AKD®2G-Sxx with Functional Safety Option 1

STO - SIL2

Installation Manual

Manual Edition: -, Beta, December 2018
Safety Edition: S101, December 2018
Valid for AKD®2G-S Hardware Revision A
Part Number 907-200003-00

Original Document

For safe and proper use, follow these instructions.
Keep them for future reference.

Beta Drives: Approvals (CE, Functional Safety, UL) are pending.

Record of Document Revisions

Revision	Remarks
...	Table with lifecycle information of this document (➜ # 145)
Beta, 12/2018	Beta edition

Hardware Revision (HR)

AKD2G	Firmware	Workbench	KAS IDE	Remarks
A	from 02-00-00-000	from 2.00.0.0000	from 3.01	Beta revision

Trademarks

- AKD is a registered trademark of Kollmorgen Corporation
- EnDat is a registered trademark of Dr. Johannes Heidenhain GmbH
- EtherCAT is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH
- Ethernet/IP is a registered trademark of ODVA, Inc.
- Ethernet/IP Communication Stack: copyright (c) 2009, Rockwell Automation
- HIPERFACE is a registered trademark of Max Stegmann GmbH
- Windows is a registered trademark of Microsoft Corporation

Technical changes which improve the performance of the device may be made without prior notice!

1 Table of Contents

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2 General

2.1 About this Installation Manual

This document, the *AKD®2G Installation Manual* ("Instructions Manual" according to EC Machinery Directive 2006/42/EC), describes the AKD®2G series of digital drives and includes information needed to safely install an AKD2G.

This document is valid for AKD2G single axis drive or dual axis drive with 110 V to 240 V or 240 V to 480 V mains voltage.

- Ouput stages: 3 A or 6 A or 12 A rated current
- Programmability options: Base drive or Position Indexer drive
- Connectivity options: analog, CANopen, EtherCAT, Ethernet/IP
- I/O options: Extended I/O (X22), Feedback&EEO (X23)
- Functional Safety options: option 1 with STO (SIL2 PLd)

A digital version of this manual (pdf format) is available on the DVD included with your drive.

Additional documents:

- *WorkBench Online Help*: describes how to use your drive in common applications. It also provides tips for maximizing your system performance with the AKD2G. The *Online Help* includes the *Parameter and Command Reference Guide* which provides information for the parameters and commands used to program the AKD2G.
- *CAN-BUS Communication*: describes how to use your drive in CANopen applications.
- *EtherCAT Communication*: describes how to use your drive in EtherCAT applications.
- *Ethernet/IP Communication*: describes how to use your drive in Ethernet/IP applications.
- *Accessories Manual*: provides information for accessories like cables and regen resistors used with AKD2G. Regional variants of this manual exist.

All documents can be downloaded from the Kollmorgen website www.kollmorgen.com.

2.2 Using the PDF Format

This document includes several features for ease of navigation

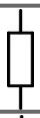
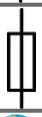
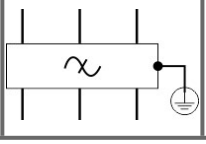
Cross References	Table of contents and index include active cross references.
Table of contents and index	Lines are active cross references. Click on the line and the appropriate page is accessed.
Page/chapter numbers in the text	Page/chapter numbers with cross references are active links.

2.3 Symbols Used

Warning Symbols

Symbol	Indication
DANGER	Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates situations which, if not avoided, could result in property damage.
NOTE	This symbol indicates important notes.
	Warning of a danger (general). The type of danger is specified by the text next to the symbol.
	Warning of danger from electricity and its effects.
	Warning of danger from hot surface.
	Warning of danger from suspended loads.
	Warning of danger from automatic start.

Drawing symbols

Symbol	Description	Symbol	Description
	Signal ground		Diode
	Chassis ground		Relay
	Protective earth		Relay switch off delayed
	Resistor		Normally open contact
	Fuse		Normally closed contact
	State-of-the-art firewall		EMC filter

2.4 Abbreviations Used

Abbreviations related to functional safety (➜ # 125).

Abbreviation	Meaning
(➜ # 53)	"see page 53" in this document
Ω	Ohms
A#, AXIS#	A# or AXIS# are placeholders for the axis number. Used with keywords or signal names
AGND	Analog ground
AMSL	Above mean sea level
Axis	Depends on context, either one AKD2G output stage or one load axis of the full motion system.
CAT	Category
CE	Communité Européenne
COM	Serial interface for a personal computer
DGND	Digital ground
EEPROM	Electrically erasable programmable memory
EEO	Emulated Encoder Output
EMC	Electromagnetic compatibility
EMF	Electromagnetic force
F-SMA	Fiber optic cable connector according to IEC 60874-2
FSoE	Fail safe over EtherCAT
KAS	Kollmorgen Automation Suite
KAS IDE	Setup software (Kollmorgen Automation Suite Integrated Development Environment)
KDN	Kollmorgen Developer Network
LED	Light-emitting diode
LSB	Low significant byte (or bit)
MSB	Main significant byte (or bit)
NI	Zero pulse
OSSD	Output Signal Switching Device
PC	Personal computer
PE	Protective earth
PELV	Protective Extra Low Voltage
PLC	Programmable logic control
PWM	Pulse-width modulation
RAM	Random access memory (volatile memory)
R_{Brake}/R_B	Regen resistor (also called a brake resistor)
RBext	External regen resistor
RBint	Internal regen resistor
RCD	Residual current device
RES	Resolver
S1	Continuous operation
tbd	To be discussed (in process)
VAC	Volts, alternating current
VDC	Volts, direct current

2.5 Referred Standards

Standard	Content
ISO 4762	Hexagon socket head cap screws
ISO 11898	Road vehicles — Controller area network (CAN)
ISO 12100	Safety of machinery: Basic concepts, general principles for design
ISO 13849	Safety of machinery: Safety-related parts of control systems
IEC 60085	Electrical insulation - Thermal evaluation and designation Maintenance
IEC 60204	Safety of Machinery: Electrical equipment of machinery
IEC 60364	Low-voltage electrical installations
IEC 60439	Low-Voltage Switchgear and Controlgear Assemblies
IEC 60529	International protection rating (IP code)
IEC 60664	Insulation coordination for equipment within low-voltage systems
IEC 60721	Classification of environmental conditions
IEC 61000	Electromagnetic compatibility (EMC)
IEC 61131	Programmable controllers
IEC 61784	Industrial communication networks - Profiles, Part 3-12 Functional safety fieldbuses
IEC 61491	Electrical equipment of industrial machines – Serial data link for real-time communications between controls and drives.
IEC 61508	Functional safety of electrical/electronic/programmable electronic safety-related systems
IEC 61800	Adjustable speed electrical power drive systems
IEC 62061	Functional safety of electrical/electronic/programmable electronic safety-related systems
IEC 82079	Preparation of instructions for use - Structuring, content and presentation
UL 61800-5-1	Adjustable speed electrical power drive systems, Safety Requirements – Electrical, Thermal, and Energy

IEC - International Electrotechnical Commission
ISO - International Organization for Standardization
UL - Underwriters Laboratories

3 Product Safety

3.1 You should pay attention to this

This section helps to recognize risks and avoid dangers to people and objects.

Specialist staff required!

Only properly qualified personnel are permitted to perform such tasks as transport, installation and setup. Qualified specialist staff are persons with expertise in transport, installation, assembly, commissioning and operation of electrotechnical equipment.

- Transport, storage, unpacking: only by personnel with knowledge of handling electrostatically sensitive components.
- Mechanical installation: only by personnel with mechanical expertise.
- Electrical installation: only by personnel with electrotechnical expertise.
- Basic tests / setup: only by personnel with expertise in electrical engineering and drive technology.

The qualified personnel must know and observe ISO 12100 / IEC 60364 / IEC 60664 and national accident prevention regulations.

Read the documentation!

Read the available documentation before installation and commissioning. Improper handling of the devices can cause harm to people or damage to property. The operator of systems using the drive system must ensure that all personnel who work with the drive read and understand the manual before using the drive.

Check Hardware Revision!

Check the Hardware Revision Number of the product (see product label). This number is the link between your product and the manual. The product Hardware Revision Number must match the Hardware Revision Number on the cover page of the manual.

Pay attention to the technical data!

Adhere to the technical data and the specifications on connection conditions. If permissible voltage values or current values are exceeded, the devices can be damaged. Unsuitable motor or wrong wiring will damage the system components. Check the combination of drive and motor. Compare the rated voltage and current of the units.

Perform a risk assessment!

The manufacturer of the machine must generate a risk assessment for the machine, and take appropriate measures to ensure that unforeseen movements cannot cause injury or damage to any person or property. Additional requirements on specialist staff may also result from the risk assessment.

Automatic restart

The drive might restart automatically after power on, voltage dip or interruption of the supply voltage, depending on the parameter setting. Risk of death or serious injury for humans working in the machine.

If the parameter AXIS#.ENDEFAULT is set to 1, then place a warning sign to the machine (Warning: Automatic Restart at Power On) and ensure, that power on is not possible, while humans are in a dangerous zone of the machine. In case of using an undervoltage protection device, you must observe EN 60204-1:2006 chapter 7.5 .

Observe electrostatically sensitive components!

The devices contain electrostatically sensitive components which may be damaged by incorrect handling. Electrostatically discharge your body before touching the device. Avoid contact with highly insulating materials (artificial fabrics, plastic film etc.). Place the device on a conductive surface.

Hot surface!

Drives may have hot surfaces during operation. The housing can reach temperatures above 80°C. Risk of minor burns! Measure the temperature, and wait until the housing has cooled down below 40 °C before touching it.

Earthing!

It is vital that you ensure that the drive is safely earthed to the PE (protective earth) busbar in the switch cabinet. Risk of electric shock. Without low-resistance earthing no personal protection can be guaranteed.

Leakage Current!

Since the leakage current to PE is more than 3.5 mA, in compliance with IEC61800-5-1 the PE connection must either be doubled or a connecting cable with a cross-section >10 mm² must be used. Deviating measures according to regional standards might be possible.

High voltages!

The equipment produces high electric voltages up to 900 V. Lethal danger exists at live parts of the device. Do not open or touch the equipment during operation. Keep all covers and cabinet doors closed. Built-in protection measures such as insulation or shielding may not be removed. Work on the electrical installation may only be performed by trained and qualified personnel, in compliance with the regulations for safety at work, and only with switched off mains supply, and secured against restart.

Never undo any electrical connections to the drive while it is live. There is a danger of electrical arcing with damage to contacts and personal injury. Wait at least 5 minutes after disconnecting the drive from the main supply power before touching potentially live sections of the equipment (such as contacts) or removing any connections.

Always measure the voltage in the DC bus link and wait until the voltage is below 50 V before handling components.

Functional Safety!

NOTICE Beta drives: Safety functionality is not approved nor certified. Do not use this functionality in applications with functional safety request.

The assessment of the safety functions according to EN13849 or EN 62061 must finally be done by the user.

Reinforced Insulation

Thermal sensors, motor holding brakes and feedback systems built into the connected motor must have reinforced insulation (according to IEC61800-5-1) against system components with power voltage, according to the required application test voltage. All Kollmorgen components meet these requirements.

Never modify the drive!

It is not allowed to modify the drive hardware without permission by the manufacturer. Opening the housing causes loss of warranty.

3.2 Shock-hazard Protection

3.2.1 Leakage current

Leakage current via the PE conductor results from the combination of equipment and cable leakage currents. The leakage current frequency pattern includes a number of frequencies, whereby the residual-current circuit breakers definitively evaluate the 50 Hz current. For this reason, the leakage current cannot be measured using a conventional multimeter. Contact our application department for help to calculate the leakage current in your application.

NOTE Since the leakage current to PE is more than 3.5 mA, in compliance with IEC61800-5-1 the PE connection must either be doubled or a connecting cable with a cross-section >10 mm² must be used. Use the PE terminal and the PE connection screws in order to fulfill this requirement.

The following measures can be used to minimize leakage currents:

- Reduce the length of the engine cable.
- Use low capacitance motor cables (➜ # 52).

3.2.2 Residual current protective device (RCD)

In conformity with IEC 60364-4-41 – Regulations for installation and IEC 60204 – Electrical equipment of machinery, residual current protective devices (RCDs) can be used provided the requisite regulations are complied with. The AKD2G is a 3-phase system with a B6 bridge. Therefore, RCDs which are sensitive to all currents must be used in order to detect any DC fault current.

Rated residual currents in the RCDs:

10 to 30 mA	Protection against "indirect contact" (personal fire protection) for stationary and mobile equipment, as well as for "direct contact".
50 to 300 mA	Protection against "indirect contact" (personal fire protection) for stationary equipment

NOTE Recommendation: In order to protect against direct contact (with motor cables shorter than 5 m) Kollmorgen recommends that each drive be protected individually using a 30 mA RCD which is sensitive to all currents.

If you use a selective RCD, the more intelligent evaluation process will prevent spurious tripping of the RCD.

3.2.3 Isolating transformers

When protection against indirect contact is absolutely essential despite a higher leakage current, or when an alternative form of shock-hazard protection is sought, the AKD2G can also be operated via an isolating transformer. A ground-leakage monitor can be used to monitor for short circuits.

NOTE Keep the length of wiring between the transformer and the drive as short as possible.

3.3 Stop / Emergency Stop / Emergency Off

The control functions Stop, Emergency Stop and Emergency Off are defined by IEC 60204. Notes for safety aspects of these functions can be found in ISO 13849 and IEC 62061.

NOTE The parameter AXIS#.DISMODE must be set to implement the different stop categories. Consult the *WorkBench Online Help* for configuring the parameter.

⚠WARNING No functional safety!

Serious injury could result when the load is not properly blocked. With vertical load the load could fall.

- Functional safety, e.g. with hanging load (vertical axes), requires an additional mechanical brake which must be safely operated, for example by a safety control.
- Set parameter AXIS#.MOTOR.BRAKEIMM to 1 with vertical axes, to apply the motor holding brake (➜ # 82) immediately after faults or Hardware Disable.

3.3.1 Stop

The stop function shuts down the machine in normal operation. The stop function is defined by IEC 60204.

NOTE The Stop Category must be determined by a risk evaluation of the machine.

Stop function must have priority over assigned start functions. The following stop categories are defined:

Stop Category 0

Shut-down by immediate switching-off the energy supply to the drive machinery (this is an uncontrolled shut-down). With the safety function STO (➜ # 127) the drive can be stopped using its internal electronics (IEC 62061 SIL2).

Stop Category 1

A controlled shut-down, whereby the energy supply to the drive machinery is maintained to perform the shut-down, and the energy supply is only interrupted when the shut-down has been completed.

Stop Category 2

A controlled shut-down, whereby the energy supply to the drive machinery is maintained.

Stop Category 0 and Stop Category 1 stops must be operable independently of the operating mode, whereby a Category 0 stop must have priority.

If necessary, provision must be made for the connection of protective devices and lock-outs. If applicable, the stop function must signal its status to the control logic. A reset of the stop function must not create a hazardous situation.

3.3.2 Emergency Stop

The Emergency Stop function is used for the fastest possible shutdown of the machine in a dangerous situation. The Emergency Stop function is defined by IEC 60204. Principles of emergency stop devices and functional aspects are defined in ISO 13850.

The Emergency Stop function will be triggered by the manual actions of a single person. It must be fully functional and available at all times. The user must understand instantly how to operate this mechanism (without consulting references or instructions).

NOTE The Stop Category for the Emergency Stop must be determined by a risk evaluation of the machine.

In addition to the requirements for stop, the Emergency Stop must fulfil the following requirements:

- Emergency Stop must have priority over all other functions and controls in all operating modes.
- The energy supply to any drive machinery that could cause dangerous situations must be switched off as fast as possible, without causing any further hazards (Stop Category 0) or must be controlled in such a way, that any movement that causes danger, is stopped as fast as possible (Stop Category 1).
- The reset must not initiate a restart.

3.3.3 Emergency Off

The Emergency Off function is used to switch-off the electrical power supply of the machine. This is done to prevent users from any risk from electrical energy (for example electrical impact). Functional aspects for Emergency Off are defined in IEC 60364-5-53.

The Emergency Off function will be triggered by the manual actions of a single person.

NOTE The result of a risk evaluation of the machine determines the necessity for an Emergency Off function.

Emergency Off is done by switching off the supply energy by electro-mechanical switching devices. This results in a category 0 stop. If this stop category is not possible in the application, then the Emergency Off function must be replaced by other measures (for example by protection against direct touching).

3.4 Warning note labels

NOTICE If a warning note label is damaged, it must be replaced immediately.

3.4.1 Notes placed on the product

3.4.2 Adhesive label in the package

NOTICE To meet UL, place the multi-language label on the drive or on the panel near the drive.

3.5 Use as Directed

The AKD2G drives are exclusively intended for driving suitable synchronous servomotors with closed-loop control of torque, speed, and/or position.

AKD2G are components that are built into electrical plants or machines and can only be operated as integral components of these plants or machines. The manufacturer of the machine used with a drive must generate a risk assessment for the machine. When the drives are built into machines or plant, the drive must not be used until it has been established that the machine or plant fulfills the requirements of the regional directives.

Cabinet and wiring

Drives must only be operated in a closed control cabinet suitable for the ambient conditions (➜ # 33). Ventilation or cooling may be necessary to keep the temperature within the cabinet below 40 °C.

Use only copper conductors for wiring. The conductor cross-sections can be derived from the standard IEC 60204 (alternatively for AWG cross-sections: NEC Table 310-16, 75 °C column).

Power supply

The drives can be supplied by 1, 2 or 3 phase industrial supply networks.

Drives in the AKD2G series can be supplied as follows:

- AKD2G-Sxx-6Vxx:
  1, 2 or 3 phase industrial supply networks (not more than 200 kA symmetrical rated current at 120 V and 240 V).
- AKD2G-Sxx-7Vxx:
  3 phase industrial supply networks (not more than 200 kA symmetrical rated current at 240 V, 400 V and 480 V).

Connection to other voltage types of supply networks is possible with an additional isolating transformer.

Repeated overvoltages between phases (L1, L2, L3) and the housing of the drive must not exceed 1000 V peak. In accordance with IEC 61800, voltage spikes (< 50 µs) between phases must not exceed 1000 V. Voltage spikes (< 50 µs) between a phase and the housing must not exceed 2000 V.

EMC filter measures for AKD2G-Sxx-6Vxx must be implemented by the user.

Motor voltage rating

The rated voltage of the motors must be at least as high as the DC bus link voltage divided by √2 produced by the drive ($U_{nMotor}>=U_{DC}/\sqrt{2}$).

Functional Safety

NOTICE Beta Drives: Safety functionality is neither approved nor certified yet. Do not use this functionality in applications with functional safety request until further notice.

NOTICE

- The network, to which the drive is connected, must be secured according to state-of-the-art information technology security requirements.
- The user IT specialists shall analyze whether further security requirements are applicable to ensure functional safety.

Review the chapter "Use as Directed" in the Functional Safety section (➜ # 123) before using safety functionality.

3.6 Prohibited Use

Other use than that described in chapter “Use as directed” is not intended and can lead to personnel injuries and equipment damage. The drive may not be used with a machine that does not comply with appropriate national directives or standards. The use of the drive in the following environments is also prohibited:

- potentially explosive areas
- environments with corrosive and/or electrically conductive acids, alkaline solutions, oils, vapors, dusts
- ships or offshore applications

NOTICE

The drive must not be connected directly to the Internet. If the network, to which the drive is connected, is not secured according to state-of-the-art information technology, this could be a functional safety risk.

4 Product life cycle handling

4.1 Transport

Transport the AKD2G in accordance with IEC 61800-2 as follows:

- Transport only by qualified personnel in the manufacturer's original recyclable packaging.
- Avoid shocks while transporting.
- Vibration/Shock: AKD2G is tested for environmental class 2M1 of IEC 60721-3-2.
- Store at or below maximum stacking height 8 cartons (see "Storage" (➜ # 24))
- Transport only within specified temperature ranges:
  -25 to +70 °C, max. rate of change 20 K/hour, class 2K3.
- Transport only within specified humidity:
  max. 95% relative humidity at +40°C, no condensation, class 2K3.

NOTICE The drives contain electrostatically sensitive components that can be damaged by incorrect handling. Electrostatically discharge yourself before touching the drive. Avoid contact with highly insulating materials, such as artificial fabrics and plastic films. Place the drive on a conductive surface.

If the packaging is damaged, check the unit for visible damage. Inform the shipper and the manufacturer of any damage to the package or product.

4.2 Packaging

The AKD2G packaging consists of recyclable cardboard with inserts and a label on the outside of the box.

Model	Package (mm) HxWxL	Total Weight (kg)
AKD2G-Sxx-6V03 to 6V12	tbd	4.2
AKD2G-Sxx-7V03 to 7V12	tbd	4.3

NOTE Mating connectors are **not** included in the package of a standard drive.

Mating connectors are included when the drive is ordered with accessories (append "-A" to the model number).

4.3 Storage

Store the AKD2G in accordance with IEC 61800-2 as follows:

- Store only in the manufacturer's original recyclable packaging.
- Store at or below maximum stacking height 8 cartons.
- Store only within specified temperature ranges: -25 to +55 °C, max.rate of change 20 K/hour, class 1K4.
- Storage only within specified humidity: 5 to 95% relative humidity, no condensation, class 1K3.
- Store in accordance with the following duration requirements:
  - Less than 1 year: without restriction.
  - More than 1 year: capacitors must be re-formed before setting up and operating the drive. Re-forming procedures are described in the Kollmorgen Developer Network (Forming).

4.4 Installation, setup and normal operation

Installation and setup information are given in this manual:

- Mechanical installation (➜ # 45)
- Electrical installation (➜ # 48)
- Setup (➜ # 111)

Normal operation tested for environmental class 3K3 according to IEC 61800-2 (➜ # 33).
The manufacturer of the machine defines the necessary end user expertise based on the risk assessment for the machine and describes the requirements for normal operation based on the application.

4.5 Decommissioning

NOTICE Only professional staff who are qualified in electrical engineering are allowed to decommission parts of the system.

DANGER: Lethal Voltages!
There is a danger of serious personal injury or death by electrical shock or electrical arcing.

- Switch off the main switch of the switchgear cabinet.
- Secure the system against restarting.
- Block the main switch.
- Wait at least 5 minutes after disconnecting.

4.6 Maintenance and cleaning

The device does not require maintenance. Opening the device voids the warranty. The inside of the unit can only be cleaned by the manufacturer.

NOTICE Do not immerse or spray the device. Avoid that liquid enters the device.

To clean the device exterior:

1. Decommission the device (see chapter 4.5 "Decommissioning").
2. Casing: Clean with isopropanol or similar cleaning solution.
   Caution : Highly Flammable! Risk of injury by explosion and fire.
   - Observe the safety notes given on the cleaning liquid package.
   - Wait at least 30 minutes after cleaning before putting the device back into operation.
3. Protective grill on fan: Clean with a dry brush.

4.7 Disassembly

NOTICE Only professional staff who are qualified in electrical engineering are allowed to disassemble parts of the system.

1. Decommission the device (see chapter 4.5 "Decommissioning").
2. Check temperature.
   CAUTION: High Temperature! Risk of minor burns. During operation, the heat sink of the drive may reach temperatures above 80 °C (176 °F). Before touching the device, check the temperature and wait until it has cooled below 40 °C (104 °F).
3. Remove the connectors. Disconnect the potential earth connection last.
4. Demount: loosen the fastening screws. Remove the device.

4.8 System Repair

NOTICE Only professional staff who are qualified in electrical engineering are allowed to exchange parts of the drive system.

CAUTION: Automatic Start! During replacement work a combination of hazards and multiple episodes may occur.

- Work on the electrical installation may only be performed by trained and qualified personnel, in compliance with the regulations for safety at work, and only with use of prescribed personal safety equipment.

Exchange of the device

Only the manufacturer can repair the device. Opening the device voids the warranty.

1. Decommission the device (see chapter 4.5 "Decommissioning").
2. Demount the device (see chapter 4.7 "Disassembly").
3. Send the device to the manufacturer.
4. Install a new device as described in this manual.
5. Setup the system as described in this manual.

Exchange of other drive system parts

If parts of the drive system (for example cables) must be replaced, proceed as follows:

1. Decommission the device (see chapter 4.5 "Decommissioning").
2. Exchange the parts.
3. Check all connections for correct fastening.
4. Setup the system as described in this manual.

4.9 Disposal

NOTICE To dispose the unit properly, contact a certified electronic scrap disposal merchant.

In accordance with the WEEE-2012/19/EC guideline and similar, the manufacturer accepts returns of old devices and accessories for professional disposal. Transport costs are the responsibility of the sender.

Contact Kollmorgen and clarify the logistics.

Send the devices in the original packaging to the manufacturer address:

North America	South America
KOLLMORGEN 201 West Rock Road Radford, VA 24141, USA	**KOLLMORGEN** Avenida João Paulo Ablas, 2970 Jardim da Glória, Cotia – SP CEP 06711-250, Brazil
Europe	**Asia**
KOLLMORGEN Europe GmbH Pempelfurtstr. 1 40880 Ratingen, Germany	**KOLLMORGEN** Floor 4, Building 9, No. 518, North Fuquan Road, Changning District, Shanghai 200335, China

5 Package

5.1 Package Supplied

When a standard drive from the AKD2G series is delivered, the following items are included in the drive package:

- AKD2G
- Printed copy of *AKD®2G Product Safety Guide* .
- DVD with WorkBench setup software .
- Panel safety label

NOTE

Mating connectors are **not** included in the package of a standard drive.

Mating connectors are included when the drive is ordered with accessories (append "-A" to the model number). With the accessories option all connectors to match the drive variant are included, excepting SubD (Feedback 3), RJ25 (CAN bus) and RJ45 (service and fieldbus networks).

Accessories Sold Separately

Accessories must be ordered separately if required.

- EMC filters for mains supply voltage, categories C2 or C3.
- External regen resistor.
- Connector kits
- Hybrid cable. Assembled hybrid motor cables are available for all regions.
- Motor cable. Assembled motor cables are available for all regions.
- Feedback cable. Assembled feedback cables are available for all regions.
- SFA (Smart Feedback Adapter) .
- SDB Module (Safe Dynamic Brake Module).
- Ethernet service cable.

5.2 Nameplate

A nameplate is attached to the side of the drive. The picture below is similar to the nameplate on the device.

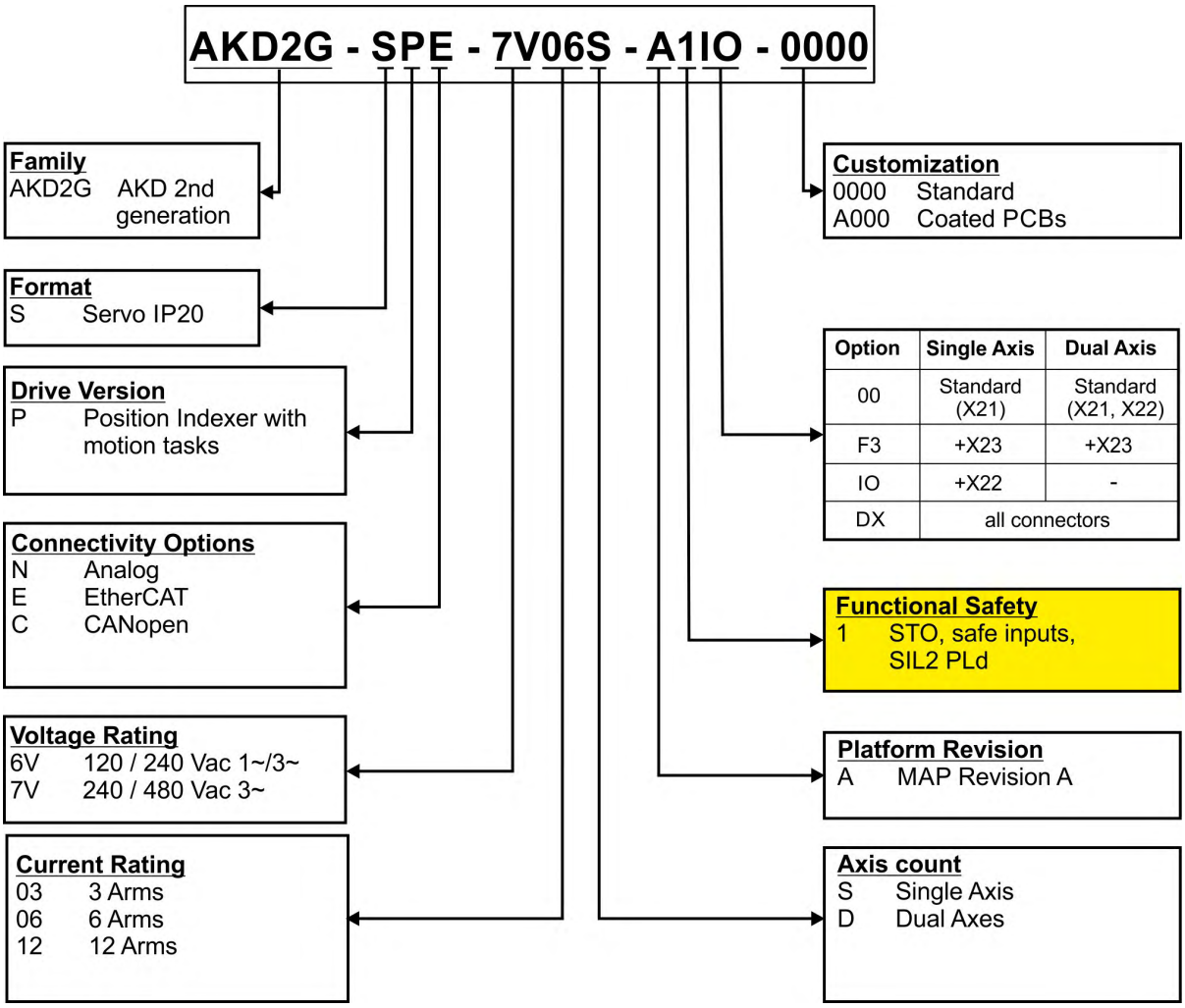
5.3 Part Number Scheme

Use the part number scheme for product identification only, not for the order process, because not all combinations of features are possible.

NOTE

Mating connectors are **not** included in the package of a standard drive.

Mating connectors are included when the drive is ordered with accessories (append "-A" to the model number).



Example AKD2G-SPE-7V06S-A1IO-0000

AKD2G IP20 housing, position indexer, EtherCAT, 240 V to 480 V mains supply, 6 A rated current, single axis, Hardware Revision A, dual channel STO SIL2 PLd, with additional I/O connector X22, uncoated, no mating connectors.

Example AKD2G-SPE-6V03D-A1DX-A000-A

AKD2G IP20 housing, position indexer, EtherCAT, 120 V to 240 V mains supply, 2 x 3 A rated current, dual axis, Hardware Revision A, dual channel STO SIL2 PLd, with all possible connector (basis + X23), PCBs coated, with mating connectors.

6 Technical description and data

6.1 The AKD2G Family of Digital Drives

Available AKD2G-SP (Position Indexer) versions

Connectivity	Voltage	Current	Axis	Rev	Safety
N-: Analog **C-**: CANopen **E-**: EtherCAT	**6V**: 120/240VAC 1~ 240VAC 3~ **7V**: 240/400/480VAC 3~	**03**: 3 A **06**: 6 A **12**: 12 A	**S-**: Single **D-**: Dual I1=I2	**A**	**1**: SIL2 STO

Connector Options for Drives with Functional Safety 1	
Single Axis	**Dual Axis**
00: Basis (X21) **IO**: Basis + X22 **F3**: Basis + X23 **DX**: Basis + X22+X23	**00**: Basis (X21, X22) **F3**: Basis + X23 **DX**: Basis + X23

Standard features

- Single axis or dual axis in one housing
- Supply voltages: single phase AC, dual phase AC, three phase AC
- Single or group supply, single or group mains fusing
- Motion bus on board, TCP/IP service channel on board
- SFD3, HIPERFACE DSL motor feedback support on board
- Support for second feedback
- Step / Direction input on board
- Encoder emulation on board
- Use with synchronous servomotors, linear motors, and induction machines
- SIL2 / PLd dual channel STO

Power section

- One, two or three phase AC supply, voltage range 85 to 528 V, 47 to 63 Hz. Connection to higher AC voltage mains only via isolating transformer.
- Fusing to be provided by the user.
- B6 bridge rectifier, integral soft-start circuit.
- DC bus link voltage range 120 to 750 VDC
- Output stage IGBT module with floating current measurement.
- Internal regen resistor for all models, external regen resistor if required.

Functional Safety

- Safety option 1: SIL2 / PLd dual channel STO, command by I/O, (➜ # 127).

Electrical safety

- Appropriate insulation / creepage distances and electrical isolation for safe electrical separation, per IEC 61800-5-1, between the power input / motor connections and the signal electronics.
- Soft-start, overvoltage detection, short-circuit protection, phase-loss detection.
- Temperature monitoring of the drive and motor.
- Motor overload protection: foldback mechanism.

Auxiliary supply voltage 24V DC

- From an external, safety approved 24 V ±10% power supply (PELV).

Parameter setting

- Setup software WorkBench for setup via TCP/IP.
- Download control parameter packages via CoE

Full digital control

- Digital current loop (update period 1.2 µs / 62.5 µs)
- Digital velocity loop (update period 62.5 µs)
- Digital position loop (update period 250 µs)

Inputs/Outputs (X21/X22/X23)

Usability depends on connector availability and usage.

- 2 programmable analog input (➜ # 101)
- 2 programmable analog output (➜ # 102)
- 12 programmable digital inputs (➜ # 103)
- 8 programmable digital outputs (➜ # 107)
- 6 programmable digital input/outputs (➜ # 107)
- 4 safe STO inputs (dual channel STO per axis) (➜ # 123)

Connector Options

- **IO**: X22 connector with additional digital inputs and outputs.
- **F3**: X23 connector for conventional motor feedbacks (Resolver, SFD, Tamagawa Smart Abs, Comcoder, 1Vp-p Sin-Cos encoders, incremental encoders, EnDAT 2.1/2.2).
- **DX**: all possible connectors for extended I/O and feedback connections.

Customization

- 0000: uncoated PCBs, standard
  0xxx: uncoated PCBs, customized coding
- A000: coated PCBs, standard
  Axxx: coated PCBs, customized coding

Connectivity

- Feedback inputs (➜ # 88)
- Encoder emulation output (➜ # 91)
- Digital Inputs/Outputs (➜ # 99)
- Service Interface (➜ # 98)
- CANopen (➜ # 95)
- Motion Bus interface (➜ # 94)

Accessories

- **SFA** (Smart Feedback Adapter) (➜ # 89).
- Hybrid motor cables, motor power cables, motor feedback cables.
- External regen resistors.

For accessories refer to your regional *Accessories Manual*.

6.2 Ambient Conditions, Ventilation, and Mounting Position

Storage, Transport	(➜ # 24)
Normal operation	Environmental class 3K3 according to IEC 61800-2
Surrounding temperature in operation	Internal regen resistor used: ● 0 to +40 °C under rated conditions ● +40 to +60 °C with current derating 3 % per Kelvin Internal regen resistor not used: ● 0 to +50 °C under rated conditions ● +50 to +60 °C with current derating 2 % per Kelvin
Humidity in operation	Relative humidity 5 to 85%, no condensation, IEC 61800-2 class 3K3
Site altitude	● Up to 1000 m above mean sea level (AMSL): no restriction ● 1,000 to 2,000 m AMSL: power derating 1.5%/100 m ● Maximum altitude: 2000 m AMSL
Pollution level	Pollution level 2 as per IEC 60664-1
Vibration	Class 3M1 according to IEC 61800-2
Shock	Class L according to IEC 61800-2
Drive protection	IP 20 according to IEC 60529
Drive EMC immunity	Increased immunity according to EN 61800-5-2
Mounting	Vertical position, in a cabinet with protection of at least IP 54
Ventilation	Built-in fan in all drive variants
NOTICE	The drive shuts down in case of excessively high temperature in the control cabinet. Make sure sufficient forced ventilation is supplied within the control cabinet.

6.3 Mechanical Data

	Units	AKD2G-Sxx-			
		6V03S, 6V06S, 6V12S	7V03S, 7V06S, 7V12S	6V03D, 6V06D	7V03D, 7V06D
Weight (with X22 and X23)	kg	2.6	2.9	2.6	2.9
Width	mm	76	75	76	75
Height, without connectors front/back	mm	220/235	255/272	220/235	255/272
Height, with connectors	mm	303	340	303	340
Depth, without connectors	mm	221	221	221	221
Depth, with connectors	mm	<235	<235	<235	<235

NOTE Dimension Drawing see section Mechanical Installation (➜ # 45).

6.4 Performance Data

Performance Data	Units	AKD2G-Sxx-	
		6V03, 6V06, 6V12, 7V03	7V06, 7V12
Normal Switching frequency (dynamic)	kHz	15	12
Loaded Switching Frequency (dynamic)	kHz	10.4	8.2
Current Loop Update Period	µs	1.28*	
Velocity Loop Update Period	µs	62.5	
Position Loop Update Period	µs	250	
Current Loop Bandwidth	Hz	3000	
Velocity Loop Bandwidth	Hz	750	
Position Loop Bandwidth	Hz	350	
Max. motor electrical frequency	Hz	599	

* Control updates every 1.28 µs. Current command is updated every 62.5 µs.

6.5 Electrical data

6.5.1 Single axis variants (S)

6.5.1.1 Mains supply data, 1 phase AC, type AKD2G-Sxx- (S)

Input data	Units	6V03S	6V06S	6V12S
Rated supply voltage (L1/N)	VAC	1 x 100 V to 240 V		
Rated supply input frequency	Hz	50 Hz to 60 Hz ±5%		
Permitted switch on/off frequency	1/h	30		
Rated input power @240 V	kVA	1.2	2.38	2.64
Rated input current at 1 x 110 Vac	A	5	9.9	11
Rated input current at 1 x 240 Vac	A	5	9.9	11
Max. inrush current	A	10		
Rated DC bus link voltage	VDC	310		

6.5.1.2 Mains supply data, 3 phase AC, type AKD2G-Sxx- (S)

Input data	Units	6V03S	6V06S	6V12S	7V03S	7V06S	7V12S
Rated supply voltage (L1/L2/L3)	VAC	3 x 100 V to 240 V			3 x 200 V to 480 V		
Rated supply input frequency	Hz	50 Hz to 60 Hz ±5%					
Permitted switch on/off frequency	1/h	30			30		
Rated input power @240 V (*480V)	kVA	1.2	2.38	2.64	2.24*	4.49*	7.65*
Rated input current at 3 x 110 Vac	A	2.9	5.7	9.2	-	-	-
Rated input current at 3 x 240 Vac	A	5	5.7	9.2	2.7	5.4	9.2
Rated input current at 3 x 400 Vac	A	-	-	-	2.7	5.4	9.2
Rated input current at 3 x 480 Vac	A	-	-	-	2.7	5.4	9.2
Max. inrush current	A	10					
Rated DC bus link voltage	VDC	310			620		

6.5.1.3 Auxiliary voltage input data, 24V DC, type AKD2G-Sxx- (S)

Input data	Units	6V03S	6V06S	6V12S	7V03S	7V06S	7V12S
Aux. voltage supply (PELV)	VDC	24 V (±10%, check voltage drop)					
- control current without motor brake	A	1					
- control current with one motor brake	A	3.5					

6.5.1.4 Output data, type AKD2G-Sxx- (S)

	Units	6V03S	6V06S	6V12S	7V03S	7V06S	7V12S
Rheostatic energy dissipation							
max. continuous power	kW	1.5	3	6	12	12	12
internal regen resistor	Ω	15	15	15	33	33	33
external regen resistor	Ω	33	33	33	33	33	33
Continuous output current (± 3%)							
at 1 x 110 Vac	Arms	3	6	12	-	-	-
at 1 x 240 Vac	Arms	3	6	12	-	-	-
at 3 x 110 Vac	Arms	3	6	12	-	-	-
at 3 x 240 Vac	Arms	3	6	12	3	6	12
at 3 x 400 Vac	Arms	-	-	-	3	6	12
at 3 x 480 Vac	Arms	-	-	-	3	6	12
Peak output current (for 5s, ± 3%)	Arms	9	18	30	9	18	30
Continuous output power @ rated input current							
at 1 x 110 Vac	kVA	tbd	tbd	tbd	-	-	-
at 1 x 240 Vac	kVA	tbd	tbd	tbd	-	-	-
at 3 x 110 Vac	kVA	tbd	tbd	tbd	-	-	-
at 3 x 240 Vac	kVA	tbd	tbd	tbd	tbd	tbd	tbd
at 3 x 400 Vac	kVA	-	-	-	tbd	tbd	tbd
at 3 x 480 Vac	kVA	-	-	-	tbd	tbd	tbd
Peak output power (for 1 s)							
at 1 x 110 Vac	kVA	tbd	tbd	tbd	-	-	-
at 1 x 240 Vac	kVA	tbd	tbd	tbd	-	-	-
at 3 x 110 Vac	kVA	tbd	tbd	tbd	-	-	-
at 3 x 240 Vac	kVA	tbd	tbd	tbd	tbd	tbd	tbd
at 3 x 400 Vac	kVA	-	-	-	tbd	tbd	tbd
at 3 x 480 Vac	kVA	-	-	-	tbd	tbd	tbd
Emissions (low/high speed fan)							
Noise emission	dB(A)	tbd	tbd	tbd	tbd	tbd	tbd
Brake output							
Voltage	VDC	24 V (±10%)					
Output current, minimum	mA	required 100 (fault detection)					
Output current, maximum	A	2.5					

6.5.2 Dual axis variants (D: I1=I2)

6.5.2.1 Mains supply data, 1 phase AC, type AKD2G-Sxx- (D)

Input data	Units	6V03D	6V06D
Rated supply voltage (L1/N)	VAC	1 x 100 V to 240 V	
Rated supply input frequency	Hz	50 Hz to 60 Hz ±5%	
Permitted switch on/off frequency	1/h	30	
Rated input power @ 240V	kVA	2.38	2.64
Rated input current at 1 x 110 Vac	A	9.9	11
Rated input current at 1 x 240 Vac	A	9.9	11
Max. inrush current	A	10	
Rated DC bus link voltage	VDC	310	

6.5.2.2 Mains supply data, 3 phase AC, type AKD2G-Sxx- (D)

Input data	Units	6V03D	6V06D	7V03D	7V06D
Rated supply voltage (L1/L2/L3)	VAC	3 x 100 V to 240 V		3 x 200 V to 480 V	
Rated supply input frequency	Hz	50 Hz to 60 Hz ±5%			
Permitted switch on/off frequency	1/h	30			
Rated input power @ 240V (*480V)	kVA	2.38	3.82	4.49*	7.65*
Rated input current at 3 x 110 Vac	A	2.9	5.7	-	-
Rated input current at 3 x 240 Vac	A	5	5.7	5.4	9.2
Rated input current at 3 x 400 Vac	A	-	-	5.4	9.2
Rated input current at 3 x 480 Vac	A	-	-	5.4	9.2
Max. inrush current (at 240 V/480 V, 20°C)	A	10			
Rated DC bus link voltage	VDC	310		620	

6.5.2.3 Auxiliary voltage input data, 24V DC, type AKD2G-Sxx- (D)

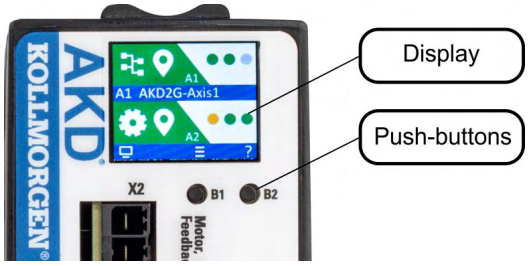
Input data	Units	6V03D	6V06D	7V03D	7V06D
Aux. voltage supply (PELV)	VDC	24 V (±10%, check voltage drop)			
- current without motor brake	A	1.25			
- control current with one motor brake	A	3.75			
- control current with two motor brakes	A	6.25			

6.5.2.4 Output data, type AKD2G-Sxx- (D)

	Units	6V03D	6V06D	7V03D	7V06D
Rheostatic energy dissipation					
max. continuous power	kW	1.5	3	3	6
internal regen resistor	Ω	15	15	33	33
external regen resistor	Ω	33	33	33	33
Continuous output current (± 3%)					
at 1 x 110 Vac	Arms	2x3	2x6	-	-
at 1 x 240 Vac	Arms	2x3	2x6	-	-
at 3 x 110 Vac	Arms	2x3	2x6	-	-
at 3 x 240 Vac	Arms	2x3	2x6	2x3	2x6
at 3 x 400 Vac	Arms	-	-	2x3	2x6
at 3 x 480 Vac	Arms	-	-	2x3	2x6
Peak output current (for 5s, ± 3%)	Arms	2x9	2x18	2x9	2x18
Continuous output power @ rated input current					
at 1 x 110 Vac	kVA	tbd	tbd	-	-
at 1 x 240 Vac	kVA	tbd	tbd	-	-
at 3 x 110 Vac	kVA	tbd	tbd	-	-
at 3 x 240 Vac	kVA	tbd	tbd	tbd	tbd
at 3 x 400 Vac	kVA	-	-	tbd	tbd
at 3 x 480 Vac	kVA	-	-	tbd	tbd
Peak output power (for 1 s)					
at 1 x 110 Vac	kVA	tbd	tbd	-	-
at 1 x 240 Vac	kVA	tbd	tbd	-	-
at 3 x 110 Vac	kVA	tbd	tbd	-	-
at 3 x 240 Vac	kVA	tbd	tbd	tbd	tbd
at 3 x 400 Vac	kVA	-	-	tbd	tbd
at 3 x 480 Vac	kVA	-	-	tbd	tbd
Emissions (low/high speed fan)					
Noise emission	dB(A)	tbd	tbd	tbd	tbd
Brake output					
Voltage	VDC	24 V (±10%)			
Output current, minimum	mA	required 100 per brake (fault detection)			
Output current, maximum	A	2.5 per brake			

6.6 LCD Display and Push-buttons (B1, B2)

The drive offers an LCD display and two push-buttons B1 / B2 for navigation.



Push-button actions

A short button press invokes the action corresponding to the symbol directly above the button. On the dashboard for example,

- a short press on B1 causes the menu system to appear, and
- a short press on B2 causes a help screen to appear.
- A long press (greater than 2 seconds) on B2 returns the display to the previous screen.

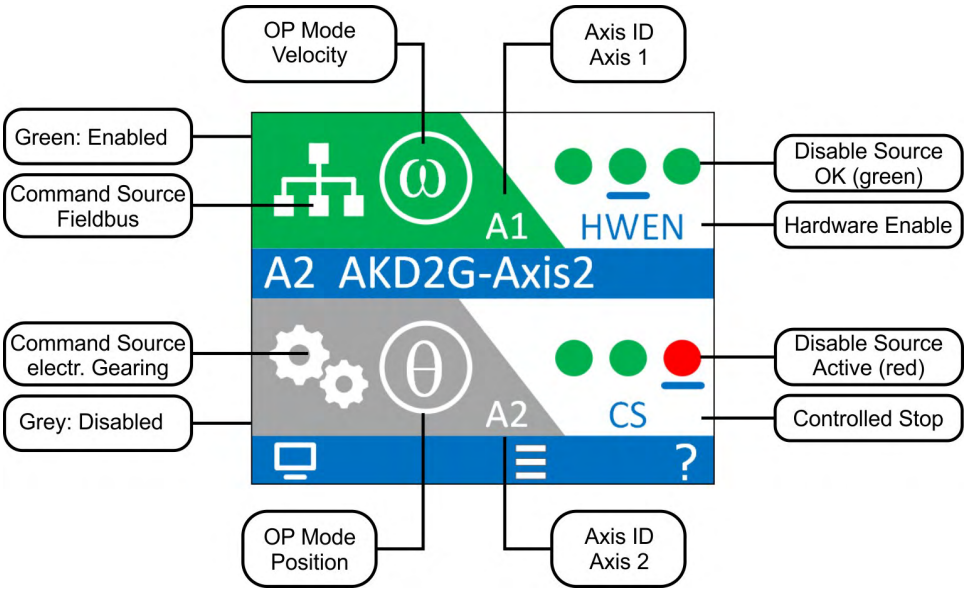
More B1 / B2 Functions	Description
Boot from SD card	Push both buttons during power up to boot with data from SD card. Press the buttons first, then hold it down while turning on the 24 V power supply.
Boot from flash fallback image	Remove the SD card, then press both buttons and hold them down while turning on the 24 V power supply to boot from an on-board recovery image. The fallback image includes a set of boot-loader, operational, and control FPGA that implements sufficient programming support to update missing or corrupt files.

LCD display

- Left Colored section
  - Color: axis status (enabled, disabled, or faulted).
  - First icon: axis command source (analog, service, electronic gearing, or fieldbus).
  - Second icon: axis operation mode (torque, velocity, or position).
  - Axis ID: A1 or A2.
- Right Non-colored section:
  - No Fault/Warning: three virtual LEDs corresponding to axis disable sources (Safe Torque Off, Hardware Enable, and Controlled Stop).
  - Faults or warnings: fault or warning code.
- Center blue bar:
  - Drive and axis names
  - IP address
  - Drive model number
  - Firmware version
- Bottom blue bar:
  - indicates whether the service port is connected to WorkBench, and
  - shows the actions that will be invoked by pushing the B1 / B2 buttons.

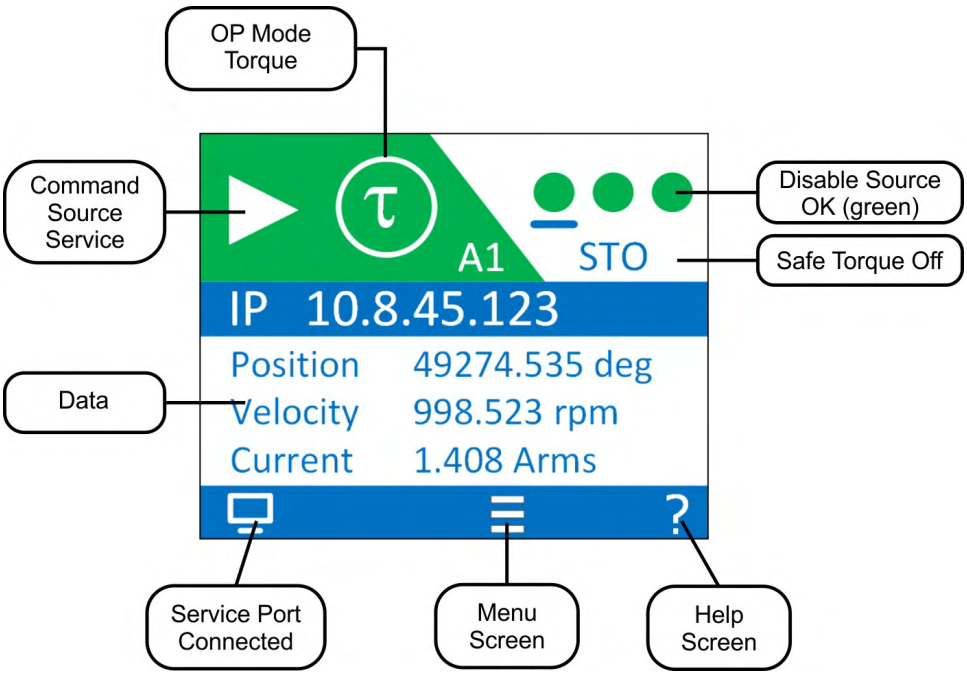
Dual axes LCD display

For dual-axis drives, the top section shows axis 1 information, the bottom section those for axis 2.



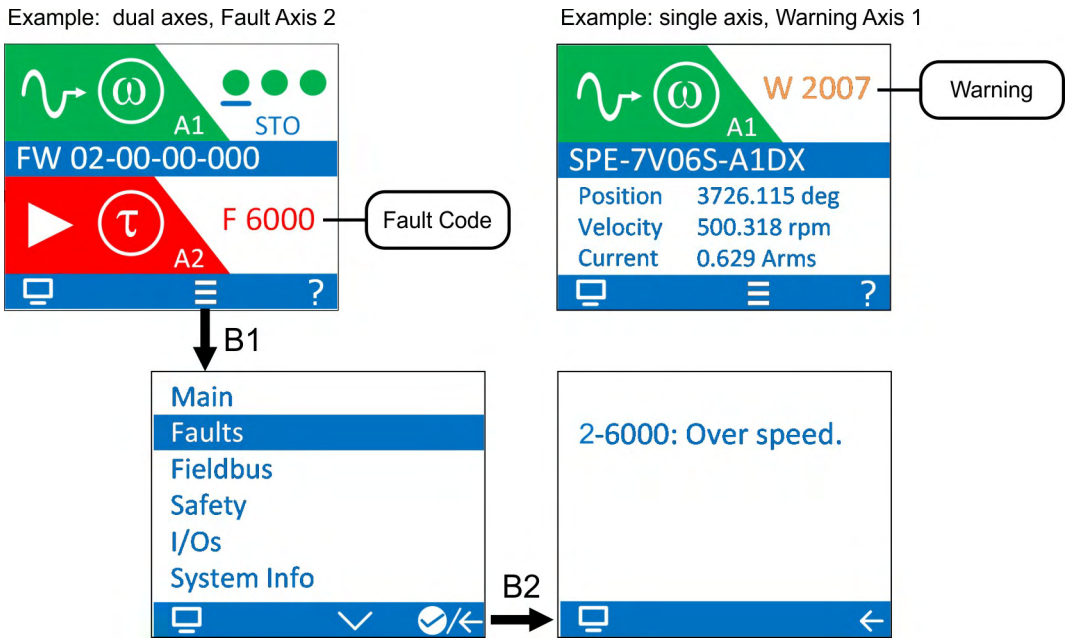
Single axis LCD display

For single axis drives, the top section shows axis 1 information while the section between the center and bottom bars is a data area where some important actual values of the axis are visible: position, velocity, current.



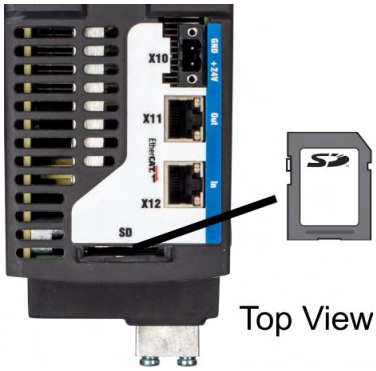
Faults and Warnings

The display shows the code of the fault or warning that occurred. If a fault occurs, the color of the left section switches to red. Navigate with B1 / B2 to the Fault screen to see a short description of the fault or warning.



See WorkBench Onlinehelp for more details.

6.7 SD Card Slot



AKD2G offer a SD card slot for

- to boot the drive with data from the SD Memory card

These features can be started from the drive display using push-buttons B1/B2.

Supported SD card types

SD cards are formatted by the manufacturer. The following table outlines the SD card types and AKD2G support.

SD Type	File System	Capacity	Supported
SD (SDSC)	FAT16	1MB to 2GB	**YES**
SDHC	FAT32	4GB to 32GB	**YES**
SDXC	exFAT (Microsoft)	>32GB to 2TB	**NO**

Features

- **Boot AKD2G with data from SD card:**
  Remove 24V. Apply 24V with both buttons pressed. Release buttons after the display is updated.

6.8 Electrical Motor Braking

6.8.1 Dynamic Braking

Dynamic braking is a method to slow down a servo system by dissipating the mechanical energy driven by the motor back EMF.

NOTE Dynamic braking is not functional safe..

The AKD2G has a built in advanced dynamic braking mode which operates fully in hardware. When activated, the drive shorts the motor terminals. This forces all of the dynamic braking current to be stopping current and insures the fastest stopping per ampere of motor terminal current.

- When current is not being limited, the mechanical energy is being dissipated in the motor resistance.
- When current is being limited, energy is returned to the drive bus capacitors.
- The drive also limits the maximum dynamic braking motor terminal current via the *AXIS#.DBILIMIT* parameter to insure that the drive, motor, and customer load do not see excessive currents/forces.

Whether and how the AKD2G uses dynamic braking depends on (*AXIS#.DISMODE*).

6.8.2 Rheostatic energy dissipation

When the amount of motor back EMF builds the bus capacitor voltage up enough the drive activates the rheostatic regenerative circuit to start dumping the returned energy in the regen resistor (also called regenerative resistor or brake resistor). All AKD2G offer internal resistor plus the ability to connect an external resistor depending on the application requirements.

NOTE External regen resistors are described in the regional *Accessories Manual*.

6.8.2.1 Functional description

1. Individual drives, not coupled through the DC bus link circuit (+DC, -DC)

When the energy fed back from the motor has an average or peak power that exceeds the pre-set level for the brake power rating, the drive generates the warning "W2010 Regen Energy Critical". If the power exceeds the set fault level, the regenerative circuit will switch off.

2. Several drives coupled through the DC bus link (+DC, -DC)

Using the built-in regenerative circuit, several drives of the same series can be operated from a common DC-bus link (➜ # 75), without any additional measures. 90% of the combined power of all the coupled drives is always available for peak and continuous power. If the power of the drive with the lowest switch-off threshold (resulting from tolerances) exceeds the set fault level, the regenerative circuit will switch off.

Switch-off on over voltage: With the regenerative circuit switched off, the DC bus link voltage is not dissipated and therefore the level increases. The drive reports an over-voltage fault if the DC bus threshold is exceeded. The drive power stage is disabled and the load coasts to a stop with the fault message "F2006 Bus Over voltage". The ready to operate contact (terminals X21/B5-B6) is opened (➜ # 110).

NOTE Observe the regeneration time (some minutes) after full load with peak brake power.

6.8.2.2 Technical data for AKD2G-Sxx-6V

Technical data for the regenerative circuit depends on the drive type and the mains voltage. Supply voltages, capacitance, and switch-on voltages are all nominal values.

Brake circuit			AC Supply
AKD2G-Sxx-	Rated data	Units	120V / 240V
6Vxxy all types	Switch-on threshold of regenerative circuit	V	380
	Overvoltage limit	V	420
	Maximum regenerative duty cycle	%	15*

AKD2G-Sxx-	Rated data	Units	120V / 240V
6V03S	Internal regen resistor	Ω	15
	Continuous power, internal resistor	W	tbd
	Peak brake power, internal resistor (0.5s)	kW	tbd
	External regen resistor	Ω	33
	Continuous brake power, external resistor	kW	tbd
	Peak brake power, external (1s)	kW	tbd
	Absorption energy in capacitors (+/- 20%)	Ws	tbd / tbd
	DC Bus Capacitance	µF	tbd
6V06S, 6V03D	Internal regen resistor	Ω	15
	Continuous power, internal resistor	W	tbd
	Peak brake power, internal resistor (0.5s)	kW	tbd
	External regen resistor	Ω	33
	Continuous brake power, external resistor	kW	tbd
	Peak brake power, external resistor (1s)	kW	tbd
	Absorption energy in capacitors (+/- 20%)	Ws	tbd / tbd
	DC Bus Capacitance	µF	tbd
6V12S, 6V06D	Internal regen resistor	Ω	15
	Continuous power, internal resistor	W	tbd
	Peak brake power, internal resistor (0.5s)	kW	tbd
	External regen resistor	Ω	33
	Continuous brake power, external resistor	kW	tbd
	Peak brake power, external resistor (1s)	kW	tbd
	Absorption energy in capacitors (+/- 20%)	Ws	tbd / tbd
	DC Bus Capacitance	µF	tbd

* depends on connected regen resistor power.

6.8.2.3 Technical data for AKD2G-Sxx-7V

Technical data for the regenerative circuit depends on the drive type and the mains voltage. Supply voltages, capacitance, and switch-on voltages are all nominal values.

Brake circuit			AC Supply	
AKD2G-Sxx-	Rated data	Units	240V	400V/480V
7Vxxy all types	Switch-on threshold of regenerative circuit	V	380	760
	Overvoltage limit	V	420	840
	Maximum regenerative duty cycle	%	15*	

AKD2G-Sxx-	Rated data	Units	240V	400V/480V
7V03S	Internal regen resistor	Ω	33	
	Continuous power, internal resistor	W	tbd	
	Peak brake power, internal resistor (0.5s)	kW	tbd	tbd
	External regen resistor	Ω	33	
	Continuous brake power, external resistor	kW	tbd	tbd
	Peak brake power, external (1s)	kW	tbd	tbd
	Absorption energy in capacitors (+/- 20%)	Ws	tbd	tbd / tbd
	DC Bus Capacitance	µF	tbd	
7V06S, 7V03D	Internal regen resistor	Ω	33	
	Continuous power, internal resistor	W	tbd	
	Peak brake power, internal resistor (0.5s)	kW	tbd	tbd
	External regen resistor	Ω	33	
	Continuous brake power, external resistor	kW	tbd	tbd
	Peak brake power, external resistor (1s)	kW	tbd	tbd
	Absorption energy in capacitors (+/- 20%)	Ws	tbd	tbd / tbd
	DC Bus Capacitance	µF	tbd	
7V12S, 7V06D	Internal regen resistor	Ω	33	
	Continuous power, internal resistor	W	tbd	
	Peak brake power, internal resistor (0.5s)	kW	tbd	tbd
	External regen resistor	Ω	33	
	Continuous brake power, external resistor	kW	tbd	tbd
	Peak brake power, external resistor (1s)	kW	tbd	tbd
	Absorption energy in capacitors (+/- 20%)	Ws	tbd	tbd / tbd
	DC Bus Capacitance	µF	tbd	

* depends on connected regen resistor power.

7 Mechanical Installation

7.1 Important Notes

⚠CAUTION High EMC Voltage Level!

Risk of electrical shock, if the servo amplifier (or the motor) is not properly EMC-grounded.

- Do not use painted (i.e. non-conductive) mounting plates.
- In unfavourable circumstances, use copper mesh tape between the earthing bolts and earth potential to deflect currents.

NOTICE Protect the drive from impermissible stresses. In particular, do not let any components become bent or any insulation distances altered during transport and handling. Avoid contact with electronic components and contacts.

NOTICE The drive will switch itself off in case of overheating. Ensure that there is an adequate flow of cool, filtered air into the bottom of the control cabinet, or use a heat exchanger (➜ # 33).

NOTICE Do not mount devices that produce magnetic fields directly beside the drive. Strong magnetic fields can directly affect internal components. Install devices which produce magnetic field with distance to the drives and/or shield the magnetic fields.

7.2 Guide to Mechanical Installation

The following tools are required (at a minimum) to install the AKD2G; your specific installation may require additional tools:

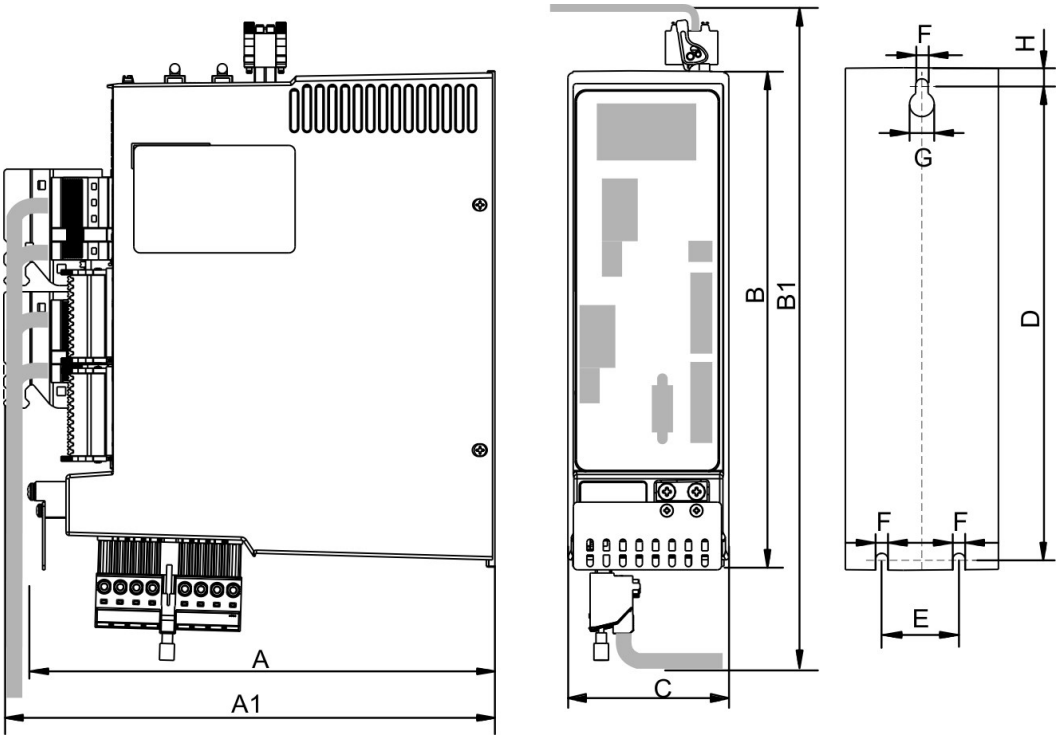
- M5 hexagon socket-cap screws (ISO 4762)
- 4 mm T-handle Allen key
- No. 2 Phillips head screwdriver
- Small slotted screwdriver

Install the drive unit as follows:

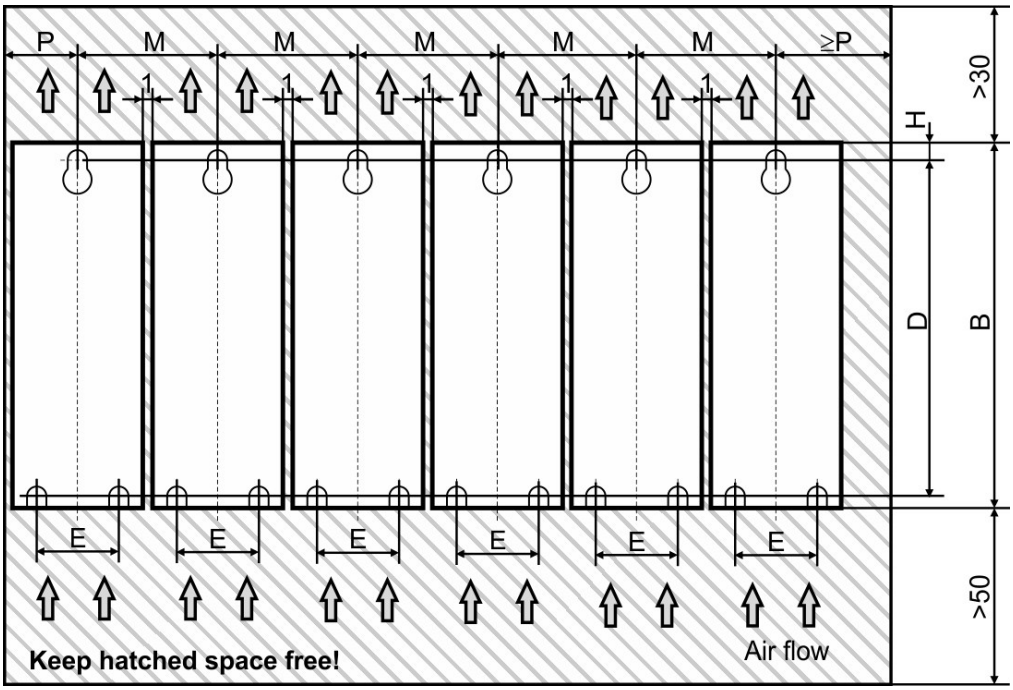
1. Prepare the site.
   Mount the drive in a closed control cabinet (ambient conditions (➜ # 33)). The site must be free from conductive or corrosive materials. For the mounting position in the cabinet (➜ # 47).
2. Check ventilation.
   Check that the ventilation of the drive is unimpeded, and keep within the permitted ambient temperature (ambient conditions (➜ # 33)). Keep the required space clearance above and below the drive (➜ # 47).
3. Check the cooling system.
   If cooling systems are used for the control cabinet, position the cooling system so that condensation water cannot drip onto the drive or peripheral devices.
4. Mount the drive.
   Assemble the drive and power supply near each other on the conductive, grounded mounting plate in the cabinet.
5. Ground the drive.
   For EMC-compliant shielding and grounding, (➜ # 55). Ground the mounting plate, motor housing and CNC-GND of the control system.

7.3 Dimensions

NOTE Mounting material: three M5 hexagon socket screws to ISO 4762, 4 mm T-handle Allen key



NOTE Outline width and height dimensions are measured on footprint level (mounting plate). Dimensions on the front plate are slightly smaller. All dimensions in mm.



Dimensions in mm	A	A1	B	B1	C	D	E	F	G	H	M	P
AKD2G-Sxx-6V (3 to 12 A)	221	232	235	303	76	221,5	36	5,8	11,5	7	78	40
AKD2G-Sxx-7V (3 to 12 A)	221	232	272	340	75	259	36	5,8	11,5	6	77	39

8 Electrical Installation

8.1 Important Notes

NOTICE Only professional staff who are qualified in electrical engineering are allowed to install the drive. Wires with color green with one or more yellow stripes must not be used other than for protective earth (PE) wiring.

DANGER **High Voltage up to 900 V!**

There is a danger of serious personal injury or death by electrical shock or electrical arcing. Capacitors can still have dangerous voltages present up to 5 minutes after switching off the supply power. Control and power connections can still be live, even if the motor is not rotating.

- Only install and wire the equipment when it is not live.
- Make sure that the cabinet is safely disconnected (for instance, with a lock-out and warning signs).
- Never remove electrical connections to the drive while it is live.
- Wait at least 5 minutes after disconnecting the drive from the main supply power before touching potentially live sections of the equipment (e.g. contacts) or undoing any connections.
- To be sure, measure the voltage in the DC bus link and wait until it has fallen below 50 V.

NOTICE Wrong mains voltage, unsuitable motor or wrong wiring will damage the drive. Check the combination of drive and motor. Compare the rated voltage and current of the units. Implement the wiring according to the matching connection diagram, see (➜ # 62) and following. Make sure that the maximum permissible rated voltage at the terminals L1, L2, L3 or +DC, –DC is not exceeded by more than 10% even in the most unfavorable circumstances (see IEC 60204-1).

NOTICE Excessively high external fusing will endanger cables and devices. The fusing of the mains power and logic power must be installed by the user. Hints for use of Residual-current circuit breakers (RCD) (➜ # 17).

NOTICE Since the leakage current to PE is more than 3.5 mA, in compliance with IEC61800-5-1 the PE connection must either be doubled or a connecting cable with a cross-section >10 mm² must be used. Deviating measures according to regional standards might be possible.

NOTICE The drive status shall be monitored by the PLC to acknowledge critical situations. We recommend wiring the ready to operate relay contact in series into the emergency off circuit of the installation. The emergency off circuit must operate the supply contactor.

NOTE It is permissible to use the setup software to alter the settings of the drive. Any other alterations will invalidate the warranty.

8.2 Guide to electrical installation

Kollmorgen recommends to install the drive electrical system as follows:

1. Select cables in accordance with IEC 60204 (➜ # 52).
2. Install shielding and ground the drive.
   For EMC-compliant shielding and grounding, see (➜ # 55).
   Ground the mounting plate, motor housing and CNC-GND of the control system.
3. For functional safety information, see (➜ # 123).
4. Wire the drive and connectors.
   Observe the "Recommendations for EMI noise reduction": (➜ # 55).
   - Wire the "Ready to Operate" contact into the emergency off circuit of the system.
   - Connect the digital control inputs and outputs.
   - Connect up analog ground (also if a fieldbus is used).
   - Connect the analog input source, if required.
   - Connect the motor (hybrid cable or power, brake and feedback cables).
   - Connect shielding at both ends.
   - If required, connect the external regen resistor (with fusing).
   - AKD2G-Sxx-6V: connect EMC filters (shielded lines between filter and drive) for second environment requirements to product category C2.
   - Connect the auxiliary voltage supply
   - Connect the main electrical supply.
     Check maximum permitted voltage value (➜ # 35).
   - Check proper use of residual-current circuit breakers (RCD): (➜ # 17).
   - Connect the PC (➜ # 98) for setting up the drive.
5. Check the wiring against the wiring diagrams:

8.3 Wiring

NOTICE Only professional staff who are qualified in electrical engineering are allowed to install the drive. Wires with color green with one or more yellow stripes must not be used other than for protective earth (PE) wiring. When installing or replacing cables, use only standardized components, which complies to the cable and wire requirements (➜ # 52).

8.3.1 General

DANGER High Voltage up to 900 V!

There is a danger of serious personal injury or death by electrical shock or electrical arcing.

- Only install and wire the equipment when it is not live, that is, when neither the electrical supply nor the 24 V auxiliary voltage nor the supply voltages of any other connected equipment is switched on.
- Make sure that the cabinet is safely disconnected (for instance, with a lock-out and warning signs). The individual voltages are switched on for the first time during setup.

NOTE The chassis ground symbol, which is used in all the wiring diagrams, indicates that you must take care to provide an electrically conductive connection with the largest feasible surface area between the unit indicated and the mounting plate in the control cabinet. This connection is for the effective grounding of HF interference, and must not be confused with the PE-symbol (PE = protective earth, safety measure as per IEC 60204).

8.3.2 Mating connectors

NOTE

- Connectors X1, X2, X21, X22 are spring clamp connectors.
- X3 and X10 are connectors with screw terminals.
- Connectors X22 and X23 are optional.

#	Description	Type	Max. Cross Section	Tightening Torque/Nm
X1/2	Motor, two wire feedback, holding brake	Connector, 4 poles power	10 mm², 8 awg	0.55
		Connector, 4 poles signal	0.5 mm², 21 awg	
X3	Mains power, regen resistor, DC-Bus	Connector, 8 poles, screw terminals	6 mm², 10 awg	0.55
X10	24V power supply	Connector, 2 poles, screw terminals	2.5 mm², 14 awg	0.2 to 0.25
X11/12	Motion Bus	RJ45	0,5 mm², 21 awg	n/a
X13/14	CAN In/Out	RJ11	0,5 mm², 21 awg	n/a
X20	Service Port	RJ45	0,5 mm², 21 awg	n/a
X21	I/O control signals	Connector, 2x11 poles	1.5 mm², 16 awg	n/a
X22	I/O control signals	Connector, 2x10 poles	1.5 mm², 16 awg	n/a
X23	Conventional feedback models	SubD 15pin HD (female)	0,5 mm², 21 awg	0.4

8.3.3 Cable and Wire Requirements

8.3.3.1 Cable material

For information on the chemical, mechanical, and electrical characteristics of the cables please refer to the accessories manual or contact customer support.

NOTE

To reach the maximum permitted cable length, you must use cable material with the following capacitance requirements:

- Motor power cable: less than 150 pF/m (phase core to shield capacitance)
- Motor Feedback cable: less than 120 pF/m (signal core to shield capacitance)
- Hybrid motor cable:
  - less than 120 pF/m (phase core/core capacitance)
  - less than 210 pF/m (phase core/shield capacitance)
  - less than 120 pF/m (signal core/core capacitance)
  - less than 210 pF/m (signal core/shield capacitance)
  - BUS Element: 45 pF/m @ 800kHz & a charact. wave resistance of 110±10Ω @ 10MHz

NOTICE

Cables should not exceed the maximum lengths stated in the tables below. The recommended maximum cable length of motor cables depends on the used cable meterial and the feedback type.

Cable functionality is only guaranteed up to the maximum length when using unmodified Kollmorgen engineered cables.

AKM2G		AKM1G			
Performance Line Cables		Performance Line Cables		Value Line Cables	
Feedback	Max. Length [m]	Feedback	Max. Length [m]	Feedback	Max. Length [m]
SFD3	50	All	25	All	12
DSL	25				
Endat 2.2	25				
Resolver	50				

8.3.3.2 Cable cross sections and requirements

The tables below describe the recommended interface cross sections and cable requirements related to AKD2G in accordance with IEC 60204.
For multi-axes systems, observe the specific operating conditions for your system.

Power Cables		Cross Section EU	Cross Section US	Remarks
Mains supply	1x3 A: 2x3 A: 1x6 A: 2x6 A: 1x12 A: 2x12 A:	1.5 mm² 1.5 mm² 1.5 mm² 2.5 mm² 2.5 mm² 6 mm²	14 awg 14 awg 14 awg 14 awg 14 awg 10 awg	600 V rated ,minimum 75°C
24 V supply	max.	2.5 mm²	14 awg	single core
DC bus link, Regen resistor	3/6 A: 12 A:	1.5 mm² 2.5 mm²	14 awg 14 awg	1000 V rated, min. 75°C, shielded for lengths >0.20 m
I/O cables				
Analog I/Os	min.	0.25 mm²	24 awg	shielded twisted pairs
Digital I/Os		0.5 mm²	20 awg	single core

Motor Power Cable (power) & Motor Combination Cable (power & brake)

Cross Section [mm] Cable	Cross Section [mm] Combi Cable	Current Carrying Capacity	Remarks
(4x1)	(4x1.0+(2x0.75))	0A < I0rms ≤ 10.1A	1000 V Rated, 80°C Current carrying capacity acc. to IEC 60204-1:2006 Table 6, Column B2 The brackets (...) show the shielding.
(4x1.5)	(4x1.5+(2x0.75))	10.1A < I0rms ≤ 13.1A	
(4x2.5)	(4x2.5+(2x1.0))	13.1A < I0rms ≤ 17.4A	
(4x4)	(4x4.0+(2x1.0))	17.4A < I0rms ≤ 23A	
(4x6)	(4x6.0+(2x1.0))	23A < I0rms ≤ 30A	

Motor Feedback Cable

Type	Cross Section [mm]	Remarks
Resolver	(4x2x0.25)	300 V rated, 80°C Shielded twisted pairs The brackets (...) show the shielding.
EnDat 2.1, BiSS B	(6x2x0.25)	
HIPERFACE	(5x2x0.25)	
EnDat 2.2, BiSS C	(5x2x0.25)	
SFD	(3x2x0.25)	
Comcoder	(8x2x0.25)	

Motor Hybrid Cable

Type	Cross Section [mm]	Current Carrying Capacity	Remarks
SFD3/DSL	(4x1.0+(2x0.34)+(2x0.75))	0A < I0rms ≤ 10.1A	1000 V rated, 80°C Current carrying capacity acc. to IEC 60204-1:2006 Table 6, Column B2 4 power lines & 2 brake lines & 2 SFD3/DSL signal lines or 6 EnDat 2.2 signal lines
SFD3/DSL	(4x1.5+(2x0.34)+(2x0.75))	10.1A < I0rms ≤ 13.1A	
SFD3/DSL	(4x2.5+(2x0.34)+(2x1.0))	13.1A < I0rms ≤ 17.4A	
SFD3/DSL	(4x4.0+(2x0.34)+(2x1.0))	17.4A < I0rms ≤ 23A	
SFD3/DSL	(4x6.0+(2x0.34)+(2x1.0))	23A < I0rms ≤ 30A	
Endat 2.2	(4x1.5+(2x0.75)+(2x2x0.14+2x0.25))	10.1A < I0rms ≤ 13.1A	
Endat 2.2	(4x4.0+(2x1.0)+(2x2x0.14+2x0.25))	17.4A < I0rms ≤ 23A	

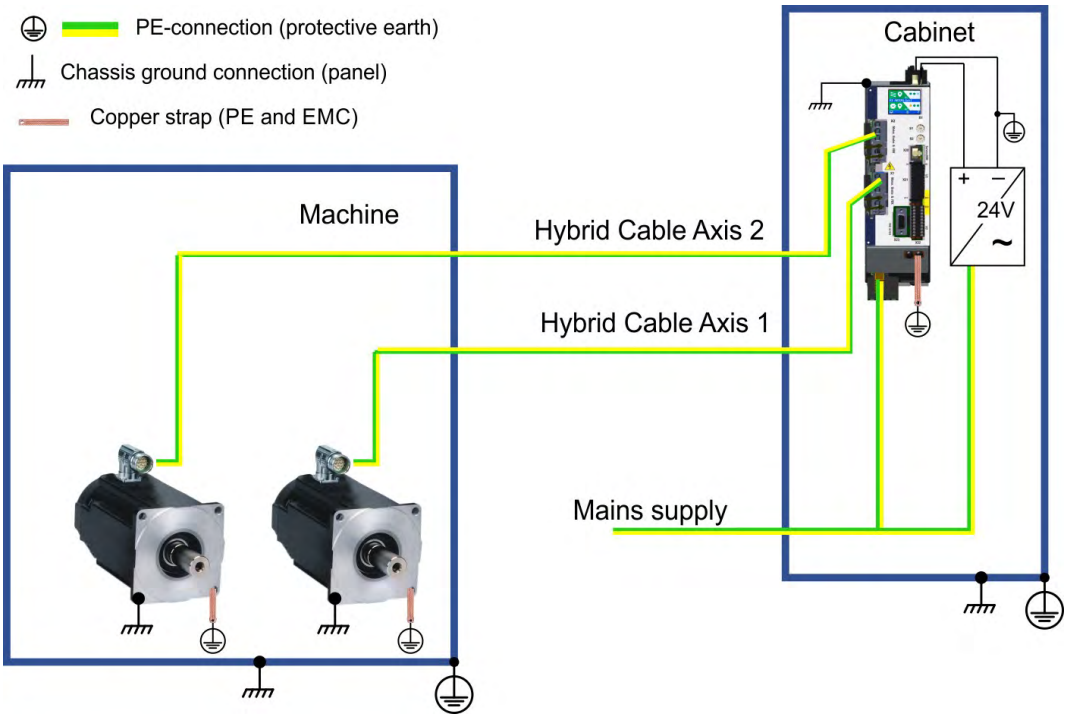
8.3.4 Protective Earth connection

Protective Earth connection of the system components is a safety measure per IEC 60204. Ensure the proper grounding of all components with the PE rail in the control cabinet as reference potential. Connect each ground individually with the intended grounding cable (neutral point connection).

The leakage current from AKD2G against PE is more than 3.5 mA. In accordance with EN 61800-5-1, the PE connection must therefore either be double implemented or a connection cable with >10mm² cross-section used.

In order to keep the impedance as low as possible, we recommend a copper earthing strap for the PE connection on the PE block.

NOTE Wire the PE connections immediately after installing the devices as the first electrical connection. Now you insert all the other lines and connectors. For disassembly, release the PE connections as the last connection.



NOTE For the use of residual current protective devices (RCD), refer to (➜ # 17).

8.4 EMI Noise Reduction

⚠CAUTION Electromagnetic Fields!

Electromagnetic radiation may, by acting on electrically conductive materials, lead to potential hazardous danger (warming, failure of implants).

- Work on the electrical installation may only be performed by trained and qualified personnel, in compliance with the regulations for safety at work, and only with switched off mains supply, and secured against restart.
- Grounding, equipotential bonding and radiation-reducing shields may not be removed.

8.4.1 Recommendations for EMI noise reduction

The following guidelines will help you to reduce problems with electrical noise in your application.

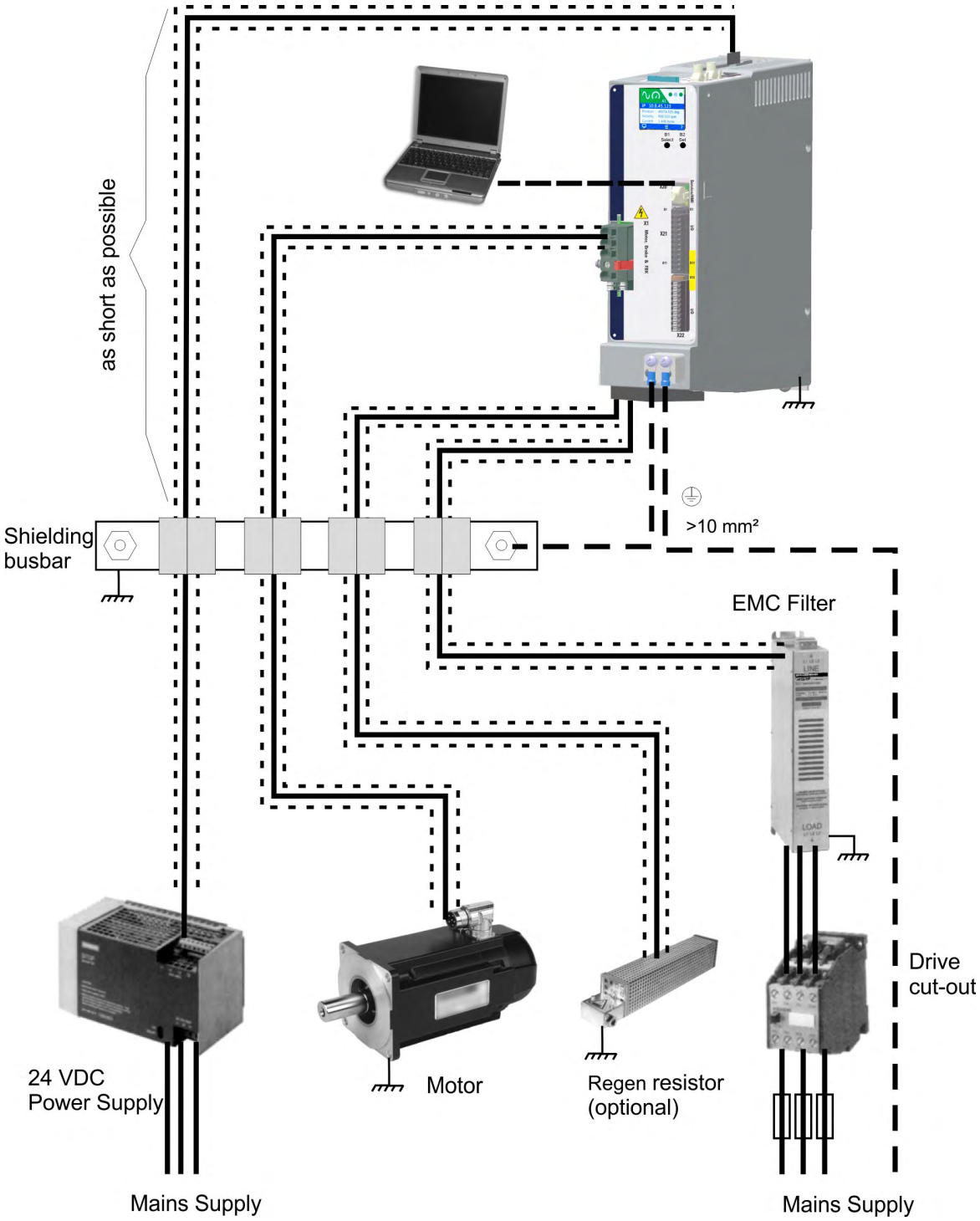
- **Ensure good connections between the cabinet components.** Connect the back panel and cabinet door to the cabinet body using several conductive braids. Never rely on hinges or mounting bolts for ground connections.
- **Ensure good ground connection.** Connect from cabinet to proper earth ground. Ground leads should be the same gauge as the leads to main power, but must cover the regional legal requirements, example (➜ # 54).
- **Use Kollmorgen cables.** Route power and control cables separately, Kollmorgen recommends a distance of at least 200 mm to improve interference immunity.
- **Ground the shielding at both ends.** Ground all shielding with large areas (low impedance), with metalized connector housings or shield connection clamps wherever possible. For cables entering a cabinet, connect shields on all 360° of the cable. Never connect a simple “pigtail.” For more information on shielding concepts, (➜ # 56).
- **With separate mains filter, maintain separation of leads entering and exiting the mains filter (line power filter).** Locate the filter as close as possible to the point where the incoming power enters the cabinet. If it is necessary for input power and motor leads to cross, cross them at 90°.
- **Feedback lines and Hybrid Cables may not be extended, since the shielding would be interrupted and the signal processing may be disturbed.**Install all feedback cables with an adequate cross-section, per IEC 60204 (➜ # 52) and use the requested cable material to reach maximum cable length.
- **Splice cables properly.** If you need to divide cables, use connectors with metal backshells. Ensure that both shells connect along the full 360° of the shields.
- **Use differential inputs for analog signals.** Noise susceptibility in analog signals is greatly reduced by using differential inputs. Use twisted-pair, shielded signal lines, connecting shields on both ends.
- **Cables between drives and filters or external regen resistors must be shielded.** Install all power cables with an adequate cross-section per IEC 60204 (➜ # 52) and use the requested cable material to reach maximum cable length.

8.4.2 Shielding with external shielding busbar

For best practice use of shielded cables Kollmorgen recommends a star point shield connection, for example, with a shielding busbar.

8.4.2.1 Shielding Concept

Example with AKD2G-Sxx--6Vxx, EMC filter and external regen resistor.

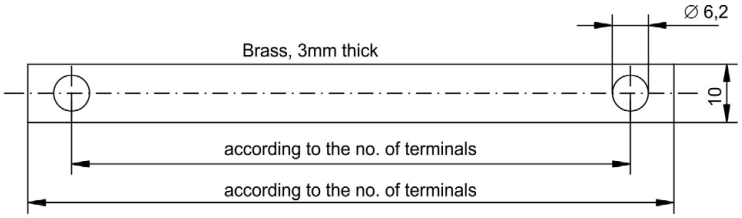


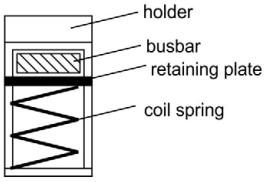
8.4.2.2 Shielding Busbar

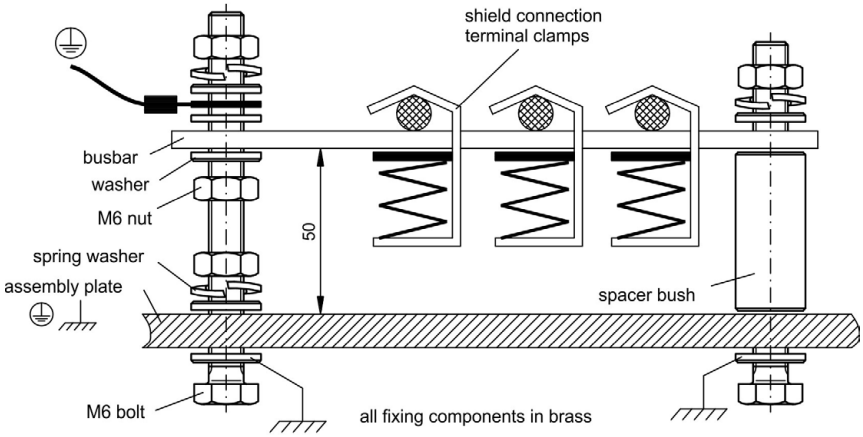
The power cable shields (line in, motor cable, external regen resistor) can be routed to an additional busbar via shield clamps.

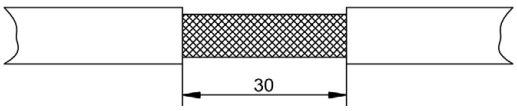
Kollmorgen recommends using Weidmüller KLBÜ shield clamps.

A possible scenario for setting up a busbar for the above shield clamps is described below.









1. Cut a busbar of the required length from a brass rail (cross-section 10 x 3 mm) and drill holes in it as indicated. All shield clamps required must fit between the drill holes.

⚠CAUTION

Risk of injury due to the spring force of the coil spring.
Use pincers.

2. Squeeze together the coil spring and the supporting plate and push the busbar through the opening in the holder.
3. Mount the busbar with the shield clamps fitted on the assembly plate. Use either metal spacer bushes or screws with nuts and accessories to maintain a spacing of 50 mm. Earth the busbar using a single conductor with a cross-section of at least 2.5 mm².
4. Strip the external cable sheath to a length of approx. 30 mm, taking care not to damage the braided shield. Push the shield clamp up and route the cable to it via the busbar.

NOTICE

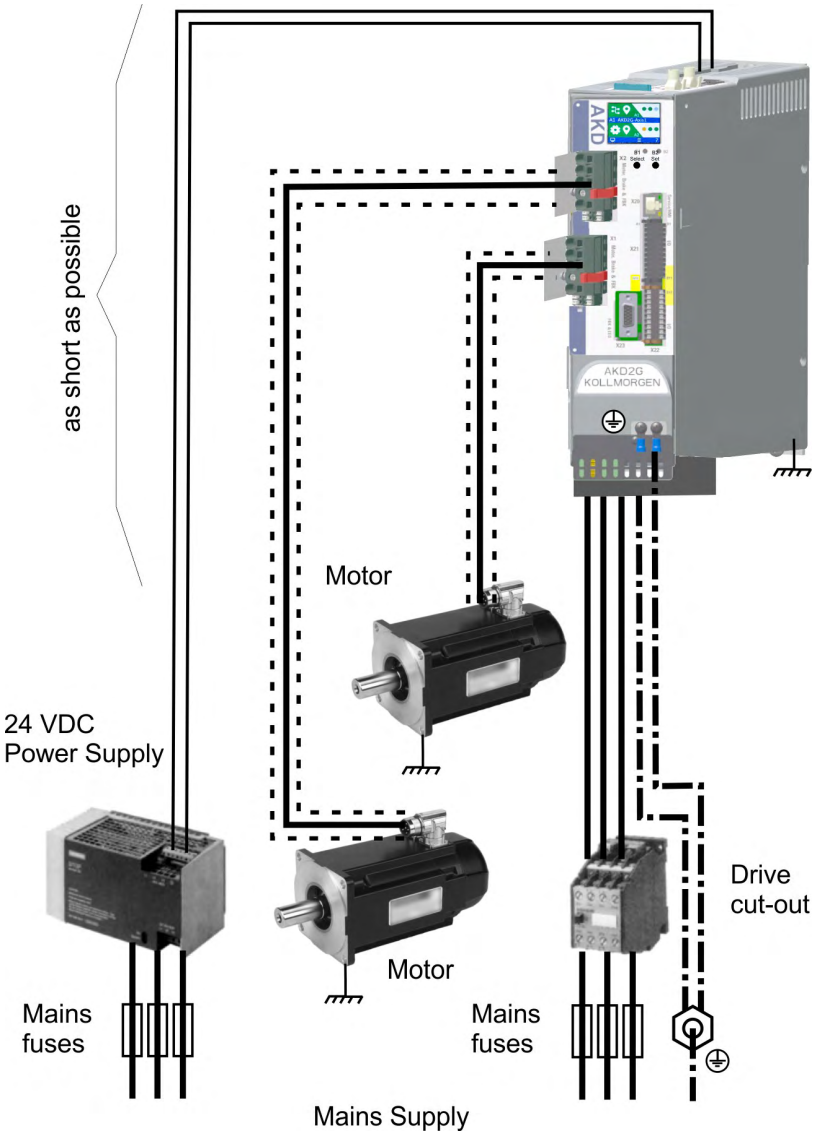
Make sure there is good contact between the shield clamp and the braided shield.

8.4.3 Shielding connection to the drive

You can connect cable shielding directly to the drive by using grounding plates, shield connection clamps, and a motor connector with strain relief and grounding plate.

8.4.3.1 Shielding Concept

Example with AKD2G-Sxx--7Vxx, dual-axis.



8.4.3.2 Grounding plates and shield connection clamps

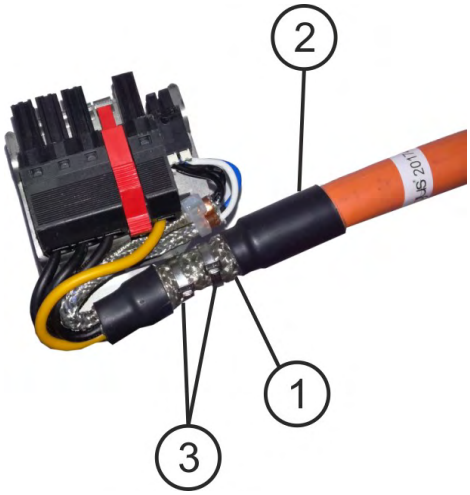
A grounding plate is mounted to the drive.

Use shield connection clamps (see accessories manual). These hook into the grounding plate and ensure optimum contact between the shield and the grounding plate.

Kollmorgen recommends using Phoenix Contact SK14 shield clamps with cable clamp range of 6-13mm.

8.4.3.3 Motor connector X1/X2 with shielding connection

Alternative connection for the motor power connection by mating connector with shield plate and strain relief. Kollmorgen motor power and hybrid motor cables are configured with shield plate.



Strip the external cable sheath to a length of approx. 80 mm, taking care not to damage the braided shield. Push the braided shield (1) back over the cable and secure with a rubber sleeve (2) or shrink sleeve.

Shorten all the wires apart from the protective earth (PE) wire (green/yellow) by about 20 mm so that the PE wire is now the longest wire. Strip all wires and fit wire end ferrules.

Secure the braided shield of the cable with metal cable ties (3) and fasten the cable.

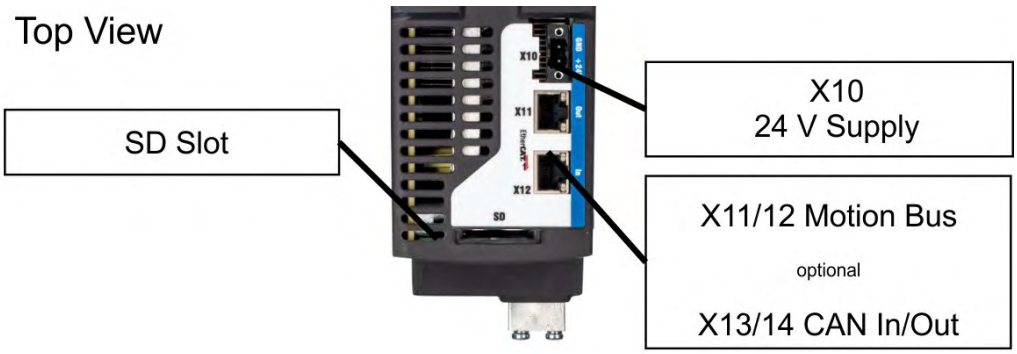
Wire the connector as shown in the connection diagram. Plug in the connector to the socket on the front of the AKD2G and secure it with the red clip.

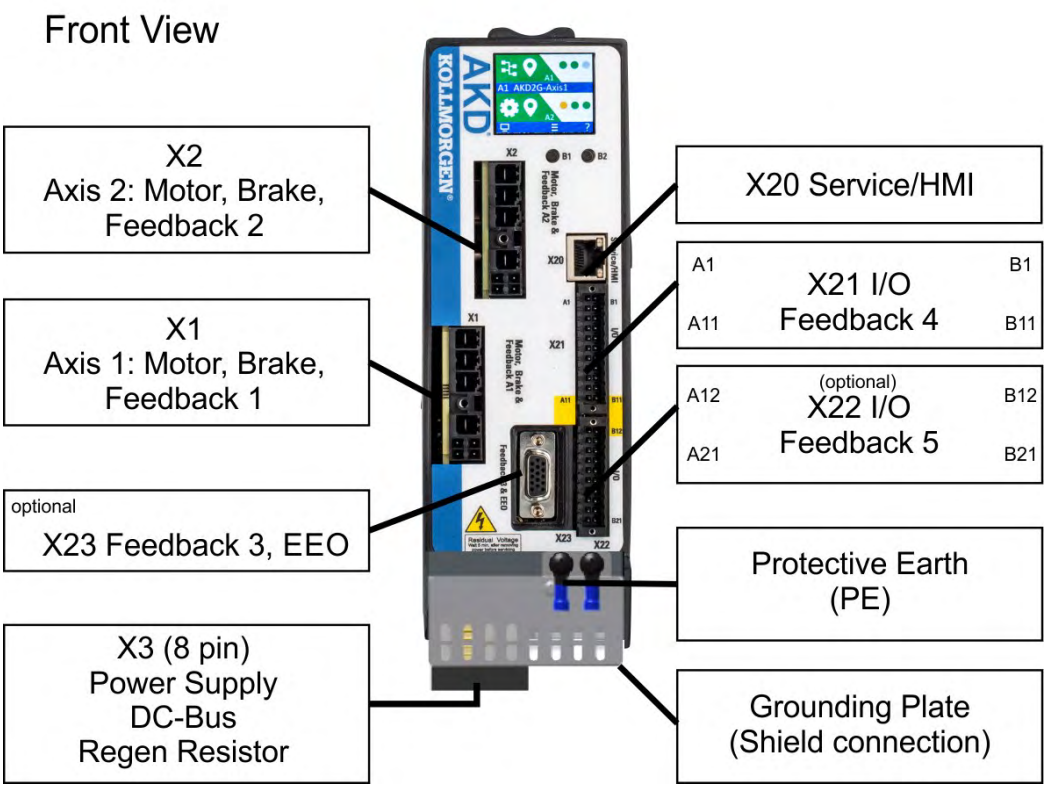
8.5 Connection Overview

8.5.1 Connector Position AKD2G-Sxx-6V

NOTE

The graphics shows an AKD2G with supply voltage 110 V to 240 V.
X2 is available with dual-axis drives only.
Optional: I/O, F3 or DX (➜ # 29).

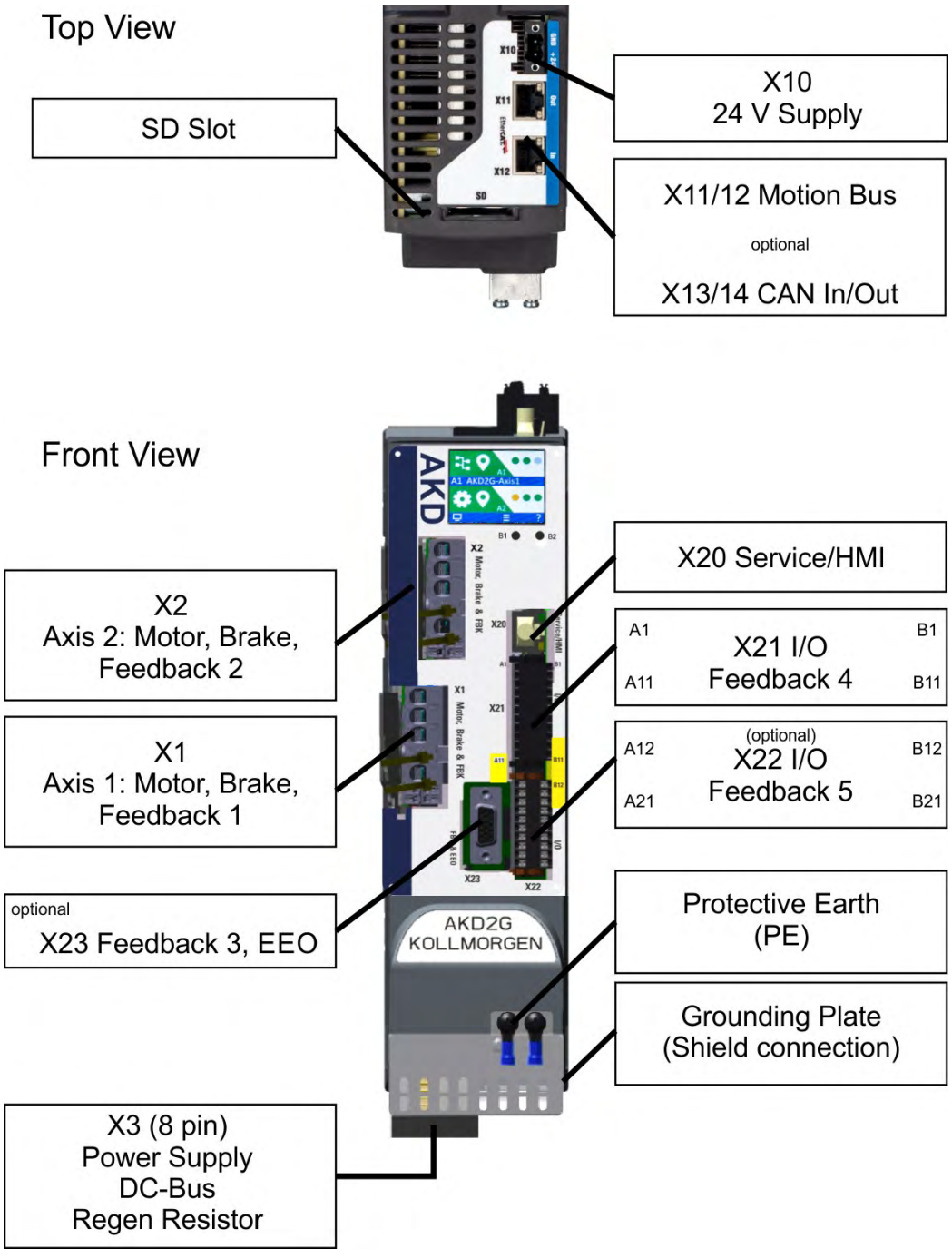




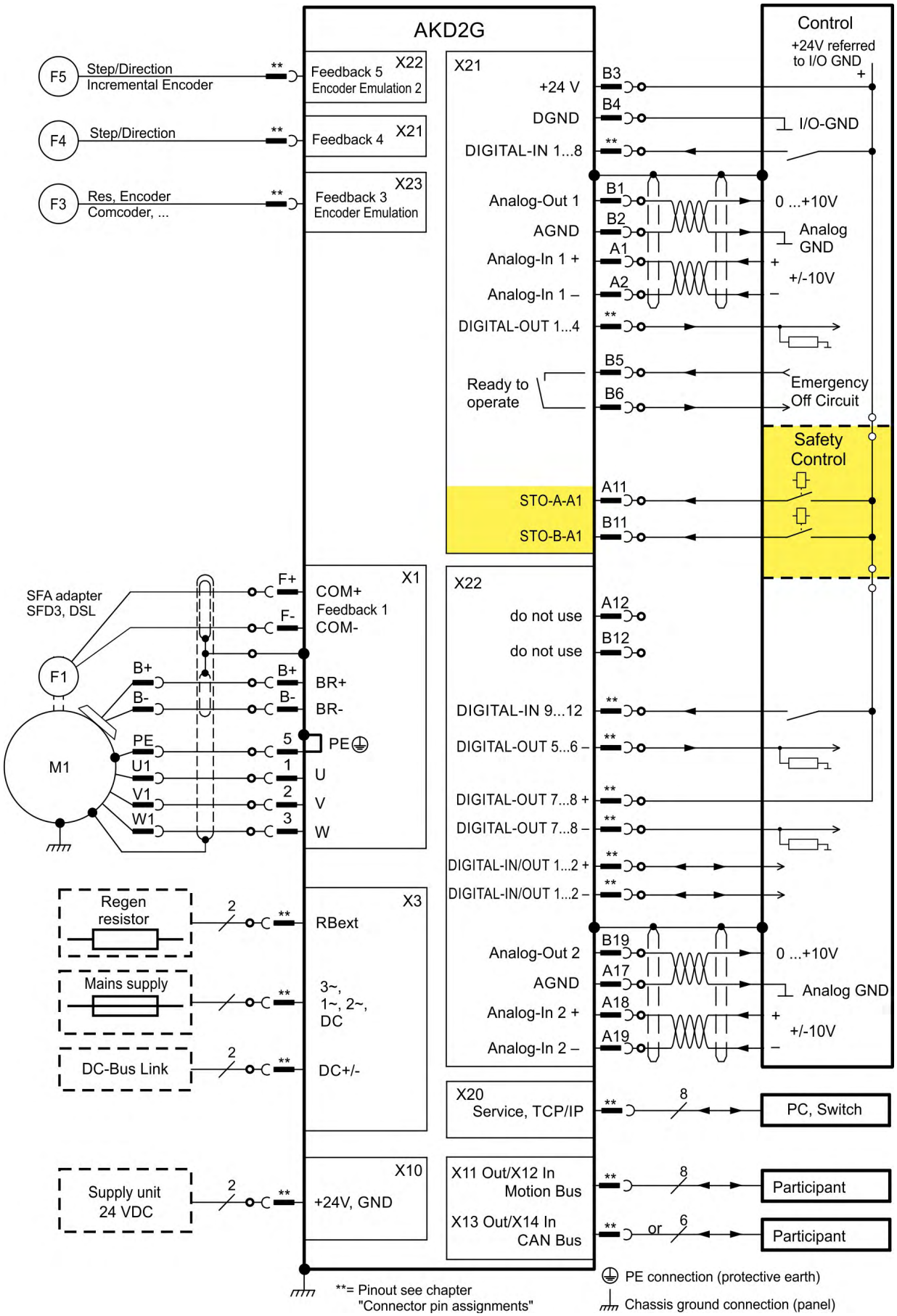
8.5.2 Connector Position AKD2G-Sxx-7V

NOTE

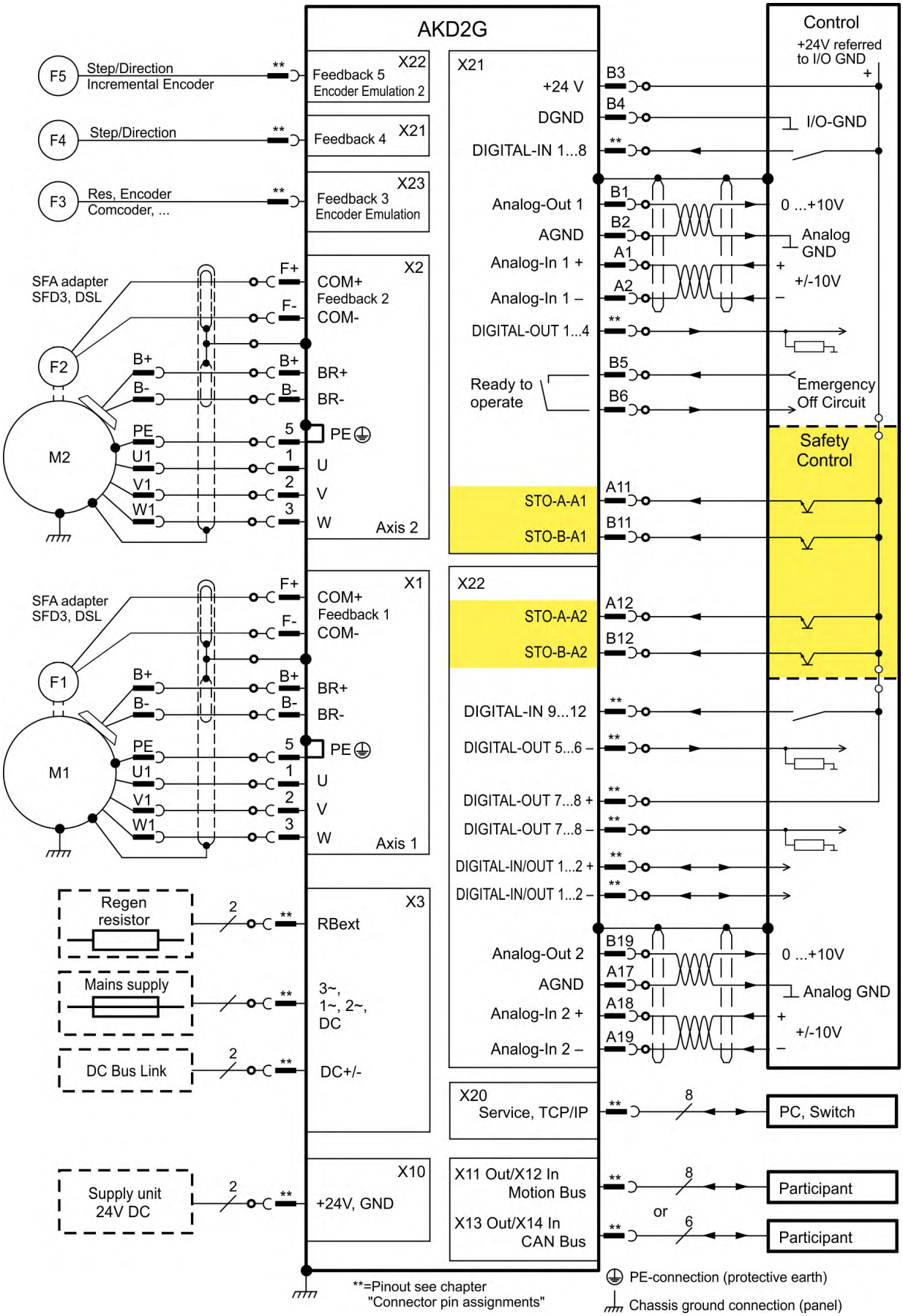
The graphics shows an AKD2G with supply voltage 240 V to 480 V.
X2 is available with dual-axis drives only.
Optional: I/O, F3 or DX (➜ # 29).



8.5.3 Wiring overview, single axis drive

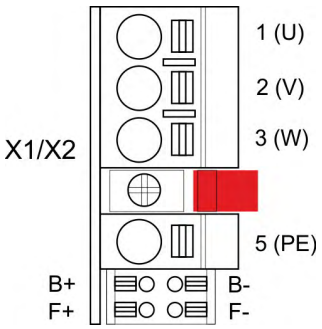


8.5.4 Wiring overview, dual axis drive



8.5.5 Connector pin assignments

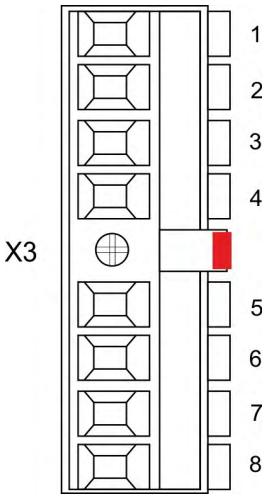
8.5.5.1 X1 and X2: Motor, Brake, Feedback 1



- 4 pin, pitch 7.62 mm plus 2x2 pin pitch 3.81 mm
- Spring clamps
- Motor power, Motor brake
- X1: Input for feedback 1 (➜ # 84)
- X2: Input for feedback 2 (➜ # 84)
- Wiring example:
  - DC Bus link (➜ # 75)
  - Motor single cable connection (➜ # 78)
  - Motor dual cable connection (➜ # 80)

Pin	Signal	Description
1	U	Motor phase U
2	V	Motor phase V
3	W	Motor phase W
	retention latch,shield screw	
5	PE	Protective earth
B+	BR+	Motor holding brake +
B-	BR-	Motor holding brake -
F+	COM+	SFD3 + or HIPERFACE DSL +
F-	COM-	SFD3 - or HIPERFACE DSL -

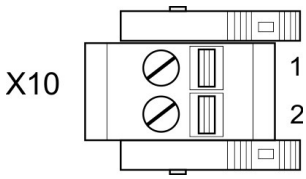
8.5.5.2 X3: Mains, regen resistor, DC-Bus



- 8 pin, pitch 7.62 mm
- Screw terminals
- Optional T version (in process)
- Mains supply, External regen resistor, DC Bus
- Wiring example:
  - Power supply (➜ # 70)
  - DC Bus link (➜ # 75)
  - External regen resistor (➜ # 76)

Pin	Signal	Description
1	PE	Protective earth
2	L1	3~ mains supply L1, 1~ supply L, DC supply +
3	L2	3~ mains supply L2
4	L3	3~ mains supply L3, 1~ supply N, DC supply -
5	RBint	internal regen resistor
6	-RB	external regen resistor -
7	+DC (+RBext)	DC Bus link+ and/or external regen resistor +
8	-DC	DC Bus link -

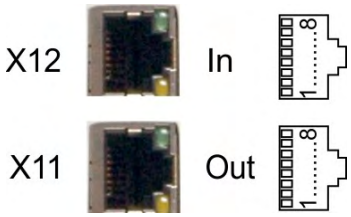
8.5.5.3 X10: 24 VDC



- 2 pin, pitch 5.08 mm
- Screw terminals
- 24 VDC supply voltage
- Wiring example:
  - Logic power supply (➜ # 75)

Pin	Signal	Description
1	+ 24 V	+24 VDC supply voltage, PELV
2	GND	Ground for 24 VDC supply voltage, PELV

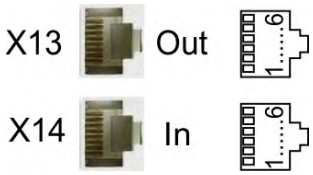
8.5.5.4 X11, X12: Motion Bus



- RJ45 with built-in green and yellow LEDs
- X12 IN port, X11 OUT port
- EtherCAT, EthernetI/P
- Interface Details: (➜ # 94)

Pin	Signal	Description	Pin	Signal	Description
1	Tx+	Transmit +	5	Term.	Termination
2	Tx-	Transmit -	6	Rx-	Receive -
3	Rx+	Receive +	7	Term.	Termination
4	Term.	Termination	8	Term.	Ttermination

8.5.5.5 X13, X14: CAN bus (optional)



- RJ-11
- X14 IN port, X13 OUT port
- Up to 1 Mbit operation
- Node ID to be set by WorkBench
- Interface Details: (➜ # 95)

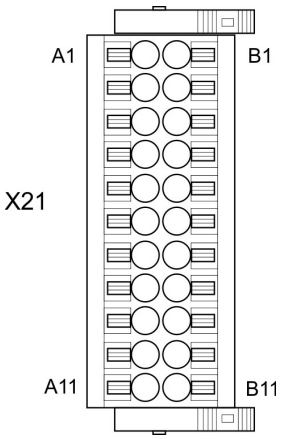
Pin	Signal	Description	Pin	Signal	Description
1	n.c.	not used	4	CAN_low	CAN bus low signal
2	Shield	Chassis	5	CAN_GND	CAN bus ground
3	CAN_high	CAN bus high signal	6	n.c.	not used

8.5.5.6 X20: Service

- RJ45 with built-in green and yellow LEDs
- 100/10 Mbit Ethernet TCP/IP
- Supports auto-IP, DHCP and fixed IP addressing
- Supports point-to-point (i.e. Auto-IP) and connection via network switches
- Supports automatic discovery in WorkBench if in the same sub-net.
- Interface Details: (➜ # 98)

Pin	Signal	Description	Pin	Signal	Description
1	Tx+	Transmit +	5	Term.	Termination
2	Tx-	Transmit -	6	Rx-	Receive -
3	Rx+	Receive +	7	Term.	Termination
4	Term.	Termination	8	Term.	Termination

8.5.5.7 X21: I/O, Feedback 4



- 2 x 11 pins (left column A, right column B), pitch 3.5 mm
- Spring clamps
- Analog and digital I/O
- Input for feedback 4 (➜ # 84)
- Wiring examples:
  - Analog input (➜ # 101)
  - Analog output (➜ # 102)
  - Digital input (➜ # 103)
  - Digital Output (➜ # 107)
  - Feedback (➜ # 86)

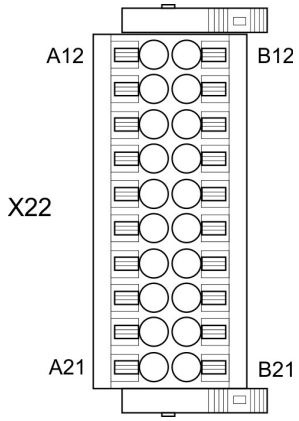
Digital I/O connectivity

Pin	Signal	Description
A1	Analog-In (AIN) 1 +	Analog Input +/- 10 V
A2	Analog-In (AIN) 1 -	
A3*	Digital-In (DIN) 1	Fast, isolated, sink, type EN 61131-2 type 1
A4*	Digital-In (DIN) 2	Fast, isolated, sink, type EN 61131-2 type 1
A5	Digital-In (DIN) 3	Slow, isolated, sink, type EN 61131-2 type 1
A6	Digital-In (DIN) 4	Slow, isolated, sink, type EN 61131-2 type 1
A7	Digital-In (DIN) 5	Slow, isolated, sink, type EN 61131-2 type 1
A8	Digital-In (DIN) 6	Slow, isolated, sink, type EN 61131-2 type 1
A9	Digital-In (DIN) 7	Slow, isolated, sink, type EN 61131-2 type 1
A10	Digital-In (DIN) 8	Slow, isolated, sink, type EN 61131-2 type 1
A11	STO-A-A1	Slow, isolated, sink, fail-safe, STO axis 1 channel A
B1	Analog-Out (AOUT) 1	Analog Output, 0 to +10 V
B2	AGND	Ground for analog I/O
B3	+24 V	+24 VDC for digital I/O and STO
B4	DGND	Ground for digital I/O and STO
B5	Digital-Out (DOUT) 9 +	Relay contact, normally open, 24 VDC, 1A
B6	Digital-Out (DOUT) 9 -	Relay contact, normally open, 24 VDC, 1A
B7	Digital-Out (DOUT) 1	Isolated, high-side, 100 mA
B8	Digital-Out (DOUT) 2	Isolated, high-side, 100 mA
B9	Digital-Out (DOUT) 3	Isolated,high-side, 100 mA
B10	Digital-Out (DOUT) 4	Isolated, high-side, 100 mA
B11	STO-B-A1	Slow, isolated, sink, fail-safe, STO axis 1 channel B

***Feedback 4 connectivity, Step/Direction CW/CCW (input)**

Pin	Signal	Description
A3	Step, CW	Fast, isolated, sink, type EN 61131-2 type 1
A4	Direction, CCW	Fast, isolated, sink, type EN 61131-2 type 1

8.5.5.8 X22: I/O extended, EEO2, Feedback 5



- 2 x 10 pins (left column A, right column B), pitch 3.5 mm
- Spring clamps
- Analog and digital I/O
- Input for feedback 5 (➜ # 84)
- Output for incremental encoder emulation (EEO2)
- Wiring examples:
  - Analog input (➜ # 101)
  - Analog output (➜ # 102)
  - Digital input (➜ # 103)
  - Digital output (➜ # 107)
  - Feedback (➜ # 87)
  - Encoder emulation (EEO2) (➜ # 91)
  - Master-Slave (➜ # 93)

Digital I/O connectivity

Pin	Signal	Description
A12	STO-A-A2	Slow, isolated, sink, fail-safe, STO axis 2 channel A
A13	Digital-In (DIN) 9	Slow, isolated, sink, type EN 61131-2 type 1
A14	Digital-In (DIN) 10	Slow, isolated, sink, type EN 61131-2 type 1
A15	Digital-In (DIN) 11	Slow, isolated, sink, type EN 61131-2 type 1
A16	Digital-In (DIN) 12	Slow, isolated, sink, type EN 61131-2 type 1
A17	AGND	Ground for analog I/O
A18	Analog-In (AIN) 2+	Analog Input, +/- 10 V
A19	Analog-In (AIN) 2-	
A20*	Digital-In/Out (DIO) 1 +	RS485 input or output
A21*	Digital-In/Out (DIO) 1 -	RS485 input or output
B12	STO-B-A2	Slow, isolated, sink, fail-safe, STO axis 2 channel B
B13	Digital-Out (DOUT) 5	Isolated, high-side, 100 mA
B14	Digital-Out (DOUT) 6	Isolated, high-side, 100 mA
B15	Digital-Out (DOUT) 7 +	Fast, isolated, sink or source, 100 mA
B16	Digital-Out (DOUT) 7 -	
B17	Digital-Out (DOUT) 8 +	Fast, isolated, sink or source, 100 mA
B18	Digital-Out (DOUT) 8 -	
B19	Analog-Out (AOUT) 2	Analog Output, 0 to +10 V
B20*	Digital-In/Out (DIO) 2 +	RS485 input or output
B21*	Digital-In/Out (DIO) 2 -	RS485 input or output

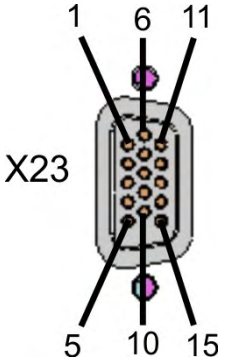
***Feedback 5 connectivity (input)**

Pin	Incremental Encoder	Step/Dir	CW/CCW
A20	Track A +	Step +	CW +
A21	Track A -	Step -	CW -
B20	Track B +	Dir +	CCW +
B21	Track B -	Dir -	CCW -

***EEO2 connectivity (output)**

Pin	Incremental Encoder
A20	A+
A21	A -
B20	B+
B21	B -

8.5.5.9 X23: Feedback 3, EEO1, I/O



- Sub-D high density 15 pin, female
- Input for feedback 3 (➜ # 84)
- Output for incremental encoder emulation (EEO1)
- Additional Digital-In/Out
- Wiring examples:
  - Feedback (➜ # 88)
  - Encoder emulation (EEO1) (➜ # 92)
  - Master-Slave (➜ # 93)
  - Digital input (➜ # 103)
  - Digital output (➜ # 107)

Feedback 3 connectivity (input)

Pin	SFD	Resolver	BiSS B	BiSS C	EnDAT 2.1	EnDAT 2.2	Hiper-face	Sine/ Cos	Sine/ Cos +Hall	Incr. Enc.	Incr. Enc. +Hall	Hall	Smart Abs	Step/ Dir	CW/ CCW
1	-	-	-	-	-	-	-	-	Hall U	-	Hall U	Hall U	-	-	-
2	-	-	CLK+	CLK+	CLK+	CLK+	-	-	Hall V	-	Hall V	Hall V	-	Stp+	CW+
3	-	-	CLK-	CLK-	CLK-	CLK-	-	-	Hall W	-	Hall W	Hall W	-	Stp-	CW-
4	SEN+	-	SEN+	SEN+	SEN+	SEN+	▌	SEN+	SEN+	SEN+	SEN+	-	SEN+	-	-
5	SEN-	-	SEN-	SEN-	SEN-	SEN-		SEN-	SEN-	SEN-	SEN-	-	SEN-	-	-
6	COM+	R1 Ref+	DAT+	DAT+	DAT+	DAT+	DAT+	Zero+	Zero+	Zero+	Zero+	-	SD+	Dir+	CCW+
7	COM-	R2 Ref-	DAT-	DAT-	DAT-	DAT-	DAT-	Zero-	Zero-	Zero-	Zero-	-	SD-	Dir-	CCW-
8	-	Thermal control (+)													
9	-	Thermal control (-)													
10	+5 V	-	+5 V	+5 V	+5 V	+5 V	8 to 9 V	+5 V	+5 V	+5 V	+5 V	+5 V	+5 V	+5 V	+5 V
11	0 V	-	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V
12	-	S1 SIN+	A+	-	A+	-	SIN+	A+	A+	A+	A+	-	-	-	-
13	-	S3 SIN-	A-	-	A-	-	SIN-	A-	A-	A-	A-	-	-	-	-
14	-	S2 COS+	B+	-	B+	-	COS+	B+	B+	B+	B+	-	-	-	-
15	-	S4 COS-	B-	-	B-	-	COS-	B-	B-	B-	B-	-	-	-	-

CLK = CLOCK, DAT = DATA, SEN = SENSE, Stp = Step

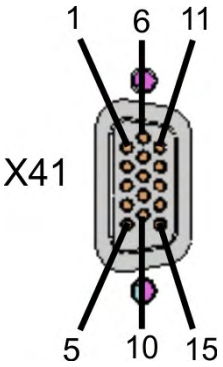
EEO1 connectivity (output)

Pin	Incremental Encoder
6	Zero+
7	Zero-
11	0 V
12	A +
13	A-
14	B+
15	B-

Digital I/O connectivity

Pin	Digital I/0
2	Digital-In/Out 6 +
3	Digital-In/Out 6 -
6	Digital-In/Out 5 +
7	Digital-In/Out 5 -
10	+5 V
11	0 V
12	Digital-In/Out 3 +
13	Digital-In/Out 3 -
14	Digital-In/Out 4 +
15	Digital-In/Out 4 -

8.5.5.10 X41: SFA Feedback converter, EEO3/EEO4 (accessory)



- Sub-D high density 15 pin, female
- 0.5 m cable, 3 flying leads for connection to X1, X2
- When connected to X1: Input for feedback 1 (➜ # 84)
- When connected to X2: Input for feedback 2 (➜ # 84)
- Output for incremental encoder emulation (EEO3 / EEO4) (➜ # 92)
- SFA Adapter converts conventional feedback signals to 2 wire feedback format
- Wiring examples:
  - Feedback and Encoder emulation (➜ # 89)
  - Master-Slave (➜ # 93)

Feedback 1/2 connectivity (input)

X41 Pin	SFD	Resol-ver	BiSS B	EnDAT 2.1	EnDAT 2.2	Hiper-face	Sine/ Cos	Sine/ Cos +Hall	Incr. Enc.	Incr. Enc. +Hall	Hall	Smart Abs	Step/ Dir	CW/ CCW
1	-	-	-	-	-	-	-	Hall U	-	Hall U	Hall U	-	-	-
2	-	-	CLK+	CLK+	CLK+	-	-	Hall V	-	Hall V	Hall V	-	Stp+	CW+
3	-	-	CLK-	CLK-	CLK-	-	-	Hall W	-	Hall W	Hall W	-	Stp-	CW-
4	SEN+	-	SEN+	SEN+	SEN+		SEN+	SEN+	SEN+	SEN+	-	SEN+	-	-
5	SEN-	-	SEN-	SEN-	SEN-		SEN-	SEN-	SEN-	SEN-	-	SEN-	-	-
6	COM+	R1 Ref+	DAT+	DAT+	DAT+	DAT+	Zero+	Zero+	Zero+	Zero+	-	SD+	Dir+	CCW+
7	COM-	R2 Ref-	DAT-	DAT-	DAT-	DAT-	Zero-	Zero-	Zero-	Zero-	-	SD-	Dir-	CCW-
8	-	Thermal control (+)												
9	-	Thermal control (-)												
10	+5 V	-	+5 V	+5 V	+5 V	8 to 9 V	+5 V	+5 V	+5 V	+5 V	+5 V	+5 V	+5 V	+5 V
11	0 V	-	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V
12	-	S1 SIN+	A+	A+	-	SIN+	A+	A+	A+	A+	-	-	-	-
13	-	S3 SIN-	A-	A-	-	SIN-	A-	A-	A-	A-	-	-	-	-
14	-	S2 COS+	B+	B+	-	COS+	B+	B+	B+	B+	-	-	-	-
15	-	S4 COS-	B-	B-	-	COS-	B-	B-	B-	B-	-	-	-	-

CLK = CLOCK, DAT = DATA, SEN = SENSE, Stp = Step

EEO3 / EEO4 connectivity (output)

X41 Pin	Incremental Encoder
6	Zero+
7	Zero-
11	0 V
12	A +
13	A-
14	B+
15	B-

8.6 Power and Logic Voltage Supply (X3/X10)

8.6.1 Mains power supply (X3)

Drives in the AKD2G series can be supplied as follows:

AKD2G-Sxx-6V

- 1, 2 or 3 phase industrial AC supply networks: 120 V or 240 V.
- DC supply networks: on request.

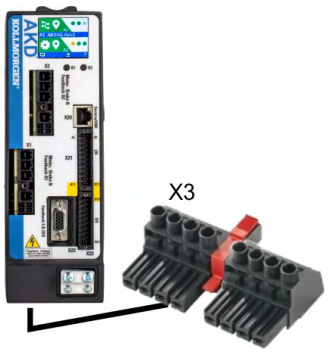
AKD2G-Sxx-7V

- 3 phase industrial AC supply networks: 240 V, 400 V or 480 V.
- DC supply networks: on request.

Connection to other voltage types of AC supply networks is possible with an additional isolating transformer.

Periodic overvoltages between phases (L1, L2, L3) and the housing of the drive must not exceed 1000 V peak.

In accordance with IEC 61800, voltage spikes (< 50 µs) between phases must not exceed 1000 V. Voltage spikes (< 50 µs) between a phase and the housing must not exceed 2000 V.



- 8 pin, pitch 7.62 mm
- optional T version
- Wiring example:
  - 1 phase AC supply (➜ # 73)
  - 2 phase AC supply (➜ # 73)
  - 3 phase AC supply (➜ # 74)
  - DC supply (➜ # 74)
- AKD2G-Sxx-6V requires external EMC filter for use in industrial environment, product category C.
- Mating connector data see (➜ # 51).

Pin	Signal	Description
1	PE	Protective earth
2	L1	3~ mains supply L1, 1~ supply L, DC supply +
3	L2	3~ mains supply L2
4	L3	3~ mains supply L3, 1~ supply N, DC supply -

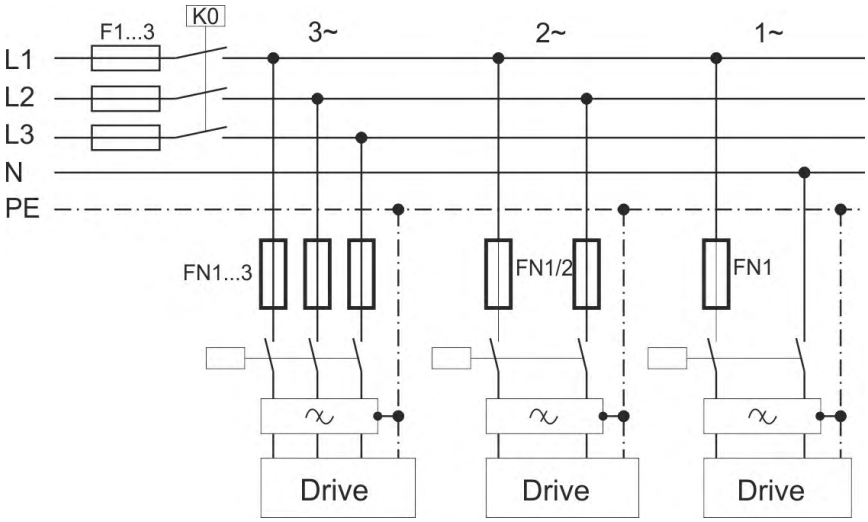
8.6.1.1 Fusing

Fuse types

- UL fuses: Class J, 600 VAC 200 kA (SCCR rating), time-delay. The fuse must be UL and CSA listed, UL recognized is not sufficient. Alternate fuses and breakers to Class J must have similar or better Ip and I^2T performance per UL 508A SB4.2 at the necessary SCCR rating.
- CE fuses: types gS or gG, 400 V/500 V, time-delay
- Fuse holders: Combined with the standard fuse blocks, finger safe fuse holders must be used according to IEC 60529.
- Automatic circuit breakers: in process, ask Kollmorgen for details.
- Group installation: in process, ask Kollmorgen for details.

Fuse Ampere ratings below are the maximum allowable. Lower Ampere ratings may be used as appropriate to the application but may cause nuisance trips.

AC supply, single drives, line fusing



- F1, F2, F3: depends on sum current and cabinet requirements.
- Filters for special EMC requirements only (➜ # 141).
- FN1, FN2, FN3 recommended rating see table below

Drive Model	FN1, FN2, FN3: max. Ampere rating	Example class J Cooper Bussmann	Example class J Ferraz Shawmut
AKD2G-Sxx-6V03S	15 A (Time-Delay)	LPJ15SP/DFJ15	AJT10/HSJ15
AKD2G-Sxx-6V06S AKD2G-Sxx-6V03D	15 A (Time-Delay)	LPJ15SP/DFJ15	AJT15/HSJ15
AKD2G-Sxx-6V12S AKD2G-Sxx-6V06D	15 A (Time-Delay)	LPJ15SP/DFJ15	AJT15/HSJ15
AKD2G-Sxx-7V03S	15 A (Time-Delay)	LPJ15SP/DFJ15	AJT15/HSJ15
AKD2G-Sxx-7V06S AKD2G-Sxx-7V03D	15 A (Time-Delay)	LPJ15SP/DFJ15	AJT15/HSJ15
AKD2G-Sxx-7V12S AKD2G-Sxx-7V06D	15 A (Time-Delay)	LPJ15SP/DFJ15	AJT15/HSJ15

AC supply, group of drives, line fusing

Ask Kollmorgen for details.

AC supply, single drives, automatic circuit breakers

Ask Kollmorgen for details.

AC supply, group of drives, automatic circuit brakers

Ask Kollmorgen for details.

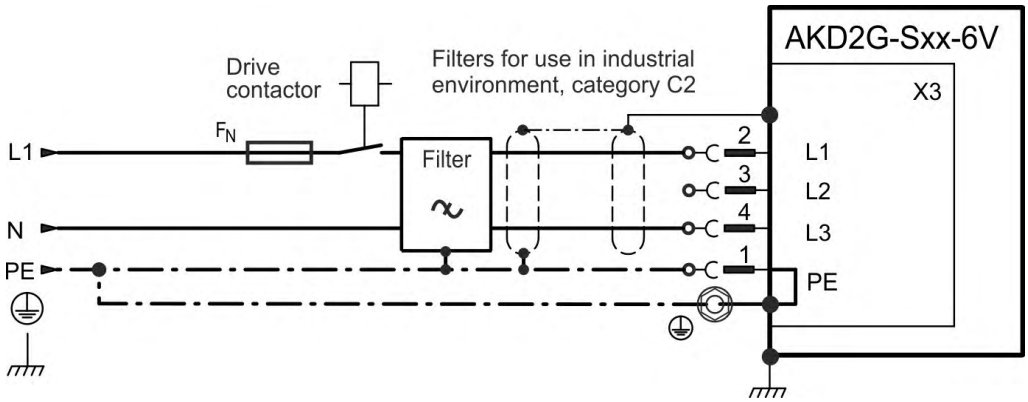
DC supply, single drives, line fusing

Ask Kollmorgen for details.

8.6.1.2 Wiring examples mains power supply

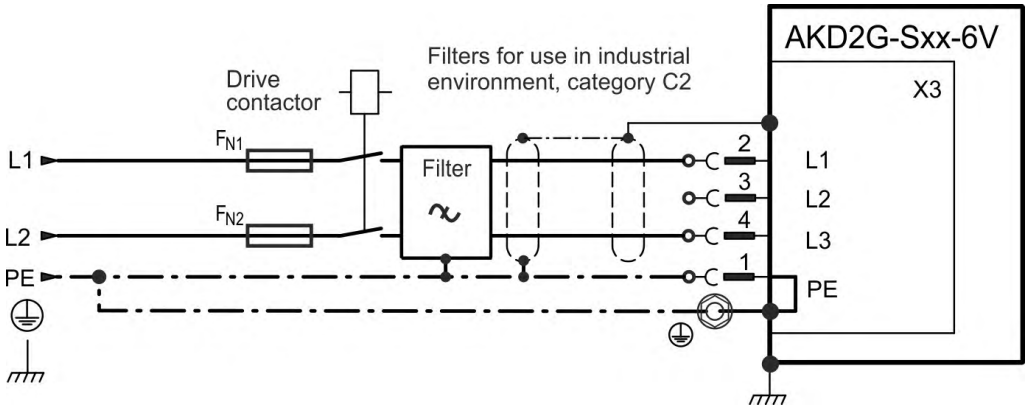
One phase AC mains (AKD2G-Sxx-6V)

- Directly to one phase supply network (120 $V_{-10\%}$ to 240 $V^{+10\%}$) with neutral line
- Deactivate phase loss detection.
- Filtering to be provided by the user.



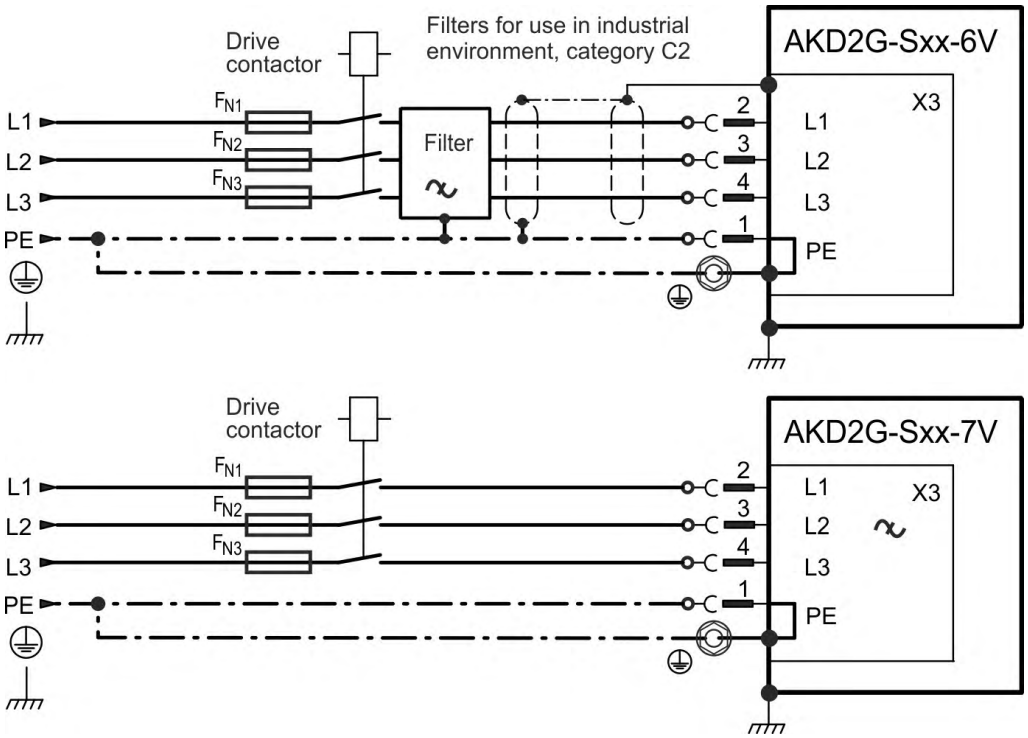
Two phases AC mains (AKD2G-Sxx-6V)

- Directly to two-phase supply network (120 $V_{-10\%}$ to 240 $V^{+10\%}$) without neutral line
- Deactivate phase loss detection.
- Filtering to be provided by the user.



Three phases AC mains (all AKD2G-Sxx-)

- Directly to 3-phase supply network (max. 240 $V^{+10\%}$ respectively 480 $V^{+10\%}$)
- Filtering for AKD2G-Sxx-6V to be provided by the user.



DC Supply (all AKD2G-Sxx-)

Ask Kollmorgen for details.

8.6.2 Auxiliary voltage power supply 24 VDC (X10)

The following diagram describes external 24 VDC power supply (PELV). The required supply current rating depends on the use of motor brake (➜ # 35) or (➜ # 37).

- 2 pin, pitch 5.08 mm
- Mating connector data see (➜ # 51).
- Undervoltage fault limit 19 V
- Overvoltage fault limit 30 V

Pin	Signal	Description
1	+ 24 V	+24 VDC supply voltage, PELV
2	GND	Ground for 24 VDC supply voltage, PELV

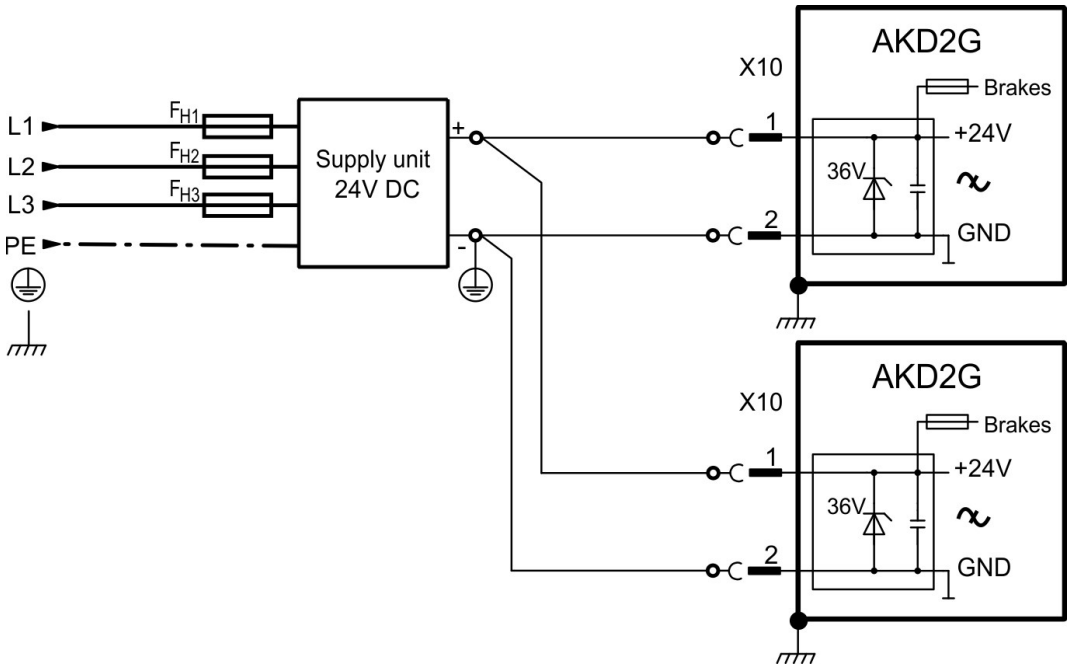
8.6.2.1 Fusing

Use 24 VDC supply manufacturers recommendation for fusing.

24 V supply (PELV)	Units	Input data single axis	Input data dual axis
Aux. voltage supply (PELV)	VDC	24 V (±10%, check voltage drop)	
- control current without motor brake	A	1	1.25
- control current with one motor brake	A	3.5	3.75

8.6.2.2 Wiring example 24 VDC supply

Example for three phase power supply unit.



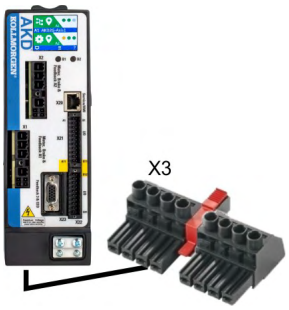
8.7 DC Bus link (X3)

NOTICE Beta Drives: DC Bus sharing functionality is pending. Do not use this functionality until further notice.

8.8 External Regen resistor (X3)

For technical data on the rheostatic brake circuit (➜ # 42).

NOTE Fusing (such as fusible cut-outs or power switches) to be provided by the user.



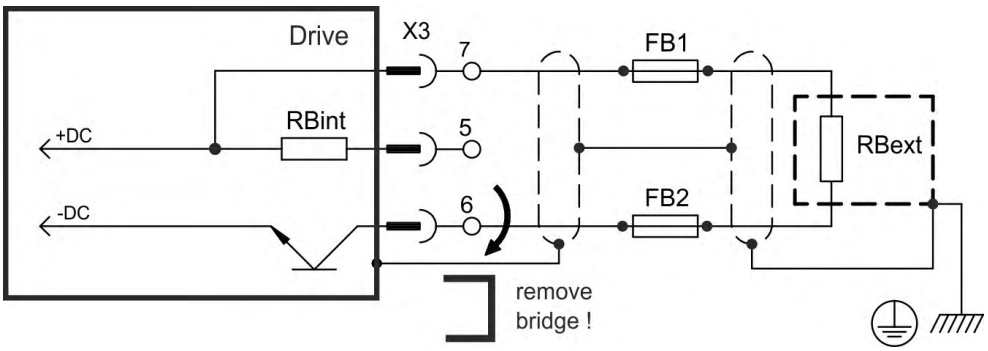
- 8 pin, pitch 7.62 mm
- optional T version
- Mating connector data see (➜ # 51).

Pin	Signal	Description
5	RBint	internal Regen resistor
6	-RB	external Regen resistor -
7	+DC (+RBext)	external Regen resistor +

8.8.1 Fusing and Wiring

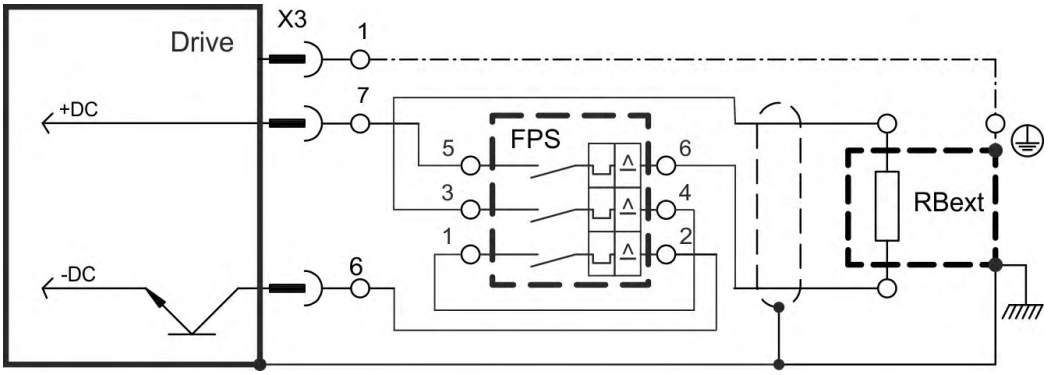
FB1 / FB2 fusing

Drive Model	Ampere rating@240V	Ampere rating@480V	UL region example:	CE Region example: Siba
all AKD2G-Sxx	10A	40A	Bussmann FWP-xxA14F	110V to 400V: gRL(gS) 400V to 480V: aR



FPS: Frizlen DC Power Switch

RBext	FPS	Range [In]	cable cross section
BAR(U)1500-33	FPS-16	10 to 16 A	min. 2.5 mm²



8.9 Motor Power, Brake and Feedback connection

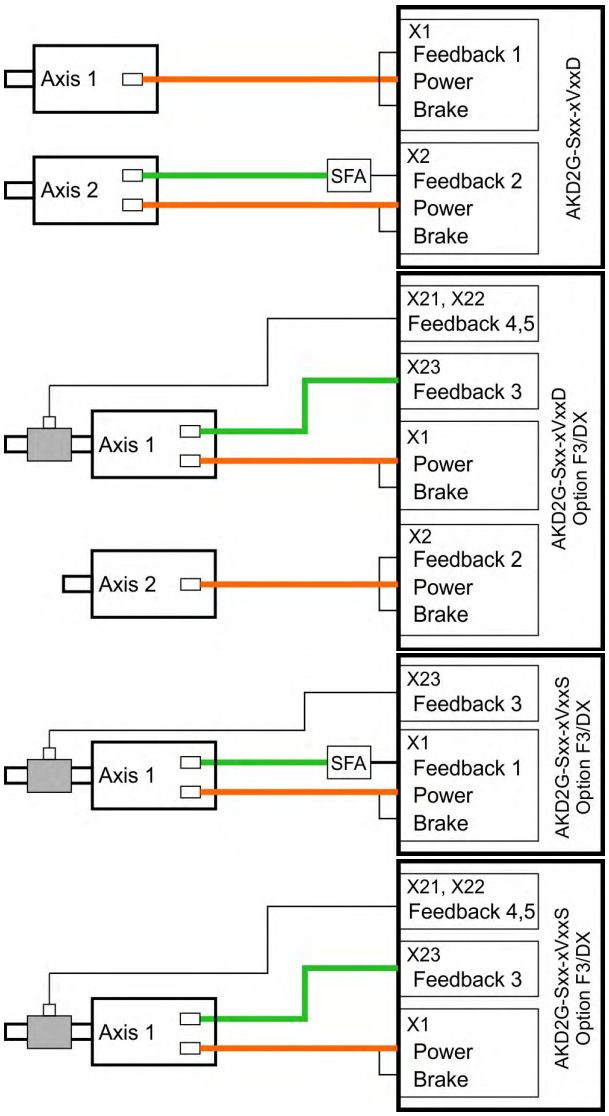
The AKD2G drive is able to protect the connected motor from overloading, if the parameters are set correctly and the thermal protection sensor is connected and supervised. With Kollmorgen motors the valid data are automatically set by the internal WorkBench motor database.

NOTICE

The dynamic voltage rise can lead to a reduction in the motor operating life and, on unsuitable motors, to flashovers in the motor winding.

- Only install motors with insulation class F (acc. to IEC60085) or above.
- Only install cables that meet the requirements (➜ # 52).

8.9.1 Motor connectivity, some examples



- Axis 1: single cable connection (➜ # 78)
  - commutation feedback: SFD3 or DSL
- Axis 2: dual cable connection (➜ # 78)
  - commutation feedback: EnDAT, HIPERFACE, Resolver etc. via SFA

- Axis 1: dual cable connection (➜ # 80)
  - commutation feedback: Resolver, SFD, EnDAT, HIPERFACE, BiSS, SinCos, ComCoder, Hall, SmartAbs etc. via X23
  - position feedback:
    - X21: Step/Direction
    - X22: Step/Direction or incremental encoder
- Axis 2: single cable connection (➜ # 78)
  - commutation feedback: SFD3 or DSL

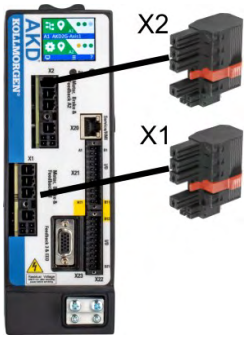
- Axis 1: dual cable connection (➜ # 80)
  - commutation feedback: EnDAT, HIPERFACE, Resolver etc. via SFA
  - position feedback:Resolver, SFD, EnDAT, HIPERFACE, BiSS, SinCos, ComCoder, Hall, SmartAbs etc. via X23
- Axis 1: dual cable connection (➜ # 80)
  - commutation feedback: Resolver, SFD, EnDAT, HIPERFACE, BiSS, SinCos, ComCoder, Hall, SmartAbs etc. via X23
  - position feedback:
    - X21: Step/Direction
    - X22: Step/Direction or incremental encoder

8.9.2 Motor single cable connection

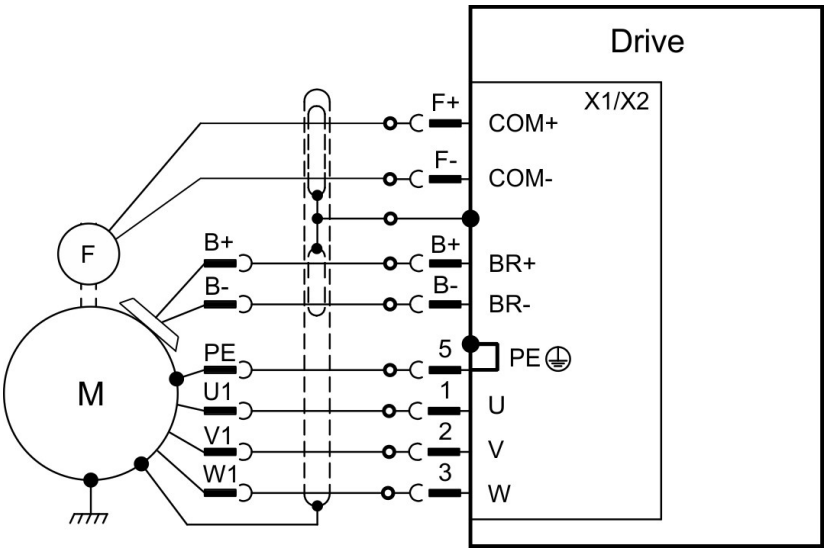
Motors with two wire feedback systems like SFD3 or Hiperface DSL can be connected to AKD2G via a single Kollmorgen hybrid cable. Depending on the AKD2G version (single or dual axis), one or two single cable motor connections are possible.

Drive type	Commutation Axis 1	Commutation Axis 2	Velocity/Position loop closure			
Single axis standard	X1	-	-	X21	-	-
Single axis with Option I/O	X1	-	-	X21	X22	-
Single axis with Option F3	X1	-	-	X21	-	X23
Single axis with Option DX	X1	-	-	X21	X22	X23
Dual axis standard	X1	X2	-	X21	X22	-
Dual axis with Option DX	X1	X2	-	X21	X22	X23

8.9.2.1 Motor Power, Brake and Feedback connectors X1, X2



- X1 (Feedback 1) / X2 (Feedback 2)
  - Motor Power: 4 pin, pitch 7.62 mm
  - Motor Brake: 2 pin, pitch 3.81 mm
  - Motor Feedback: 2 pin, pitch 3.81 mm
- Cable length: maximum 50 m
- Use Kollmorgen cables
- Mating connector data see (➜ #51).
- Feedback types: SFD3, HIPERFACE DSL



Pinout is identical for connectors X1 and X2.

Pin	Signal	Description
1	U	Motor phase U
2	V	Motor phase V
3	W	Motor phase W
5	PE	Protective earth
B+	BR+	Brake positive line (safety notes and details refer to (➜ #82))
B-	BR-	Brake negative line (safety notes and details refer to (➜ #82))
F+	COM+	SFD3, HIPERFACE DSL
F-	COM-	

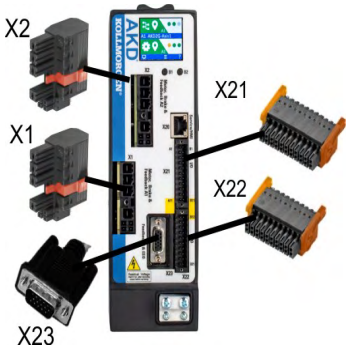
8.9.2.2 Feedback connectors X21, X22, X23

- Velocity/Position loop closing
- Use Kollmorgen cables
- Mating connector data see (➜ # 51).
- Cable length: maximum 50 m

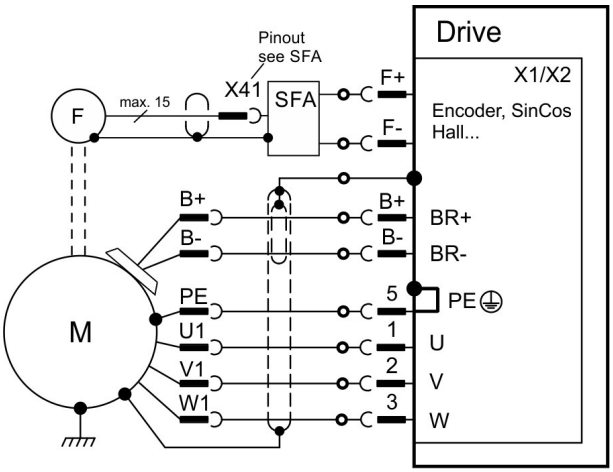
Connector	Functionality	Pinout, Wiring
X21	Step/Direction, CW/CCW	(➜ # 86)
X22	Step/Direction, CW/CCW, Incremental Encoder	(➜ # 87)
X23	Several conventional feedback types	(➜ # 88)

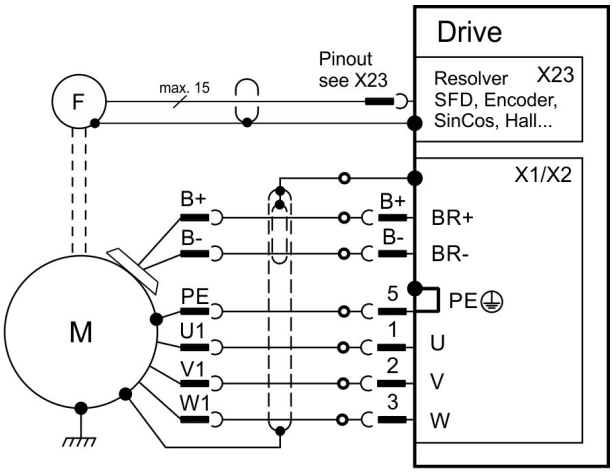
8.9.3 Motor dual cable connection

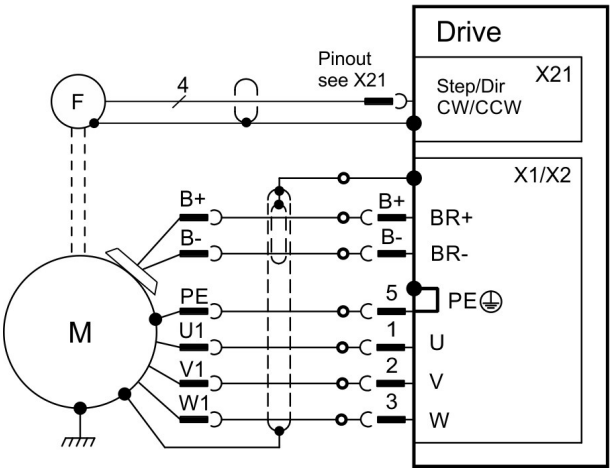
Motors with conventional commutation feedback systems like resolver or sine encoder can be connected to AKD2G with separated power/brake and feedback cables. Feedback functions are assigned with parameters in WorkBench. Scaling and other settings are performed in WorkBench, too. Velocity / Position loop closing and electronic gearing / master-slave connection are possible via X21, X22, X23 depending on the drive version and physical restrictions.

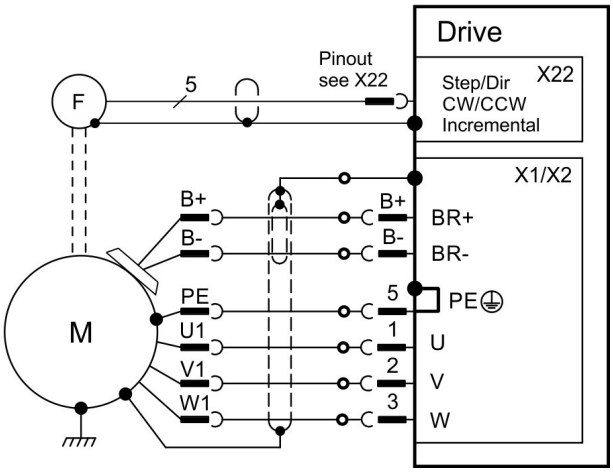


- X1 (Feedback 1) / X2 (Feedback 2)
  - Motor Power: 4 pin, pitch 7.62 mm
  - Motor Brake: 2 pin, pitch 3.81 mm
  - SFA connection: 2 pin, pitch 3.81 mm
  - Feedback types: see SFA connectivity (➜ # 89)
- X23 (Feedback 3)
  - SubD HD 15 poles
  - Feedback types: see X23 connectivity (➜ # 88)
- X21 (Feedback 4)
  - 2 x 11 pins (left connector A, right connector B)
  - Feedback types: see X21 connectivity (➜ # 86)
- X22 (Feedback 5)
  - 2 x 10 pins (left connector A, right connector B)
  - Feedback types: see X22 connectivity (➜ # 87)
- Mating connector data see (➜ # 51).









8.9.3.1 Motor power and motor brake connectors X1, X2

Usually these lines are part of the Kollmorgen motor cable connected to X1 or X2. For motor brake safety notes and functional details refer to (➜ # 82).

- Use Kollmorgen cables
- Mating connector data see (➜ # 51).
- Cable length: maximum 50 m

Pin	Signal	Description
1	U	Motor phase U
2	V	Motor phase V
3	W	Motor phase W
5	PE	Protective earth
B+	BR+	Brake positive, with Kollmorgen cables only
B-	BR-	Brake negative, with Kollmorgen cables only

8.9.3.2 Feedback connectors X1, X2, X41, X21, X22, X23

- Use Kollmorgen cables
- Mating connector data see (➜ # 51).
- Cable length: maximum 50 m

Connector	Functionality	Pinout, Wiring
X1/X2	SFD3, DSL, SFA	(➜ # 85)
X41	SFA at X1 or X2 , several conventional feedback types	(➜ # 89)
X21	Step/Direction, CW/CCW	(➜ # 86)
X22	Step/Direction, CW/CCW, Incremental Encoder	(➜ # 87)
X23	Several conventional feedback types	(➜ # 88)

Feedback connector X1, X2, X41

Conventional feedback systems can be connected to X1 or X2 via the optional feedback adapter SFA. SFA offers the additional connector X41.

- Connector X1 is a standard connector. Input for SFD3, DSL, or SFA.
- Connector X2 is standard for dual-axis drives. Input for SFD3, DSL, or SFA.
- SFA: adapter for several conventional feedback types

Feedback connector X21

- Connector X21 is a standard connector.
- Input for Step/Direction and CW/CCW.

Feedback connector X22

- Connector X22 is standard connector for dual-axis drives.
- Connector X22 is part of option DX or IO for single axis drives.
- Input for Step/Direction, CW/CCW, Incremental encoder

Feedback connector X23

- Connector X23 is part of option DX or F3.
- Input for several conventional feedback types.

8.9.4 Motor Holding Brake Connection

A 24 V holding brake in the motor can be controlled directly by the drive. For proper function, check voltage drop, measure voltage at brake input and check brake function (on and off).

Brake voltage supply via 24 V ±10% auxiliary voltage supply of the drive on X10. Minimum and maximum brake current see Electrical Data (➜ # 36) respectively (➜ # 38).

AKD2G offers one motor brake output for every axis on connector X1 and X2 (➜ # 82).

Connector	Usable for
X1	Primary motor brake axis 1
X2	Primary motor brake axis 2

⚠WARNING No functional Safety!

Serious injury could result when the load is not properly blocked. This function does not ensure functional safety.

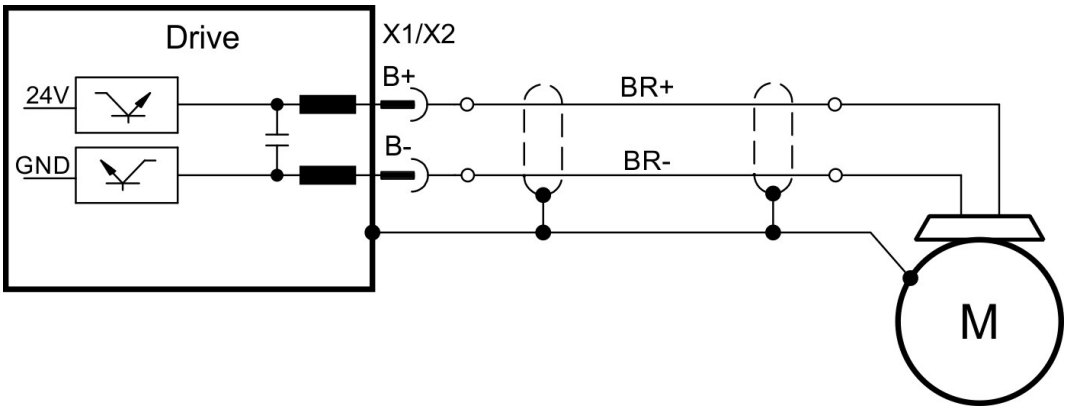
- Functional safety, e.g. with hanging load (vertical axes), requires an additional brake.
- The Hardware Enable does not initiate a controlled stop but switches off the power stage immediately.
- Set parameter AXIS#.MOTOR.BRAKEIMM to 1 with vertical axes, to apply the brake immediately after faults or Hardware Disable.

Pinout X1 / X2

Pin	Signal	Description
B+	BR+	Brake positive line
B-	BR-	Brake negative line

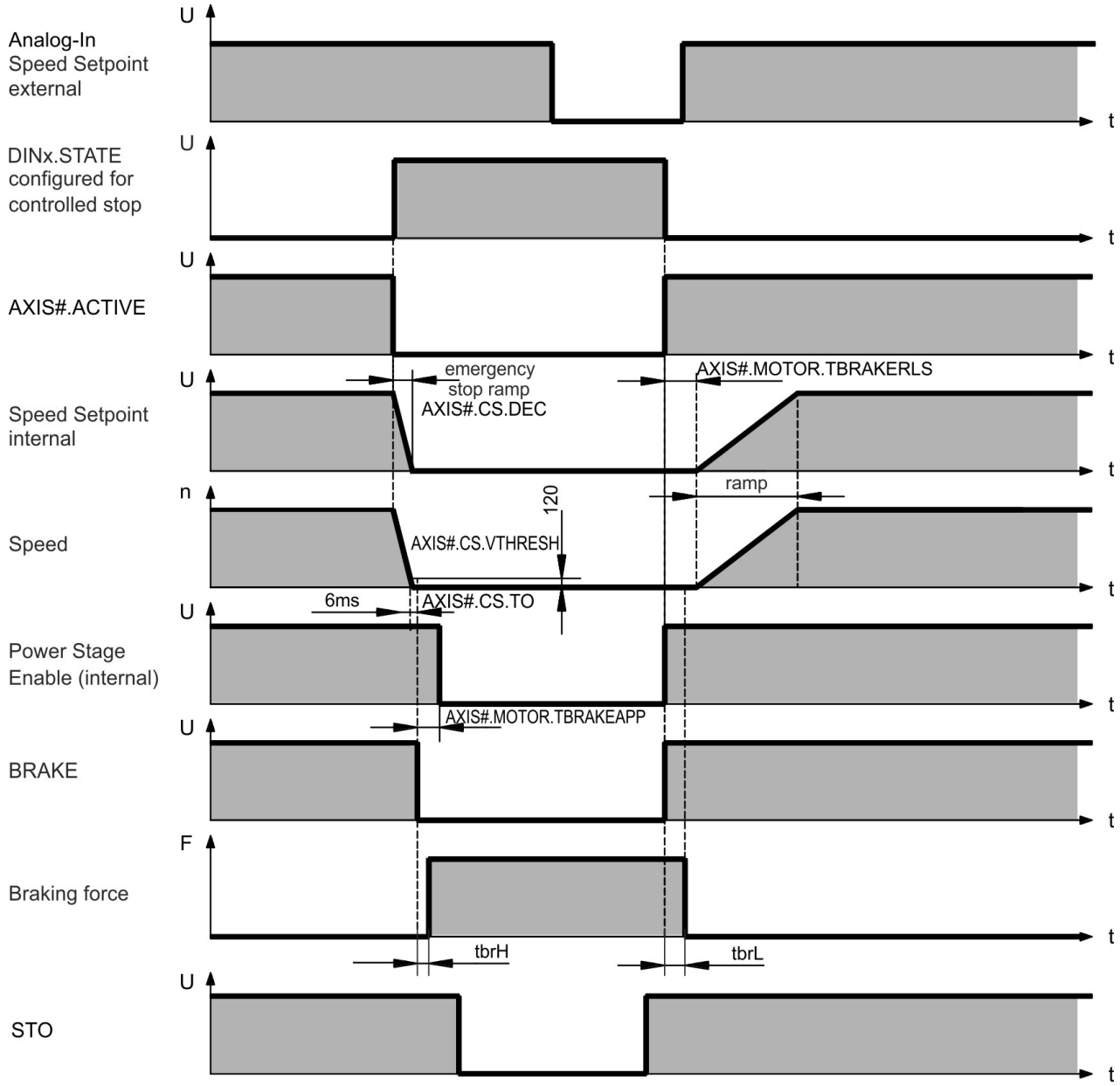
Wiring

Usually the brake lines are part of the Kollmorgen hybrid single cable connection to X1 respectively X2 (➜ # 78).



Functionality

The brake function must be enabled through a parameter. The diagram below shows the timing and functional relationships between the controlled stop signal, speed,and braking force. All values can be adjusted with parameters; values in the diagram are default values.



The drive speed setpoint is internally driven down an adjustable ramp (AXIS#.CS.DEC) to 0 V.

With default values the output for the brake is switched on when the speed has reached 5 rpm (AXIS#.CS.VTHRESH) for at least 6 ms (AXIS#.CS.TO). The rise (t_{brH}) and fall (t_{brL}) times of the holding brake that is built into the motor are different for the various types of motor.

8.9.5 Feedback Connection

AKD2G offers up to five feedback channels. These channels can serve

- to commutate the motor (single cable (➜ # 78) or dual cable (➜ # 82)),
- to close the velocity and/or position loops, and
- to act as a command source (electronic gearing, flying sheer, master-slave (➜ # 90)).

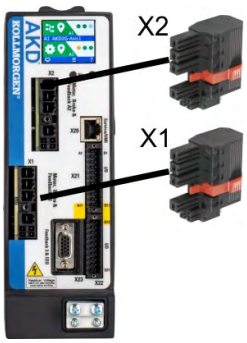
The usage of the five channels may be freely configured in software, subject only to a few restrictions that are not physically sensible.

- Exactly one feedback channel per axis can commutate the motor.
- At most one feedback channel per axis can serve as the command source and the same feedback channel cannot also commutate the motor.
- A feedback channel can serve as the command source for more than one axis.
- FB1 cannot commutate axis 2. FB2 cannot commutate axis 1.

Feedback channel	Connector	Pinout	Usable for
Feedback 1	X1	(➜ # 85)	Axis 1: commutation feedback
	X41	(➜ # 89)	Axis 1 via SFA: commutation feedback
Feedback 2	X2	(➜ # 85)	Axis 2: commutation feedback
	X41	(➜ # 89)	Axis 2 via SFA: commutation feedback
Feedback 3	X23	(➜ # 88)	commutation feedback, velocity/position, command
Feedback 4	X21	(➜ # 86)	commutation feedback, velocity/position, command
Feedback 5	X22	(➜ # 87)	commutation feedback, velocity/position, command

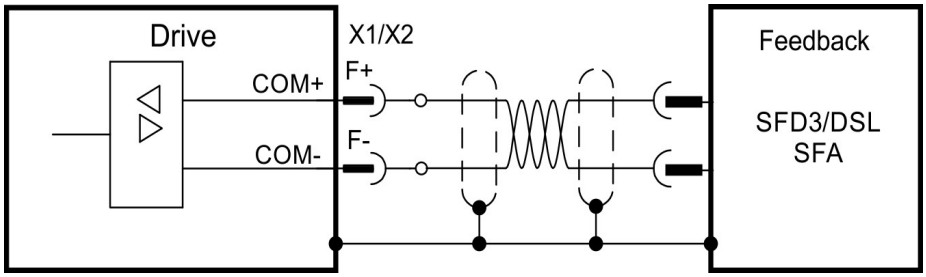
Feedback Types	Connectors
SFD3	X1, X2
Encoder Hiperface DSL	X1, X2
Resolver	X23, X41
SFD	X23, X41
SinCos Encoder BiSS B (analog)	X23, X41
Encoder BiSS C (digital)	X23
SinCos Encoder ENDAT 2.1	X23, X41
Encoder ENDAT 2.2 (digital)	X23, X41
Encoder HIPERFACE	X23, X41
Sine Encoder	X23, X41
Sine Encoder + Hall	X23, X41
Incremental Encoder	X22, X23, X41
Incremental Encoder + Hall (Comcoder)	X23, X41
Hall Sensors	X23, X41
Tamagawa Smart Abs	X23, X41
Step/Direction	X21, X22, X23, X41
CW/CCW	X21, X22, X23, X41

8.9.5.1 Feedback Connector X1, X2

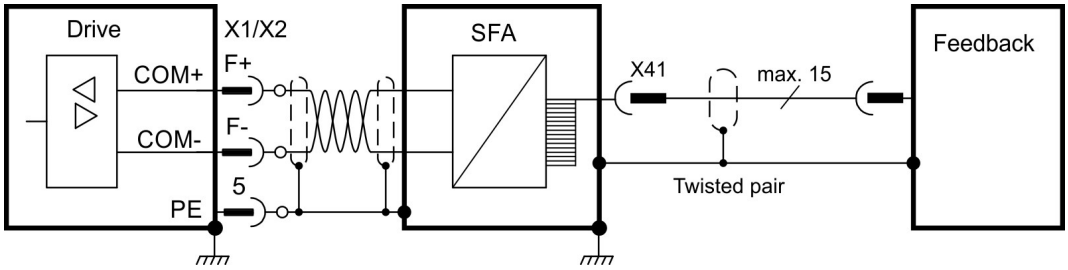


- 4 pin, pitch 7.62 mm plus 2x2 pin pitch 3.81 mm
- Input for commutation feedback: SFD3, DSL, SFA

Wiring example SFD3 or HIPERFACE DSL



Wiring example conventional Feedback types with SFA

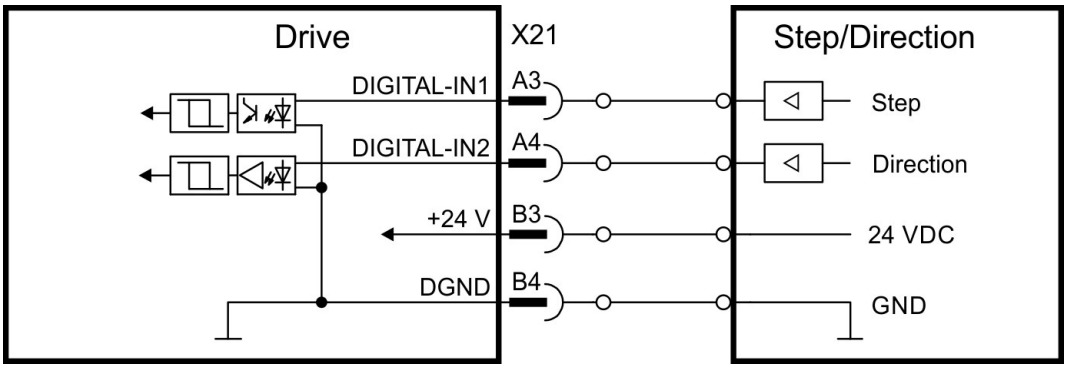


Pin	Signal	Description
F+	COM+	SFD3 +, HIPERFACE DSL +, SFA +
F-	COM-	SFD3 -, HIPERFACE DSL -, SFA -
5	PE	Cable shield (PE)

8.9.5.2 Feedback Connector X21

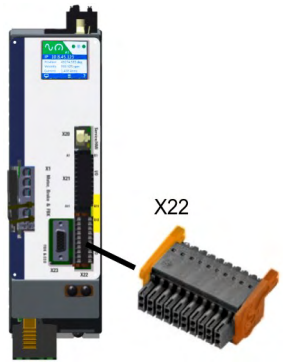
- 2 x 11 pins (left connector A, right connector B), pitch 3.5 mm
- Fast input, isolated, sink, type EN 61131-2 type 1
- Input for commutation or position feedback.
- Input for Electronic Gearing, (➜ # 90)
- Mating connector data see (➜ # 51).

Wiring example



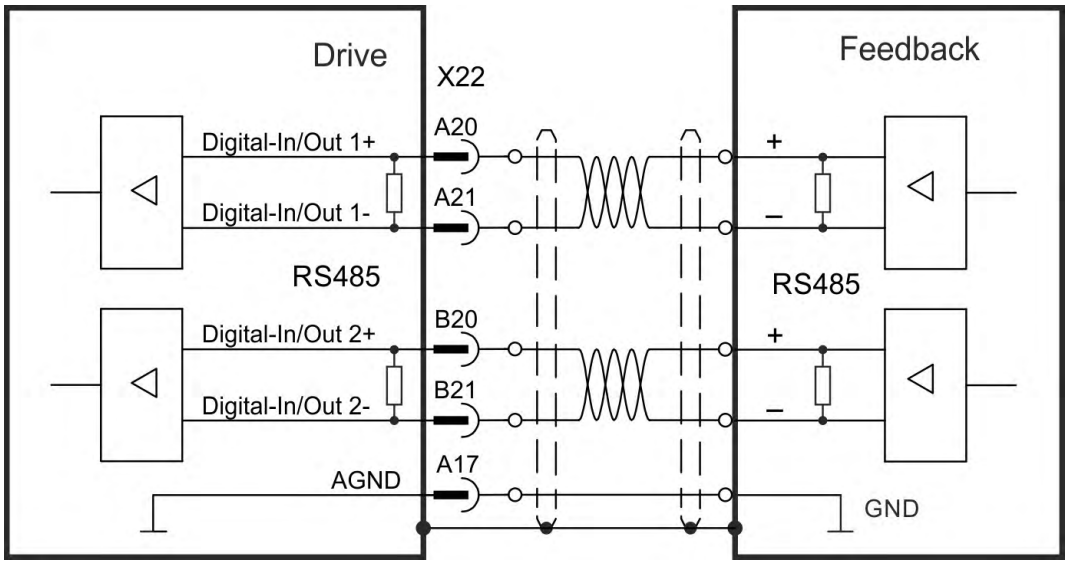
X21 Pin	Step/Direction	CW/CCW
A3	Step	CW
A4	Direction	CCW
B4	Common (DGND)	Common (DGND)

8.9.5.3 Feedback Connector X22



- Standard for dual axis drives, (➜ # 29), optional for single axis drives
- 2 x 10 pins (left connector A, right connector B), pitch 3.5 mm
- RS485 inputs
- Input for commutation or position feedback.
- Input for Electronic Gearing, (➜ # 90)
- Output for encoder emulation (EEO2), (➜ # 91)
- Mating connector data see (➜ # 51).

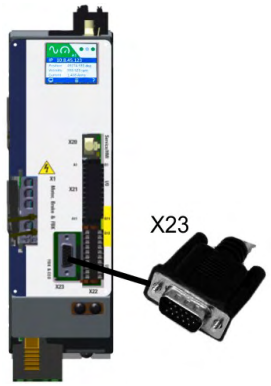
Wiring example (Input)



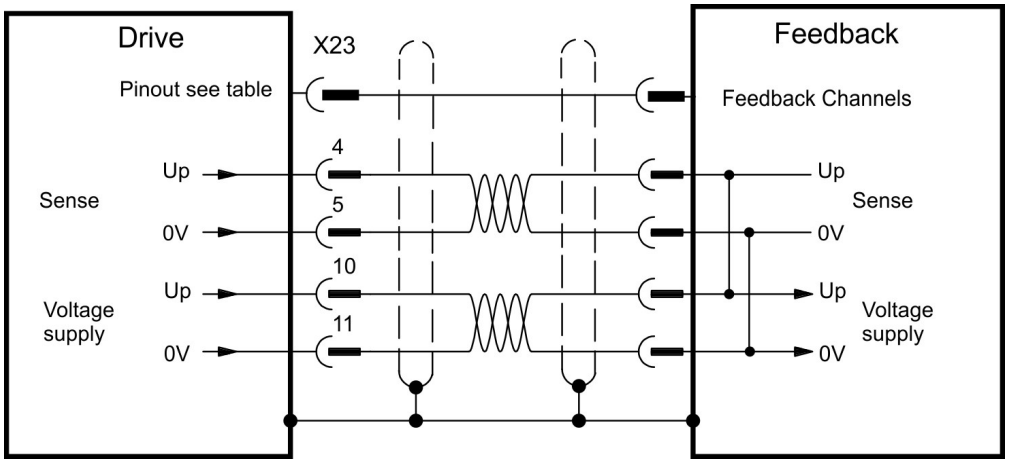
EEO output connection is similar.

X22 Pin	Step/Direction	CW/CCW	Incremental Encoder
A20	Step +	CW +	Track A +
A21	Step -	CW -	Track A -
B20	Direction +	CCW +	Track B +
B21	Direction -	CCW -	Track B -
A17	AGND	AGND	AGND

8.9.5.4 Feedback Connector X23



- Connectivity Option F3 or DX (➜ # 29)
- Sub-D high density 15 pin, female
- Use Kollmorgen feedback cables
- Input for several feedback types
- Input for Electronic Gearing, (➜ # 90)
- Output for encoder emulation (EEO1), (➜ # 91)
- Digital input (➜ # 103), Digital output (➜ # 107)
- Mating connector data see (➜ # 51).



Encoder power supply (X23 pins 10/11):

- Maximum voltage 9 V with shorted sense contacts (4/5), rated voltage 5 V +/-5%.
- Rated supply current is 350 mA.
- Voltage rise time ~4 ms with full load and 220 µF of capacitance.
- Encoder power lines capacitance 10 µF to 220 µF

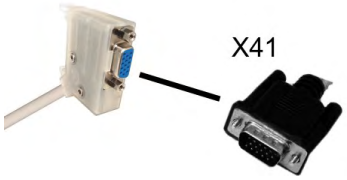
X23 Pin	SFD	Resol-ver	BiSS B	BiSS C	EnDAT 2.1	EnDAT 2.2	Hiper-face	Sine/ Cos	Sine/ Cos +Hall	Incr. Enc.	Incr. Enc. +Hall	Hall	Smart Abs	Step/ Dir	CW/ CCW
1	-	-	-	-	-	-	-	-	Hall U	-	Hall U	Hall U	-	-	-
2	-	-	CLK+	CLK+	CLK+	CLK+	-	-	Hall V	-	Hall V	Hall V	-	Step+	CW+
3	-	-	CLK-	CLK-	CLK-	CLK-	-	-	Hall W	-	Hall W	Hall W	-	Step-	CW-
4	SEN+	-	SEN+	SEN+	SEN+	SEN+		SEN+	SEN+	SEN+	SEN+	-	SEN+	-	-
5	SEN-	-	SEN-	SEN-	SEN-	SEN-		SEN-	SEN-	SEN-	SEN-	-	SEN-	-	-
6	COM+	R1 Ref+	DAT+	DAT+	DAT+	DAT+	DAT+	Zero+	Zero+	Zero+	Zero+	-	SD+	Dir+	CCW+
7	COM-	R2 Ref-	DAT-	DAT-	DAT-	DAT-	DAT-	Zero-	Zero-	Zero-	Zero-	-	SD-	Dir-	CCW-
8	-	Thermal control (+)													
9	-	Thermal control (-)													
10	+5 V	-	+5 V	+5 V	+5 V	+5 V	8 to 9 V	+5 V	+5 V	+5 V	+5 V	+5 V	+5 V	+5 V	+5 V
11	0 V	-	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V
12	-	S1 SIN+	A+	-	A+	-	SIN+	A+	A+	A+	A+	-	-	-	-
13	-	S3 SIN-	A-	-	A-	-	SIN-	A-	A-	A-	A-	-	-	-	-
14	-	S2 COS+	B+	-	B+	-	COS+	B+	B+	B+	B+	-	-	-	-
15	-	S4 COS-	B-	-	B-	-	COS-	B-	B-	B-	B-	-	-	-	-

CLK = CLOCK, DAT = DATA, SEN = SENSE

8.9.5.5 Feedback Connector X41 (SFA, accessory)

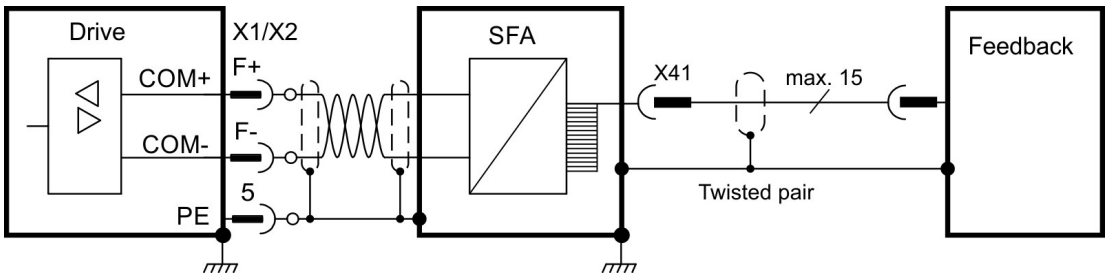
SFA (**S**mart **F**eedback **A**dapter) converts conventional feedback signals to a 2-wire serial signal. SFA can be mounted to a top hat rail EN50022–35×7.5 (or EN50022–35×15) or laid into the cable duct.

SFA adds a 15 pole HD SubD female connector X41 to the system for connection of a Kollmorgen motor feedback cable (see regional *Accessories Manual*).



- Sub-D high density 15 pin, female
- 0.5 m shielded cable with 3 flying leads for connection to X1 or X2
- Input for Electronic Gearing, (➜ # 90)
- Connected feedback must be set in WorkBench
- Use Kollmorgen feedback cables
- Output for encoder emulation (EEO3/EEO4), (➜ # 91)
- Master-Slave (➜ # 93)

Connect the three flying leads of the SFA cable to X1 (FB1, EEO3) or X2 (FB2, EEO4) :



X41 Pin	SFD	Resol-ver	BiSS B	EnDAT 2.1	EnDAT 2.2	Hiper-face	Sine/ Cos	Sine/ Cos +Hall	Incr. Enc.	Incr. Enc. +Hall	Hall	Smart Abs	Step/ Dir	CW/ CCW
1	-	-	-	-	-	-	-	Hall U	-	Hall U	Hall U	-	-	-
2	-	-	CLK+	CLK+	CLK+	-	-	Hall V	-	Hall V	Hall V	-	Step+	CW+
3	-	-	CLK-	CLK-	CLK-	-	-	Hall W	-	Hall W	Hall W	-	Step-	CW-
4	SEN+	-	SEN+	SEN+	SEN+		SEN+	SEN+	SEN+	SEN+	-	SEN+	-	-
5	SEN-	-	SEN-	SEN-	SEN-		SEN-	SEN-	SEN-	SEN-	-	SEN-	-	-
6	COM+	R1 Ref+	DAT+	DAT+	DAT+	DAT+	Zero+	Zero+	Zero+	Zero+	-	SD+	Dir+	CCW+
7	COM-	R2 Ref-	DAT-	DAT-	DAT-	DAT-	Zero-	Zero-	Zero-	Zero-	-	SD-	Dir-	CCW-
8	-	Thermal control (+)												
9	-	Thermal control (-)												
10	+5 V	-	+5 V	+5 V	+5 V	8 to 9 V	+5 V	+5 V	+5 V	+5 V	+5 V	+5 V	+5 V	+5 V
11	0 V	-	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V
12	-	S1 SIN+	A+	A+	-	SIN+	A+	A+	A+	A+	-	-	-	-
13	-	S3 SIN-	A-	A-	-	SIN-	A-	A-	A-	A-	-	-	-	-
14	-	S2 COS+	B+	B+	-	COS+	B+	B+	B+	B+	-	-	-	-
15	-	S4 COS-	B-	B-	-	COS-	B-	B-	B-	B-	-	-	-	-

CLK = CLOCK, DAT = DATA, SEN = SENSE

8.10 Electronic Gearing, EEO, Master-Slave

AKD2G offers several feedback channels. These channels may also be used as the command source (input) for electronic gearing or master-slave or for EEO (Emulated Encoder Output).

Feedback channel	EEO channel	Connector	Pinout and wiring example	Keyword to configure the sensor type
Feedback 1	EEO3	X1	(➜ # 85)	FB1.SELECT
		X41	(➜ # 89)	
Feedback 2	EEO4	X2	(➜ # 85)	FB2.SELECT
		X41	(➜ # 89)	
Feedback 3	EEO1	X23	(➜ # 88)	FB3.SELECT
Feedback 4	n/a	X21	(➜ # 86)	FB4.SELECT
Feedback 5	EEO2	X22	(➜ # 87)	FB5.SELECT

8.10.1 Electronic Gearing

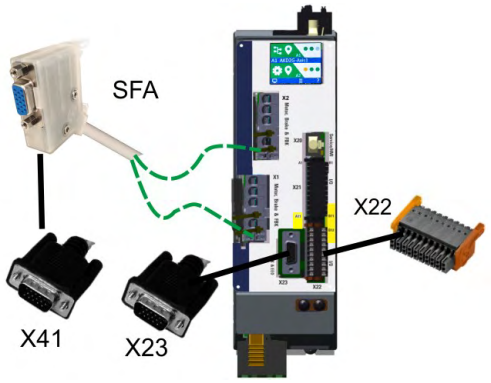
AKD2G offers up to five feedback channels. Any of these channels may be used as the gearing command source. The gearing source is selected for each axis using AXIS#.GEAR.FBSOURCE. Refer to the WorkBench Online Help for more information.

8.10.2 Emulated Encoder Output (EEO)

The drive calculates the motor shaft position from the cyclic- absolute signals of the commutation feedback, generating incremental-encoder compatible pulses or CW/CCW signals or Pulse/Direction signals from this information.

The resolution and the index (zero) position can be set in WorkBench. The outputs are driven from an internal supply voltage. Refer to the WorkBench Online Help for more information.

NOTE When using a multispeed resolver (more than 2 poles) as commutation feedback, the EEO will create only one zero pulse per each mechanical revolution of the motor. The zero pulse is dependent on the motors starting position!



NOTE Examples for Master-Slave connection see (➜ # 93).

Technical characteristics X22, EEO2

Pulse outputs on the connector X22 are 2 signals, tracks A and B, with 90° phase difference (i.e. in quadrature, hence the alternative term “A quad B” output).

- Electrical Interface: RS-485, max. current 100 mA, the maximum number of connected slaves is determined by the loading characteristics of the slaves, 32 slaves can be driven if the input impedance of the bias network is 10kΩ and only one slave has a DC termination resistor.
- Max signal (channel) output frequency: 3 MHz
- The pulses per revolution value is settable
- Pulse phase shift: 90°±20°

X22	Signals EEO2	Description
A17	AGND	Analog ground
A20	Track A+	EEO2 output, channel A positive
A21	Track A-	EEO2 output, channel A negative
B20	Track B+	EEO2 output, channel B positive
B21	Track B-	EEO2 output, channel B negative

Technical characteristics X23, EEO1

Pulse outputs on the SubD connector X23 are 3 signals, A, B and Index, with 90° phase difference (i.e. in quadrature, hence the alternative term “A quad B” output), with a zero pulse.

- Electrical Interface: 5V TTL, current 60 mA, max. number of connected slaves is determined by the loading characteristics of the slaves, 32 slaves can be driven if the input impedance of the bias network is 10kΩ and only one slave has a DC termination resistor.
- Max signal (channel) output frequency: 3 MHz
- The pulses per revolution value is settable
- Pulse phase shift: 90°±20°

X23	Signals EEO1	Description
6	Zero+	EEO1 output, index positive
7	Zero-	EEO1 output, index negative
11	0 V	EEO1 output, ground
12	Track A+	EEO1 output, channel A positive
13	Track A-	EEO1 output, channel A negative
14	Track B+	EEO1 output, channel B positive
15	Track B-	EEO1 output, channel B negative

Technical characteristics X41 (SFA), EEO3/EEO4 (in process)

Pulse outputs on the SubD connector X41 are 3 signals, A, B and Index, with 90° phase difference (i.e. in quadrature, hence the alternative term “A quad B” output), with a zero pulse.

- Electrical Interface: 5V TTL, current 60 mA, max. number of connected slaves is determined by the loading characteristics of the slaves, 32 slaves can be driven if the input impedance of the bias network is 10kΩ and only one slave has a DC termination resistor.
- Max signal (channel) output frequency: 3 MHz
- The pulses per revolution value is settable
- Pulse phase shift: 90°±20°

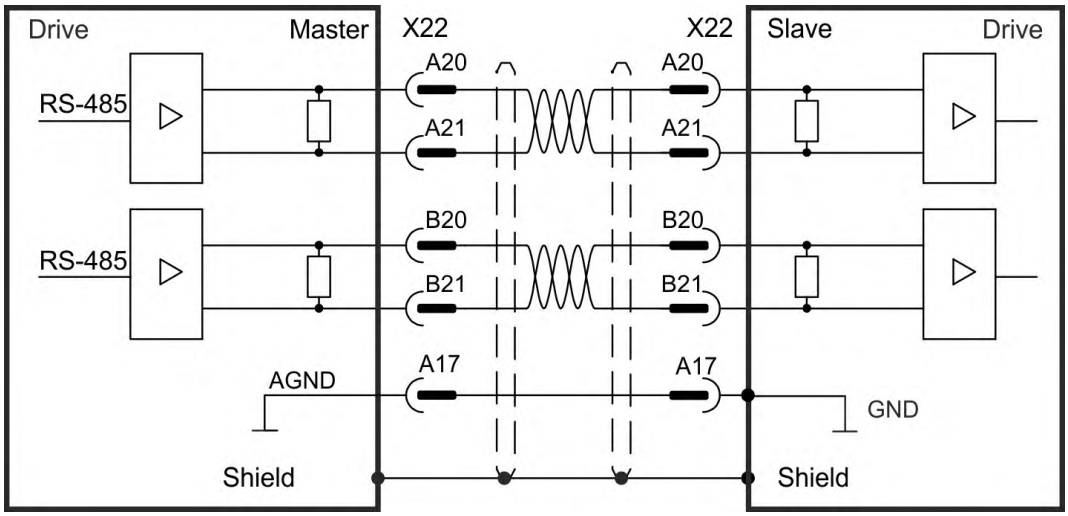
X41	Signals EEO3	Description
6	Zero+	EEO3 output, index positive
7	Zero-	EEO3 output, index negative
11	0 V	EEO3 output, ground
12	Track A+	EEO3 output, channel A positive
13	Track A-	EEO3 output, channel A negative
14	Track B+	EEO3 output, channel B positive
15	Track B-	EEO3 output, channel B negative

8.10.3 Master-Slave control

Several AKD2G can be connected as slave drives to another AKD2G which acts as a master. The slave drives use the master's encoder output signal (EEO, (➜ # 91)) as command input and follow these commands (velocity and direction).

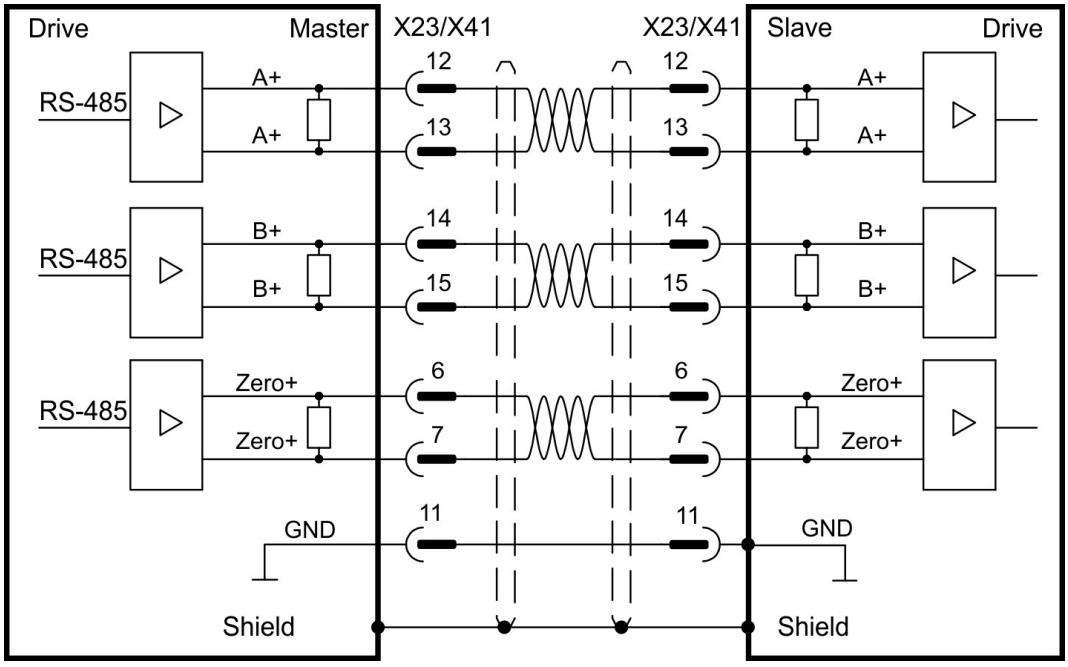
8.10.3.1 Master-Slave using X22

The master is configured for EEO4 (➜ # 91) on X2, the Slave uses X1 for command input.



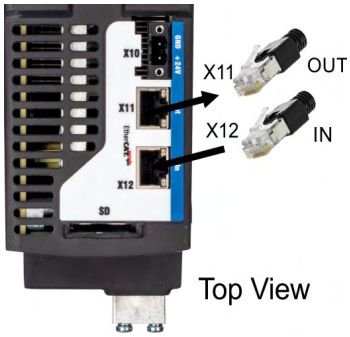
8.10.3.2 Master-Slave using optional X23 or X41

The master is configured for EEO1 (➜ # 92) on X23 or EEO3/EEO4 ((➜ # 92) with SFA) on X41, the Slave uses X23 (or X41 with SFA) for command input.



8.11 Motion Bus Interface (X11/X12)

The motion bus interface has RJ-45 connectors and can be used for communicating with field-bus devices.



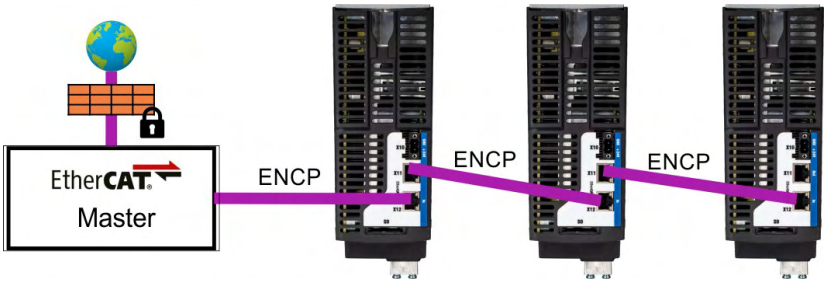
- RJ45 with built-in green/red dual-color LED
- X12 IN port, X11 OUT port
- EtherCAT

Pin	Signal	Description
1	Tx+	Transmit +
2	Tx-	Transmit -
3	Rx+	Receive +
4	Termination	Bob Smith termination
5	Termination	Bob Smith termination
6	Rx-	Receive -
7	Termination	Bob Smith termination
8	Termination	Bob Smith termination

NOTICE Do not connect the Ethernet line for the PC or PAC with the set up software to the motion bus interface X11/X12. The service Ethernet cable must be connected to X20.

Bus topology example (EtherCAT)

We suggest to use Kollmorgen ENCP cables. For more possible system solutions refer to the WorkBench Online Help.

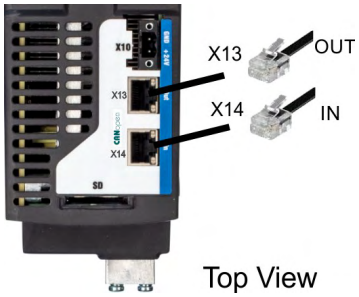


Communication profile

For EtherCAT communication profile description refer to the manual "*AKD2G EtherCAT Communication*".

8.12 CAN-Bus Interface (X13/X14)

AKD2G drives with connectivity option **CN** can be connected to a CAN-Bus via two 6-pin RJ25 connectors X13/X14.



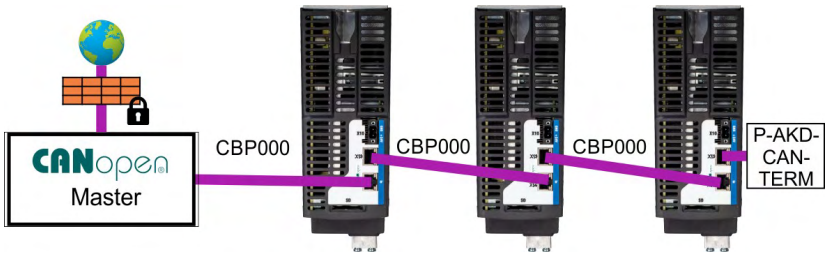
Top View

- RJ25
- Up to 1000 kbit/s operation
- Node ID to be set by WorkBench
- Baudrate to be set by WorkBench

Pin	Signal	Description
1	Termination	Internal Termination Resistor
2	Shield	Chassis
3	CAN_high	CAN bus high signal
4	CAN_low	CAN bus low signal
5	CAN_GND	CAN bus ground
6	Termination	Internal Termination Resistor

8.12.1 CAN-Bus Topology

We recommend the use of Kollmorgen CBP000 cables.



Cable requirements

To meet ISO 11898, a bus cable with a characteristic impedance of 120 Ω should be used. The maximum usable cable length for reliable communication decreases with increasing transmission speed.

As a guide, you can use the following values measured by Kollmorgen; however, these values are not assured limits:

- Characteristic impedance: 100–120 Ω
- Cable capacitance max.: 60 nF / 1000 m
- Lead loop resistance: 159.8 Ω / 1000 m

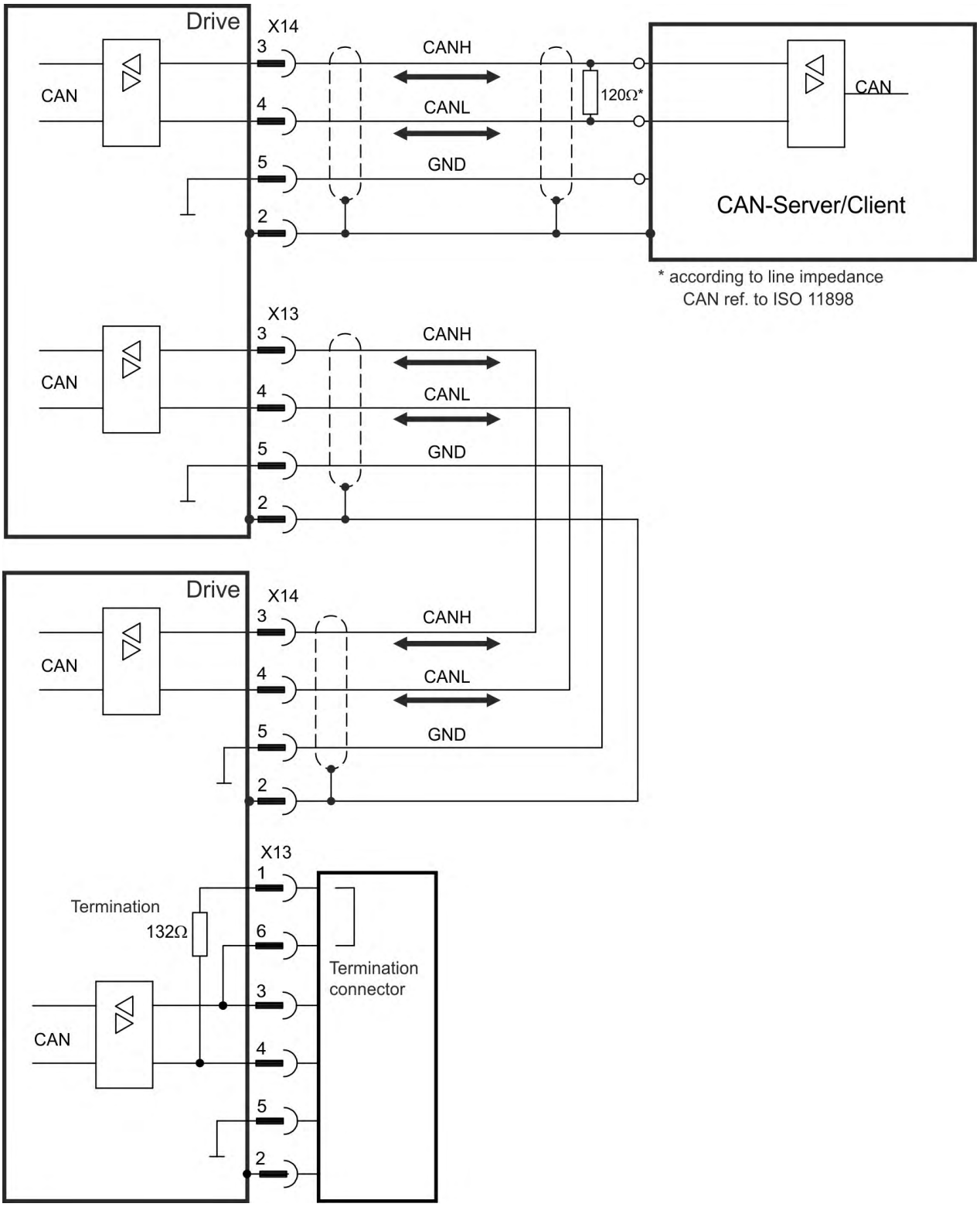
Transmission Rate (kBaud)	1000	500	250	125
Maximum Cable Length (m)	25	100	250	500

Lower cable capacitance (max. 30 nF / 1000 m) and lower lead resistance (loop resistance, 115 Ω / 1000 m) allow larger distances. The characteristic impedance 150 ± 5 Ω requires terminating resistor 150 ± 5 Ω.

Communication profile

For CANopen communication profile description refer to the manual "*AKD2G CAN-Bus Communication*".

8.12.2 CAN-Bus Wiring



8.12.3 Baud rate for CAN-Bus

The transmission rate can be set via the parameter **CANBUS.BAUD** in WorkBench.

Baud rate [kBit/s]	CANBUS.BAUD
125	125 (default)
250	250
500	500
1000	1000

With a fix baud rate, the drive sends the boot up message with the baud rate saved in the drive's non volatile memory after a power cycle.

8.12.4 Node Address for CAN-Bus

The node address can be set via parameter **CANBUS.NODEID** in WorkBench.

NOTE After changing the node address, you must turn off the 24 V auxiliary supply for the drive and then turn it on again.

8.12.5 CAN-Bus Termination

The last bus device on both ends of the CAN-Bus system must have termination resistors. The AKD2G has built-in 132 ohms resistors that can be activated by connecting pins 1 and 6. An optional termination plug is available for AKD2G (*P-AKD-CAN-TERM*). The optional termination plug is an RJ25 connector with an enclosed wire jumper between pins 1&6. The termination plug should be inserted into the X13 connector of the last drive in the CAN network.

NOTE Remove the termination connector if the AKD2G is not the last CAN-Bus device and use X13 for connecting the next CAN node.

8.13 Service Interface (X20)

- RJ45 with built-in green/red dual-color LED
- 100/10 Mbit Ethernet TCP/IP
- Supports Auto-IP, DHCP and fixed IP addressing
- Supports point-to-point (i.e. Auto-IP) and connection via network switches
- Supports automatic discovery in WorkBench if in the same sub-net.

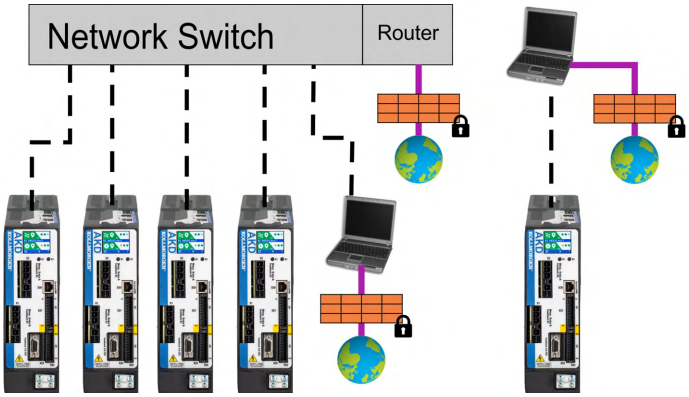
Pin	Signal	Description
1	Tx+	Transmit +
2	Tx-	Transmit -
3	Rx+	Receive +
4	Termination	Bob Smith termination
5	Termination	Bob Smith termination
6	Rx-	Receive -
7	Termination	Bob Smith termination
8	Termination	Bob Smith termination

Operating, position control, and motion-block parameters can be set up by using the setup software on an ordinary commercial PC (➜ # 117).

Connect the service interface X20 of the drive to an Ethernet interface on the PC directly or via a network switch, **while the supply to the equipment is switched off.** Use standard Cat. 5 Ethernet cables for connection (in some cases crossover cables will also work).

Confirm that the link LED on the AKD2G (RJ45 connector) and on your PC (or network switch) are both illuminated. If both lights are green, then you have a good electrical connection.

8.13.1 Possible Network Configurations



8.14 I/O Connection (X21/X22/X23)

8.14.1 Pinout

X21

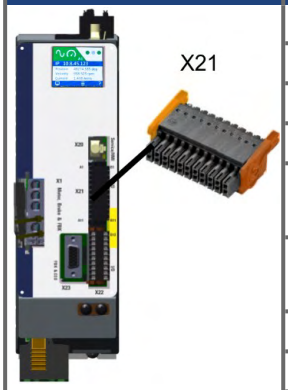
- standard
- 2 x 11 pins, pitch 3.5 mm
- A: left connector
- B: right connector

X22

- standard for dual-axis drives
- optional for single axis drives
- 2 x 10 pins, pitch 3.5 mm
- A: left connector
- B: right connector

X23

- optional
- SubD 15 pins HD
- Mating connector: male

X21	Pin	Signal		Pin	Signal
	A1	Analog-In (AIN) 1 +		B1	Analog-Out (AOUT) 1
	A2	Analog-In (AIN) 1 -		B2	AGND
	A3*	Digital-In (DIN) 1		B3	+24 V
	A4*	Digital-In (DIN) 2		B4	DGND
	A5	Digital-In (DIN) 3 (HW-Enable Axis 1)		B5	Digital-Out (DOUT) 9 + (Relay)
	A6	Digital-In (DIN) 4 (HW-Enable Axis 2)		B6	Digital-Out (DOUT) 9 - (Relay)
	A7	Digital-In (DIN) 5		B7	Digital-Out (DOUT) 1
	A8	Digital-In (DIN) 6		B8	Digital-Out (DOUT) 2
	A9	Digital-In (DIN) 7		B9	Digital-Out (DOUT) 3
	A10	Digital-In (DIN) 8		B10	Digital-Out (DOUT) 4
	A11	STO-A-A1		B11	STO-B-A1

X22 (optional for single axis drives, standard for dual-axis drives)	Pin	Signal		Pin	Signal
	A12	STO-A-A2, dual-axis		B12	STO-B-A2, dual-axis
	A13	Digital-In (DIN) 9		B13	Digital-Out (DOUT) 5
	A14	Digital-In (DIN) 10		B14	Digital-Out (DOUT) 6
	A15	Digital-In (DIN) 11		B15	Digital-Out (DOUT) 7 +
	A16	Digital-In (DIN) 12		B16	Digital-Out (DOUT) 7 -
	A17	AGND		B17	Digital-Out (DOUT) 8 +
	A18	Analog-In (AIN) 2+		B18	Digital-Out (DOUT) 8 -
	A19	Analog-In (AIN) 2-		B19	Analog-Out (AOUT) 2
	A20*	Digital-In/Out (DIO) 1 +		B20*	Digital-In/Out (DIO) 2 +
	A21*	Digital-In/Out (DIO) 1 -		B21*	Digital-In/Out (DIO) 2 -

X23 (optional)	Pin	Signal
	2	Digital-In/Out (DIO) 6 +
	3	Digital-In/Out (DIO) 6 -
	6	Digital-In/Out (DIO) 5 +
	7	Digital-In/Out (DIO) 5 -
	10	+5 V
	11	0 V
	12	Digital-In/Out (DIO) 3 +
	13	Digital-In/Out (DIO) 3 -
	14	Digital-In/Out (DIO) 4 +
	15	Digital-In/Out (DIO) 4 -

8.14.2 Technical data

Interface	Electrical Data
Analog inputs Analog-In (AIN) 1 to 2	• ±10 VDC • common mode rejection ratio: > 30 dB at 60 Hz • resolution 16 bit and full monotonic • update rate: 16 kHz • non-linearity < 0.1% of full scale • offset drift max. 250 µV/°C • input impedance > 13 kΩ
Analog outputs Analog-Out (AOUT) 1 to 2	• 0 to +10 VDC, max 20 mA • resolution 16 bit and full monotonic • update rate: 4 kHz • non-linearity < 0.1% of full scale • offset drift max. 250 µV/°C • short circuit protected to AGND • output impedance 110 Ω
Digital inputs Digital-In (DIN) 1 to 2 IEC 61131-2 Type 1	• ON: 11 VDC to 30 VDC, 2 mA to 15 mA • OFF: -5 VDC to 5 VDC, max.15 mA • galvanic isolation for 60 VDC • activation / de-activation delay: < 1 µs / < 1 µs
Digital inputs Digital-In (DIN) 3 to 12 IEC 61131-2 Type 1	• ON: 11 VDC to 30 VDC, 2 mA to 15 mA • OFF: -5 VDC to 5 VDC, max.15 mA • galvanic isolation for 60 VDC • delay activation/de-activation: about 5 µs / 500 µs
Digital outputs Digital-Out (DOUT) 1 to 6	• max. 30 VDC, 100 mA • short circuit proof • galvanic isolation for 60 VDC • delay activation/de-activation: about 5 µs / 300 µs
Digital outputs Digital-Out (DOUT) 7 to 8	• volt-free contacts, 100 mA • sink or source • galvanic isolation for 60 VDC • delay activation/de-activation: about 5 µs / 50 µs
Digital inputs/outputs Digital-In/Out (DIO) 1 to 6 RS485	• reference potential X22: AGND, X23: 0V • input OFF: -0.3 V to +0.3 V • selectable termination, difference/single ended • delay activation/de-activation: about 50 ns
Digital output Digital-Out (DOUT) 9	• max. 30 VDC, 1A • max. 42 VAC, 1 A • isolation 400 VDC contact/coil • delay open/close: 10 ms / 10 ms
Safe digital inputs Axis 1: STO-A-A1, STO-B-A1 Axis 2: STO-A-A2, STO-B-A2	• ON: 17 VDC to 30 VDC, 5 mA to 6 mA • OFF: 0 VDC to 5 VDC, max.1 mA • galvanic isolation for 60 VDC • delay activation/de-activation about: 1.5 ms / 3.5 ms

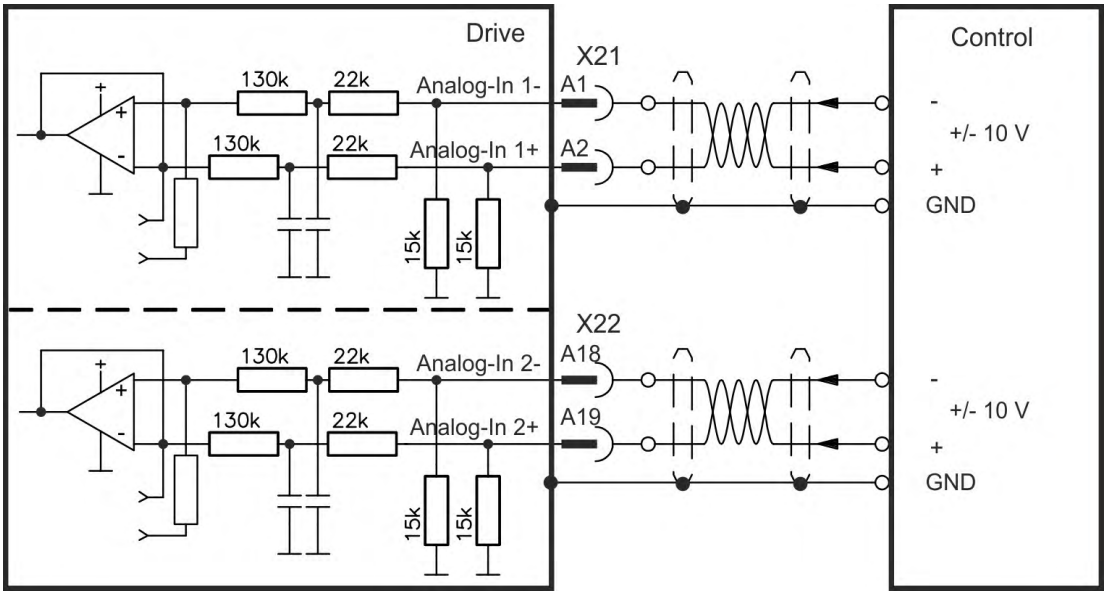
8.14.3 Analog Input

The drive is fitted with differential inputs for analog torque, velocity, or position control. The standard drive offers one analog input on X21, dual axis drives and drives with built-in option IO or DX offer a second analog input on X22.

Technical characteristics

- Differential input voltage range: ± 10 V
- Maximum input voltage referring to I/O Return: -12.5, +16.0 V
- Resolution: 16 Bit and fully monotonic
- Firmware update rate: 16 kHz
- Unadjusted offset: < 50 mV
- Offset drift typ: 250 µV / ° C
- Gain or slope tolerance: +/- 3%
- Nonlinearity: < 0.1% of full scale or 12.5 mV
- Common Mode Rejection Ratio: > 30 dB at 60 Hz
- Input impedance: > 13k Ωs
- Signal to noise ratio referred to full scale:
  - AIN.CUTOFF = 3000 Hz: 14 bit
  - AIN.CUTOFF = 800 Hz: 16 bit

Analog Input Wiring Diagram



Application examples for set point input Analog-In:

- reduced-sensitivity input for setting-up/jog operation
- pre-control/override

Defining the direction of rotation

Standard setting: clockwise rotation of the motor shaft (looking at the shaft end) affected by positive voltage between terminal (+) and terminal (-)

To reverse the direction of rotation, swap the connections to terminals +/- or change keyword AXIS#.DIR in WorkBench.

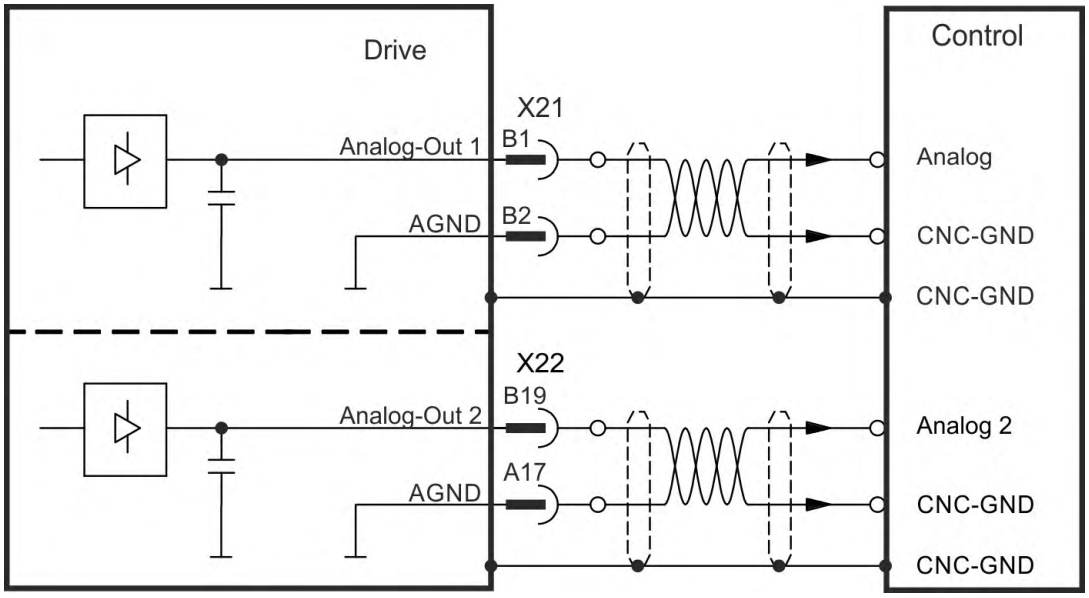
8.14.4 Analog Output

Analog Outputs can be used to output converted analog values of digital measurements recorded in the drive. The standard drive offers one analog output on X21, dual axis drives and drives with built-in option IO or DX offer a second analog output on X22.

Technical characteristics

- Output voltage range referring to AGND: 0 to 10 V
- Resolution: 16 Bit and fully monotonic
- Update rate: 4 kHz
- Unadjusted offset: < 50 mV
- Offset drift typ: 250 µV/°C
- Gain or slope tolerance: +/- 3%
- Nonlinearity: < 0.1% of full scale or 20 mV
- Output impedance: 110 Ω
- Specification complies with IEC 61131-2 Table 11
- -3 dB Bandwidth: >8 kHz
- Maximum output current: 20 mA
- Capacitive load: any value but response speed limited by max Iout and by Rout
- Protected for short circuit to AGND

Analog Output Wiring Diagram



8.14.5 Digital Inputs

The drive provides 8 digital inputs on X21. Dual axis drives and drives with built-in option IO or DX offer additional 4 inputs on X22 and 2 programmable Input/Outputs on X22. If X23 is built-in and not used for feedback or EEO function, then it offers 4 additional programmable Input/Outputs.

All inputs can be used to initiate pre-programmed actions. A list of actions is included in the WorkBench. If an input is programmed, it must be saved to the drive.

The drive provides 4 safe digital inputs on X21 and X22. These inputs can be used as safe inputs, based on the installed functional safety option (see Functional Safety (➜ # 123)).

NOTE Depending on the selected function, the inputs are high or low active. Digital input filter can be set in WorkBench to change sensitivity of the inputs (see Online Help).

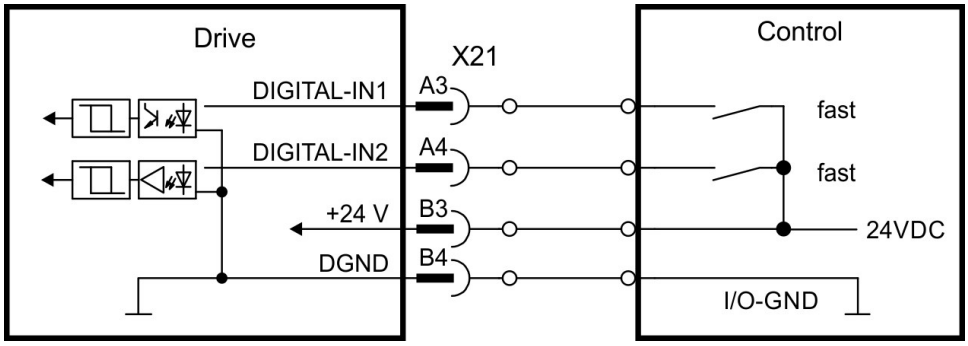
8.14.5.1 Digital-In 1 and 2

These inputs (IEC 61131-2 Type 1) are particularly fast and are therefore suitable for position latch functions. They can also be used as 24 V inputs for electronic gearing (➜ # 90).

Technical characteristics

- Floating, reference common line is DGND
- High: 11 to 30 V/2 to 15 mA , Low: -5 to +5 V/<15 mA
- Update rate: firmware reads hardware input state every 250 µs
- High accuracy latch: motor feedback position or interpolated time is latched or captured within 2 µs of input signal transition (with digital input filter set to 40 ns)
- The AKD2G capture engine is polled every 62.5 µs (16 kHz) by the firmware

Wiring example



8.14.5.2 Digital-In 3 to 12

These inputs (IEC 61131-2 Type 1) are programmable with the setup software.

Manufacturer setting:

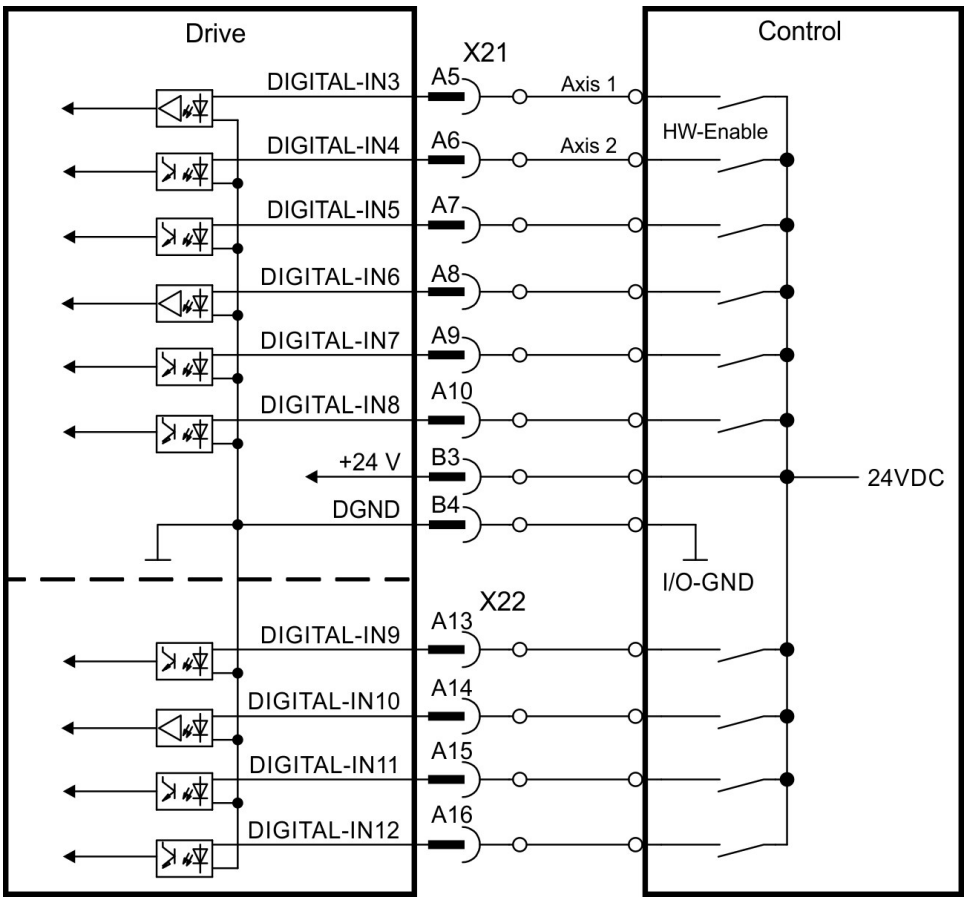
- Digital-In 3: HW-Enable Axis 1
- Digital-In 4: HW-Enable Axis 2
- Digital-In 5 ...12: off

Choose the function you require in WorkBench. For more information refer to WorkBench.

Technical characteristics

- Floating, reference common line is DGND
- High: 11 to 30 V/2 to 15 mA , Low: -5 to +5 V/<15 mA
- Update rate: firmware reads hardware input state every 250 µs

Wiring example



8.14.5.3 Digital-In/Out 1 and 2

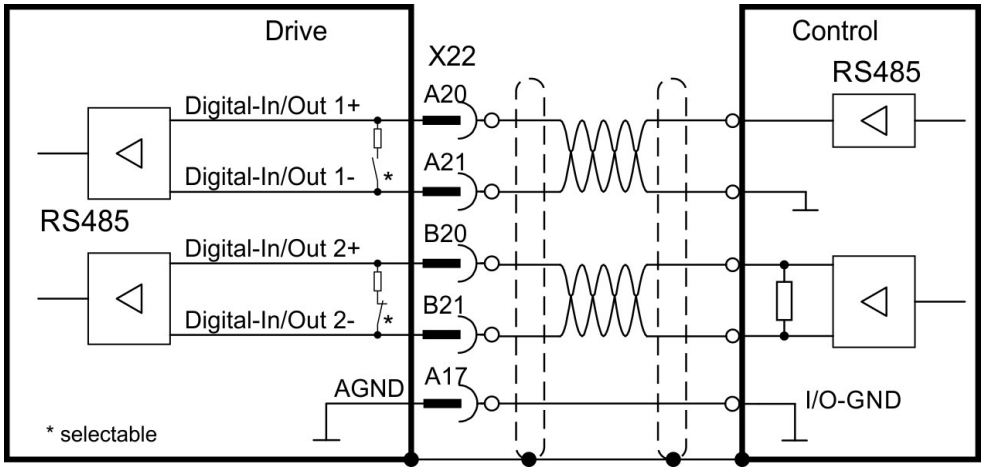
Pins X22/A20-A21 (Digital-In/Out 1) and X22/B20-B21 (Digital-In/Out 2) can be defined as either inputs or outputs. For programming refer to WorkBench.

NOTICE NOT compatible with 24V signal level! Will be damaged if connected to +24V!

Technical characteristics if configured as input

- RS485, reference common line is AGND
- No wire break detection
- Digital IN/OUT 1/2: Selectable DC termination for differential or single ended input
- Update rate: firmware reads hardware input state every 250 µs

Wiring example



8.14.5.4 Digital-In/Out 3 to 6

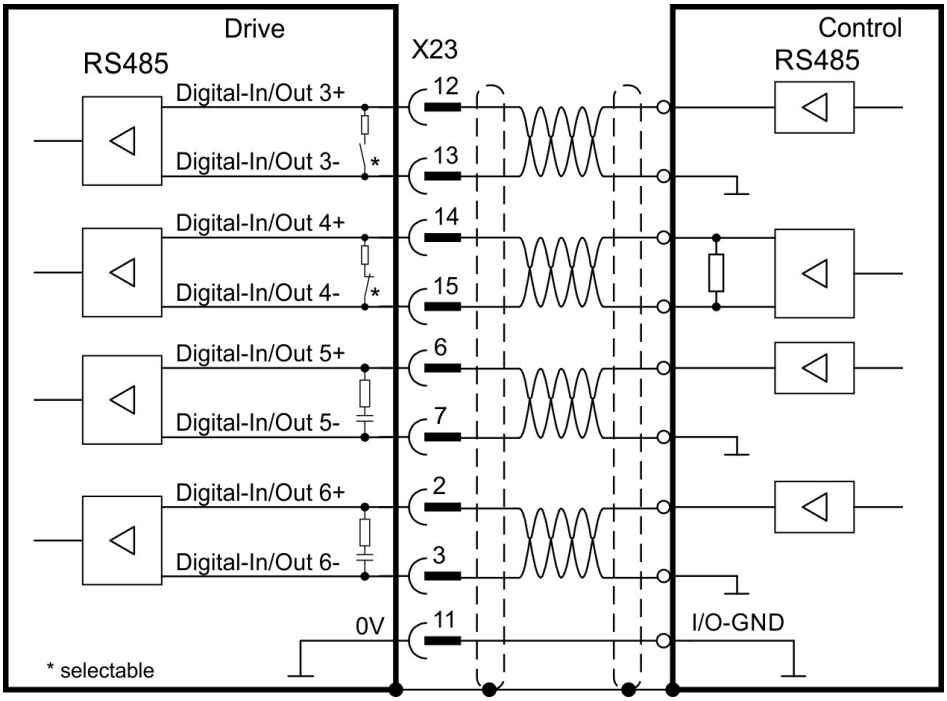
X23 can be used for digital I/O. The channels can be defined as inputs or outputs. For programming refer to WorkBench.

NOTICE NOT compatible with 24V signal level! Will be damaged if connected to +24V!

Technical characteristics if configured as input

- RS485, reference common line is 0V
- No wire break detection
- Digital IN/OUT 3/4: Selectable DC termination for differential or single ended input
- Digital IN/OUT 5/6: AC termination for single ended input
- Update rate: firmware reads hardware input state every 250 µs

Wiring example



8.14.6 Digital Outputs

The drive provides 4 digital outputs on X21. For more information refer to the setup software.

Dual axis drives and drives with built-in option IO or DX offer additional 4 digital outputs and 2 programmable Input/Outputs. If X23 is built-in and not used for feedback or EEO function, then it offers 4 additional programmable Input/Outputs.

The relay output can be used as fault or ready to operate signal.

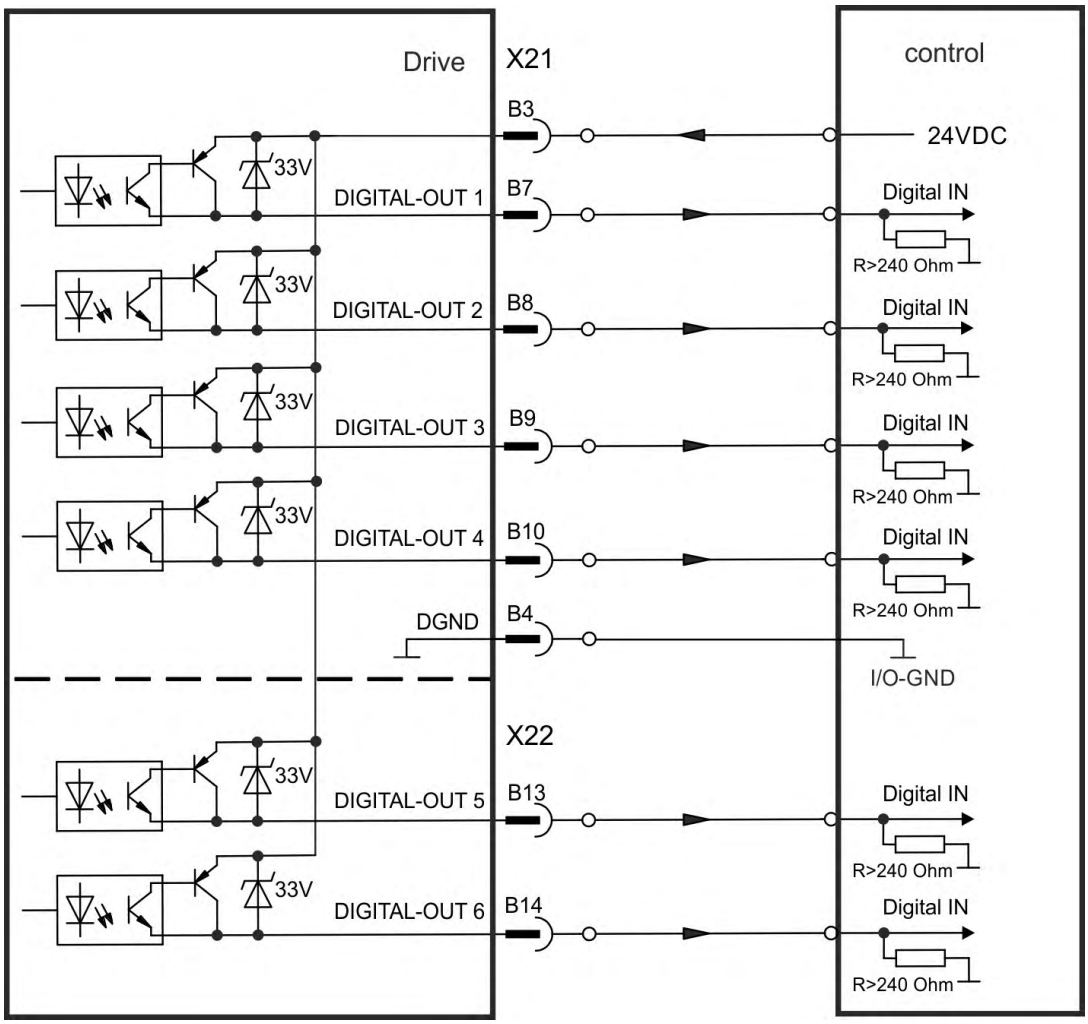
Choose the required action in the setup software. Messages from pre-programmed actions. A list of actions is included in the WorkBench. If an output is programmed, it must be saved to the drive.

8.14.6.1 Digital-Out 1 to 6

These outputs are programmable with the setup software. By default, all outputs are not programmed (off).

Technical characteristics

- The outputs can switch +5 V to +30 V
- All digital outputs are floating
- High side, output current max.100 mA
- Update rate: 250 µs



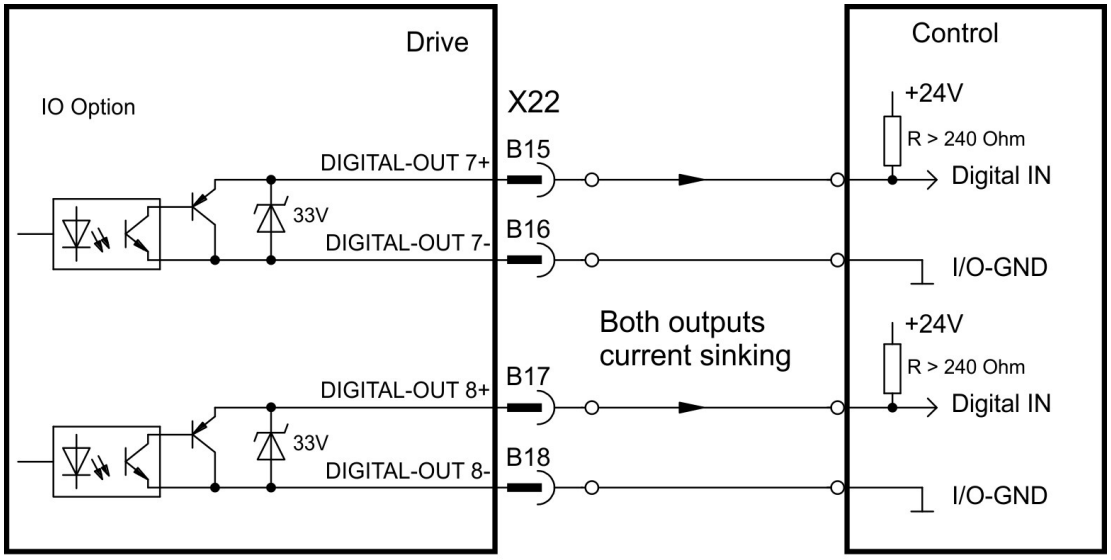
8.14.6.2 Digital-Out 7 and 8

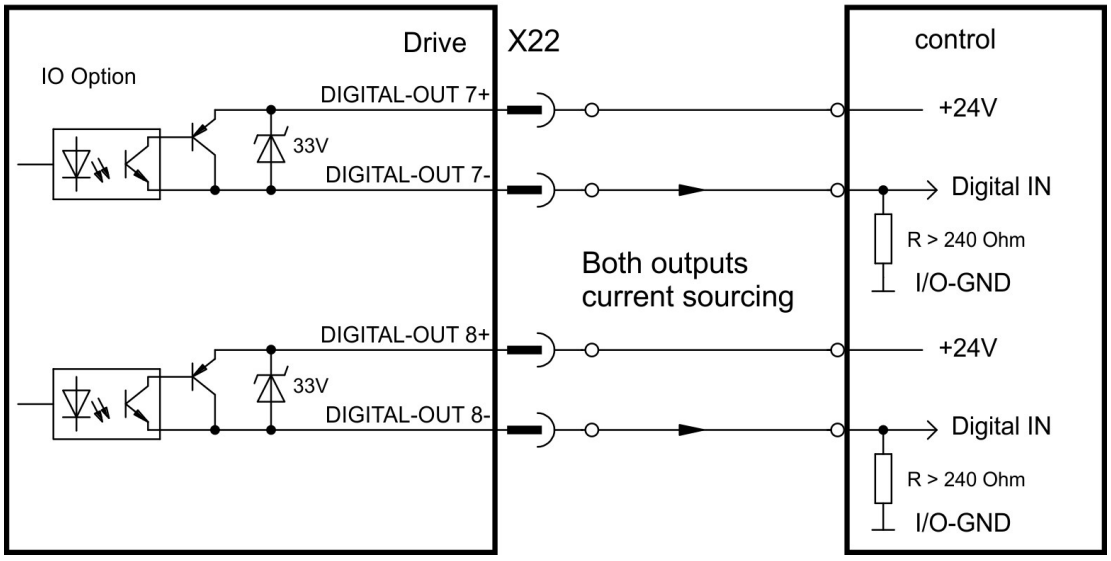
These outputs are programmable with WorkBench. By default, all outputs are not programmed (off).

Technical characteristics

- The outputs can switch +5 V to +30 V
- The two channels are isolated from one another and not referred to a common potential
- Output current max.100 mA
- Can be wired as sinking or sourcing (see examples below)
- Update rate: 250 µs

Wiring examples



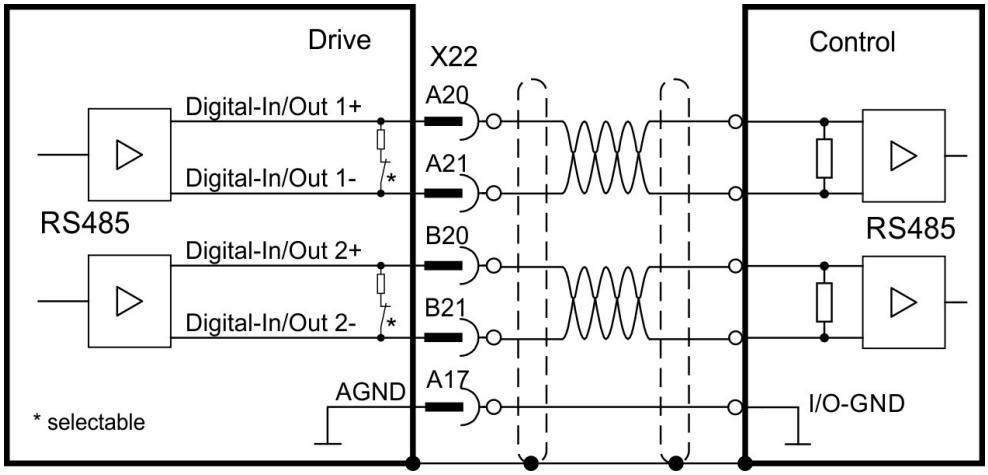


8.14.6.3 Digital-In/Out 1 and 2

Pins X22/A20-A21 (Digital-In/Out 1) and X22/B20-B21 (Digital-In/Out 2) can be used as either inputs or outputs. For programming refer to WorkBench.

Technical characteristics if configured as output

- RS485, reference common line is AGND
- Selectable DC terminationfor differential or single ended output, no wire break detection
- Update rate: 250 µs

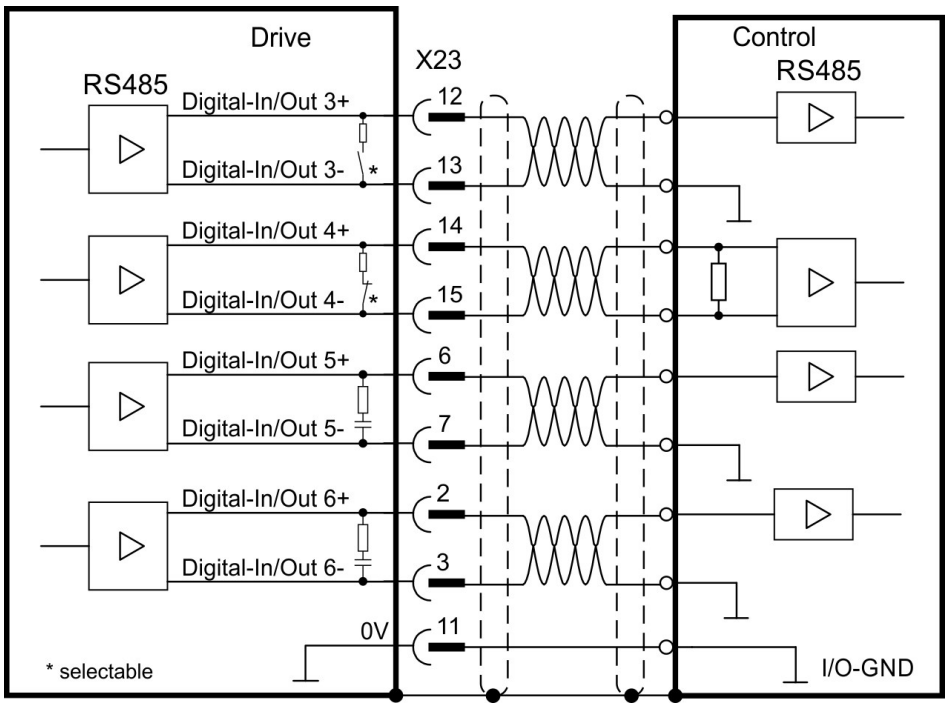


8.14.6.4 Digital-In/Out 3 to 6

X23 can be used for digital I/O. The channels can be defined as inputs or outputs. For programming refer to WorkBench.

Technical characteristics if configured as output

- RS485, reference common line is 0V
- No wire break detection
- Digital IN/OUT 3/4: Selectable DC termination for differential or single ended output
- Digital IN/OUT 5/6: AC termination for single ended output
- Update rate: 250 µs

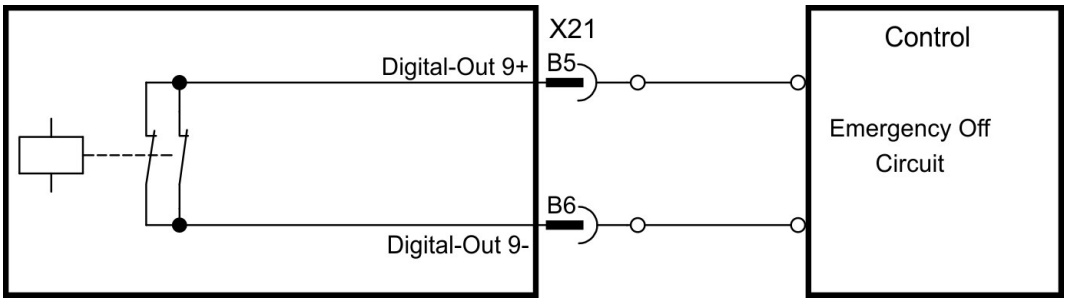


8.14.6.5 Digital-Out 9, Relay contacts

Digital-Out 9 is programmable with the setup software (for more information refer to WorkBench).
By default, the output function is defined as ready to operate output by action keyword.

Technical characteristics

- Relay output, max. 30 VDC or 42 VAC, 1 A
- Time to close: max. 10 ms
- Time to open: max. 10 ms



9 Setup

9.1 Important Notes

NOTICE Only professional personnel with extensive knowledge in the fields of electrical engineering and drive technology are allowed to test and set up the drive

DANGER Lethal Voltage!

There is a danger of serious personal injury or death by electrical shock. Lethal danger exists at live parts of the device.

- Built-in protection measures such as insulation or shielding may not be removed.
- Work on the electrical installation may only be performed by trained and qualified personnel, in compliance with the regulations for safety at work, and only with switched off mains supply, and secured against restart.

WARNING Automatic Restart!

Risk of death or serious injury for humans working in the machine. The drive might restart automatically after power on, voltage dip or interruption of the supply voltage, depending on the parameter setting. If parameter AXIS#.ENDEFAULT is set to 1,

- then place a warning sign ("WARNING: Possible Automatic Restart" or similar) to the machine.
- Ensure, that power on is not possible, while humans are in a dangerous zone of the machine.

CAUTION High Temperature!

Risk of minor burns. The heat sink of the drive can reach temperatures up to 80°C in operation.

- Check the heat sink temperature before handling the drive.
- Wait until the heat sink has cooled down to 40°C before touching it.

NOTICE If the drive has been stored for more than 1 year, you must re-form the capacitors in the DC bus link circuit. Re-forming procedures are described in the KDN (Forming).

NOTE Additional information on setting up the equipment:

- Programming parameters and control loop behavior are described in the online help of the setup software.
- The setup of any fieldbus is described in the corresponding manual on the DVD.

9.2 Guide to drive setup

NOTICE Setup must be done in two major steps:

1. Drive setup (this section). This section presents an example to test the drive initially. If the drive (motor, feedback, control circuits, I/Os) is well parameterized, then proceed with the
2. Functional Safety setup (➜ # 123).

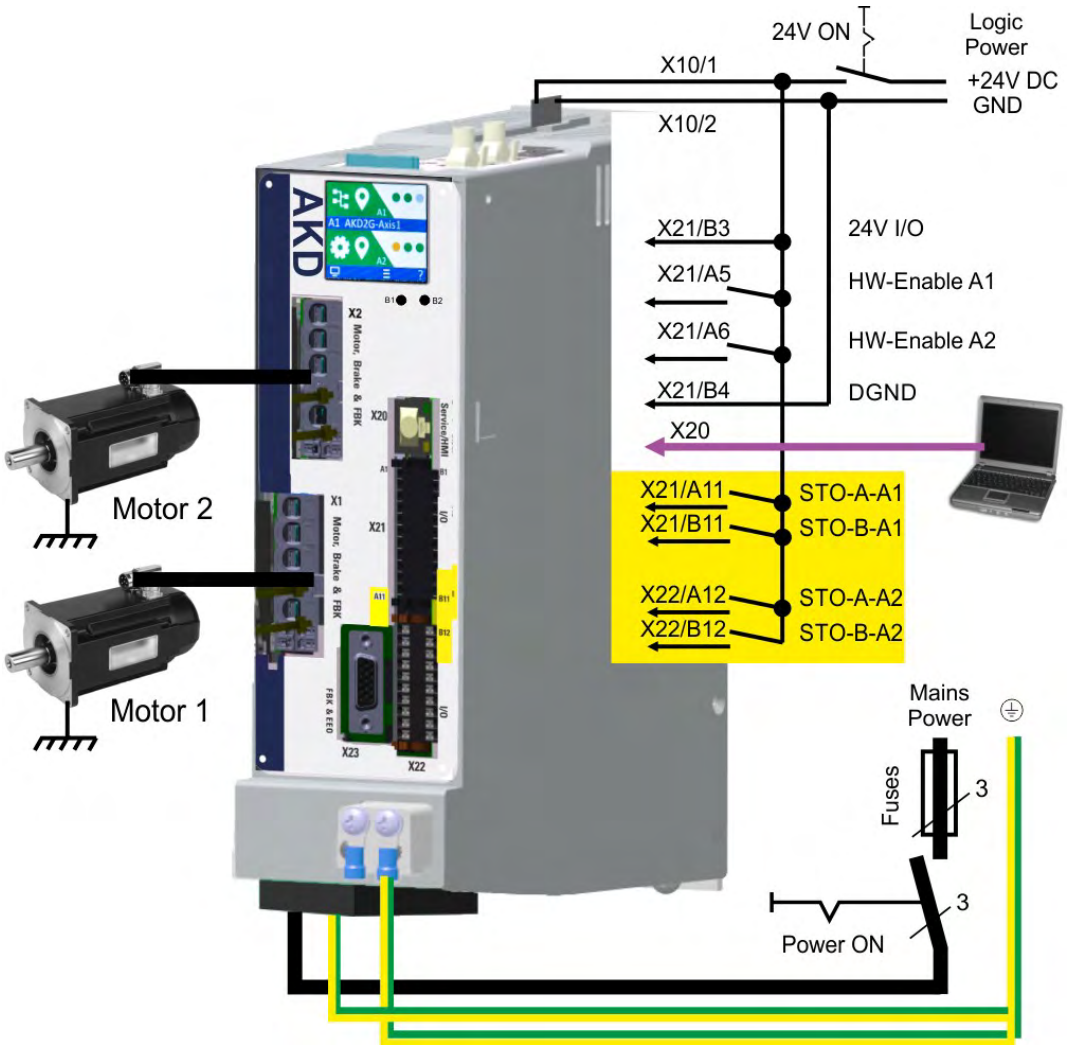
9.2.1 Initial Drive Test Procedure

9.2.1.1 Unpacking, mounting, and wiring the AKD2G

1. Unpack the drive and accessories.
2. Mount the drive.
3. Wire the drive or apply the minimum wiring for drive testing as described below.
4. Make sure you have on hand the following information about the drive components:
   - rated mains supply voltage
   - motor type (motor data, if the motor type is not listed in the motor database)
   - feedback unit built into the motor (type, poles/lines/protocol)
   - moment of inertia of the load

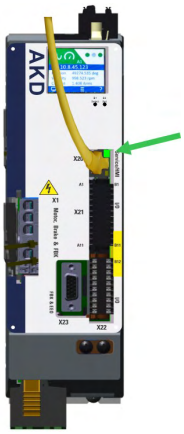
9.2.1.2 Minimum wiring for drive test without load, example

NOTICE This wiring diagram based on default settings is for general illustration only and does not fulfill any requirements for EMC, functional safety, or functionality of your application.



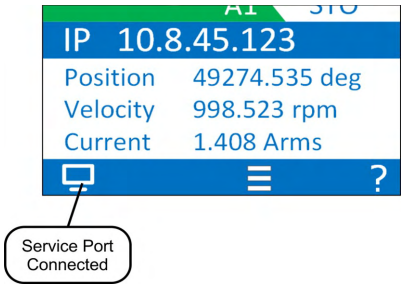
9.2.1.3 Confirm connections (example: directly to PC)

You can turn on logic power to the drive through the X10 connector (mains power voltage is not needed for communications).



Confirm that the link LEDs on the drive (green LED on the RJ45 connector) and on your PC are both illuminated. If both LEDs are illuminated, then you have a working electrical connection.

The LCD display shows a sign, if the connection between AKD2G and WorkBench is active.



Use WorkBench to configure the drive via the service interface.

9.2.1.4 System integration

MAC Address

The unique MAC address is pre-defined by the manufacturer (see nameplate).

Service IP Address

The AKD2G service port X20 supports auto-IP, DHCP and static IP addressing.

The drive is delivered with IP address 0.0.0.0. Depending on the connection (switch or PC) either DHCP or auto-IP mechanism assignes a unique IP address.

WorkBench uses the IP address to detect AKD2G devices in the LAN and start communication. With WorkBench you can set a static IP address for the drive (keyword *IP.ADDRESS*).

EtherCAT Node Address

The EtherCAT node address is assigned automatically by the EtherCAT master.

CAN Node ID

Set a CAN node ID for the drive in WorkBench (keyword *CANBUS.NODEID*).

9.2.1.5 Install and start WorkBench

WorkBench is available from the DVD included with the drive. WorkBench is also available on the Kollmorgen Website: www.kollmorgen.com. Select the install file and follow the instructions given by the installer.

Once installation is complete, click the WorkBench icon to start the program.

9.2.1.6 Setup the axis in WorkBench

Use the setup wizard and

1. Connect the axis,
2. Setup the axis and
3. Save parameter set to the drive.

Refer to the WorkBench Online Help for details.

9.2.1.7 Enable the axis (Hardware)

1. Switch 24 V to the STO inputs (X21/A11-B11 for axis 1 or X21/A12-B12 for axis 2)
2. Switch 24 V to the digital inputs for Hardware Enable Axis 1 (X21/A5) or 2 (X21/A6).

9.2.1.8 Move the motor axis

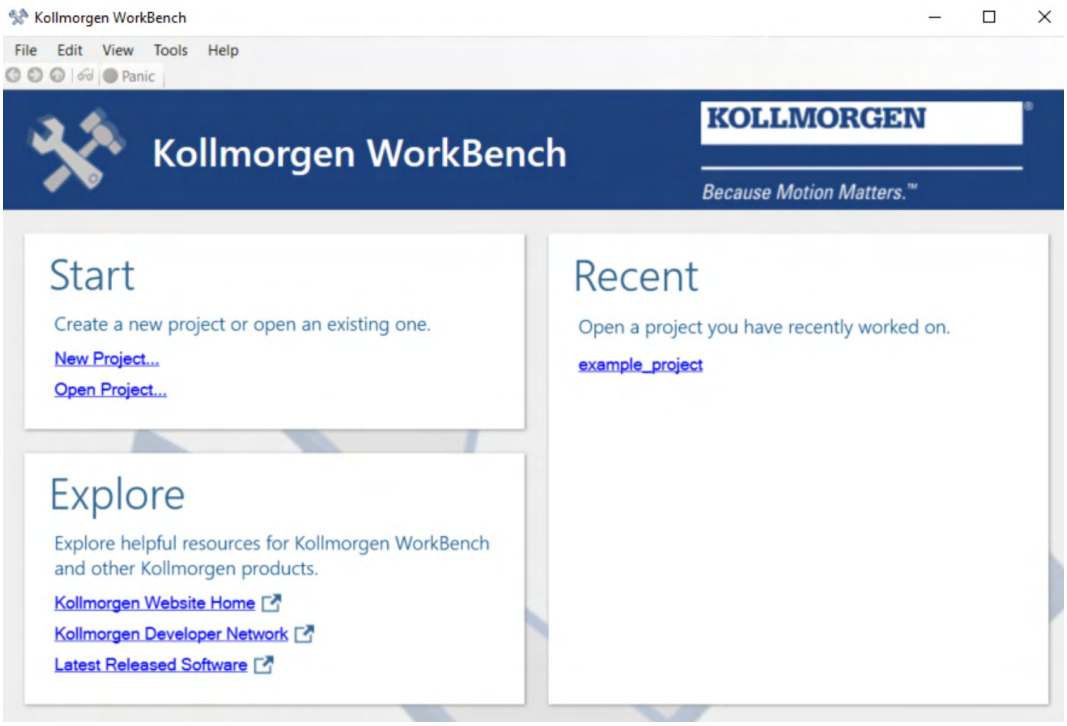
1. Select the axis in WorkBench
2. Enter Service Motion view
3. select "Reversing", check the default velocity and time settings for plausibility
4. Click on Start.

9.2.1.9 Tune the axis

Details see *WorkBench Online Help*

9.2.2 Setup software WorkBench

This chapter describes the installation of the setup software WorkBench for AKD2G drives. Kollmorgen offers training and familiarization courses on request.



9.2.2.1 Use as directed

The setup software is intended to be used for altering and saving the operating parameters for the AKD2G series of drives. The attached drive can be set up with the help of this software, and during this procedure the drive can be controlled directly by the service functions.

Only professional personnel who have the relevant expertise (➜ # 15) are permitted to carry out online parameter setting for a drive that is running.

Sets of data that have been stored on data media are not safe against unintended alteration by other persons. Unexpected move could be the result if you use unchecked data. After loading a set of data you must therefore validate parameters which are relevant for the application before enabling the drive.

9.2.2.2 Software description

Each drive must be configured to the requirements of your machine. For most applications, you can use a PC and WorkBench (the drive setup software) to set up the operating conditions and parameters for your drive.

The PC is connected to the drive by an Ethernet cable (➜ # 98). The setup software provides the communication between the PC and AKD2G. You can find the setup software on the accompanying DVD and in the download area of the Kollmorgen website.

You can alter parameters easily and instantly observe the effect on the drive, since there is a continuous (online) connection to the drive. You can also read important actual values from the drive, which are displayed on the monitor of the PC (oscilloscope functions).

You can save sets of data on data media (archiving) and load them into other drives or use them for backup. You can also print out the data sets.

Most standard feedback systems are plug and play compatible. Motor nameplate data is stored in the feedback device and read by the drive automatically at startup. Non-plug and play Kollmorgen motors are stored in WorkBench and can be loaded with one-click using the Motor screen in the WorkBench software.

An extensive online help with integrated description of all variables and functions supports you in each situation.

9.2.2.3 Hardware requirements

The Service interface (X20, RJ45) of the drive is connected to the Ethernet interface of the PC by an Ethernet cable (➜ # 98).

Minimum requirements for the PC:

Processor: at least 1 GHz
RAM: 512 MB
Graphics adapter : Windows compatible, color
Drives : hard disk with at least 500 MB free space, DVD drive or download from internet
Interface : one free Ethernet Interface, or Switch port

9.2.2.4 Operating systems

Windows 7/8/10

WorkBench works with Windows 7, 8 and 10.
DotNet framework 4.6.1 or higher is required.

Unix, Linux

The functioning of the software has not been tested for Windows running with Unix. The software does not run on Linux.

9.2.2.5 Installation under Windows 7/8/10

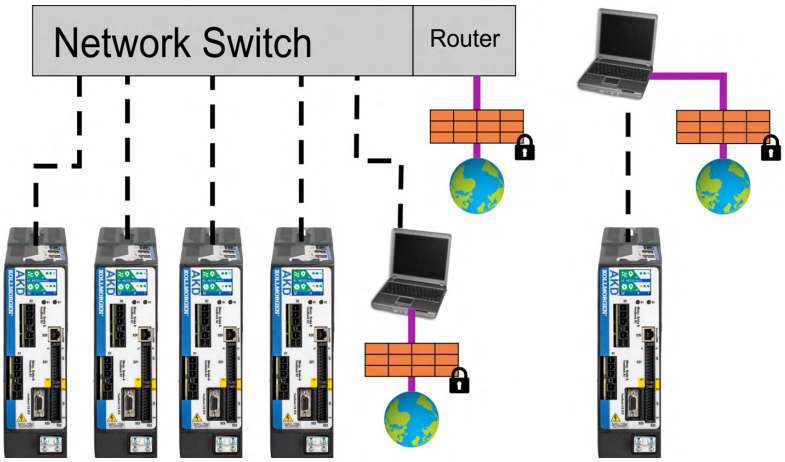
The DVD includes an installation program for the setup software. The latest setup software can be downloaded from www.kollmorgen.com.

Installation

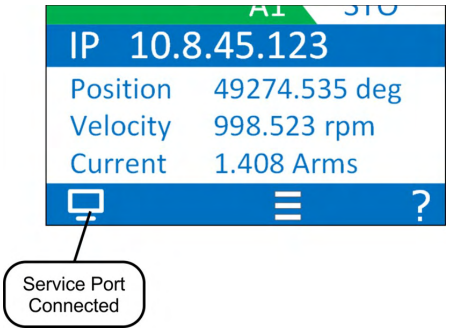
- Autostart function activated:
  Insert the DVD into a free drive. A window with the start screen opens. There you find a link to the setup software WorkBench. Click it and follow the instructions.
- Autostart function deactivated:
  Insert the DVD into a free drive. Click **Start** (task bar), then **Run**. Enter the program call: x:\index.htm (x = correct DVD drive letter).
  Click **OK** and proceed as described above.

Connection to the Ethernet interface of the PC

- Connect the interface cable to an Ethernet interface on your PC or to a Switch and to the service interface X20 of the AKD2G (➔ # 98).



The LCD display shows a sign, if the connection between AKD2G and WorkBench is active.



9.3 Switch-On and Switch-Off Behavior

This chapter describes the switch-on and switch-off behavior of the AKD2G with STO.

Behavior of “holding brake” function

Drives with an enabled holding brake function have a special timing for switching on and off the output stage (➜ # 82). Events that remove the AXIS#.ACTIVE signal trigger the holding brake to apply. As with all electronic circuits, the general rule applies that there is a possibility of the internal holding brake module failing.

Functional safety, e.g. with hanging load (vertical axes), requires an additional mechanical brake which must be safely operated, for example by a safety control.

If velocity drops below threshold *AXIS#.CS.VTHRESH* or timeout occurs during a stop procedure, the brake is applied. Set parameter AXIS#.MOTOR.BRAKEIMM to 1 with vertical axes, to apply the motor holding brake (➜ # 82) immediately after faults or Hardware Disable.

Behavior when undervoltage condition is present

The behavior in an undervoltage condition depends on the VBUS.UVMODE setting.

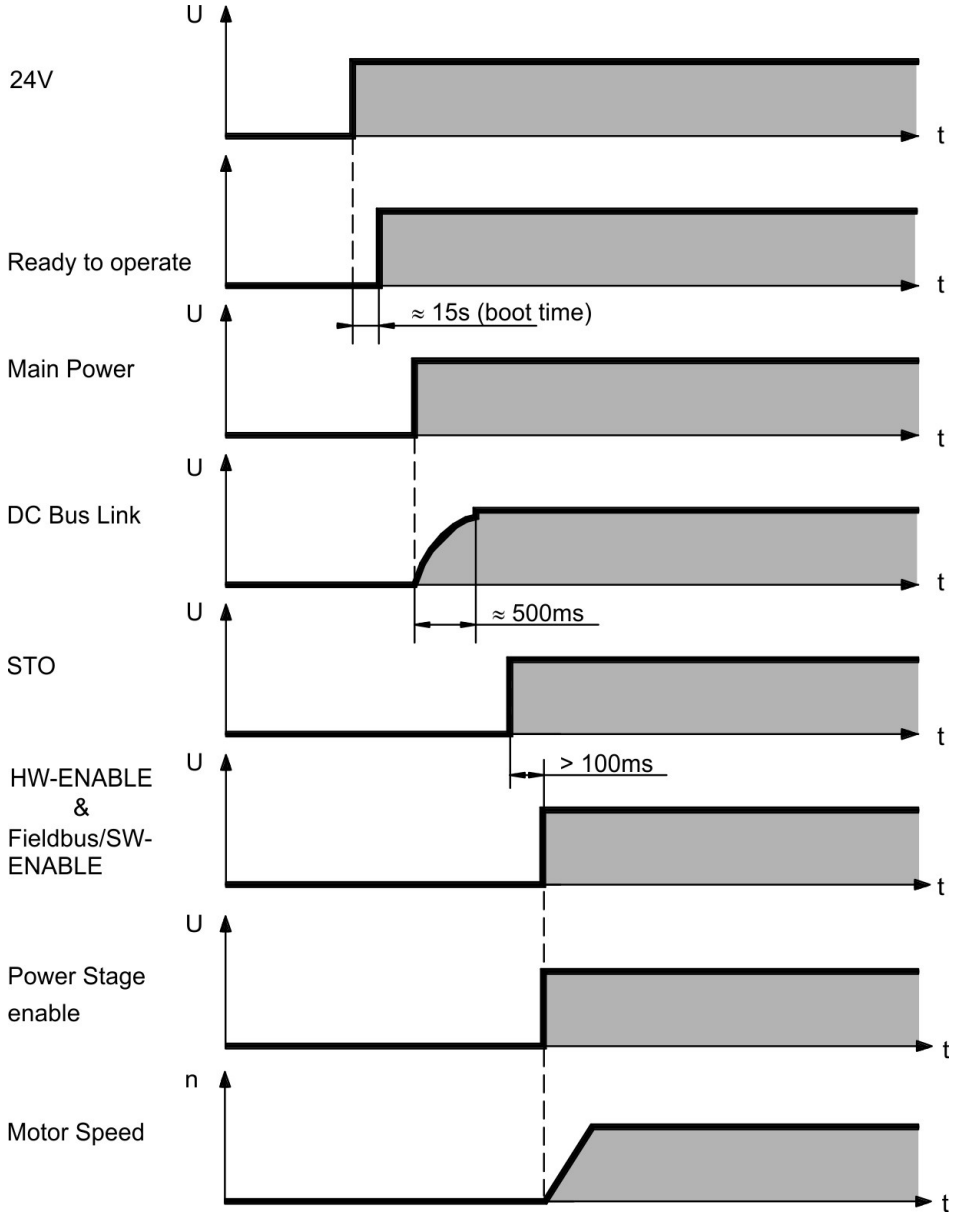
VBUS.UVMODE	DC Bus Undervoltage Mode. Consult the *WorkBench Online Help* for configuring the parameter.
0	The drive will report a F2007 undervoltage fault any time an undervoltage condition occurs.
1 (default)	The drive will report a warning W2007 if not enabled. The drive will report a fault if the drive is enabled when the condition occurs, or an attempt is made to enable while an under voltage condition occurs.

Functional Safety

The drive can be secured to standstill with STO. Even when power is being supplied, the drive shaft is protected against unintentional restart. The chapter “Functional Safety” describes how to use the safety functions (➜ # 124).

9.3.1 Switch-on behavior in standard operation

The diagram below illustrates the correct functional sequence for switching the drive on.



9.3.2 Switch-off behavior

Chapter in process

9.4 Fault and Warning Messages

9.4.1 Fault and warning messages AKD2G

A Fault is generally a notification of a critical system failure which will stop machine operation. Depending on the severity of the fault will depend on which system-stop mechanism is used.

A Warning is generally a notification to the user which is not critical and does not require the machine to immediately shut off.

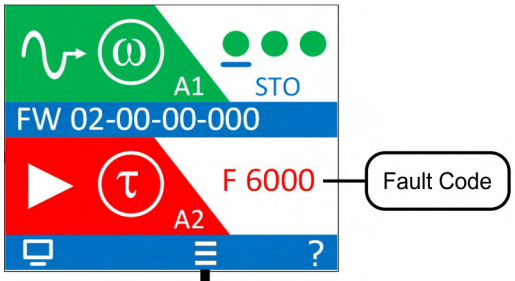
Faults and Warnings follow the same pattern and are identified by a four digit code:

G G X X

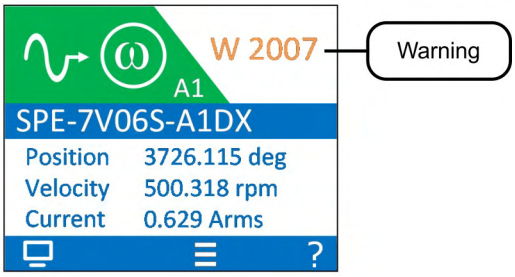
where GG is a two digit group code, and XX is a two digit ID.

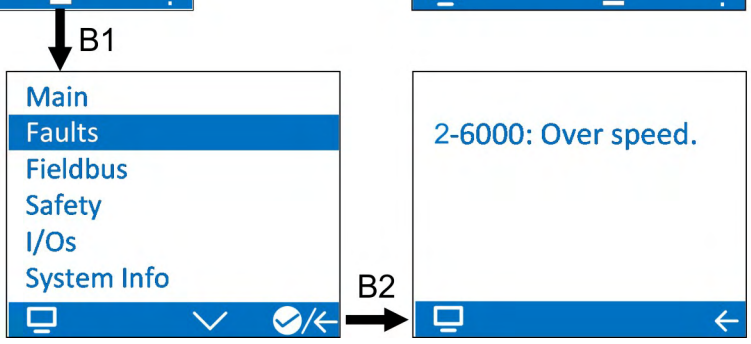
The display on the front panel of the drive shows the code of the fault or warning that occurred. Navigate with B1 / B2 to the Fault screen to see a short description of the fault or warning.

Example: dual axes, Fault Axis 2



Example: single axis, Warning Axis 1





You can retrieve faults on a per-axis basis with the keyword: AXIS#.FAULTS, where # is the Axis number.

Multiple faults may be present when a fault condition is occurring. Check the AKD2G WorkBench Fault Screen or read the status of DRV.FAULTS and AXIS#.FAULTS through the controller or HMI for the entire list of faults.

DRV.FAULTS will return all faults across all Axes, with the format #-GGXX where # is the axis number and GGXX is the four digit fault/warning code.

Retrieving Warnings is very similar, you can use AXIS#.WARNINGS, or DRV.WARNINGS.

NOTICE Eliminate errors and faults in compliance with work safety rules. Troubleshooting only by qualified and trained staff.

NOTE More information about fault messages, remedy and clearing faults can be found in the WorkBench online help.

9.5 Troubleshooting the AKD2G

Drive problems occur for a variety of reasons, depending on the conditions in your installation. The causes of faults in multi-axis systems can be especially complex. If you cannot resolve a fault or other issue using the troubleshooting guidance presented below, customer support can give you further assistance.

NOTICE Eliminate errors and faults in compliance with work safety rules. Troubleshooting only by qualified and trained staff.

NOTE More details on the removal of faults can be found in the WorkBench online help and in **KDN**.

Problem	Possible Causes	Remedy
HMI message: Communication fault	1. wrong cable used, cable plugged into wrong position on drive or PC 2. wrong PC interface selected	1. plug cable into the correct sockets on the drive and PC 2. select correct interface
Drive does not enable	1. HW Enable configured but not wired 2. HW or SW Enable not set	1. connect HW Enable to the selected input 2. Apply 24V to HW Enable and select SW Enable in WorkBench / Fieldbus
Motor does not rotate	1. drive not enabled 2. software enable not set 3. break in setpoint cable 4. motor phases swapped 5. brake not released 6. drive is mechanically blocked 7. motor pole no. set incorrectly 8. feedback set up incorrectly	1. apply ENABLE signal 2. set software enable 3. check setpoint cable 4. correct motor phase sequence 5. check brake control 6. check mechanics 7. set motor pole no. 8. set up feedback correctly
Motor oscillates	1. gain is too high (speed controller) 2. feedback cable shielding broken 3. AGND not wired up	1. reduce AXIS#.VL.KP (speed controller) 2. replace feedback cable 3. join AGND to CNC-GND
Drive reports following error	1. Irms or Ipeak set too low 2. current or velocity limits apply 3. accel/decel ramp is too long	1. verify motor/drive sizing 2. verify that AXIS#.IL.LIMITN/P, AXIS#.VL.LIMITN/P are not limiting the drive 3. reduce AXIS#.ACC/AXIS#.DEC
Motor overheating	1. motor operating above its rating 2. motor current settings incorrect	1. verify motor/drive sizing 2. verify motor continuous and peak current values are set correctly
Drive too soft	1. AXIS#.Kp (speed controller) too low 2. AXIS#.Ki (speed controller) too low 3. filters set too high	1. increase AXIS#.VL.KP (speed controller) 2. increase AXIS#.VL.KI (speed controller) 3. refer to documentation regarding reducing filtering (AXIS#.VL.AR*)
Drive runs roughly	1. AXIS#.Kp (speed controller) too high 2. AXIS#.Ki (speed controller) too high 3. filters set too low	1. reduce AXIS#.VL.KP (speed controller) 2. reduce AXIS#.VL.KI (speed controller) 3. refer to documentation regarding increasing filtering (AXIS#.VL.AR*)

10 Functional Safety

Valid for AKD2G Hardware Revision A

Revision History for section Functional Safety

Revision	Remarks
S101, 12/2018	Functional Safety Option 1, beta version

10.1 General notes

NOTICE Beta Drives: Functional Safety of AKD2G is neither approved nor certified. Do not use this functionality in applications with functional safety request.

Resulting Functional Safety classification (SIL and/or PL level) is calculated across the drive system. The drive system usually consists of

- motion controller (e.g. AKC/KAS),
- safety controller (e.g. KSM),
- servo drives (AKD2G) and servo motors (e.g. AKM2G),
- motor brakes, feedback systems,
- cables to connect drive and motor,
- sensors/actors.

The safety properties listed in this chapter can be reached if the Kollmorgen components are used.

NOTICE Only properly qualified personnel are permitted to perform such tasks as installation, setup and parameterization.

- Mechanical installation: only by qualified personnel with mechanical expertise according to IEC 60417-6183.
- Electrical installation: only by qualified personnel with electrotechnical expertise according to IEC 60417-6182.
- Parameterizing Functional Safety: only by trained personnel with expertise appropriate to the complexity and safety integrity level of the drive system.
- Verification/Validation: only by trained personnel after any changes to the installation. The expertise of the personnel must be appropriate to the complexity and safety integrity level of the drive system.

⚠CAUTION High electrical voltage!

Risk of electrical shock! The safety functions do not provide an electrical separation from the power output. If manual access to the motor or drive power terminals is necessary,

- disconnect the drive from mains supply,
- consider the discharging time of the DC-Bus link,
- ensure the cabinet is safely disconnected and protected against unintended switch-on (for instance, with a lock-out and warning signs).

10.2 Use as directed

Safety functions are intended to reduce the risk of the machine operation to the required tolerable risk. To achieve functional safety, the wiring of the safety circuits must meet the safety requirements of IEC 60204, ISO 12100 and ISO 13849.

NOTICE

- The network, where the drive is connected to, must be secured according to state-of-the-art information technology security requirements.
- The user IT specialists shall analyze whether further security requirements are applicable to ensure functional safety.

NOTICE The drive firmware can be updated without opening the AKD2G while it is built into the machine. The parameter sets must be reloaded, verified and proof tested before normal operation is started.

10.3 Prohibited use

The safety functions must not be used if the drive is to be made inactive for Emergency-Off situations. In an Emergency-Off situation, the main relay is switched off (by the Emergency-Off button).

The device does not require maintenance. Opening the device voids the warranty. In case of damage or malfunction the drive must be sent for repair or must be replaced.

10.4 Abbreviations used for functional safety

More abbreviations see (➜ # 12).

Abbreviation	Meaning
A#, AXIS#	A# or AXIS# are placeholders for the axis number. Used with keywords (AXIS#.SAFE.STO.ACTIVATESOURCE) or signal names (STO-A-A#)
(➜ # 53)	"see page 53" in this document
CCF	Common cause failure
FS	Functional Safety
FS1	Functional Safety Option 1 (STO)
HFT	Hardware fault tolerance
MTTFd	Mean time to dangerous failure
OSSD	Output Switching Signal Device
PELV	Protective Extra Low Voltage
PFHd	Probability of dangerous failure per hour
PL	Performance Level
SC	Systematic Capability
SIL	Safety Integrity Level
STO	Safe Torque Off
TM	Mission time

10.5 Enclosure, wiring

Enclosure

Since the drive meets IP20, you must select an enclosure that permits safe operation of the drive. The enclosure must at least meet IP54 .

Storage	
• **Temperature** • **Humidity**	• -25 to +55 °C, maximum rate of change 20 K/hour, class 1K4. • 5 to 95% relative humidity, no condensation, class 1K3.

Transport	
NOTE	Transport only in the manufacturer's original recyclable packaging.
• **Temperature** • **Humidity** • **Shock**	• -25 to +70 °C, maximum rate of change 20 K/hour, class 2K3. • max. 95% relative humidity at +40°C, no condensation, class 2K3. • Avoid shocks while transporting. AKD2G modules are tested for environmental class 2M1 of IEC 60721-3-2.

Operation	
• **Temperature** • **Humidity**	• 0 to +40 °C under rated conditions, IEC 61800-2 class 3K3 +40 to +55 °C with continuous current derating 4 % per Kelvin • Relative humidity 5 to 85%, no condensation, IEC 61800-2 class 3K3
Site altitude	• Up to 1000 m above mean sea level (AMSL): no restriction • 1,000 to 2,000 m AMSL: power derating 1.5%/100 m • Maximum altitude: 2000 m AMSL
Drive EMC immunity	Increased immunity according to EN 61800-5-2
Drive Pollution level	Pollution level 2 as per IEC 60664-1
Drive Vibration class	Class 3M1 according to IEC 61800-2
Drive Shock class	Class L according to IEC 61800-2
Drive protection class	IP20 according to IEC 60529
Enclosure protection	At least IP 54 according to IEC 60529

Wiring

Wiring inside the specified enclosure (IP54) must meet the requirements of the standard IEC 60204-1 and ISO 13849-2 (Table D.4).

Wiring outside the specified enclosure (IP54) must be laid durably protected from outside damage (for example, by laying the cable in a duct), placed in different sheathed cables, or protected individually by grounding connection.

Use copper wires, 0.5 mm² (20 awg), wire ferrules. Maximum distance for unshielded cables 30 m.

NOTICE The wiring of the digital inputs and outputs must be done in a way, that short circuits between the inputs, the outputs or to a supply line are avoided.

10.6 Functional Safety Option 1 (I/O, SIL2 PLd)

NOTICE Beta Drives: STO function of AKD2G is neither approved nor certified. Do not use this functionality in applications with functional safety request.

Valid for AKD2G devices with Functional Safety Option 1:

AKD2G - xxx - xxxxx - x1xx - xxxx

Standards

Standard	Edition	Content
ISO 13849	2015	Safety of machinery: Safety-related parts of control systems
IEC 62061	2015	Functional safety of electrical/electronic/programmable electronic safety-related systems

Available Safety Functions

Abbr.	Function	Activation	Refer to
STO	Safe Torque Off	Safe digital inputs for one or for both axis	(➜ # 129)

10.6.1 Technical Data

NOTE Safe inputs are fixed to the STO function.

When STO function (Safe Torque Off) is not needed, then all STO inputs must be connected directly with +24 V. The STO function is then bypassed and cannot be used.

I/O data

- Reference ground is DGND
- Galvanic isolation for 60 VDC
- Activation delay about 5 µs
- De-activation delay about 500 µs
- Use 24 VDC ±15% PELV power supply
- High level 17 VDC to 30 VDC, 5 mA to 6 mA
- Low level 0 VDC to 5 VDC, max.1 mA

Pinout

X21	Signal	Description
A11	STO-A-A1	STO channel A (for axis 1)
B11	STO-B-A1	STO channel B (for axis 1)

Drives with two axes, or option IO or DX:

X22	Signal	Description
A12	STO-A-A2	STO channel A (for axis 2)
B12	STO-B-A2	STO channel B (for axis 2)

Keywords

Keyword	Description
AXIS#.SAFE.STO.A	Reads the status of STO input channel A for axis #.
AXIS#.SAFE.STO.B	Reads the STO input channel B for axis #.
AXIS#.SAFE.STO.ACTIVE	Reads the STO status of axis#.
AXIS#.SAFE.STO.REPORTFAULT	F9000 and W9000 are triggered for axis # only, if set to 1 (default).

NOTE For full keyword description refer to the *Functional Safety Parameter Reference Guide* (➜ # 135).

Factory Default Settings

AXIS#.SAFE.STO.REPORTFAULT is set to 1.

10.6.2 Safety Properties Overview

These inputs are compatible with safety equipment that emits test pulses. However, test pulses are not required. Incoming test pulses of up to 1 ms duration are ignored. The dwell time of the test pulses should not exceed 10%.

The hardware fault tolerance is HFT = 1 according to IEC 61508. Two faults might lead to loss of the safety functions.

The systematic capability according to IEC 61508 for the safety-related subsystems of the drive are SC = 2. TM = 20 Years, SFF = 100%.

Function	ISO 13849-1	$MTTF_d$ Years	IEC 62061	PFH [1/h]	CCF [%]	Response time
STO dual channel	PL d, Cat. 3	i.p.	SIL 2	i.p.	>65	< 3.5 ms

10.6.3 STO (Safe Torque Off)

Safe **T**orque **O**ff description for drive option Functional Safety 1.

10.6.3.1 Description

STO is suited for SIL 2 according to IEC 62061 and PLd / Cat.3 according to ISO 13849-1. STO is a type A subsystem according to IEC 61508.

STO turns off the drive output stage that powers the motor. STO function corresponds to a not controlled braking according to IEC 60204-1, category 0.

10.6.3.1.1 Important Notes

NOTICE The safety properties given in this documentation refers to the device AKD2G with functional safety option 1. The user has to determine the safety properties of the safety chain.

⚠WARNING No Brake Power!

Serious injury could result when a suspended load is not properly blocked. The drive cannot hold a vertical load when STO is active.

- Add a safe mechanical blocking (for instance, a motor-holding brake).

10.6.3.1.2 Precondition before activation

None.

10.6.3.1.3 Activation

The digital STO inputs (channel A and B) must be connected to the output of a safety control or a safety relay, which at least meets the requirements of PLd, Cat. 3 according to ISO 13849. Technical data of the safe inputs (➜ # 127).

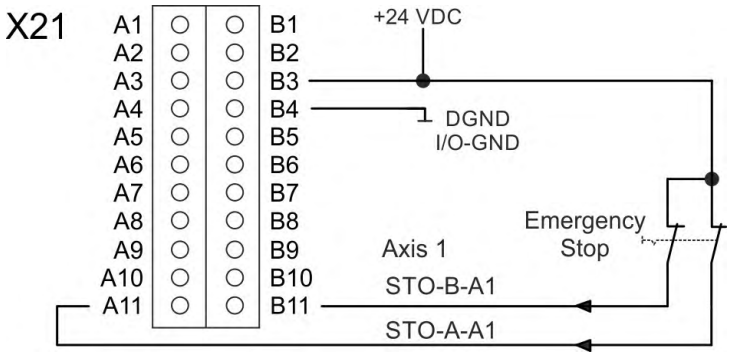
If one of the STO inputs goes open-circuit or 0 V, then power supply to the motor stops within 3.5 ms. The motor will lose all torque and coast to a stop.

If the drive detects that the two STO inputs are in a different state for longer than 100 ms, then a simultaneity fault F9005 occurs (➜ # 132).

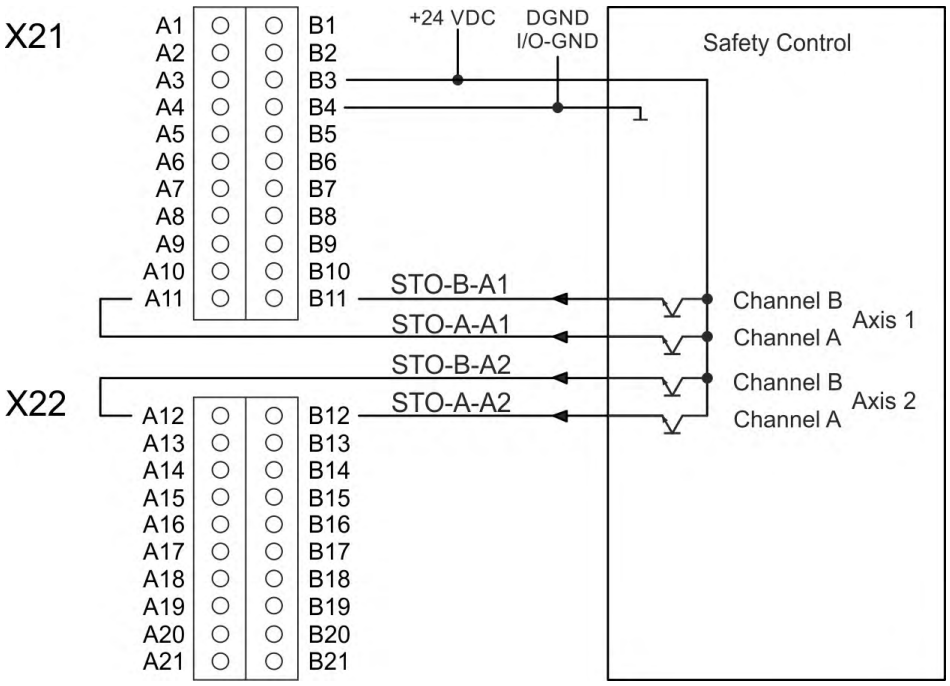
NOTE Review the enclosure and wiring instructions (➜ # 126).

Wiring example STO single axis, SIL2/PLd, Emergency Stop

Note: AXIS1.SAFE.STO.REPORTFAULT should be set to 1 if STO is activated by a switch.



Wiring example STO dual axis, SIL2/PLd, Safety Control



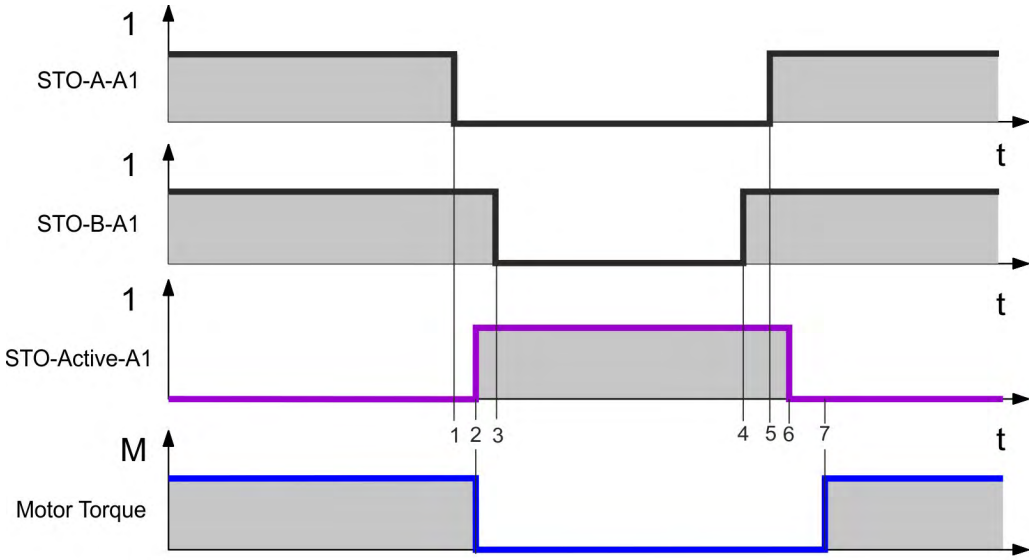
10.6.3.1.4 Restart

Example for Axis 1.

	AXIS1.SAFE.STO. REPORTFAULT = 1	AXIS1.SAFE.STO. REPORTFAULT = 0
Example 1: Axis 1 was disabled, STO is activated	Message W9000 Restart: 1. deactivate STO 2. enable axis 1	Restart: 1. deactivate STO 2. enable axis 1
Example 2: Axis 1 was enabled, STO is activated	Messages W9000 and F9000 Restart: 1. disable axis 1 2. deactivate STO 3. clear fault 4. enable axis 1	Restart: 1. deactivate STO
Example 3: Axis 1 was disabled, STO is activated faulty	Message F9005 Restart: 1. check wiring 2. remedy the cause 3. deactivate STO 4. clear fault 5. enable axis 1	Message F9005 Restart: 1. check wiring 2. remedy the cause 3. deactivate STO 4. clear fault 5. enable axis 1

10.6.3.1.5 Timing

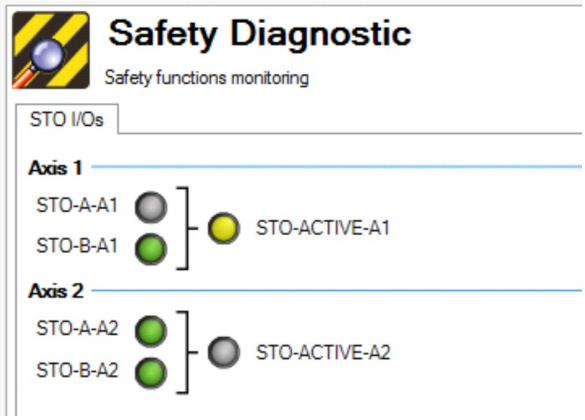
Example for axis 1.



Timing	max	Remarks
t1		STO channel A enabled (0 V)
t1 to t2	2 ms	STO enable delay (response time)
t2		STO active
t3		STO channel B enabled (0 V)
t1 to t3	100 ms	accepted delay between dual channel edges
t4		STO channel B disabled (+24 V)
t5		STO channel A disabled (+24 V)
t4 to t5	100 ms	accepted delay between dual channel edges
t5 to t6	2 ms	STO release delay
t6		STO release
t6 to t7		Zero if AXIS1.STO.REPORTFAULT=0 Until 'no fault' if AXIS1.STO.REPORTFAULT=1
t7		Power section released.

10.6.3.2 Safety Diagnostic view in WorkBench

The WorkBench view "Safety Diagnostic" shows the current status on the safe inputs (AXIS#.SAFE.STO.A/B) and the logical status of the STO function for every axis.



10.6.3.3 Fault Reaction / Failure Messages

With the dual-channel control of the STO (SIL2/PLd Cat.3) safety function, the switch-off paths STO-A-A# and STO-B-A# are switched separately by two outputs of a safety controller.

W9000 and F9000 are conditioned by the value of *AXIS#.SAFE.STO.REPORTFAULT*. If this keyword is set to 1 (default value) then the W9000 and F9000 will be triggered as described.

STO-A-A#	STO-B-A#	ENABLE	Drive Message	Motor Torque	Safe State
0 V	0 V	0 V	W9000	no	yes
0 V	0 V	+24 V	F9000	no	yes
+24 V	+24 V	0 V	-	no	no
+24 V	+24 V	+24 V	-	yes	no
+24 V	0 V	0 V	F9005*	no	yes
+24 V	0 V	+24 V	F9005*	no	yes
0 V	+24 V	0 V	F9005*	no	yes
0 V	+24 V	+24 V	F9005*	no	yes

* different status of STO-A/B for more than 100 ms
A#: A1 for axis 1 or A2 for axis 2.

10.6.4 Verification, Commissioning

10.6.4.1 Verification

Check and verify the STO wiring (examples (➜ # 129)). The installation must be verified by trained personnel after any changes to the installation. The level of experience of the personnel must be appropriate to the complexity and safety integrity level of the drive system.

10.6.4.2 Proof test

NOTICE

You must test the STO function after initial start of the axis, after each intervention into the wiring of the system, or after exchange of one or several components of the system.

Precondition: AXIS#.SAFE.STO.REPORTFAULT = 1

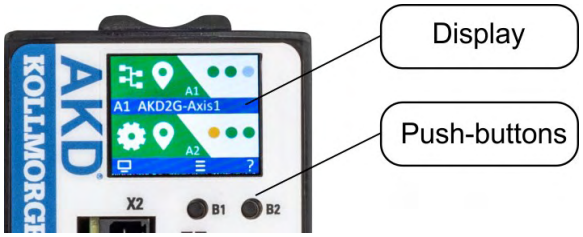
Method 1, axis remain enabled	Method 2, axis disabled
1. Stop the axis with setpoint 0V. **2. Caution: Block vertical load.** 3. Keep the axis enabled. **DANGER: Do not enter hazardous area!** 4. Activate the STO function for example by opening the protective screen. 5. The axis displays fault F9000.	1. Stop the axis with setpoint 0V. **2. Caution: Block vertical load.** 3. Disable the axis (Enable=0V). 4. Activate the STO function, for example, by opening the protective screen 5. The axis displays fault W9000.

10.7 Safety Faults, Safety Warnings

AKD2G with safety option 1 do not have safety failure modes.

10.7.1 Drive LCD Display

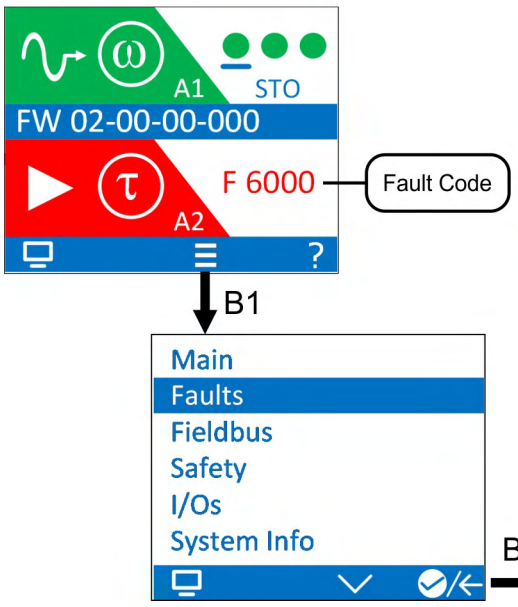
The drive offers an LCD display and two push-buttons B1 / B2 for navigation.



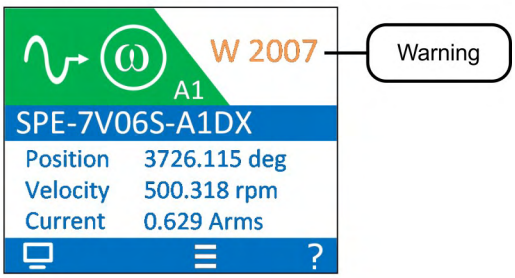
The display on the front panel of the drive shows the code of the fault or warning that occurred. Safety Faults and Warnings follow the same pattern and are identified by a four digit code 90 XX, where 90 is the two digit group code, and XX is a two digit ID.

Navigate with B1 / B2 to the Fault screen to see a short description of the fault or warning. See WorkBench Onlinehelp for details.

Example: dual axes, Fault Axis 2



Example: single axis, Warning Axis 1



10.7.2 Drive Safety Faults

NOTE More information about drive fault messages, remedy and clearing faults can be found in the WorkBench online help.

#	Description	Cause	Remedy
F9000	Safe torque off.	Safe torque off function has been triggered.	Reapply supply voltage to STO if safe to do so.
F9003	Incorrect safety card detected	Drive is configured to have a safety module (functional safety option 2 or 3) but one is not detected.	Return hardware to manufacturer
F9004	Safe torque off pulse and standard lines don't match	Safe Motion Module communication is not as expected	Contact Customer Support
F9005	STO Simultaneity	The two STO inputs did not change state within 100ms of each other.	Clear faults

10.7.3 Drive Safety Warnings

NOTE More information about drive warnings can be found in the WorkBench online help.

#	Description	Cause	Remedy
W9000	Safe torque off.	Safe torque off function has been triggered.	Reapply supply voltage to STO if safe to do so.

10.7.4 Troubleshooting safety functionality

NOTICE Eliminate errors and faults in compliance with work safety rules. Troubleshooting only by qualified and trained staff.

Problem	Possible Causes	Remedy causes
A group "90" safety fault or safety warning message is visible in the drive LCD display	Refer to the safety fault (➜ # 134) and safety warnings (➜ # 134) tables.	
A fault or warning message of another group than "90" is visible in the drive LCD display	Refer to the drive fault and drive warnings tables (➜ # 121) and more detailled descriptionsin the WorkBench online help.	
Drive does not enable	1. HW Enable configured but not wired 2. STO active 3. HW or SW Enable not set	1. connect HW Enable to the selected input 2. deactivate STO prior to HW Enable 3. apply 24V to HW Enable and select SW Enable in WorkBench / Fieldbus
Motor does not rotate	1. STO active 2. hardware enabled not set 3. software enable not set 4. axis setup not correct 5. Fault message active	1. deactivate STO prior to HW Enable 2. apply 24V to HW Enable 3. set software enable in WorkBench / Fieldbus 4. check wiring and axis parameters 5. clear fault

10.8 Functional Safety Keyword Reference Guide

This section describes the keywords used for functional safety.

10.8.1 AXISx.SAFE.STO Parameters

This section describes Safe Torque Off keywords.

10.8.1.1 AXIS#.SAFE.STO.ACTIVE

10.8.1.1.1 Description

Indicates the Safe Torque Off (STO) state of the axis. The STO status is an AND link of AXIS#.SAFE.STO.A and AXIS#.SAFE.STO.B signals.

Value	Description
1	STO active (inputs +0V)
0	STO inactive (inputs 24V)

10.8.1.1.2 Context

For full STO information refer to Safe Torque Off (➜ # 129).

10.8.1.1.3 Versions

Action	Version	Notes
Implemented	02-00-00-000	

10.8.1.1.4 General Information

Type	Read Only
Units	N/A
Range	0 or 1
Default Value	N/A
Data Type	Integer
Stored in Non Volatile Memory	No

10.8.1.1.5 Variants Supported

All variants are supported.

10.8.1.2 AXIS#.SAFE.STO.A

10.8.1.2.1 Description

Indicates the state for STO-A input.

Value	Description
1	24V present (STO inactive, allowed to enable)
0	24V not present (STO active, axis disabled)

10.8.1.2.2 Context

For full STO information refer to Safe Torque Off (➜ # 129).

10.8.1.2.3 Versions

Action	Version	Notes
Implemented	02-00-00-000	

10.8.1.2.4 General Information

Type	Read Only
Units	N/A
Range	0 or 1
Default Value	N/A
Data Type	Integer
Stored in Non Volatile Memory	No

10.8.1.2.5 Variants Supported

All variants are supported.

10.8.1.3 AXIS#.SAFE.STO.B

10.8.1.3.1 Description

Indicates the state for STO-B input.

Value	Description
1	24V present (STO inactive, allowed to enable)
0	24V not present (STO active, axis disabled)

10.8.1.3.2 Context

For full STO information refer to Safe Torque Off (➜ # 129).

10.8.1.3.3 Versions

Action	Version	Notes
Implemented	02-00-00-000	

10.8.1.3.4 General Information

Type	Read Only
Units	N/A
Range	0 or 1
Default Value	N/A
Data Type	Integer
Stored in Non Volatile Memory	No

10.8.1.3.5 Variants Supported

All variants are supported.

10.8.1.4 AXIS#.SAFE.STO.REPORTFAULT

10.8.1.4.1 Description

This keyword indicates whether an STO Fault will be created when the STO input is lost while the axis is enabled.

Value	Description
1	STO fault is indicated when axis is enabled and an STO occurs (default)
0	STO fault is not indicated (warning is still present)

10.8.1.4.2 Context

For full STO information refer to Safe Torque Off (➜ # 129).

10.8.1.4.3 Versions

Action	Version	Notes
Implemented	02-00-00-000	

10.8.1.4.4 General Information

Type	Read/Write
Units	N/A
Range	0 or 1
Default Value	1
Data Type	Integer
Stored in Non Volatile Memory	Yes

10.8.1.4.5 Variants Supported

All variants are supported.

11 Approvals

NOTICE Beta Drives: Approvals (CE, Functional Safety, UL) are in process.

11.1 Conformance with UL/cUL

NOTE UL/cUL listing in process.

11.2 Conformance with CE

INFO CE approval in process.

11.3 Conformance with RoHS

Directive 2011/65/EC of the European Union on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) became operative as from the 3rd of January, 2013. Following substances namely are involved

Lead (Pb), Cadmium (Cd), Hexavalent chromium (CrVI), Polybrominated biphenyls (PBB), Polybrominated diphenyl ethers (PBDE), Mercury (Hg)

The device is manufactured in conformance with RoHS.

11.4 Conformance with REACH

EU Regulation no. 1907/2006 deals with the registration, evaluation, authorization and restriction of chemical substances 1 (abbreviated to "REACH").

The device does not contain any substances (CMR substances, PBTsubstances, vPvB substances and similar hazardous substances stipulated in individual cases based on scientific criteria) above 0.1 mass percent per product that are included on the candidate list.

11.5 Functional Safety approval

NOTICE Functional Safety of AKD2G is not approved nor certified. Do not use this functionality in applications with functional safety request.

Kollmorgen offers 3 levels of functional safety implementation for AKD2G:

- Safety Option 1 : STO, SIL2 PLd (➜ # 127), digital I/O command
- Safety Option 2 (in process): STO, SS1, SBC, SBT, SIL3 PLe , digital I/O or FSoE command
- Safety Option 3 (in process): STO, SS1-t, SS1-r, SS2, SLS, SSM, SSR, SDI, SLA, SAR, SLI, SLP, SCA, SBC, SDB, SBT, SIL3 PLe , digital I/O or FSoE command

This manual is valid for AKD2G drives with Functional Safety Option 1.

11.6 Conformance with EAC

EAC is the abbreviation for Eurasian Conformity. The mark is used in the states of the Eurasian Customs Union (Russia, Belarus, Kazakhstan) similar to the European CE mark.

Kollmorgen declares, that the device has passed all required conformity procedures in a member state of the Eurasian Customs Union, and that the device meets all technical requirements requested in the member states of the Eurasian Customs Union:

- Low voltage (TP TC 020/2011)
- Electromagnetic Compatibility (TP TC 004/2011)

Contact: Intelisys LLC. , Bakuninskaya Str. d 14, Building 10, RU-105005 Moskau

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13 Record of document revisions

Revision	Remarks
Beta, 12/2018	Beta edition

About KOLLMORGEN

Kollmorgen is a leading provider of motion systems and components for machine builders. Through world-class knowledge in motion, industry-leading quality and deep expertise in linking and integrating standard and custom products, Kollmorgen delivers breakthrough solutions that are unmatched in performance, reliability and ease-of-use, giving machine builders an irrefutable marketplace advantage.

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