5/2-ST-3,80

Note	A loss of the 24V supply > 10 ms creates a fault: Internally the "SBM (System Ready)" message is reset and the main contactor is released.

8.4.10 [X20] mains supply - power supply to charging circuit, controller for main contactor

⚠ DANGER

Danger to life from touching electrical connections!

Electrical terminals and connectors carry voltages that may cause death or serious injury upon contact.

When the LEDs on the front panels are OFF, this does not indicate that the electrical terminals have been de-energized.

Steps to prevent:

- Prior to any work on the device: Observe the 5 safety rules.
- Measure the terminal voltages. There may be no voltage present.
- Plug and pull connections only when there is no voltage.
- For devices that are connected to a DC bus, or generate it yourself, you need to consider the discharge times of the dc bus capacitors mentioned in the converter documentation
- Before commencing work, the connections must be isolated from the voltage supply at both ends! (both ends mean: AC and DC bus supply side)

NOTICE

Material Damage!

Material damage caused by incorrect handling!

Mechanical damage to terminals!

Disconnected signal lines.

Steps to prevent:

- The plug connectors are partially encoded. Do not push in with force.
- Never pull on the cable, but rather on the connector casing.
- For service purposes, use the control tap.

Description:

L1, L2, L3: The DC bus capacitors are charged by the internal charging circuit.

The DC bus capacitors supply power by way of dynamic acceleration. Generative energy is temporarily stored.

After completing the loading process of the DC bus a relay is activated in the KE. The externally installed main contactor K1 is switched on over the NO contact (EH1/EH2) of the relay and thus the KE module is connected directly to the mains power.

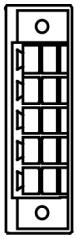
Technical data:

- Mains voltage: 3 x 400 V - 480 V ± 10%, 50/60 Hz (symmetric three-phase power supply)
- Inductor voltage of the main contactor K1 depending on the type: 24 VDC or 24 - 230 VAC 50/60Hz.
- The connections for terminals X20: L1, L2, L3 and
  X01: L1.1, L2.1, L3.1 have to be wired in phase.

Version:

Type	Pins
Connector	5

Assignment:

[X20]	Connection	Description
front view, device side L1 L2 L3 EH1 EH2 	L1	Line phase L1 secured by charging fuses
	L2	Line phase L2 secured by charging fuses
	L3	Line phase L3 secured by charging fuses
	EH1	Controller, main contactor K1
	EH2	Input for exciting voltage of main contactor K1

Connection:

Recommended cable type	5-wire, unshielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Wire end ferrule with plastic sheath
Shield connection	-

	Compact power supply			
	KE 10	**KE 20-F** **KE 20** **KE 20-0EU** **KES 20** **KES 20-0EU**	**KE 40** **KE 40-0EU** **KES 40-0EU**	**KEN 60 (KE 60-S4)** **KE 60** **KE 60-0EU** **KES 60** **KES 60-0EU**
Cross-section min./max.	0.25 mm² / 4 mm² AWG 24 / AWG 10			
Recommended wire cross-sections	1 mm² AWG 16			
Cable stripping length	10 mm			
Tightening torque	0.5 - 0.6 Nm			
Terminal	PC4HV/5			

	Compact power supply	
	KEN 120 **KE 120** **KE 120-0EU** **KES 120** **KES 120-0EU**	**KE 180-0EU** **KES 180-0EU**
Cross-section **min./max.**	0.25 mm² / 4 mm² AWG 24 / AWG 10	
Recommended **wire cross-sections**	1 mm² AWG 16	
Cable stripping length	10 mm	
Tightening torque	0.5 - 0.6 Nm	
Terminal	PC4HV/5	

Note	The fastening screws must be tightened. (0.5 - 0.6 Nm)

8.4.11 [X21] two binary outputs and supply voltage for X21 and X22

NOTICE	
Material Damage!	**Material damage caused by incorrect handling!** Mechanical damage to terminals! Disconnected signal lines. **Steps to prevent:** • The plug connectors are partially encoded. Do not push in with force. • Never pull on the cable, but rather on the connector casing. • For service purposes, use the control tap.

Description:

Terminal X21 features 2 binary outputs.

The supply voltage for terminals X21 and X22 is applied on terminal X21.

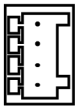
Technical data:

- Potentially separated by optocoupler
- Encoding pin 2
- Nominal voltage outputs: +24 V ext
- Nominal current (outputs): 100 mA, permanently short-circuit safe
- Updates: 1 ms

Version:

Type	Pins
Connector with spring connection	4

Assignment:

[X21]	Connection	Signal	Description
front view, device side PIN 4 PIN 3 PIN 2 PIN 1 	1	SBM	Binary output 1 (BA1) Default assignment: Code 33029 (SBM) The output indicates the fault-free status of the module. Binary output 1 can be freely configured. ID32865 'Port 3 Bit 0'
	2	DC Bus Enable	Binary output 2 (BA2) Default assignment: Code 33030 (QUE) The output indicates a loaded DC bus. Binary output 2 can be freely configured. ID32866 'Port 3 Bit 1'
	3	0 V	Reference potential of the external supply voltage 24V DC
	4	24 VDC	Shared feed of the external supply voltage 24 VDC for the binary outputs to X21 and X22.

Connection:

Recommended cable type	4-wire, shielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Flexible line or wire end ferrule without plastic sheath
Shield connection	Lay on one end on the module casing

	Complete KEN / KE / KES series
Cross-section min./max.	0.25 mm² / 0.5 mm² AWG 24 / AWG 20
Recommended wire cross-sections	0.5 mm² AWG 20
Cable stripping length	8 mm
Terminal	FK-MC 0,5/4-ST-2,5

Note	The 0 V potential should be earthed at the central PE.

8.4.12 [X22] two binary inputs and two binary outputs

NOTICE	
Material Damage!	**Material damage caused by incorrect handling!** Mechanical damage to terminals! Disconnected signal lines. **Steps to prevent:** • The plug connectors are partially encoded. Do not push in with force. • Never pull on the cable, but rather on the connector casing. • For service purposes, use the control tap.

Description:

Terminal X22 features 2 binary inputs and 2 binary outputs.

The supply voltage for terminal X22 is fed in via terminal X21.

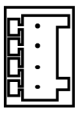
Technical data:

- Potentially separated by optocoupler
- encoding pin 4
- Nominal voltage inputs: +24 V ext
- Nominal current inputs: 8 mA
- Monitoring cycle: 1 ms
- Nominal voltage outputs: +24 V ext.
- Nominal current (outputs): 100 mA, permanently short-circuit safe
- Updates: 1 ms

Version:

Type	Pins
Connector with spring connection	4

Assignment:

[X22]	Connection	Signal	Description
front view, device side PIN 4 PIN 3 PIN 2 PIN 1 	1	FL	Binary input 1 (BE1) Permanent setting: Clear error (FL) After removing the cause for error the compact power supply can be returned into the "System ready" status SBM = 1 with "Clear error" (positive edge at input FL).
	2	DC bus enable	Binary input 2 (BE2) Permanent setting: DC bus on (UE) The charging circuit of the compact power supply is controlled by way of a positive edge and the subsequent status UE=1.
	3	-	Binary output 3 (BA3) Default setting: Code 33123 (VBNX) UPS control Binary output 3 can be freely configured. ID32867 'Port 3 Bit 2'
	4	-	Binary output 4 (BA4) Default setting: - Binary output 4 can be freely configured. ID32868 'Port 3 Bit 3'

Connection:

Recommended cable type	4-wire, shielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Flexible line or wire end ferrule without plastic sheath
Shield connection	Lay on one end on the module casing

	Complete KEN / KE / KES series
Cross-section min./max.	0.25 mm² / 0.5 mm² AWG 24 / AWG 20
Recommended wire cross-sections	0.5 mm² AWG 20
Cable stripping length	8 mm
Terminal	FK-MC 0,5/4-ST-2,5

8.4.13 [X23] service interface

Only for service purposes (AMK)

8.4.14 [X25] PTC thermistor connection (temperature sensor)

NOTICE	
Material Damage!	**Fire hazard!** The brake resistor may overheat in general if: the rotational energy is not limited, a component in the power supply is defective or it is not installed properly. The cooling air through the brake resistor can reach temperatures of up to 200 °C. **Steps to prevent:** • The PTC thermistor in the brake resistor must be used for temperature monitoring. Connection to X25, evaluation in the power supply. • The brake resistor may not be installed in the air intake area for cooling electronic equipment. • Do not use any flammable materials in the direct vicinity of the brake resistor.

NOTICE	
Material Damage!	**Material damage caused by incorrect handling!** Mechanical damage to terminals! Disconnected signal lines. **Steps to prevent:** • The plug connectors are partially encoded. Do not push in with force. • Never pull on the cable, but rather on the connector casing. • For service purposes, use the control tap.

Description:

PTC thermistor connection for temperature monitoring on the external brake resistor (and mains filter).

Technical data:

- PTC thermistor

Version:

Type	Pins
Connector with spring connection	2

Assignment:

[X25]	Connection	Signal	Direction	Description
front view, device side PIN 2 PIN 1 	1	RT1	A	Connection PTC thermistor
	2	RT2	E	Connection PTC thermistor

Connection:

Recommended cable type	2-wire, shielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Flexible line or wire end ferrule without plastic sheath
Shield connection	Lay on one end on the module casing

	Complete KEN / KE / KES series
Cross-section min./max.	0.25 mm² / 0.5 mm² AWG 24 / AWG 20
Recommended wire cross-sections	0.5 mm² AWG 20
Cable stripping length	8 mm
Terminal	FK-MC 0,5/2-ST-2,5

Note	If the brake resistor / PTC thermistor is not present, RT1 and RT2 have to be bridged.

8.4.15 [X85/X86] real-time Ethernet

Description:

The compact power supplies KE(N/S) xx-0EU have a real-time Ethernet interface.

The interface is constructed as a real-time Ethernet interface and supports the following protocols:

- EtherCAT SoE (Servo Drive Profile over EtherCAT according to IEC 61800-7-300)
- EtherCAT CoE (Drive profile CiA 402 according to IEC 61800-7-201/301)
- EtherCAT EoE (Ethernet over EtherCAT)
- VARAN SoV (Servo Drive Profile over VARAN (SoV) according to IEC 61800-7-300)

X85: Connection master or previous node

X86: Connection next node (X85)

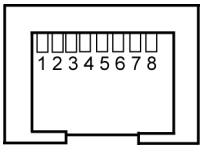
Technical data:

- 100BASE-T 100 Mbit/s Ethernet standard
- Data frame and assignment of the RJ45 socket
- Maximum length 50 m (industrial environment)

Features:

Type	Pins	Class
RJ45	8	Socket

Assignment:

[X85] / [X86]	Pin	Signal	Description
front view, device side 	1	Tx+	Transmit data +
	2	Tx-	Transmit data -
	3	Rx+	Receive data +
	4	-	Reserved
	5	-	Reserved
	6	Rx-	Receive data -
	7	-	Reserved
	8	-	Reserved

Connection:

Cable type	Patch cable of the category CAT5e, shielded
Cross-section min-max	0.32 mm² / AWG 22
Shield connection	Both sides
Cable assembly	RJ45 connector, prefabricated cables
Note	-

8.4.16 [X136, X137, X236, X237] ACC bus interface

Description:

The ACC bus system bus (ACC: AMKSYN CAN COMMUNICATION) is a standard 2.0B CAN bus connection, which features an additional hardware synchronisation.

Access to all parameters is available via the ACC bus.

Long ACC bus lines (total: > 25 m) may make it necessary to reduce the transmission speed. In consultation with the AMK service department, the baud rate for all modules (KE/KW) needs to be set to a lower value.

X236: KE, KEN, KES

X237: KE, KEN, KES

X136: KU/KW-R03(P) and KU/KW-R04

X137: KU/KW-R03(P) and KU/KW-R04

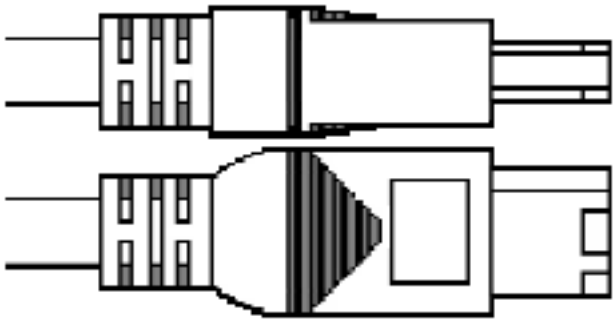
Technical data:

- Standard firewire cable acc. to IEEE1394
- Maximum lengths varies acc. to transfer speed.

Version:

Type	Pins	Class
FireWire connector IEEE1394	6	Socket

Counterpart of FireWire cable:



Assignment:

[X136] / [X137] / [X236] / [X237]	Connection	X136 / X236		X137 / X237	
		Signal	Description	Signal	Description
top view, device side X136 X236  X137 X237 	1	N.C.		N.C.	
	2	GND	Ground	GND	Ground
	3	SYNC_H	SYNC High	CAN_H	CAN High
	4	SYNC_L	SYNC Low	CAN_L	CAN Low
	5	CAN_H	CAN High	SYNC_H	SYNC High
	6	CAN_L	CAN Low	SYNC_L	SYNC Low
	Casing	PE	Shield	PE	Shield

Connection:

Recommended cable type	3x2-wire, pair-stranded, shielded
Cable assembly	FireWire connector IEEE1394

	Complete KEN / KE / KES series
Terminal	AMK part no. 29240
Prefabricated cables	140 mm (AMK part no. 29237)
	210 mm (AMK part no. 29231)
	300 mm (AMK part no. 200053)
	1 m (AMK part no. 29523)
	1.8 m (AMK part no. 29543)
	4 m (AMK part no. 29544)
	5 m (AMK part no. 200507)
	10 m (AMK part no. 29545)

8.4.17 [X235] USB

Description:

Via the mini-USB interface, the compact power supply can be connected to a PC and the software AIPEX PRO for startup and diagnosis.

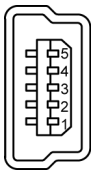
Technical data:

USB V1.1 Slave

Features:

Type	Pins	Class
USB V1.1 type A to mini-USB type B	5	Socket

Assignment:

[X235]	Connection	Signal	Description
front view, device side 	1	5 VDC input	External 5 VDC supply from USB master, max. 50 mA current consumption
	2	D–	Data –
	3	D+	Data +
	4	5 VDC	Reserved for AMK
	5	GND	Reference potential

Connection:

Cable type	Data+ and Data– pair-stranded, shielded
Cross-section min-max	0.08 mm² / AWG 28
Shield connection	Attached on both sides
Cable assembly	Prefabricated cables
Note	Maximum 3 metres length permitted for USB cable! With active USB repeater, longer cable lengths are possible.

8.5 Connection technology KE without fieldbus interface

Compact power supplies KEN 5-xN, and KEN 5-S10 and KEN 20-0N are configured with print terminals with spring-cage connections.

By use of stranded wires with ferrules, the devices can be wired tool-freely by push-in terminals. For stranded wires without ferrules and for loosening the terminal connection, you will need a screwdriver.

8.5.1 PE connection

⚠ DANGER

Danger to life from electrical shock!

In the event of an interruption to the PE connection, avoid touching the casing because life-threatening levels of voltage may be present!

Steps to prevent:

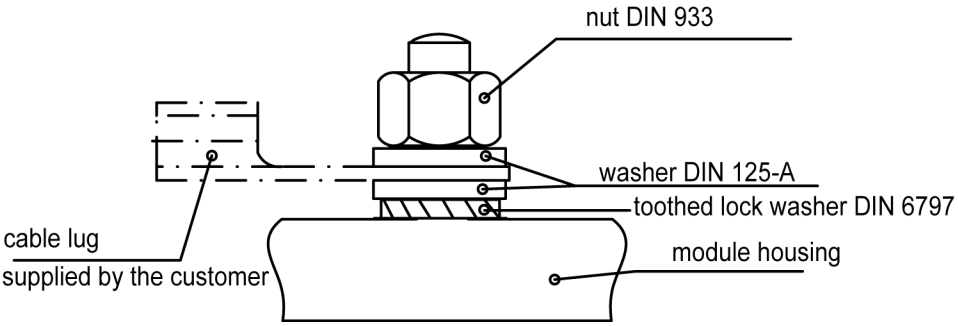
- EN 61800-5-1 requires that the devices be firmly connected on the power side.
- The PE conductor must have a cross-section of at least 10 mm^2 or must have a second PE connection with a cross-section at least equal to the mains feeder (cf. EN 61800-5-1).

Cross-section AC wire	Cross-section PE wire
≤ 10 mm^2	= 10 mm^2
10 ... 16 mm^2	= Cross-section AC wire
16 ... 35 mm^2	= 16 mm^2
≥ 35 mm2	≈ 1/2 x Cross-section AC wire

Description:

The PE connection is a screw bolt M5 on the module casing (see front view) for attaching PE lines and cable shields.

Configure as follows:



Connection:

Recommended cable type	1-wire, unshielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Ring cable lug

	Compact power supply	
	KEN 5-0N, KEN 5-FN, KEN 5-S10	**KEN 20-0N**
Recommended wire cross-sections	10 mm² AWG 6	10 mm² AWG 6
Tightening torque	4 Nm	4 Nm

Note	Further information: Siehe 'Earthing' auf Seite 110.

8.5.2 [X01] mains supply

⚠ DANGER	
	**Danger to life from touching electrical connections!** Electrical terminals and connectors carry voltages that may cause death or serious injury upon contact. When the LEDs on the front panels are OFF, this does not indicate that the electrical terminals have been de-energized. **Steps to prevent:** • Prior to any work on the device: Observe the 5 safety rules. • Measure the terminal voltages. There may be no voltage present. • Plug and pull connections only when there is no voltage. • For devices that are connected to a DC bus, or generate it yourself, you need to consider the discharge times of the dc bus capacitors mentioned in the converter documentation • Before commencing work, the connections must be isolated from the voltage supply at both ends! (both ends mean: AC and DC bus supply side)

Description:

Mains supply over the main contactor K1 and the optional mains choke

Technical data KEN 5-xN:

- Mains voltage: 3 x 230 ... 480 VAC ±10 %, 47 ... 63 Hz
  symmetric three-phase power supply with earthed neutral
  maximum voltage unbalance 3 %
- Further information: Siehe ' General technical data' auf Seite 25.

Technical data KEN 5-S10 and KEN 20-0N:

- Mains voltage: 3 x 400 ... 480 VAC ±10 %, 47 ... 63 Hz
  symmetric three-phase power supply with earthed neutral
  maximum voltage unbalance 3 %
- Further information: Siehe ' General technical data' auf Seite 25.

Version:

Type	Pins
print terminal with spring-cage connection	3

Name [X01]	Connection
L1	Main contactor or mains choke
L2	Main contactor or mains choke
L3	Main contactor or mains choke

Connection:

Recommended cable type	4-wire, unshielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Wire end ferrule with plastic sheath
Shield connection	If available, attach on both sides

	Compact power supply	
	KEN 5-0N, KEN 5-FN, KEN 5-S10	**KEN 20-0N**
Cross-section min./max.	0.25 mm² / 4 mm² AWG 22 / AWG 12	0.75 mm^2 - 10 mm^2 AWG 18 - AWG 7
Recommended wire cross-sections	1.5 mm² AWG 16	6 mm² AWG 8
Cable stripping length	15 mm	18 mm
Terminal	SPT 5/ 3-H-7,5	SPT 16/3-H-10,0

Note	The cable shield has to be stranded on both sides.

8.5.3 [X02] DC bus

⚠ DANGER	
	**Danger to life from electric shock!** LED displays on the front, when indicating OFF, do not mean that the device terminals are voltage-free. After switching off the mains, the buffer capacitors for the DC bus can still have a charge and lead to a life-threatening DC voltage. **Steps to prevent:** • After switching off, expect a discharge time of at least 5 minutes. • Measure the voltage in the DC bus between the UZP / UZN terminals to ensure that the terminals are voltage-free.

Description:

The DC bus supplies DC power to the connected inverter modules or decentralised inverters.

Technical data KEN5-xN:

- 300 ... 750 VDC

Technical data KEN 5-S10 and KEN 20-0N:

- 540 ... 650 VDC

Version:

Type	Pins
print terminal with spring-cage connection	2

Name [X02]	Connection
UZP	DC bus voltage (+)
UZN	DC bus voltage (-)

Connection:

Recommended cable type	2-wire, unshielded Use only AMK DC bus UZ cable sets. Further information: Siehe 'DC bus wiring' auf Seite 68.
Cable assembly	Wire end ferrule with plastic sheath When using compact inverters KWD or KWZ must be replaced the pin terminal against with a wire end ferrule with plastic sheath.
Shield connection	If available, attach on both sides

	Compact power supply	
	KEN 5-0N, KEN 5-FN, KEN 5-S10	**KEN 20-0N**
Cross-section min./max.	0.25 mm² / 4 mm² AWG 22 / AWG 12	0.75 mm² / 10 mm² AWG 18 / AWG 7
Recommended wire cross-sections	2.5 mm² AWG 12	10.0 mm² AWG 7
Cable stripping length	15 mm	18 mm
Terminal	SPT 5/ 4-H-7,5	SPT 16/ 4-H-10,0

Note	A maximum length of 1 meter is permitted for the cable to connect the DC bus voltage when assembling the device with a distance between the modules. (Use of longer cables only after consulting with AMK). A 2-wire shielded cable might have to be used in order to limit interference radiation. The cable shield has to be stranded on both sides.

8.5.4 [X03] external brake resistor

⚠ DANGER	
	**Danger to life from touching electrical connections!** Electrical terminals and connectors carry voltages that may cause death or serious injury upon contact. When the LEDs on the front panels are OFF, this does not indicate that the electrical terminals have been de-energized. **Steps to prevent:** • Prior to any work on the device: Observe the 5 safety rules. • Measure the terminal voltages. There may be no voltage present. • Plug and pull connections only when there is no voltage. • For devices that are connected to a DC bus, or generate it yourself, you need to consider the discharge times of the dc bus capacitors mentioned in the converter documentation • Before commencing work, the connections must be isolated from the voltage supply at both ends! (both ends mean: AC and DC bus supply side)

Description:

An externally connected brake resistor converts excess brake energy into heat.
Controller and brake transistor are standard features on the compact power supply.

Technical data:

- Switch threshold at 800V UZP/UZN

Version:

Type	Pins
print terminal with spring-cage connection	2

Name [X03]	Connection
RBP	Connection for brake resistor
RBN	Connection for brake resistor

Connection:

Recommended cable type	2-wire, shielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Wire end ferrule with plastic sheath
Shield connection	Attached on both sides

	Compact power supply	
	KEN 5-0N, KEN 5-FN, KEN 5-S10	**KEN 20-0N**
Cross-section min./max.	0.25 mm² / 4 mm² AWG 22 / AWG 12	0.75 mm² / 10 mm² AWG 18 / AWG 7
Recommended wire cross-sections	1.5 mm² AWG 16	6 mm² AWG 8
Cable stripping length	15 mm	18 mm
Terminal	SPT 5/ 4-H-7,5	SPT 16/ 4-H-10,0

8.5.5 [X04] two binary outputs and supply voltage

NOTICE	
Material Damage!	**Material damage caused by incorrect handling!** Mechanical damage to terminals! Disconnected signal lines. **Steps to prevent:** • The plug connectors are partially encoded. Do not push in with force. • Never pull on the cable, but rather on the connector casing. • For service purposes, use the control tap.

Description:

Terminal X04 features 2 binary outputs.

The supply voltage for the binary outputs is applied on terminal X04.

Technical data:

- Potentially separated by optocoupler
- Nominal voltage outputs: +24 V ext
- Nominal current (outputs): 100 mA, permanently short-circuit safe
- High-side switch
- Updates: 1 ms

Version:

Type	Pins
print terminal with spring-cage connection	4

Assignment from SW-version: V1.02_1438_205360

[X04]	Connection	Signal	Description
front view, device side	WBA	24 VDC	Feed of the external supply voltage 24 VDC for the binary outputs to X04
	BA1	QUE	Binary output 1 The output indicates a completely loaded DC bus
	BA2	SBM	Binary output 2 System ready message
	GND	0 V	Reference potential of the external supply voltage 24 VDC

Assignment until SW-version: V1.02_1416_204981

[X04]	Connection	Signal	Description
front view, device side	WBA	24 VDC	Feed of the external supply voltage 24 VDC for the binary outputs to X04
	BA1	SBM	Binary output 1 The output indicates a completely loaded DC bus
	BA2	BTE	Binary output 2 Monitoring external temperature monitoring The output indicates the ready message of the brake
	GND	0 V	Reference potential of the external supply voltage 24 VDC

Connection:

Recommended cable type	4-wire, shielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Flexible line or wire end ferrule without plastic sheath
Shield connection	Attached on both sides

	Compact power supply	
	KEN 5-0N, KEN 5-FN, KEN 5-S10	**KEN 20-0N**
Cross-section min./max.	0.25 mm² / 1.5 mm² AWG 24 / AWG 16	0.25 mm² / 1.5 mm² AWG 24 / AWG 16
Recommended wire cross-sections	0.5 mm² AWG 20	0.5 mm² AWG 20
Cable stripping length	flexible line 10 mm wire end ferrule 8 mm	flexible line 10 mm wire end ferrule 8 mm
Terminal	SPT 1,5/ 4-H-3,5	SPT 1,5/ 4-H-3,5

Note	Maximum line length 30 m The 0 V potential should be earthed at the central PE.

8.5.6 [X06] PTC thermistor connection (temperature sensor)

NOTICE	
Material Damage!	**Fire hazard!** The brake resistor may overheat in general if: the rotational energy is not limited, a component in the power supply is defective or it is not installed properly. The cooling air through the brake resistor can reach temperatures of up to 200 °C. **Steps to prevent:** • The PTC thermistor in the brake resistor must be used for temperature monitoring. Connection to X25, evaluation in the power supply. • The brake resistor may not be installed in the air intake area for cooling electronic equipment. • Do not use any flammable materials in the direct vicinity of the brake resistor.

Description:

PTC thermistor connection for temperature monitoring on the external brake resistor.

A safely isolated temperature sensor is required.

Technical data:

- PTC thermistor

Version:

Type	Pins
print terminal with spring-cage connection	2

Assignment:

[X06]	Connection	Signal	Description
front view, device side	1	RT1	Connection PTC thermistor
	2	RT2	Connection PTC thermistor

Connection:

Recommended cable type	2-wire, shielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Flexible line or wire end ferrule without plastic sheath
Shield connection	Lay on one end on the module casing

	Compact power supply	
	KEN 5-0N, KEN 5-FN, KEN5-S10	**KEN 20-0N**
Cross-section min./max.	0.25 mm² / 1.5 mm² AWG 24 / AWG 16	0.25 mm² / 1.5 mm² AWG 24 / AWG 16
Recommended wire cross-sections	0.5 mm² AWG 20	0.5 mm² AWG 20
Cable stripping length	flexible line 10 mm wire end ferrule 8 mm	flexible line 10 mm wire end ferrule 8 mm
Terminal	SPT 1,5/ 2-H-3,5	SPT 1,5/ 2-H-3,5

Note	Maximum line length 30 m If the brake resistor / PTC thermistor is not present, RT1 and RT2 have to be bridged.

8.5.7 [X08, X07] supply voltage 24 VDC

NOTICE	
Material Damage!	**Overload of the terminal and the internal circuit board!** The connected rating of the terminals X08, X09 is restricted. The terminals X08 or X09 are designed for a current of at most 8 A. **Steps to prevent:** • A looping of the 24 VDC supply voltage is permitted for a total of 5 modules at the most. • If more than 5 devices are installed, each group of five needs to be supplied separately with 24 VDC.

Description:

For supplying the internal switched mode power supply and the fan.

X08: Connection 24 VDC supply voltage

X07: Looping of the voltage

The terminal blocks X08 and X07 are connected internally.

After applying the 24 VDC supply voltage, the DC bus will be loaded automatically when switching on the mains voltage (X01). Switching back on again is not possible until the DC bus voltage is dropped below 60 VDC. The LED H2 going out and the binary output BA2 resetting, indicate this voltage level

Technical data:

- 24 VDC ± 15% Power supply unit with potential separation according to VDE 0160.
- Ripple max. 5%, with integrated switch-on current limitation
- The 0 V potential of the power supply unit should be earthed at the central PE.

Version:

Type	Pins
print terminal with spring-cage connection	2

Assignment:

<table>
<tr><th>[X08] / [X07]</th><th>Connection</th><th>Signal</th><th>Description</th></tr>
<tr><td rowspan="4">front view,
device side</td><td>24B</td><td>24 VDC</td><td>24 VDC transmission: Can be used for STO / motor holding brake.
<table>
<tr><th>Connection</th><th>Signal level</th><th>Meaning</th></tr>
<tr><td>C</td><td>16 - 24 VDC</td><td>STO = OFF,
Motor holding brake = can be opened</td></tr>
<tr><td>C</td><td>0 - 7 VDC</td><td>STO = ON,
Motor holding brake = ZU</td></tr>
</table>
The supply voltage directly controls the STO state and at the same time supplies an optional motor holding brake with power.</td></tr>
<tr><td>0B</td><td>0 VDC</td><td>Reference potential for 24 B</td></tr>
<tr><td>24V</td><td>24 VDC</td><td>Connection 24 VDC logic supply</td></tr>
<tr><td>0V</td><td>0 VDC</td><td>Connection 0 VDC logic supply</td></tr>
</table>

Connection:

Recommended cable type	2-wire, unshielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Flexible line or wire end ferrule without plastic sheath
Shield connection	-

	Compact power supply	
	KEN 5-0N, KEN 5-FN, KEN 5-S10	**KEN 20-0N**
Cross-section min./max.	0.25 mm²/ 1.5 mm² AWG 24 / AWG 16	0.25 mm²/ 1.5 mm² AWG 24 / AWG 16
Recommended wire cross-sections	0.75 mm² AWG 18	0.75 mm² AWG 18
Cable stripping length	flexible line 10 mm wire end ferrule 8 mm	flexible line 10 mm wire end ferrule 8 mm
Terminal	SPT 1,5/4-H-3,5	SPT 1,5/4-H-3,5

Note	Maximum line length 30 m A loss of the 24V supply > 10ms creates a fault: Internally the "SBM (System Ready)" message is reset and the main contactor is released.

8.6 Connection technology KW

8.6.1 PE connection

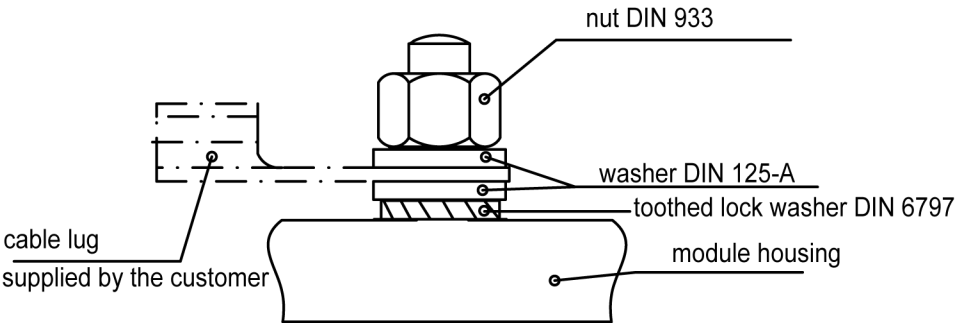
DANGER	
	**Danger to life from electrical shock!** In the event of an interruption to the PE connection, avoid touching the casing because life-threatening levels of voltage may be present! **Steps to prevent:** • EN 61800-5-1 requires that the devices be firmly connected on the power side. • The PE conductor must have a cross-section of at least 10 mm^2 or must have a second PE connection with a cross-section at least equal to the mains feeder (cf. EN 61800-5-1).

Cross-section AC wire	Cross-section PE wire
≤ 10 mm^2	= 10 mm^2
10 ... 16 mm^2	= Cross-section AC wire
16 ... 35 mm^2	= 16 mm^2
≥ 35 mm2	≈ 1/2 x Cross-section AC wire

Description:

The PE connection is a screw bolt on the module casing (see front view) for attaching PE lines and cable shields.

Configure as follows:



Connection:

Recommended cable type	1-wire, unshielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Ring cable lug

	Compact inverter			
	KWD 1, 2, 5 KWD 1, 2, 4 -F	**KW 2, 3, 5, 8 KW 2, 4, 6 -F**	**KW 10, KW 20 KW 9-F**	**KW 40 KW 60**
Recommended wire cross-sections	10 mm² AWG 6			16 mm² AWG 4
Tightening torque	4 Nm		8 Nm	15 Nm

	Compact inverter		
	KW 100	**KW 150**	**KW 200**
Recommended wire cross-sections	35 mm² AWG 1	95 mm² kcmil 250	120 mm^2 kcmil 300
Tightening torque	15 Nm	12 Nm	12 Nm

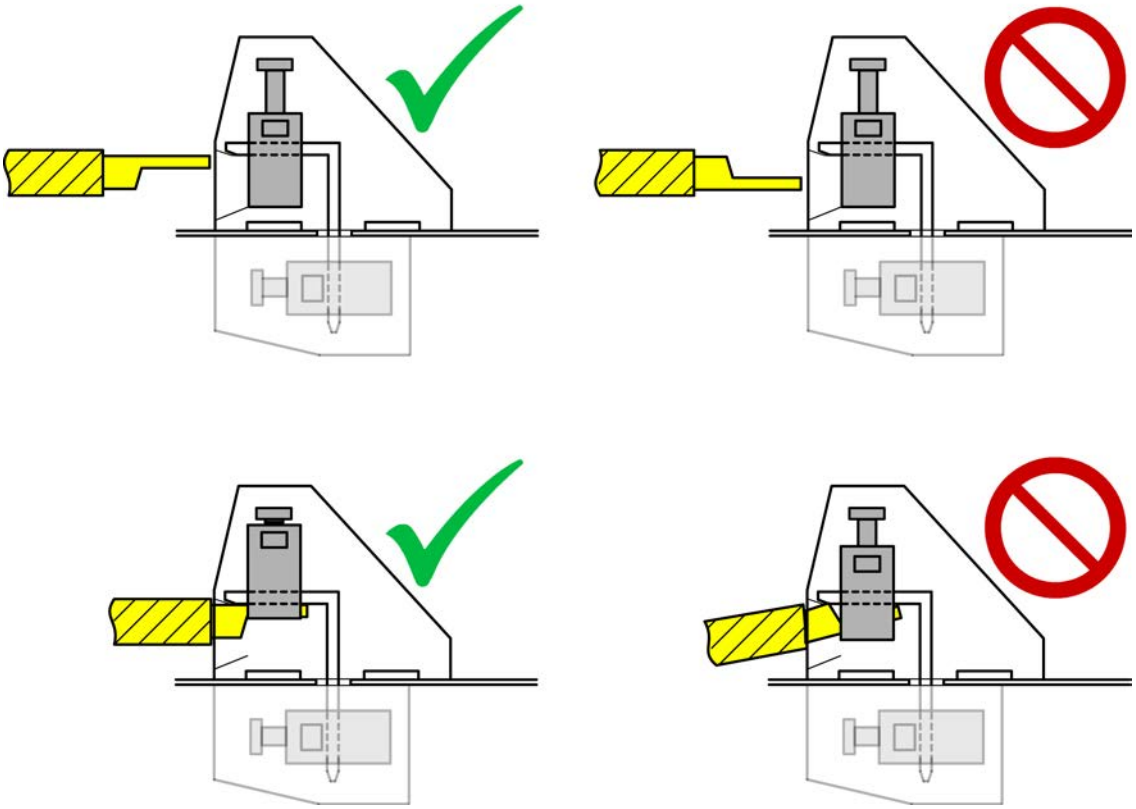
Note	Further information: Siehe 'Earthing' auf Seite 110.

8.6.2 Terminal connection technology

When using pin cable lugs please note!

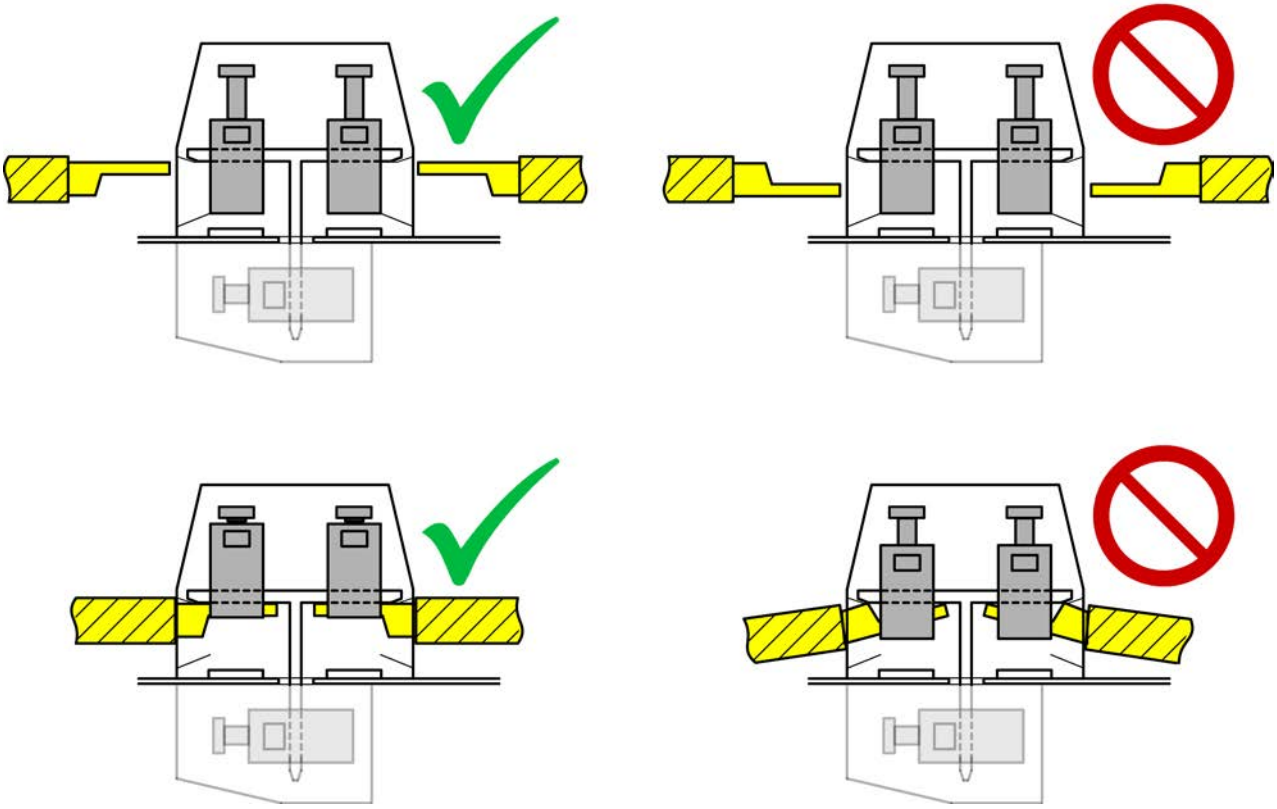
Terminal HDFKVxx

Connection	Description	Device
[X04]	Motor connection	KW 9-F - KW 100
[X06]	DC bus	KW 100



Terminal HDFKVxx - TWIN

Connection	Description	Device
[X05]	DC bus	KW 9-F - KW 200



8.6.3 [X04] motor connection

⚠ DANGER

Danger to life from touching electrical connections!

The permanent magnets of the rotor induce dangerous voltage at the motor connections when the axis rotates, even when the motor is not electrically connected. If the motor is connected to an inverter, the induced DC voltage is linked to the terminals UZP and UZN for the DC bus.

Steps to prevent:

- Make sure that the motor shaft does not rotate.
- Make sure that shock-hazard protection is installed at the motor connections.
- Make sure that the terminals UZP / UZN are free of voltage.

Description:

[X04] A/B: A and B are used to distinguish between power output stages and controller card connections in the case of double inverters.

U: Motor phase U

V: Motor phase V

W: Motor phase W

Technical data:

- 0 - 350 VAC (sine-shaped output current), output frequency range 0 - 800/1200 Hz for U/f-operation. Speed setpoint values are limited to 30000 rpm.
- Range of output frequency varies based on controller card in use

Version:

Type	Pins
Up to KW 100: Screw terminal	3
KW 150, KW 200: Thread bolt	3

Connection:

Recommended cable type	4-wire, shielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Up to KW 100: Wire end ferrule with plastic sheath KW 150/ KW 200: ring cable lug
Shield connection	Attached on both sides

	Compact inverter			
	KWD 1, 2, 5 KWD 1, 2, 4-F	**KW 2, 3 KW 2, 4-F**	**KW 5, 8 KW 6-F**	**KW 10 KW 9-F**
Cross-section min./max.	0.25 / 1.5 mm² AWG 24 / AWG 14	0.5 / 4 mm² AWG 20 / AWG 10		0.5 / 10 mm² AWG 20 / AWG 6
Recommended wire cross-sections	1 mm² AWG 16	1 mm² AWG 16	1,5 mm² AWG 14	2.5 mm² AWG 12
Cable stripping length	9 mm	14 mm		11 mm
Tightening torque	0.4 - 0.5 Nm	0.5 - 0.6 Nm		1.5 - 1.8 Nm
Terminal	Front 2,5-H	Front 4-H		HDFKV10[1)]

	Compact inverter			
	KW 20	**KW 40**	**KW 60**	**KW 100**
Cross-section min./max.	0.5 / 10 mm² AWG 20 / AWG 6	4 / 25 mm² AWG 10 / AWG 2	16 / 50 mm² AWG 4 / AWG 1/0	35 / 95 mm² AWG 1 / AWG 4/0
Recommended wire cross-sections	6 mm² AWG 8	16 mm² AWG 4	35 mm² AWG 1	95 mm² AWG 4/0
Cable stripping length	11 mm	19 mm	24 mm	27 mm
Tightening torque	1.5 - 1.8 Nm	4.0 - 4.5 Nm	6 - 8 Nm	15 - 20 Nm
Terminal	HDFKV10[1)]	HDFKV25[1)]	HDFKV50[1)]	HDFKV95[1)]

	Compact inverter	
	KW 150	**KW 200**
Cross-section min./max.	- / 240 mm² - / kcmil 600	- / 240 mm² - / kcmil 600
Recommended wire cross-sections	120 mm² kcmil 300	185 mm² kcmil 500
Cable stripping length	-	
Tightening torque	15 Nm	15 Nm
Terminal	Threat bolt M12[2)]	Threat bolt M12[2)]

Note	1) When using pin cable lug: Siehe 'Terminal connection technology ' auf Seite 149. 2) When using 2 cables: Siehe 'Connection technology - connection bolts with 2 ring cable lugs' auf Seite 169. Further information: Siehe Motor power and encoder cable auf Seite 112.

8.6.4 [X05] DC bus

⚠ DANGER	
	**Danger to life from electric shock!** LED displays on the front, when indicating OFF, do not mean that the device terminals are voltage-free. After switching off the mains, the buffer capacitors for the DC bus can still have a charge and lead to a life-threatening DC voltage. **Steps to prevent:** • After switching off, expect a discharge time of at least 5 minutes. • Measure the voltage in the DC bus between the UZP / UZN terminals to ensure that the terminals are voltage-free.

Description:
The DC bus supplies DC power to the connected inverter modules.

Technical data:

- KE, KEN: 540 ... 650 VDC
- KES: UZP/UZN = regulated 650 VDC (max. 720 VDC)

Version:

Type	Pins
Screw terminal	2

Name [X05]	Connection
UZP	DC bus voltage (+)
UZN	DC bus voltage (-)

Connection:

Recommended cable type	2-wire, unshielded Use only AMK DC bus UZ cable sets. Further information: Siehe 'DC bus wiring' auf Seite 68.
Cable assembly	Wire end ferrule with plastic sheath
Shield connection	Attached on both sides

	Compact inverter			
	KWD 1, 2, 5 KWD 1, 2, 4 -F	**KW 2, 3, 5, 8 KW 2, 4, 6 -F**	**KW 10 KW 9-F**	**KW 20**
Cross-section min./max.	0.5 mm² / 4 mm² AWG 20 / AWG 12		0.5 mm² / 10 mm² AWG 20 / AWG 6	
Recommended wire cross-sections	4 mm² AWG 10		10 mm² AWG 6	
Cable stripping length	14 mm		11 mm	
Tightening torque	0.5 - 0.6 Nm		1.5 - 1.8 Nm	
Terminal	Front 4-H-7,62-2		HDFKV10TWIN[1)]	

	Compact inverter			
	KW 40 KW 60	**KW 100**	**KW 150**	**KW 200**
Cross-section min./max.	4 mm² / 25 mm² AWG 10 / AWG 2	4 mm² / 25 mm² AWG 10 / AWG 2	4 mm² / 25 mm² AWG 10 / AWG 2	4 mm² / 25 mm² AWG 10 / AWG 2
Recommended wire cross-sections	25 mm² AWG 2	25 mm² AWG 2	25 mm² AWG 2	25 mm² AWG 2
Cable stripping length	19 mm	19 mm	19 mm	19 mm
Tightening torque	4.0 - 4.5 Nm	4.0 - 4.5 Nm	4.0 - 4.5 Nm	4.0 - 4.5 Nm
Terminal	HDFKV25TWIN[1)]	HDFKV25TWIN[1)]	HDFKV25TWIN[1)]	HDFKV25TWIN[1)]

Note	1) When using pin cable lug: Siehe 'Terminal connection technology ' auf Seite 149. A maximum length of 1 meter is permitted for the cable to connect the DC bus voltage when assembling the device with a distance between the modules. A 2-wire shielded cable might have to be used in order to limit interference radiation. In this case, the cable shield has to be stranded on both sides. (Use of longer cables only after consulting with AMK).

8.6.5 [X06] DC bus

⚠ DANGER	
	**Danger to life from electric shock!** LED displays on the front, when indicating OFF, do not mean that the device terminals are voltage-free. After switching off the mains, the buffer capacitors for the DC bus can still have a charge and lead to a life-threatening DC voltage. **Steps to prevent:** • After switching off, expect a discharge time of at least 5 minutes. • Measure the voltage in the DC bus between the UZP / UZN terminals to ensure that the terminals are voltage-free.

Description:

The DC bus supplies DC power to the connected inverter modules.

Terminal X06 must be connected to terminal X06 on the compact power supply.

Technical data:

- Terminal is present only for KW 100, KW 150, KW 200
- Max. connection power
  KW 100: 100 kW
  KW 150, KW 200: 200 kW
- KE, KEN: 540 ... 650 VDC
- KES: UZP/UZN = regulated 650 VDC (max. 720 VDC)

Version:

Type	Pins
KW 100: Screw terminal	2
KW 150, KW 200: Thread bolt	2

Name [X06]	Connection
UZP	DC bus voltage (+)
UZN	DC bus voltage (-)

Connection:

Recommended cable type	2-wire, unshielded Use only AMK DC bus UZ cable sets. Further information: Siehe 'DC bus wiring' auf Seite 68.
Cable assembly	KW 100: Wire end ferrule with plastic sheath KW150 / KW 200: ring cable lug
Shield connection	If available, attach on both sides

	Compact inverter		
	KW 100	**KW 150**	**KW 200**
Cross-section min./max.	35 mm² / 95 mm² AWG 1 / AWG 3/0	- / 240 mm^2 - / kcmil 600	- / 240 mm^2 - / kcmil 600
Recommended wire cross-sections	50 mm² AWG 1/0	120 mm^2 AWG 4/0	185 mm^2 kcmil 300
Cable stripping length	27 mm	-	
Tightening torque	15 - 20 Nm	15 Nm	15 Nm
Terminal	HDFKV95[1)]	Threat bolt M12[2)]	Threat bolt M12[2)]

Note	1) When using pin cable lug: Siehe 'Terminal connection technology ' auf Seite 149. 2) When using 2 cables: Siehe 'Connection technology - connection bolts with 2 ring cable lugs' auf Seite 169. A maximum length of 1 meter is permitted for the cable to connect the DC bus voltage when assembling the device with a distance between the modules. (Use of longer cables only after consulting with AMK). A 2-wire shielded cable might have to be used in order to limit interference radiation. In this case, the cable shield has to be stranded on both sides.

8.6.6 [X08, X09] supply voltage 24 VDC

NOTICE	
Material Damage!	**Overload of the terminal and the internal circuit board!** The connected rating of the terminals X08, X09 is restricted. The terminals X08 or X09 are designed for a current of at most 8 A. **Steps to prevent:** • A looping of the 24 VDC supply voltage is permitted for a total of 5 modules at the most. • If more than 5 devices are installed, each group of five needs to be supplied separately with 24 VDC.

NOTICE	
Material Damage!	**Material damage caused by incorrect handling!** Mechanical damage to terminals! Disconnected signal lines. **Steps to prevent:** • The plug connectors are partially encoded. Do not push in with force. • Never pull on the cable, but rather on the connector casing. • For service purposes, use the control tap.

Description

For supplying the internal switched mode power supply and the fan.

X08: Connection 24 VDC supply voltage

X09: Looping of the voltage

Technical data

- 24 VDC ± 15% Power supply unit with potential separation according to VDE 0160.
- Ripple max. 5%, with integrated switch-on current limitation
- The 0 V potential of the power supply unit should be earthed at the central PE.

Version

Type	Pins	Class
Connector with spring connection	2	1-row pin strip

Assignment

[X08] / [X09]	Connection	Signal	Description
front view, device side X09 PIN 2 X09 PIN 1 X08 PIN 2 X08 PIN 1 	1	0 VDC	Connection 0 VDC logic supply
	2	24 VDC	Connection 24 VDC logic supply

Connection

Recommended cable type	2-wire, unshielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Flexible line or wire end ferrule without plastic sheath
Shield connection	-

	Complete KE/KW series
Cross-section min./max.	0.25 mm²/ 1.5 mm² AWG 24 / AWG 16
Recommended wire cross-sections	0.75 mm² AWG 18
Cable stripping length	9 mm
Terminal	FK-MCP 1,5/2-ST-3,80

Note	A loss of the 24V supply > 10 ms creates a fault: Internally the "SBM (System Ready)" message is reset and the main contactor is released.

8.6.7 [X12] motor PTC thermistor connection

NOTICE	
Material Damage!	**Material damage resulting from Overheating!** AMK servo motors are provided with sensors for temperature monitoring. Motors without or with bypassed sensors for temperature can overheat and be destroyed. **Steps to prevent:** • Connect the sensors for temperature of the servo motor for temperature monitoring • Activate the I²t monitoring of the servo motor in ID32773 'Service bits' Bit 14.

NOTICE	
Material Damage!	**Material damage caused by incorrect handling!** Mechanical damage to terminals! Disconnected signal lines. **Steps to prevent:** • The plug connectors are partially encoded. Do not push in with force. • Never pull on the cable, but rather on the connector casing. • For service purposes, use the control tap.

Description:

Connection for monitoring temperature of a servo motor.

Technical data:

Configurable via ID34166 'Temperature sensor motor'

Version:

Type	**Pins**
Connector with spring connection	2

Assignment:

[X12]	**Connection**	**Signal**	**Description**
front view, device side PIN 2 PIN 1 	1	RT1 (+)	Connection temperature sensor, take care of the polarity at KTY!
	2	RT2 (-)	Connection temperature sensor, take care of the polarity at KTY!

Connection:

Recommended cable type	2-wire, shielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Flexible line or wire end ferrule without plastic sheath
Shield connection	Lay on one end on the module casing

	Complete KW series
Cross-section min./max.	0.25 mm² / 0.5 mm² AWG 24 / AWG 20
Recommended wire cross-sections	0.5 mm² AWG 20
Cable stripping length	8 mm
Terminal	FK-MC 0,5/2-ST-2,5

8.6.8 [X13] acknowledgement power output stage enable transmission

NOTICE	
Material Damage!	**Material damage caused by incorrect handling!** Mechanical damage to terminals! Disconnected signal lines. **Steps to prevent:** • The plug connectors are partially encoded. Do not push in with force. • Never pull on the cable, but rather on the connector casing. • For service purposes, use the control tap.

Description:

Siehe 'Function description - EF safety function' auf Seite 189.

Technical data:

- Encoding pin 1

Version:

Type	Pins
Connector with spring connection	3

Assignment:

[X13]	Connection	Signal	Description
front view, device side PIN 3 PIN 2 PIN 1 	1	QES	Release relay removed Signal identical to X16 Pin 2; for forwarding to further KW modules
	2	WQF	Power supply for relay contact QEF Signal identical to X16 Pin 3; for forwarding to further KW modules
	3	QEF	Acknowledgement of power output stage enable Signal identical to X16 Pin 4; for forwarding to further KW modules

Connection:

Recommended cable type	3-wire, unshielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Flexible line or wire end ferrule without plastic sheath
Shield connection	-

	KWs with EF logic
Cross-section min./max.	0.25 mm² / 0.5 mm² AWG 24 / AWG 20
Recommended wire cross-sections	0.5 mm^2 AWG 20
Cable stripping length	8 mm
Terminal	FK-MC 0,5/3-ST-2,5

8.6.9 [X14] power output stage enable transmission

NOTICE	
Material Damage!	**Material damage caused by incorrect handling!** Mechanical damage to terminals! Disconnected signal lines. **Steps to prevent:** • The plug connectors are partially encoded. Do not push in with force. • Never pull on the cable, but rather on the connector casing. • For service purposes, use the control tap.

Description:

Siehe 'Function description - EF safety function' auf Seite 189.

Technical data:

- encoding pin 3

Version:

Type	Pins
Connector with spring connection	3

Assignment:

[X14]	Connection	Signal	Description
front view, device side PIN 3 PIN 2 PIN 1 	1	WEF	Reference potential 0 V ext. for the input current to EF / EF2 Signal identical to X15 Pin 3; for forwarding to further KW modules
	2	EF	Power output stage enable EF Signal identical to X15 Pin 2; for forwarding to further KW modules
	3	EF2	Power otput stage enable EF2 Signal identical to X15 Pin 1; for forwarding to further KW modules

Connection:

Recommended cable type	3-wire, unshielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Flexible line or wire end ferrule without plastic sheath
Shield connection	-

	KWs with EF logic
Cross-section min./max.	0.25 mm² / 0.5 mm² AWG 24 / AWG 20
Recommended wire cross-sections	0.5 mm^2 AWG 20
Cable stripping length	8 mm
Terminal	FK-MC 0,5/3-ST-2,5

8.6.10 [X15] power output stage enable EF / EF2

NOTICE	
Material Damage!	**Material damage caused by incorrect handling!** Mechanical damage to terminals! Disconnected signal lines. **Steps to prevent:** • The plug connectors are partially encoded. Do not push in with force. • Never pull on the cable, but rather on the connector casing. • For service purposes, use the control tap.

Description:

In normal operation, inputs "EF" and "EF2" must be set at the same time. This enables the power output stage.

An interruption on EF or EF2 causes an immediate and secure blocking of the cycle pulses for the power output stage; when controller enable set (RF), an error message is generated and the drive coasts to stop.

Siehe 'Function description - EF safety function' auf Seite 189.

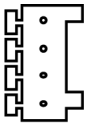
Technical data:

- Potentially separated by optocoupler
- Nominal voltage inputs: +24V ext, typ. 9 mA
- encoding pin 3

Version:

Type	Pins
Connector with spring connection	4

Assignment:

[X15]	Connection	Signal	Description
front view, device side PIN 4 PIN 3 PIN 2 PIN 1 	1	EF2	Power output stage enable EF2
	2,4	EF	Power output stage enable EF
	3	WEF	Reference potential 0 V ext. for the input current to EF / EF2

Connection:

Recommended cable type	4-wire, unshielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Flexible line or wire end ferrule without plastic sheath
Shield connection	-

	KWs with EF logic
Recommended wire cross-sections	0.5 mm^2 AWG 20
Cable stripping length	8 mm
Terminal	FK-MC 0,5/4-ST-2,5

8.6.11 [X16] acknowledgement of power output stage enable

NOTICE	
Material Damage!	**Material damage caused by incorrect handling!** Mechanical damage to terminals! Disconnected signal lines. **Steps to prevent:** • The plug connectors are partially encoded. Do not push in with force. • Never pull on the cable, but rather on the connector casing. • For service purposes, use the control tap.

Description:

Siehe 'Function description - EF safety function' auf Seite 189.

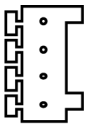
Technical data:

- Encoding pin 2

Version:

Type	Pins
Connector with spring connection	4

Assignment:

[X16]	Connection	Signal	Description
front view, device side PIN 4 PIN 3 PIN 2 PIN 1 	1	WQS	Feed +24 V ext. for relay contact QES (KWD / KWZ QES A/B)
	2	QES	Acknowledgement power output stage blocked; the motor is not energised. Prerequisite **EF= 0 AND EF2 = 0**
	3	WQF	Feed +24 V ext. for relay contact QEF (QEF A/B)
	4	QEF	Acknowledgement of power output stage enable Prerequisite **EF= 1 AND EF2 = 1**

Connection:

Recommended cable type	4-wire, unshielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Flexible line or wire end ferrule without plastic sheath
Shield connection	-

	KWs and KWDs with EF logic
Cross-section min./max.	0.25 mm² / 0.5 mm² AWG 24 / AWG 20
Recommended wire cross-sections	0.5 mm^2 AWG 20
Cable stripping length	8 mm
Terminal	FK-MC 0,5/3-ST-2,5

8.6.12 [X17] power output stage enable EF / EF2

NOTICE	
Material Damage!	**Material damage caused by incorrect handling!** Mechanical damage to terminals! Disconnected signal lines. **Steps to prevent:** • The plug connectors are partially encoded. Do not push in with force. • Never pull on the cable, but rather on the connector casing. • For service purposes, use the control tap.

Description:

In normal operation, inputs 'EF' and 'EF2' must be set at the same time. This enables the power output stage.
An interruption on EF or EF2 causes an immediate and secure blocking of the cycle pulses for the power output stage.
An interruption to the preset Controller enable (RF) triggers the generation of an error message and the drive coasts to stop.

Siehe 'Function description - EF safety function' auf Seite 189.

Technical data:

- Potentially separated by optocoupler
- Nominal voltage inputs: +24V ext, typ. 9 mA
- Axis A: encoding pin 3
- Axis B: Encoding pin 2

Version:

Type	Pins
Connector with spring connection	3

Assignment:

[X17]	Connection	Signal	Description
front view, device side PIN 3 PIN 2 PIN 1 	1	EF2	Power output stage enable EF2
	2	WEF	Reference potential 0 V ext. for the input current to EF / EF2
	3	EF	Power output stage enable EF

Connection:

Recommended cable type	3-wire, unshielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Flexible line or wire end ferrule without plastic sheath
Shield connection	-

	KWDs with EF logic
Cross-section min./max.	0.25 mm² / 0.5 mm² AWG 24 / AWG 20
Recommended wire cross-sections	0.5 mm^2 AWG 20
Cable stripping length	8 mm
Terminal	FK-MC 0,5/3-ST-2,5

8.6.13 [X18] power output stage enable transmission

NOTICE	
Material Damage!	**Material damage caused by incorrect handling!** Mechanical damage to terminals! Disconnected signal lines. **Steps to prevent:** • The plug connectors are partially encoded. Do not push in with force. • Never pull on the cable, but rather on the connector casing. • For service purposes, use the control tap.

Description:

Siehe 'Function description - EF safety function' auf Seite 189.

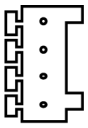
Technical data:

- Axis A: encoding pin 3
- Axis B: Encoding pin 2

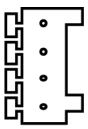
Version:

Type	Pins
Connector with spring connection	4

Assignment of X18 axis A:

[X18A]	Connection	Signal	Description
front view, device side PIN 4 PIN 3 PIN 2 PIN 1 	1	QESA	Acknowledgement power output stage blocked; the motor is not energised. Prerequisite **EF = 0 AND EF2 = 0** Relay contact NC (24 VDC, max. 200 mA).
	2	QEF	Acknowledgement of power output stage enable Prerequisite **EF = 1 AND EF2 = 1**
	3	EF2	Power otput stage enable EF2 Signal identical to X17 Pin 1; for forwarding to further KW modules
	4	EF	Power output stage enable EF Signal identical to X17 Pin 3; for forwarding to further KW modules

Assignment of X18 axis B:

[X18B]	Connection	Signal	Description
front view, device side PIN 4 PIN 3 PIN 2 PIN 1 	1	WQSB	Feed +24 V ext. for relay contact QESB
	2	QEF	Acknowledgement of power output stage enable Prerequisite **EF = 1 AND EF2 = 1**
	3	EF2	Power otput stage enable EF2 Signal identical to X17 Pin 1; for forwarding to further KW modules
	4	EF	Power output stage enable EF Signal identical to X17 Pin 3; for forwarding to further KW modules

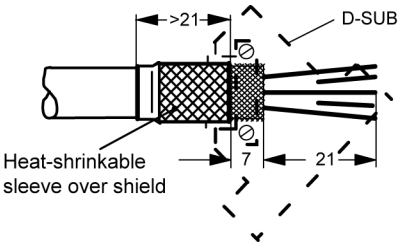
Connection:

Recommended cable type	4-wire, unshielded Further information: Siehe 'Wiring' auf Seite 109.
Cable assembly	Flexible line or wire end ferrule without plastic sheath
Shield connection	-

	KWDs with EF logic
Cross-section min./max.	0.25 mm² / 0.5 mm² AWG 24 / AWG 20
Recommended wire cross-sections	0.5 mm^2 AWG 20
Cable stripping length	8 mm
Terminal	FK-MC 0,5/4-ST-2,5

8.7 Connection technology - D-SUB connector

1. Metallic D-SUB casings with a side cable output have to be used. The cable shield is earthed through the D-SUB casing on the KE/KW module.
2. Remove outer cable insulation (to about 21 mm for 9-pin D-SUB connector).
3. Evert cable shield over the outer insulation sheath.
4. Fix and insulate the shield with heat-shrinkable sleeve so that a blank shielding edge of approx. 7 mm width remains.
5. Connect the plug.
6. Relieve the cable with strain relief clamp and securely connect the everted blank shield edge with the metallic plug casing.
7. After plugging the corresponding plug pedestal into the KE/KW casing, the D-sub connector has to be screwed onto the pedestal.



8. If shielded cables have to be interrupted by a plug connector, a continuing shield connection has to be ensured by placing the shield onto the connector casing. The shield may not lead over connector contacts.
9. Cables leading into the casing have to be secured with grounding cable screw connections with which the cable shield is directly attached to the casing.

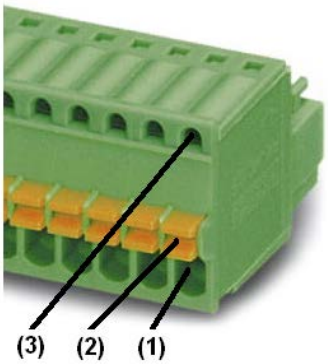
8.8 Connection technology - plug connector

NOTICE	
Material Damage!	**Material damage caused by incorrect handling!** Mechanical damage to terminals! Disconnected signal lines. **Steps to prevent:** • The plug connectors are partially encoded. Do not push in with force. • Never pull on the cable, but rather on the connector casing. • For service purposes, use the control tap.

For plug connectors X08, X09, X12, X13, X14, X15, X16, X17, X18, X21, X22, X25 the conductor connection is realised by spring tension.

For inserting and removing the conductor **(1)**, the loosening switch **(2)** on the terminal front has to be loosened with a screw driver.

For service purposes, a control tap **(3)** with a check plug D = 1.2 mm is possible with these terminals.



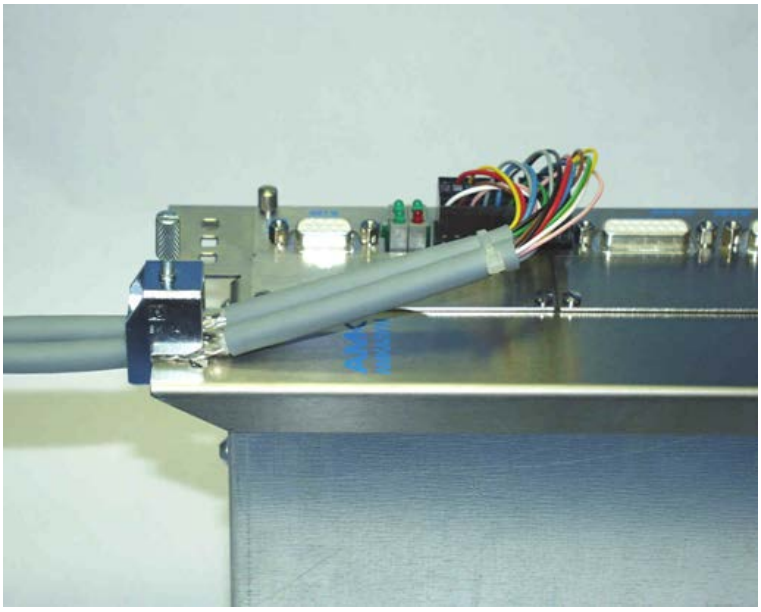
Observe the recommended wire cross-section and the cable stripping length when wiring.

The connection information can be found in the terminal descriptions.

8.9 Connection technology - shielding terminals

Signal and control lines

Abbildung 1:



Cable shield connection for signal and control lines on the top of the KE/KW casing.

Shielding terminals KP-SK 8, KP-SK 14, KP-SK 20.

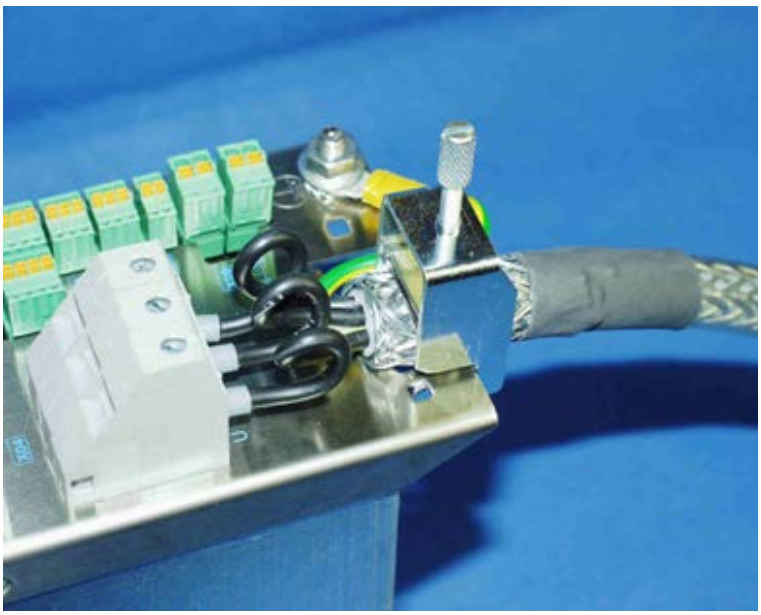
Motor cable

Remove the outer cable insulation to the required length. Do not damage the cable shield/cable strands when removing the insulation.

Cut off cable shield at a length of approx. 30 mm. Secure the end of the shield in place with a heat-shrinkable sleeve so that an exposed shielding edge of about 15 mm width remains. Connect cable strands (U, V, W, PE) to terminals U/V/W and the PE bolts.

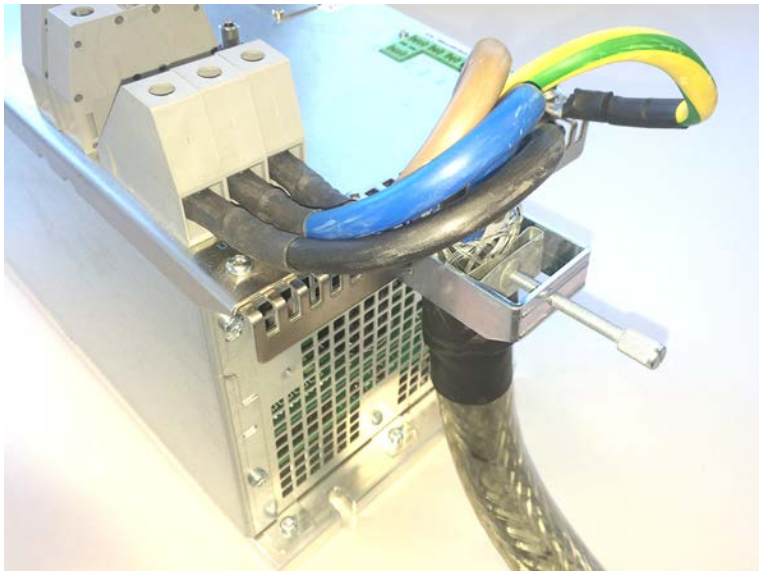
Fix the cable shield to the shielding terminal type KP-SK 8 - SK 35 (AMK accessory) so that the cable shield is connected as securely as possible to the bare front plate or the copper busbar on the bottom of the device (only with casings 170/255 mm in width).

Abbildung 2:



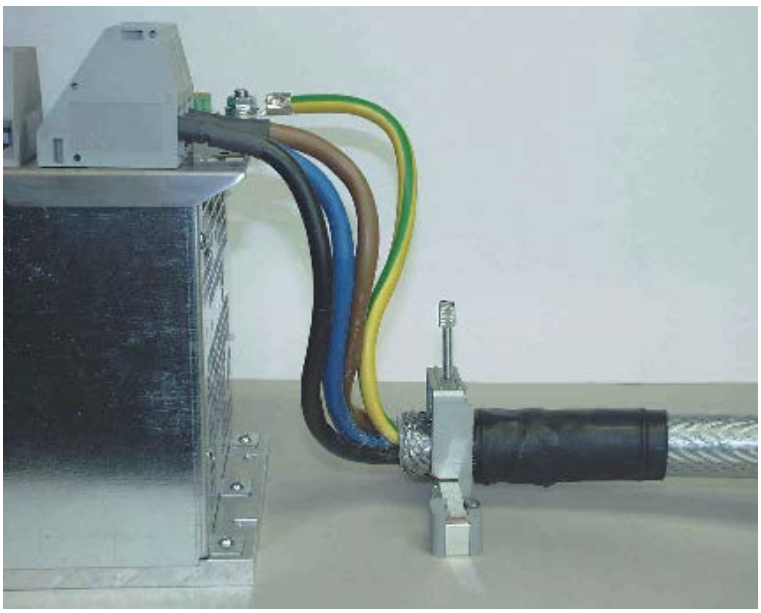
Cable shield connection for mains cable / motor cable / brake resistor cable on the KE/KW casing.
Shielding terminals KP-SK 14 and KP-SK 20.

Abbildung 3:



Cable shield connection for motor cable on the KW 40 or KW 60 casing.
Shielding terminals KP-SK 35.

Abbildung 4:



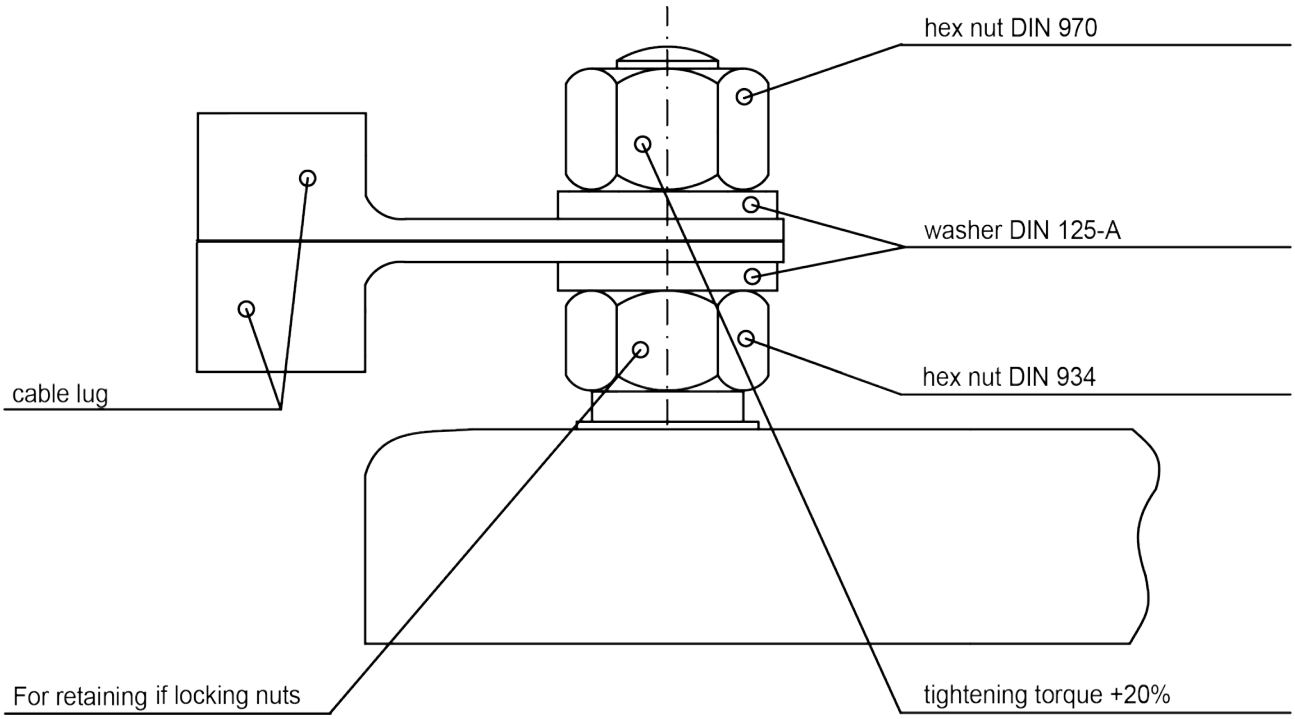
Earthing of motor cable shield using shielding terminal KP-SK 35. (variant 2: fix shielding terminal with busbar to assembly plate)

The support brackets for mounting the copper busbar can be removed from the base of the KE/KW device and mounted on the uncoated metallic assembly plate.

The assembly plate must be connected to the rear panel of the KE/KW casing, directly to the cold plate or using a copper braided strip (low-inductive).

8.10 Connection technology - connection bolts with 2 ring cable lugs

Please note, when connecting two cables with the same output direction.



9 Functional description KE

9.1 Theory of operation

The compact power supply KE generates the DC bus voltage for the KW inverter modules, for the decentralized inverters iX or motors iDT with integrated inverter. Excessive energy generated when braking the motors is fed back into the mains supply by way of suitable devices KE and KES.
In the event of mains failure, the generated brake energy can no longer be feed back into the mains supply. In such cases, the energy is discharged via an external brake resistor.

The KE compact power supply includes the following functional groups:

- Controlled inverter bridge for generating DC bus voltage and for feeding back excessive brake energy into the network. An AC/DC converter bridge is installed on KEN units without the feedback function.
- Charging device for DC bus intermediate circuit
- Brake transistor
  In the event of a mains failure, the generative energy that occurs when braking the motors is initially stored in the DC bus capacitors. If this causes the DC bus voltage to exceed its limit value, the brake transistor is activated and converts the excessive brake energy into heat using a brake resistor. The brake transistor is integrated into the device, whereas the brake resistor needs to be installed externally.
- Switched mode power supply
  The switched mode power supply is supplied with 24 V DC externally via the X08/X09 terminal.It generates the internal voltages.
- Fieldbus interface to control the module and analyse the status (not available on KEN 5-xN)

Overview of integrated protection and monitoring functions

- Mains failure
- Under- and overvoltage in line
- Phase sequence
- Switch status, main contactor
- I^2t -Monitoring of line currents and external line elements (e.g. mains choke)
- Excess temperature of power supply and external line elements (e.g. brake resistor, mains filter)
- Under- and overvoltage on DC bus
- Short on DC bus during 'DC bus ON'
- Electronic voltage (24 VDC switching power supply, +5 V, +12 V, -12 V)
- Bus communication
- Switch status, brake transistor
- Frequency limitation, brake transistor
- Short on brake resistor
- Discharge of DC bus down to 50 V on 'DC bus OFF' by brake transistor

Overview of integrated protection and monitoring functions for KEN5-xx (power supply without fieldbus)

- Mains detection when switching on
- Mains failure
- Undervoltage mains
- Excess temperature of power supply and external line elements (e.g. brake resistor, mains filter)
- Under- and overvoltage on DC bus
- Short on DC bus during switching on (power on) and charging DC bus
- Switch status, brake transistor
- Frequency limitation, brake transistor
- Short on brake resistor
- Discharge of DC bus down to 25 V by brake transistor while power off

KES-specific amendment

The compact power supply KES creates a stable DC bus voltage from the network alternating voltage to feed the inverter modules of the KE/KW drive system. The DC bus voltage is regulated to the value set by the parameters.

The line current for the feed-in and feedback is sinus shaped and has the phase position of 0° and 180° to the line alternating voltage respectively. This enhances the power factor (relation of real performance to appeared performance) and reduces the induced distortion on the mains. Norm EN 61000-3-12 defines the overtone value of line current. The measured overtone value of the KES devices is better than the limit value defined by the norm (THD < 13 % and PWHD < 22 %).

The regulated DC bus makes the system insensitive against strong variations in the power supply. For a constant DC bus voltage the operating point of the connected inverter remains the same, therefore there is enough servo reserve so that the required motor current can flow.

9.2 Changing the default settings

9.2.1 KE with ACC bus interface

The KE address is preset at the factory to 33 (default value). The device is ready for immediate use with this address. Other KE addresses (address "34" ... "39" are permitted) must be preset in encoded form via the DIP switch S1 in the KE front panel (see below).

The baud rate is preset at the factory to 1000 kBd (default value). The device is ready for immediate use with this setting.

Transmission speed

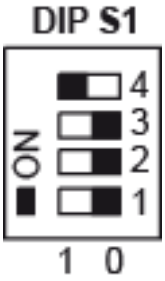
Long ACC bus lines (> 25 m) may make it necessary to reduce the transmission speed. In consultation with the AMK service department, the baud rate for all modules (KE/KW) needs to be set to a lower value (see below).

Configuration and further information: Siehe 'Maximum available ACC bus length' auf Seite 79..

Additional information on the ACC bus: Siehe 'ACC bus interface' auf Seite 178.

9.2.1.1 KE ACC bus baud rate

Setting by DIP switch “S1”

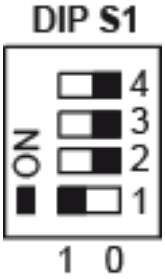


DIP 4	DIP 3	DIP 2	DIP 1	ACC-bus baud rate
1	0	0	0	1000 kBd (default)
	0	0	1	500kBd
	0	1	0	250 kBd
	0	1	1	125 kBd
	1	0	0	Reserved
	1	0	1	Reserved
	1	1	0	Reserved
	1	1	1	Operation without ACC-Bus

Switch 4 to “1”,
Set baud rate by code with the switches 1...3
24V = OFF/ON for storing in EEPROM.

9.2.1.2 KE ACC bus addressing

Setting by DIP switch “S1”



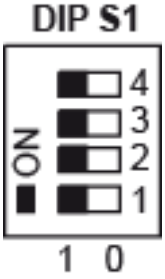
DIP 4	DIP 3	DIP 2	DIP 1	ACC-bus address
0	0	0	0	Other sources
	0	**0**	**1**	**33 (default)**
	0	1	0	34
	0	1	1	35
	1	0	0	36
	1	0	1	37
	1	1	0	38
	1	1	1	39

Switch 4 to “0”,
Set address by code with the switches 1...3
24V = OFF/ON for storing in EEPROM.

9.2.1.3 KE operation without ACC bus

When operating the KE module without ACC-Bus all 4 switches need to be set to “1”.

The ACC-Bus interface is deactivated when the KE module is switched on.



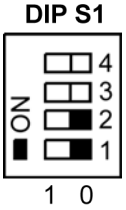
If the ACC-Bus interface on the supply module is active without connection to an ACC-bus master, the SBM is set after a time delay >15 second.

9.2.2 KE with realtime-Ethernet interface

The KE address is preset at the factory to 0 (default value). With this setting, the address will be set by the bus master automatically or it can be set in parameter ID34023 'BUS address participant' by the user. The device is ready for use with this address.
Other KE addresses (address "133" ... "135" are permitted) can be preset in encoded form via the DIP switch S1 in the KE front panel (see below).

9.2.2.1 EtherCAT addressing

Setting by DIP switch “S1”

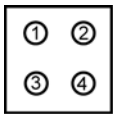
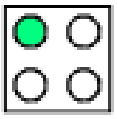
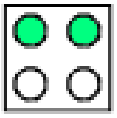
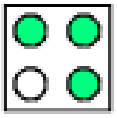


DIP 4	DIP 3	DIP 2	DIP 1	Address
x	x	0	0	S1 = 0 AND ID34023 = 0 => automatic address setting S1 = 0 AND ID34023 ≠ 0 => address of ID34023 valid
x	**x**	**0**	**1**	Address = 133, value is written to ID34023
x	x	1	0	Address = 134, value is written to ID34023
x	x	1	1	Address = 135, value is written to ID34023
1	1	1	1	If an error occurred during software flashing, P1 starts via P1 monitor

9.3 LED status indicator

9.3.1 KE with ACC bus interface

The LED block H1 with four LEDs indicates the status of the compact power supply.
In networked systems the status can also be read on the ACC bus.

Status indicator H1 on the front of the device  LED 1, 2, 4: green LED 3: red		**System ready message (SBM)** The compact power supply is supplied with 24 VDC, and has powered up without error but is still not active. The system waits for the control command UE *Converter ON*.
		**Acknowledgement DC bus ON** The control signal UE is active. The DC bus voltage was built up error-free via the mains connection and the charging circuit.
		**Feedback ready** Feedback into the grid is ready.
		Diagnostic message Error status (module is disconnected from the grid) LED 3 and combination of LEDs 1, 2 and 4 provide information on error. Siehe 'Behaviour in case of an error' auf Seite 175. For information on the diagnostic messages, refer to the document "PDK_025786_ Diagnose".

9.3.2 KE with real-time Ethernet interface

H5	H5	Ethernet bus (link status)
H4	H4	Ethernet bus (link status)
H3	H3	Bus status
H2	H2	Feedback
H1	H1	KE status

9.3.3 KE without fieldbus interface

The following failures will be indicated by binary outputs and LED signals:

- over-voltage DC bus (no brake resistor, resistance too high)
- short circuit DC bus during loading
- over-temperature heat sink
- over-temperature brake resistor (over-temperature or missing bridge)

H1	H1	KE status
H2	H2	DC bus
H3	H3	brake resistor

9.4 Behaviour in case of an error

If an error occurs in the compact power supply, it is returned to a secure state, the LEDs light up and a diagnostic message is generated.

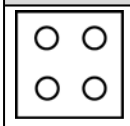
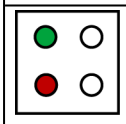
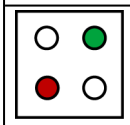
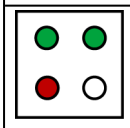
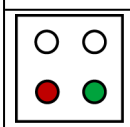
1. Feedback is deactivated internally.
2. SBM is withdrawn (SBM = 0)
3. The compact power supply is disconnected from the grid by withdrawing UE internally.
4. The DC bus voltage is discharged via the external brake resistor (default setting, properties based on ID32901 'Global service bits', bit 9).
5. QUE is reset.
6. Once the fault is resolved and the error is cleared, the compact power supply is rebooted and acknowledges this with SBM = 1.

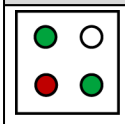
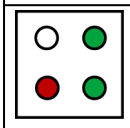
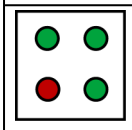
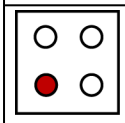
The error number can be read, displayed and evaluated by the fieldbus master or the AMK software AIPEX PRO via the fieldbus interface.

For information on the diagnostic messages, refer to the document "PDK_025786_Diagnose".

9.4.1 LED status indicator

9.4.1.1 KE with ACC bus interface

LED display	Meaning / causes of error
	**Line reset** • External supply voltage 24 VDC unavailable • Power on reset status during line ramp-up • Line reset in operation (reduction of voltages in power supply unit)
	**Limit value for mains voltage** • The mains voltage range to X20 exceed the value of 530 VAC or are below the value of 320 VAC for a period greater than 6.4 s. • At least one line phase to X20 is missing. • At least one line phase to X01 is missing.
	**Phase sequence L1/L2/L3** • The sequence of line phases L1, L2 and L3 to X20 do not correspond to the sequence of L1.1, L2.1 and L3.1 to X01. • External main contactor (connection via X20/EH1, EH2) is not activated when switched on (wiring, fuse defective)
	**DC bus** • Inhibit time for UE: The variable inhibit time for switching the compact power supply back on was not observed. A successful "Clear error" operation is immediately possible; activation (UE=1) only possible after inhibit time has elapsed • Short in DC bus (wiring, IGBT defective) • The charging time of the DC bus voltage is too long (electrolytic capacitor load too large, charging resistors defective) • DC bus voltage exceeds maximum allowed value of 850 VDC (this error is also displayed on the inverters)
	**Feedback fault** • Synchronisation with line is not possible after system boots • Mains frequency outside of tolerance range 47...63 Hz • The mains current exceeds the maximum limit value

LED display	Meaning / causes of error
	**Short circuit** • Short circuit in brake transistor (brake resistor value too low, resistor defective, cable defective, earth) These errors can only be reset once using the function "Clear error FL". If the error occurs a second time, it can only be cleared by switching off the supply voltage.
	**Excess temperature** • Heat sink temperature or external temperature via X25 (RT1, RT2), (brake resistor) exceeded • Overload capacity exceeded
	**Fault in electronic voltage** • Value of internal power supply voltages +/- 12 VDC is below the permitted tolerance threshold • The external supply voltage (24 VDC) is below the permitted threshold
	**Controller** • Error in checksum SEEP • Error in ACC bus • Watchdog monitoring • Stack monitoring • Time level monitoring

9.4.1.2 KE with real-time Ethernet interface

LED	Class	State	Meaning
H1	KE Status	Off	Initialisation
		Green	System ready (SBM)
		Green flashing	DC bus loading finished (SBM and QUE)
		Orange flashing	Warning occurs on active 'DC bus on'
		Orange	Warning occurs on inactive 'DC bus on'
		Red	Error; reaction depends on error number
H2	Feedback	Off	System ready (SBM)
		Green	Drive in control (SBM and QRF)
H3	Bus status	Off	Initialisation
		Green flashing	Pre-Operational
		Green single flash	Safe-Operational
		Green	Operational
		Red flashing	Configuration error
		Red flashing (once)	Reset to operating mode operational, safe-operational, pre-operational or initialisation, depending on kind of error
H4	Ethernet-Bus (Link status)	Off	No connection at X85
		Green	Link-connection at X85
		Flashing	Link/ Activity-connection at X85 and data transfer
H5	Ethernet-Bus (Link status)	Off	No connection at X86
		Green	Link-connection at X86
		Flashing	Link/ Activity-connection at X86 and data transfer

9.4.1.3 KE without fieldbus interface

LED	Class	State	Meaning
H1	KE status	continuous green	24 VDC supply voltage OK, correct processor run-up
		continuous red	over-voltage DC bus or loading failure DC bus
H2	DC bus	continuous green	DC bus loaded (QUE) and system ready message (SBM)
		continuous red	temperature failure KE or mains failure (LED will go out if U_Z falls below 60 VDC)
H3	Brake resistor	continuous green	brake ready message (brake chopper OK) and temperature of external component OK
		continuous red	failure brake chopper or temperature failure external component

A failure can be reset by mains or 24 VDC reset.

9.5 ACC bus interface

The ACC bus interface is a CAN bus interface with an additional hardware synchronisation line used to synchronise the inverter modules with the transfer protocol DS301, version 4.01. The compact power supply can send and receive data via the ACC bus interface. The send and receive data is mapped in PDOs. The transfer type is 254: asynchronous PDO, event-guided. The minimum cycle time for cyclical PDO transmission is 10 ms.

The entire CANopen functionality is defined in the device description file KER3_207_0604.eds. EDS files can be downloaded on the AMK website.

The compact power supply is an ACC bus slave participant with the default address 33 (21 hex). Other KE addresses (address "34" ... "39" are permitted) must be preset in encoded form via the DIP switch S1 in the KE front panel. The baud rate is preset at the factory to 1000 kBd (default value). Further information: Siehe 'Changing the default settings' auf Seite 172..

ACC bus-specific characteristics

The SBM output indicates the fault-free status of the module after initialisation.

In case of an error in the SBM the System Ready is reset and the main contactor is released.

ACC bus interface status	Other ACC bus subscribers	KE response
KE ACC bus interface enabled	An ACC bus master + x other slaves available	SBM is set
KE ACC bus interface enabled	No ACC bus subscribers	SBM is set after 15 seconds
KE ACC bus interface disabled (all S1 DIP switches ON)		SBM is set
KE ACC bus interface enabled Configuration ID32795 Source UE = signal via ACC bus (e.g. code 5)	No ACC bus subscribers	Set after 15 seconds

9.5.1 PDO mapping variables

All three transmit variables (iMessage16, diMessage32 and wDeviceState) must be mapped for the compact power supply. It is not permitted to only configure one of the three variables. The PDO is transferred event-guided (transfer type EVENT). The shortest possible cycle time for this message is 10 ms.

9.5.2 Configurable feedback values

API variable name	CAN index	CAN sub-index	Copy direction	Use
iMessage16	0x2040	0x01	Tx	Configurable, cyclical 16-bit feedback value message (ID32785 'Message 16')
diMessage32	**0x2040**	0x02	Tx	Configurable, cyclical 32-bit feedback value message (ID32786 'Message 32')

9.5.3 Status and control variables

<table>
<tr><th>API variable name</th><th>CAN index [hex]</th><th>CAN sub-index [hex]</th><th>Copying direction</th><th>Use</th></tr>
<tr><td>wDeviceState</td><td>0x2048</td><td>0x00</td><td>Tx</td><td>
<table>
<tr><th colspan="3">Status bits</th></tr>
<tr><th>Bit</th><th>Syntax</th><th>Meaning</th></tr>
<tr><td>0</td><td>SBM</td><td>System ready message</td></tr>
<tr><td>1</td><td>DC Bus Enable</td><td>Acknowledgement 'Converter ON'</td></tr>
<tr><td>2</td><td>QFL</td><td>Acknowledgement clear error</td></tr>
<tr><td>3</td><td>-</td><td>-</td></tr>
<tr><td>4</td><td>WARN</td><td>Warning message</td></tr>
<tr><td>5</td><td>ERR</td><td>Error message</td></tr>
<tr><td>6..15</td><td>-</td><td>-</td></tr>
</table>
</td></tr>
<tr><td>wDeviceControl</td><td>0x2049</td><td>0x00</td><td>Rx</td><td>
<table>
<tr><th colspan="3">Control bits</th></tr>
<tr><th>Bit</th><th>Syntax</th><th>Meaning</th></tr>
<tr><td>0</td><td>FL</td><td>Clear error</td></tr>
<tr><td>1</td><td>DC bus enable</td><td>Converter ON</td></tr>
<tr><td>2..15</td><td>-</td><td>-</td></tr>
</table>
</td></tr>
</table>

9.6 Real-time Ethernet interface

Instead of the ACC bus interface, the compact power supplies KE xx-0EU contain a real-time Ethernet interface which supports the following protocols:

- EtherCAT SoE protocol (Servo Drive Profile over EtherCAT according to IEC 61800-7-300)
- EtherCAT CoE (Drive profile CiA 402 according to IEC 61800-7-201/301)
- EtherCAT EoE (Ethernet over EtherCAT)
- VARAN SoV protocol (Servo Drive Profile over VARAN)

9.7 Display of actual value

The power supply supports a configurable 16-bit display value and a 32-bit display value. To configure the values, the code from the following table must be entered in the parameter (ID32785 'Message 16' or ID32786 'Message 32').

Parameter	Name	Scaling
16-bit display values (ID32785)		
ID32836	'DC bus voltage'	V
ID33101	'Display overload inverter'	0,1 %
ID33116	'Temperature internal'	0.1° C
ID34144	'Nominal voltage effective'	0.1 V
ID34145	'Line current effective'	0.1 A
ID34197	'Display external component'	0,1 %
ID34198	'mains frequency'	0.1 Hz
32-bit display values (ID32786)		
ID34058	'Line output'	W

The configurable display values can be evaluated by the controller via the ACC bus interface.

All 16-bit display values can also be configured in the 32-bit message ID32786 'Message 32'.

9.8 Configuring binary outputs

The compact power supply supports four configurable binary outputs (terminal X21: BA1 and BA2, X22: BA3 and BA4).

The binary outputs of the compact power supplies KEN 5-0N and KEN 5-FN are fixed.
The configuration cannot be changed.

To configure the binary output, the code of the required signal is written to its parameters.

Binary output	Parameter
BA1	ID32865 'Port 3 Bit 0'
BA2	ID32866 'Port 3 Bit 1'
BA3	ID32867 'Port 3 Bit 2'
BA4	ID32868 'Port 3 Bit 3'

Signals that can be assigned to a binary output:

Code	Function	Note
0	-	Function disabled
33016	Power supply overload warning	Prerequisite for warning bit active: ID33101 'Display overload inverter' > ID32999 'Overload limit inverter' Further information: Siehe 'Mains current monitoring' auf Seite 184.
33017	Warning excess temperature power supply	The excess temperature threshold is preset for each specific device in the unit itself and cannot be changed in the application. The temperature of the rear panel of the module is evaluated in accordance with ID33116. Warning 2350 'Device temperature warning' is generated together with the warning bit. After four seconds, the compact power supply switches off and displays error message 2346 'Converter temperature error'. Further information: Siehe 'Temperature monitoring' auf Seite 184.

Code	Function	Note
33022	Warning: Excess temperature of external components on X25	e.g. brake resistor and/or mains filter The excess temperature threshold is preset for each specific device in the unit itself and cannot be changed in the application. Warning 1074 'External line component temperature warning' is generated at the same time together with the warning bit. After four seconds, the power supply switches off and displays error message 1041 'Overtemperature external component mains'. Further information: Siehe 'Temperature monitoring' auf Seite 184.
33029	SBM	'System Ready' message (default assignment of binary output BA1)
33030	DC Bus Enable	Acknowledgement 'Converter on' (default assignment of binary output BA 2)
33074	Warning active	Group warning (all warning messages for compact power supply are linked via an OR operator)
33075	Fan control	Signal to control an external fan on the compact power supply; the signal is activated at 78% of the cut-off temperature. Once the temperature falls below this level, the fan runs for another minute. AMK service: (cut-off temperature [0.1°] SEEP ID34060 'List SEEP 1', element 39) (special function: lift)
33123	VBNX	Signal to UPS control Further information: Siehe 'Controlling a UPS' auf Seite 181.
33919	Warning overload of external component mains	e.g. mains choke ALN45 and ALN60-SI Prerequisite for warning bit active: ID34197 'Display external component' > ID34196 'Treshold external component' Further information: Siehe 'Monitoring of external component mains' auf Seite 185.
33920	Warning BRN-network feedback standby	This output is logically 1 if the feedback of the compact power supply is inactive for a short time due to mains voltage or overcurrent error. The pulse duration is at least 22 ms.

Example:

ID32867 'Port 3 Bit 2' = 33016

Binary output BA3 is set once ID33101 'Display overload inverter' is > ID32999 'Overload limit inverter'.

Changes to parameters do not take effect until the system is booted.

9.9 Controlling a UPS

In the event the mains voltages drops in at least one line phase for the period of min. 1.5 ms up to max. 100 ms, the compact power supply generates the VBNX signal (code 33123), which can be assigned to a binary output. This requires that the 24 VDC is also supplied to the compact power supply when mains failure occurs. The signal is 22 ms longer than the voltage drop in order to ensure that the VBNX signal is still set should any short-term cyclical drops in the mains voltage occur. The function has to be enabled using the parameter ID32901 'Global service bits', bit 3.

9.10 24 VDC buffering (internal UPS)

The internal device supply will be during an external short-time breakdown supplied through the DC Bus.

The 24 VDC buffering is integrated at the compact power supplies with the identifier KE,KES,KEN xxx-xxU.

If the 24 VDC value decrease less than 20 VDC the 24 VDC buffering will be activated. If the 24 VDC value overshoot 23 VDC the 24 VDC buffering will be deactivated.

During the buffering, the DC voltage will be regulated to 22 VDC for maximum 0,5 s. The maximum buffer time is fix and do not change if the output current is less than 10 A. After 0,5 s the buffering will deactivated. The next decrease under 18 VDC generates the message 1101 error logic voltage.

Use an external serial diode (10 A) in front of the 24 VDC input (X08/X09). In this case the buffering of the KE/KW system is always possible – still an external or a device without buffering has a short circuit.

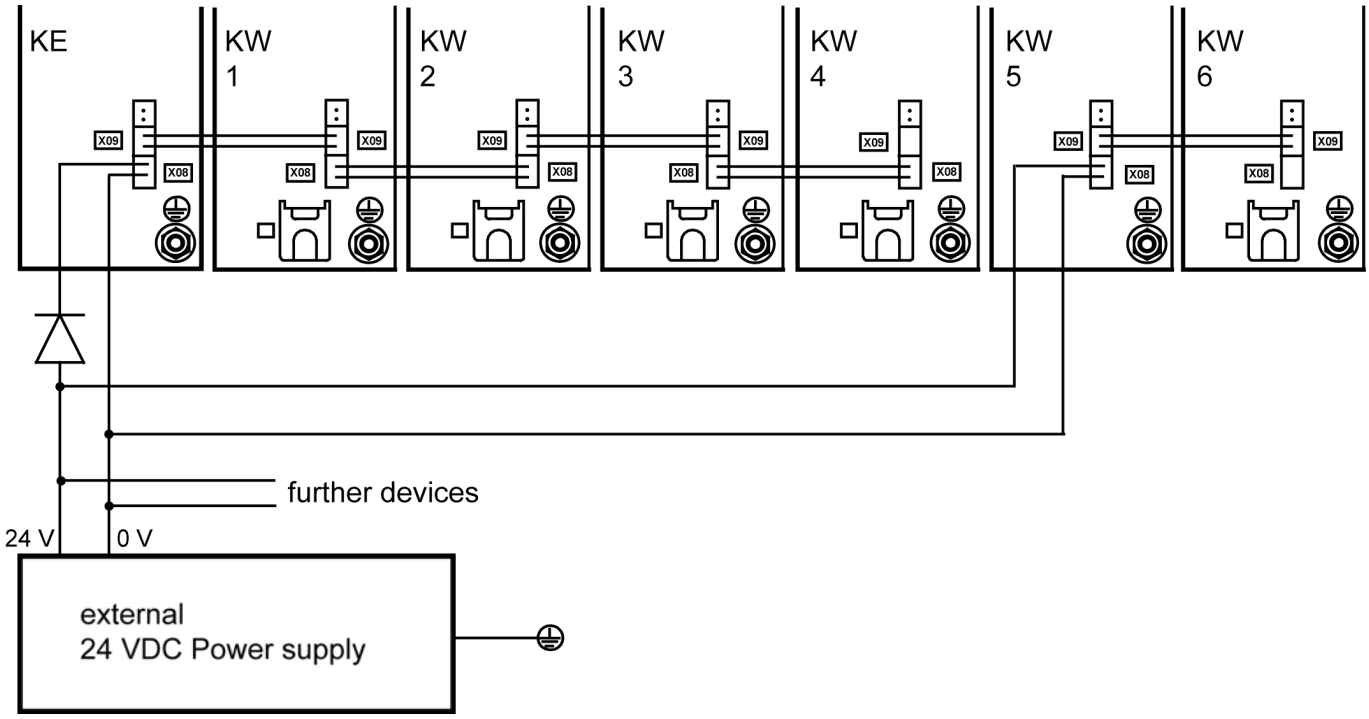
You can detect a voltage decrease with the VBNX signal.Siehe Controlling a UPS ab Seite 181

24 VDC buffer	
Regulated output voltage	22 VDC
Maximum output current	10 A
Maximum buffer time t_{on}	0,5 s
Minimum off-phase after t_{on} 0,5 s	52 s
Protection	Over current Maximum buffer time Over load
Error reaction	Switch off with 1101 Error Logic voltage
Clamp X08/X09 Current Maximum current for <= 0,5 s	 8 A 10 A

Example wiring

NOTICE	
Material Damage!	**Overload of the terminal and the internal circuit board!** The connected rating of the terminals X08, X09 is restricted. The terminals X08 or X09 are designed for a current of at most 8 A. **Steps to prevent:** • A looping of the 24 VDC supply voltage is permitted for a total of 5 modules at the most. • If more than 5 devices are installed, each group of five needs to be supplied separately with 24 VDC.

Example: Loop via X08/X09 with serial diode (10 A)
KW1 to KW4 with buffering, KW5 and KW6 without buffering



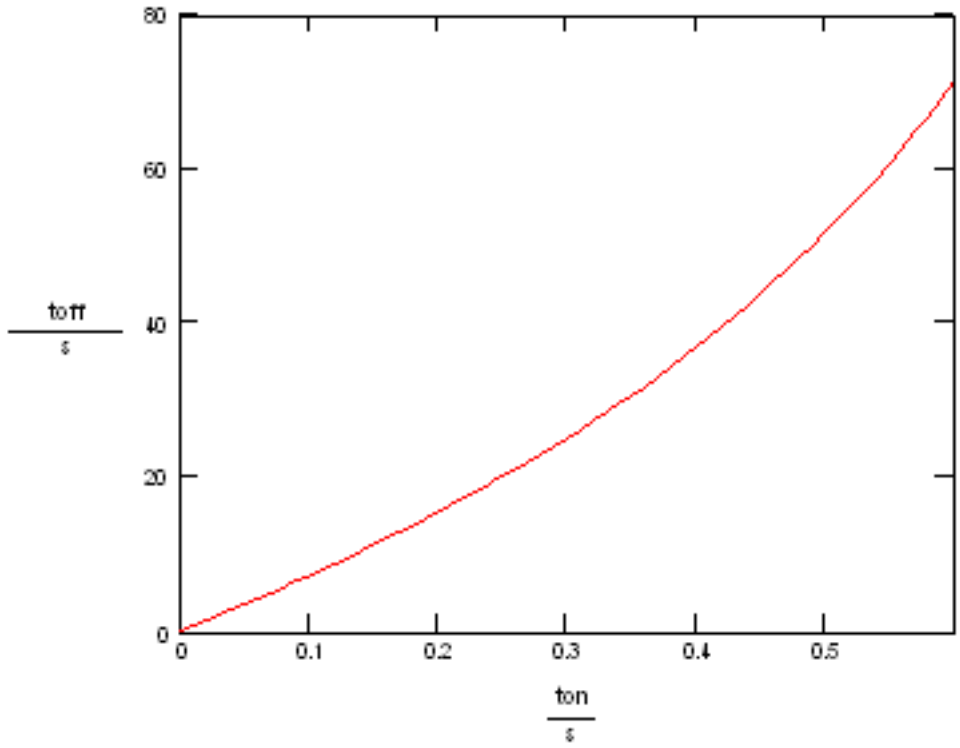
Overload protection

An off-phase between two buffering's must be kept.

A buffer time of t_{on} 0,5 s needs an off-phase of t_{off} with 52 s.

If the off-phase t_{off} will not be observed the 24 VDC buffering will be stopped earlier.

Minimum off-phase between two buffering's



9.11 DC bus voltage

DC bus voltage KE and KEN

The DC bus voltage is calculated as follows: connected mains voltage x 1.35.

Example:

Mains voltage 400 V x 1.35 = 540 V DC bus voltage

DC bus voltage KES

The compact power supply KES creates a controlled DC bus voltage from the network alternating voltage to feed the inverter modules of the KE/KW drive system. The DC bus voltage is regulated to the value set by the parameter ID34170 'Setpoint DC bus voltage'.

Using the parameters ID34207 'DC gain KP', ID34208 'Integral time DC control' and ID34209 'Differentiation time DC control', it is possible to adapt the DC bus voltage controller to the application.

If all 3 parameters = 0, the internal default values apply.

Prerequisite:

ID34170 'Setpoint DC bus voltage' ≤ 650 V: Mains voltage 3 x 320 VAC .. 3 x 530 VAC

ID34170 'Setpoint DC bus voltage' > 650V: Mains voltage 3 x 360 VAC .. 3 x 530 VAC

9.12 Mains current monitoring

The compact power supply automatically performs I^2t monitoring of the line currents in order to protect against overloads. The function is always enabled. The mains current monitoring function generates a warning message 2357 'Device overload warning' as soon as ID32999 'Overload limit inverter' is reached or exceeded. This warning can be assigned to a binary output (code 33016). By evaluating this warning message in the application, countermeasures can be taken to prevent the compact power supply from switching off. If the load in the device falls below the threshold established in ID32999, the binary output is reset. If the I^2t counter reaches the value of 100%, the error message 2358 'Device overload error' is generated, the compact power supply disconnects from the grid and the drive comes to a stop.

The current value of I^2t monitoring can be read in the parameter ID33101 'Display overload inverter' or the configurable ID32785 'Message 16'.

The warning message on the LED status indicator (red, flashing LED) is not automatically reset. It must be reset using the command 'Clear error FL'.

9.13 Temperature monitoring

9.13.1 Module-internal

The module temperature is captured by a KTY sensor. If the modules are subject to critical temperatures (e.g. due to inadequate cooling), a warning is generated followed by a diagnostic message four seconds later after the warning time expires. Continuous monitoring of the temperature values is possible via ID33116 'Temperature internal'. The warning can be assigned to a binary output (code 33017).

The current temperature value can be read out via the parameter ID33116 'Temperature internal' or the configurable ID32785 'Message 16'.

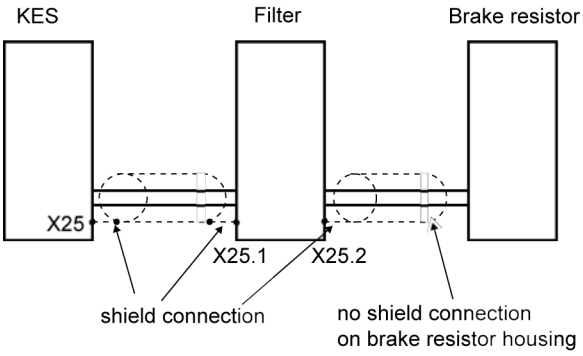
(The cut-off temperature varies from module to module.)

9.13.2 External elements

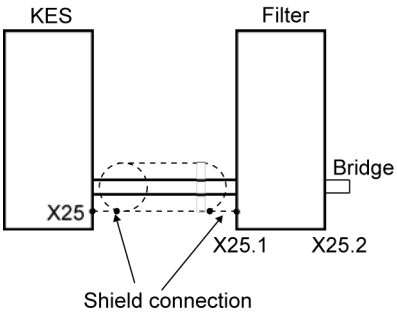
External elements (e.g. mains filter, brake resistor) equipped with temperature sensors (PTC thermistor) are connected to terminal X25 in order to monitor the temperature. Temperature monitoring for the compact power supply is activated when the sensor is triggered.

The diagnostic messages 1074 'External line component temperature warning' and (followed by a warning time of four seconds) 1041 'Overtemperature external component mains' are generated in the compact power supply. The warning can be assigned to a binary output (code 33022).

With the KES compact power supply, mains filters and brake resistors can be monitored simultaneously by connecting the PTC thermistor in series. Connection with a shielded cable, cable shield on both sides between casing of the compact power supply casing and the mains filter as well as on one side between mains filter casing and brake resistor. The temperature monitoring in compact power supply is activated, if at least one of the two sensors are triggered.



If no braking resistor (PTC thermistor) is present, RT1 and RT2 must be bridged in X25.2 on the mains filter.



9.14 Monitoring of external component mains

The compact power supply automatically performs I^2t monitoring of the external line elements (e.g., mains chokes ALN xx SI) in order to protect this from overload. The external component is protected if the parameters ID34193 'Nominal current external component', ID34194 'Peak current external component', ID34195 'Peak current time external component' and ID34196 'Treshold external component' were adjusted to the component to be protected. The monitoring function generates warning message 1111 'Warning external component' when the overload threshold as defined by ID34196 is reached or exceeded. This warning can be assigned to a binary output (code 33919). By evaluating this warning message in the application, countermeasures can be taken to prevent the compact power supply from switching off. If the load falls below the threshold established in ID34196, the binary output is reset. If the I^2t counter reaches the value of 100%, error message 1112 'Overload error external component'is generated and the compact power supply disconnects from the grid.

The current value of I^2t monitoring can be read in the parameter ID34197 'Display external component' or the configurable parameter ID32785 'Message 16'.

9.15 Fan control

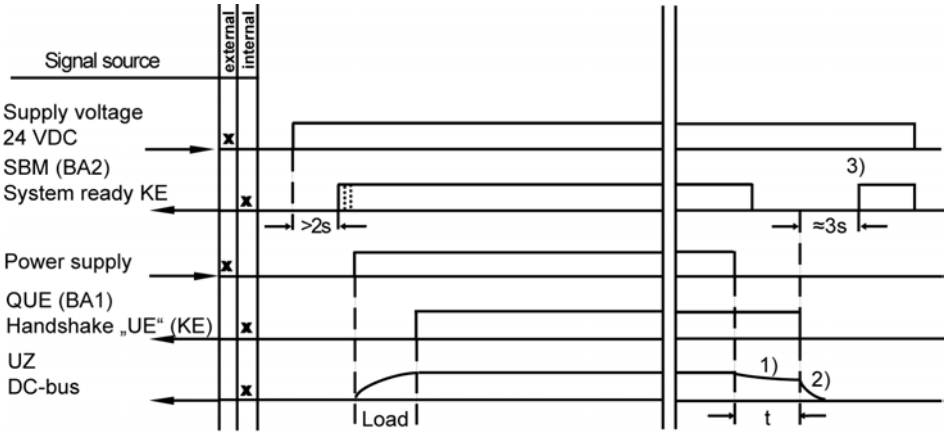
In the integrated air cooling system, the fan is supplied from the KE and is temperature-dependent controlled.

The fan is activated at 78% of the cut-off temperature. Once the temperature falls below this level, the fan runs for another minute.

9.16 Switch-on diagram and switch-off diagram

KE without fieldbus interface

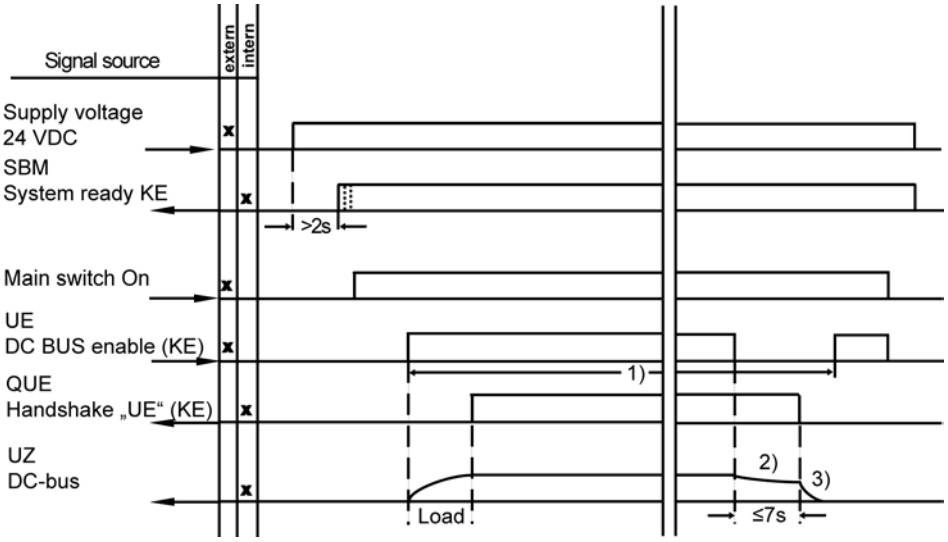
KEN 5-0N, KEN 5-FN, KEN 5-S10 and KEN 20-0N



1) Detection of power supply separation. Time (t) is depend from the application
2) Active discharge: The DC bus voltage is discharged via the external brake resistor
3) Switch-on again is possible

KE with fieldbus interface

KE x, KE x-F, KE x-0EU, KEN x, KEN x-F, KES x, KES x-0EU

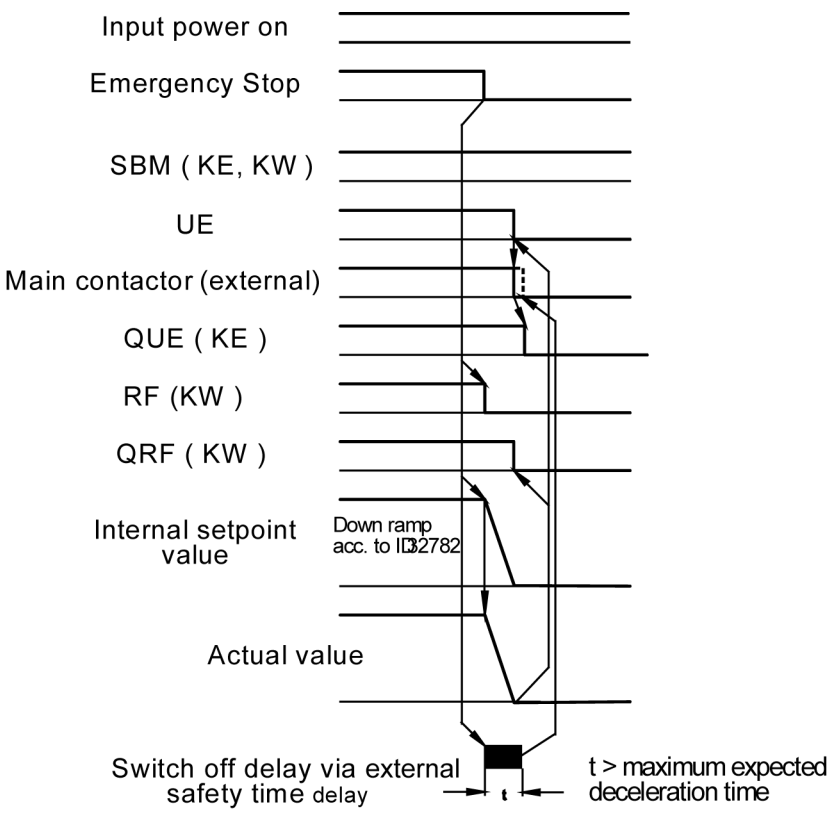


1) Inhibit Time for Control Signal UE: Siehe 'DC bus capacity' auf Seite 67.
2) Detection of power supply separation
3) Active discharge: The DC bus voltage is discharged via the external brake resistor (default setting, properties based on ID32901 'Global service bits' bit 9).

9.17 Pulse diagram EMERGENCY STOP

In case of an emergency off, the control of all RFxs has to be interrupted in its hardware. This causes the system to switch internally to speed control with a digital setpoint of "0". The motors are braked. Since the main contactor is still energised (UE = 1), regenerative feedback can continue to function. With the motors idling, the QRFxs are reset (QRFx = 0 All motors must be evaluated). Now the UE needs to be reset, the main contactor de-energises, the system disconnects from the grid on the power side and QUE is reset.

When the emergency off circuit is interrupted, a switch-off delay must be started via an external safety time relay. Once the time has expired, the time relay contact externally de-energises the control of the main contactor K1 and, in the process, disconnects the system from the grid if it was not possible to decelerate the axes within the safety time.


Input power on
Emergency Stop
SBM (KE, KW)
UE
Main contactor (external)
QUE (KE)
RF (KW)
QRF (KW)
Internal setpoint value
Down ramp acc. to ID32782
Actual value
Switch off delay via external safety time delay
t
t > maximum expected deceleration time

10 Functional description KW

10.1 Theory of operation

The main task of the compact inverter KW is to regulate current for the servo motor.

The controller card calculates the instantaneous values for reference currents (which are then to saved to the three motor coils in the stator via the inverter) cyclically based on the specified setpoint, the actual values for phase currents and the rotor position. Synchronised with the 8 kHz basic cycle, the power semiconductor (IGBT) is controlled pulse-width-modulated so that the motor coils carry sine-shaped currents statically. The control unit is fully digital in design. The logic and power component are electrically isolated by an optocoupler. The inverter currents are monitored I^2t. The inverter output is protected against overcurrent.

The speed and positional control loops are carried out by the controller card. The system determines the actual speed and position values from the motor encoder signals.

The motor encoder signals are monitored. If the encoder fails, the System Ready message (SBM) is reset, the cycle pulses are blocked and the drive coast to stop.

The controller cards and/or optional cards are installed in the compact inverters according to the specific application. They are not included in this description.

Double Inverter Modules AMKASYN KWD

The compact inverter inverter module KWD features two stand-alone KW inverters in one casing. A range of different optional controller cards are available, thus ensuring the device can be customised to best suit your application. KWDs represent an extremely compact solution that functions as a precise, highly dynamic controller for various DC motor types with outputs ranging from 1 to 5 kVA.

Safety for Man and Machine

In addition to delivering the best in functional standards, the servo inverter offers top-level safety. The integrated EF safety function used to protect against restart is certified in accordance with EN ISO 13849-1 (Cat.4, PL e).

The compact inverter includes the following functional groups:

- DC bus capacitors with DC bus detection
- IGBT controller and IGBT inverter
- Control and monitoring logic
- Logic for power output stage enable EF
- Switched mode power supply
  The switched mode power supply is supplied with 24 V DC externally via the X08/X09 terminal.It generates the internal voltages: +5 V, +12 V, -12 V.
- Mounting slot for controller card / optional cards

10.2 Temperature monitoring

10.2.1 Module-internal

The module temperature is captured by a KTY sensor. If the modules are subject to critical temperatures (e.g. due to inadequate cooling), the warning 2350 'Device temperature warning' is generated. After ID32943 'Warning time' expires (default: four seconds) the drive changes to an error state and generates the error message 2346 'Converter temperature error'.

The current temperature value can be read out via the parameter ID33116 'Temperature internal' or the configurable ID32785 'Message 16'.

(The cut-off temperature varies from module to module.)

10.2.2 Servo motor

The servo motor's temperature sensor is connected to terminal X12 to monitor the temperature. Temperature monitoring for the compact inverter is activated when the sensor is triggered and the warning message 2351 'Motor temperature warning' is generated. After ID32943 'Warning time' expires (default: four seconds) the drive changes to an error state and generates the error message 2347 'Motor temperature error'.

Continuous monitoring of the temperature values is possible via ID33117 'Temperature external' using a KTY 84 temperature sensor.

(The cut-off temperature and the type of sensor are specified in the motor data sheet.)

10.3 Fan control

With KW modules (module width: 55 mm) that feature an integrated air-cooling system, the external fan is always in operation.
With KW modules (module width: 86 mm) that feature an integrated air-cooling system, the external fan is activated with controller enable RF=1 and runs for approx. one minutes when RF=0.

10.4 EF requirements

Hardware and software requirements are outlined in the list used to track release versions of certified compact inverter modules.
See: TÜV_Versionsfreigaben.pdf

If all prerequisites are fulfilled, "4" is shown under ID34055 'EF type'.
If "2" is shown, safety in acc. with EN ISO 13849-1 (Cat.4, PL e) is not possible.

KW xx-0N devices do not feature an integrated EF safety function.

10.5 Function description - EF safety function

KW compact inverter modules with integrated EF safety function to protect against restart.

Inspected by TÜV SÜD in acc. with: EN ISO 13849-1 (Cat.4, PL e)

The EF safety function is redundantly executed. The norm specifications are fulfilled through the use of a two-channel hardware logic (EF/EF2) in combination with two-channel software monitoring found on the controller card.

Interrupting the control inputs EF/EF2 will cause the trigger signals for control of the power output stages to be safely blocked in two channels. The motor is in a secure state without having the drive system completely separated from power.

The power output stage enable EF/EF2 may only be removed with the controller enable RF switched off and the motor in stand-still. Shut-down of EF/EF2 during the run will create an error message in the drive and the motor runs down.

The evaluation of the outputs QEF/QES is not safety-relevant and therefore not part of the certification.

Function:

The power output stages are unblocked by setting the signal EF AND EF2. EF and EF2 must be controlled with one switching path each. The single-channel control of the signals EF and EF2, for example by bridging the two signals, is not certified.

After these have been enabled, the drive can be powered by setting RF controller enable.

The output QES=1 signals that the output stages is safely blocked in two channels.

The output QEF=1 signals that at least one EF and/or EF2 signal has been set. The output stage is not blocked or only one channel is. (QES = 0). The single-channel control of the signals EF and EF2, e.g. by a bridge, is not part of the certification and does not correspond to the safety category PL e according to EN ISO 13849-1.

Individual fuse protection:

Each module is controlled separately. Acknowledgement signals are available for every module. The power output stage can in this way be blocked and unblocked independent of other drives.

Individual device fuse protection KWD/KWZ

Control and acknowledgement signals are transmitted. The power output stages A and B can be blocked and unblocked as a group.

Group fuse protection:

Control and acknowledgement signals are forwarded by each module. The power output stages for all modules can be blocked and unblocked as a group.

10.5.1 Signal description for power output stage enable

The compact double inverters KWD and KWZ consist of two power output stages A and B in one casing. The signals are complemented by supplement A or B.

Signal	Direction	Meaning
EF	E	Control signal, power output stage enable EF
EF2	E	Control signal, power output stage enable EF2
QEF	A	Acknowledgement of control signal, power output stage enable min. 1 control signal for EF/EF2 power output stage enable is set
QES	A	Output stage safely blocked
WEF	E	Reference potential 0 VDC ext. for control signals EF/EF2
WQF	E	Supply 24 VDC ext. Power supply for relay contact QEF
WQS	E	Supply 24 VDC ext. Power supply for relay contact QES

10.5.2 Acknowledgement signals QEF / QES

Input EF	Input EF2	Output QEF	Output QES	Meaning
0	**0**	**0**	**1**	Power output stages **safety blocked**, two-channel Motor is not supplied with power, setting of controller enable RF=1 triggers an error message.  **Safety state**
0	1	1	0	Power output stages blocked one-channel Motor is not supplied with power, setting of controller enable RF=1 triggers an error message.  **Unsafe state**
1	0	1	0	Power output stages blocked one-channel Motor is not supplied with power, setting of controller enable RF=1 triggers an error message.  **Unsafe state**
1	**1**	**1**	**0**	Power output stages unblocked Motor can be supplied with power by setting controller enable RF=1.  **Unsafe state**

10.5.3 Drive behaviour

Responses of module to various switch statuses

(>> represents the signal change)

Input EF	Input EF2	n_{act} [rpm]	RF	Drive response	Response to errors
0	0	0	0 >> 1	Error message 2320	Set RF 1 >> 0 Run command FL Clear error Wait for SBM
0	1	0	0 >> 1		
1	0	0	0 >> 1		
1	**1**	**0**	**0 >> 1**	**The drive is supplied with power**	
1	1 >>0	≠ 0	1	Power supply to motor is immediately cut. The motor runs down. Error message 2320	Set RF 1 >> 0 Run command FL Clear error Wait for SBM
1 >> 0	1	≠ 0	1		
1 >> 0	1 >> 0	≠ 0	1		

10.5.4 Reaction time EF safety function

Response behaviour power output stage

The control signals of the EF safety functions are influenced by an internal hardware and software filter.

An EF/EF2 signal disruption greater than 50 µs affect directly to the hardware The power output stage is immediately locked.

Response behaviour until diagnostic message 2320 'Output stage enabling (EF) inactive with controller enable RF active'

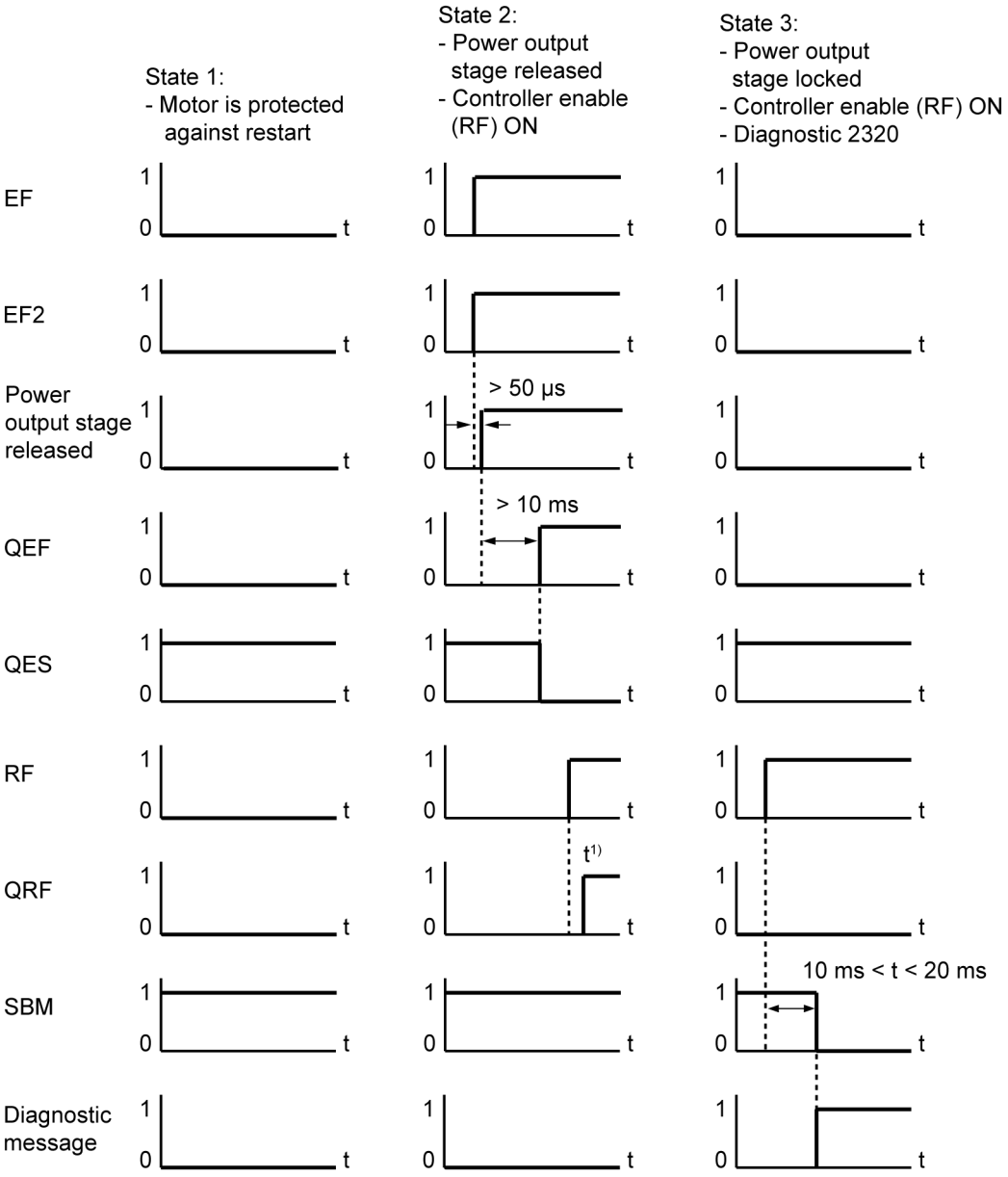
The control signal at the EF/EF2 input is detected in a 1 ms task. An internal error is detected after 10 cycles (10 ms) with low signal. The internal error is evaluated by the EF safety function in a 10 ms task and issued by the system as a diagnostic message 2320.

The diagnostic message according to EF/EF2 (consistent) low signal, is set by the software filter at latest after 20 ms.

Special case input signal EF/EF 2 bounces

The detected high and low signals are buffered with an internal counter (0 - 10). In the case of a bouncing input signal, the counter is reduced by 1 at a high signal. At a low signal the counter increase by 1. If the counter value is 10, an internal error is detected. The internal error is evaluated by the EF safety function in a 10 ms task and issued by the system as a diagnostic message 2320.

Diagrams with constant EF/EF2 signals

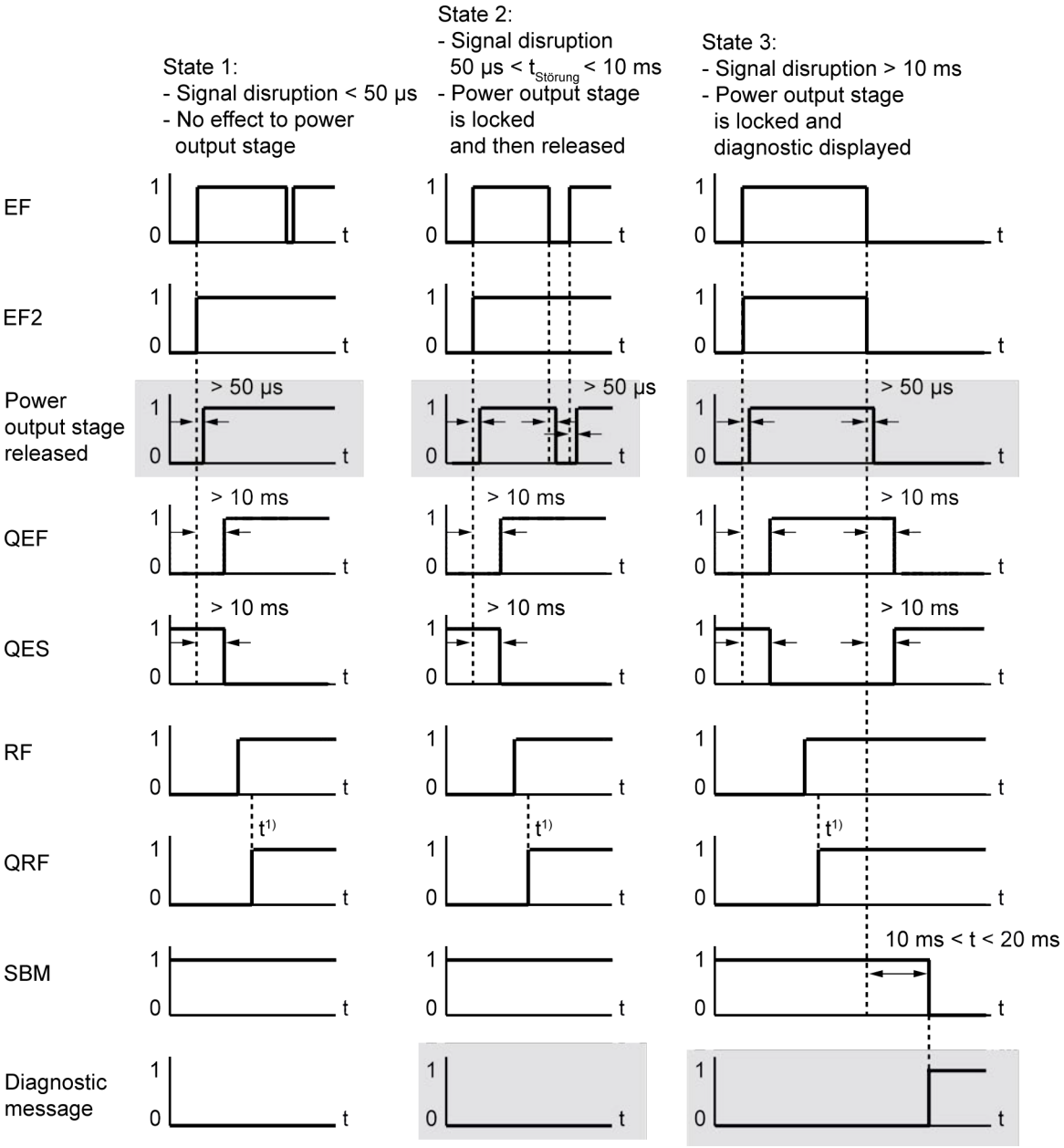


1) Depends on the connected motor

State	
1	The control signal EF/EF2 is deactivated. The power stage is deactivated. SBM = 1, QEF = 0, QES = 1, no diagnostics message The hardware acknowledgment signals QEF and QES indicates the safe and torque-free state of the motor.
2	The control signal EF/EF2 is constantly present. The power stage is released. SBM = 1, QEF = 1, QES = 0, no diagnostics message The motor can be energized by the control signal RF 'controller enable'.

State	
3	The control signal EF/EF2 is deactivated. The power stage is locked. SBM = 1, QEF = 0, QES = 1, no diagnostics message The hardware acknowledgment signals QEF and QES indicates the safe and torque-free state of the motor. The control signal RF 'Controller enable' is set. SBM is reset and the drive generates the diagnostic message 2320 'EF inactive' with the description 'Output stage enabling (EF) inactive with controller enable RF active'.

Diagrams with irregular EF/EF2 signals (signal disruption)



1) Depends on the connected motor

State	
1	On the control signal EF/EF2 are signal disruptions of less than 50 µs. The signal disruptions has no effect on the power output stage. SBM = 1, QRF = 1, no diagnostics message

State	
2	This operating state is not permissible. On the control signal EF/EF2 are approximately 50 µs > signal disruptions < 10 ms available. The power output stage is locked after approximately greater than 50 µs. After the signal disruptions (less than 10 ms), the power stage is released again. The motor is energized. SBM = 1, QRF = 1, no diagnostics message If there are differences between the setpoint and the actual value, torque jumps occur. The controller is unnecessarily busy. Depending on the active operating mode, e.g. a following error occurs. The relay outputs QEF and QES are directly controlled by the hardware. Due to the reaction times of the relays, undefined status displays can be output in this state. Signal disruption less than approximately 10 ms do not generate a diagnostic message because of a integrated software filter.
3	On the control signal EF/EF2 are signal disruptions of more than 10 ms. The power output stage is locked after approximately greater than 50 µs. The hardware acknowledgment signals QEF and QES indicates the torque-free state of the motor (> 10 ms). SBM and QRF is reset and the drive generates the diagnostic message 2320 'EF inactive' with the description 'Output stage enabling (EF) inactive with controller enable RF active'. The diagnostic message according to EF/EF2 (consistent) low signal, is set by the software filter at latest after 20 ms.

10.5.5 EF individual fuse protection KW

Each module is controlled separately. Acknowledgment signals are available for every module. The power output stage can in this way be blocked and unblocked independent of other modules.

To do so, lay the wiring as described below:

EF safety function control

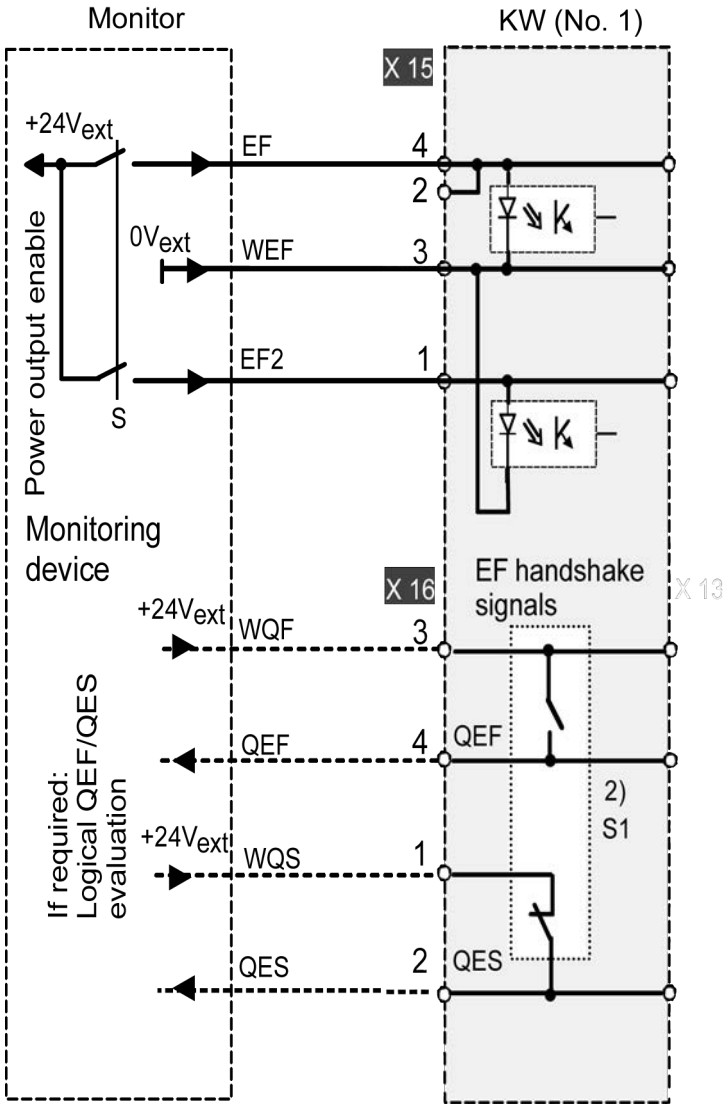
24 VDC ext. control signal EF2	>>	X15 Pin 1 EF2
24 VDC ext. control signal EF	>>	X15 Pin 2 EF
0 VDC ext.	>>	X15 Pin 3 WEF

Acknowledgment power output stage blocked/enabled

24 VDC ext.	>>	X16 Pin 1 WQS (QES power supply)
X16 Pin 2	>>	Acknowledgment signal QES (QES = 1: Output stage safely blocked)

Acknowledgment of power output stage enable (QEF) of the input control signals EF AND/OR EF2

24 VDC ext.	>>	X16 Pin 3 WQF (QEF power supply)
X16A Pin 4	>>	Acknowledgment signal QEF (min. 1 EF(2) control signal is set)



10.5.6 EF individual fuse protection KWD/KWZ

Each module is controlled separately. Acknowledgment signals are available for every module. The power output stage can in this way be blocked and unblocked independent of other modules.

To do so, lay the wiring as described below:

EF safety function control

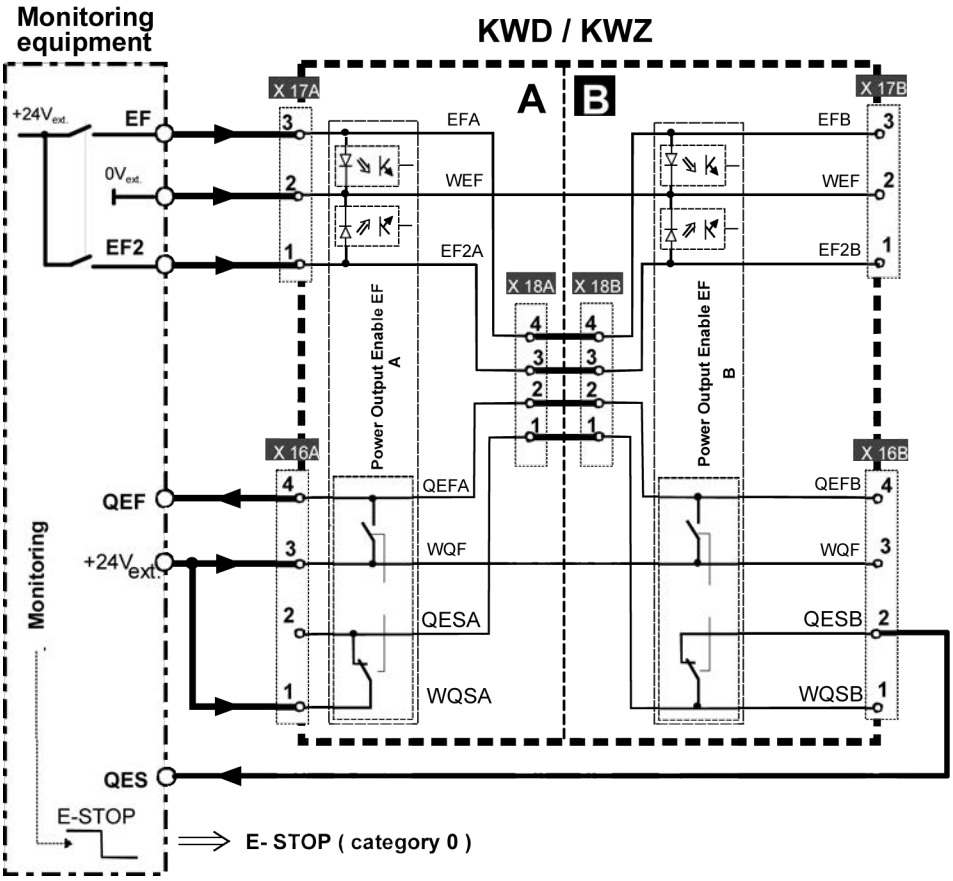
24 VDC ext. control signal EF2	>>	X17A Pin 1 EF2
0 VDC ext.	>>	X17A Pin 2 WEF
24 VDC ext. control signal EF	>>	X17A Pin 3 EF

Acknowledgment power output stage blocked/enabled

24 VDC ext.	>>	X16A Pin 1 WQSA (QESA power supply)
X16A Pin 2	>>	Acknowledgment signal QESA (QESA = 1: Output stage safely blocked)

Acknowledgment of power output stage enable (QEFA or QEFB) of the input control signals EF AND/OR EF2

24 VDC ext.	>>	X16A Pin 3 WQFA (QEFA power supply)
X16A Pin 4	>>	Acknowledgment signal QEFA (min. 1 EF(2) control signal is set)



Power output stage enable, one-channel

The single-channel control of the signals EF and EF2, e.g. by a bridge, is not part of the certification and does not correspond to the safety category PL e according to EN ISO 13849-1.

If the power output stage enable is only carried by one channel, pin 3 (EF2_x) and pin 4 (EF_x) have to be bridged with individual fuse protection of the drives in connectors 18A and 18B. For group fuse protections, pin 1 ... 4 in connectors 18A and 18B have to be bridged parallel. In the last KWD module of the group, pin 1 and pin 3 in connector 17B have to be bridged.

10.5.7 EF individual device fuse protection KWD/KWZ

Control and acknowledgment signals are transmitted. The power output stages A and B can be blocked and unblocked as a group. To do so, lay the wiring as described below:

EF safety function control

24 VDC ext. control signal EF2	>>	X17A Pin 1 EF2
0 VDC ext.	>>	X17A Pin 2 WEF
24 VDC ext. control signal EF	>>	X17A Pin 3 EF

Looping control signals EF/EF2

X18A Pin 3	>>	X18B Pin 3 (EF2 control signal)
X18A Pin 4	>>	X18B Pin 4 (EF control signal)

Acknowledgment power output stage blocked/enabled

24 VDC ext.	>>	X16A Pin 1 WQSA (QESA power supply)
X16A Pin 2	>>	Acknowledgment signal QESA (QESA = 1: Output stage safely blocked)

Transmission of output stage blocked/enabled

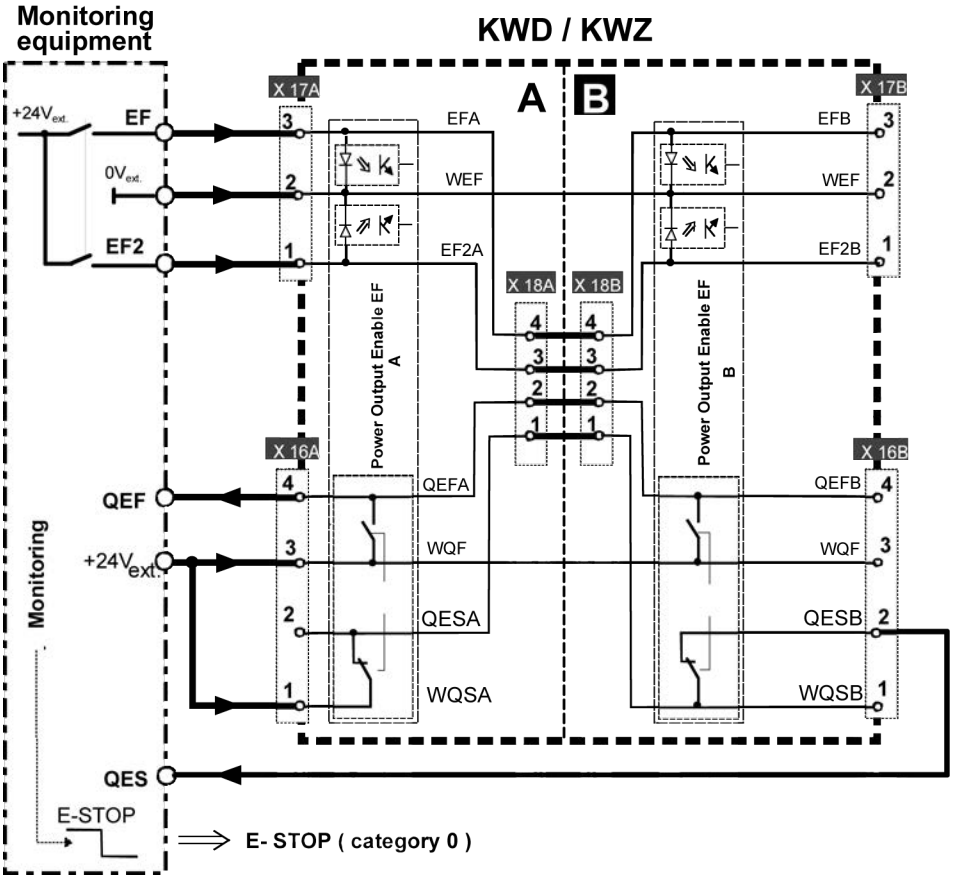
X18A Pin 1	>>	X18B Pin 1 acknowledgment signal QES (QES = 1: Output stage safety blocked)

Acknowledgment of power output stage enable (QEFA or QEFB) of the input control signals EF AND/OR EF2

24 VDC ext.	>>	X16A Pin 3 WQF (QEFA power supply)
X16A Pin 4	>>	Acknowledgment signal QEFA (min. 1 EF(2) control signal is set)

Power output stage enable transmission (QEFA or QEFB) of the input control signals EF AND/OR EF2

X18A Pin 2	>>	X18B Pin 2 Acknowledgment signal QEFA (min. 1 EF(2) control signal is set)



10.5.8 EF group fuse protection KW

Control and acknowledgment signals are forwarded by each module. The power output stages for all modules can be blocked and unblocked as a group. Universal acknowledgment signals are available.

To do so, lay the wiring as described below:

EF safety function control

24 VDC ext. control signal EF2	>>	X15 Pin 1 EF2
24 VDC ext. control signal EF	>>	X15 Pin 2 EF
0 VDC ext.	>>	X15 Pin 3 WEF

Control signal transmission EF/EF2

X14 Pin 1	>>	X15 Pin 3 (WEF 0 VDC ext.)
X14 Pin 2	>>	X15 Pin 2 or Pin 4(EF)
X14 Pin 3	>>	X15 Pin 1 (EF2)

Acknowledgment power output stage blocked/enabled

24 VDC ext.	>>	X16 Pin 1 WQS (QES power supply)
X16 Pin 2	>>	Acknowledgment signal QES (QES = 1: Output stage safely blocked)

Transmission of acknowledgment output stage blocked/enabled

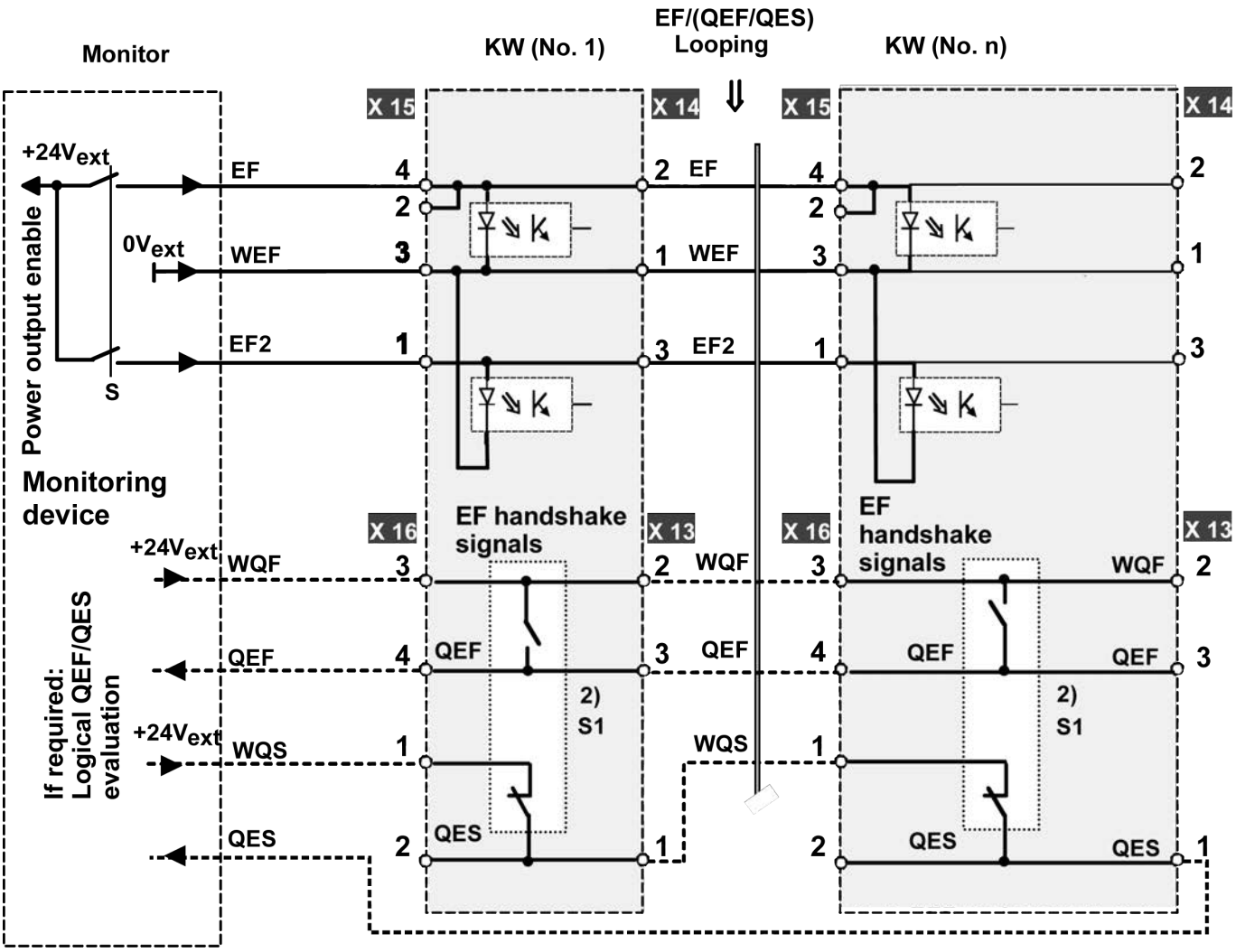
X13 Pin 1	>>	X16 Pin 1

Acknowledgment of power output stage enable (QEFx ... QEFn) of the input control signals EF AND/OR EF2

24 VDC ext.	>>	X16 Pin 3 WQF (QEF power supply)
X16A Pin 4	>>	Acknowledgment signal QEF (min. 1 EF(2) control signal is set)

Transmission: acknowledgment of power output stage enable (QEFx ... QEFn) of the input control signals EF AND/OR EF2

X13 Pin 2	>>	X16 Pin 3 (WQF 24 VDC)
X13 Pin 3	>>	X16 Pin 4 (QEF acknowledgment signal)


Monitor
KW (No. 1)
EF/(QEF/QES)
Looping
KW (No. n)
X 15
X 14
X 16
X 13
+24Vext
0Vext
EF
WEF
EF2
WQF
QEF
WQS
QES
Power output enable
S
Monitoring device
If required:
Logical QEF/QES
evaluation
EF handshake signals
2)
S1

10.5.9 EF group fuse protection KWD / KWZ

Control and acknowledgment signals are forwarded by each module. The power output stages for all modules can be blocked and unblocked as a group. Universal acknowledgment signals are available.

To do so, lay the wiring as described below:

EF safety function control

24 VDC ext. control signal EF2	>>	X17A Pin 1 EF2
0 VDC ext.	>>	X17A Pin 2 WEF
24 VDC ext. control signal EF	>>	X17A Pin 3 EF

Fowarding of control signal EF/EF2 (device)

X18A Pin 3	>>	X18B Pin 3 (EF2 control signal)
X18A Pin 4	>>	X18B Pin 4 (EF control signal)

Routing of EF safety function from KWD/KWZ to KWD/KWZ

X17B Pin 1	>>	X17A Pin 1 (EF2 control signal)
X17B Pin 2	>>	X17A Pin 2 (WEF 0 VDC ext.)
X17B Pin 3	>>	X17A Pin 3 (EF control signal)

Acknowledgment power output stage blocked/enabled

24 VDC ext.	>>	X16A Pin 1 WQSA (QESA power supply)
X16A Pin 2	>>	Acknowledgment signal QESA (QESA = 1: Output stage safely blocked)

Transmission of output stage blocked/enabled

X18A Pin 1	>>	X18B Pin 1 Acknowledgment signal QES (QES = 1: Output stage safety blocked)

Acknowledgment of power output stage enable (QEFAx ... QEFAn or QEFBx ... QEFBn) of the input control signals EF AND/OR EF2

24 VDC ext.	>>	X16A Pin 3 WQF (QEFA power supply)
X16A Pin 4	>>	Acknowledgment signal QEFA (min. 1 EF(2) control signal is set)

Power output stage enable transmission (QEFAx ... QEFAn or QEFBx ... QEFBn) of the input control signals EF AND/OR EF2

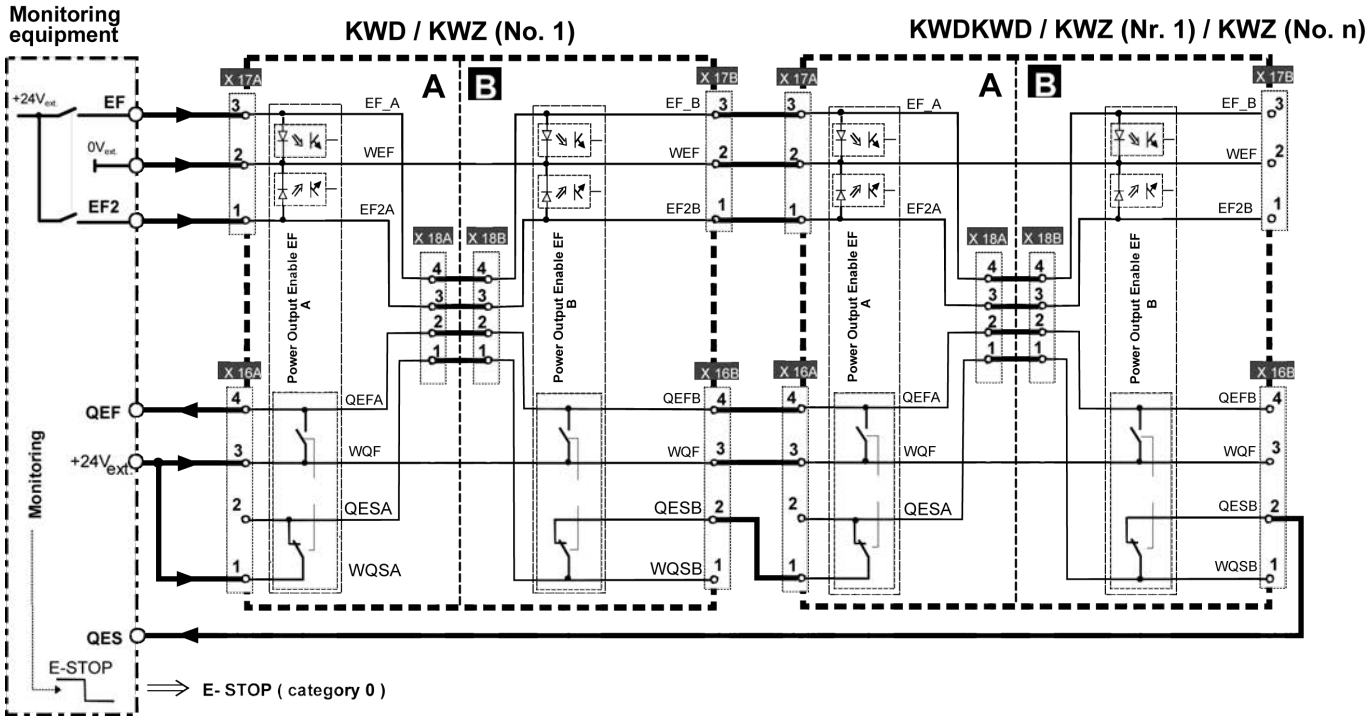
X18A Pin 2	>>	X18B Pin 2 Acknowledgment signal QEFA (min. 1 EF(2) control signal is set)

Output stage transmission blocked/enabled KWD/KWZ to KWD/KWZ

X16B Pin 2	>>	X16A Pin 1 (QES)

Output stage transmission EF AND/OR EF2 KWD/KWZ to KWD/KWZ

X16B Pin 3	>>	X16A Pin 3 (WQF 24 VDC)
X16B Pin 4	>>	X16A Pin 4 (QEF)


Monitoring equipment
KWD / KWZ (No. 1)
KWDKWD / KWZ (Nr. 1) / KWZ (No. n)
+24V ext.
EF
0V ext.
EF2
QEF
+24V ext.
Monitoring
QES
E-STOP
E- STOP (category 0)
X 17A
X 17B
X 16A
X 16B
X 18A
X 18B
A
B
EF_A
EF_B
WEF
EF2A
EF2B
QEFA
QEFB
WQF
QESA
QESB
WQSA
WQSB
Power Output Enable EF A
Power Output Enable EF B

10.5.10 EF group fuse protection combination of KW with KWD/KWZ

Control and acknowledgment signals are forwarded by each module. The power output stages for all modules can be blocked and unblocked as a group. Universal acknowledgment signals are available.

Perform the wiring as described below:

EF safety function control KW

24 VDC ext. control signal EF	>>	X15 Pin 2 EF
24 VDC ext. control signal EF2	>>	X15 Pin 1 EF2
0 VDC ext.	>>	X15 Pin 3 WEF

Control signal transmission EF/EF2 to KWD/KWZ

X14 Pin 1	>>	X17A Pin 2 (WEF 0 VDC ext.)
X14 Pin 2	>>	X17A Pin 3 or Pin 4 (EF)
X14 Pin 3	>>	X17A Pin 1 (EF2)

Acknowledgment power output stage blocked/enabled

24 VDC ext.	>>	X16 Pin 1 WQS (QES power supply)
X16 Pin 2	>>	Acknowledgment signal QES (QES = 1: Output stage safely blocked)

Transmission of acknowledgment output stage blocked/enabled

X13 Pin 1	>>	X16A Pin 1 (QES)

Acknowledgment of power output stage enable (QEF) of the input control signals EF AND/OR EF2

24 VDC ext.	>>	X16 Pin 3 WQF (QEF power supply)
X16A Pin 4	>>	Acknowledgment signal QEF (min. 1 EF(2) control signal is set)

Transmission: acknowledgment of power output stage enable (QEF) of the input control signals EF AND/OR EF2

X13 Pin 2	>>	X16A Pin 3 (WQF 24 VDC)
X13 Pin 3	>>	X16A Pin 4 (acknowledgment signal QEF)

Looping control signals EF/EF2

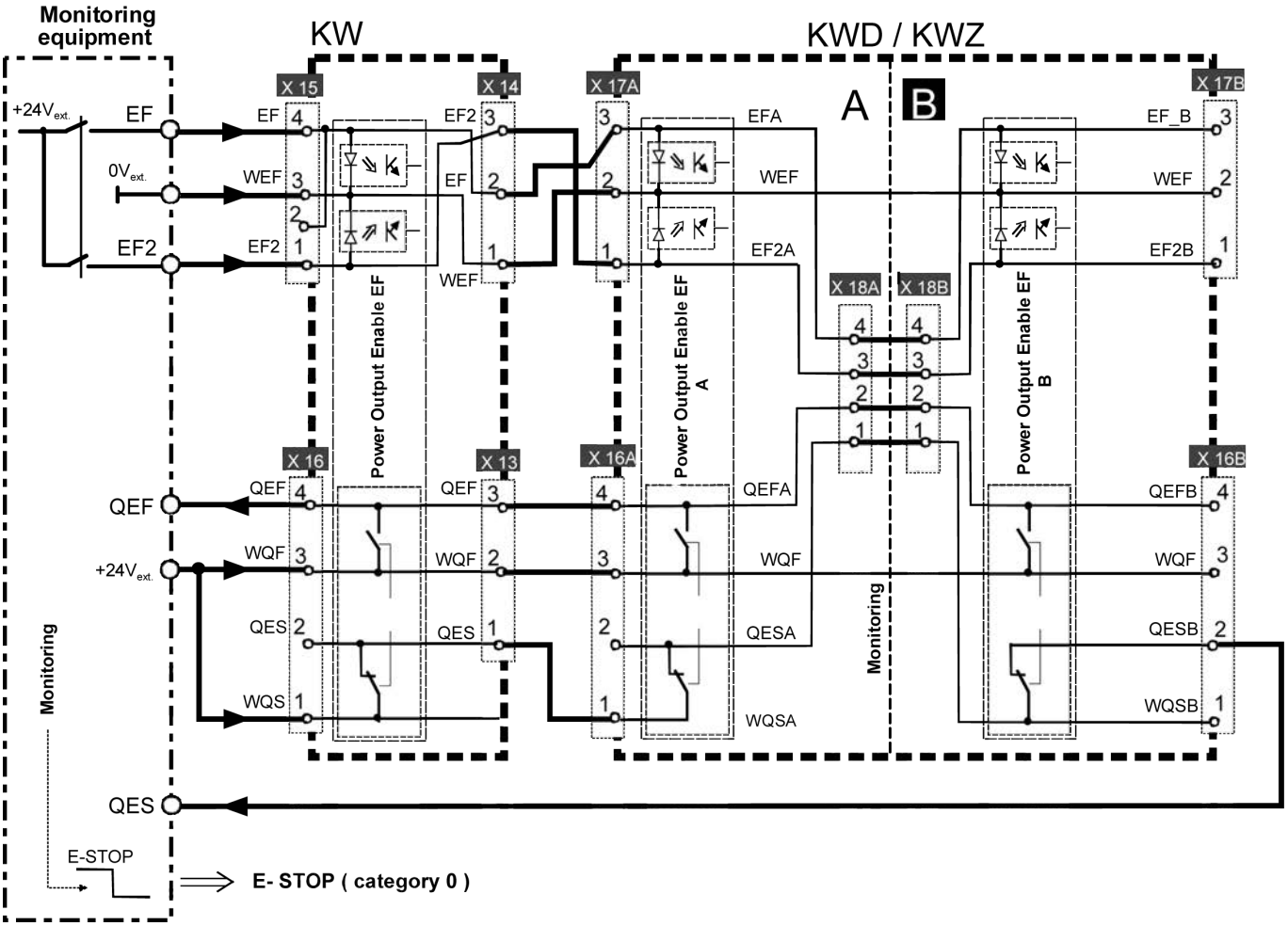
X18A Pin 3	>>	X18B Pin 3 (EF2 control signal)
X18A Pin 4	>>	X18B Pin 4 (EF control signal)

Transmission of output stage blocked/enabled

X18A Pin 1	>>	X18B Pin 1 Acknowledgment signal QES (QES = 1: Output stage safety blocked)

Power output stage enable transmission EF AND/OR EF2

X18A Pin 2	>>	X18B Pin 2 Acknowledgment signal QEFA (min. 1 EF(2) control signal is set)


Monitoring equipment
KW
KWD / KWZ
+24V ext.
0V ext.
EF
EF2
QEF
QES
E-STOP
Monitoring
X 15
X 14
X 17A
X 17B
X 16
X 13
X 16A
X 16B
X 18A
X 18B
A
B
EF
WEF
EF2
QEF
WQF
QES
WQS
EFA
EF2A
QEFA
WQSA
EF_B
EF2B
QEFB
QESB
WQSB
Power Output Enable EF
Power Output Enable EF A
Power Output Enable EF B
Monitoring
E- STOP (category 0)

11 Maintenance, cleaning, and disposal

Maintenance

The KE/KW modules do not require any maintenance.

Defective AMK components can be sent to AMK for appraisal and repairs.

For personnel not authorised by AMK, it is forbidden to open and/or modify the units in any way. Failure to comply with this requirement shall immediately void the warranty. In these cases, AMK assumes no liability for any subsequent damages.

Cleaning

NOTICE	
Material Damage!	**Material damage!** Electrical shorts can occur if water enters the device. **Steps to prevent:** • Whenever necessary, you can clean the surfaces of the units with a dry dust cloth or a slightly moistened cloth with neutral detergent. No humidity may get into the devices while performing this task! • The inside of the modules may only be cleaned by AMK.

Disposal

Clarify with your local recycling company which materials and chemicals need to be separated and how to dispose of them. Observe the local regulations for disposal.

Examples of materials to be disposed of separately:

Components

- Electronic scrap, e.g., encoder electronics
- Iron scrap
- Aluminium
- Non-ferrous metal, e.g., motor windings
- Insulating materials

Chemicals

- Coolant
- Oils (disposal as hazardous waste, in acc. with the pertinent legislation; in Germany, the Waste Oil Ordinance (AltölV) applies)
- Grease
- Solvents
- Paint residue

12 Replacement

12.1 General safety notes

Generally there is a danger from electrical drives because of improper use, uncontrollable movements due to defective components, software errors, handling errors, errors in the installation and with components, errors because of environmental influences, and from touching current-carrying parts.

12.1.1 For your safety

⚠ DANGER

Danger to life from electrical shock!

In the event of an interruption to the PE connection, avoid touching the casing because life-threatening levels of voltage may be present!

Steps to prevent:

- EN 61800-5-1 requires that the devices be firmly connected on the power side.
- The PE conductor must have a cross-section of at least 10 mm^2 or must have a second PE connection with a cross-section at least equal to the mains feeder (cf. EN 61800-5-1).

Cross-section AC wire	Cross-section PE wire
≤ 10 mm^2	= 10 mm^2
10 ... 16 mm^2	= Cross-section AC wire
16 ... 35 mm^2	= 16 mm^2
≥ 35 mm2	≈ 1/2 x Cross-section AC wire

⚠ DANGER

Danger to life from touching electrical connections!

Electrical terminals and connectors carry voltages that may cause death or serious injury upon contact. The teminals of the DC circuit capacitors (UZP, UZN) on the front panel of the device may retain hazardous DC voltage for up to 5 minutes after switching off the device!

In OFF state, the LED indicators on the device front panels do not indicate the voltage status of the terminals.

Steps to prevent:

- Provide shock-hazard protection
- Prior to any work on the device: Turn off the main switch to disconnect the power supply, and secure switch against being turned on again.
- Wait at least 5 minutes for components to discharge.
- Connection or disconnection of terminals is only allowed if they are free of voltage.
- Measure the terminals voltage to verify that the terminal is de-energized. One suitable measuring point is the DC bus between the UZP and UZN terminals.
- If the PE connection between the modules is open, avoid touching the casing since dangerous voltages may be present. During the proper operation of the KE/KW modules there is an earth leakage current of more than 3.5 mA. In this case, the standard requires that the devices be firmly connected to PE. The PE conductor must have a cross section of at least 10 mm^2.
- Do not connect, disconnect and/or install the electrical lines (terminal cables, plugs, sockets) and optional modules until they have been electrically de-energized.

12.1.2 Avoiding material damage

NOTICE	
Material Damage!	**Electronic components could be destroyed through static discharge!** Therefore touching of the electrical connections (e. g. signal and power supply cable or option and controller cards) must be avoided. Otherwise you can be damaged the components when touching by static discharge. **Steps to prevent:** • Avoid touching electrical connections and contacts. • During handling the electronic component discharge yourself by touching PE. • Pay attention to the ESD-notes (electrostatic discharge).

NOTICE	
Material Damage!	**Mechanical damage!** Contact problems due to pins that are bent or out of alignment. Damage may result if the screw joints are not straight when connecting the two parts. **Steps to prevent:** • Never force connectors and plug-in cards! • Before tightening the screw joints (e.g., power and encoder plugs), check whether the connector (spring) and socket (slot) are properly positioned. After this is complete, tighten the screw connection according to the specifications.

12.2 Safety

In particular on drive systems, the instructions pertaining to safety and the following five safety rules have to be kept in the specified sequence:

1. Switch off electrical circuits (also electronic and auxiliary circuits).
2. Secure against being switched on again.
3. Determine that there is no voltage.
4. Ground and short circuit.
5. Cover or close off neighboring parts that are under voltage.

Reverse the measures taken in reverse order after completing the work.

12.3 Dismounting and replacing a compact power supply

Dismounting of the compact power supply

1. Set main switch to off and allow for a discharge time of > 5 minutes for the DC bus terminals.
2. Remove strain relief / detach shielding terminal connections of connecting cables.
3. Unplug all connectors:
   - Connector X20 (where applicable), disconnect vibration-free screw connection before unplugging
   - X21, X22, X25, X08, X09
   - X04, X06, X07, X08 (only with KEN 5-0N, KEN 5-FN, KEN 5-S10, KEN 20-0N)
   - X236 (ACC load resistor), X237 (ACC bus) on the top of the device
4. Disconnect individual conductors of power supply: Connector X01 or X07 (with KEN 5, KEN 5-F).
5. Detach connections for DC bus UZP / UZN: connectors X02 and X06 (only with KE / KEN / KEN 120, KE / KES 180).
6. Detach connections for external brake resistor (where applicable):
   Connections X03 and X03.1 / X03.2 (only with KE / KEN / KES 120).
7. Unplug PE connections from the PE bolts.
8. For devices with widths of 170 / 255 / 425 mm, unfasten the 2 / 4 / 8 clamping bolts at the centre of the unit.
   Unscrew fastening screws for KE module.
9. Lift KE module up slightly and pull out to remove.

Mounting of the compact power supply

1. Clean mounting surface for cold plate and new KE module.
2. Insert and lower new KE module.
3. For devices with widths of 170 / 255 / 425 mm, first securely fasten the 2 / 4 / 8 clamping bolts at the centre of the unit
   Tighten fastening screws.
   (Further information: Siehe 'Installation of cold plate modules on the cooling system' auf Seite 106.and.Siehe 'Installation of modules with integrated air cooling' auf Seite 107.)
4. Attach all PE connections to the PE bolts.
   (Further information: Siehe 'PE connection' auf Seite 113.)
5. Connect power supply in-phase: Connector X01 or X07 (with KEN 5, KEN 5-F).
   (Tightening torques: Siehe 'Tightening torques, connection terminals' auf Seite 209.)
6. Connect DC bus UZP, UZN: Connectors X02 and X06 (only with KE / KEN / KES 120, KE / KES 180).
   (Tightening torques: Siehe 'Tightening torques, connection terminals' auf Seite 209.)
7. Connect external brake resistor (where available): Connectors X03 and X03.1 / X03.2 (with KE / KEN / KES 120).
   (Tightening torques: Siehe 'Tightening torques, connection terminals' auf Seite 209.)
8. Plug all connectors into the accompanying pedestal:
   (Tightening torques: Siehe 'Tightening torques, connection terminals' auf Seite 209.)
   - Connector X20 (where applicable), disconnect vibration-free screw connection before unplugging,
   - X21, X22, X25, X08, X09,
   - X04, X06, X07, X08 (only with KEN 5-0N / KEN 5-FN / KEN 5-S10, KEN 20-0N)
   - X236 (ACC load resistor), X237 (ACC bus) on the top of the device.
9. Establish all shield connections / attach all strain reliefs using shielding terminals.
   (Tightening torques: Siehe 'Tightening torques, connection terminals' auf Seite 209.)
10. Switch on 24V power supply (and mains).
11. If the default KE address / KE baud rate are not used:
    Set and save KE address and baud rate using DIP switch S1.
    (Further information: Siehe 'Changing the default settings' auf Seite 172.)
    If other parameters were configured in the KE module that was replaced (e.g. Source converter ON), these settings must be entered on the operator panel of the master KW or the ID numbers must be loaded using the AMK PC software AIPEX or AIPEX PRO to the KE.
12. Switch off 24V power supply (and mains).
13. Switch the system back on.

12.4 Dismounting and replacing a compact inverter

Dismounting the compact inverter

1. Set main switch to off and allow for a discharge time of > 5 minutes for the DC bus terminals.
2. Remove strain relief / shielding terminal connections of connecting cables.
3. Unplug all connectors, including the one on top of the unit.
   On the D-SUB connectors, first unfasten the locking screws and then disconnect the connectors.
4. Disconnect DC bus UZP / UZN connections: Connectors X05 and X06 (only with KW100 / KW150 / KW200).
5. Make sure the motor connections to X04 (X04A / X04B) are clearly labelled. Disconnect motor(s).
6. Unplug PE connections from PE bolts.
7. For devices with widths of 170 / 255 / 425 mm, first unfasten the 2 / 4 / 8 clamping bolts at the centre of the unit.
   Unfasten 2 / 4 / 6 / 10 fastening screws for inverter module.
8. Lift the module up slightly and pull out to remove.

Mounting the compact inverter

1. Clean mounting surface for cold plate and new inverter module.
2. Insert and lower the new inverter module.
3. For devices with widths of 170 / 255 / 425 mm, first fasten the 2 / 4 / 8 clamping bolts at the centre of the unit.
   Tighten fastening screws.
   (Further information:Siehe 'Installation of cold plate modules on the cooling system' auf Seite 106. and Siehe 'Installation of modules with integrated air cooling' auf Seite 107.)
4. Attach all PE connections to the PE bolts.
   (Further information: Siehe 'PE connection' auf Seite 113.)
5. Connect DC bus UZP, UZN: Connections X05 and X06 (only with KW100 / KW150 / KW200).
   (Tightening torques: Siehe 'Tightening torques, connection terminals' auf Seite 209.)
6. Connect motor connections U, V, W (X04, X04A / X04B). Observe phase sequence.
   (Tightening torques: Siehe 'Tightening torques, connection terminals' auf Seite 209.)
7. Plug all connectors into the matching pedestal, including the one on top of the unit.
   To the D-SUB connectors, also fasten the locking screws.
   (Tightening torques: Siehe 'Tightening torques, connection terminals' auf Seite 209.)
8. Carefully re-connect all shield connections / strain reliefs using shielding terminals.
   (Tightening torques: Siehe 'Tightening torques, connection terminals' auf Seite 209.)
9. Transfer application-specific data from the old to the new module:

Importing application-specific data

The KW and KWD modules feature a plug-in controller card. All application-specific data is stored on the controller card. The controller card must be transferred to the new module when replacing an older one.

Where available, optional cards are securely connected to the controller card. If such cards exist, unfasten the screws for the controller card and optional cards. Then install the unit on the new module.

During acceleration, diagnostic message 1440 'Data record changed' is generated in the KW / KWD. The function 'Clear error' clears this message and transfers the new KW / KWD serial number to the controller card.

13 Summary datas

13.1 Tightening torques, module assembly

NOTICE	
Material Damage!	**Observe the tightening torques.** Note the tightening torques specified in the documentation for screw connections and screw terminals, otherwise the conductivity and the security of the connection are not ensured.

13.1.1 Cold plate modules

T-slot acc. to DIN 508 (AMK part no. 18139), M6 inner thread for fastening screws M6 x 20
(where required, clamping bolts are found on module)

Tightening torques, modules	Module width 55 mm / 85 mm	Module width 170 mm / 255 mm / 425 mm	Tool
Clamping bolts *	---	5 Nm	Allen (size 4)
Mounting rear panel M6	8 Nm	8 Nm	Allen (size 5)

* In the first step, securely fasten the clamping bolts. In the second step, the rear panel mounts (top/bottom) are tightened.

13.1.2 Modules with integrated air cooling

M6 x length min. 12 mm
Tightening torque for rear panel mounts: 8 Nm

13.2 Tightening torques, connection terminals

NOTICE	
Material Damage!	**Observe the tightening torques.** Note the tightening torques specified in the documentation for screw connections and screw terminals, otherwise the conductivity and the security of the connection are not ensured.

Terminal / Fastening	Module width 55 mm	Module width 85 mm	Module width 170 mm	Module width 255 mm	Module width 425 mm
X01, X06,	0,5-0,6 Nm	1,5-1,8 Nm	4-4.5 Nm (KE/KW 60:6-8 Nm)	15-20 Nm	15 Nm
X07	0,5-0,6 Nm	-	-	-	-
X02, X05	0,5-0,6 Nm	1,5-1,8 Nm	4-4,5 Nm	4-4,5 Nm	4-4,5 Nm
X03	0,5-0,6 Nm	1,5-1,8 Nm	2-2,3 Nm	2-2,3 Nm	4-4,5 Nm
X04	0,5-0,6 Nm	1,5-1,8 Nm	4-4.5 Nm (KE/KW 60:6-8 Nm)	15-20 Nm	15 Nm
X20	0,7-0,8 Nm				
PE connection	4 Nm	8 Nm	15 Nm	15 Nm	12 Nm
D-SUB casing	0,8 Nm				
Shielding terminals KP-SK 8	0,6 Nm				
KP-SK 14... KP-SK 20	0,8 Nm				
KP-SK 35	1,8 Nm				

13.3 Recommended wire cross-sections for the compact power supply

Cross-sections acc. to EN 60204-1: Installation type C

For a certify CSAus unit you must observe following rules:

CSA C22.2 Tab.3, Cl. 3 and Tab. 31 on rather UL508C: Tab. 40.3, Copper, 75 °C
Use copper wires only
Use 75 °C minimum wire only

It is not allowed in both norms to be less the recommended cable cross section (AWG).

Recommended wire cross-sections	mm² / AWG	mm² / AWG
Terminal	**KEN 5-0N, KEN 5-FN, KEN 5-S10**	**KEN 20-0N**
X01 Feed	3 x 1.5 / AWG 16	3 x 6 / AWG 8
X02 DC bus	2 x 2.5 / AWG 12	2 x 10 / AWG 7
X03 Brake resistor	2 x 1.5 / AWG 16	2 x 6 / AWG 8
X04 Binary outputs / supply	4 x 0.5 / AWG 20	4 x 0,5 / AWG 20
X06 Brake resistor PTC	2 x 0.5 / AWG 20	2 x 0,5 / AWG 20
X08, X07 Power supply unit (24 VDC, 0 V)	2 x 0.75 / AWG 18	2 x 0,75 / AWG 18
PE connection	1 x 10 / AWG 6	1 x 10 / AWG 6

Recommended wire cross-sections	mm² / AWG	
Terminal	**KEN 5, KEN 5-F**	**KEN 10, KEN 10-F**
X07 Feed	4 x 1.5 / AWG 14	4 x 2.5 / AWG 12
X02 DC bus	2 x 1.5 / AWG 14	2 x 4 / AWG 10
X03 Brake resistor	2 x 1.5 / AWG 14	2 x 1.5 / AWG 14
X25 Brake resistor PTC	2 x 0.5 / AWG 20	2 x 0.5 / AWG 20
X08, X09 Power supply unit (24 VDC, 0 V)	2 x 0.75 / AWG 18	2 x 0.75 / AWG 18
X21 Binary outputs / supply	4 x 0.5 / AWG 20	4 x 0.5 / AWG 20
X22 Binary inputs / binary outputs	4 x 0.5 / AWG 20	4 x 0.5 / AWG 20
X25 PTC thermistor connection	2 x 0.5 / AWG 20	2 x 0.5 / AWG 20
PE connection	1 x 10 / AWG 6	1 x 10 / AWG 6

Recommended wire cross-sections	mm² / AWG	
Terminal	**KE 10**	**KE 20-F KE 20, KE 20-0EU KES 20, KES 20-0EU**
X01 Feed	4 x 2.5 / AWG 12	4 x 6 / AWG 8
X02 DC bus	2 x 10 / AWG 6	2 x 10 / AWG 6
X03 Brake resistor	2 x 6 / AWG 8	2 x 6 / AWG 8
X25 Brake resistor PTC	2 x 0.5 / AWG 20	2 x 0.5 / AWG 20
X20 Line (charging circuit)	3 x 1 / AWG 16	3 x 1 / AWG 16
X20 Main contactor excitation (EH1, EH2)	2 x 1 / AWG 16	2 x 1 / AWG 16
X08, X09 Power supply unit (24 VDC, 0 V)	2 x 0.75 / AWG 18	2 x 0.75 / AWG 18
X21 Binary outputs / supply	4 x 0.5 / AWG 20	4 x 0.5 / AWG 20
X22 Binary inputs / binary outputs	4 x 0.5 / AWG 20	4 x 0.5 / AWG 20
X25 PTC thermistor connection	2 x 0.5 / AWG 20	2 x 0.5 / AWG 20
PE connection	1 x 10 / AWG 6	1 x 10 / AWG 6

Recommended wire cross-sections	mm² / AWG	
Terminal	**KE 40, KE 40-0EU KES 40-0EU**	**KEN 60 (KE 60-S4) KE 60, KE 60-0EU KES 60, KES 60-0EU**
X01 Feed	4 x 16 / AWG 4	4 x 35 / AWG 1
X02 DC bus	2 x 16 / AWG 4	2 x 25 / AWG 2
X03 Brake resistor	2 x 6 / AWG 8	2 x 6 / AWG 8
X25 Brake resistor PTC	2 x 0.5 / AWG 20	2 x 0.5 / AWG 20
X20 Line (charging circuit)	3 x 1 / AWG 16	3 x 1 / AWG 16
X20 Main contactor excitation (EH1, EH2)	2 x 1 / AWG 16	2 x 1 / AWG 16
X08, X09 Power supply unit (24 VDC, 0 V)	2 x 0.75 / AWG 18	2 x 0.75 / AWG 18
X21 Binary outputs / supply	4 x 0.5 / AWG 20	4 x 0.5 / AWG 20
X22 Binary inputs / binary outputs	4 x 0.5 / AWG 20	4 x 0.5 / AWG 20
X25 PTC thermistor connection	2 x 0.5 / AWG 20	2 x 0.5 / AWG 20
PE connection	1 x 16 / AWG 4	1 x 16 / AWG 4

Recommended wire cross-sections	mm² / AWG	
Terminal	**KEN 120 KE 120, KE 120-0EU KES 120, KES 120-0EU**	**KE 180-0EU KES 180-0EU**
X01 Feed	4 x 95 / AWG 4/0	3 x 180 (70 °C) / kcmil 500
X02 DC bus	2 x 25 / AWG 2	2 x 25 / AWG 2
X06 DC bus	2 x 50 / AWG 1/0	2 x 150 / kcmil 250
X03 Brake resistor	2 x (2 x 6) / AWG 8	2 x (2 x 16) / AWG 6
X25 Brake resistor PTC	2 x 0.5 / AWG 20	2 x 0,5 / AWG 20
X20 Line (charging circuit)	3 x 1 / AWG 16	3 x 1 / AWG 16
X20 Main contactor excitation (EH1, EH2)	2 x 1 / AWG 16	2 x 1 / AWG 16
X08, X09 Power supply unit (24 VDC, 0 V)	2 x 0.75 / AWG 18	2 x 0,75 / AWG 18
X21 Binary outputs / supply	4 x 0.5 / AWG 20	4 x 0,5 / AWG 20
X22 Binary inputs / binary outputs	4 x 0.5 / AWG 20	4 x 0,5 / AWG 20
X25 PTC thermistor connection	2 x 0.5 / AWG 20	2 x 0,5 / AWG 20
PE connection	1 x 50 / AWG 1/0	1 x 95 / kcmil 250

13.4 Max. connection diameters for the compact power supply

Terminal	KEN 5 KEN 5-F KEN 10 KEN 10-F	KEN 5-0N KEN 5-FN KEN 5-S10	KEN 20-0N	KE 10 KE 20-F KE 20 KE 20-0EU KES 20 KES 20-0EU	KE 40 KE 40-0EU KES 40-0EU	KEN 60 (KE 60-S4) KE 60 KE 60-0EU KES 60 KES 60-0EU	KEN 120 KE 120 KE 120-0EU KES 120 KES 120-0EU	KE 180-0EU KES 180-0EU
X01	-	4 mm² AWG 12	10 mm² AWG 7	10 mm² AWG 6	25 mm² AWG 2	50 mm² AWG 1/0	95 mm² AWG 1/0	240 mm² kcmil 600
X02 *	4 mm² AWG 12	4 mm² AWG 12	10 mm² AWG 7	10 mm² AWG 6	25 mm² AWG 2	25 mm² AWG 2	25 mm² AWG 2	25 mm² AWG 2
X03 (X03.1, X03.2)	2.5 mm² AWG 14	4 mm² AWG 12	10 mm² AWG 7	10 mm² AWG 6	16 mm² AWG 4	16 mm² AWG 4	16 mm² AWG 4	25 mm² AWG 2
X06	-	-	-	-	-	-	95 mm² AWG 1/0	240 mm² kcmil 600
X06	-	1.5 mm² AWG 16	1.5 mm² AWG 16	-	-	-	-	-
X07	4 mm² AWG 12	-	-	-	-	-	-	-
X08, X09	1.5 mm² AWG 16	-	-	1.5 mm² AWG 16	1.5 mm² AWG 16	1.5 mm² AWG 16	1.5 mm² AWG 16	1,5 mm² AWG 16
X08, X07	-	1.5 mm² AWG 16	1.5 mm² AWG 16	-	-	-	-	-
X20	-	-	-	4 mm² AWG 10	4 mm² AWG 10	4 mm² AWG 10	4 mm² AWG 10	4 mm² AWG 10
X21, X22, X25	0.5 mm² AWG 20	-	-	0.5 mm² AWG 20	0.5 mm² AWG 20	0.5 mm² AWG 20	0.5 mm² AWG 20	0,5 mm² AWG 20
X04	-	1.5 mm² AWG 16	1.5 mm² AWG 16	-	-	-	-	-

* Use only AMK DC bus UZ cable sets. Further information: Siehe 'DC bus wiring' auf Seite 68.

13.5 Recommended wire cross-sections for the compact inverter

Cross-sections acc. to EN 60204-1: Installation type C

For a certify CSAus unit you must observe following rules:

CSA C22.2 Tab.3, Cl. 3 and Tab. 31 on rather UL508C: Tab. 40.3, Copper, 75 °C
Use copper wires only
Use 75 °C minimum wire only

It is not allowed in both norms to be less the recommended cable cross section (AWG).

Recommended wire cross-sections	mm² / AWG		
Terminal	**KWD 1**	**KWD 2**	**KWD 5**
X05 DC bus (UZP, UZN)	2 x 4 / AWG 10		
X04 Motor connection (shielded)	4 x 1 / AWG 16		
X12 Motor - PTC thermistor connection	2 x 0.5 / AWG 20		
X08, X09 Power supply unit (24 VDC, 0 V)	2 x 0.75 / AWG 18		
X13, X14, X17	3 x 0.5 / AWG 20		
X15, X16, X18	4 x 0.5 / AWG 20		
PE connection	1 x 10 / AWG 6		

Recommended wire cross-sections	mm² / AWG			
Terminal	**KW 2**	**KW 3**	**KW 5**	**KW 8**
X05 DC bus (UZP, UZN)	2 x 4 / AWG 10		2 x 4 / AWG 10	
X04 Motor connection (shielded)	4 x 1 / AWG 16		4 x 1.5 / AWG 14	
X12 Motor - PTC thermistor connection	2 x 0.5 / AWG 20		2 x 0.5 / AWG 20	
X08, X09 Power supply unit (24 VDC, 0 V)	2 x 0.75 / AWG 18		2 x 0.75 / AWG 18	
X13, X14, X17	3 x 0.5 / AWG 20		3 x 0.5 / AWG 20	
X15, X16, X18	4 x 0.5 / AWG 20		4 x 0.5 / AWG 20	
PE connection	1 x 10 / AWG 6		1 x 10 / AWG 6	

Recommended wire cross-sections	mm² / AWG	
Terminal	**KW 10**	**KW 20**
X05 DC bus (UZP, UZN)	2 x 10 / AWG 6	2 x 10 / AWG 6
X04 Motor connection (shielded)	4 x 2.5 / AWG 12	4 x 6 / AWG 8
X12 Motor - PTC thermistor connection	2 x 0.5 / AWG 20	2 x 0.5 / AWG 20
X08, X09 Power supply unit (24 VDC, 0 V)	2 x 0.75 / AWG 18	2 x 0.75 / AWG 18
X13, X14, X17	3 x 0.5 / AWG 20	3 x 0.5 / AWG 20
X15, X16, X18	4 x 0.5 / AWG 20	4 x 0.5 / AWG 20
PE connection	1 x 10 / AWG 6	1 x 10 / AWG 6

Recommended wire cross-sections	mm² / AWG	
Terminal	**KW 40**	**KW 60**
X05 DC bus (UZP, UZN)	2 x 25 / AWG 2	2 x 25 / AWG 2
X04 Motor connection (shielded)	4 x 16 / AWG 4	4 x 35 / AWG 1
X12 Motor- PTC thermistor connection	2 x 0.5 / AWG 20	2 x 0.5 / AWG 20
X08, X09 Power supply unit (24 VDC, 0 V)	2 x 0.75 / AWG 18	2 x 0.75 / AWG 18
X13, X14, X17	3 x 0.5 / AWG 20	3 x 0.5 / AWG 20
X15, X16, X18	4 x 0.5 / AWG 20	4 x 0.5 / AWG 20
PE connection	1 x 16 / AWG 4	1 x 16 / AWG 4

Recommended wire cross-sections	mm² / AWG	
Terminal	**KW 100**	**KW 150**
X05 DC bus (UZP, UZN)	2 x 25 / AWG 2	2 x 25 / AWG 2
X06 DC bus (UZP, UZN)	2 x 50 / AWG 1/0	2 x 120 / AWG 4/0
X04 Motor connection (shielded)	4 x 95 / AWG 4/0	4 x 120 / kcmil 300
X12 Motor- PTC thermistor connection	2 x 0.5 / AWG 20	2 x 0,5 / AWG 20
X08, X09 Power supply unit (24 VDC, 0 V)	2 x 0.75 / AWG 18	2 x 0,75 / AWG 18
X13, X14, X17	3 x 0.5 / AWG 20	3 x 0,5 / AWG 20
X15, X16, X18	4 x 0.5 / AWG 20	4 x 0,5 / AWG 20
PE connection	1 x 35 / AWG 1	1 x 95 / kcmil 250

Recommended wire cross-sections	mm² / AWG
Terminal	**KW 200**
X05 DC bus (UZP, UZN)	2 x 25 / AWG 2
X06 DC bus (UZP, UZN)	2 x 185 / kcmil 300
X04 Motor connection (shielded)	4 x 185 / kcmil 500
X12 Motor- PTC thermistor connection	2 x 0,5 / AWG 20
X08, X09 Power supply unit (24 VDC, 0 V)	2 x 0,75 / AWG 18
X13, X14, X17	3 x 0,5 / AWG 20
X15, X16, X18	4 x 0,5 / AWG 20
PE connection	1 x 120 / kcmil 300

13.6 Max. connection diameters for the compact inverter

Terminal	KWD 1 KWD 2 KWD 5	KW 2, 3, 4-F KW 5, 6-F KW 8	KW 9-F KW 10 KW 20	KW 40	KW 60	KW 100	KW 150	KW 200
X04	2.5 mm² AWG 14	2.5 mm² AWG 14	10 mm² AWG 6	25 mm² AWG 2	50 mm² AWG 1/0	95 mm² AWG 4/0	240 mm² kcmil 600	240 mm² kcmil 600
X05 *	4 mm² AWG 12	4 mm² AWG 12	10 mm² AWG 6	25 mm² AWG 2	25 mm² AWG 2	25 mm² AWG 2	25 mm² AWG 2	25 mm² AWG 2
X06 *	-	-	-	-	-	95 mm² AWG 4/0	240 mm² kcmil 600	240 mm² kcmil 600
X08, X09	1.5 mm² AWG 16	1.5 mm² AWG 16	1.5 mm² AWG 16	1.5 mm² AWG 16	1.5 mm² AWG 16	1.5 mm² AWG 16	1.5 mm² AWG 16	1.5 mm² AWG 16
X12, X13, X14, X15, X16, X17 (A/B) X18 (A/B)	0.5 mm² AWG 20	0.5 mm² AWG 20	0.5 mm² AWG 20	0.5 mm² AWG 20	0.5 mm² AWG 20	0.5 mm² AWG 20	0.5 mm² AWG 20	0.5 mm² AWG 20

* Use only AMK DC bus UZ cable sets. Further information: Siehe 'DC bus wiring' auf Seite 68.

13.7 Shield connections

For shielded cables, please use cables with copper braided shield, tin-plated.

Terminal	Cable type	Shield connection on module, on one side	Shield connection on both sides	Comment Connection / Interface
X01 **X07**	4-wire, 1), unshielded	-	-	Power supply / mains feeder, mains choke
X02	2-wire 2)	-	-	DC bus
X03 **X03.1/X03.2**	2-wire, shielded		x	External brake resistor
X04 **X04A/B**	4-wire, shielded		x	Motor
X05 / X06	2-wire 2)	-	-	DC bus
X08, **X09**	2-wire, 3) unshielded	-	-	Supply voltage 24 VDC
X12 **X12A/B**	2-wire, shielded	x		Temperature sensor motor PTC thermistor
X13	3-wire, unshielded	-	-	Transmission power output stage enable EF
X14	3-wire, unshielded	-	-	Transmission power output stage enable EF
X15	4-wire, unshielded	-	-	Power output stage enable EF
X16 **X16A/B**	4-wire, unshielded	-	-	Power output stage enable EF
X17A/B	4-wire, unshielded			Power output stage enable EF
X18A/B	4-wire, unshielded			Power output stage enable EF
X20	3-wire + 2-wire, unshielded	-	-	Mains supply - charging circuit, main contactor
X21	4-wire, shielded	x		Binary I/O
X22	4-wire, shielded	x		Binary I/O
X25	2-wire, shielded	x		Temperature sensor, brake resistor
X130 **X130A/B**	4 x 2 x 0.25 pair-stranded, + 4 x 0.5 shielded		x	Resolver
X131 **X131A/B**	4 x 2 x 0.25 pair-stranded, + 4 x 0.5 shielded 5)		x	Encoder connection type I / S / T / E / F

Terminal	Cable type	Shield connection on module, on one side	Shield connection on both sides	Comment Connection / Interface
X132 X132A/B	4 x 2 pair-stranded, shielded	x		Square wave pulse input/output
X133 X133A/B	6-wire, shielded 4)	x		Binary inputs / outputs, analogue inputs
X135 X135A/B	8-wire, shielded	x		KW operator panel incl. cables
	3-wire, shielded	x		PC
X136/X137 A / B	3 x 2 pair-stranded, shielded		x	ACC bus
X236/X237 A / B	3 x 2 pair-stranded, shielded		x	ACC bus

Notes:

1. To reach the limit values of the radio interference suppression, it may be necessary for modules from KE 60 up with external mains filter, unfavourable cable layout and long cable lengths to use a shielded cable for the mains feeder in the switch cabinet. The cable shield has to be earthed on both sides.
2. A maximum length of 1 meter is permitted for the cable to connect the DC bus voltage when assembling the device with a distance between the modules. A 2-wire shielded cable might have to be used in order to limit interference radiation. The shield has to be grounded to the casing on both ends. (Use of longer cables only after consulting with AMK).
3. No more than 5 modules may be connected via plug connectors X08 and X09.
4. A shielded cable has to be used for the binary inputs and outputs. The shield of the cable has to be placed at one side of the KW casing. If a single shielded cable cannot be used for the entire length, a shielded cable with a length of about 1 meter has to be laid to a transfer element. After that, individual cables without shield can be used.
5. The shield of the generator cable X130 / X131 / X132 is grounded by the metallic casing of the D-sub connector on the KW side.
   The shield of the cable has to be grounded by the screw connection in the plug casing on the motor side. The braided shield is everted over the terminal insert. After screwing together, the shield is placed over the contact spring and the plug casing on the mass.

The generator plug set, consisting of a round plug and 12 contact sockets can be obtained from AMK:
Straight plug, part no.: 49163
Angled plug, part no.: 49362

14 Certificates

The certificates are available through AMKmotion sales or on the AMKmotion website.

- CSA - Certificate of compliance
- Declaration of conformity
- TUEV

You can get it as follows:

- AMKmotion homepage - service - download - registration - start online documentation - certificates
  (One-time manual activation by AMKmotion sales department is necessary.
  The auto-registration via AMKmotion homepage does not include access to the entire documentation.)
  www.amk-motion.com/en/content/download_area

15 Dimensions

15.1 Dimensions - cold plate modules

Cold plate modules are fastened with screws to an external cold plate. The cold plate can be liquid- or air-cooled.

Module width	Module name	Dimensions
55 mm	KEN 5, KEN 5-0N, KEN 5-S10, KEN 10, KEN 20-0N KW 2, KW 3, KW 5, KW 8 KWD 1, KWD 2, KWD 5	Siehe 'Dimensions - cold plate modules 55 mm' auf Seite 218.
85 mm	KE 10 KE 20, KES 20 KW 10, KW 20	Siehe 'Dimensions - cold plate modules 85 mm' auf Seite 219.
170 mm	KE 40, KES 40 KEN 60 (KE 60-S4), KE 60, KES 60 KW 40, KW 60	Siehe 'Dimensions - cold plate modules 170 mm' auf Seite 220.
255 mm	KEN 120, KE 120, KES 120 KW 100	Siehe 'Dimensions - cold plate modules 255 mm' auf Seite 221.
425 mm	KE 180, KES 180 KW 150	Siehe 'Dimensions - cold plate modules 425 mm' auf Seite 221.

15.1.1 Dimensions - cold plate modules 55 mm

Compact power supply

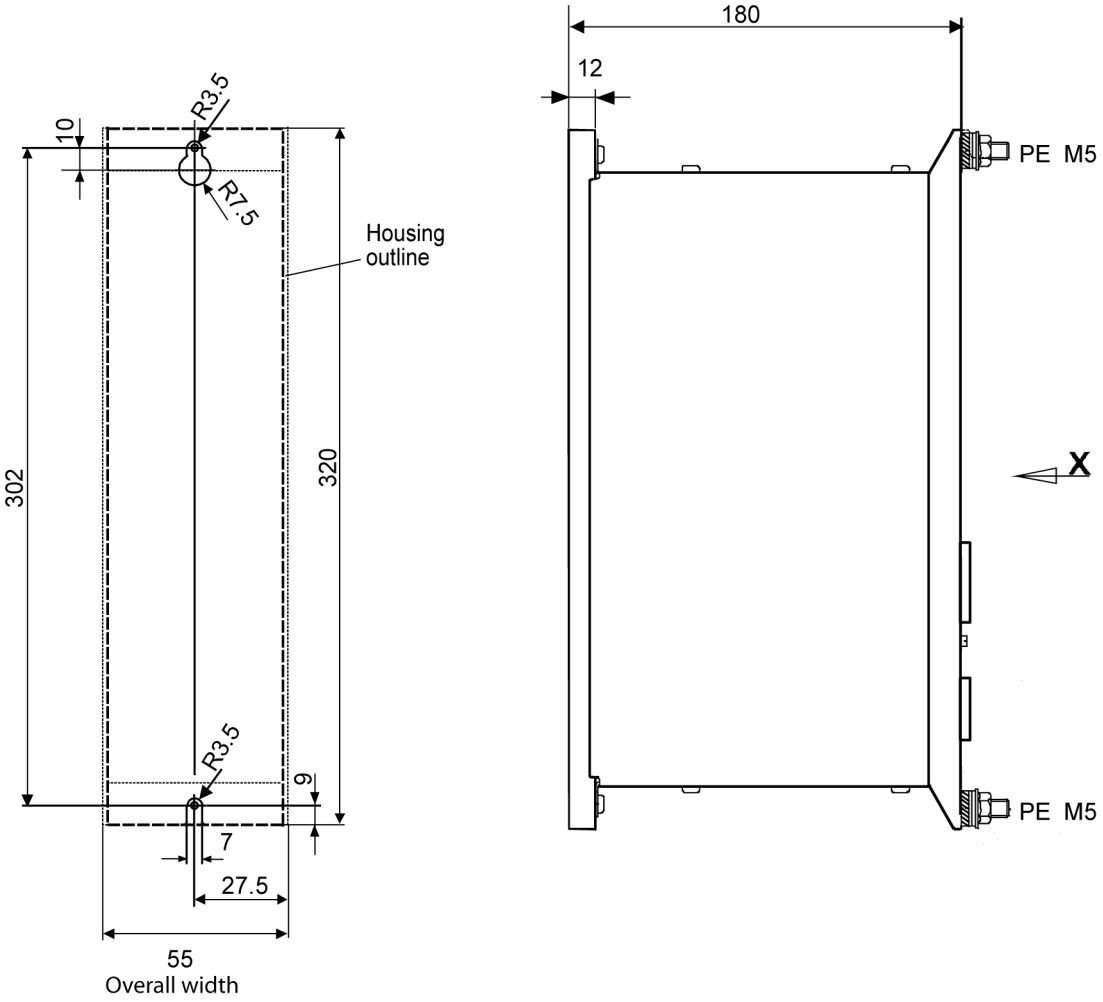
KEN 5, KEN 5-0N, KEN 5-S10, KEN 10, KEN 20-0N

Compact inverter

KW 2, KW 3, KW 5, KW 8
KWD 1, KWD 2, KWD 5

Base plate and side view

X: View of front of casing



15.1.2 Dimensions - cold plate modules 85 mm

Compact power supply

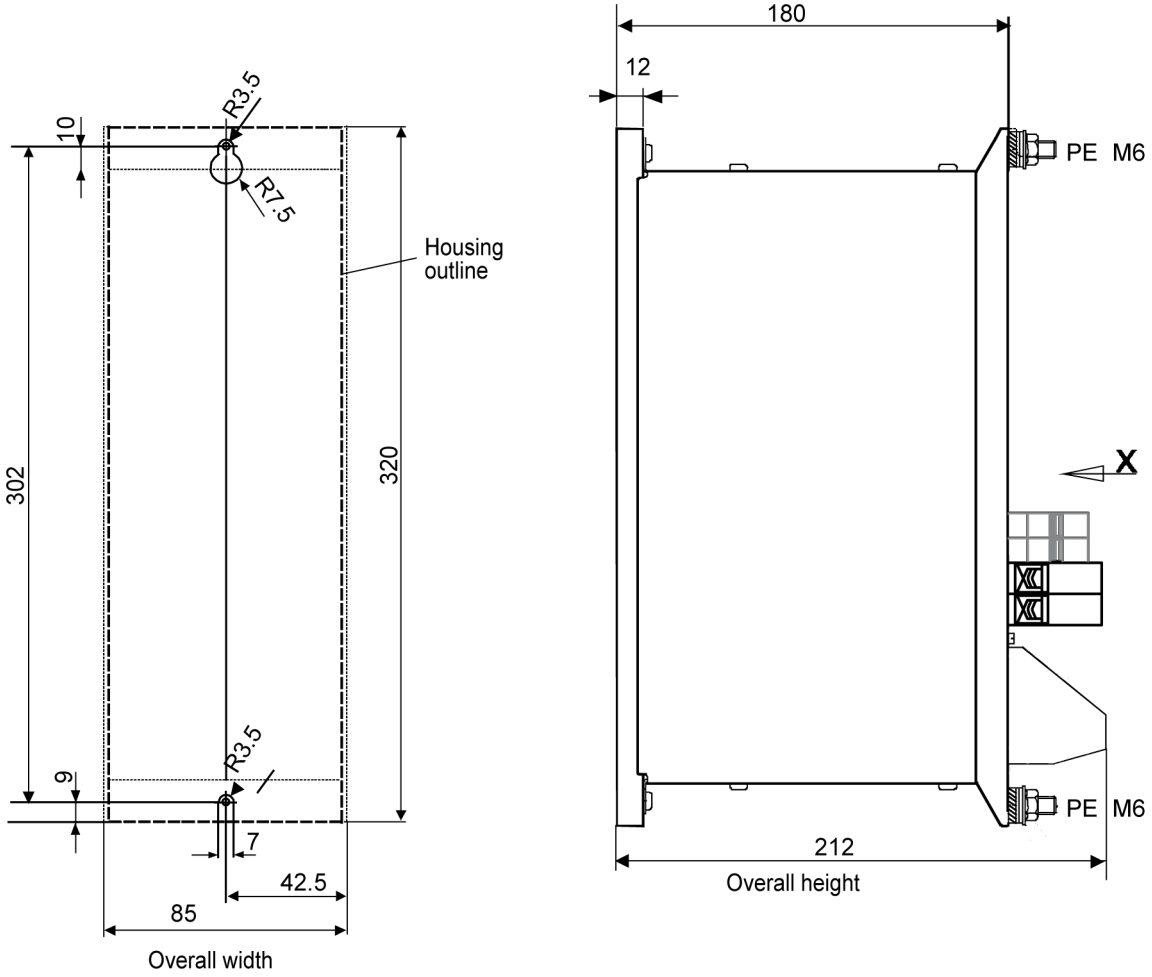
KE 10
KE 20, KE 20-0EU
KES 20, KES 20-0EU

Compact inverter

KW 10, KW 20

Base plate and side view

X: View of front of casing



15.1.3 Dimensions - cold plate modules 170 mm

Compact power supply

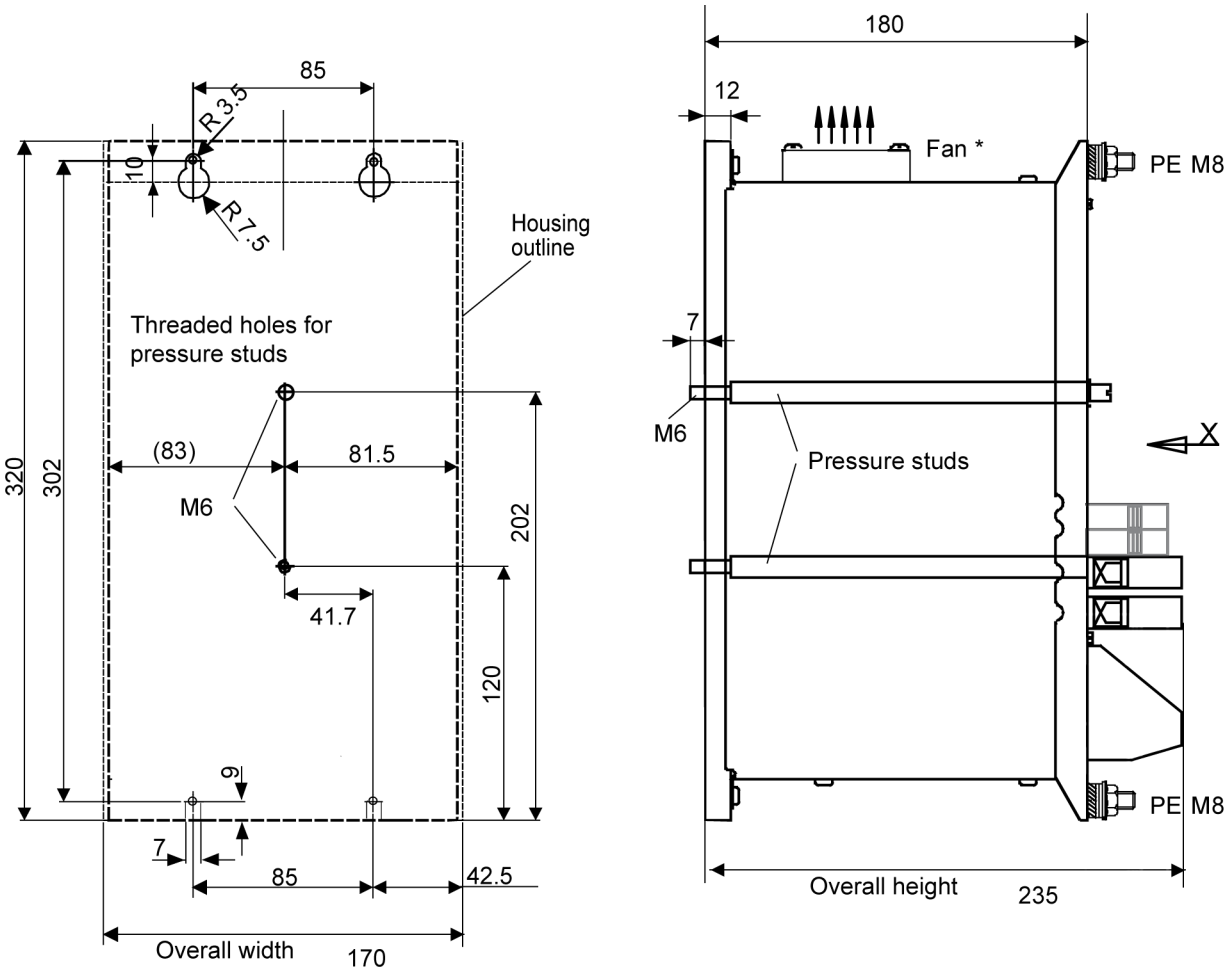
KE 40, KE 40-0EU
KES 40-0EU
KEN 60 (KE 60-S4)
KE 60, KE 60-0EU
KES 60, KES 60-0EU

Compact inverter

KW 40, KW 60

Base plate and side view

X View of front of casing



* Only KW 60 is equipped with a fan

Clamping bolts: When installed, the screw head is counter-sunk in the casing and the clamping bolt is screwed into the assembly plate.

15.1.4 Dimensions - cold plate modules 255 mm

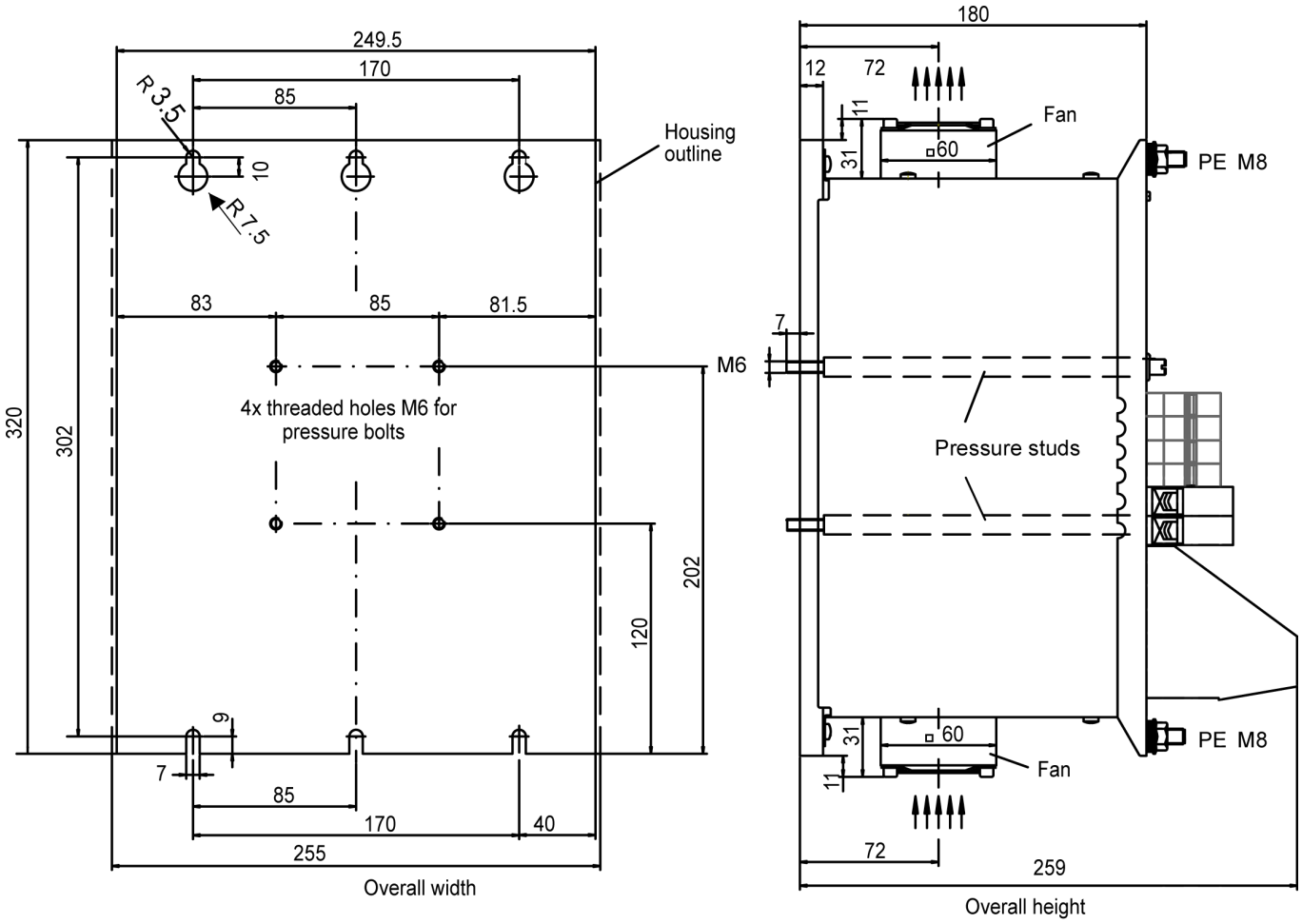
Compact power supply

KEN 120
KE 120, KE 120-0EU
KES 120, KES 120-0EU

Compact inverter

KW 100

Base plate and side view



Clamping bolts: When installed, the screw head is counter-sunk in the casing and the clamping bolt is screwed into the assembly plate.

15.1.5 Dimensions - cold plate modules 425 mm

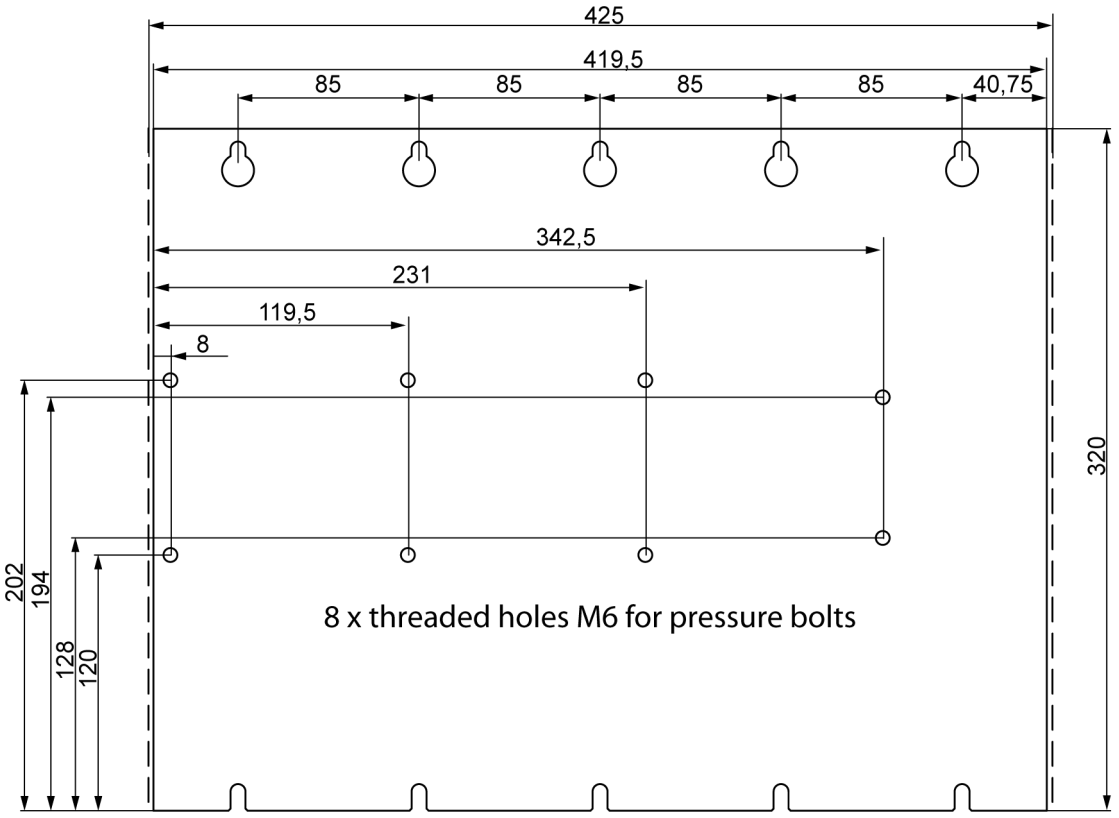
Compact power supplies

KE 180-0EU
KES 240-0EU

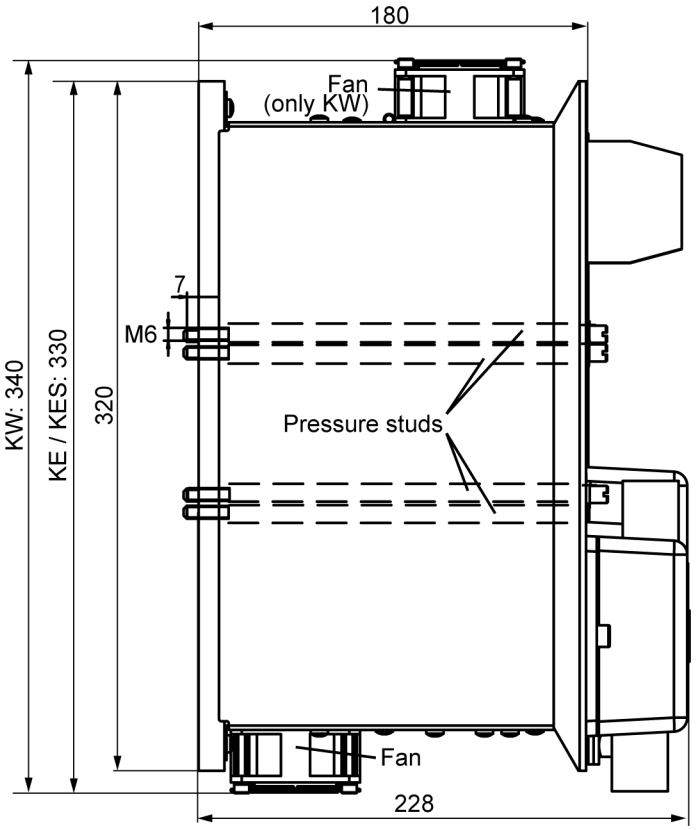
Compact inverters

KW 150, KW 200

Base plate



Side view



Pressure bolts: When the device is mounted, the screw heads of the pressure bolts will be countersunk in the casing and the pressure bolts will be screwed into the mounting plate.

15.2 Dimensions of air-cooled modules

Air-cooled modules feature an integrated air-cooling system.

Module width	Module name	Dimensions
55 mm	KEN 5-F, KEN 5-FN, KEN 10-F KW 2-F, KW 4-F,KW 6-F KWD 1-F, KWD 2-F, KWD 4-F	Siehe 'Dimensions of air-cooled modules (55 mm)' auf Seite 223.
85 mm	KE 20-F KW 9-F	Siehe 'Dimensions of air-cooled modules 85 mm' auf Seite 224.

15.2.1 Dimensions of air-cooled modules (55 mm)

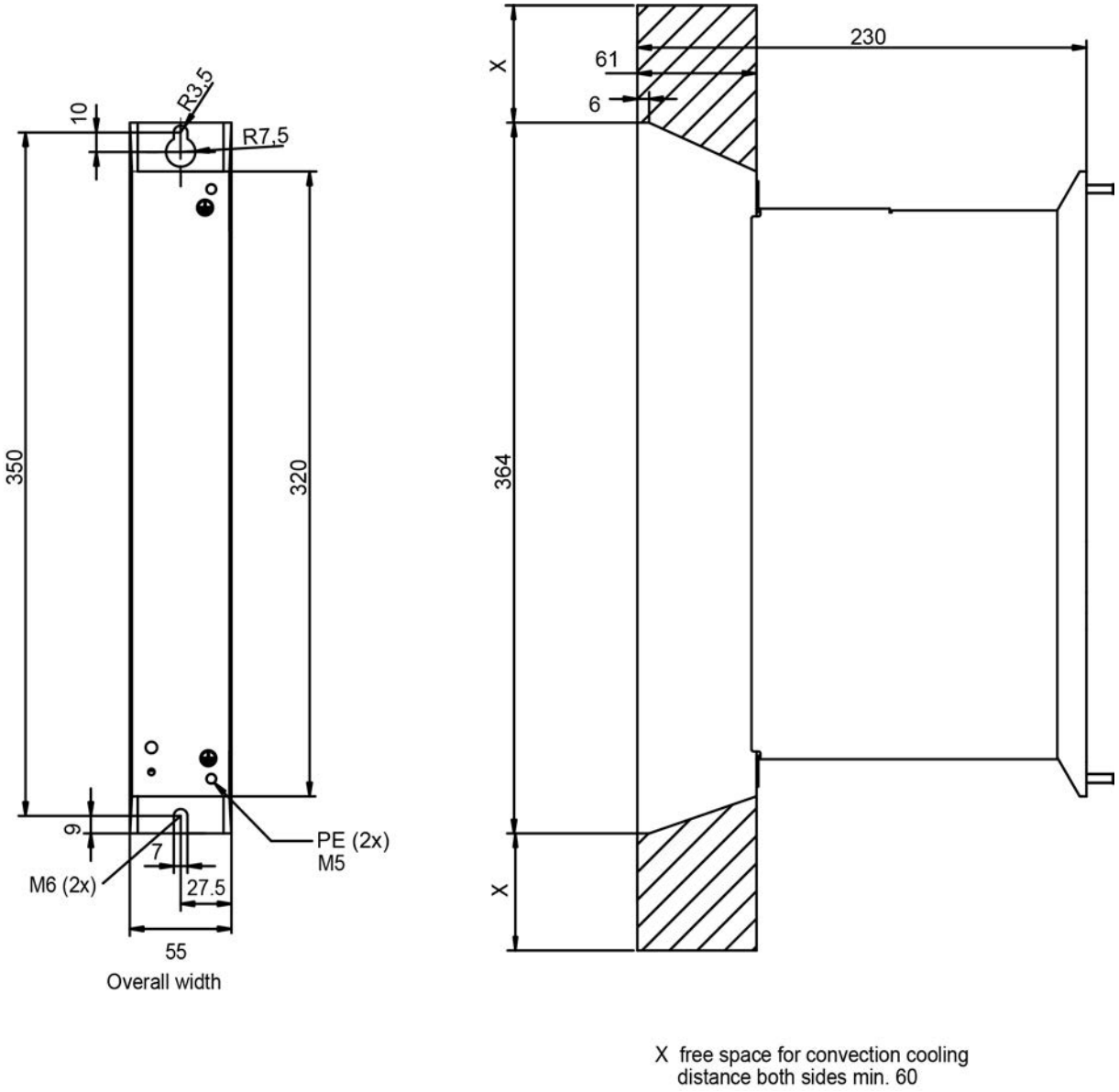
Compact power supply

KEN 5-F, KEN 5-FN, KEN 10-F

Compact inverter

KW 2-F, KW 4-F,KW 6-F
KWD 1-F, KWD 2-F, KWD 4-F

Base plate and side view

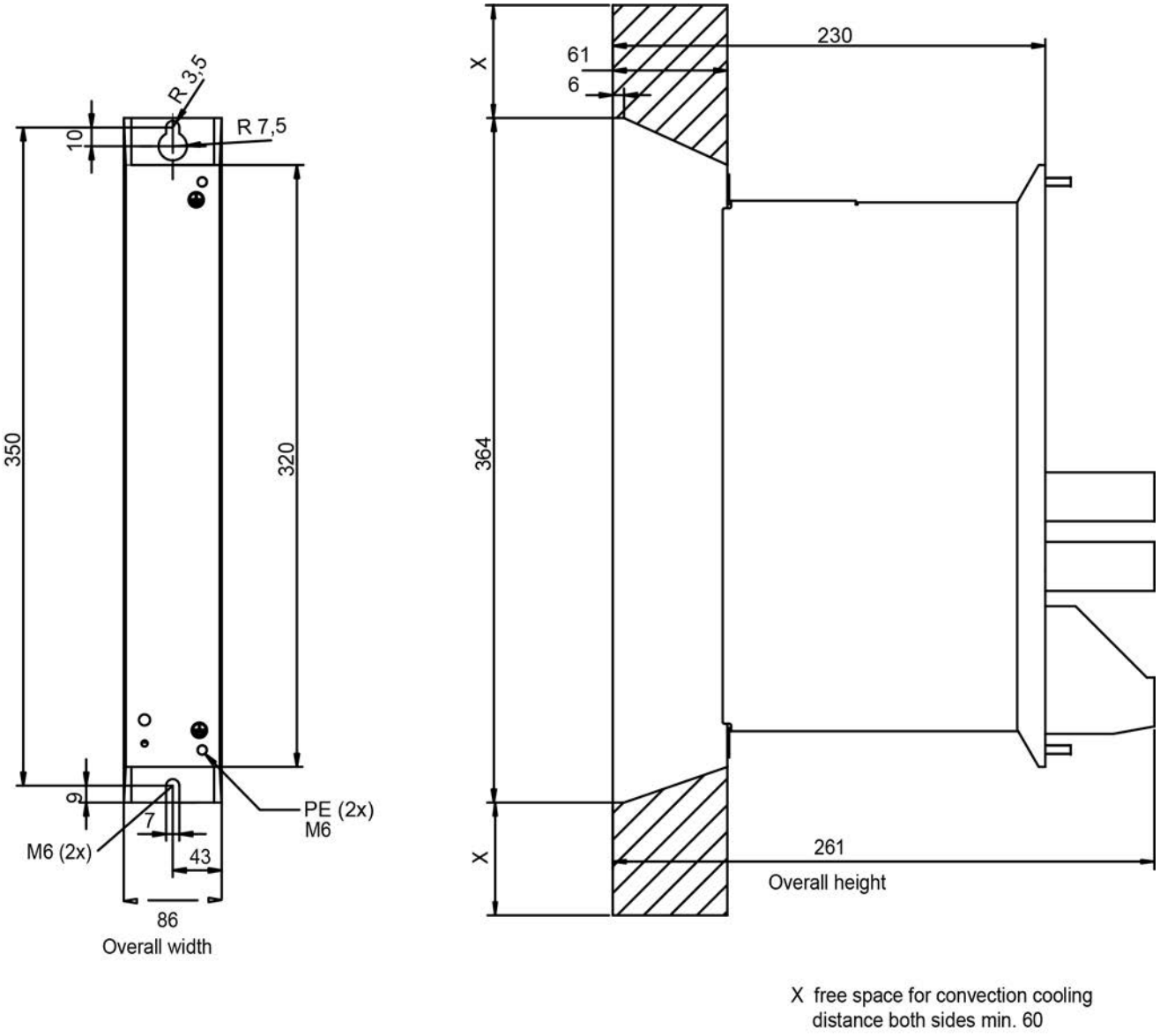


15.2.2 Dimensions of air-cooled modules 85 mm

Compact power supply
KE 20-F

Compact inverter
KW 9-F

Base plate and side view



X free space for convection cooling
distance both sides min. 60

Glossary

A

ACC
AMK CAN Communication (CAN bus interface with standard CANopen protocol DS301 and additional hardware synchronization signal)

AIPEX
AMK startup and parameterizing software (PC software): Programming, parameterization, configuration, diagnosis, oscilloscope, status information

ATF
AMK Tool Flasher (PC software for transferring firmware to device)

AWG
American Wire Gauge (Coding of wire diameter)

B

BI
Digital input

BO
digital output

D

DO
Digital output

Default
Factory setting

DI
Digital input

E

EtherCAT
Real-time Ethernet bus

EnDat 2.2
Motor encoder interface protocol of the company Heidenhain

EnDat 2.1
Motor encoder interface protocol of the company Heidenhain

EMC
Electromagnetic compatibility

ESD
Electrostatic discharge

EGB
Electrostatic endangered component

EF2
Power output stage enable

EDS
Electronic data sheet

EF
Power output stage enable

EMV
Electromagnetic compatibility

F

Firmware
System software, loaded by AMK

FL
Command (Causes a new system run-up)

I

iX
AMKASMART decentralized inverter

IGBT
Power electronic component, e. g. transistor

I-encoder
Incremental encoder, optical encoder with sine and cosine track and zero pulse

ID
Parameter identification numbers acc. to SERCOS Standard

i^2t
Integral of the squared current over time

iC
AMKASMART decentralized inverter with power supply

I/O
Input / output

iDT
AMKASMART Servo motors with integrated inverter

K

KWZ
AMKASYN compact two-axes inverter to control two motors

KWF
AMKASYN U/f double AC inverter

KTY
Type of a temperature sensor

KW-Rxx
AMKASYN controller card for installation into compact inverter

KWD
AMKASYN compact double inverter to control two motors

KEN
AMKASYN compact power supply without recovery

KP
Proportional gain (speed control, PID controller)

KES
AMKASYN compact power supply with sinusoidal voltage and current

KE/KW
Modular AMK drive system (contains compact power supply KE, compact inverter KW with controller card and applicable option card)

KE
AMKASYN compact power supply with recovery

KW
AMKASYN compact inverter

M

Modulo
Modulo processing of position setpoint and actual values

N

NHN
Heights measured above the base height levelReference plane for heights over the sea level for Germany since 1992. The reference plane is located in Germany on the church in Wallenhorst.

NK
Cam switch

P

Parameter
Identification number acc. to SERCOS standard

PDK_xxxxxx_abcdefgh
Product documentation; xxxxxx - AMK part no. , abcdefgh - name

PTC
PTC resistor

PWM
Pulse width modulation

Q

QUE
Acknowledgment DC bus on; shows that DC bus is loaded

QBR
Acknowledgment motor holding brake

QES
Acknowledgment power output stage disable

QEF2
Acknowledgement power output state enable (2 channel) QEF, QEF2 are the mirrored input signals EF, EF2. The state bits can be configured with ID26 'Configuration status bits' for field bus transmission or on a binary output (EF: code 33135, EF2: code 33136)

QEF
Acknowledgement power output state enable (2 channel) QEF, QEF2 are the mirrored input signals EF, EF2. The state bits can be configured with ID26 'Configuration status bits' for field bus transmission or on a binary output (EF: code 33135, EF2: code 33136)

QRF
Acknowledgment controller enable; the drive is controlled in the activated operation mode

R

RF
Command 'Controller enable'; the drive is energized and will be controlled depending on the selected operation mode. Controller enable can only be set if the device is error-free (SBM = TRUE) and acknowledgement DC bus on is set (QUE = TRUE).Acknowledgement controller enable (QRF) is set.

S

SBM
System ready message; shows that the device is error-free In case of error. SBM will be reset

SCCR
Short Circuit Current Rating: Maximum available short-circuit current an device can sustain without the occurrence of damage

SoV
Servo Drive Profile over VARAN (Nach IEC 61800-7-300)

SoE
Servodrive Profile (SERCOS) over EtherCAT (Acc. to IEC 61800-7-300)

SERCOS
Standardized digital interface for communication between controller and field bus participants.

T

Tn
Integral-action time in speed control (PID controller)

Td
Differentiating time in speed control (PID controller)

U

UE
Command 'DC bus on' control signal to load the DC bus e.g. in KE. DC bus on can only be set if the device is error-free (SBM = TRUE). After the DC bus is loaded, the acknowledgement message QUE is set.

UPS
Uninterruptible power supply

UZ
DC bus (voltage)

UZN
DC bus voltage pole negative

UZP
DC bus voltage pole positive

V

VBNX
Extended mains phase failure signal VBNX to trigger an UPS

W

WEF
Reference potential power output stage enable

WQF
Reference potential power output stage enable acknowledgement

WQS
Reference potential power output stage disable acknowledgement

Your opinion is important!

With our documentation we want to offer you the highest quality support in handling the AMKmotion products.
That is why we are now working on optimizing our documentation.
Your comments or suggestions are always of interest to us.
We would be grateful if you take a bit of time and answer our questions. Please return a copy of this page to us.

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Thank you for your assistance.
Your AMKmotion documentation team

1. How would you rate the layout of our AMKmotion documentation?

   (1) very good (2) good (3) satisfactory (4) less than satisfactory (5) poor

2. Is the content structured well?

   (1) very good (2) good (3) moderate (4) hardly (5) not at all

3. How easy is it to understand the documentation?

   (1) very easy (2) easy (3) moderately easy (4) difficult (5) extremely difficult

4. Did you miss any topics in the documentation?

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