

Kollmorgen Essentials Drive

3, 6, 12 Amp Single-Axis Servo Drive with Functional Safety
Option 1, STO - SIL2

Installation Manual, English



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



KOLLMORGEN

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1 Welcome to Kollmorgen Essentials



The Kollmorgen Essentials System is a mid-featured motion control system consisting of servo motors, servo drives, and cables. The system is designed to be scalable from plug-and-play to highly customized tuning in WorkBench. Simply hook a Kollmorgen Essentials Drive up to a Kollmorgen Essentials Motor using a Kollmorgen Essentials Cable on your network, and open WorkBench. WorkBench can walk you through a few steps to set up the drive.

Kollmorgen Essentials Drive Models

Current Rating	100-240V _{AC} 1Φ/3Φ (6V)	240-480V _{AC} 3Φ (7V)
3A	KED-SPM-6V03S-A100-0000	KED-SPM-7V03S-A100-0000
6A	KED-SPM-6V06S-A100-0000	KED-SPM-7V06S-A100-0000
12A	KED-SPM-6V12S-A100-0000	KED-SPM-7V12S-A100-0000

Kollmorgen Essentials Motor Models

Power Rating	200-240V _{AC} 1Φ/3Φ(2V)	400-480V _{AC} 3Φ(4V)
200W	KEM-2V020	
400W	KEM-2V040	KEM-4V040
750W	KEM-2V075	KEM-4V075
1000W	KEM-2V100	KEM-4V100
1500W	KEM-2V150	KEM-4V150
2500W	KEM-2V250	KEM-4V250
3000W	KEM-2V300	KEM-4V300
4000W		KEM-4V400

- See [Compare Kollmorgen Essentials Drives to AKD2G and AKD Drives](#).
- See [Essentials Drive Installation](#) about setting up the Kollmorgen Essentials Drive.
- See [Essentials Motor Installation](#) about setting up the Kollmorgen Essentials Motor.

2 General

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2.1 About this Installation Manual

This Installation Manual describes the Kollmorgen Essentials Drive series of digital servo drives and includes information to safely install the product.

Manual updates can be downloaded from the Kollmorgen website (www.kollmorgen.com).

Product information for use consists of:

- **Product Support Page:** <http://www.kollmorgen.com/kes/>
- **Safety Notes:** Multilingual document with safety information
- **Installation Manual:** Describes the product series of digital drives and includes information to safely install it. Contact Kollmorgen customer support for a printed copy of the installation manual.
- **Essentials Documentation Portal:** webhelpdev.kollmorgen.com/essentials/english/, contains a superset of all Essentials documentation
- **EtherCAT Communication:** Describes how to use your drive in EtherCAT applications.
- **EtherNet/IP Communication:** Describes how to use your drive in EtherNet/IP applications.
- **PROFINET Communication:** Describes how to use your drive in PROFINET applications.
- **Accessories Manual:** Provides information for accessories like cables and regen resistors used with your product. Regional variants of this manual available.

2.2 Symbols Used

2.2.1 Warning Symbols

Symbol	Indication
	Indicates a hazardous situation which, if not avoided, will result in death or serious injury .
	Indicates a hazardous situation which, if not avoided, could result in death or serious injury .
	Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
	Indicates situations which, if not avoided, could result in property damage.
	Indicates useful information.
	High Noise Pollution. The type of danger is specified by the text next to the symbol.
	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.
	Warning of danger from molten particle projection.

2.2.2 Drawing Symbols

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

2.3 Abbreviations Used

Abbreviations related to functional safety (→ # 117).

Abbreviation	Meaning
(→ # 53)	"see page 53" in this document
→ xyz	"see chapter xyz" in this document
Ω	Ohms
A#, AXIS#	A# or AXIS# are used for axis 1, with parameters or signal names.
AGND	Analog ground
AquadB	In quadrature output, used for incremental encoder emulation
AMSL	Above mean sea level
Axis	Depends on context, either one servo drive output stage or one load axis of the full motion system.
CAT	Category
CE	Communauté 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
FS1	Functional Safety Option 1
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	Most significant byte (or bit)
NI	Zero pulse
OSSD	Output Signal Switching Device
PE	Protective earth
PELV	Protective Extra Low Voltage
PLC	Programmable logic control
PWM	Pulse-width modulation
RAM	Random access memory (volatile memory)
RBrake/RB	Regen resistor (also called a brake resistor)
RBext	External regen resistor
RBint	Internal regen resistor
RCCB	Residual-current circuit breakers
RCD	Residual current device
RES	Resolver
S1	Continuous operation
tbd	To be determined (in progress)
V _{AC}	Volts, alternating current

Abbreviation	Meaning
V _{DC}	Volts, direct current

3 Product Safety

To avoid possible damage, read and follow the instructions.

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3.1 You should pay attention to this

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

Specialist staff required!

The devices are intended for industrial applications.

Machine builders must employ qualified personnel. Qualified personnel are people who have been trained to transport, install, commission, and operate electrical drives.

- 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 expertise in electrical engineering.
- 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 or wrong motor wiring will damage the system components. Check the combination of servo drive and motor and 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.

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.

Earthing!



Risk of electric shock! Personal protection is at risk without low-resistance earthing. Ensure that the servo drive is safely earthed to the PE (protective earth) busbar in the switch cabinet.

Leakage Current!

Since the leakage current to PE is more than 3.5 mA, double the PE connection or use a connecting cable with a cross-section $>10 \text{ mm}^2$ to be compliant with IEC 61800-5-1.

Deviating measures according to regional standards might be possible.

Functional Safety!

You are responsible for the assessment of the safety functions according to EN 13849 or EN 62061.

Reinforced Insulation

Thermal sensors, motor holding brakes, and feedback systems built into the connected motor must have reinforced insulation (according to IEC 61800-5-1) against system components with power voltage according to the required application test voltage. All Kollmorgen components meet these requirements.

Never modify the drive!

Never open the cover of the drive, as the electronic components installed there generate dangerous high voltages. The components often still carry high voltage even after disconnection from the mains.

Therefore, the drive may only be opened by authorized specialist personnel.

Kollmorgen shall not be held accountable for any defects, malfunctions, or degradations resulting from users opening up the device. In case of damage or malfunction, send the drive for repair or replacement.

High noise pollution!

Fans generate noise of up to 74 dBA when operating at maximum load. This can lead to hearing damage. Keep the cabinet doors closed during operation. Use ear protection if the control cabinet has to be opened during servicing. The operator must provide ear protection and monitor its use depending on the daily noise exposure level determined.

3.2 Use as Directed

Use your Kollmorgen Essentials Drive exclusively with Kollmorgen Essentials Motors and Kollmorgen Essentials Cables, or with suitable synchronous servo motors, such as Kollmorgen AKM, AKMA, AKME, AKMH, and AKM2G with SFD-M or SFD-3 feedback, that are capable of closed-loop control of torque, speed, and/or position.

Your servo drive is a component that is built into electrical plants or machines and can only be operated as integral component of these plants or machines. The manufacturer of the machine used with a servo drive must conduct a risk assessment for the machine. When the servo drive is built into a machine or plant, it must not be used until it has been established that the machine or plant fulfills the requirements of the regional rules, laws, and regulations.

Cabinet and wiring

Only operate your device in a closed control cabinet suitable for the ambient conditions (IP54) (→ # 38). Make sure to keep the temperature within the cabinet within the acceptable limits with help of ventilation or cooling.

Only use copper conductors for wiring. The conductor cross-sections can be derived from the standard IEC 60204-1 for CE, and NEC Table 310-16, 75C column for USA, or equivalent codes for other nationalities, including applicable deratings.

NOTE

- If you cannot operate your servo drive in a control cabinet, contact Kollmorgen.
- Additional protective equipment (e.g., for connector X1) may be required, depending on the servo drive model and use case.

Power supply

The servo drives can be supplied by 1, 2 or 3 phase (TN-S or TT).

Servo drives in the Kollmorgen Essentials Drive series can be supplied as follows:

- KED-SPM-6V:
1, 2 or 3 phase industrial supply networks: 100-240V_{AC} nominal.
- KED-SPM-7V:
3 phase industrial supply networks: 240-480V_{AC} nominal.

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

Periodic overvoltage's between phases (L1, L2, L3) and the PE/housing of the drive must not exceed 1000V peak. In accordance with EN 61800:

- Voltage spikes (< 50 µs) between phases must not exceed 1000V.
- Voltage spikes (< 50 µs) between a phase and the PE/housing must not exceed 2000V.

Motor voltage rating

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

Functional Safety

NOTICE

- The network to which the servo 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.

Read the section (Use as directed, → # 116) in the Functional Safety chapter before using safety functionality.

3.3 Prohibited Use

Other use than that described in the previous “Use as Directed” section is not intended and can lead to personnel injuries and equipment damage.

The servo drive may not be used with a machine that does not comply with appropriate

- national laws,
- rules,
- regulations and
- applicable standards.

The use of the servo drive in the following environments is also prohibited:

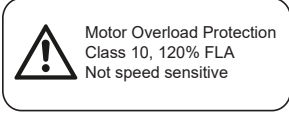
- potentially explosive areas
- environments with corrosive and/or electrically conductive acids, alkaline solutions, oils, vapors, dusts
- ships or offshore applications

NOTICE

If the network to which the servo drive is connected is not secured according to state-of-the-art information technology, this could be a security risk.

3.4 Warning Note Labels

3.4.1 Notes placed on the product

	Attention Before installing or servicing, refer to the installation manual and safety instructions.
	Residual Voltage Wait 5 minutes after removing power before servicing.
	Hot Surface Do not touch heatsink.
	Protective Earth Always connect ground wire to terminal with this symbol.
	Electronic Overload Protection The internal electronic overload protection is not speed sensitive.

3.4.2 Adhesive label in the package

NOTICE

Follow the instructions given on the adhesive labels in the package.
If a warning note label is damaged, replace it immediately.

3.5 Shock-hazard Protection

3.5.1 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 RCD definitively evaluate the 50/60 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 3.5mA, in compliance with IEC 61800-5-1 the PE connection must either be doubled or a connecting cable with a cross-section >10mm² must be used. Use the PE terminal and the PE connection screws in order to fulfill this requirement.

Use the following measures to minimize leakage currents:

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

3.5.2 Residual current protective device (RCD)

In conformity with IEC 60364-4-41 - Regulations for installation and IEC 60204-1 - Electrical equipment of machinery, residual current protective devices (RCDs) can be used, provided they comply with the requisite

regulations. The servo drive is a 3-phase system with a B6 bridge. Use RCDs which are sensitive to all currents 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".
30 to 50 mA	Protection against "indirect contact" (personal fire protection) for stationary equipment

3.5.3 Isolating transformers

The servo drive can be operated with an isolating transformer. A ground-leakage monitor may also be used to detect short circuits. This will provide protection against indirect contact despite a higher leakage current, or when an alternative form of shock-hazard protection is needed.



The length of wiring between the transformer and the servo drive should be as short as possible.

3.6 Stop / Emergency Stop / Emergency Off

The control functions Stop, Emergency Stop, and Emergency Off are defined by IEC 60204-1.

Notes for functional 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 for software disabling. Consult the *WorkBench Online Help* for configuring the parameter. Only STO (stop category 0) is a certified safety function.



WARNING

Vertical load could fall!

Serious injury caused by improperly blocked load. The internal brake function does not ensure functional safety.

- Functional safety, e. g. with hanging loads (vertical axis) requires one or more safe brakes, depending on required safety level. These brakes must be controlled by an external safe brake controller.
- The STO and Hardware Enable (if configured) do not initiate a controlled stop but switches off the power stage immediately.
- Set parameter `AXISx.MOTOR.BRAKEIMM` to 1 with vertical axes, to apply the brake immediately after faults or hardware disable.
- Risk assessment of the application determines the necessary measures.

3.6.1 Stop

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

NOTE

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

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

Stop Category 0

Shut-down by immediately switching-off the energy supply to the servo drive machinery (this is an uncontrolled shut-down).

For a stop without using safety functions like STO, set `AXIS#.DISMODE` to 0.

The safety function STO stops the servo drive as required by Stop Category 0 (IEC 62061).

Stop Category 1

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

To achieve this behavior, set `AXIS#.DISMODE` to 2.

Stop Category 2

A controlled shut-down in which the energy supply to the servo drive machinery is maintained.

Stop Category 0 and Stop Category 1 stops must be operable independently of the operating mode, and Category 0 stop must have priority. Hardwired STO has always the highest priority.

If necessary, provision must be made for the connection of protective devices and lock-outs. A reset of the stop function must not create a hazardous situation.

3.6.2 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 is 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 fulfill the following requirements:

- Emergency Stop must have priority over all other functions and controls in all operating modes.
- The energy supply to any servo 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.

3.6.3 Emergency Off

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

The Emergency Off function is 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 (e.g., by protection against direct touching).

4 Product Life Cycle Handling

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4.1 Transport

Transport the Kollmorgen Essentials Drive in accordance with EN 61800-2 as follows:

- Transport only by qualified personnel in the manufacturer's original recyclable packaging.
- **NOTICE:** Avoid shocks while transporting.
- Vibration/Shock: Kollmorgen Essentials Drive is tested for environmental class 2M1 of IEC 60721-3-2.
- Store at or below a maximum stacking height of 8 cartons. (Storage, → # 26)
- 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 servo drives contain electrostatically sensitive components that can be damaged by incorrect handling. Electrostatically discharge yourself before touching the servo drive. Avoid contact with highly insulating materials, such as artificial fabrics and plastic films. Place the servo 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 Kollmorgen Essentials Drive packaging consists of recyclable cardboard with inserts and a label on the outside of the box.

Model	Package (mm) HxWxL	Total Weight (kg)
KED-6V03/KED-6V06	108 x 295 x 295	1.7
KED-6V12/KED-7V03/KED-7V06	108 x 295 x 295	2.4
KED-7V12	158 x 394 x 292	4.3

NOTE

Mating connectors

- X1 (Motor Power) and X23 (Feedback Connector) are provided on the hybrid motor cable (sold separately). See also "Cables" chapter in Kollmorgen Essentials Drive Installation Manual.
- X10 (Auxiliary Voltage Power Supply Connector) and X3 (Mains Power Connector) are included.
- X11/12 (Industrial Ethernet Interface Connectors) are standard Industrial Ethernet connections. Cables need to be provided by the user.
- X20 (Service Interface Connector) is a standard USB-C connection. Cables need to be provided by the user.
- X21 (Digital I/O) is based on standard D-Sub connections. Cables need to be provided by the user.

Other connectors and cables need to be provided by the user.

4.3 Storage

Store the Kollmorgen Essentials Drive in accordance with EN 61800-2 as follows:

- Store only in the manufacturer's original recyclable packaging.
- Store at or below a maximum stacking height of 8 cartons.
- Store only within the specified temperature ranges:
 - -25 °C to +55 °C, max. rate of change 20 K/hour, class 1K4.
- Store only within the 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 servo drive.
- A rubber plug is provided with the servo drive. Use it for the USB-C slot for protection against particle ingress.

4.4 Installation, Setup, and Normal operation

- Mechanical installation (→ # 45)
- Electrical installation (→ # 49)
- Setup (→ # 92)

Normal operation tested for environmental class 3K3 according to EN 61800-2 (→ # 38).

The machine manufacturer 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.

Follow these steps for decommissioning:



DANGER

Lethal voltages!
Immediate danger to life caused by electrical energy.

1. Switch off the main switch of the switchgear cabinet.
2. Secure the system against restarting.
3. Block the main switch.
4. Wait at least 5 minutes after disconnection from the main supply power before touching potentially live sections of the equipment (e.g. contacts) or undoing any connections.

4.6 Maintenance and Cleaning

The device does not require maintenance, it should be inspected once a year by professional staff.

NOTICE

Do not immerse or spray the device.
Avoid liquid entering the device.
The inside of the unit can only be cleaned by the manufacturer.
Opening the device voids the warranty.

4.6.1 Cleaning Procedure

1. Decommission the device.
See (Decommissioning, → # 26).

2. Casing: Clean with Isopropanol or similar cleaning solution.



Highly flammable! Risk of injury by explosion and fire.
Observe the safety notes given on the cleaning liquid package and 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

Follow these steps for disassembly:

1. Decommission the device.
See (Decommissioning, → # 26).
2. Check temperature.



High temperature! Risk of minor burns caused by hot surfaces.

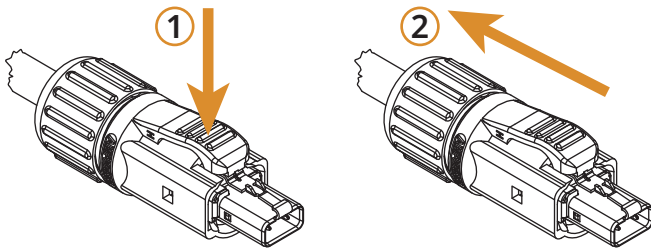
During operation, the heat sink of the drive may reach temperatures above 80 °C (176 °F).

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.

Removal of connector X23

1. Press the latch down.
2. Pull the connector straight out. Do not twist.



4.8 System Modification

NOTICE

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

Caution: Automatic restart! 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 switched off mains supply, and secured against restart.

4.8.1 Exchanging the Device

Only the manufacturer can repair the device.

Opening the device or housing voids the warranty.

1. Decommission the device.
See (Decommissioning, → # 26).
2. Demount the device.
See (Disassembly, → # 28).
3. Send the device to the manufacturer.
See (Disposal, → # 30).
4. Install a new device as described in the Installation Manual.
5. Setup the system as described in the Installation Manual.

4.8.2 Exchanging Other Servo Drive System Parts

Use this procedure if parts of the servo drive system (e.g., cables) must be replaced.

1. Decommission the device.
See (Decommissioning, → # 26).
2. Exchange the parts.
3. Check all connections for correct fastening.
4. Setup the system as described in the Installation Manual.

4.9 Disposal

NOTICE

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

In accordance with the WEEE-2012/19/EU guideline and similar, the manufacturer accepts returns of old devices and accessories for professional disposal. The sender needs to cover the costs for the transport.

Contact Kollmorgen to clarify the logistics.

For disposal, send the device, in the original packaging, to the appropriate manufacturer's address.

Region	Disposal Address
North America	Kollmorgen Corporation 201 West Rock Road Radford, VA 24141, USA
Europe	Kollmorgen s.r.o. Attn.: Repair Department Evropská 864 664 42 Modřice, Brno Czech Republic

5 Package

5.1 Package Supplied	32
5.2 Part Number Scheme	33
5.3 Nameplate	34

5.1 Package Supplied

The package includes:

- Kollmorgen Essentials Drive
- Panel safety label

NOTE

Mating connectors

- X1 (Motor Power) and X23 (Feedback Connector) are provided on the hybrid motor cable (sold separately). See also "Cables" chapter in Kollmorgen Essentials Drive Installation Manual.
- X10 (Auxiliary Voltage Power Supply Connector) and X3 (Mains Power Connector) are included.
- X11/12 (Industrial Ethernet Interface Connectors) are standard Industrial Ethernet connections. Cables need to be provided by the user.
- X20 (Service Interface Connector) is a standard USB-C connection. Cables need to be provided by the user.
- X21 (Digital I/O) is based on standard D-Sub connections. Cables need to be provided by the user.

Other connectors and cables need to be provided by the user.

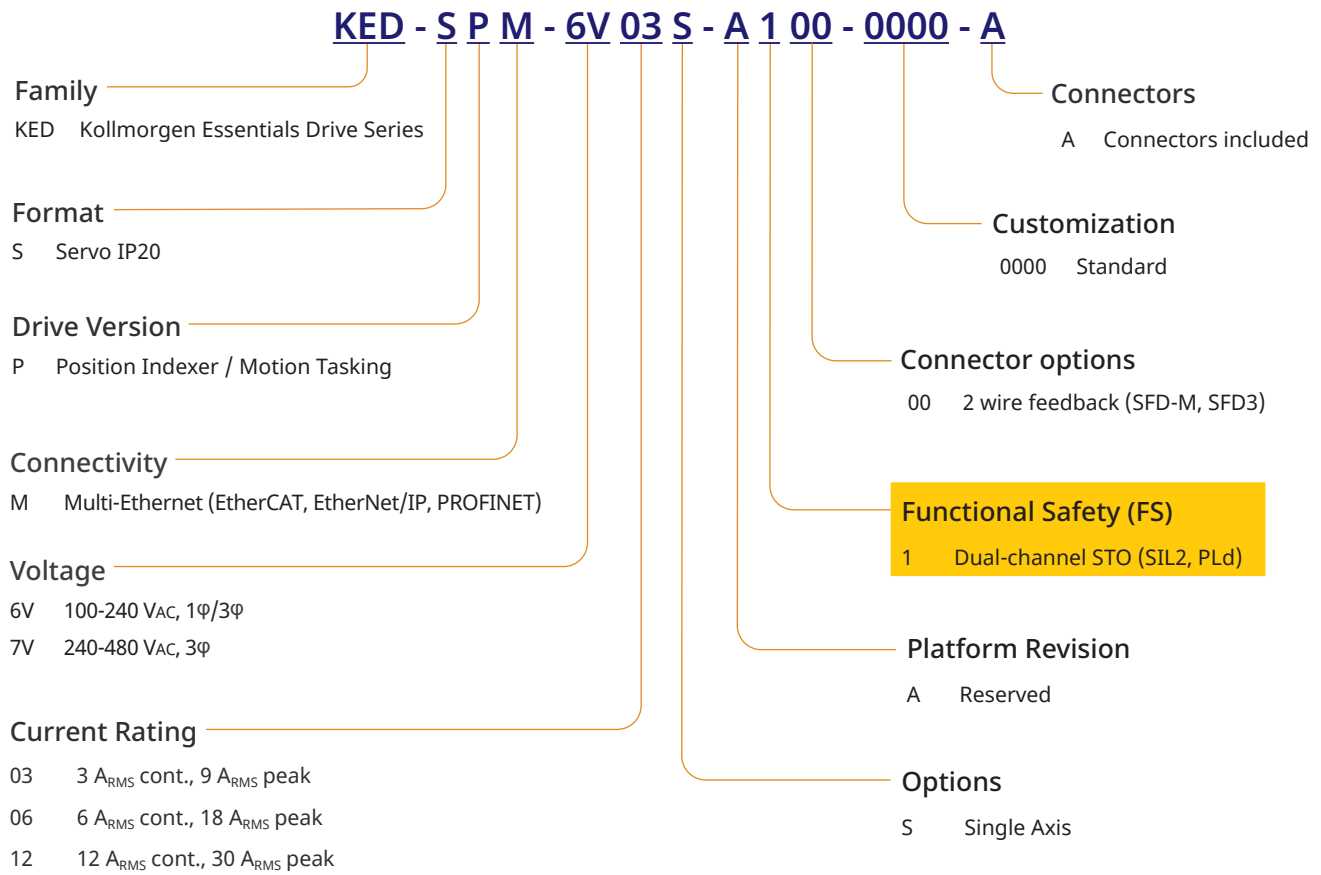
Accessories sold separately

Please order accessories separately if required, see (Accessories for Kollmorgen Essentials Drives, → # 137).

- EMC filters for mains supply voltage, categories C2 or C3
- External regen resistor
- Mating connector kits
- Motor chokes
- Hybrid motor cables with connectors

5.2 Part Number Scheme

Use the part number scheme for product identification only.



Kollmorgen Essentials Drive Options 100-240 VAC, 1 ϕ /3 ϕ

- KED-SPM-6V03S-A100-0000-A
- KED-SPM-6V06S-A100-0000-A
- KED-SPM-6V12S-A100-0000-A

Kollmorgen Essentials Drive Options 240-480 VAC, 3 ϕ

- KED-SPM-7V03S-A100-0000-A
- KED-SPM-7V06S-A100-0000-A
- KED-SPM-7V12S-A100-0000-A

NOTE

The "-A" connector option will not appear on product nameplates or packaging when purchased.

5.3 Nameplate

A nameplate is attached to the side of the servo drive. Examples:

KOLLMORGENTM

201 W. Rock Road
Radford, VA 24141

Customer Support:
North America: +1 (540) 633-3400
Europe: +49 (0) 2102-9394-0
Italy: +39 (0) 362-594260

Model No: KED-SPM-6V03S-A100-0000

Serial No: B2-2252-10039 HW Rev: A



www.kollmorgen.com

Ratings at 40°C (See manual for ratings >40°C)		
	INPUT	OUTPUT
Voltage	120-240 VAC	0-240 Vac
Frequency	50/60 Hz	0-599Hz
Phase	1 Ph/3 Ph	3 Ph
FL Current	4/3.2 Arms	3 Arms
Power @ 240 Vac	0.9/1.3 kVA	
Enclosure Protection Rating:		IP20




LISTED
IND.CONT.EQ.
86F2
E141084

Assembled in Czech republic - BCZ

KOLLMORGENTM

Pempelfurtstr. 1
40880 Ratingen Germany

Customer Support:
North America: +1 (540) 633-3400
Europe: +49 (0) 2102-9394-0
Italy: +39 (0) 362-594260

Model No: KED-SPM-7V12S-A100-0000

Serial No: D3-2612-00002 HW Rev: PA



www.kollmorgen.com/KES

Ratings at 40°C (See manual for ratings >40°C)		
	INPUT	OUTPUT
Voltage	240-480 Vac	0-480 Vac
Frequency	50-60 Hz	0-599Hz
Phase	3 Ph	3 Ph
FL Current	12.3 Arms	12 Arms
Power @ 240 Vac	10.2 kVA	
Enclosure Protection Rating:		IP20

BETA UNIT

Assembled in Germany
Made in Europe

6 Technical Description and Data

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6.1 The Family of Kollmorgen Essentials Drives

Available Kollmorgen Essentials Drive Versions

Connectivity	Rated Voltages	Current	Axis	Rev	Functional Safety
M: Multi-Ethernet (EtherNet/IP, EtherCAT, PROFINET)	6V: 100-240V _{AC} , 1Φ/3Φ 7V: 240-480V _{AC} , 3Φ	03: 3A 06: 6A 12: 12A	S: Single Axis	A	1: SIL2 STO

Standard Features

- Support for secondary incremental position input.
- 2 high-speed and 2 regular speed digital inputs, 2 digital outputs.
- Single axis.
- Supply voltages:
 - AC single phase, split phase, three phase AC neutral.
- Single or group supply, single or group mains fusing.
- Industrial Ethernet on board.
- SFD-M, SFD-3 motor feedback support.
- Step/Direction input.
- Use with AC synchronous servomotors and open loop induction machines.

Power Section

- Single or three phase AC supply, 5% to 110% of rated AC voltage over 47 to 63 Hz.
 - Connection to higher AC voltage mains only by using isolating transformer.
- Three phase bridge rectifier, integral soft-start circuit.
- DC bus link voltage can be connected in parallel for power sharing.
- Floating current sensors measure actual motor current.
- Regenerative circuit with dynamic distribution of the generated power between several servo drives on the same DC bus link circuit.
- External regen resistor required.

Functional Safety Option

- FS1: STO; SIL2 PLd, command by I/O (→ # 121)

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, over voltage detection, short-circuit protection, phase-loss detection.
- Temperature monitoring of the servo drive and motor.
- Electronic Class 10 motor overload protection: foldback mechanism or optional fault response.
 - The internal electronic overload protection is not speed sensitive.

Auxiliary Supply Voltage 24V_{DC}

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

Parameter Setting

- WorkBench Software for setup via USB.
- Download control parameter packages via Industrial Ethernet.

Full Digital Control

- Digital current loop (update 1.28 μ s / command 62.5 μ s).
- Digital velocity loop (update period 62.5 μ s).
- Digital position loop (update period 250 μ s).

Inputs/Outputs (X21)

- 2 high-speed and 2 regular speed digital inputs.
- 2 digital outputs.

Connectivity

- Feedback input (→ # 84).
- Digital Inputs/Outputs (→ # 90).
- Service Interface (→ # 89).
- Industrial Ethernet interface (→ # 85).

Accessories

- Connector kit with mating connectors X3 and X10.

For accessories refer to the (→ Accessories for Kollmorgen Essentials Drives # 137).

6.2 Ambient Conditions, Ventilation and Mounting Position

Storage, Transport	(→ # 25)
Normal operation	Environmental class 3K3 according to IEC 61800-2
Surrounding temperature in operation	- Normal operation at rated values up to 40°C - Derating (2% per °C or 10% per 5°C) for 40°C to 55°C max. Note: Operation only with external regen resistor!
Humidity in operation	Relative humidity 5 to 85%, no condensation, IEC 61800-2 class 3K3
Site altitude	- Up to 1000m AMSL (above mean sea level): no restriction 1000 to 2000m AMSL: power derating 1.5%/100m - Maximum altitude: 2000m 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
Servo drive protection	IP 20 according to IEC 60529
Servo drive EMC immunity	Increased immunity according to EN 61800-5-2
Mounting	Vertical position, in a cabinet with protection of at least IP 54 Minimum cabinet size (WxHxD): 406 x 406 x 254 mm
Ventilation	Built-in fan, make sure that the ventilation is not blocked
NOTICE	The servo 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

	Unit	6V03	6V06	6V12	7V03	7V06	7V12
Weight	kg	1.1	1.1	2.0	2.7	2.7	2.7
Width	mm	60	60	70	70	70	70
Height, without connectors	mm	172	172	200	200	200	220
Height, with connectors	mm	190	190	225	225	225	245
Depth, without connectors	mm	165	165	202	202	202	202
Depth, with connectors	mm	210	210	255	255	255	255

NOTE

Dimension drawing see section Mechanical Installation (→ # 45).

6.4 Performance Data

Performance Data	Units	6V03...12	7V03...06	7V12
Switching frequency (dynamic)	kHz	15.0	11.0	9.8
Voltage rise (dU/dt) speed	kV/μs	7.0	7.0	7.0
Bandwidth current	kHz	3	3	3
Bandwidth velocity	Hz	750	750	750
Bandwidth position	Hz	350	350	350

6.5 Electrical Data

6.5.1 Mains supply data, 1 phase AC

Input data	Units	6V03	6V06	6V12
Operational supply voltage (line to line)	V _{AC}	80 to 265		
Rated supply voltage	V _{AC}	100 to 240		
Rated supply input frequency (±5%)	Hz	50 to 60		
Permitted switch on/off frequency	1/h	30		
Rated input VA at 240 V	kVA	0.9	3.1	3.8
Rated input current	A	4	13	12
Max. inrush current	A	40	90	180
Rated DC bus link voltage	V _{DC}	300		

6.5.2 Mains supply data, 3 phase AC

Input data	Units	6V03	6V06	6V12	7V03	7V06	7V12
Operational supply voltage (Line to Line)	V _{AC}	80 to 265			160 to 525		
Rated supply voltage	V _{AC}	100 to 240			240 to 480		
Rated supply input frequency (±5%)	Hz	50 to 60					
Permitted switch on/off frequency	1/h	30					
Rated input VA at 240 V (* at 480 V)	kVA	1.3	4	6.7	2.8*	5.5*	10.2
Rated input current	A	3.2	9.7	16	3.7	6.6	12.3
Max. inrush current (peak)	A	40	90	180	40	90	180
Rated DC bus link voltage	V _{DC}	140 to 340			280 to 680		

6.5.3 Output data

	Units	6V03	6V06	6V12	7V03	7V06	7V12
Continuous output current (± 3%)	Arms	3	6	12	3	6	12
Peak output current (for 2s, ±3%)	Arms	9	18	30	9	18	30
Continuous electrical drive output power at rated input current							
At 1 x 120 V _{AC}	W	312.5	625	800	-	-	-
At 1 x 240 V _{AC}	W	625	1250	1600	-	-	-
At 3 x 120 V _{AC}	W	312	625	1250	-	-	-
At 3 x 240 V _{AC}	W	625	1250	2500	600	1250	2500
At 3 x 400 V _{AC}	W	-	-	-	1000	2000	4200
At 3 x 480 V _{AC}	W	-	-	-	1200	2500	5000
Peak output power (for 2 s)							
At 1 x 120 V _{AC}	W	937.5	1875	2000	-	-	-
At 1 x 240 V _{AC}	W	1875	3750	4000	-	-	-
At 3 x 120 V _{AC}	W	936	1875	3125	-	-	-
At 3 x 240 V _{AC}	W	1875	3750	6250	1800	3750	6250
At 3 x 400 V _{AC}	W	-	-	-	3000	6000	10500
At 3 x 480 V _{AC}	W	-	-	-	3600	7500	12500
Thermal dissipation, disabled	W	12	12	12	12	12	12
Thermal dissipation at rated current	W	50	80	140	70	110	220
Inductive load							
Minimum at 120 V _{AC}	mH	2.04	1.02	0.61	-	-	-
Minimum at 240 V _{AC}	mH	4.44	2.22	1.33	-	-	-
Minimum at 400 V _{AC}	mH	-	-	-	4.44	2.22	1.33
Minimum at 480 V _{AC}	mH	-	-	-	7.41	3.7	2.22
Maximum	mH	240	120	60	610	310	210
Regeneration Braking	(→ # 41)						
Brake output							
Voltage (±10%)	V _{DC}	24					
Output under current fault	mA	100 (required for fault detection)					
Output over current fault	A	2.25 (required for fault detection)					
Output current, maximum	A	1.3	1.3	1.3	1.3	1.3	1.5

6.5.4 Steady State Control Current per Brake Option

Auxiliary 24 V _{DC} (±10%, check voltage drop) Supply Voltage (PELV)	Units	Current
Base current with NO brake	A	< 1
Total current with brake	A	< 2.8

6.6 Electrical Motor Braking

6.6.1 Drive dynamic braking

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

NOTE

Drive dynamic braking is not a part of functional safety.

The drive has a built in advanced drive dynamic braking mode which operates fully in hardware. When activated, the drive powers the motor terminals with voltages to maximize the stopping force per amount of motor current. This advanced method 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 winding 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 by using the *AXIS#.DBLIMIT* parameter to insure that the drive, motor, and customer load do not see excessive currents/forces.

Whether and how the drive uses dynamic drive braking depends on *AXIS#.DISMODE*.

6.6.2 Regenerative braking

When the amount of returned energy from the motor builds the bus capacitor voltage up enough the drive activates the regenerative braking circuit to start dumping the returned energy in the regen resistor (also called regenerative resistor or brake resistor). The servo drive can only be operated with an external regen resistor.

NOTE

For more information on external regen resistors, see the (→ Accessories for Kollmorgen Essentials Drives # 137).

6.6.2.1 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 preset 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 and the drive will disable.

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

NOTE

The servo drives must be coupled within the parameters described in the chapter "DC Bus Sharing between Kollmorgen Essentials Drives (→ # 77)

With an external brake resistor, using the built-in regenerative circuit, several drives of the same series can be operated from a common DC-bus link (→ # 76), 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 on that drive.

Switch-off on over voltage: With the regenerative circuit switched off, the returned energy is not dissipated and therefore the DC-bus link level increases. The drive reports an over-voltage fault if the DC-bus voltage threshold is exceeded. When this happens, the drive power stage is immediately disabled and the load coasts to a stop with the fault message "F2006 Bus Over voltage".

NOTE

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

6.6.2.2 Technical data - 240V servo drives

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
Model	Rated data	Units	100-240V
KED-6V03 KED-6V06 KED-6V12	Regen start voltage at rated supply voltage	V	380
	Overvoltage limit	V	420
	Maximum regenerative duty cycle	%	35*
	External regen resistor (recommended 33 Ω)	Ω	>15
	Continuous brake power, external resistor	kW	3A: 0.5 6A: 1 12A: 2
	Peak brake power, external (1s)	kW	5 / 14
KED-6V03	Absorption energy in capacitors (± 20%)	Ws	tbd
KED-6V06	DC Bus Capacitance	μF	1120
KED-6V12	Absorption energy in capacitors (± 20%)	Ws	9 / 35
	DC Bus Capacitance	μF	2460

* depends on connected regen resistor power.

6.6.2.3 Technical data - 480V servo drives

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.

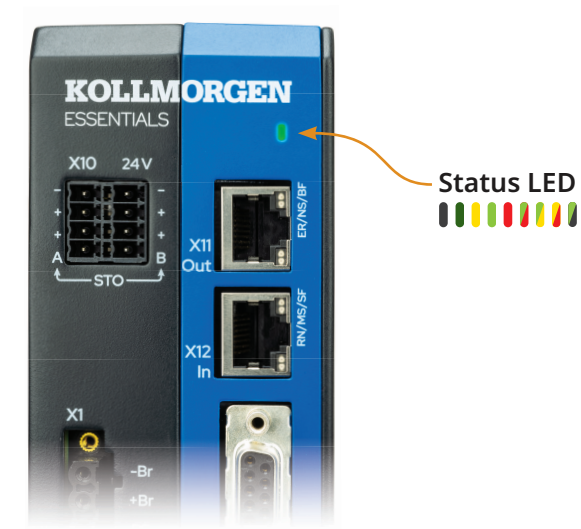
Brake circuit			AC Supply	
Model	Rated data	Units	240V	400-480V
KED-7V03 KED-7V06 KED-7V12	Regen start voltage at rated supply voltage	V	380	633 / 760
	Overvoltage limit	V	420	840
	Maximum regenerative duty cycle	%	35*	
	External regen resistor (recommended 33 Ω)	Ω	≥25	
	Continuous brake power, external resistor	kW	3A: 1 6A: 2 12A: 4	
	Peak brake power, external (1s)	kW	6	24
KED-7V03	Absorption energy in capacitors (±20%)	Ws	3	30 / 18
KED-7V06	DC Bus Capacitance	μF	235	
KED-7V12	Absorption energy in capacitors (±20%)	Ws	6	50 / 35
	DC Bus Capacitance	μF	470	

* depends on connected regen resistor power.

6.7 LED and Push-button B1

LED

The Kollmorgen Essentials Drive has an LED on its front side that indicates the status by a tri-color red-green-yellow light.



Color		State
	Dark	Control board unpowered
	Dark, yellow flash	Control board powered, disabled, no faults, warnings
	Dark, green flash	Control board powered, disabled, no faults, no warnings
	Dimly green	Control board powered but still booting up
	Green	Control board powered, enabled, no faults, no warnings
	Green/Red blink	Control board powered, downloading in progress
	Green, dark flash	Control board powered, dynamic brake active, no faults
	Green, yellow flash	Control board powered, enabled, no faults, warnings
	Yellow/Red blink (10 seconds)	Control board powered, DRV.BLINKDISPLAY command executed
	Red	Control board powered, faults
	Dark, red flash	Control board powered and running in Recovery mode

Push button B1

The Kollmorgen Essentials Drive has a push-button B1 on its top side.



B1 Functions	Description
Recovery Mode	Press this button during power up to run in recovery mode. This mode allows for a firmware file to be downloaded through WorkBench in case the firmware in the servo drive has been corrupted.

7 Mechanical Installation

7.1 Important Notes	46
7.2 Guide to Mechanical Installation	47
7.3 Dimensions	48

7.1 Important Notes

**WARNING****High voltages!**

Risk of electric shock caused by improper installation.

- 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.
- Ensure that protective measures such as insulation or shielding are complete and intact.

**CAUTION****High EMC Voltage Level!**

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

- Use electrically conductive mounting plates, e. g. made of aluminum or galvanized steel.
- Use copper mesh tape between the earthing bolts and earth potential to deflect currents in unfavorable circumstances.

**CAUTION****Ejection of molten particles!**

Molten drive component particles may be ejected causing injuries if particles fall into the servo drive or the servo drive has been damaged. Shut down the device, wear appropriate protective gear, and cover the ventilation slots above the device during maintenance work, troubleshooting, and fault rectification.(→ # 28)

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.

7.2 Guide to Mechanical Installation

You need at least the following tools to install your drive:

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

Your specific installation may require additional tools.

NOTICE

- Do not mount the drive right next to devices that produce magnetic fields. Strong magnetic fields can directly affect internal components. Install the drive with distance to such devices and/or shield the magnetic fields.
- **Risk of burns from disconnecting the plug under load!** Make sure that the screws are tightened.

Install the drive unit as follows:

1. Mount the drive in a closed control cabinet (ambient conditions (→ # 38). The site must be free from conductive or corrosive materials. For the mounting position in the cabinet see (→ # 48).
2. Check that the ventilation of the drive is unimpeded and keep within the permitted ambient temperature (→ # 38). Keep the required space clearance above and below the drive (→ # 48).
3. Ensure that there is an adequate flow of cool, filtered air into the bottom of the control cabinet, or use a heat exchanger (→ # 38).

NOTICE

The drive will switch itself off in case of overheating.

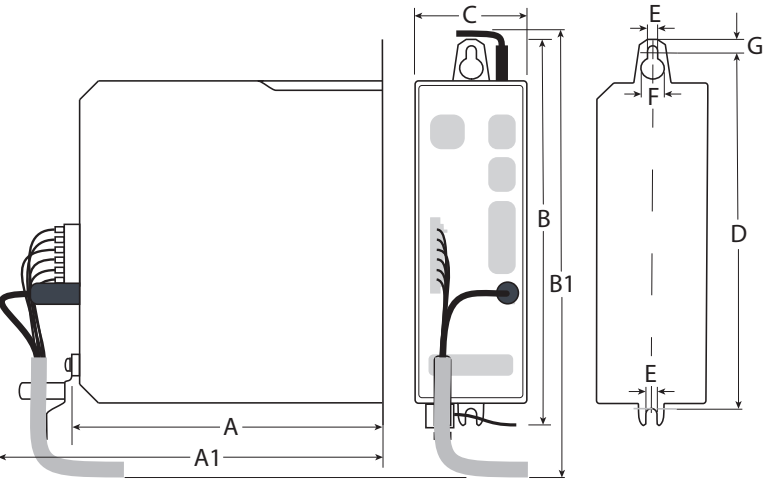
4. If you are using a cooling system for the control cabinet position the cooling system in a way that condensation water cannot drip onto the drive or peripheral devices.
5. Assemble the drive and power supply next to each other on the conductive, grounded mounting plate in the cabinet.
6. Ground the mounting plate, motor housing, and CNC-GND of the control system. For EMC-compliant shielding and grounding see (→ # 55).

7.3 Dimensions

NOTE

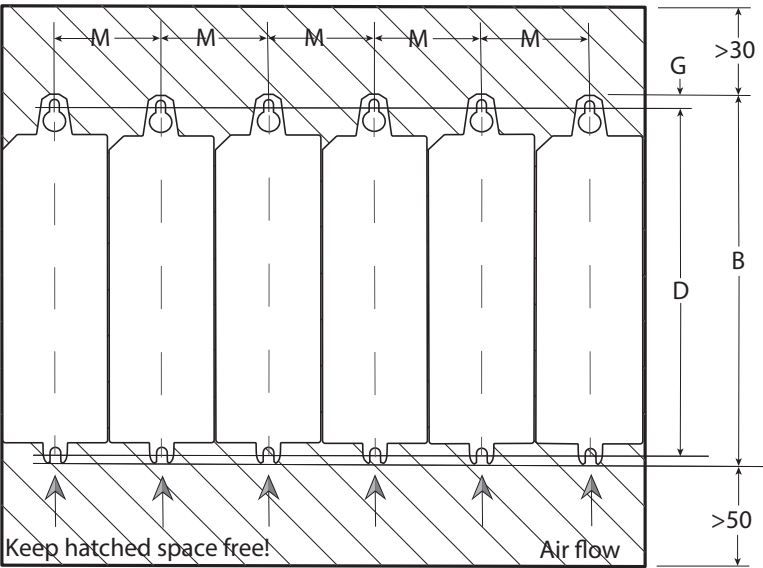
Mounting: 2 x M5 hexagon socket screws to ISO 4762, 4mm hexagon ball head screwdriver

Parameter	Unit	6V03	6V06	6V12	7V03	7V06	7V12
Weight (without mating connectors)	kg	<1.1	<1.1	<2.0	<2.7	<2.7	<2.7



NOTE

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



Model	Unit	A	A1	B	B1	C	D	E	F	G	M
KED-6V03...06	mm	165	225	173	215	60	195.4	5.8	11.4	8	≥0
KED-6V12/KED-7V03...06	mm	202	262	200	242	70	224.5	5.8	11.4	8	≥0
KED-7V12	mm	202	210	220	262	70	239.8	3	5.7		71

8 Electrical Installation

8.1	Important Notes	50
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8.7	DC Bus Link Connector X3	76
8.8	Regen Resistor Connector X3	78
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8.10	Industrial Ethernet Interface Connector X11/X12	85
8.11	Service Interface Connector X20	89
8.12	Digital I/O - X21	90

8.1 Important Notes



DANGER High Voltage up to 500V!

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 50V.



CAUTION Ejection of molten particles!

Molten drive component particles may be ejected causing injuries if particles fall into the servo drive or the servo drive has been damaged. Shut down the device, wear appropriate protective gear, and cover the ventilation slots above the device during maintenance work, troubleshooting, and fault rectification. (→ # 28)

NOTICE

- Only professional staff who are qualified in electrical engineering are allowed to install the servo 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 comply to the cable and wire requirements (→ # 50).
- Wrong mains voltage, unsuitable motor, or wrong wiring will damage the servo drive. Check the combination of servo 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).
- 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 the use of residual current devices (RCD) (→ # 20).
- 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.
- 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 WorkBench to change the settings of the servo drive. Any other alteration 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 (→ # 113).
4. Wire the drive and connectors.
Observe the "Recommendations for EMI noise reduction": (→ # 55).
 - Wire the Safe Torque Off (STO) inputs into the emergency off circuit of the system.
 - Connect the digital control inputs and outputs.
 - Connect the motor hybrid cable.
 - Connect shielding at both ends and ground cable to drive via cable clamp.
 - Connect the external regen resistor (with fusing).
 - Connect the mains filter FN2060/FN2090/FN3040/FN3287 for second environment requirements to product category C2.
 - Connect the auxiliary voltage supply.
 - Connect the main electrical supply.
Check maximum permitted voltage value (→ # 39).
 - Check proper use of residual current devices (RCD): (→ # 20).
 - Connect the PC (→ # 89) for setting up the drive.
5. Check the wiring against the wiring diagrams:

Wiring reference	Page
Overview	(→ # 62)
Connector pinout	(→ # 64)
Mains power supply	(→ # 71)
Logic power supply	(→ # 75)
DC Bus Link	(→ # 76)
External Regen Resistor	(→ # 78)
Motor cable connection	(→ # 80)
Motor Holding Brake	(→ # 81)
Feedback Connection	(→ # 84)
Industrial Ethernet interface	(→ # 85)
Service interface	(→ # 89)
Digital I/O	(→ # 90)
Functional Safety option 1	(→ # 121)

8.3 Wiring

8.3.1 General



DANGER High voltages up to 500V!

- 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 24V auxiliary voltage nor the supply voltages of any other connected equipment is switched on.
 - Ensure the cabinet is safely disconnected and protected against unintended switch-on (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 (see (Symbols Used, → # 10)) 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

Mating connector overview

#	Description	Type	Max. Cross Section
X1	Motor, holding brake	Connector, 4 pol. power	10 mm², 8 awg
X3	Mains power, regen resistor, DC-Bus	Connector or T-type, 8 pol.	6 mm², 10 awg
X10	24V power supply, STO input	Connector, 8 pol.	1.5 mm², 14 awg
X21	I/O control signals	Connector, DB9 (9-pin D-sub)	1.5 mm², 16 awg
X23	Motor feedback	2-pin connector	

8.3.3 Cable and Wire Requirements

The Kollmorgen Essentials Drive has one motor cable (X1) which you can use for all motors.

For information on the chemical, mechanical, and electrical characteristics of the cable please refer to the (→ # 134) section or contact our customer support.

Motor cable (X1):

Supports SFD-M and SFD-3.

Maximum cable lengths

6V servo drives	7V servo drives
50m without choke	30m without choke

NOTICE

Cables should not exceed the maximum lengths. The recommended maximum cable length of motor cables depends on the used cable material and the feedback type. Cable functionality is only guaranteed up to the maximum length when using unmodified Kollmorgen engineered cables.

I/O cable (X21):

- Maximum distance for unshielded I/O lines is 3m inside the cabinet.
- If the I/O cable leaves the cabinet, ensure EMC shielding.

8.3.3.1 Cable cross sections and requirements

The tables below describe the recommended interface cross sections and cable requirements related to the servo drive according to IEC 60204.

Power Cables	Cross Section	Cable Requirements
Main supply	Minimum: KED-SPM-xV003: 1.5mm ² / 16 awg KED-SPM-xV006: 1.5mm ² / 16 awg KED-SPM-xV012: 2.5mm ² / 14 awg	• Electrical strength: 600V • Minimum temperature rating: 75°C
24 V _{DC} supply	Maximum: 1.5mm ² / 16 awg	Single line
DC bus link, regen resistor	Minimum: KED-SPM-xV003: 1.5mm ² / 16 awg KED-SPM-xV006: 1.5mm ² / 16 awg KED-SPM-xV012: 2.5mm ² / 14 awg	• Electrical strength: 1000V • Minimum temperature rating: 75°C • Shielded for lengths > 0.20m
Digital I/Os	Minimum: 0.25mm ² / 24 awg	Single line

8.3.3.2 Kollmorgen Essentials Hybrid Cable Wiring Specifications

Cable*	Type	Cross Section [mm ²]	Current Carrying Capacity	Remarks
H2-51-015-YZ-xxxx00	Power + Brake + SFD-M/ SFD3	(4x1.5+(2x0.34)+(2x0.75))	10.1A < I _{0rms} ≤ 13.1A	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 SFD-M/SFD3 signal lines
H2-52-015-YZ-xxxx00				
H2-52-025-YZ-xxxx00		(4x2.5+(2x0.34)+(2x1.0))	13.1A < I _{0rms} ≤ 17.4A	

* YZ = A5, W1 or W5

8.3.4 Protective Earth Connection

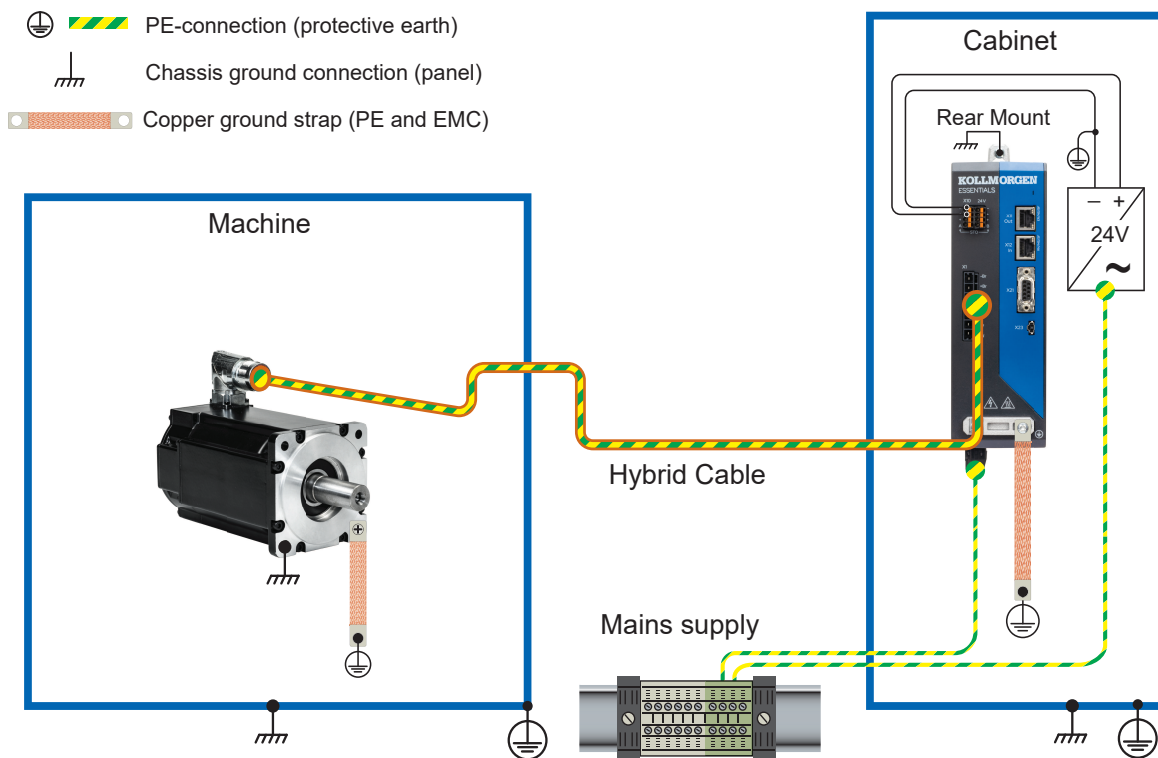
Protective Earth connection of the system components is a safety measure per IEC 60204. Ensure the proper grounding of all components with the PE rail in the control cabinet as reference potential. Connect each ground individually with the intended grounding cable (neutral point connection).

The leakage current from Kollmorgen Essentials Drive 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 >10 mm² 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 as the first electrical connection immediately after installing the devices. Then 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 (→ # 20).

8.4 EMI Noise Reduction



CAUTION

Electromagnetic fields!

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

- 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.
- Do not remove grounding, equipotential bonding and radiation-reducing shields.

8.4.1 Reducing EMI noise

With the help of the following instructions, you can reduce electrical interference in the application:

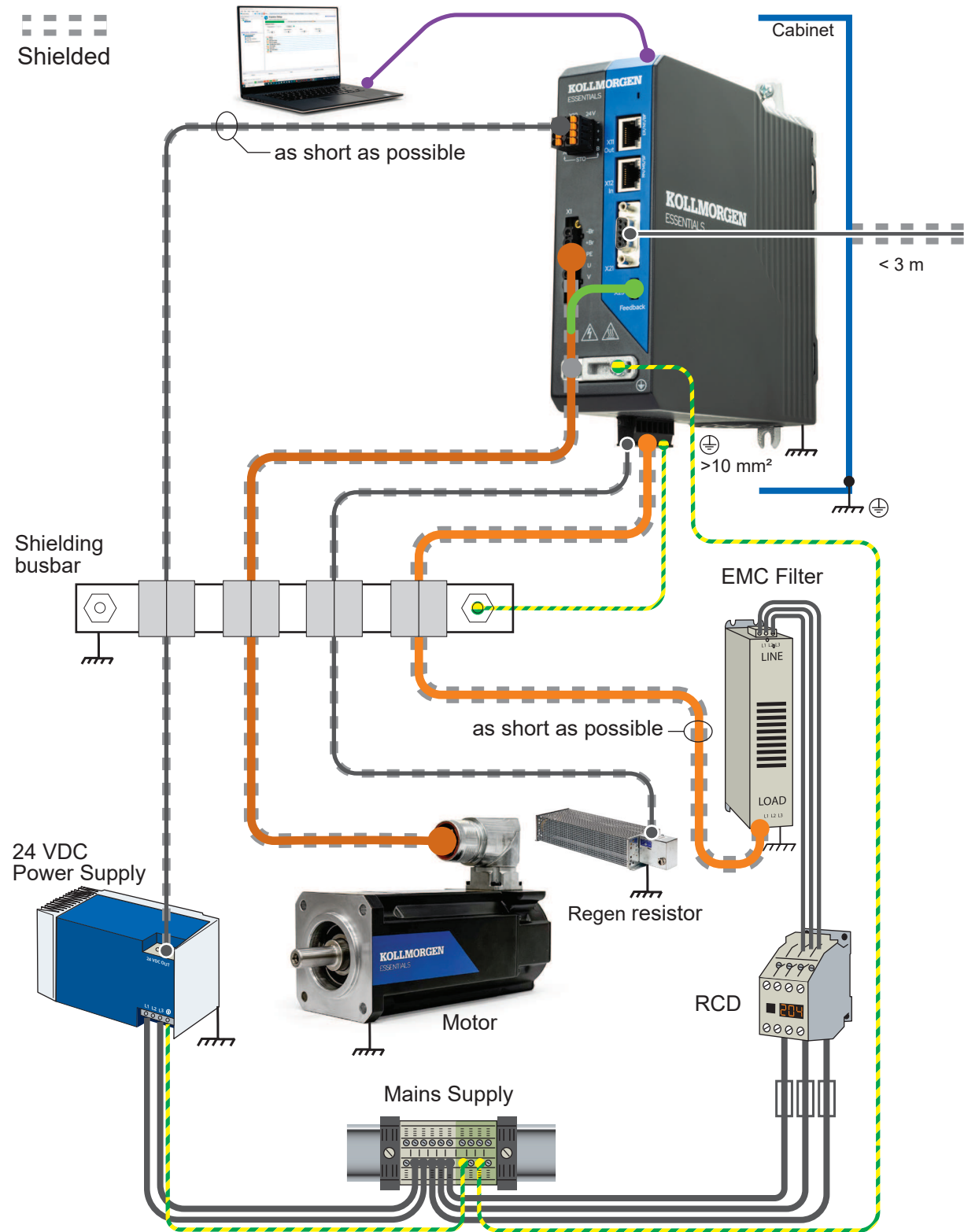
- **Ensure good connections between the cabinet components.** Connect the back panel and cabinet door to the cabinet body using several conductive braids. Never rely on hinges or mounting bolts for ground connections.
- **Ensure good ground connection.** Connect from cabinet to proper earth ground. Ground 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 200mm 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°.
- **Observe cable length limits.** Maximum distance for unshielded I/O lines is 3m inside the cabinet. If the I/O cable leaves the cabinet, it must be EMC shielded.
- **Do not extend feedback lines and hybrid cables, 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 (→ # 53) 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.
- **Shield cables between drives and filters or external regen resistors.** Install all power cables with an adequate cross-section per IEC 60204 (→ # 53) and use the requested cable material to reach maximum cable length.

8.4.2 Shielding with External Shielding Busbar

Kollmorgen recommends a star point shield connection, for example, with a shielding busbar.

8.4.2.1 Shielding Concept

Example with servo drive, EMC filter and external regen resistor.



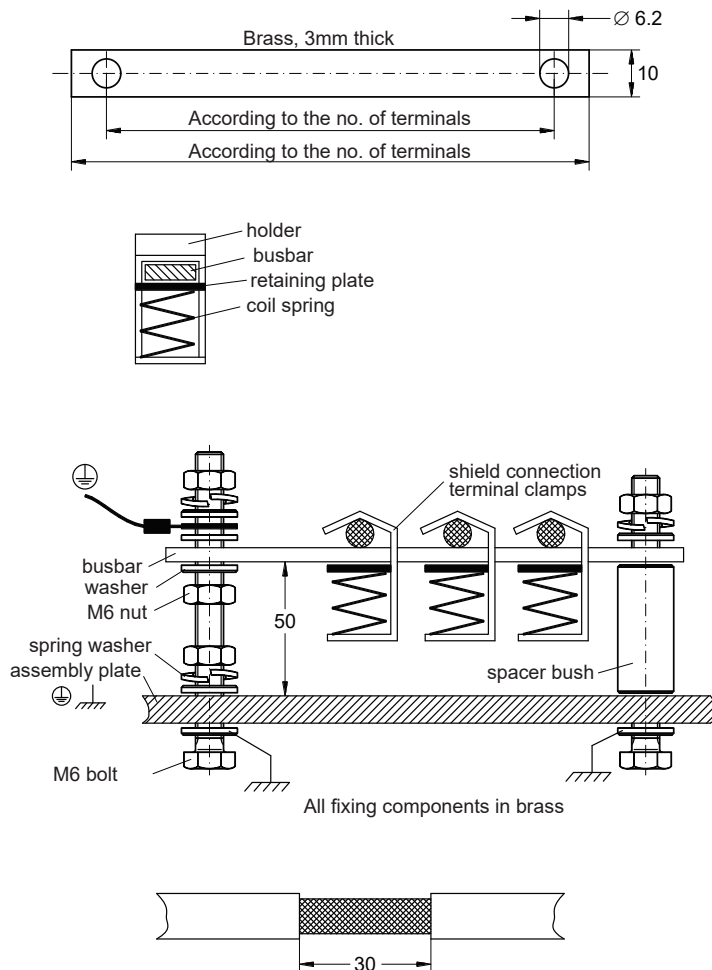
8.4.2.2 Shielding Busbar



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.

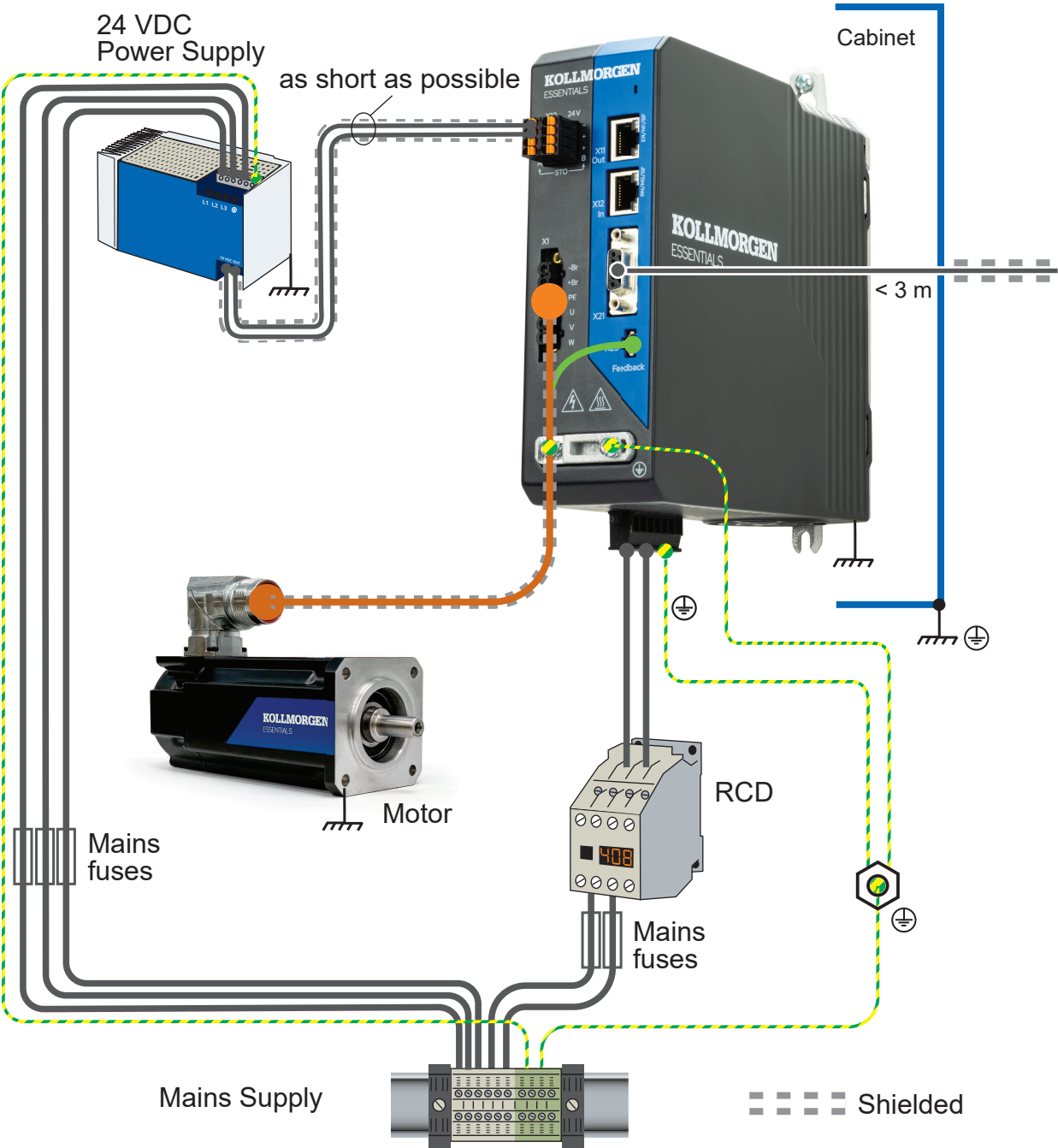
A possible scenario for setting up a busbar for the shield clamps is described below.



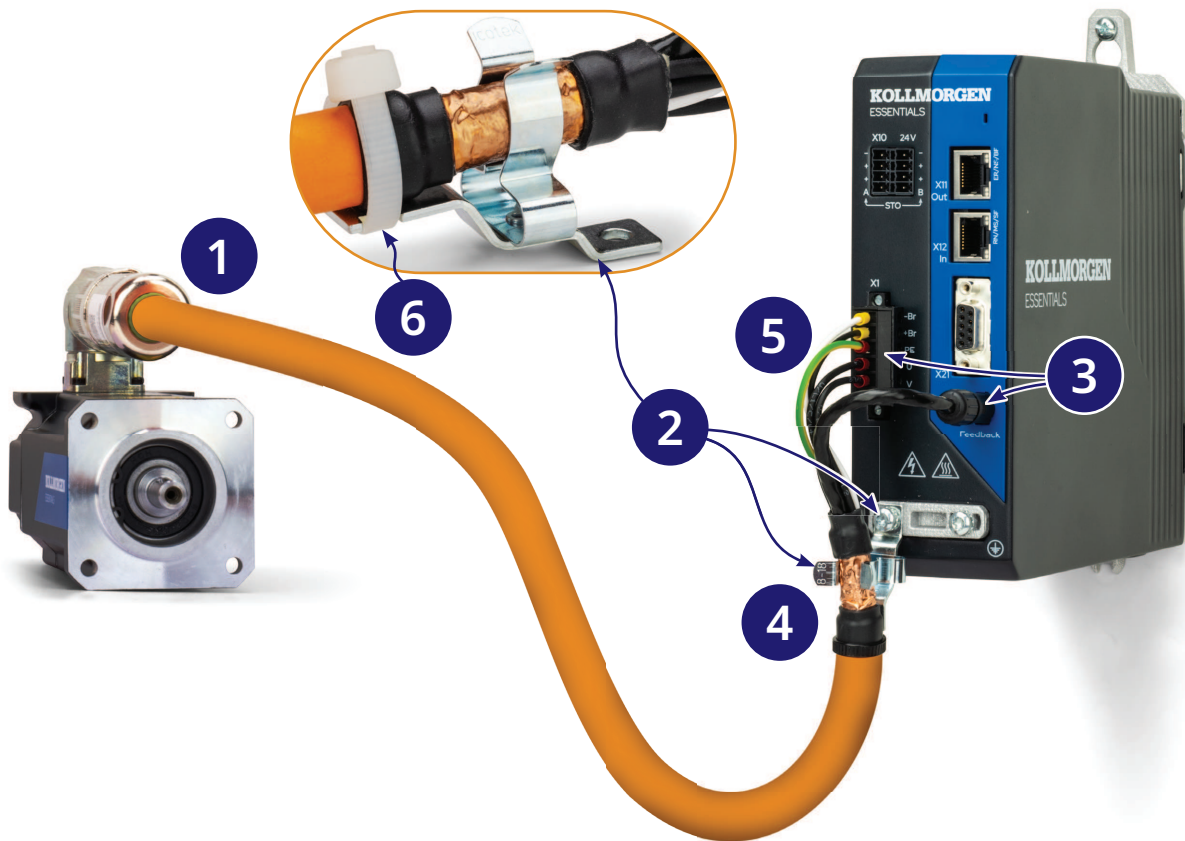
1. Cut a busbar of the required length from a brass rail (cross-section 10 x 3mm) and drill holes in it as indicated. All shield clamps required must fit between the drill holes.
CAUTION: Risk of injury due to the spring force of the coil spring. Use pliers.
2. Squeeze together the coil spring and the 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 50mm. Earth the busbar using a single conductor with a cross-section of at least 2.5mm².
4. Strip the external cable sheath to a length of approx. 30mm, 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 Servo Drive

8.4.3.1 Shielding Concept



8.4.3.2 Mounting the shield clamp and motor cable

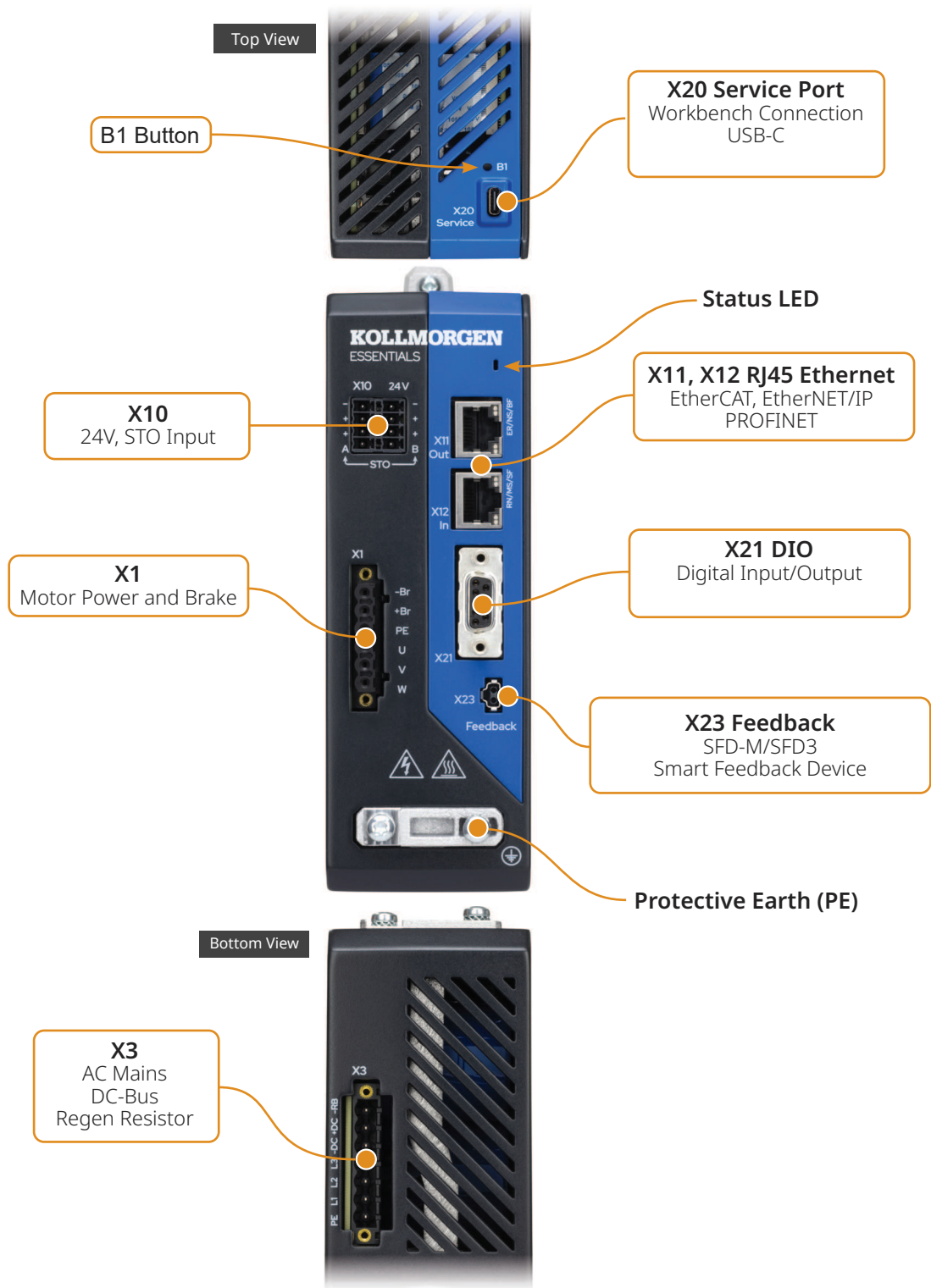


1. Connect the cable to the motor (1).
2. Secure the shield clamp (2) to the servo drive using the M4 screw (included). Tighten the screw to a maximum torque of 1.2 Nm in the designated threaded hole.
3. Connect plugs X1 and X23 (3) to the servo drive.
4. Secure the copper wrapped section of the cable (4) in the shield clamp and ensure that the individual wires of the cable (5) are not under excessive bending stress.
5. Secure the cable with a cable tie (4)(6) to the shield clamp as shown. Ensure the cable tie is in the designated shield clamp notch (6) to avoid sliding off the clamp.

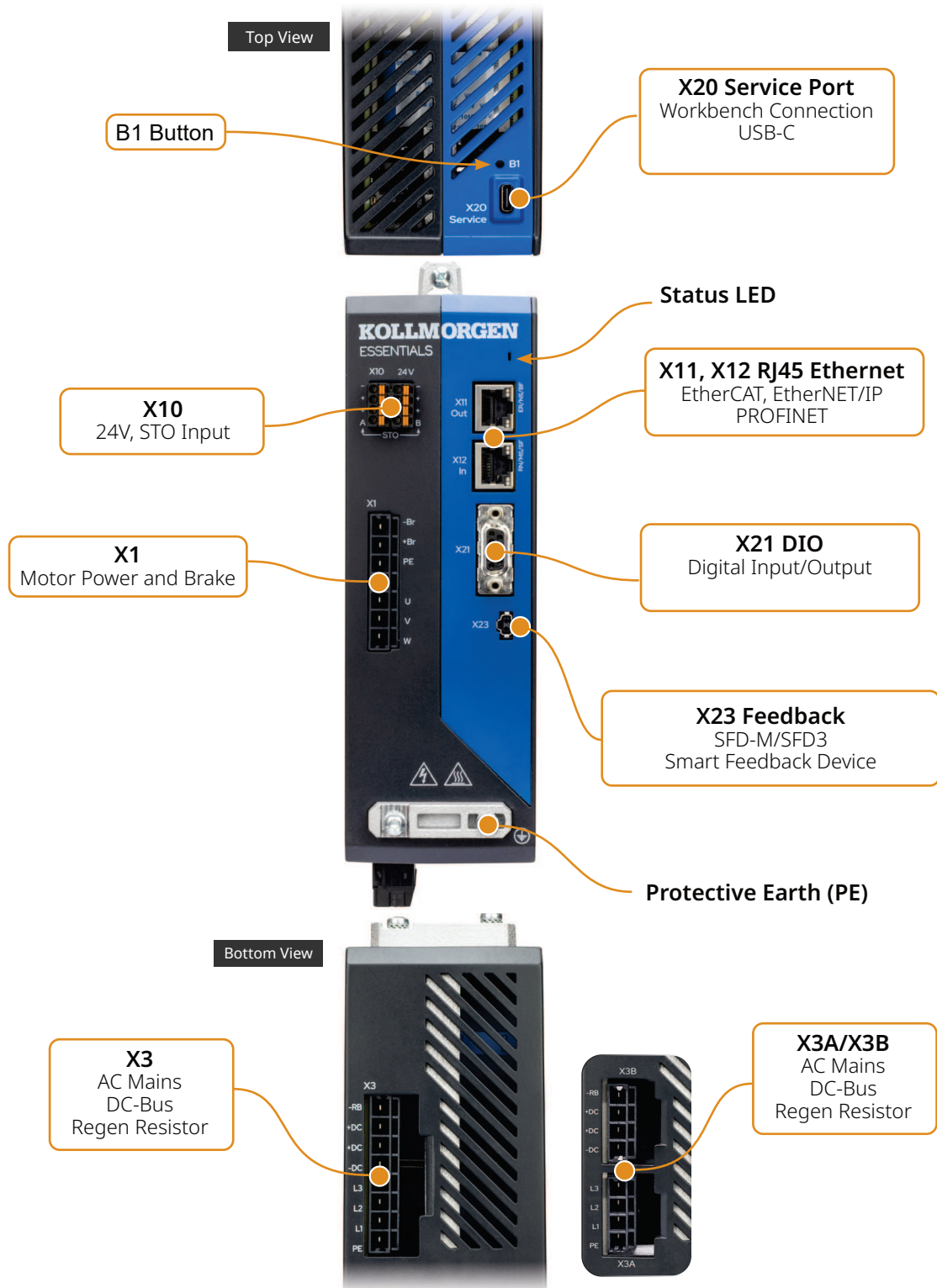
The shield clamp and the motor cable are now properly mounted.

8.5 Connection Overview

8.5.1 Connector Position - Kollmorgen Essentials Drive 6V03...06

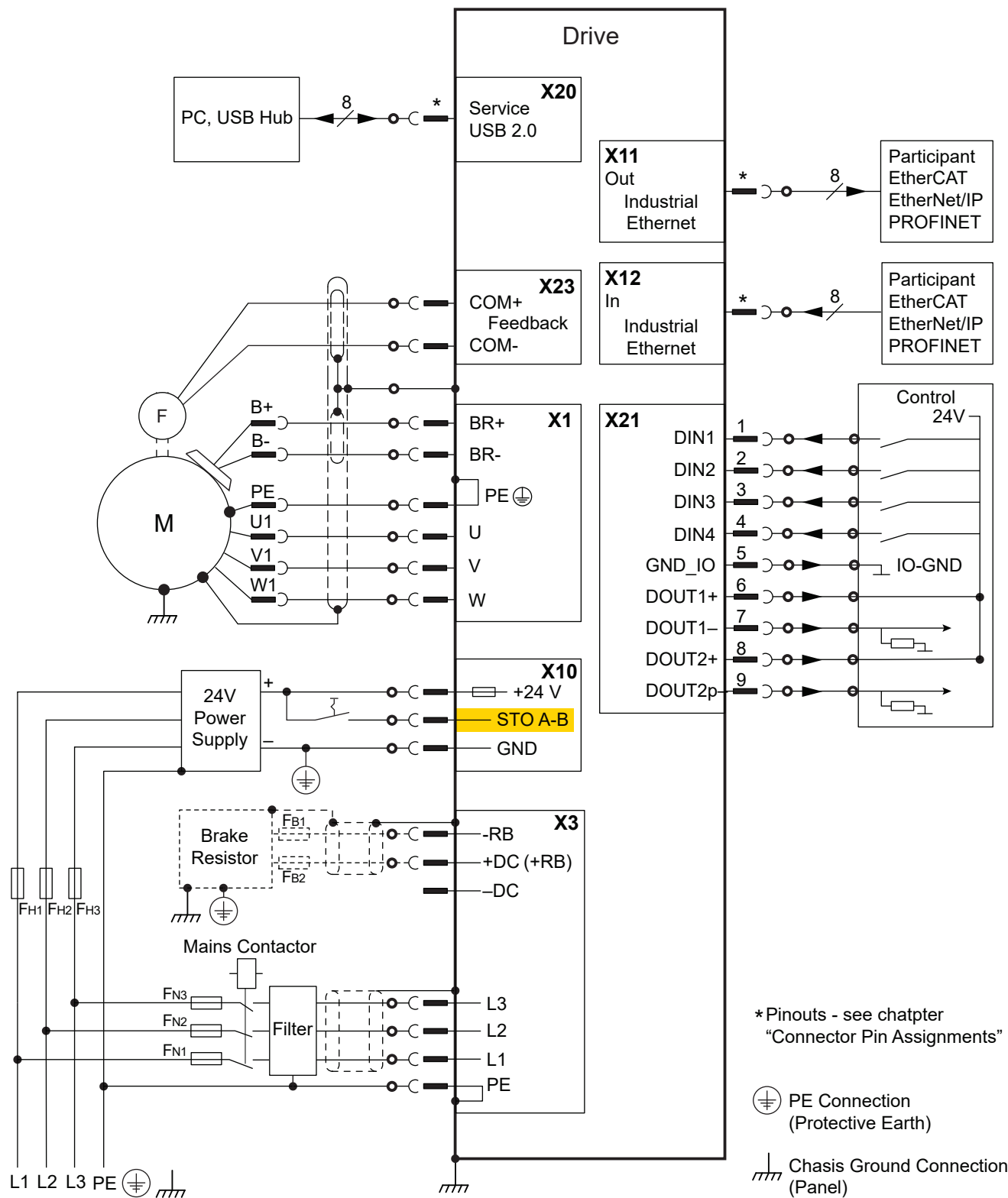


8.5.2 Connector Position - Kollmorgen Essentials Drive 6V12 and 7V03...12

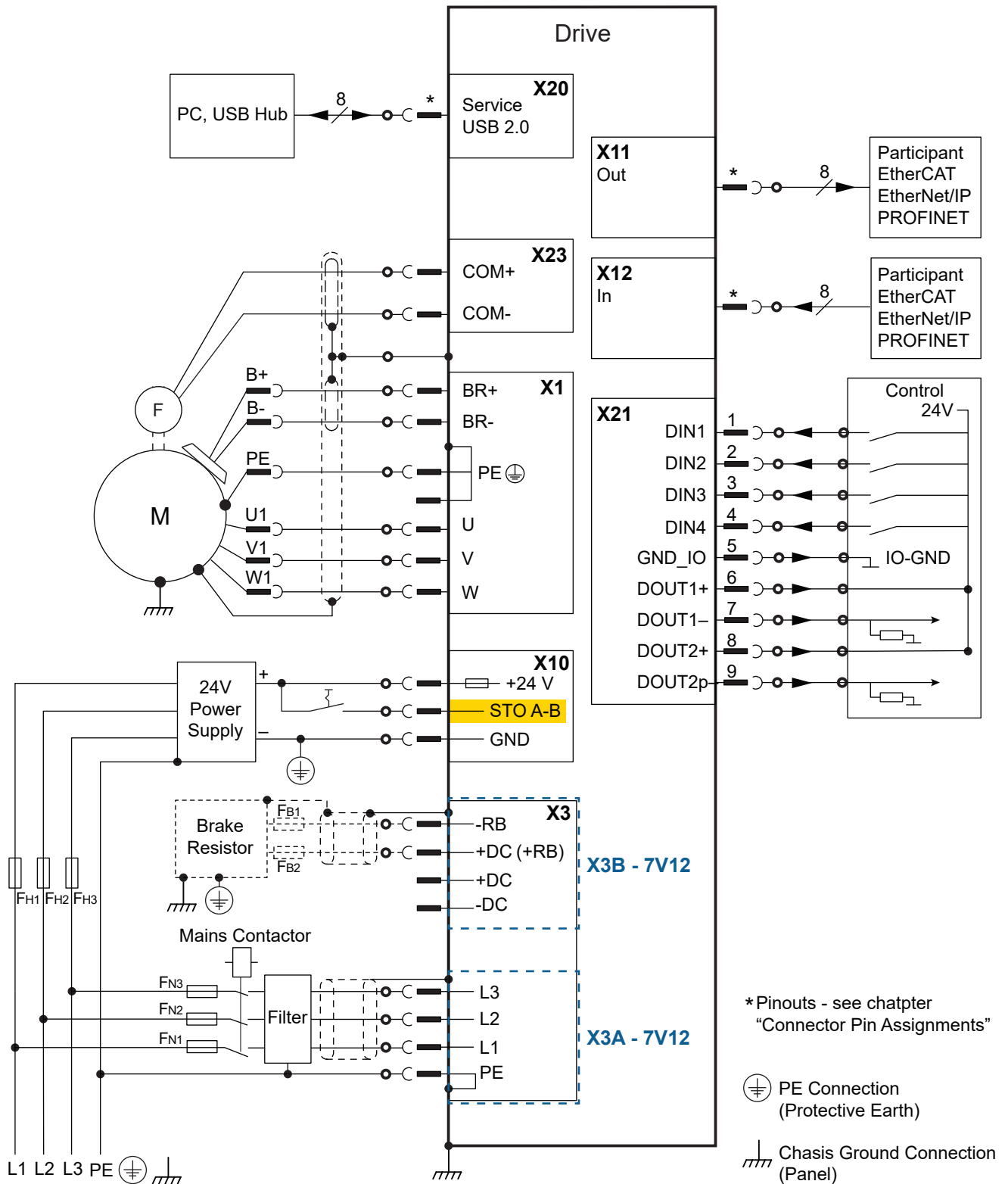


8.5.3 Wiring Overview

8.5.3.1 Connection Diagram - Kollmorgen Essentials Drive 6V03/06



8.5.3.2 Connection Diagram - Kollmorgen Essentials Drive 6V12, 7V03...12

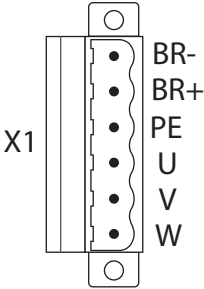
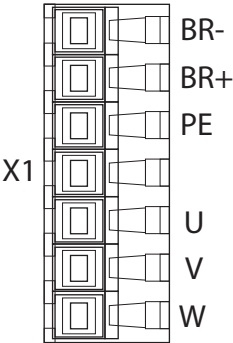


8.5.4 Connector Pinout

Information to wiring, mating connectors and cables (→ # 52).

8.5.4.1 X1: Motor power and brake

X1 specifications

Pinout diagram	Specifications
	Motor power, motor brake
	KED-6V03, KED-6V06 • 6 pin, pitch 5.08mm • 6 slotted conductor screws • Tightening torque for mounting screws: 0.5-0.6Nm • 2 locking screws: 0.3Nm
	KED-6V12, KED-7V03... 12 • 7 pin, pitch 6.35mm • Tightening torque for mounting screws: 0.3Nm • No screw contacts

X1 pinout for 6V03/06 servo drives

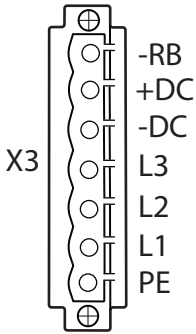
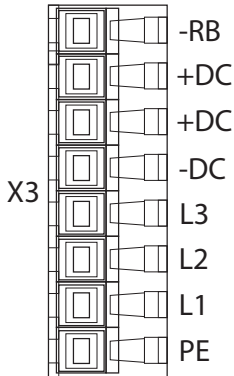
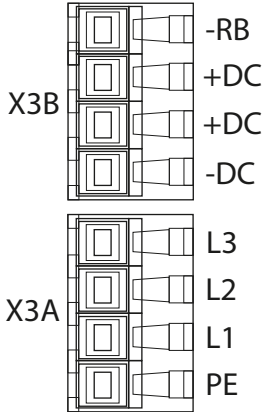
Pin	Signal	Description
1	BRAKE-	Negative connection to the mechanical brake
2	BRAKE+	Positive connection to the mechanical brake
3	PE	Protective earth
4	U	Connection to motor phase
5	V	Connection to motor phase
6	W	Connection to motor phase

X1 pinout for 6V12 and 7V03... 12 servo drives

Pin	Signal	Description
1	BRAKE-	Negative connection to the mechanical brake
2	BRAKE+	Positive connection to the mechanical brake
3	PE	Protective earth
4		
5	U	Connection to motor phase
6	V	Connection to motor phase
7	W	Connection to motor phase

8.5.4.2 X3: Mains, regen resistor, DC-Bus

X3 specifications

Pinout diagram	Specifications
	Mains supply, external regen resistor, DC bus
 X3	KED-6V03, KED-6V06 • 7 pin, pitch 5.08mm • Tightening torque for mounting screws: 0.3Nm • Tightening torque for ladder screws: 0.5-0.6Nm
 X3	KED-6V12, KED-7V03, KED-7V06 • 8 pin, pitch 6.35mm • No screw contacts
 X3B X3A	KED-7V12 • 8 pin, pitch 6.35mm • No screw contacts

X3 pinout for 6V03/06 servo drives

Pin	Signal	Description
1	-RB	Negative end of braking resistor*
2	+DC_BUS	Positive DC bus; positive end of braking resistor*
3	-DC_BUS	Negative DC bus
4	AC_L3	Mains input phase
5	AC_L2	Mains input phase
6	AC_L1	Mains input phase
7	PE	Protective earth

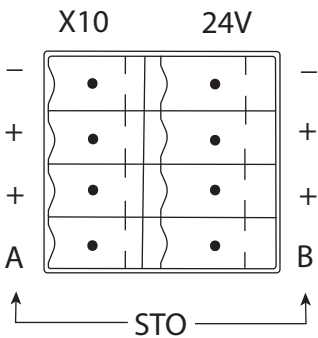
X3 pinout for 6V12 and 7V03...12 servo drives

Pin	Signal	Description
1	-RB	Negative end of braking resistor*
2	+DC_BUS	Positive DC bus; positive end of braking resistor*
3	+DC_BUS	Positive DC bus; positive end of braking resistor*
4	-DC_BUS	Negative DC bus
5	AC_L3	Mains input phase
6	AC_L2	Mains input phase
7	AC_L1	Mains input phase
8	PE	Protective earth

*mounted externally

8.5.4.3 X10: 24 VDC and STO input

X10 specifications

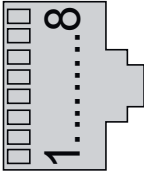
Pinout diagram	Specifications
	• 4x2 pin, pitch 3.5mm • Spring clamps • 24 VDC supply voltage, STO inputs

X10 pinout

Signal	Pin	Pin	Signal
GND_24V	1A	1B	GND_24V
+24V	2A	2B	+24V
+24V	3A	3B	+24V
STO-A	4A	4B	STO-B

8.5.4.4 X11/12: Industrial Ethernet

X11/12 specifications

Pinout diagram	Specifications
X11/12 	• RJ45 with built-in green/red dual-color LED • EtherCAT, EtherNet/IP, PROFINET • Interface Details: (→ # 85)

X11/12 pinout

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

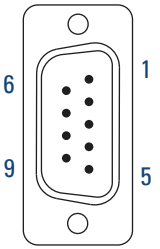
8.5.4.5 X20: Service

X20 specifications

Connector at computer	Connector at servo drive	Length	Image	Right-angle connector at servo drive	Spec	Type
A male	C male	< 2m			USB 2.0	Data transfer and charge
C	C	< 2m			USB 2.0	Data transfer and charge

8.5.4.6 X21: I/O

X21 specifications

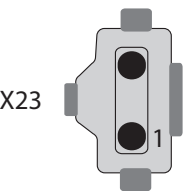
Pinout diagram	Specifications
	• DB9 (9-pin D-sub), female • Locking screws, tightening torque: 0.4Nm (3.5inlbs) • 4 Digital-In, 2 Digital-Out

X21 pinout

Pin	Signal	Description
1	DIN1	High-speed digital input, 24V signalling
2	DIN2	High-speed digital input, 24V signalling
3	DIN3	Slow digital input, 24V signalling
4	DIN4	Slow digital input, 24V signalling
5	GND_IO	Common for digital inputs
6	DOUT1+	Digital output 1, positive connection
7	DOUT1-	Digital output 1, negative connection
8	DOUT2+	Digital output 2, positive connection
9	DOUT2-	Digital output 2, negative connection

8.5.4.7 X23: Single-cable Feedback

X23 specifications

Pinout diagram	Specifications
	• IEC 63171-6 connector • SFD-M/SFD-3 feedback

X23 pinout

Pin	Signal	Description
1	DP+	Data+ with +12V
2	DP-	Data- with 0V

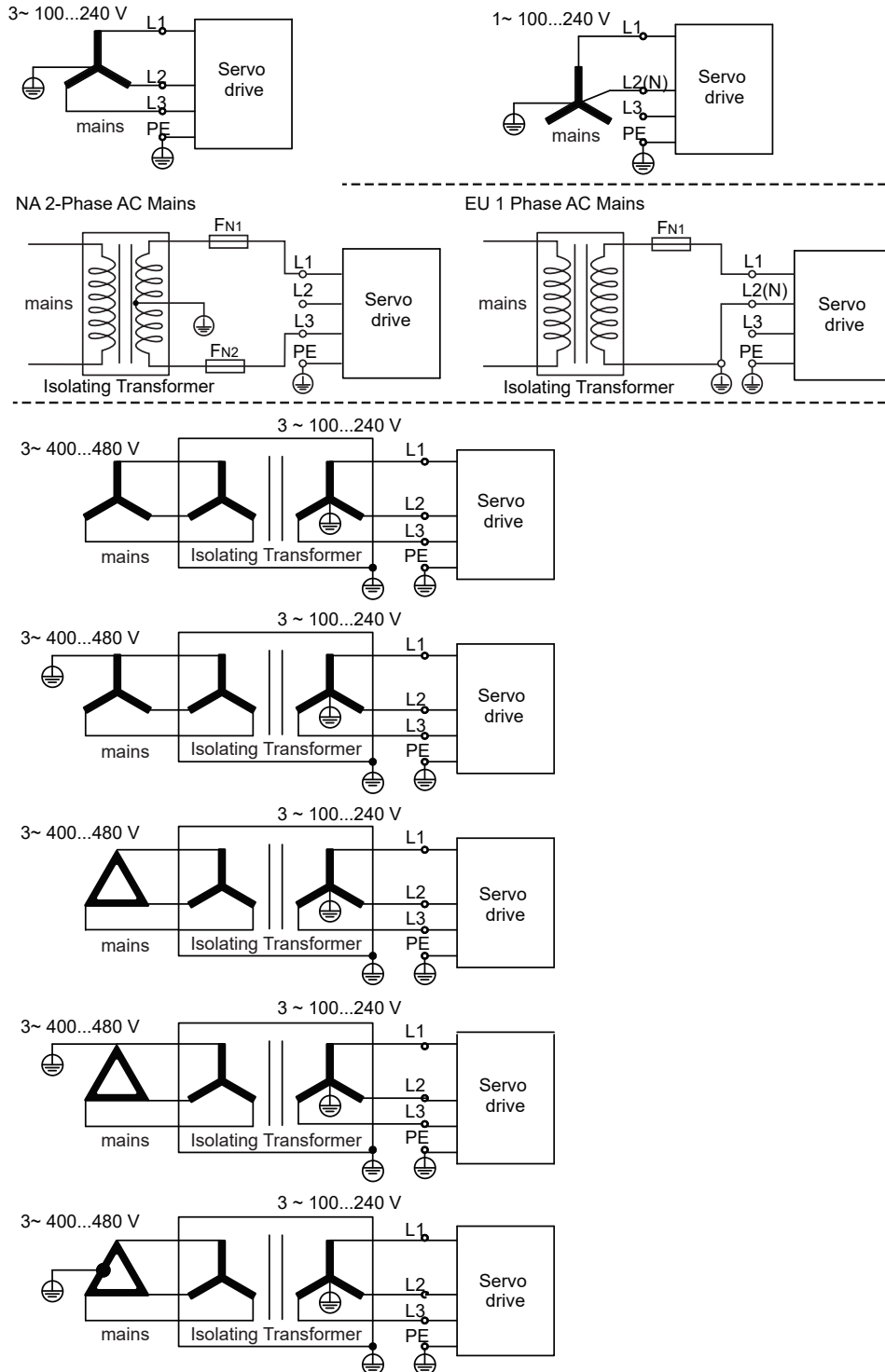
8.6 Power and Logic Voltage Supply (X3/X10)

8.6.1 Electrical Supply Connection

8.6.1.1 Connection to various mains supply networks - 240V servo drive

NOTICE

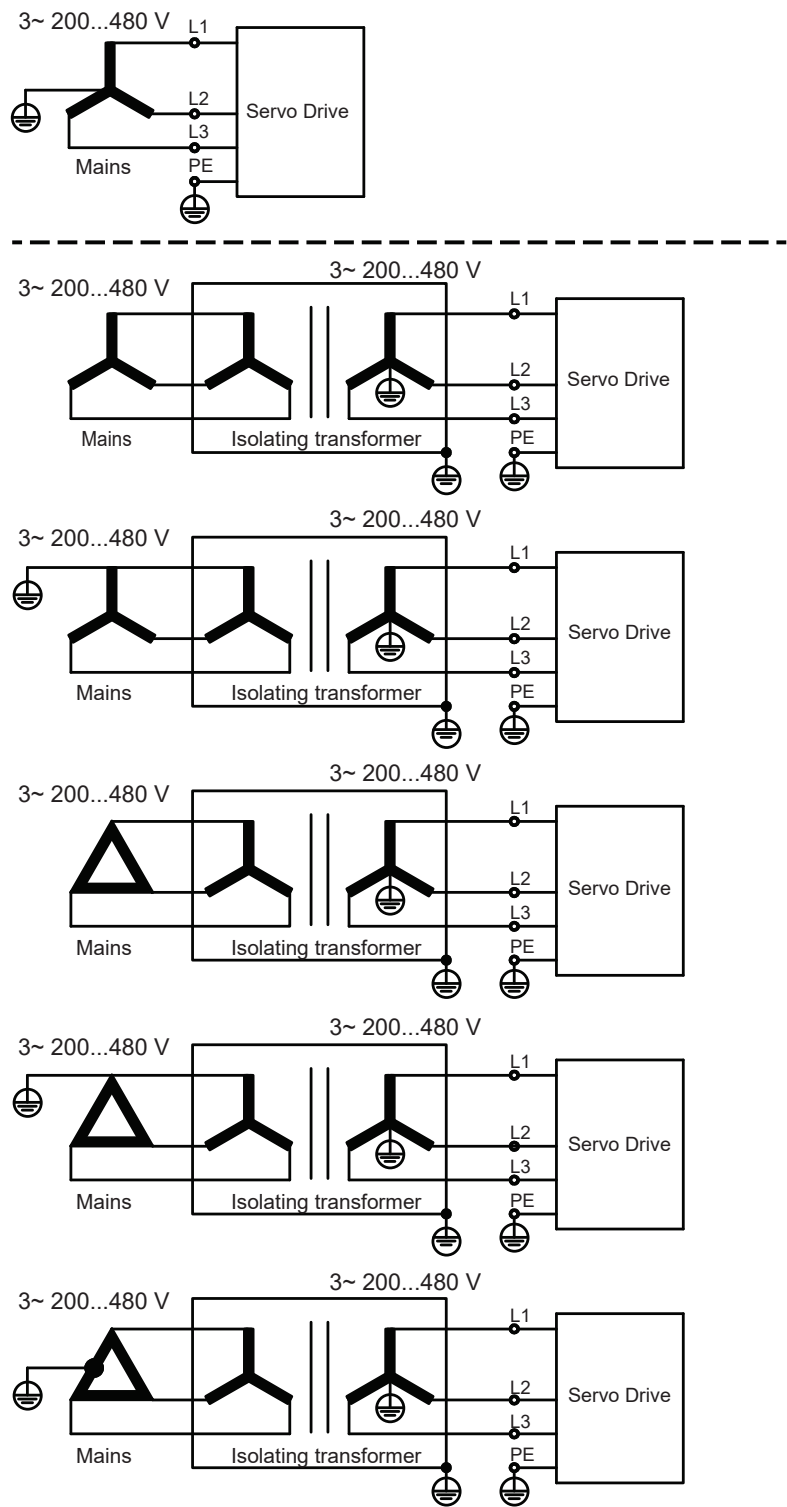
An isolating transformer is required for 400 to 480V networks to get a maximum voltage of 240V +10%.



8.6.1.2 Connection to various mains supply networks - 480V servo drive

NOTICE

An isolating transformer is required for 120V networks to get a minimum voltage of 200V +10%.



8.6.2 Mains Power Supply Connector X3

Servo drives in the Kollmorgen Essentials Drive series can be supplied as follows:

KED-6V03/06

- 1, 2 or 3 phase industrial AC supply networks (TN-S or TT, see [KSN](#)): (→ # 39)

KED-6V12

- 3 phase industrial AC supply networks (TN-S or TT, see [KSN](#)): (→ # 39)

KED-7V03...12

- 3 phase industrial AC supply networks (TN-S or TT, see [KSN](#)): (→ # 39)

For connection to corner grounded delta supply networks contact Kollmorgen customer support.

Periodic overvoltages between phases (L1, L2, L3) and the PE/housing of the servo drive must not exceed 1,000V peak. In accordance with IEC 61800, voltage spikes (< 50 µs) between phases must not exceed 1,000V. Voltage spikes (< 50 µs) between a phase and the PE/housing must not exceed 2,000V.



X3 - 6V03/6V06



X3 - 6V12/7V03/7V06



X3A / X3B - 7V12

- 8/4 pin, pitch 7.62/10.16mm
- Wiring example:
 - 1 phase AC supply (→ # 72)
 - 2 phase AC supply (→ # 72)
 - 3 phase AC supply (→ # 73)
- The servo drive requires external EMC filter for use in industrial environment, product category C.
- Mating connector data (→ # 52)
- Fusing with different system structures (→ # 74)

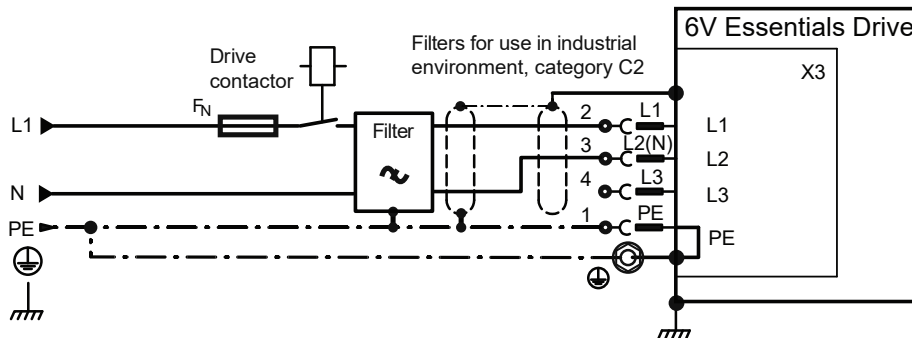
Pin	Label	Signal	1~ Supply	2~Supply	3~ Supply
1	PE	PE	Protective earth	Protective earth	Protective earth
2	L1	L1	Phase L1	Phase L1	Phase L1
3	L2	L2	Neutral N	n.c.	Phase L2
4	L3	L3	n.c.	Phase L2	Phase L3

For DC supply: observe notes (→ # 71).

8.6.2.1 Wiring examples mains power supply

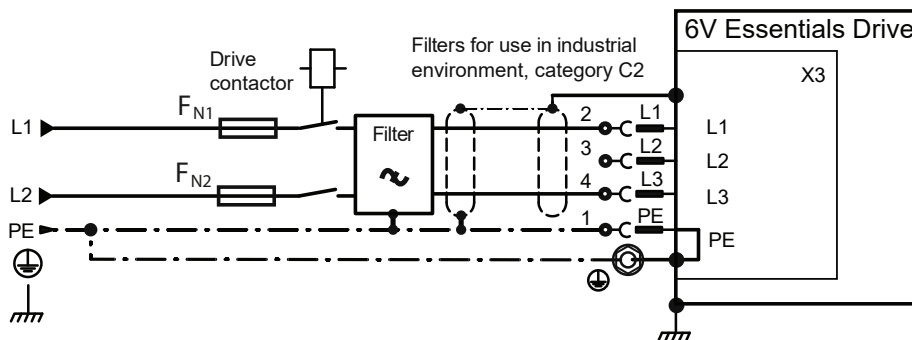
One phase AC mains (240V servo drive)

- Directly to one phase supply network with neutral line.
- Activate single phase supply (VBUS.THREEPHASE = 0).
- Set VBUS.ACNO MINAL to desired nominal AC line voltage for lines other than nominal rated VAC.
- For complete information refer to WorkBench Help.
- You need to provide AC line filtering. Use filter type FN2090 and refer to the (→ Accessories for Kollmorgen Essentials Drives # 137) for more information. Use a shielded cable between filter and drive.



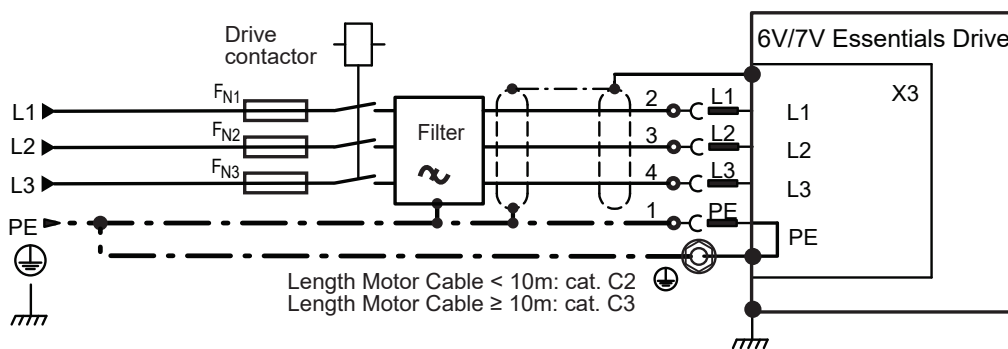
Two phases AC mains (240V servo drive)

- Directly to two-phase supply network without neutral line.
- Activate single phase supply (VBUS.THREEPHASE = 0).
- Set VBUS.ACNO MINAL to desired nominal AC line voltage for lines other than nominal rated VAC.
- For complete information refer to WorkBench Help.
- You need to provide AC line filtering. Use filter type FN2090 and refer to the (→ Accessories for Kollmorgen Essentials Drives # 137) for more information. Use a shielded cable between filter and drive.



Three phases AC mains

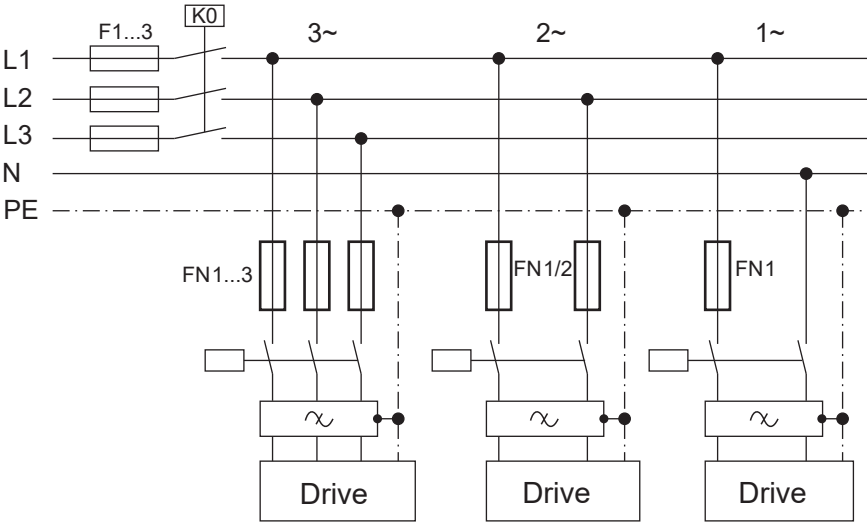
- Directly to 3-phase supply network.
- Activate 3-phase supply (VBUS.THREEPHASE = 1).
- Set VBUS.ACNOINAL to desired nominal AC line voltage for lines other than nominal rated VAC.
- For complete information refer to WorkBench Help.
- You need to provide AC line filtering. Use filter type FN2090 and refer to the (→ Accessories for Kollmorgen Essentials Drives # 137) for more information. Use a shielded cable between filter and servo drive.
 - **240V** servo drive with 3 and 12 A_{rms}:
 - Motor cable < 10 m: use filter FN 2090 in industrial environment, category C2.
 - Motor cable ≥ 10 m: use filter FN 2060 in industrial environment, category C3.
 - **480V** servo drive with 03...12 A_{rms}:
 - Motor cable < 10 m: use filter FN3287/FN3288 in industrial environment, category C2.
 - Motor cable ≥ 10 m: use filter FN3040 in industrial environment, category C3.



8.6.2.2 Fusing

Fuse types	Description
US fuses	- Class J, 600V_{AC}, 200kA SCCR, time-delay - Class CC fuses with lower let through current than Class J, they must not exceed the ampere ratings indicated in the following table "<i>Ampere Ratings for Kollmorgen Essentials Drives</i>" - must be UL and CSA listed Note: Alternate fuses to Class J must have similar or better I_p and I²T performance per UL 508A SB4.2 at max. 5kA SCCR rating.
EU fuses	gS or gG, 400/500V, time-delay
Semiconductor	Not yet qualified
Fuse holders	Use finger-safe fuse holders according to EN 60529 in combination with the standard fuse blocks.
Automatic circuit breakers	Not yet qualified

AC supply, single servo drives, line fusing



- F1, F2, F3: depends on sum of application's required input currents and cabinet requirements.
- Filters for special EMC requirements only (→ # 138).
- FN1, FN2, FN3 recommended rating see table below:

Ampere ratings for Kollmorgen Essentials Drives

Servo drive Model	FN1, FN2, FN3: Ampere rating	Example class J Eaton Bussmann	Example class J Mersen
KED-6V03/06	10A (Time-Delay)	LPJ10SP, DFJ10	AJT10, HSJ10
KED-6V12	15A (Time-Delay)	LPJ15SP, DFJ15	AJT15, HSJ15
KED-7V03/06	10A (Time-Delay)	LPJ10SP, DFJ10	AJT10, HSJ10
KED-7V12	15A (Time-Delay)	LPJ15SP, DFJ15	AJT15, HSJ15

8.6.3 Auxiliary Voltage Power Supply Connector X10

The following diagram describes external 24 VDC power supply (PELV). The required supply current rating depends on the use of motor brake (→ # 39).



- 2x4 pin, pitch 3.5mm
- T-type mating connector data (→ # 52)
- Undervoltage fault limit 19V
- Overvoltage fault limit 30V

For control supply current requirement specifications see section (→ # 40).

8.6.3.1 Fusing

Use 24 VDC supply manufacturer's recommendation for fusing.

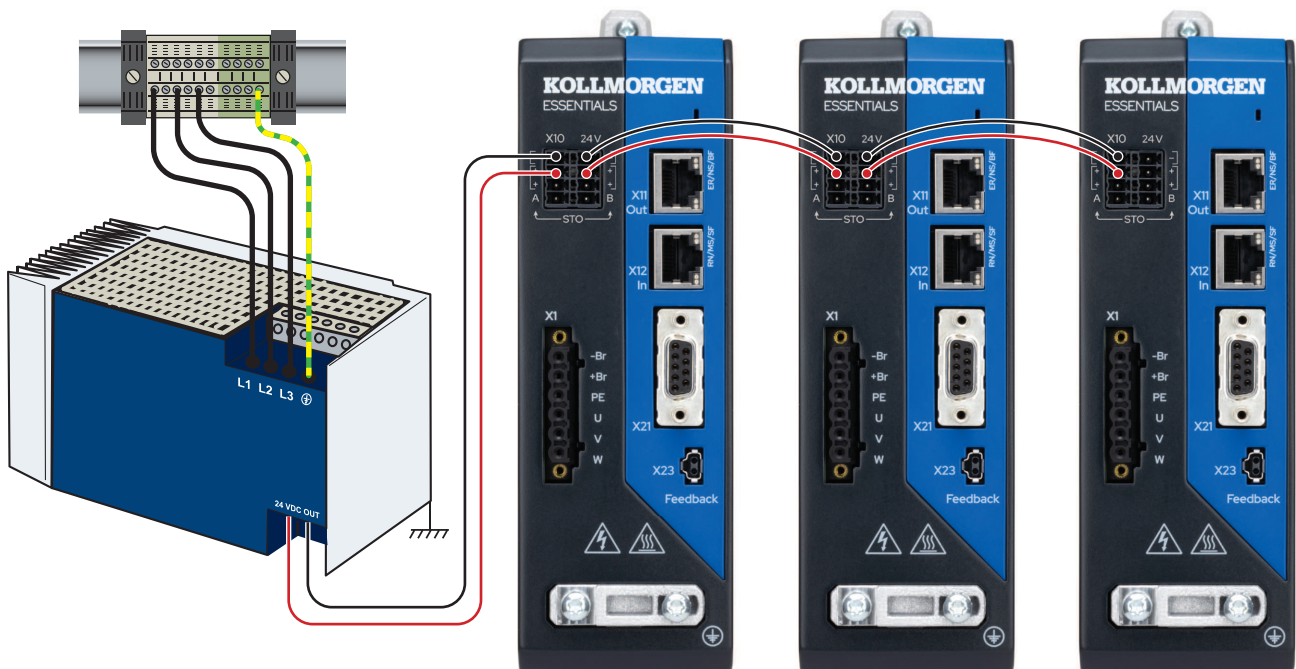
8.6.3.2 Wiring example 24 VDC supply

Maximum current for one string of daisy-chained X10T connectors is 8A. The sum of the control currents of the connected servo drives should not exceed 8A.

Possible connections:

- 5 servo drives in line, no brakes
- 3 servo drives in line, with brakes
- in a ring connection the number of servo drives can be doubled

Wiring example with three phase power supply unit:

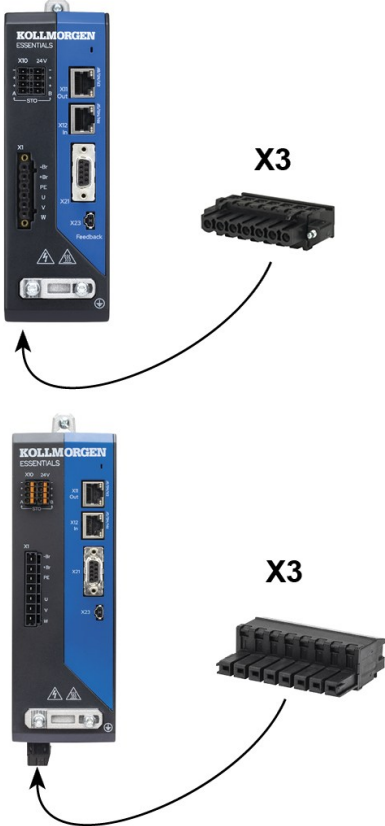


8.7 DC Bus Link Connector X3

The DC bus link can be connected in parallel so that the power returned from slowing down motors is divided between all the servo drives that are connected to the same DC bus link circuit. Every servo drive must have its own power connection to mains voltage sharing the same branch, over current protection devices, even if the DC bus link is used. Generative servo drives should be placed beside servo drives that need energy thereby reducing current flow across longer distances.

NOTICE

Servo drives can be destroyed if DC bus link voltages are different. Only servo drives with mains supply that share the same AC branch, over current protection devices (identical mains supply voltage) may have the DC bus links interconnected.
Interconnection of DC bus links works best in systems powered by 3-phase AC or DC power. Consult Kollmorgen for DC bus linking with single phase AC power input.



- Mains supply, external regen resistor, DC bus

KED-6V03/KED-6V06:

- 7 pin, pitch 5.08mm
- Tightening torque for mounting screws: 0.3Nm
- Tightening torque for ladder screws: 0.5-0.6Nm

KED-6V12/KED-7V03...12:

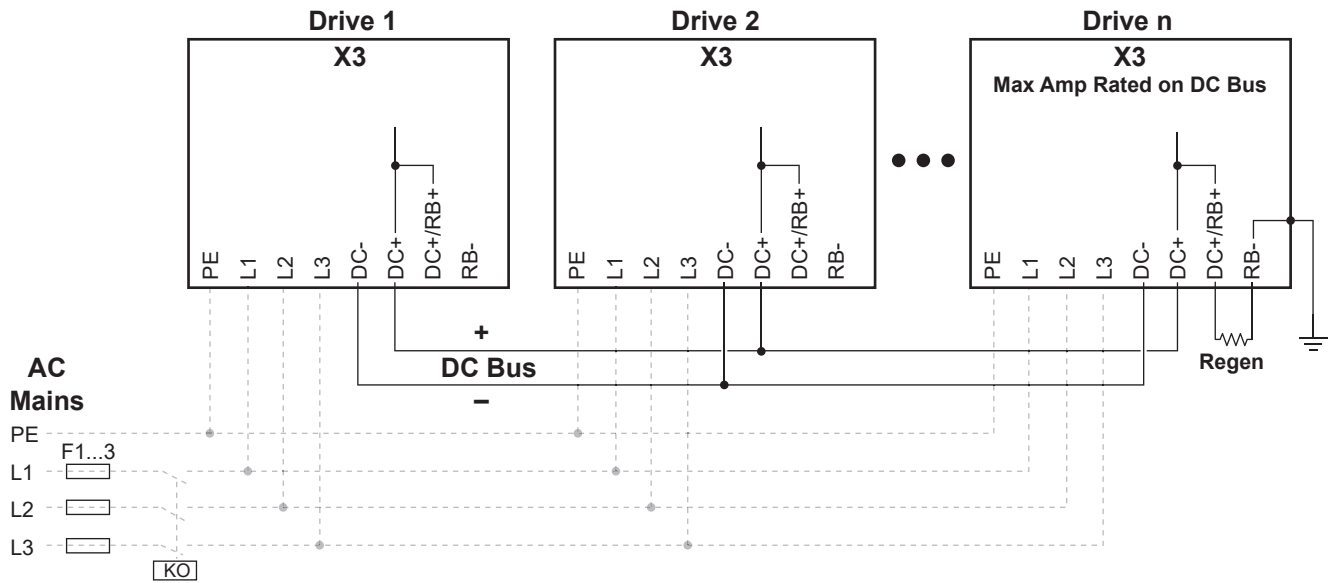
- 8 pin, pitch 6.35mm
- No screw contacts

Mating connector data (→ # 52)

Pin	Label	Signal	Description
5	-DC	-DC	DC Bus link negative
6	+DC	+DC	DC Bus link positive

8.7.1 DC Bus sharing between Kollmorgen Essentials Drives

All servo drives are connected to AC with the same number of phases and the same voltage.



When several units are connected to the same AC mains, the units need to be able to share a common DC Bus via the X3 connector, as shown in the following table "Total number of servo drives allowed".

Total number of servo drives allowed

Total number of servo drives allowed	KED-6V03	KED-6V06	KED-6V12	KED-7V03	KED-7V06	KED-7V12
KED-6V03	3	2	2			
KED-6V06	2	3	2			
KED-6V12	2	3	3			
KED-7V03				3	2	2
KED-7V06				2	3	3
KED-7V12				2	3	3

NOTE

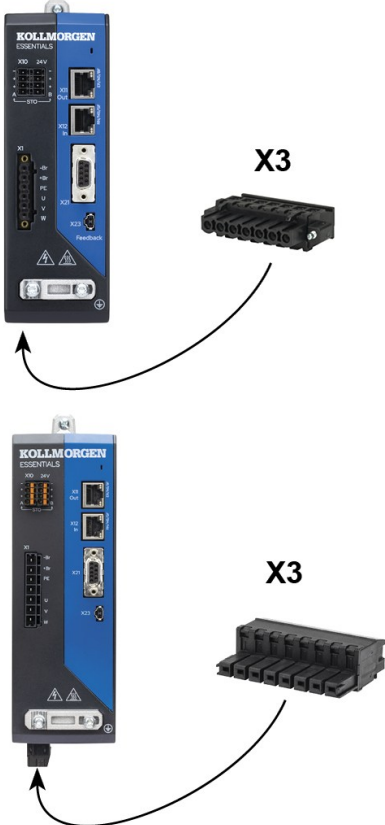
Always connect the regen resistor to the servo drive with the highest current rating.

8.8 Regen Resistor Connector X3

For technical data on the regenerative brake circuit refer to (→ # 41).

NOTE

You are responsible for fusing (such as fusible cut-outs or power switches).



- Mains supply, external regen resistor, DC bus

KED-6V03/KED-6V06:

- 7 pin, pitch 5.08mm
- Tightening torque for mounting screws: 0.3Nm
- Tightening torque for ladder screws: 0.5-0.6Nm

KED-6V12/KED-7V03...12:

- 8 pin, pitch 6.35mm
- No screw contacts

- Mating connector data (→ # 52).
- Refer to the WorkBench online help for parameter setting (REGEN.EXT, REGEN.REXT, REGEN.WATTEXT)

Pin	Label	Signal	Description
7	+DC	+DC	external Regen resistor + / DC bus link positive
8	-RB	-RB	external Regen resistor -

8.9 Motor Power, Brake, and Feedback Connection

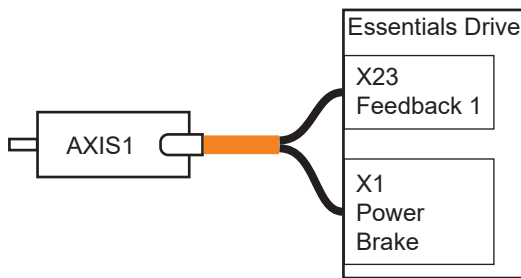
A drive is able to protect a connected motor from overloading if the parameters are set correctly and the thermal protection sensor is connected and supervised. The valid data are automatically set by the WorkBench motor database for Kollmorgen motors. Refer to parameter AXIS#.MOTOR.RTYPE for supported thermal sensors.

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 (→ # 53).

8.9.1 Motor Connectivity Example

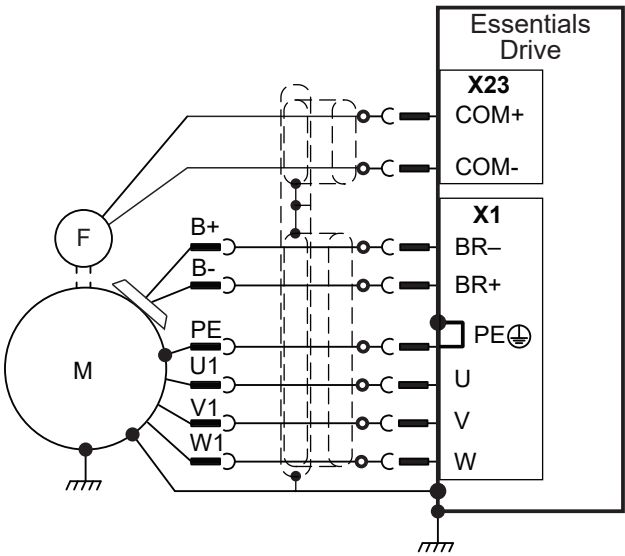


For grounding shield connection, see (→ # 58)

8.9.2 Motor Cable Connection

Motors with two wire feedback systems like SFD-M can be connected to the servo drive by using a single Kollmorgen hybrid cable.

8.9.2.1 Motor power and brake connector X1



- X1 (Feedback 1)
 - Motor Power: 4 pin, pitch 7.62mm
 - Motor Brake: 2 pin, pitch 3.81mm
 - Motor Feedback: 2 pin, pitch 3.81mm
- Cable length and mating connector data: (→ # 52)
- Use Kollmorgen cables
- Feedback type: SFD-M
 - Rated voltage 11V.
 - Rated current is 350mA

8.9.2.2 Motor leads to servo drive connector X1

X1 pinout for 6V03/06 servo drives

Pin	Signal	Description
1	BRAKE-	Negative connection to the mechanical brake
2	BRAKE+	Positive connection to the mechanical brake
3	PE	Protective earth
4	U	Connection to motor phase
5	V	Connection to motor phase
6	W	Connection to motor phase

X1 pinout for 6V12 and 7V03...12 servo drives

Pin	Signal	Description
1	BRAKE-	Negative connection to the mechanical brake
2	BRAKE+	Positive connection to the mechanical brake
3	PE	Protective earth
4		
5	U	Connection to motor phase
6	V	Connection to motor phase
7	W	Connection to motor phase

8.9.2.3 Motor feedback cable connector to servo drive feedback connector X23

Pin	Signal	Description
1	COM+	SFD-M Positive Signal
2	COM-	SFD-M Negative Signal

8.9.3 Motor Holding Brake Connection

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

The brake is powered by the 24V auxiliary supply on X10. For minimum and maximum brake current see Electrical Data (→ # 40).

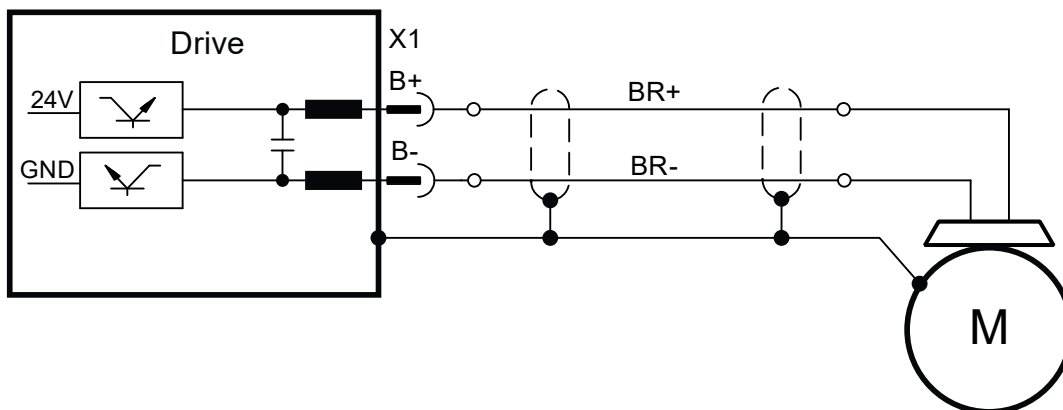
	! WARNING	No functional safety!
Serious injury could result when the load is not properly blocked. The internal brake function does not ensure functional safety. • The Hardware Enable does not initiate a controlled stop but switches off the power stage immediately. • Set parameter AXISx.MOTOR.BRAKEIMM to 1 with vertical axes, to apply the brake immediately after faults or hardware disable.		

Pinout for motor brake X1

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

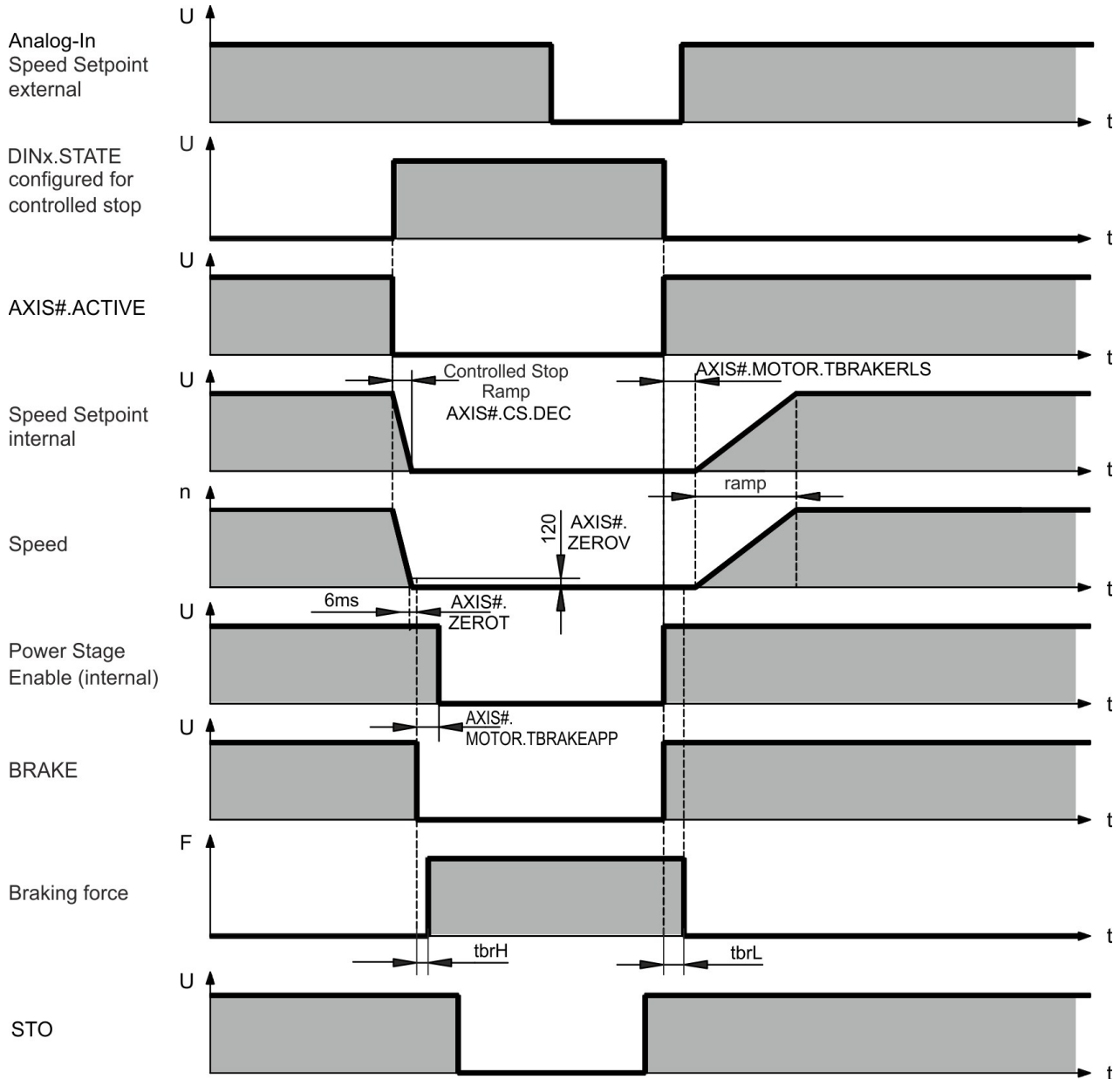
Wiring

Typically the brake line is part of the Kollmorgen cable connection to X1 (→ # 80).



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 servo drive speed setpoint is internally driven down an adjustable ramp (AXISx.CS.DEC) to 0 V.

With default values the output for the brake is switched on when the speed has reached 5 rpm (AXISx.ZEROV) for at least 6 ms (AXISx.ZEROT). 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.

8.9.4 Feedback Connector X21

The X21 port provides input for command or feedback options:

- Step/Direction
- CW/CCW
- Incremental Encoder without index or halls

The servo drive provides 4 digital inputs and 2 digital outputs on the X21 DB9 (9-pin D-sub) port. Pins 1 and 2 are fast input, isolated, sink, type EN 61131-2 type 1 and are capable of quadrature feedback input.

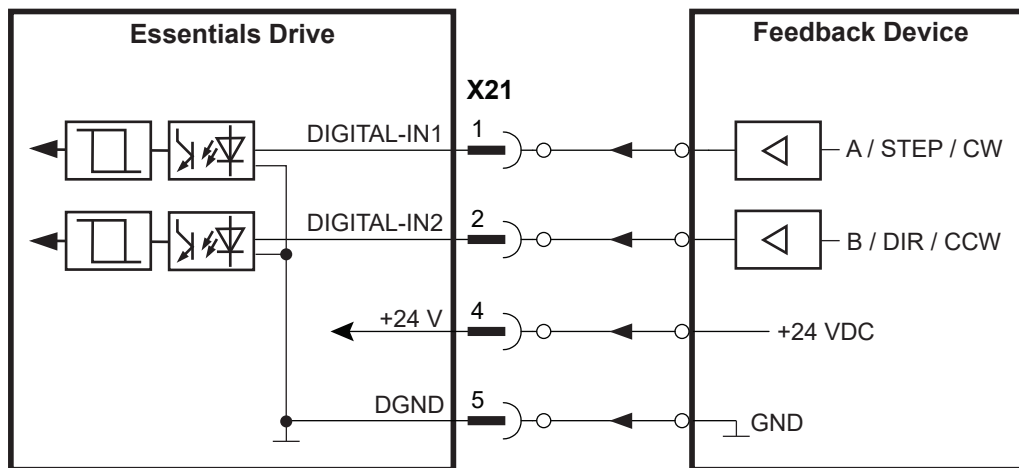
NOTICE

Maximum distance for unshielded I/O lines is 3m inside the cabinet. Ensure EMC shielding if the I/O cable leaves the cabinet.

NOTICE

The X21 digital inputs are 24V and not compatible with 5V logic.

8.9.4.1 X21 Feedback Connector Pinout



X21 Pin	Incr. Encoder FB2.IDENTIFIED 11	Step/Direction FB2.IDENTIFIED 13	Incr. Encoder FB2.IDENTIFIED 14
1	A	Step	CW
2	B	Direction	CCW
4	24 V _{DC}	24 V _{DC}	24 V _{DC}
5	Common (DGND)	Common (DGND)	Common (DGND)

8.9.5 Feedback Connector X23

The Kollmorgen Essentials Drive offers one feedback channel.

The use of this feedback channel may be freely configured in the software, subject only to a few restrictions that are not physically sensible.

Cable length

See (→ Cable and Wire Requirements # 53) for max. cable length of SFD-M and SFD-3.

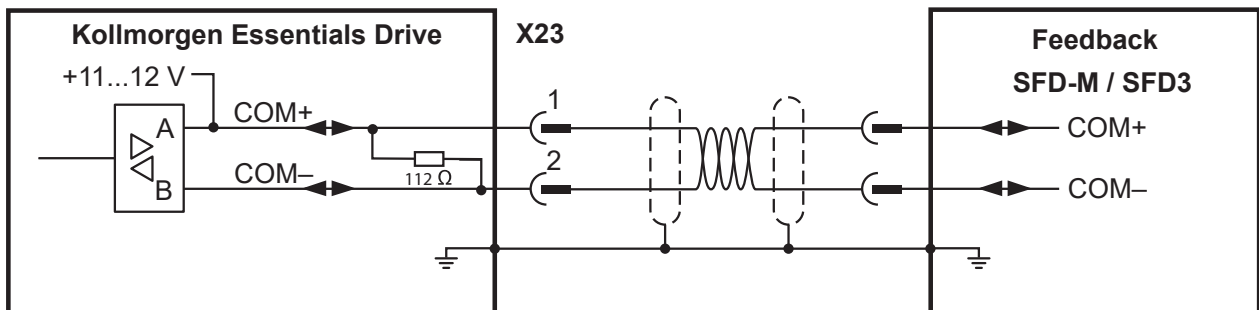
Specifications



- 2-wire connection with 12V signal
- SFD-3 and SFD-M are supported
- Up to 350mA available from 11V...12V at the servo drive

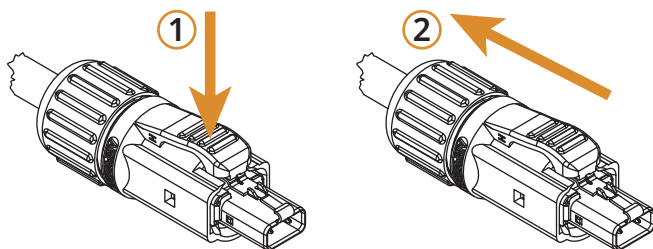
Wiring diagram

The diagram below shows the connection of the two-wire SFD3/SFD-M feedback system.



Removal of connector X23

1. Press the latch down.
2. Pull the connector straight out. Do not twist.



8.10 Industrial Ethernet Interface Connector X11/X12

The Industrial Ethernet interface has two RJ45 connectors with two associated LEDs at each port.



- RJ45 with built-in green/red bi-color LED
- EtherCAT
- EtherNet/IP
- PROFINET

NOTICE

Industrial Ethernet interface X11/X12 pinout depends on the protocol used. Refer to the matching fieldbus communication manual.

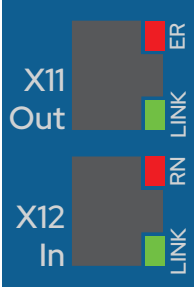
Link/Activity LED

The link/activity LED at each port is green.

LED	Meaning
Off	no connection
Lit	LINK: connection
Flashes	activity (packets detected)

8.10.1 EtherCAT

The Kollmorgen Essentials Drive can be connected as a slave to the EtherCAT network (CoE) by using RJ45 connectors X11 (out port) and X12 (in port). The communication status is indicated by the built-in connector LEDs.

	Port	LED Indicator	Function
	X11 Out	ER "ERROR"	Returns potentials communication failures:
			Off = No Error
			Blinking = Invalid configuration
			Single Flash = Local error
			Double Flash = Process data watchdog
		Link/ Activity	On/Blinking: Physical link/Data Traffic on.
			Static off: No link.
	X12 In	RN "RUN"	Returns the device state:
			Off = INIT
			Blinking = PRE-OPERATIONAL
			Single Flash = SAFE-OPERATIONAL
			On = OPERATIONAL
			Flickering = Initialization or BOOTSTRAP
		Link/ Activity	On/Blinking: Physical link/Data Traffic on.
			Static off: No link.

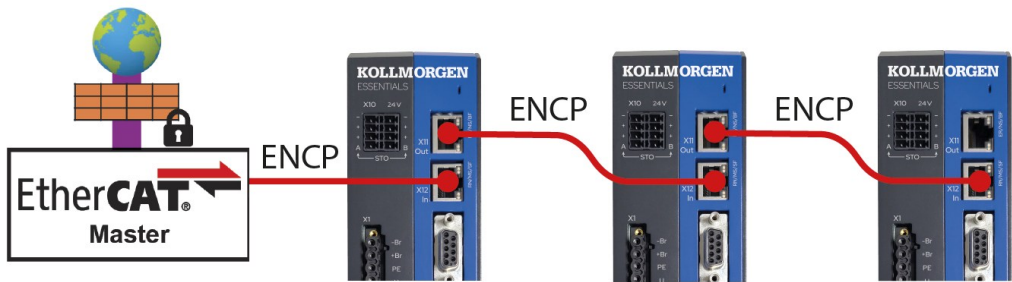
Cables

Use standard Ethernet cables with at least these characteristics:

- Category 5 (CAT5) or better according to EN 50173 or ISO/IEC 11801
- Shielding: S/FTP or better

Bus topology example (EtherCAT)

We suggest using 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*.

8.10.2 PROFINET

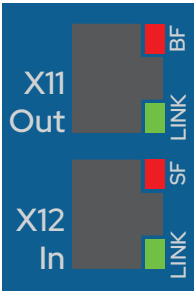
The Kollmorgen Essentials Drive can be connected as a slave to a PROFINET network by using RJ45 connectors X11 (Port 2) and X12 (Port 1). PROFINET RT or IRT protocols can be used.

Address

The Industrial Ethernet address is set automatically.

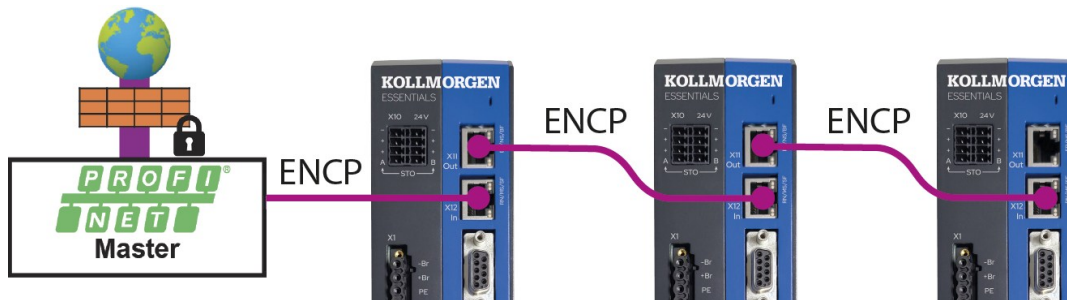
LEDs

The communication status is indicated by the built-in connector LEDs.

	Port	LED Indicator	Function
	X11 Out	BF	 ON = No Configuration, low speed, no link
			 OFF = No Error
			 Flashing 2Hz = No data exchange
		Link/Activity	 ON = Connection to the Ethernet
			 OFF = No connection to the Ethernet
			 Flashing = Sends/receives Ethernet frames
	X12 In	SF	 ON = Watchdog timeout; channel / generic / extended diagnosis present; system error
			 OFF = No Error
			 Flashing 2Hz = DCP signal service is initiated via the bus
		Link/Activity	 ON = Connection to the Ethernet
			 OFF = No connection to the Ethernet
			 Flashing = Sends/receives Ethernet frames

Bus topology example (PROFINET)

We recommend using ENCP cables. For more possible system solutions refer to the WorkBench Online Help.



Communication profile

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



8.10.3 EtherNet/IP

The Kollmorgen Essentials Drive can be connected as a slave to an EtherNet/IP network by using RJ45 connectors X11 (Port 2) and X12 (Port 1).

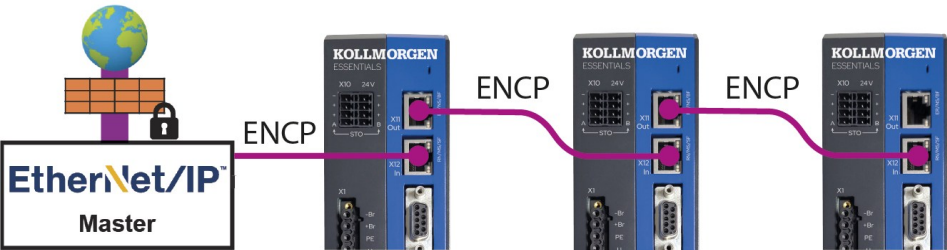
LEDs

The communication status is indicated by the built-in connector LEDs.

	LED Indicator		Status	Function
	Network Status (NS)		On	Connection
			Flashing	No Connection
			Off	No power, No IP Address
			On	Duplicate IP Address
			Flashing	Connection Time-Out
			Flashing	Self-Test
	Link/Activity		On	Ethernet Connection
			Off	No Ethernet Connection
	Module Status (MS)		On	Device Operational
			Flashing	Standby
			Off	No Power
			On	Unclearable Fault
			Flashing	Clearable Fault
			Flashing	Self-Test
	Link/Activity		On	Ethernet Connection
			Off	No Ethernet Connection

Bus topology example (EtherNet/IP)

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



8.11 Service Interface Connector X20

The Service Interface X20 provides USB connection to a PC running WorkBench software for configuration, firmware updates and diagnostics.



NOTE

Rubber plug

Insert the rubber dust plug into the X20 USB-C slot when no cable is inserted, in order to protect it against particle/dust ingress and to protect against impairment of connection quality.

The rubber plug is included with the servo drive.

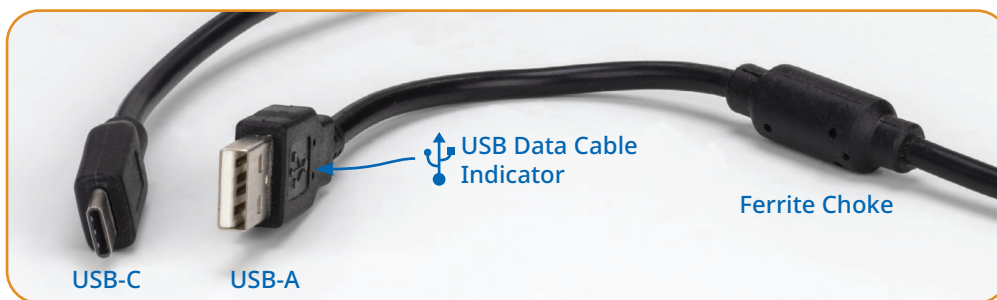
8.11.1 Cables

Use standard USB-C data cables up to 2m length. One end of the cable must have a USB-C connector to plug into the servo drive. The other end which connects to a PC or USB hub may be USB-C or USB-A.

NOTICE

Use data cables

Some USB cables are only designed for providing charging power. These will not work for communicating with the servo drive.



8.11.2 Ferrites

In an electrically noisy environment, ferrites on the USB cable may be helpful to avoid inconsistent communications. A ferrite is most helpful on the PC end of the cable. Snap-on ferrite cores and USB cables with built-in ferrites are commonly available.

8.12 Digital I/O - X21

The servo drive provides 4 digital inputs and 2 digital outputs on the X21 DB9 (9-pin D-sub) port. All inputs and outputs can be used to initiate pre-programmed actions. A list of actions is included in WorkBench. If an input, or output is programmed, it must be saved to the servo drive.

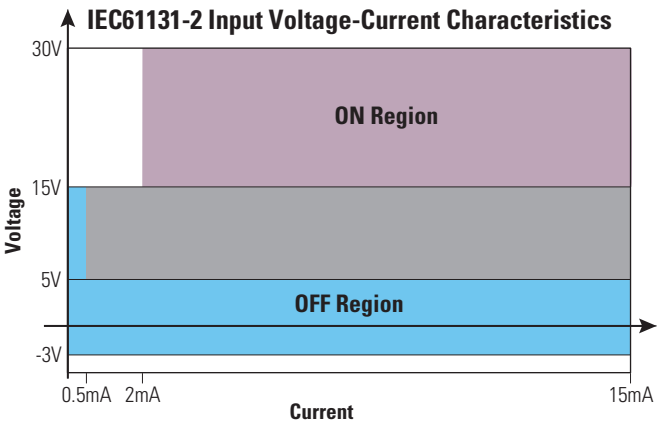
NOTICE

Maximum distance for unshielded I/O lines is 3m inside the cabinet. Ensure EMC shielding if the I/O cable leaves the cabinet.

NOTE

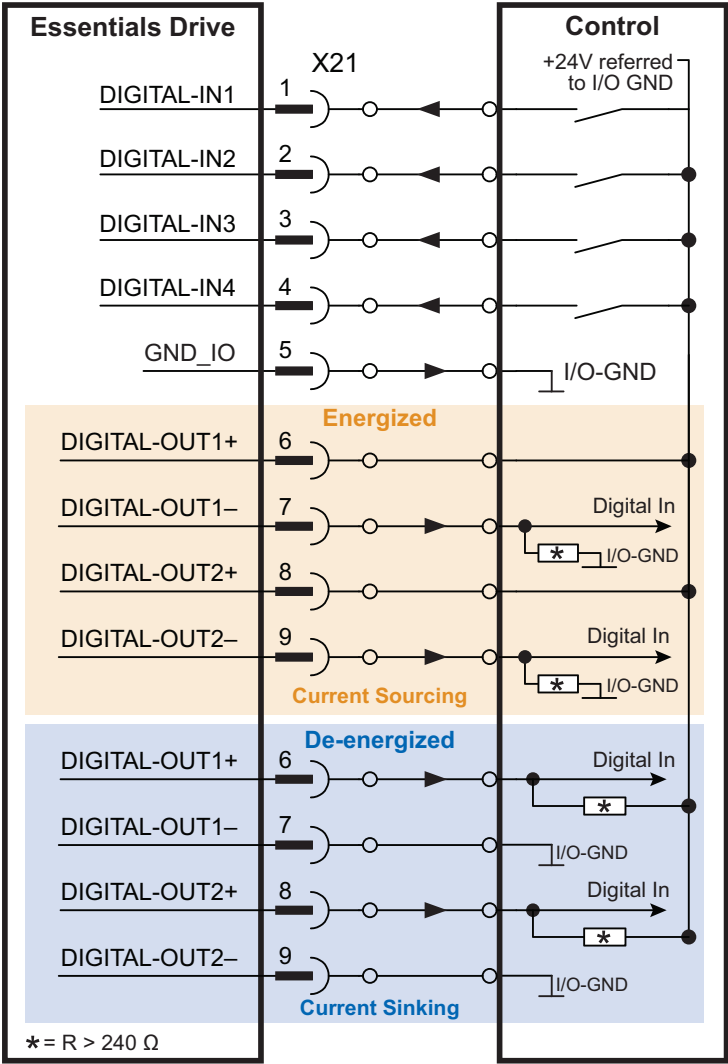
Depending on the selected function, the inputs are high or low active. Set the digital input filter in WorkBench to change sensitivity of the inputs (see Online Help).

Type 1 digital inputs according to IEC61131-2 have the following input voltage current characteristics:



Channel	Type	Explanation
DIN1, DIN2	Fast, 24V, 61131-2 Type 1 input	An isolated, current sinking digital input referred to GND_24V. The threshold and current characteristics are IEC61131-2 Type 1. The activation delay (0->1) is <1µs and the de-activation delay (1->0) is <1µs. Additional filtering also takes place in the FPGA with selectable filter values. Can also support quadrature feedback.
DIN3, DIN4	Slow, 24V, 61131-2 Type 1 input	An isolated, current sinking digital input referred to GND_24V. The threshold and current characteristics are IEC61131-2 Type 1. The activation delay (0->1) is on the order of 5µs and the de-activation delay (1->0) is on the order of 500µs. Additional filtering also takes place in the FPGA with selectable filter values.
DOUT1, DOUT2	Slow, 24V, Digital output	An isolated pair of volt-free contacts. Collector (+) and emitter (-) brought out to separate pins. 100mA rated with latch off upon over-current.

8.12.1 Connector Pinout - X21



9 Setup

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9.1 Important Notes



DANGER Lethal voltages!

Risk of death or serious injury caused by contact with live components.

- Never remove built-in protection measures such as insulation or shielding.
- 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.
- Keep all covers and the control cabinet closed during operation.
- Do not touch the device during operation.



WARNING Automatic restart!

Risk of death or serious injury for humans working in the machine caused by automatic restart after power on, voltage dip or interruption of the supply voltage, depending on the parameter setting. If parameter AXIS#DEFAULT is set to 1,

- then place a warning sign ("WARNING: Possible Automatic Restart" or similar) to the machine.
- ensure, that power on is enabled, while humans are in a dangerous zone of the machine.

ATTENTION: The servo drive can be ready to operate when 24V are applied to STO inputs.



CAUTION Ejection of molten particles!

Molten drive component particles may be ejected causing injuries if particles fall into the servo drive or the servo drive has been damaged. Shut down the device, wear appropriate protective gear, and cover the ventilation slots above the device during maintenance work, troubleshooting, and fault rectification.(→ # 28)



CAUTION High temperature!

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

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

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.

NOTICE

If the servo drive has been stored for more than 1 year, re-form the capacitors in the DC bus link circuit. Re-forming procedures are described in the Kollmorgen Support Network ([Forming](#)).

NOTE

Additional information on setting up the equipment:

- Programming parameters and control loop behavior are described in the Essentials Portal.
- The setup of any Industrial Ethernet is described in the corresponding manual.

9.2 Guide to Servo Drive Setup

Setup your servo drive in two major steps:

1. Servo drive setup (this section). This section presents an example to test the drive initially. If the servo drive (servo motor, feedback, control circuits, I/Os) is well parameterized, then proceed with step 2.
2. Functional Safety (→ # 121)

9.2.1 Initial Procedure for Servo Drive Test

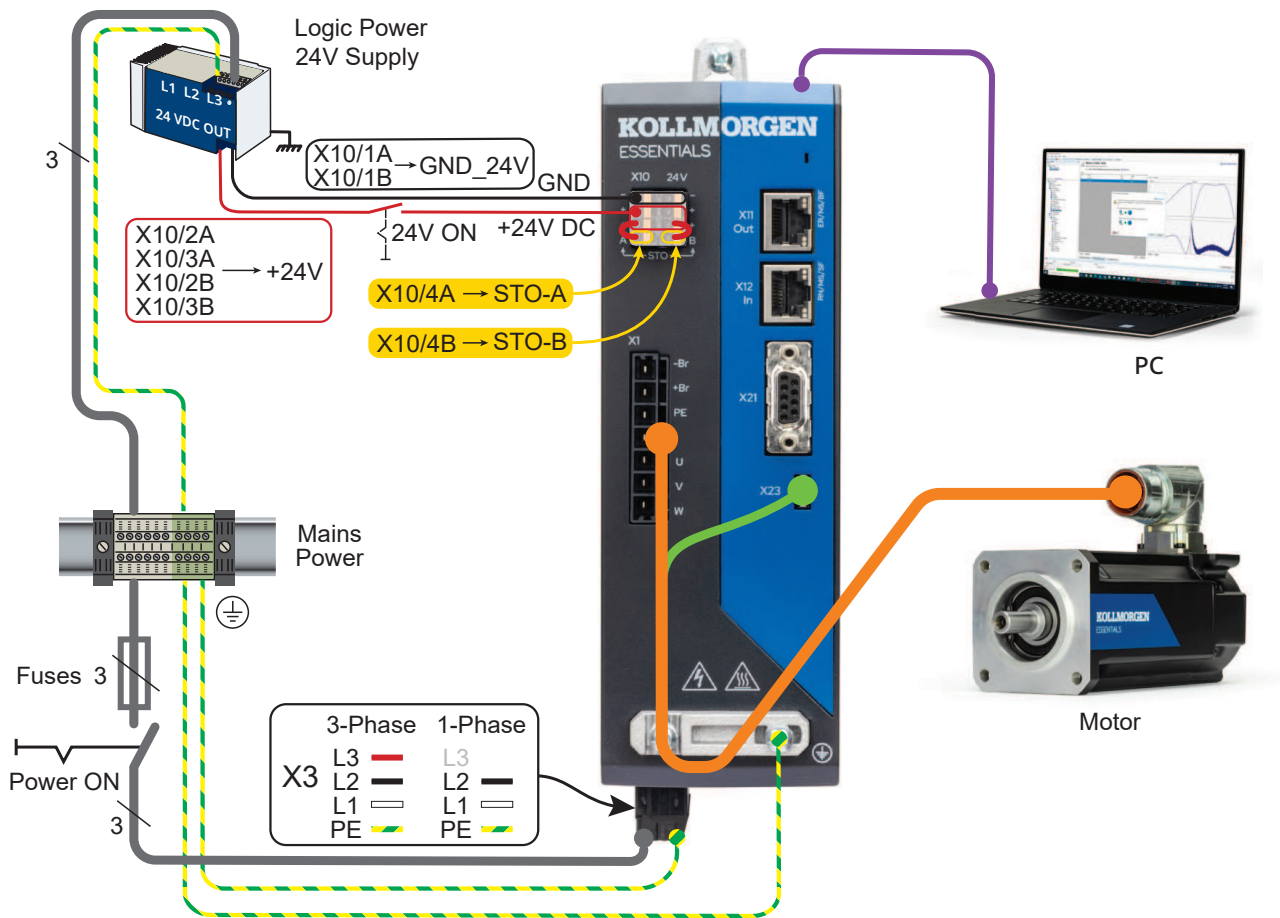
9.2.1.1 Unpacking, mounting, and wiring the Kollmorgen Essentials Drive

1. Unpack the servo drive and accessories.
2. Mount the servo drive.
3. Wire the servo drive or apply the minimum wiring for servo drive testing as described below.
4. Have the following information about the servo drive components readily available:
 - 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 servo drive test without load, example

NOTICE

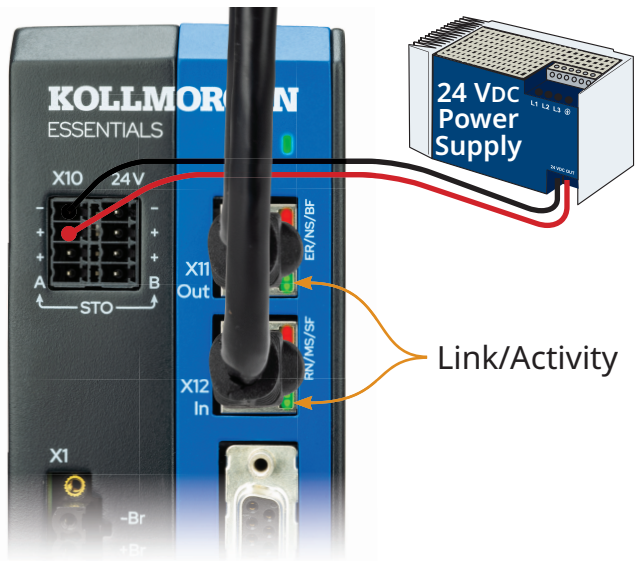
This wiring diagram based on default settings is for general illustration only and does not fulfill any requirements for EMC, functional safety, or functionality of your application.



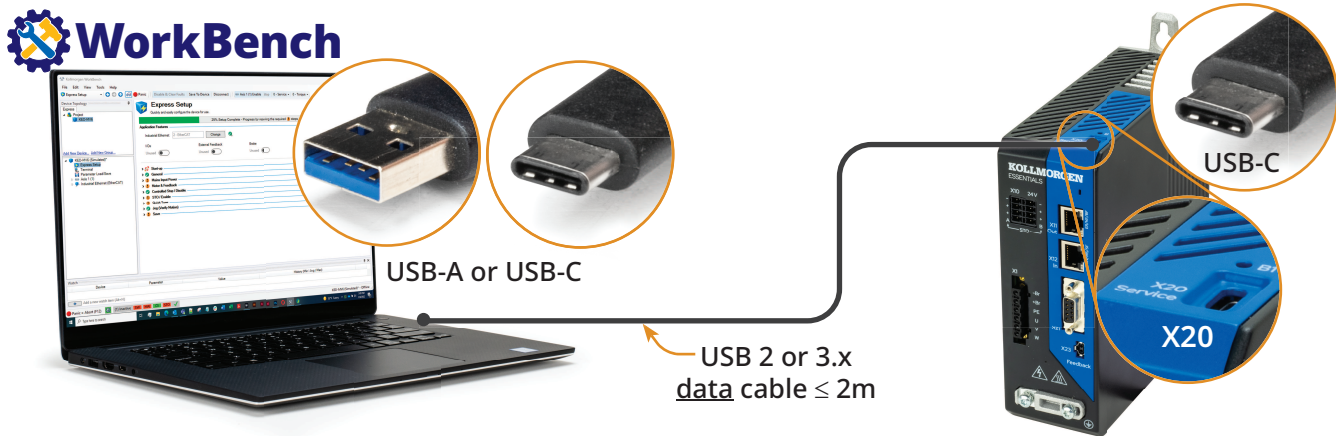
9.2.1.3 Confirm connections (example: directly to PC)

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

Confirm that the link LEDs on the servo 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.



Use WorkBench to configure the servo drive by using the service interface.



9.2.1.4 Industrial Ethernet Setup

Before connecting the servo drive to a PLC:

1. Select the desired Industrial Ethernet type through the WorkBench software.
2. Follow the instructions in this manual to install WorkBench and connect to the servo drive.
3. Select the desired protocol in Express Setup or in the Industrial Ethernet view in Full Setup.

After selecting the protocol, set the device address.

PROFINET

Set the station name and IP address manually through the PROFINET master.

EtherNet/IP

Set the IP address for EtherNet/IP from the Industrial Ethernet view in WorkBench.

EtherCAT

The EtherCAT node is assigned automatically by the EtherCAT master.



WorkBench can connect to the drive through EtherCAT using TwinCAT/EoE. See "Setup Ethernet over EtherCAT (EoE)" in the [Kollmorgen Essentials Documentation Portal](#) for instructions.

9.2.1.5 Install and start WorkBench

WorkBench is available on the Kollmorgen website. Select the install file and follow the instructions given by the installer.

Once the 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.
3. Save the parameter set to the servo drive.

Refer to the WorkBench Online Help for details.

9.2.1.7 Enable the axis (Hardware)

1. Switch on 24V to X10 using any of the (+) and (-) pins. This will power on the servo drive logic.
2. Switch on 24V to the STO inputs (A) and (B) on X10. This will allow the servo drive to be enabled.

NOTE

- The X10 (+) pins are all internally connected allowing logic power to be bussed across multiple servo drives. The same is true for X10 (-) pins
- If machine STO is not required at this point, the plug is setup to easily jumper 24V from (+) to (A) on the left side of the plug, and from (+) to (B) on the right side of the plug. This will allow the servo drive to be enabled. For use in a machine, the input voltage to (A) and (B) is provided by the machine safety circuit.

9.2.1.8 Move the motor axis

1. Select the Axis in WorkBench.
2. Under Motion, select **Service Motion**.

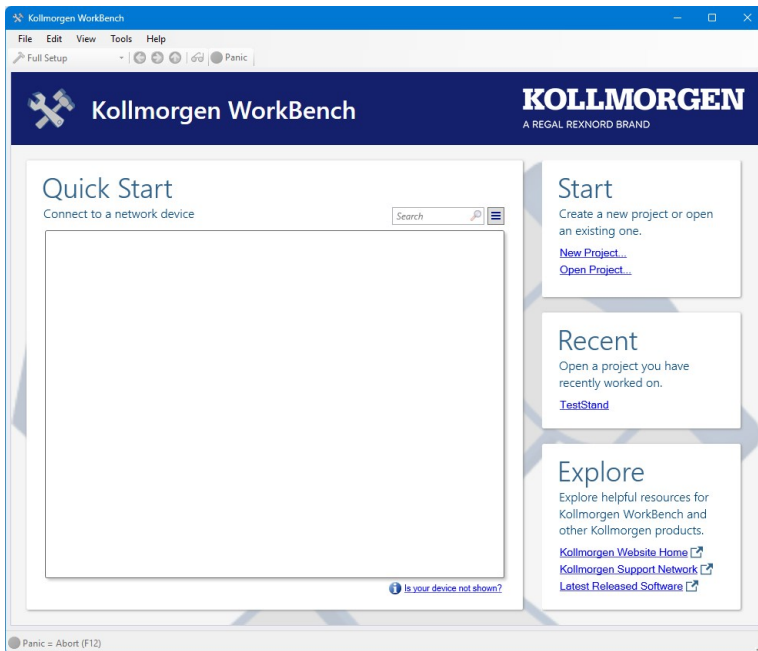
3. Select **Reversing**, check the default velocity and time settings for plausibility.
4. Select **Start**.

9.2.1.9 Tune the axis

Details see *WorkBench Online Help*

9.2.2 WorkBench Installation

This chapter describes the installation of the WorkBench software for the Kollmorgen Essentials Drive. Kollmorgen offers training and familiarization courses on request.



9.2.2.1 Use as directed

With WorkBench you can alter and save the operating parameters for the Kollmorgen Essentials Drive series. An attached drive can be set up with the help of this software. During this procedure the drive can be controlled directly by the service functions.

Only professional personnel who have the relevant expertise (→ # 1, Specialist staff required!) are permitted to carry out online parameter setting for a drive that is running.

! IMPORTANT

Data sets that have been stored on media are not safe against unintended alteration by other persons. The use of unchecked data can result in unexpected movement. Always validate parameters which are relevant for the application before enabling the drive after loading a set of data.

9.2.2.2 WorkBench Software Description

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

A USB-C cable connects the PC with the servo drive (→ # 89), WorkBench establishes the communication between PC and servo drive.

With WorkBench you can

- easily change parameters and directly see what happens with your drive due to a continuous online connection to the drive,
- read important and actual values from the drive which are displayed on the PC (oscilloscope functions),
- save data sets on data media (archiving) and load them onto other drives or use them for backup,
- print data sets.

Most standard feedback systems are plug and play compatible. Motor nameplate data is stored in the feedback device and read by the servo 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 software.

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

Please find the software to set up your servo drive in the [Downloads page](#) of the Kollmorgen website.

9.2.2.3 WorkBench Requirements

The Service Interface X20 provides USB connection to a PC running WorkBench software for configuration, firmware updates and diagnostics.

Hardware Requirements

- Any PC capable of running the (→ # 100)
- A minimum of 500 MB free disk space
- 1 available Ethernet Interface or Switch port
- 1 available USB-C port

Supported Operating Systems

- Windows® 10
- Windows 11

Required Components

- .NET 10.0.4
- Visual C++ Redistributable 2010 SP1 (x86)
- Visual C++ Redistributable 2013 (x86)
- Visual C++ Redistributable 2017-2026 (x86)
- WebView2 Runtime

9.2.2.4 Installation under Windows 10 and Windows 11

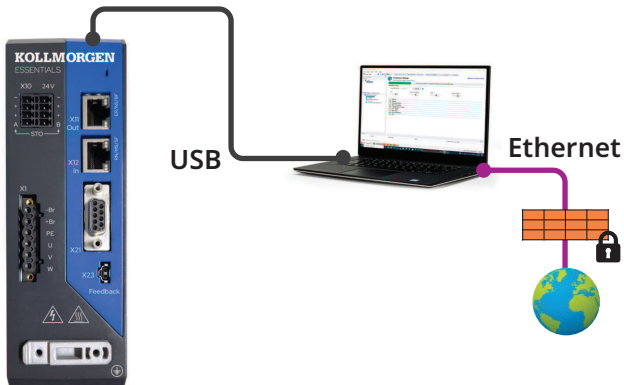
Use WorkBench to setup your servo drive. You can download the latest version from the Kollmorgen website's [Downloads page](#).

Install WorkBench as follows:

1. Download one of the following installation packages from www.kollmorgen.com:
 - Standard installation: Contains the application with complete help files. Dependencies such as the .NET Framework will be downloaded from the internet if not already installed.
 - Full installation: Contains the application with complete help files and includes embedded dependencies such as the .NET Framework.
2. After complete download, double-click on the downloaded file and follow the instructions.

Interface Connections

- Connect the interface cable to an Ethernet interface on your PC and the USB-C cable to the service interface X20 (→ # 89).



9.3 Switch-On and Switch-Off Behavior

This section describes the switch-on and switch-off behavior of the Kollmorgen Essentials Drive with STO.

Behavior of “holding brake” function

Servo drives with an enabled holding brake function have a special timing for switching the output stage on and off (→ # 81). Events that remove the AXIS#.ACTIVE signal trigger the holding brake to be applied. As with all electronic circuits, the general rule applies that there is a possibility of the internal holding brake module failing.

If the servo drive detects the motor to be at zero velocity (as configured by AXIS#.ZEROT and AXIS#.ZEROV) 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 (→ # 81) immediately after faults or Hardware Disable.

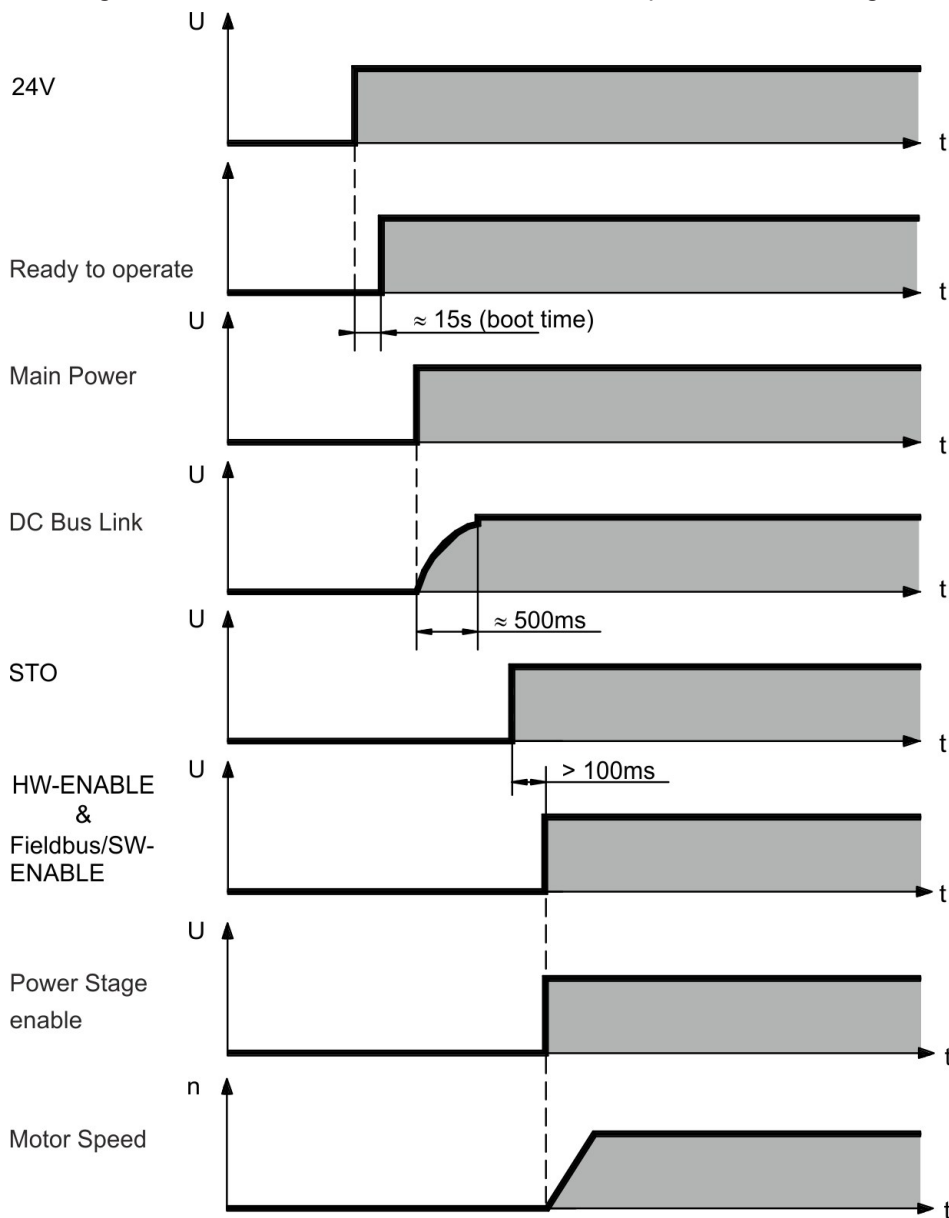
Behavior when undervoltage condition is present

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 servo drive will report a F2007 undervoltage fault any time an undervoltage condition occurs.
1 (default)	The servo drive will report a warning W2007 if not enabled. The servo drive will report a fault if it is enabled when the condition occurs, or an attempt is made to enable while an under voltage condition occurs.

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

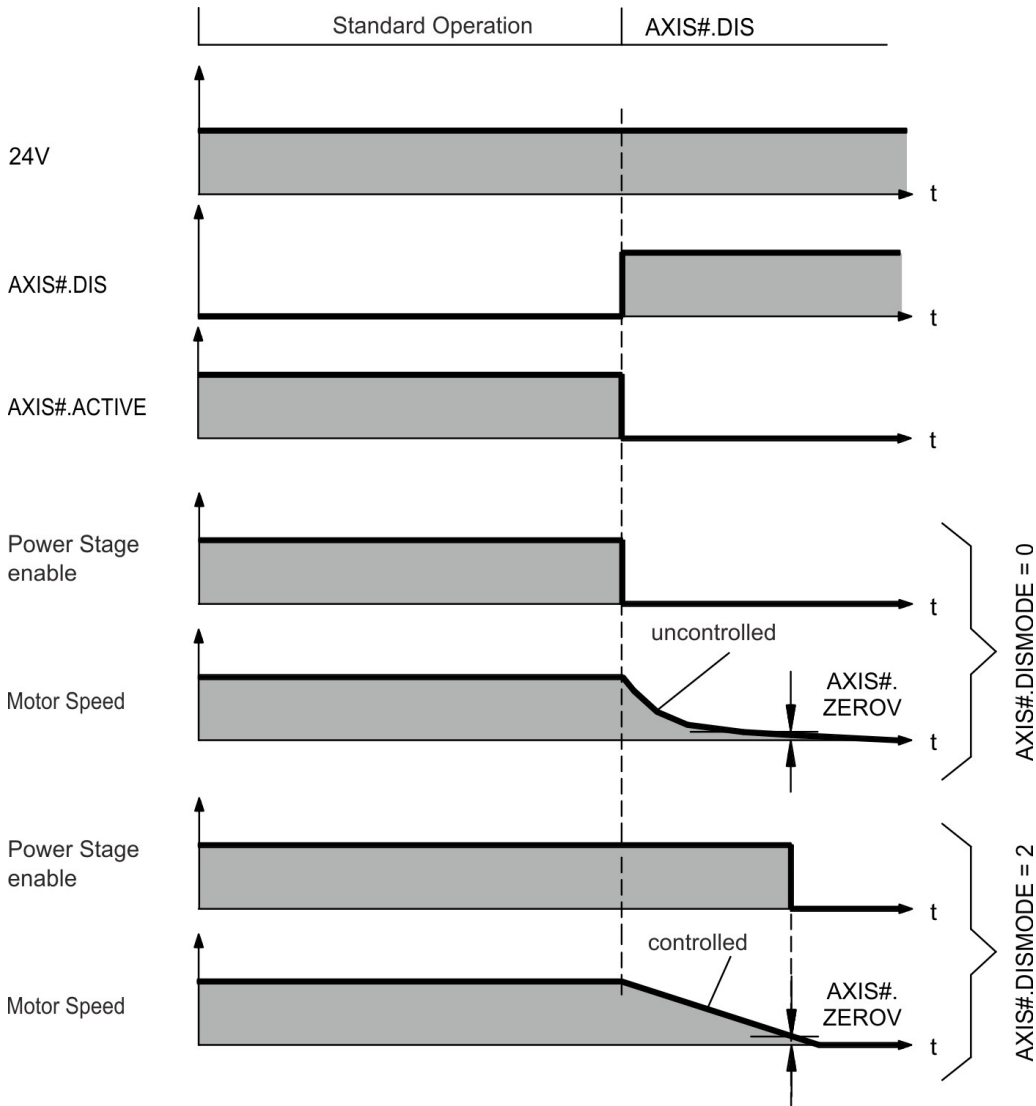
NOTE

The 24V supply of the servo drive must remain constant. STO disables the power stage immediately. Configured digital inputs and Industrial Ethernet commands can be used to perform controlled stops.

9.3.2.1 Switch-off behavior using the AXIS#.DIS command

The enable/disable button in WorkBench issues a *AXIS#.DIS* command internally to the drive. See *WorkBench Online Help* for configuring inputs and software commands. Sometimes this enable signal is called "Software Enable" (SW-Enable).

AXIS#.DISMODE	<i>AXIS#.DISMODE</i> controls the behavior of the <i>AXIS#.DIS</i> command issued through WorkBench, or terminal, or fieldbus.
0	Disable axis immediately, if the servo drive detects the motor to be at zero velocity <i>AXIS#.ZEROV</i> or timeout occurs brake is applied. Category 0 stop according to IEC 60204 (→ # 22).
2	Use controlled stop to disable servo drive, if the servo drive detects the motor to be at zero velocity <i>AXIS#.ZEROV</i> or timeout occurs brake is applied. Category 1 stop according to IEC 60204 (→ # 22).

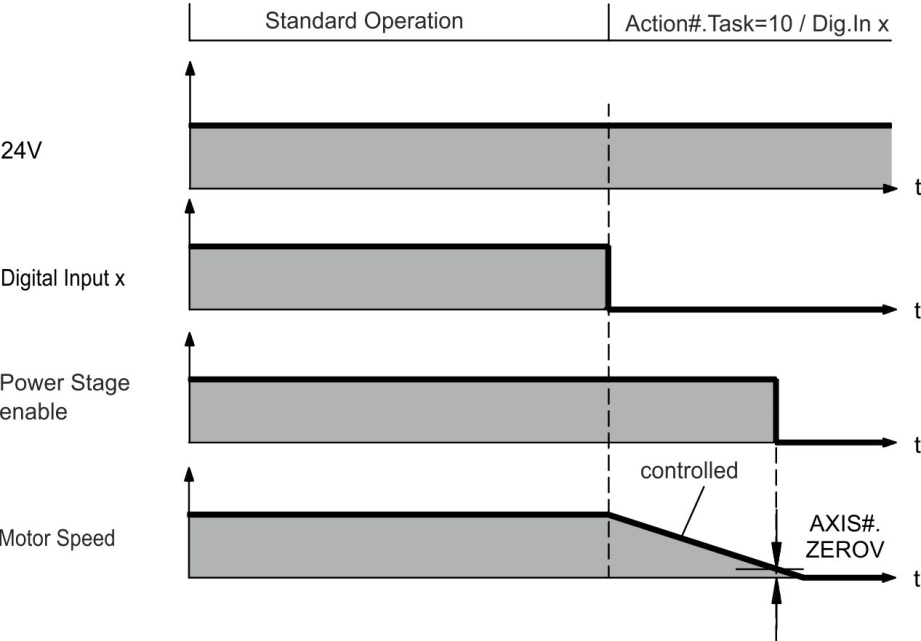


If the servo drive detects the motor to be at zero velocity (*AXIS#.ZEROV*) or timeout occurs (*AXIS#.ZEROT*), the motor brake is applied (→ # 81).

9.3.2.2 Switch-off behavior using a digital input (controlled stop)

This is a category 1 stop according to IEC 60204 (→ # 22).

A digital input can be configured to bring the servo motor to a controlled stop and then disable the servo drive and apply the holding brake (if present). See the *WorkBench Online Help* for information on configuring Digital Inputs.

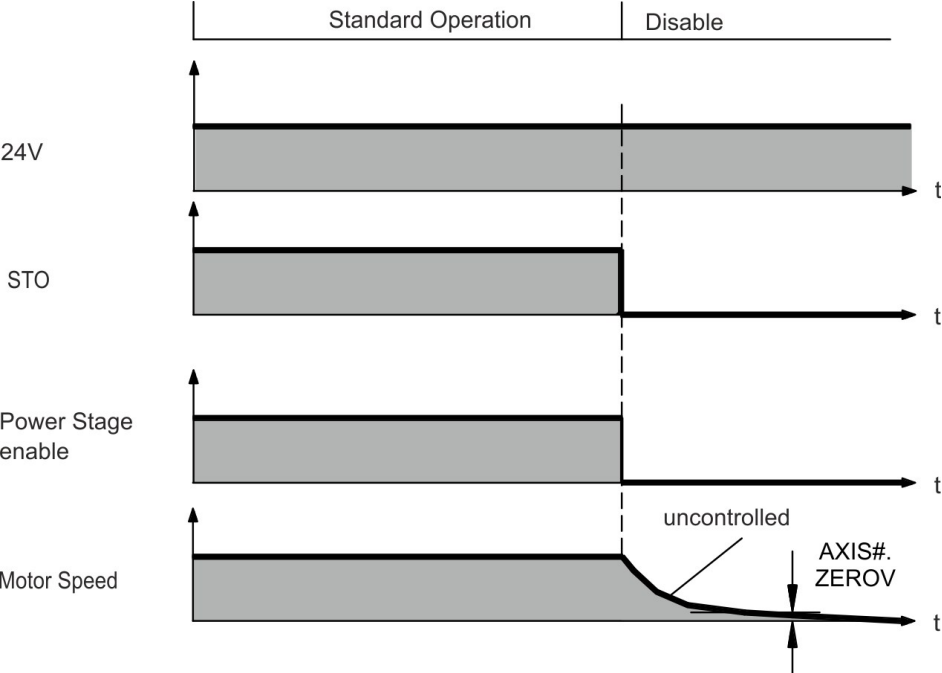


If the servo drive detects the motor to be at zero velocity (AXIS#.ZEROV) or timeout occurs (AXIS#.ZEROT), the motor brake is applied(→ # 81).

9.3.2.3 Switch-off behavior using STO input (uncontrolled stop)

This is a category 0 stop according to IEC 60204 (→ # 22).

The STO input disables the power stage immediately.



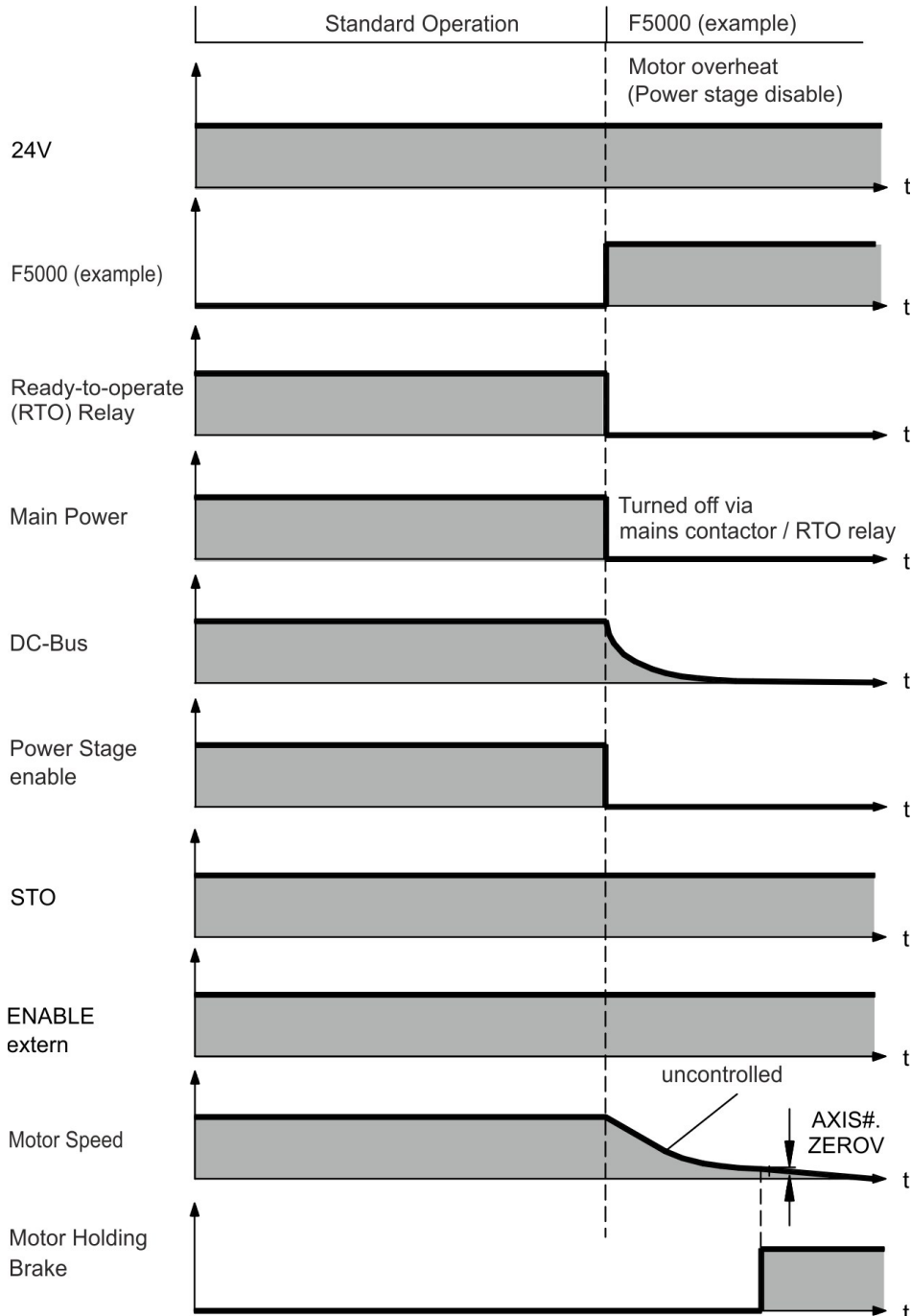
If the servo drive detects the servo motor to be at zero velocity (AXIS#.ZEROV) or timeout occurs (AXIS#.ZEROT), the servo motor brake is applied (→ # 81). Set parameter AXIS#.MOTOR. BRAKEIMM to 1 with vertical axes, to apply the motor holding brake immediately after STO.

9.3.2.4 Switch-off behavior in the event of a fault

The behavior of the servo drive always depends on the fault type and the setting of a number of different parameters (AXIS#.DISMODE, VBUS.UVFTHRESH, AXIS#.ZEROV, and others; see the *WorkBench Online Help* for more details). See the *Drive Fault and Warning Messages and Remedies* section of the *WorkBench User Manual* for a table describing the specific behavior of each fault. The next pages show examples for the possible fault behaviors. The fault relay output (DOUT9) switches the main contactor (Emergency Off circuit).

Switch-off behavior for faults that cause an immediate power stage disable

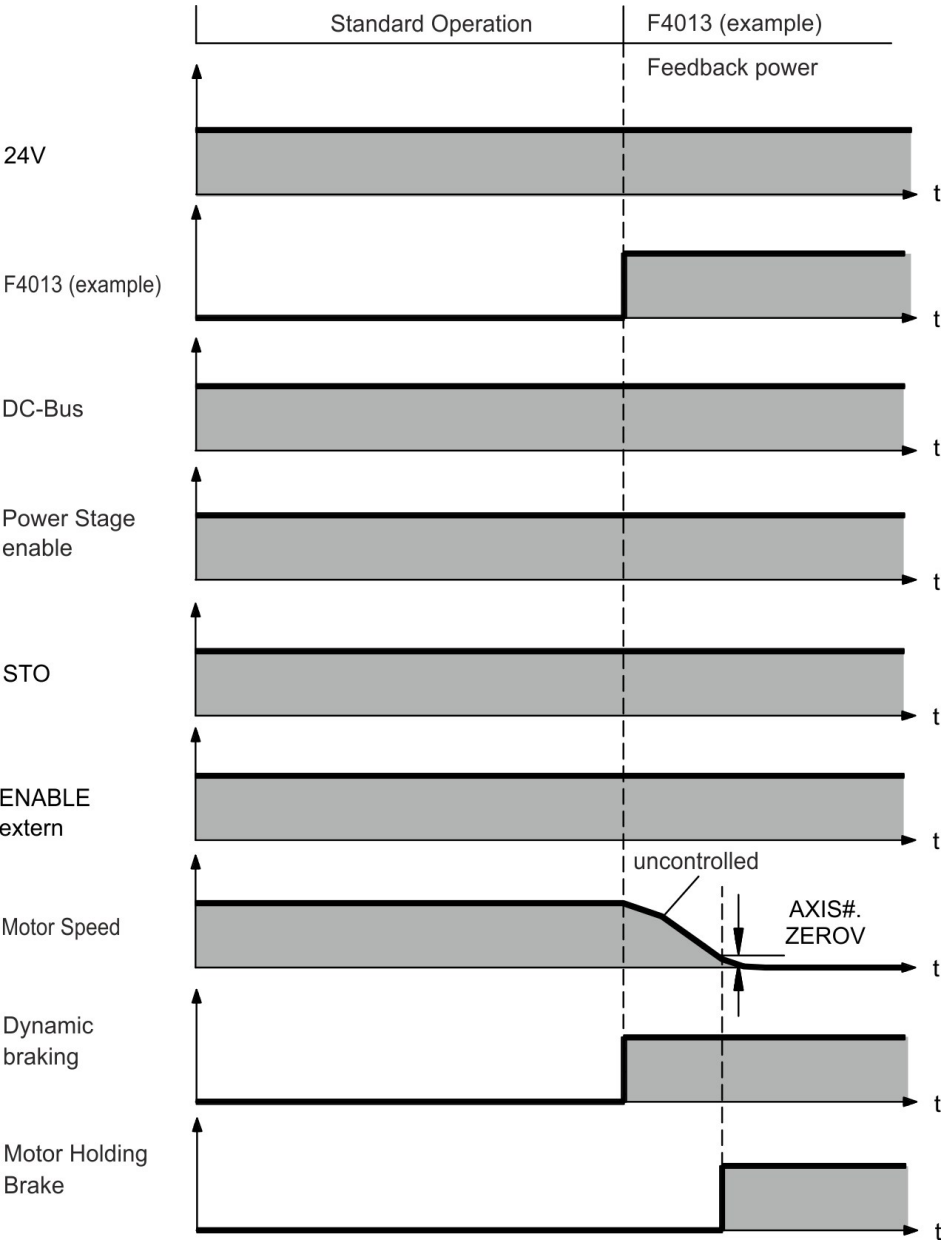
This is a category 0 stop according to IEC 60204 (→ # 22).



If the servo drive detects the servo motor to be at zero velocity (AXIS#.ZEROV) or timeout occurs (AXIS#.ZEROT), the motor brake is applied (→ # 81). Set parameter AXIS#.MOTOR. BRAKEIMM to 1 with vertical axes, to apply the motor holding brake immediately after faults.

Switch-off behavior for faults that cause dynamic braking

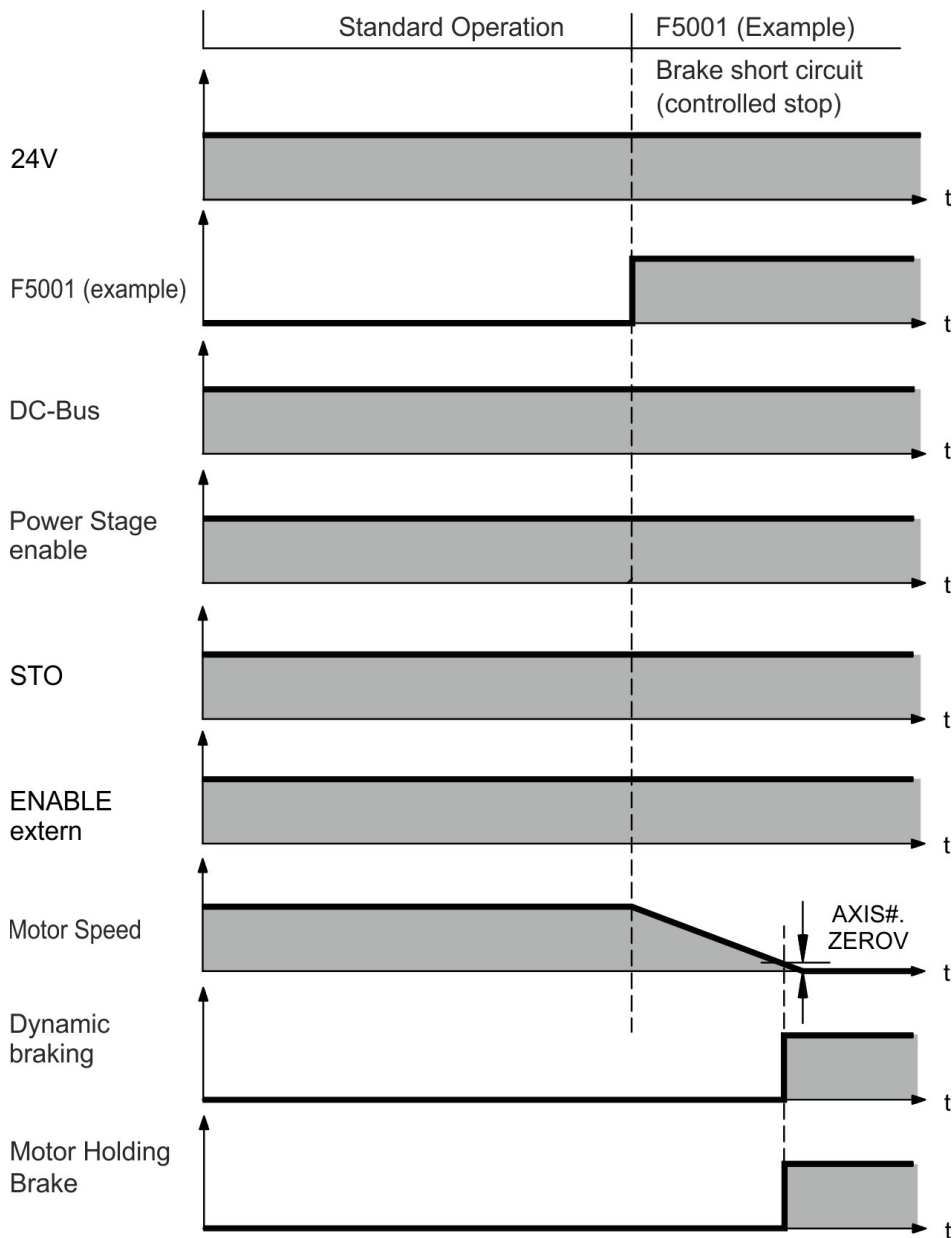
This is a category 2 stop according to IEC 60204 (→ # 22).



If the servo drive detects the motor to be at zero velocity (AXIS#.ZEROV) or timeout occurs (AXIS#.ZEROT), the motor brake is applied (→ # 81).

Switch-off behavior for faults that cause a controlled stop

This is a category 2 stop according to IEC 60204 (→ # 22).



If the servo drive detects the motor to be at zero velocity (AXIS#.ZEROV) or timeout occurs (AXIS#.ZEROT), the motor brake is applied (→ # 81).

9.4 Fault and Warning Messages

Definition

A fault is generally a notification of a critical system failure which will stop machine operation. The severity of the fault depends 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.

GG	Group	GG	Group
10	System	4#	Feedback (# indicates feedback number)
11	File	50	Motor
15	Hardware	55	Wake and Shake
20	Power	60	Motion
25	Temperature	70	Fieldbus
30	Software	90	Safety

The following ways will help you identify a system failure:

1. Visible inspection: See status LED on the front side of the servo drive (→ # 43).
2. Via Fieldbus: Fault status will be reported to higher level PLC.
3. Via Service port: Connect the servo drive directly to your PC via USB and identify any errors with WorkBench.

NOTICE

NOTE

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

More information about fault messages, remedy and clearing faults can be found in the WorkBench User Manual.

9.5 Troubleshooting

Servo drive problems occur for a variety of reasons, depending on the conditions in your installation. If you cannot resolve a fault or other issue using the troubleshooting guidance presented below, customer support can give you further assistance.



DANGER High voltages!

Electric shock caused by improper maintenance. Immediate danger to life caused by electrical energy.

- 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.
- Wait at least 5 minutes after disconnection from the main supply power before touching potentially live sections of the equipment (e.g. contacts) or undoing any connections.
- Measure the DC bus link voltage and wait until it has fallen below 50V.
- Never remove built-in protection measures such as insulation or shielding.

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 User Manual.

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

10 Safety Manual for FS1

Revision History for Safety Manual

Edition	Date	Remarks
S102	May 2026	Pulse length paragraph edited in chapter "Safety Properties Overview", operation temperature corrected in chapter "Enclosure, wiring", further explanation for mission time added, Hardware Revision table removed (duplicate)
S101	September 2025	First edition

The Safety Manual is valid for:

Kollmorgen Essentials Drive with Functional Safety Option 1 (FS1)

KED - xxx - xxxxx - x1xx - xxxx

Safety Functions: STO; SIL2 PLd, activation by digital I/O

Contents:

10.1	General Notes	115
10.2	Verification	120
10.3	Safety Function Option 1 (I/O, SIL2 PLd)	121
10.4	Safety Faults, Safety Warnings	127
10.5	Functional Safety Parameter Reference	129

10.1 General Notes

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

- motion controller (e.g. AKC/KAS),
- safety controller (e.g. SCU or similar),
- servo drives (e.g. Kollmorgen Essentials Drive) and servo motors (e.g. Kollmorgen Essentials Motor),
- motor brakes, feedback systems,
- cables to connect servo drive and motor,
- sensors/actors

The safety properties listed in this chapter can be reached with Kollmorgen components.



DANGER

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).



CAUTION

Ejection of molten particles!

Molten drive component particles may be ejected causing injuries if particles fall into the servo drive or the servo drive has been damaged. Shut down the device, wear appropriate protective gear, and cover the ventilation slots above the device during maintenance work, troubleshooting, and fault rectification.(→ # 28)

NOTICE

Ensure the compliance of the application with all relevant directives and local electrical code. You are responsible for implementation and validation of the drive system and safety system.

Only properly qualified personnel are permitted to perform installation, setup and verification/validation tasks.

- 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.
- 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.

NOTE

Safe State (= STO Active):

In a safe state the drive removes the motor torque from all axes.

10.1.1 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 the drive is connected to must be secured according to state-of-the-art information technology security requirements.
- The IT specialists shall analyze whether further security requirements are applicable to ensure functional safety.
- The drive firmware can be updated. The parameter sets must be reloaded, verified and proof tested before normal operation is started.
- In certain types of machinery, two motors drive a single mechanical axis. It is the responsibility of the user to ensure that a fault reaction on the first motor-drive set is also carried out on the second motor-drive set and vice versa. Safe I/O and/or a safe fieldbus such as FSoE can be used to achieve this.

10.1.2 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 STO function requires two-channel control if the performance level SIL2 / PLd Cat.3 in the system is to be achieved. The connection of a constant 24 VDC voltage to one of the STO inputs is not permitted if the safety function is to be used.

Never modify the drive!



Never open the cover of the drive, as the electronic components installed there generate dangerous high voltages. The components often still carry high voltage even after disconnection from the mains.

Therefore, the drive may only be opened by authorized specialist personnel.

Kollmorgen shall not be held accountable for any defects, malfunctions, or degradations resulting from users opening up the device. In case of damage or malfunction, send the drive for repair or replacement.

10.1.3 Abbreviations used for functional safety

More abbreviations see (→ # 12).

Abbreviation	Meaning
A#, AXIS#	A# or AXIS# are used for axis 1, with parameters (AXIS#.SAFE.STO.ACTIVE) or signal names (STO-A-A#)
(→ # 53)	"see page 53" in this document
→ xyz	"see chapter xyz" in this document
CCF	Common Cause Failure
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
PFH	Probability of dangerous failure per hour
PL	Performance Level
SC	Systematic Capability
SFF	Safe Failure Fraction
SIL	Safety Integrity Level
STO	Safe Torque Off
TM	Mission Time

10.1.4 Enclosure, wiring

Enclosure

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

Transport in accordance with IEC 61800-2	
NOTE	Transport only in the manufacturer's original recyclable packaging.
Temperature	-25 °C to +70 °C, maximum rate of change 20 K/hour, class 2K3.
Relative Humidity	max. 95% at +40 °C, no condensation, class 2K3.
Shock	NOTICE: Avoid shocks while transporting. Drive modules are tested for environmental class 2M1 of IEC 60721-3-2.
Storage in accordance with IEC 61800-2	
Temperature	-25 °C to +55 °C, max. rate of change 20 K/hour, class 1K4.
Relative Humidity	5 to 95% relative humidity, no condensation, class 1K3.
Operation in accordance with IEC 61800-2	
Environmental Class	Environmental class 3K3
Temperature	- Normal operation at rated values up to 40°C - Derating (2% per °C or 10% per 5°C) for 40°C to 55°C max. Note: Operation only with external regen resistor!
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	Minimum cabinet size (WxHxD): 406 x 406 x 254 mm
Enclosure Protection	At least IP54 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). Use copper wires, 0.5mm² (20 awg), wire ferrules. Maximum distance for unshielded I/O lines is 3m inside the cabinet. If the I/O cable leaves the cabinet, it must be EMC shielded.

Wiring outside the specified enclosure 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).

NOTICE

When wiring the digital inputs and outputs, avoid short circuits between the inputs, outputs, or to supply lines.

10.2 Verification

Check and verify the STO wiring (examples (→ # 123)). The installation must be verified 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.

Diagnostic test

NOTICE

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 drive system. The proof test interval is one year to meet the required PFH.

Precondition: [AXIS#.SAFE.STO.REPORTFAULT](#) = 1

Warning: Do not enter hazardous area during proof test!

Method 1, axis remains enabled	Method 2, axis disabled
1. Stop the axis to standstill. 2. Caution: Block vertical load. 3. Keep the axis enabled. 4. Activate the STO function for example by opening the protective screen. 5. The axis displays fault F9000.	1. Stop the axis to standstill. 2. Caution: Block vertical load. 3. Disable the axis. 4. Activate the STO function, for example, by opening the protective screen 5. The axis displays fault W9000.

10.3 Safety Function Option 1 (I/O, SIL2 PLd)

The safety function STO on the Kollmorgen Essentials Drive with functional safety option 1 is certified.

NOTICE

The servo drive is ready to operate with pre-configured STO function.

Standards

Standard	Content
ISO 13849-1:2023	Safety of machinery: Safety-related parts of control systems
IEC 62061:2021	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	(→ # 123)

10.3.1 Safety Properties Overview

OSSD test pulses are not required. The inputs however are compatible with safety equipment that emits test pulses. Incoming test pulses of up to 1ms duration are ignored. The pulse length of the test pulses must not exceed 10% of the pulse period.

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 = 75%.

*Components must be replaced by new ones after 20 years.

Function	ISO 13849-1	MTTF _d Years	DC _{AVG} [%]	IEC 62061	PFH [1/h]	CCF [%]	Response Time
STO dual channel	PL d, Cat. 3	100	71.5	SIL2	1.0E-09	65	< 10ms

NOTE

Execute the STO function at least once per year to achieve SIL2.

10.3.2 Technical Data

NOTE

Safe inputs are fixed to the STO function.

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

I/O hardware 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 30VDC, 5mA to 6mA
- Low level 0 VDC to 5 VDC, max. 1mA

Pinout

X10	Signal	Description
4A	STO-A	STO channel A
4B	STO-B	STO channel B

Parameters

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

NOTE

For parameter description refer to the *Safety Parameters Reference Guide*(→ # 129).

Factory Default Settings

- The servo drive is ready to operate with pre-configured STO function.
- [AXIS#.SAFE.STO.REPORTFAULT](#) is set to 1.

10.3.3 STO (Safe Torque Off)

Safe Torque Off description for drive option Functional Safety 1.

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

This safety function turns off the drive output stage that powers the motor and corresponds to an uncontrolled stop according to IEC 60204-1, category 0.

10.3.3.1 Important Notes

NOTICE

The safety properties given in this documentation refer to the device Kollmorgen Essentials Drive with functional safety option 1. You need to determine the safety properties of the safety chain.



Vertical load could fall!

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).

10.3.3.2 Activation

The digital STO inputs (channel A and B) must be connected to the output of a safety device, which at least meets the requirements of PLd, Cat. 3 according to ISO 13849. Technical data of the safe inputs (→ # 121).

If one of the STO inputs goes open-circuit or 0V, then power supply to the servo motor stops within <10ms. The servo motor will lose all torque and coast to a stop.

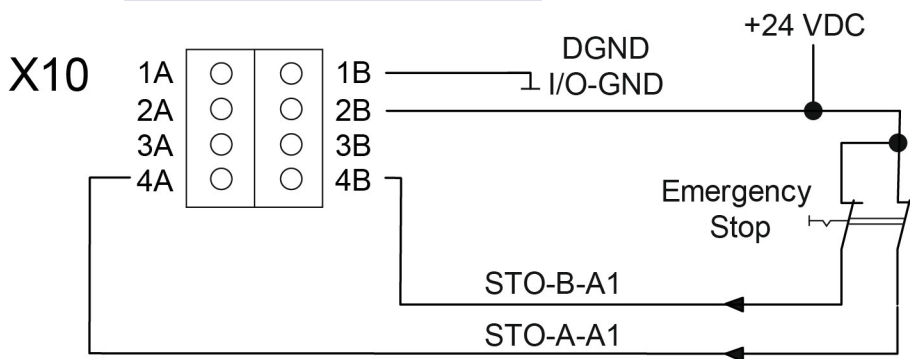
If the servo drive detects that the two STO inputs are in a different state for longer than 100ms, then a simultaneity fault F9005 occurs (→ # 126).

NOTE

Review the enclosure and wiring instructions (→ # 118).

Wiring example STO, SIL2/PLd, Emergency Stop

Note: Set **AXIS#.SAFE.STO.REPORTFAULT** to 1 if STO is activated by a switch.

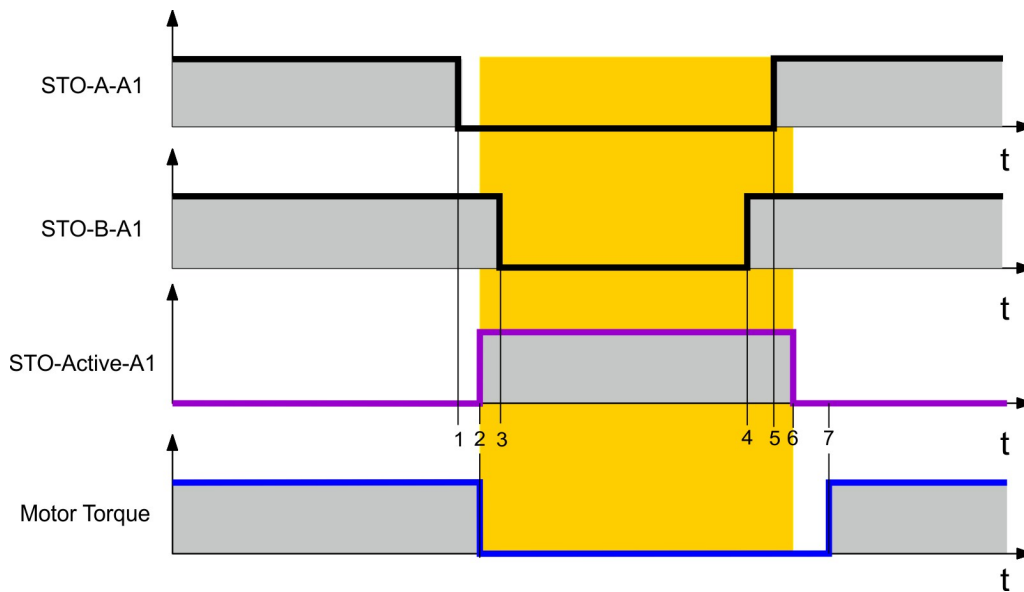


10.3.3.3 Restart*Examples*

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

10.3.3.4 Timing

Example.



Timing	max	Remarks
t1		STO channel A enabled (0 V)
t1 to t2	<10ms	STO enable delay (response time)
t2		STO active
t3		STO channel B enabled (0 V)
t1 to t3	≤100ms	accepted delay between dual channel edges
t4		STO channel B disabled (+24 V)
t5		STO channel A disabled (+24 V)
t4 to t5	≤100ms	accepted delay between dual channel edges
t5 to t6	<10ms	STO release delay
t6		STO release
t6 to t7		Zero if AXIS#.SAFE.STO.REPORTFAULT=0 Until 'no fault' if AXIS#.SAFE.STO.REPORTFAULT=1
t7		Power stage enabled.

10.3.3.5 Safety Diagnostic view in WorkBench

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



10.3.3.6 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](#).

[AXIS#.SAFE.STO.REPORTFAULT](#) set to 1 (default)

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 100ms

A#: A1 for axis 1.

[AXIS#.SAFE.STO.REPORTFAULT](#) set to 0

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	W9000	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 100ms

A#: A1 for axis 1.

10.4 Safety Faults, Safety Warnings

The Kollmorgen Essentials Drive with safety option 1 does not have safety failure modes.

10.4.1 Drive Safety Faults

NOTE

More information about servo drive fault messages, remedy and clearing faults can be found in the WorkBench User Manual.

Fault	Description	Cause	Remedy
F9000	Safe Torque Off	STO function has been triggered while the axis was enabled.	See (→ # 1, STO (Safe Torque Off))
F9004	Safe Torque Off digital and analog lines don't match	Hardware fault on the power board.	Restart drive. If issue persists, contact technical support.
F9005	STO Simultaneity	The two STO inputs did not change state within 100ms of each other.	Check wiring and safety apparatus

10.4.2 Safety Warnings

NOTE

More information about servo drive warnings can be found in the WorkBench User Manual.

Warning	Description	Cause	Remedy
W9000	Safe Torque Off	STO function has been triggered.	See (F9000 , → # 127)

10.4.3 Troubleshooting Functional Safety

NOTICE

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

Problem	Possible Causes	Remedy causes
A group "90" safety fault or safety warning message is visible in WorkBench	Refer to the Drive Safety Fault and Warning tables (→ # 127).	
A fault or warning message of another group than "90" is visible in WorkBench	Refer to the drive fault and drive warnings tables (→ # 110) and more detailed descriptions in the WorkBench User Manual.	
Safety faults and warnings are not visible/reported	<u>AXIS#.SAFE.STO.REPORTFAULT</u> is set to 0	Set <u>AXIS#.SAFE.STO.REPORTFAULT</u> to 1
STO cannot be deactivated (no torque)	1. External safety device defective. 2. STO wiring defective. 3. Auxiliary voltage low. 4. STO inputs defective. 5. F9004 visible 6. F9005 visible. 7. OSSD pulses too long (>1ms). 8. STO channels are unequal for more than 100ms.	1. Check external safety device. 2. Check STO wiring for short-circuit or similar. 3. Check voltage level (→ # 121) . 4. Send drive to manufacturer for repair. 5. Send drive to manufacturer for repair. 6. Check safety hardware system. 7. Check safety controller. Switch off OSSD. 8. Check external safety device.
Drive does not enable	1. STO is still active.	1. Deactivate STO prior to HW Enable.

10.5 Functional Safety Parameter Reference

Abbreviations

- Acc. = Access: RO = Read Only, RW = Read/Write, WO = Write Only
- N/A = Not Available, Y = Yes, N = No
- Parameters are sorted alphanumerically

Parameters related to safety functions	Acc.	Default	Parameter Package	CAN over EtherCAT	
				Axis Index 0x....	Sub
AXIS#.SAFE.STO.A	RO	N/A	N/A	5007	3
AXIS#.SAFE.STO.ACTIVE	RO	N/A	N/A	5007	2
AXIS#.SAFE.STO.B	RO	N/A	N/A	5007	4
AXIS#.SAFE.STO.REPORTFAULT	RW	1	Servo Drive	5007	1

10.5.1 Safety Parameters, sorted alphanumeric

10.5.1.1 AXIS#.SAFE.STO.A

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)

Context

For complete STO information refer to "STO (Safe Torque Off)" (→ # 123).

Versions

Action	Version	Notes
Implemented	02-00-00-000	

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

EtherCAT CoE and CANopen

Command	Index	SubIndex	Data Type	Units	Float Scale	Access	PDO Mappable
AXIS1.SAFE.STO.A	5007h	03h	Unsigned8	-	-	Read only	Yes

EtherNet/IP

ID	Instance	Attribute	Name	Data Type	Access	User Mappable
10000	1	10000 (0x2710)	AXIS1.SAFE.STO.A	Unsigned8	Read Only	Yes

PROFINET

Parameter	PNU	Data Type	Access	Units
AXIS1.SAFE.STO.A	10000	Unsigned8	Read Only	-

10.5.1.2 AXIS#.SAFE.STO.B

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)

Context

For complete STO information refer to "STO (Safe Torque Off)" (→ # 123).

Versions

Action	Version	Notes
Implemented	02-00-00-000	

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

EtherCAT CoE and CANopen

Command	Index	SubIndex	Data Type	Units	Float Scale	Access	PDO Mappable
AXIS1.SAFE.STO.B	5007h	04h	Unsigned8	-	-	Read only	Yes

EtherNet/IP

ID	Instance	Attribute	Name	Data Type	Access	User Mappable
10001	1	10001 (0x2711)	AXIS1.SAFE.STO.B	Unsigned8	Read Only	Yes

PROFINET

Parameter	PNU	Data Type	Access	Units
AXIS1.SAFE.STO.B	10001	Unsigned8	Read Only	-

10.5.1.3 AXIS#.SAFE.STO.ACTIVE

Description

Indicates the Safe Torque Off (STO) state of the axis.

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

Context

For complete STO information refer to "STO (Safe Torque Off)" (→ # 123).

Versions

Action	Version	Notes
Implemented	02-00-00-000	

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

EtherCAT CoE and CANopen

Command	Index	SubIndex	Data Type	Units	Float Scale	Access	PDO Mappable
AXIS1.SAFE.STO.ACTIVE	5007h	02h	Unsigned8	-	-	Read only	Yes

EtherNet/IP

ID	Instance	Attribute	Name	Data Type	Access	User Mappable
10002	1	10002 (0x2712)	AXIS1.SAFE.STO.ACTIVE	Unsigned8	Read Only	Yes

PROFINET

Parameter	PNU	Data Type	Access	Units
AXIS1.SAFE.STO.ACTIVE	10002	Unsigned8	Read Only	-

10.5.1.4 AXIS#.SAFE.STO.REPORTFAULT

Description

This parameter controls whether a Safe Torque Off (STO) fault F9000 will be created when STO is activated while the axis is enabled. The STO warning W9000 is always generated if this parameter is 1 and the STO function is active.

Value	Description
1	W9000 / F9000 are generated when axis is enabled and an STO occurs (default)
0	W9000 / F9000 are not generated

Context

For complete STO information refer to "STO (Safe Torque Off)" (→ # 123).

Versions

Action	Version	Notes
Implemented	02-00-00-000	

General Information

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

EtherCAT CoE and CANopen

Command	Index	SubIndex	Data Type	Units	Float Scale	Access	PDO Mappable
AXIS1.SAFE.STO.REPORTFAULT	5007h	01h	Unsigned8	-	-	Read/Write	No

EtherNet/IP

ID	Instance	Attribute	Name	Data Type	Access	User Mappable
10003	1	10003 (0x2713)	AXIS1.SAFE.STO.REPORTFAULT	Unsigned8	Read/Write	Yes

PROFINET

Parameter	PNU	Data Type	Access	Units
AXIS1.SAFE.STO.REPORTFAULT	10003	Unsigned8	Read/Write	-

11 Essentials Cables

Kollmorgen can only guarantee the performance and quality of its servo systems when you use servo motors, servo drives, and cables supplied by Kollmorgen. Not all cables are created equal.

The Kollmorgen Essentials Cable not only works with Kollmorgen Essentials Motors, but will also work with Kollmorgen AKM and AKM2G servo motors configured with a “9” connector option for AKM or “A” connector option for AKM2G and SFD-M or SFD-3 feedback.

11.1 Essentials Cable Properties

Bend Radius and Weight Specifications

Cable Type	Main Conductor Size [mm²]	OD [mm]	Bend Radius (min.)		Cable Weight	
			Static [mm]	Dynamic [mm]	Assembled Weight of 1 Meter Cable [kg]	Weight Adder per Meter [kg/m]
H2	1.5	13.2	66	92.4	0.40	0.20
	2.5	14.2	71	99.4	0.55	0.25

Note: Essentials Cables are rated for 80°C and 1000V

Life Cycle – Lifetime at Specified Conditions

Cable Type	Cycles @ Bend Radius [F x DIA]	Temp from/to [°C]
H2	12E+06	-40/+90

Certifications/Standards

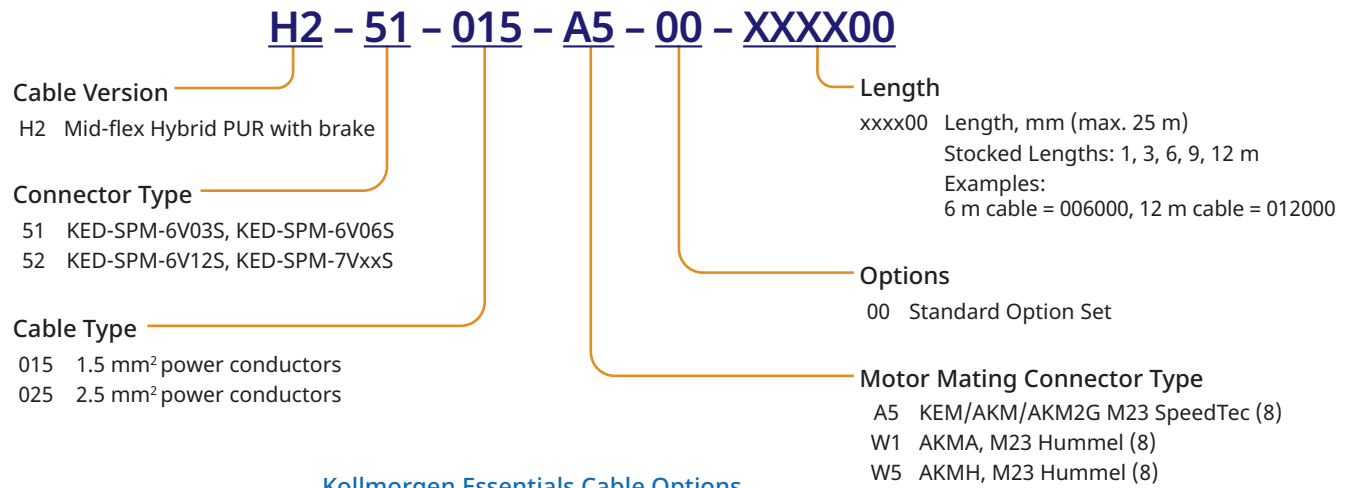
CE	Oil Resistance
CEI 20-35	Flame Resistance
Lead-free	Silicone-Free
Clean room	UL/ULC
NFPA 79	

11.1.1 Kollmorgen Essentials Hybrid Cable Wiring Specifications

Cable*	Type	Cross Section [mm²]	Current Carrying Capacity	Remarks
H2-51-015-YZ-xxxx00	Power + Brake + SFD-M/ SFD3	(4x1.5+(2x0.34)+(2x0.75))	10.1A < I0rms ≤ 13.1A	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 SFD-M/SFD3 signal lines
H2-52-015-YZ-xxxx00				
H2-52-025-YZ-xxxx00		(4x2.5+(2x0.34)+(2x1.0))	13.1A < I0rms ≤ 17.4A	

* YZ = A5, W1 or W5

11.2 Essentials Cable Nomenclature



Kollmorgen Essentials Cable Options

- H2-51-015-Ax-xxxx00 for KED-SPM-6V03S, KED-SPM-6V06S
- H2-52-015-Ax-xxxx00 for KED-SPM-7V03S, KED-SPM-7V06S
- H2-52-025-Ax-xxxx00 for KED-SPM-6V12S, KED-SPM-7V12S

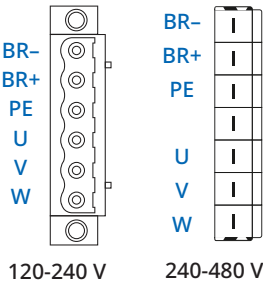
Ax = A5, W1 or W5

Each cable option will have 25 SKUs (xxxx00), from 001000 (1 m) up to 025000 (25 m) in 1 m increments

11.3 Essentials Cable Connector Pinouts

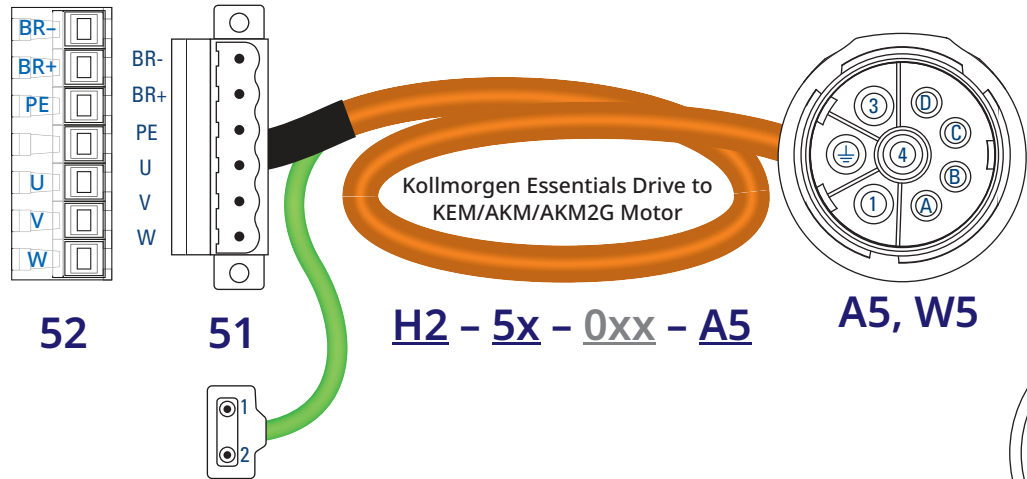
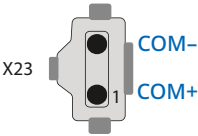
Drive Connector X1: Motor, Power + Brake

Signal	Description
BR-	Motor holding brake
BR+	Motor holding brake
PE	Protective Earth (motor housing)
U	Motor Phase U
V	Motor Phase V
W	Motor Phase W



Drive Connector X23: Feed-back Pinouts

Pin	SFD-M
1	COM+
2	COM-



Motor Connector Pinout

A5/W5 Pin	Function	W1 Pin
1	U	U
2	PE	PE
3	W	W
4	V	V
A	Brake +	A
B	Brake -	D
C	SFD-M+	1
D	SFD-M-	2



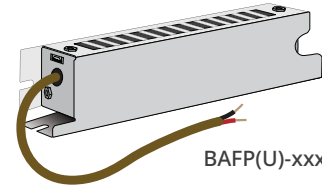
12 Accessories for Kollmorgen Essentials Drives

Contact an authorized Kollmorgen Essentials distributor or Kollmorgen Customer Support to place an order, or to request more information.

Regen Resistors - External IP40

BAFP(U)-85-33-S 85 W, 33 Ohm, 210 x 60 x 27 mm
For use with 6V03 and 6V06 drives

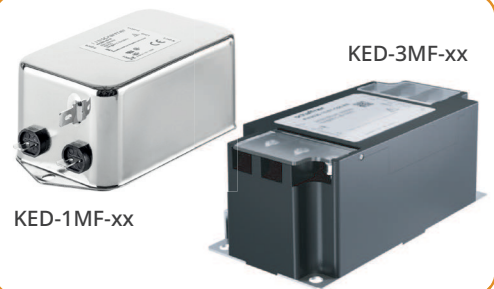
BAFP(U)-100-33-S 100 W, 33 Ohm, 239 x 70 x 27 mm
For use with 6V12 and 7Vxx drives



BAFP(U)-xxx-33-S

EMC Filters

Drive Model	Filter Order Code			
	≤ 10 m Cable Standard EMC Requirements		> 10 m Cable High EMC Requirements	
	1 phase (6V only)	3 phase (6V/7V)	1 phase (6V only)	3 phase (6V/7V)
6V03/7V03	KED-1MF-06	KED-3MF-10	DE-202203	DE-202205
6V06/7V06	KED-1MF-10	KED-3MF-10	DE-202204	DE-202205
6V12/7V12	KED-1MF-20	KED-3MF-20	DE-TBD	DE-202206



KED-1MF-xx

KED-3MF-xx

Chokes

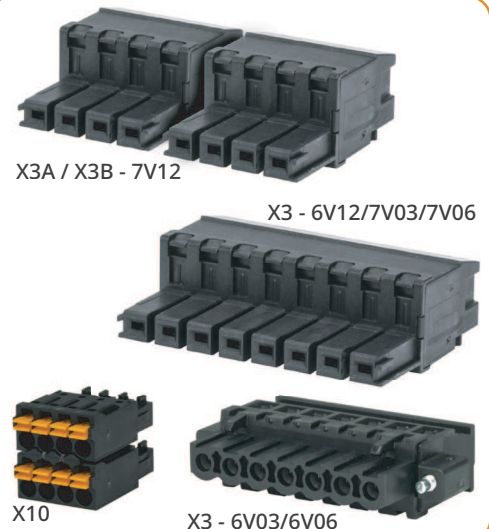
3YLE-XX XX = current rating
Motor Chokes are needed with motor cable >30 m (6Vxx drive models) or >50 m (7Vxx drive models)



3YLE-xx

Mating Connectors

KED-CONKIT-MV36	Connector kit with X3 and X10 connectors for 6V03S, 6V06S
KED-CONKIT-MV12	Connector kit with X3 and X10 connectors for 6V12S
KED-CONKIT-HV36	Connector kit with X3 and X10 connectors for 7V03S, 7V06S
KED-CONKIT-HV12	Connector kit with X3 and X10 connectors for 7V12S
KED-CON-X3-MV36	Mating connector X3 (Mains Power) for 6V03S, 6V06S
KED-CON-X3-MV12	Mating connector X3 (Mains Power) for 6V12S
KED-CON-X3-HV36	Mating connector X3 (Mains Power) for 7V03S, 7V06S
KED-CON-X3-HV12	Mating connector X3 (Mains Power) for 7V12S
KED-CON-X10	Mating connector X10 (24V in and STO)



X3A / X3B - 7V12

X3 - 6V12/7V03/7V06

X10

X3 - 6V03/6V06

Shield Clamp

KED-SHIELD-25
Shield clamp for up to 2.5 mm² cable



KED-SHIELD-25

13 Certificates and Declarations

NOTICE

If the servo drive is labeled Beta, approvals are pending.

13.1	Conformance with UL/cUL & CSA	139
13.2	Conformance with EU	141
13.3	Conformance with PFAS	141
13.4	Conformance with CAL_Prop65	142
13.5	Conformance with POP	142
13.6	Conformance with TSCA	142
13.7	Energy Efficiency Information according to EN 61800-9-2	143

13.1 Conformance with UL/cUL & CSA

The servo drives are listed under UL (Underwriters Laboratories Inc.) file number **E141084**.

USL, CNL - Power conversion equipment (NMMS, NMMS7)

USL (United States Standards - Listed): Indicates Investigated to United States Standard for Power Conversion Equipment, UL 61800-5-1.

CNL (Canadian National Standards - Listed): Indicates investigation to Canadian Standard for Industrial Control Equipment, CAN/CSA - C22.2, No. 274-17.

UL Markings / Marquages UL

English	Français
Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code, Canadian Electrical Code, or Machinery Directive, and any additional local codes.	Une protection de court-circuit à semi-conducteur intégrale ne fournit pas de protection de la dérivation. Il convient de garantir une protection de la dérivation conforme au NEC et aux réglementations locales en vigueur.
This product is suitable for use on a circuit capable of delivering not more than 5 kA (SCCR) when protected by class J fuses. (→ # 74)	Ce produit peut être utilisé sur un circuit capable de délivrer un maximum de 5 kA (SCCR) lorsqu'il est protégé par des fusibles ou des disjoncteurs de classe J. (→ # 74)
Suitable for motor group installation on a circuit capable of delivering not more than 5 kA (SCCR) symmetrical.	Convient pour une installation de groupe moteur sur un circuit capable de délivrer pas plus de 5 kA rms symétriques.
These drives provide Class 10 solid state motor overload protection at 120% of the rated FLA current. The drive overload trip point should not be set to less than 10% above the motor rated current: $AXIS\#.IL.FOLDFTHRESHU \geq 1.1 * AXIS\#.MOTOR.ICONT$.	Ces variateurs offrent une Class 10 protection contre les surcharges de moteur à semi-conducteur à 120% du courant FLA nominal. Le point de déclenchement en surcharge du variateur ne doit pas être réglé à moins de 10% au dessus du courant nominal du moteur: $AXIS\#.IL.FOLDFTHRESHU \geq 1,1 * AXIS\#.MOTOR.ICONT$.
These devices are intended to be used in a pollution degree 2 environment and must be placed in an enclosure with min. size of 16 x 16 x 10 inches	Ces appareils sont prévus pour une utilisation dans un environnement de pollution de niveau 2 et doivent être placés dans une enceinte avec min. taille de 406 x 406 x 254 mm
Surrounding air temperature 40°C. Refer to chapter "Ambient Conditions", for other temperature ratings.	La température de l'air ambiant 40 °C. Voir chapitre "Ambient Conditions", pour connaître les autres températures.
Use 75°C copper wire only, except for control circuits.	Utiliser uniquement des fils de cuivre à 75°C, sauf pour les circuits de commande.
- Connector X3 torque requirements: - screw terminals, tightening torque 18 in-lbs - locking screw, tightening torque 3.5 in-lbs	- Exigences de couple du connecteur X3: - bornes à vis, couple de serrage 2 Nm - vis de blocage, couple de serrage 0,35 Nm
CAUTION Risk of Electrical Shock! Capacitors can have dangerous voltages present up to five minutes after switching off the supply power. For increased safety, measure the voltage in the DC bus link and wait until the voltage is below 50 V.	ATTENTION: Risque de choc électrique! Des tensions dangereuses peuvent persister dans les condensateurs jusqu'à cinq minutes après la mise hors tension. Pour plus de sécurité, mesurez la tension dans la liaison de bus CC et attendez qu'elle soit inférieure à 50 V.

13.2 Conformance with EU

NOTE

Declarations of Conformity can be found on the Kollmorgen website.
The conformity is only valid on the delivery date.

The drives have been tested by an authorized testing laboratory in a defined configuration, using the system components that are described in this documentation. Any divergence from the configuration and installation described in this documentation means that the user will be responsible for carrying out new measurements to ensure conformance with regulatory requirements.

Kollmorgen declares the conformity of the product series Kollmorgen Essentials Drive with the following directives:

- EC Directive 2006/42/EU, Machinery Directive
Used harmonized standard EN 61800-5-2
- EC Directive 2014/35/EU, Low Voltage Directive
Used harmonized standard EN 61800-5-1
- EC Directive 2014/30/EU, EMC Directive
Used harmonized standard EN 61800-3

NOTICE

These devices can cause high-frequency interferences in non industrial environments and may require measures for interference suppression (such as additional external EMC filters).

Maximum distance for unshielded I/O lines is 3 m inside the cabinet. If the I/O cable leaves the cabinet, it must be EMC shielded.

13.2.1 Conformance with RoHS

The drives are manufactured in conformance with the directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 concerning the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS), including Commission Delegated Directive 2015/863/EU for installation into Finished Electrical and Electronic Equipment (EEE). One or more exemptions per Annex III of Directive 2011/65/EU may be applicable.

The chemical composition of the product may change due to environmental influences.

13.2.2 Conformance with REACH

The servo drives are manufactured in conformance with the regulation (EC) 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH).

Based on Article 33, Paragraph (1), Kollmorgen communicates that the servo drives and articles used may contain substances listed in the Restriction List in Annex XVII in the allowed uses. The servo drives may contain substances listed in the Candidate List of Substances of Very High Concern (SVHC) as published by the European Chemical Agency on their official website.

The chemical composition of the product may change due to environmental influences.

13.3 Conformance with PFAS

Per- and polyfluoroalkyl substances (PFAS) is a group of manmade chemicals used to make fluoropolymer coatings and products that resist heat, oil, stains, grease, and water.

Fluoropolymer coatings can be in a variety of products. This can include clothing, furniture, adhesives, food packaging, heat-resistant non-stick cooking surfaces, and the insulation of electrical wire.

This device **does** contain perfluoroalkyl and polyfluoroalkyl substances, known as PFAS.

Please find the corresponding declaration on the [Kollmorgen Website](https://www.kollmorgen.com).

13.4 Conformance with CAL_Prop65

This device complies with the California's Safe Drinking Water and Toxic Enforcement Act of 1986, more commonly referred to as Proposition 65 ("Prop 65").

The device may contain one or more of the substances listed by the States of California, Environmental Protection Agency, Office of Environmental Health Hazard Assessment (OEHHA) as "chemical known to the State to cause cancer or reproductive toxicity". However, the presence of such chemicals in this device create no or negligible exposure to humans or the environment.

Please find the corresponding declaration on the [Kollmorgen Website](#).

13.5 Conformance with POP

The drives are manufactured in conformance with the Stockholm Convention. The drives do not contain Persistent Organic Pollutants (POP) listed in the annexes to the Regulation (EU) 2019/1021 and published by the European Chemical Agency on their official website.

Please find the corresponding declaration on the [Kollmorgen Website](#).

13.6 Conformance with TSCA

The United States Environmental Protection Agency (EPA) has issued a rule, under Section 6(h) of the Toxic Substances Control Act (TSCA), which will phase out the use of 5 Persistent Bioaccumulative and Toxic (PBT) substances.

Kollmorgen **does not intentionally add** these substances to the products and the supply chain also confirms that they are not used.

Please find the corresponding declaration on the [Kollmorgen Website](#).

13.7 Energy Efficiency Information according to EN 61800-9-2

System Type	Configuration	Efficiency η^*	Efficiency Class*
CDM**	KED-SPM-6V03S-A100-0000	≈ 97%	IE2
	KED-SPM-6V06S-A100-0000	≈ 97%	
	KED-SPM-6V12S-A100-0000	≈ 97%	
	KED-SPM-7V03S-A100-0000	≈ 96%	
	KED-SPM-7V06S-A100-0000	≈ 97%	
	KED-SPM-7V12S-A100-0000	≈ 97%	
PDS***	KED-SPM-6V03S-A100-0000 + KEM-2V075-AC9NC	≈ 80%	IES4
	KED-SPM-6V06S-A100-0000 + KEM-2V150-AC9NC	≈ 85%	
	KED-SPM-6V12S-A100-0000 + KEM-2V300-AC9NC	≈ 87%	
	KED-SPM-7V03S-A100-0000 + KEM-XXX	≈ 78%	IES3
	KED-SPM-7V06S-A100-0000 + KEM-XXX	≈ 86%	IES4
	KED-SPM-7V12S-A100-0000 + KEM-XXX	≈ 87%	IES4

* Efficiency values and efficiency classification are determined at the operating point (90; 100) (percentage of rated speed and rated current)

** CDM (Complete Drive Module) - servo drive (KED) unit without the motor

*** PDS (Power Drive System) - combination of servo drive, servo motor, and ancillary equipment

Additional notes:

- Servo motor and servo drive are selected to match as optimized Power Drive System (PDS).
- Additional values at other operating points are available on request.

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15 Kollmorgen Documentation Legal Information

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Any of these Kollmorgen patents may be used and/or identified in Kollmorgen products, firmware, and/or software.

- US Patent 2017/0211640 (method and apparatus for power saving, fail-safe control of an electromechanical brake), patent pending.
- US Patent 8,154,228 (Dynamic Braking For Electric Motors).
- US Patent 8,214,063 (Auto-tune of a Control System Based on Frequency Response).
- US Patent 8,566,415 (Safe Torque Off over network wiring).
- US Patent 10,374,468 (System and method for improved DC power line communication).
- US Patent 10,520,050 (Method and apparatus for power-saving, fail-safe control of an electromechanical brake).
- US Patent 10,840,696 (Method and apparatus for limiting the output voltages of switch mode power supplies).
- US Patent 16,247,478 (method and apparatus for limiting the output voltages of switching mode power supplies), patent pending.

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- Mylar: DUPONT Teijin Films U.S.
- PHOENIX CONTACT: Phoenix Contact GmbH & Co. KG.
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- Scotch-Weld 2214: 3M Company.
- sercos: Sercos International E.V.
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Adafruit display library	https://github.com/adafruit	https://github.com/adafruit/Adafruit-ST7735-Library/blob/master/README.txt
Arduino Map function	http://creativecommons.org	http://creativecommons.org/licenses/by-sa/3.0/
C++ Mathematical Expression Library	http://www.partow.net/programming/exprtk/index.html	MIT License
civetweb: Embedded C/C++ web server	https://github.com/civetweb/civetweb	MIT License
CoreSight Library	http://www.apache.org	http://www.apache.org/licenses/LICENSE-2.0
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DockPanelSuite	http://sourceforge.net/projects/dockpanelsuite/	https://opensource.org/licenses/MIT
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mbd Microcontroller Library	http://www.apache.org	http://www.apache.org/licenses/LICENSE-2.0
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Microsoft Edge WebView2	https://developer.microsoft.com/en-us/microsoft-edge/webview2	Microsoft Edge WebView2 Runtime LICENSE
MigraDoc	http://www.pdfsharp.net/migradocoverview.ashx	http://www.pdfsharp.net/MigraDoc_License.ashx
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MVVM Light Toolkit	https://github.com/lbugnion/mvtmlight	https://galasoft.ch/license_MIT.txt
OpENer EtherNet/IP	https://github.com/EIPStackGroup/OpENer	http://eipstackgroup.github.io/OpENer/de/d7e/license.html
PdfSharp	http://www.pdfsharp.net/migradocoverview.ashx	http://www.pdfsharp.net/PDFsharp_License.ashx
Qt Framework	https://www.qt.io/product/framework	terms of the LGPL3
Qwt project	http://qwt.sourceforge.net/	Qwt
SharpZipLib	https://github.com/icsharpcode/SharpZipLib	https://github.com/icsharpcode/SharpZipLib/blob/master/LICENSE.txt
SNMP		http://www.net-snmp.org/about/license.html
SQLite	https://system.data.sqlite.org	https://system.data.sqlite.org/index.html/doc/trunk/www/copyright.wiki
U-Boot	http://www.denx.de/wiki/U-Boot	GNU General Public License 2.0
Zed Graph	http://sourceforge.net/projects/zedgraph/	https://opensource.org/licenses/LGPL-2.0
Zlib software library		Zlib License

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