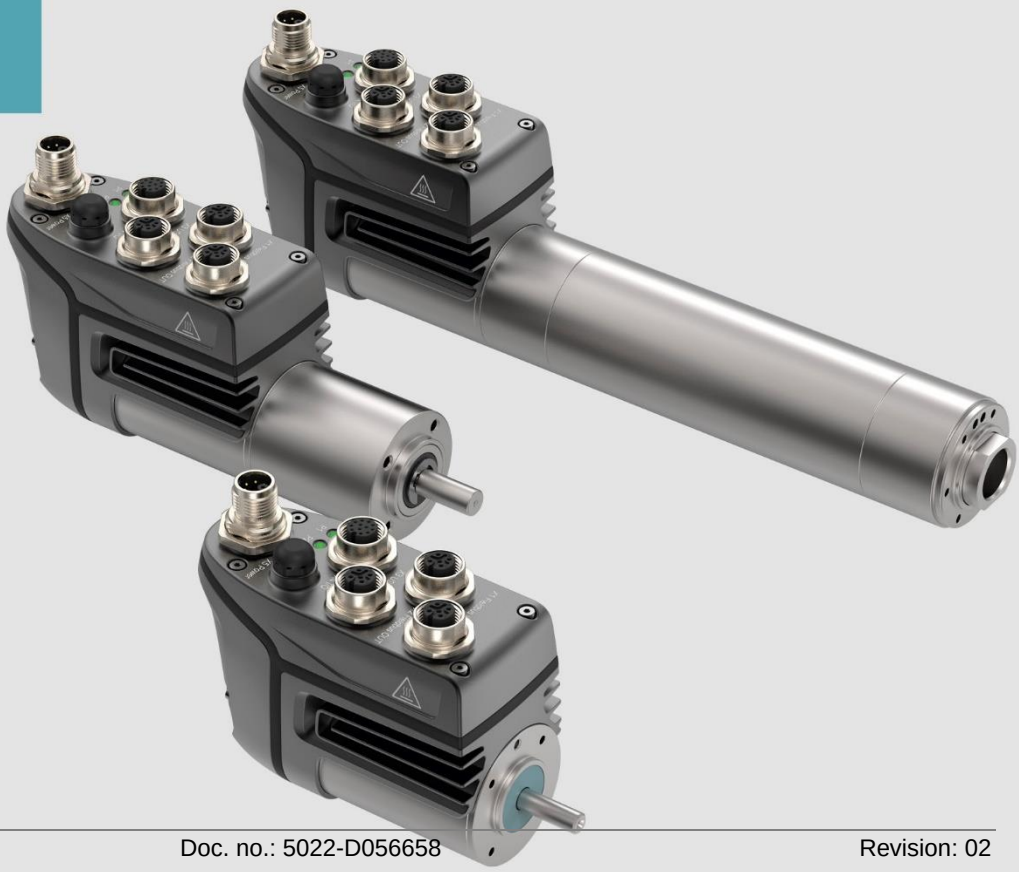
WITTENSTEIN | cyber motor

cyber® dynamic system

Operating manual



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Revision history

Revision	Date	Comment	Chapter
01	**21/04/2020**	**New Version**	**All**
02	**10/03/2021**	**Connector type; Pin no.**	**6.4.1, 6.4.2**

Technical support

In the event of technical questions, contact the following address:

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If you have any questions about installation, commissioning or optimization, please contact our support hotline.

WITTENSTEIN cyber motor GmbH support hotline

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In the event of technical malfunctions, contact us at the following address:

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Contents

1 About this manual

This manual contains information which is necessary for the safe use of the drive system **cyber® dynamic system**, hereafter referred to as the drive system.
Every drive system is described in a technically clear manner with its material number (MN) and serial number (SN) (see also chapter 3.3 “Name plate”).
In case of conflict between this general operating manual and the material-specific documentation, the material-specific documentation applies. This operating manual is valid for the product (drive system) unless another, material-specific documentation exists.
If this manual is supplied with amendment sheets (e.g. for special applications), then the information in the amendment is valid. Contradictory specifications in this manual are therefore void.
The operator must ensure that this operating manual is read through by all persons assigned to install, operate, or maintain the drive system, and that they fully comprehend its content.
Store this manual within reach of the drive system.
Inform colleagues who work in the area around the machine about the **safety instructions** so that no one is hurt.
The original was prepared in German, all other language versions are translations of the original instructions.

1.1 Signal words

The following signal words are used to indicate hazards, things that are forbidden and important information:

	⚠ DANGER **This signal word indicates an imminent danger that will cause serious injuries or even death.**
	⚠ WARNING **This signal word indicates a potential hazard that could cause serious injuries and even death.**
	⚠ CAUTION **This signal word indicates a potential hazard that could cause minor or serious injuries.**
	NOTICE **This signal word indicates a potential hazard that could lead to property damage.**
	A note without a signal word indicates application hints or especially important information for working with the drive system.

1.2 Safety symbols

The following safety symbols are used to indicate hazards, things that are forbidden and important information:

			
General danger	Hot surface	Suspended loads	Entanglement
			
Magnetic field	Information	Electric voltage	Electrostatically sensitive device
			
Crushing	No persons with pacemakers		

1.3 Structure of the safety information

Safety information in this manual has been structured according to the following template:

⚠ CAUTION

Explanatory text shows the consequences of disregarding this information.

- Instructive text uses direct address to indicate what to do.

1.4 Information symbols

The following information symbols are used:

- Indicates an action to be performed

➲ Indicates the results of an action

ⓘ Provides additional handling information

2 Safety

This operating manual, especially the safety instructions, and the rules and regulations valid for the operating site, must be observed by all persons working with the drive system.
In addition to the safety instructions in this manual, also observe any legal and otherwise applicable environmental and accident prevention rules and regulations (e.g. personal safety equipment).

2.1 Approvals

2.1.1 CE conformity

The drive system was tested in authorized testing laboratories in accordance with the requirements of this documentation. Deviations and nonconformity with requirements in this documentation mean that the drive system may not fulfill statutory requirements under certain circumstances.

The drive system is in conformity with the following directives:

- EC directive (2009/125/EC)
- Machinery Directive (2006/42/EC)
- Electromagnetic Compatibility (EMC) (2014/30/EU)
- RoHS Directive (2011/65/EU)

Startup is prohibited within the scope of the EC directives until it has been determined that the machine/system in which this drive system is installed corresponds to the regulations within these directives.
In terms of interference immunity, the drive system fulfills the requirement for the category “second environment” (industrial environment).
In the area of interference emission, the drive system fulfills the requirements for category C3.

	NOTICE
	• In a residential environment, the drive system may cause radio interference, necessitating interference suppression measures such as an external EMC filter.

2.1.2 Conformity with TÜV NRTL

This drive system is approved under the TÜV reference number 028-713170081-000 and falls under the category Power Conversion Equipment.

Explanations:
NRTL: Approval according to standards of the United States in accordance with UL 61800-5-1
Approval according to national Canadian standards in accordance with C22.2 No. 274-13, 1st edition

NRTL Markings:

- Maximum Altitude: 2000 m
- Maximum Surrounding Air Temperature: 55 °C
- These devices are intended to be used in a pollution degree 2 environment
- Use minimum 90 °C copper wire
- Integral Solid State short circuit Protection
- 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 and any additional local codes

- For Canada (CSA): Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the Canadian Electrical Code, Part I
- Use only UL listed Class G Fuse with a rating of minimum 300 Vdc and max fuse rating of 10 A and an DC interrupt rating of 10 kA or higher, e.g. Bussmann SC-10. Alternately use an UL listed fuse with an lower I^2t rating of 25 kA and an Ip value of 10.5 kA
- Tightening torque for factory wiring terminals: 0.5 Nm
- These products are intended for operation within circuits not connected directly to the supply mains (galvanically isolated from the supply, i.e. on transformer secondary).
- This EUT is for use in non-hazardous locations, operated by qualified personell skilled in its use.
- This EUT shall be supplied with the specified rated voltages according to the user manual.
- The EUT fulfils the requirements of the tested standards only, if it is supplied with a source that has a prospective short-circuit current of at least 5000 A.

2.1.3 Safety conformity (STO) in accordance with the Machinery Directive

The drive system provides a two-channel, functionally safe STO function (**S**afe **T**orque **O**ff). The function disables the firing pulses of the power transistors so that the drive can be switched safely to torque OFF.

The circuit design has been tested and subsequently assessed by TÜV Süd. According to that assessment, the circuit design used for the “Safe Torque Off” safety function in the drive system of the cyber dynamic system is suitable for meeting the requirements for SIL 3 in accordance with EN 61508 and category 4 PLe in accordance with EN ISO 13849-1:2015.

The subsystems (drive systems) are fully described in terms of safety by the following characteristics:

Operating mode	EN 13849-1	EN 61508	PFH_D [1/h]
Single-channel	PLd, cat 3	SIL 2	1E-10
Two-channel	PLe, cat 4	SIL 3	1E-10

2.2 Commissioning

For installation in machines and systems, start of intended use of the drive system is prohibited until it has been determined that the machine or system complies with the provisions of the EC Machinery Directive 2006/42/EC and the EC EMC Directive 2014/30/EU.
For use in residential areas, additional EMC measures are necessary.
It is the responsibility of the manufacturer of the machine or system to ensure that the limit values, as stipulated by the EMC regulations, are adhered to.

2.3 Hazards

The drive system has been constructed according to current technological standards and accepted safety regulations.
To avoid danger to the user or damage to the machine, the drive system may only be used as intended (see chapter 2.5 “Intended use”) and in a technically flawless and safe state.

2.4 Personnel

Only qualified technicians who have read and understood this manual may carry out work on the drive system.
Information on the drive system, in particular the safety instructions, must be accessible to all persons who work with the drive system.

Qualified technicians are characterized by their education and training in the use of electronic drive technology. They know the relevant standards and accident prevention regulations for drive technology and can evaluate its use. Potential hazards are recognized immediately. The local regulations (ICE, VDE, VGB) are known to the technicians and are taken into account during their work.

In case of ambiguities and functions that are not described or not sufficiently described in the documentation, the manufacturer or retailer must be contacted.

2.5 Intended use

The drive system is designed to be used in industrial systems.
Other applications must first be approved by the manufacturer.
The drive system can be optionally equipped with a holding brake.

- The holding brake is not a safety brake (compare DIN EN 13849-1 or leaflet on vertical axles from SMBG (South German Wood and Metal Trade Association)), and is not suitable for personal protection or as a service brake.

They are used in industrial environments. For use in residential areas, additional EMC measures are necessary. The user must prepare a hazard analysis of the final product.

2.6 Improper use

The drive system is not suitable for use in the following areas:

- Life-sustaining medical devices
- Applications in potentially explosive atmospheres
- Use in nuclear plants
- Use in airplanes

2.7 Risks

The manufacturer must strive to reduce residual risks associated with the drive system as much as possible by taking appropriate action. Nonetheless, known residual risks must be taken into account for the risk assessment of machines and systems.

2.8 Prohibited movements

Prohibited movements can be caused by:

- The failure or shut-down of safety monitoring
- Software nonconformity in associated controllers or bus systems
- Nonconformity during parameterization
- Nonconformity in wiring
- Limited reaction time of the controller
- Operation outside of the specifications
- Electromagnetic interference, lightning strike
- Component failure

2.9 Dangerous temperatures

Dangerous temperatures on the surface of the device can be caused by:

- Nonconformity in installation
- Incorrect installation site
- Nonconformity in electrical protection
- Conductive pollution, condensation

2.10 Guarantee and liability

Guarantee and liability claims are excluded for personal injury or material damage in case of

- Ignoring the information on transport and storage
- Improper use (misuse)
- Improper or not carried out maintenance and repair
- Improper / disassembly or incorrect operation
- Operation of the drive system when safety devices and equipment are defective
- Operation of a heavily soiled drive system
- Modifications or reconstructions that have been carried out without written authorization from **WITTENSTEIN cyber motor GmbH**

2.11 Additional documents

You have already received the following documents for your specific drive system:

- Dimensional drawing (5007–...)
- System characteristics (5012–...)
- Encoder system data sheet (5093–...)

For additional information, please contact our Sales department. Always state the serial number (SN) when doing so.

2.12 Reasonably foreseeable misuse

Any usage that exceeds the maximum permitted speeds, torques and temperature is considered misuse and is therefore prohibited.

2.13 General safety instructions

⚠ DANGER

Faulty electrical connections or unapproved live components can lead to explosions that can cause serious injuries and even death.

- Have all electrical connection work performed by trained technicians only. The valid standards and directives must be observed for this.
- Only suitable tools may be used for connection work.
- Immediately replace damaged cables or plugs.

ⓘ Electrical connection work refers to all work on the electrical circuit for which faults and associated hazards cannot be excluded.

⚠ WARNING

When the motor shaft is still turning or when the motor is externally driven (generator operation), voltage is induced. This can cause lethal current surges.

- Ensure that no plugs or connections are exposed.

⚠ WARNING

Connecting the power and signal supply lines under voltage is not permitted and can lead to machine damage, serious injury or even death.

- Make sure that the power supply unit is always in a voltage-free state before connecting.

⚠ WARNING

Separation of the power and signal supply lines under voltage is not permitted and can lead to machine damage, serious injury or even death.

- Make sure that the drive is always in a voltage-free state before disconnecting its power and signal supply.

⚠ WARNING

Components equipped with permanent magnets and components that feature magnetic fields can influence/impede the function of active medical implants (e.g. pacemakers, defibrillators). This can lead to severe injuries or even death.

- Keep a sufficient distance to these components (stator, rotor) during assembly.
- If permanent magnets or permanent magnetic fields are directly accessible (especially with rotary kit motors or the primary and secondary parts of linear motors), you are prohibited from approaching these motor parts.
- If there are concerns, contact the manufacturer of the active medical implants or consult **WITTENSTEIN cyber motor GmbH**.

⚠ WARNING

Objects flung out by moving components can cause serious injuries and death.

- Remove objects and tools from the drive system before putting it into operation.

⚠ WARNING

Moving components on the drive system can pull in or crush parts of the body and cause serious injuries and even death.

- Keep a sufficient distance to moving machine components when the drive system is running.
- Secure the machine against restarting and unintentional movement during assembly and maintenance work.

⚠ WARNING

A wrong direction of rotation or direction of movement may result in serious injury or death.
The direction of rotation or movement may differ from the standard IEC 60034-8.

- Before and during startup, ensure that the drive system has the correct direction of rotation or movement.
- Be sure to avoid a collision (caused e.g. by crashing against an end stop).
- With the danger area secured, check the direction of rotation or movement in a slow motion, ideally by limiting the current and torque.

⚠ WARNING

A damaged drive system can cause accidents and injury.

- Never use a drive system that has been overloaded due to misuse or a machine crash.
- Replace affected drive systems, even if no external damage is visible.

⚠ CAUTION

The hot motor or controller housing can cause serious burns.

- Touch the motor or controller housing only when wearing protective gloves or after the drive system has been idle for some time.

⚠ CAUTION

During the mechanical assembly of the drive systems onto the application, and during mechanical maintenance work, handling errors can lead to severe crushing injuries as well as to damage to the drive system or the application.

- Have all mechanical assembly and maintenance work carried out by trained personnel only.
- Only use suitable tools for assembly and maintenance work.

⚠ CAUTION

During the mechanical assembly and maintenance of kit motors (rotary motors without housings or linearly moving primary and secondary parts), the attractive forces of the permanent magnets can cause severe crushing injuries and damage to the motor or the application.

- Have all mechanical assembly and maintenance work carried out by trained personnel only.
- Only use suitable (e.g. non-ferromagnetic) tools for assembly and maintenance work.

3 Description of the cyber® dynamic system

3.1 General information

All drive systems consist of a brushless, electrical machine with an integrated servo drive.
The drive systems of the **CDSL series (linear systems)** consist of a drive system with an integrated threaded spindle and bearing:

- The rotation of the drive system is transformed into a linear movement of the tappet via the threaded spindle. Ball screws are used as threaded spindles.

The drive system can be optionally equipped with a holding brake. The holding brake is **not** a safety brake.

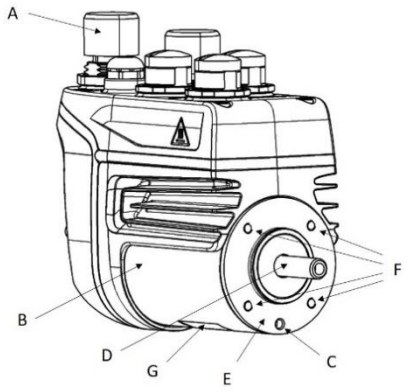
		Designation
	A	Power connector
	B	Motor housing
	C	Orientation hole
	D	Shaft pinion / thrust tube
	E	Motor flange (output side)
	F	Fastening screw thread
	G	Name plate

Table 1: CDSR overview

3.2 Code

Hardware:

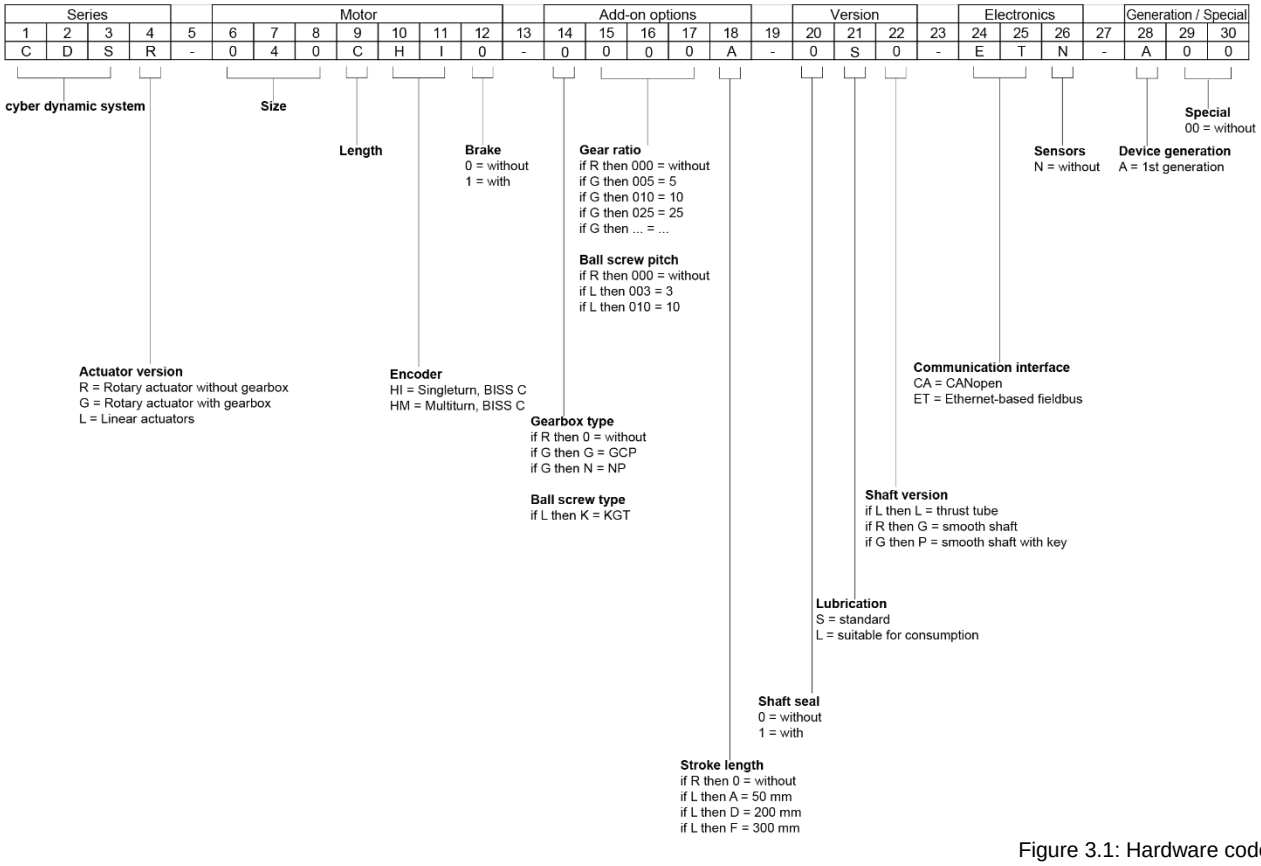


Figure 3.1: Hardware code

Firmware:

Product type			Software			Fieldbus			Generation			Version			Sub-version	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
C	Y	D	F	W	-	C	A	-	0	2	-	0	1	-	0	1

Product type
CYD – cyber drive

Software class
FW – Firmware

Fieldbus interface
CA = CANopen
EC = EtherCAT
PN = PROFINET
EI = EtherNet/IP
SC = SERCOS III
ME = Multi-Ethernet

Generation
02 = 2nd Generation

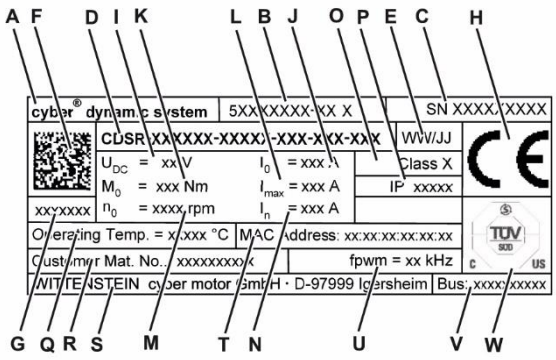
Version
XX = Latest version
01 = Version 1
02 = Version 2
...

Sub-version
XX = Latest sub-version
01 = Sub-version 1
02 = Sub-version 2
...

Figure 3.2: Firmware code

3.3 Name plate

The name plate consists of a laser inscription on the motor housing. It depends on the version of the drive system.



		Designation
	A	Product designation
	B	Material number
	C	Serial number
	D	Type code
	E	Calendar week and year of production
	F	Data matrix code (DMC)
	G	Service portal code
	H	CE mark
	I	Intermediate circuit voltage U_{DC}
	J	Continuous stall current I_0
	K	Continuous stall torque M_0
	L	Maximum current I_{max}
	M	No-load speed n_0
	N	Rated current I_n
	O	Insulation class
	P	Protection class
	Q	Ambient temperature
	R	Customer material number
	S	Manufacturer
	T	MAC address
	U	PWM frequency
	V	Bus interface
	W	TÜV logo

Table 2: CDSR name plate

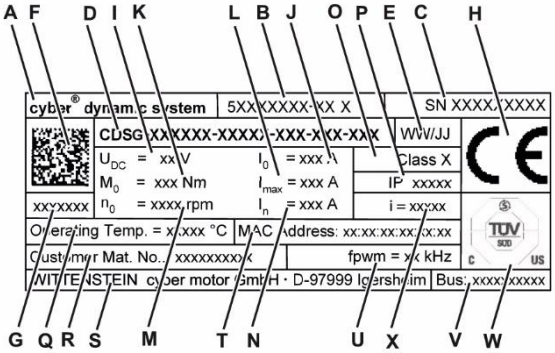
		Designation
	A	Product designation
	B	Material number
	C	Serial number
	D	Type code
	E	Calendar week and year of production
	F	Data matrix code (DMC)
	G	Service portal code
	H	CE mark
	I	Intermediate circuit voltage U_{DC}
	J	Continuous stall current I_0
	K	Continuous stall torque M_0
	L	Maximum current I_{max}
	M	No-load speed n_0
	N	Rated current I_n
	O	Insulation class
	P	Protection class
	Q	Ambient temperature
	R	Customer material number
	S	Manufacturer
	T	MAC address
	U	PWM frequency
	V	Bus interface
	W	TÜV logo
	X	Gear ratio

Table 3: CDSG name plate

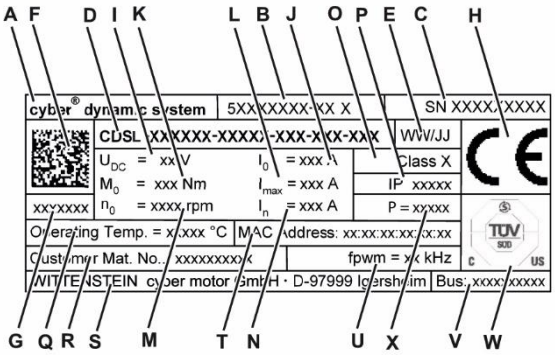
		Designation
	A	Product designation
	B	Material number
	C	Serial number
	D	Type code
	E	Calendar week and year of production
	F	Data matrix code (DMC)
	G	Service portal code
	H	CE mark
	I	Intermediate circuit voltage U_{DC}
	J	Continuous stall current I_0
	K	Continuous stall torque M_0
	L	Maximum current I_{max}
	M	No-load speed n_0
	N	Rated current I_n
	O	Insulation class
	P	Protection class
	Q	Ambient temperature
	R	Customer material number
	S	Manufacturer
	T	MAC address
	U	PWM frequency
	V	Bus interface
	W	TÜV logo
	X	Ball screw pitch

Table 4: CDSL name plate

Customized deviations are permissible.
The data matrix code (DMC) is in the format C18x18 according to ECC200. It contains the service portal address including the service portal code.

3.4 Electrical data

Electrical data	Unit	Value
Nominal supply voltage, intermediate circuit	V DC	48
Nominal power	W	nom. 150 / max. 500
Intermediate circuit voltage	V DC	12 … 60
Logic power supply	V DC	12 … 60
Current consumption of logic supply	mA DC	50 ... 230
Nominal output current of the output stage	Aeff	3.3
Peak output current of the output stage (for 5s)	Aeff	11.5
Clock frequency of the output stage	kHz	16
STO voltage	V	12 … 60

Table 5: Electrical data

3.5 Performance data

Refer to the system characteristics (5012–...) for the maximum permissible technical data. For additional information, please contact our Sales department. Always state the serial number (SN) when doing so.

3.6 Description of the cyber® dynamic system

WITTENSTEIN cyber® dynamic system is an intelligent drive system with a continuous power of up to 137 W and a peak output of up to 315 kW.
The housing with protection class IP65 enables decentralized assembly, which means that the drive system can be integrated modularly and flexibly in the machine structure, reducing wiring. Depending on the device version, CANopen according to DS402, EtherCAT with CoE, PROFINET RT/IRT, Ethernet/IP Cip Sync or SERCOS III with FSP Drive is available as a communication interface.
The intelligence is reflected in high-resolution power regulation and decentralized motion tasks. Intuitive startup and diagnosis is possible using the PC-based, MotionGUI 2 graphic user interface.

3.6.1 Integrated safety

- Comprehensive functions to protect the drive system, such as overvoltage, overcurrent, short circuit or ground fault.
- Temperature monitoring of the drive system

3.6.2 Digital regulation

- Digital d-q current controller (PI) with a sampling rate of up to 32 kHz
- Digital position and speed controller (PI) with a sampling rate of 8 kHz
- Feed forward control of speed and current possible
- Pulse width modulation with a clock rate of 16 kHz
- Anti-windup structure for all controllers

3.6.3 Inputs and outputs

- 4 programmable galvanically isolated digital inputs, 24 V
- 2 programmable galvanically isolated digital outputs, 24 V (short-circuit proof)

3.6.4 Environmental conditions

- Ambient temperature during operation: 0 ... 55 °C for nominal data
- Air humidity during operation: Relative humidity < 95 %, non-condensing
- Installation altitude: < 2000 m above sea level without affecting performance
- Protection class: IP 65 according to EN60529

3.7 Requirements for cables and wiring

- In general, use high-quality, shielded motor and encoder cables to avoid EMC problems.

Further requirements regarding NRTL compliance are listed in chapter 2.1.2 “Conformity with TÜV NRTL”.

3.8 STO safety function

The STO safety function (**S**afe **T**orque **O**ff) is used for safe torque shutdown and to reliably protect drives from restarting. The drive system is fitted with a two-channel STO function as standard in the basic model.

ⓘ Instructions for the STO safety function can be found in the appendix (see chapter 11 “STO safety function instructions”).

3.9 Weight

3.9.1 CDSR (motor with integrated servo drive)

Without brake	
Maximum weight [kg]	0.63

With brake	
Maximum weight [kg]	0.81

3.9.2 CDSR (motor-gearbox combination with integrated servo drive)

Without brake		
NP gearbox	**Ratio**	
1-stage	**5**	**10**
Maximum weight [kg]	1.3	1.3
2-stage	**25**	
Maximum weight [kg]	1.5	

Without brake				
GCP gearbox	**Ratio**			
1-stage	**4**			
Maximum weight [kg]	0.9			
2-stage	**12.25**	**20**	**25**	**30.67**
Maximum weight [kg]	1	1	1	1
3-stage	**49**	**64**	**100**	
Maximum weight [kg]	1.1	1.1	1.1	

With brake		
NP gearbox	**Ratio**	
1-stage	**5**	**10**
Maximum weight [kg]	1.6	1.6
2-stage	**25**	
Maximum weight [kg]	1.8	

With brake				
GCP gearbox	**Ratio**			
1-stage	**4**			
Maximum weight [kg]	1.1			
2-stage	**12.25**	**20**	**25**	**30.67**
Maximum weight [kg]	1.2	1.2	1.2	1.2
3-stage	**49**	**64**	**100**	
Maximum weight [kg]	1.3	1.3	1.3	

3.9.3 CDSL (linear actuator with integrated servo drive)

Without brake			
	Pitch [mm] **3 / 10**		
Stroke length [mm]	**50**	**200**	**300**
Maximum weight [kg]	2.0	3.3	3.1

With brake			
	Pitch [mm] **3 / 10**		
Stroke length [mm]	**50**	**200**	**300**
Maximum weight [kg]	2.2	3.5	3.3

4 Transport and storage

4.1 Scope of delivery

- Check the completeness of the delivery against the delivery note.
  ⓘ Immediately notify the carrier, the insurance company, or
  WITTENSTEIN cyber motor GmbH in writing of any missing parts or damage.

4.2 Packaging

The drive system is delivered packed in foil and/or cardboard boxes.

- Dispose of the packaging materials at the recycling sites intended for this purpose.
  Please observe the valid national regulations for waste disposal.

4.3 Transport

⚠ WARNING

Suspended loads can fall and can cause injuries.

- Do not stand under suspended loads.
- Secure the drive system before transport with suitable fasteners (e.g. belts).

NOTICE

Hard knocks, caused by rough handling (for example, falling or hard dropping), can damage the drive system.

- Only use hoisting equipment and lifting accessories with sufficient capacity.
- Never exceed the maximum permissible loads for hoisting equipment.
- Lower the drive system slowly.

Note the weight of the payload and use an appropriate transport device.
For specifications on the weights, see chapter 3.9 “Weight”.

- Transport temperature: -40 ... 70 °C, max. 20 K/hour fluctuation
- Transport air humidity: Relative humidity max. 95%, non-condensing

NOTICE

The drive system contains components that are sensitive to electrostatic charge and can be damaged when handled improperly.

- Observe the directives concerning ESD protection.

4.4 Storage

- Store the drive system in horizontal position in the original packaging.
  The ambient conditions must be dry, dust-free, and not subjected to vibrations.
  - Storage only in ESD-compliant original packaging
  - Storage temperature: -20 ... 60 °C, max. 20 K/hour fluctuation
  - Air humidity: Relative humidity max. 95%, non-condensing
- Store the drive system for a maximum of 2 years.

For storage logistics, we recommend the “first in – first out” method.

5 Mechanical installation

5.1 Safety instructions

- For the mechanical installation, the ESD information must be observed.
- The drive system must be checked for mechanical damage before installation. Only install drive systems which are in good working order.
- It is not permitted to operate drive systems exposed to condensation.

⚠ CAUTION

- The drive system may only be assembled with the power disconnected.
- Systems that are electrically connected must be properly secured so they cannot be switched back on and warning signs must be put up. Assembly may only be performed by trained personnel.

5.2 Assembly

Read the general safety instructions before beginning to work (see chapter 2.13 “General safety instructions”).

5.2.1 Preparations

NOTICE

Compressed air can damage the drive system seals.

- Do not use compressed air to clean the drive system.

NOTICE

If present, the temperature sensors and rotor position encoders, particularly Hall effect sensors and encoders, can be damaged by electrostatic discharge.

- Observe the directives concerning ESD protection.

- Clean / de-grease the output shaft / thrust tube of the drive system with a clean, lint-free cloth moistened with a suitable grease-dissolving but non-aggressive cleaning agent.
- Dry all fitting surfaces to neighboring components to achieve the proper friction values for the screw connections.
- In addition, check the fitting surfaces for damage and impurities.
- For all drive systems, use screws with property class A2-70.
  Exception CDSL with stroke length 200 mm and 300 mm: For these drive systems, use screws with property class 12.9.
- Do **not** use washers.

5.2.2 Preparations for CDSL series (linear actuators with integrated servo drive)

NOTICE

The drive system may be damaged in the case of improper assembly.

- Only install the drive system on level, no-vibration, rigid structures.
- Ensure freedom of motion of the customer application.
- Arrange the drive system and the application optimally with respect to one other to avoid lateral forces and thus premature wear of the threaded spindle.
- Avoid lateral forces and bending torques on the thrust tube.
- Avoid banging and knocking the tappet.

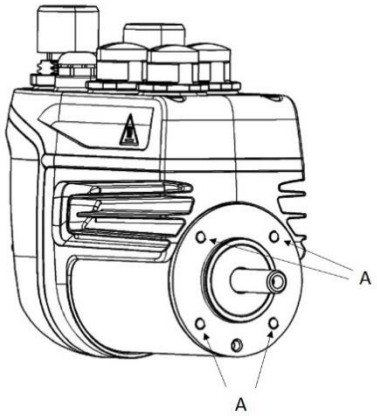
NOTICE

Moving outside the permissible stroke path, at both the minimum and maximum position, will damage the threaded spindle.

- Limit the stroke of the drive system using appropriate measures (e.g. stops, or buffers) for the extended and retracted end position.
- These end stops must be dimensioned appropriately and be capable of absorbing the kinetic energy of the moving parts, which may be moving at high speeds.

5.3 Attaching the CDSx to a machine

	• Observe the safety and processing instructions for the threadlocker to be used.



- Coat the fastening screws with a threadlocker.
- Fasten the drive system to the machine with the fastening screws through the threaded bores (A).
- Attach the drive system so that the name plate can still be read.

ⓘ For specified tightening torques for screws of property class A2-70, see chapter 10.1 “Tightening torques for common thread sizes in general mechanical engineering”.

NOTICE

Fastening screws that are screwed in too far can damage the drive system.

- Screw in the screws only up to their maximum depth.

ⓘ See dimensional drawing (5007–...).

5.4 Components attached to the output side

NOTICE

Distortions during mounting operations can damage the drive system.

- Do not use force when mounting gearwheels and toothed belt pulleys onto the output shaft.
- Never attempt to assemble by force or hammering!
- Only use suitable tools and devices for assembly.

For additional information, please contact our Sales department. Always state the serial number (SN) when doing so.

6 Electrical installation

6.1 Safety instructions

- Read the general safety instructions before beginning to work (see chapter 2.13 “General safety instructions”).
- For the electrical installation, the ESD instructions must be observed.

⚠ CAUTION

- Systems that are electrically connected must be properly secured so they cannot be switched back on and warning signs must be put up. Installation may only be performed by trained personnel.
- Before startup, it must be checked that the wiring is correct and is free of mechanical damage. Only drive systems with wiring in a flawless condition may be put into operation.
- Incorrect voltage, reverse polarity and defective wiring can damage or destroy the drive system.
- Excessive or inadequate protection of the power supply can damage the cables or the drive system.
- To comply with protection class IP65, connections which are not being used must be fitted with dummy connectors which are included in delivery.

The drive system does not include integrated ballast resistance, which means that an extra brake stopper including brake resistance must be connected for feedback.

Observe the separate instructions for the STO safety function (see chapter11 “STO safety function instructions”).

6.2 Installing the electrical connections

⚠ DANGER

Electrically live components may result in electric shocks if touched and can cause serious injuries and even death.

- Observe the five safety rules of electrical engineering before starting electrical installation work:
  - Switch off the power supply.
  - Secure against being switched on again.
  - Check that there is no voltage.
  - Ground and short-circuit.
  - Cover neighboring and electrified parts.
- Before switching the voltage back on, check that all electrified parts are equipped with suitable and undamaged contact protection.
- Check whether there are protective caps on the plugs. If protective caps are missing, check the plugs for damage and soiling.

⚠ DANGER

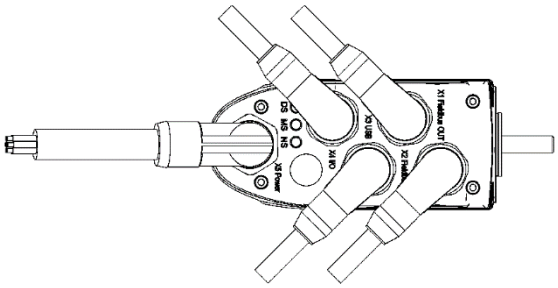
Electrical work performed in damp areas may result in electric shocks and can cause serious injuries and even death.

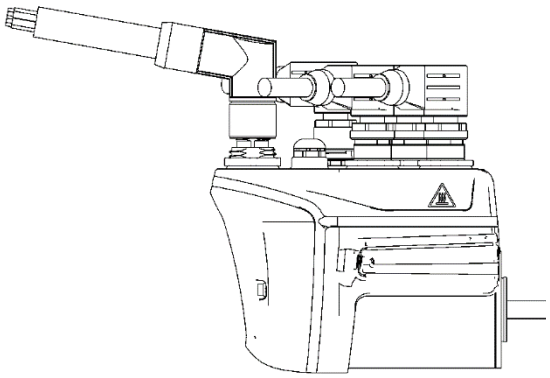
- Carry out the electrical assembly only in dry areas.

6.2.1 Installation space

The installation size must be sufficiently large.
A minimum distance of 25 mm on all sides of the drive system must be observed.

Cables with straight and angled plugs are available in the accessories of the drive system. The following figure shows the direction of the cable outlets with angled plugs. The plugs are not rotatable.





6.2.2 Mounting position

Any mounting position can be selected.

6.2.3 Ventilation / cooling

Sufficient convection for cooling of the drive system must be ensured at the installation location.
To avoid overheating, closed installation sites with low volume flow are not suitable for installation of the drive system.

6.2.4 Environmental conditions for vibration/shock

The drive system fulfills the following specifications:

- Vibration according to DIN EN 60068-2-6:2008
  - Frequency range 10 Hz – 150 Hz
  - Acceleration 5 g
- Shock according to DIN EN 60068-2-27:2010
  - Shock form: semi-sinusoidal
  - Acceleration 50 g
  - Shock duration: 11 ms

6.3 Requirements for power adapters and supply voltage

The drive system's logic supply and power supply (12-60 VDC) must be provided using power adapters or supply voltage sources with safe extra low voltage in SELV/PELV design to IEC 60950 / EN 60204. Power adapters or supply voltage sources having only basic installation are not permissible.

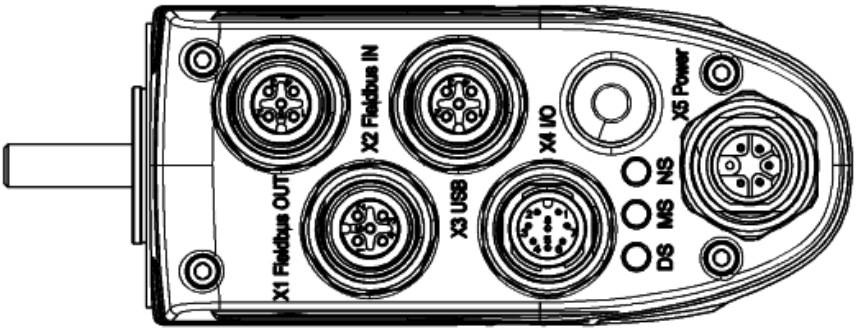
⚠ DANGER

The use of unsuitable power adapters not in SELV/PELV design can lead to dangerously high voltages in the event of a fault, which could lead to dangerous electric shocks resulting in injuries or death.

6.4 CDSx pin assignment

6.4.1 Overview of plug connections

The following illustration shows the arrangement of the plug connections with associated label on the drive system:



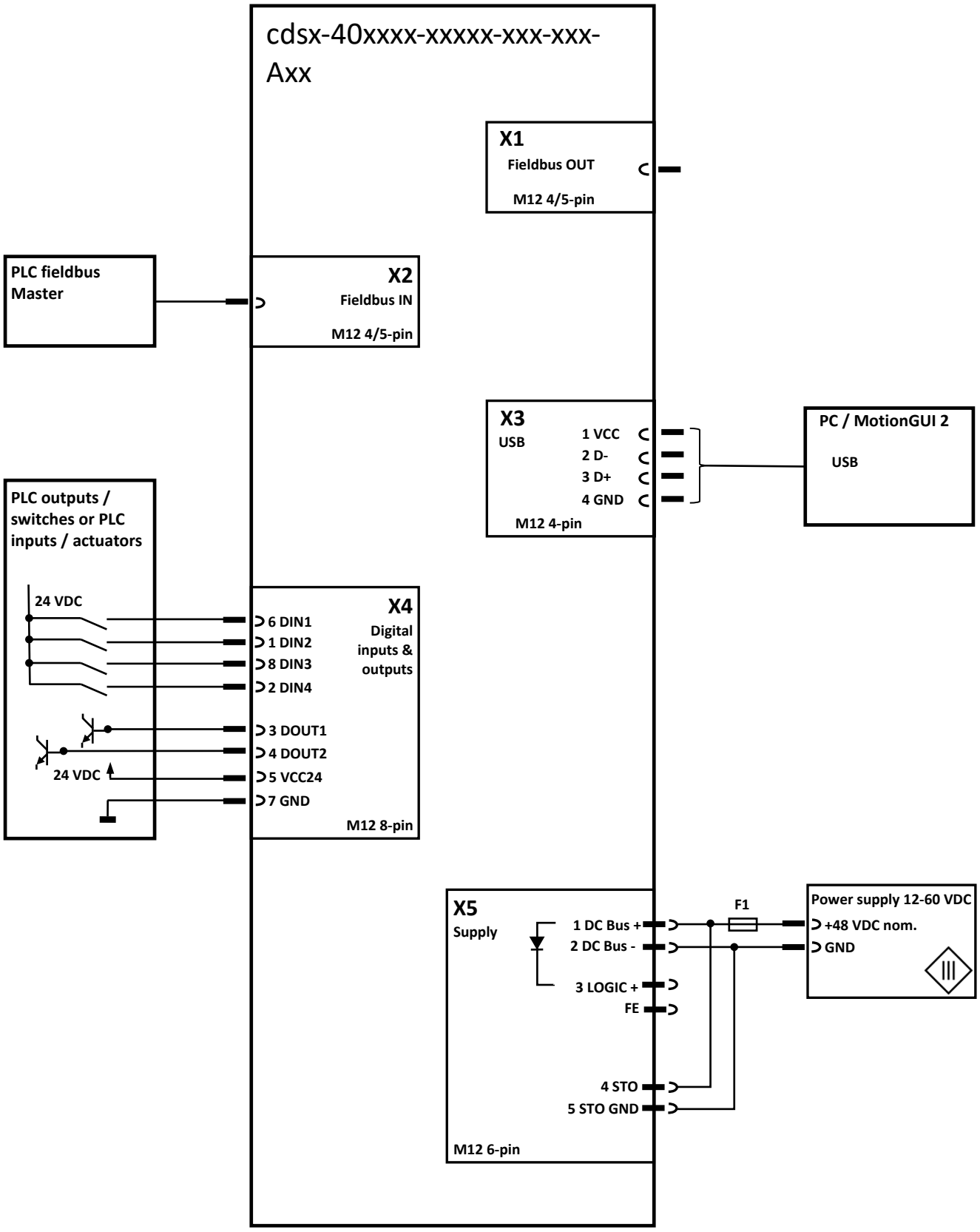
No.	Function	Connector type on the device	Connector type on the cable
X1	Fieldbus interface Output	CAN: M12 5-pin, female, A-coded Ethernet-based: M12 4-pin, female, D-coded	CAN: M12 5-pin, male, A-coded Ethernet-based: M12 4-pin, male, D-coded
X2	Input fieldbus interface	CAN: M12 5-pin, male, A-coded Ethernet-based: M12 4-pin, female, D-coded	CAN: M12 5-pin, female, A-coded Ethernet-based: M12 4-pin, male, D-coded
X3	USB diagnostic interface	M12 4-pin, female, A-coded	M12 4-pin, male, A-coded
X4	Digital inputs/outputs	M12 8-pin, male, A-coded	M12 8-pin, female, A-coded
X5	Power supply	M12 6-pin, male, M-power	M12 6-pin, female, M-power

Table 6: Overview of plug connections

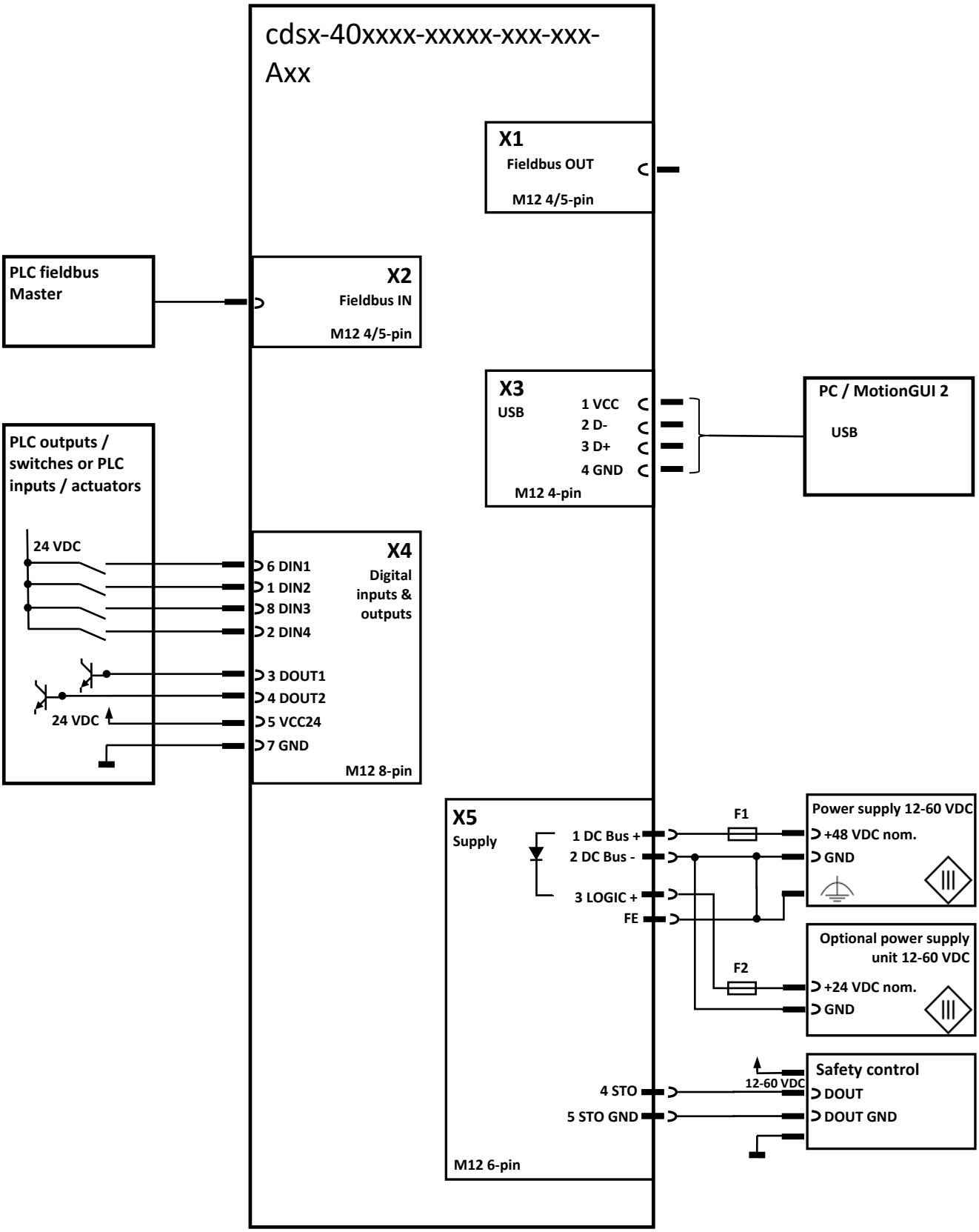
6.4.2 Connection diagram

The following illustrations show the key connection diagrams of the drive system when supplied with SELV and PELV power supply units:

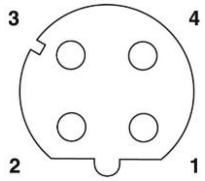
Connection diagram with one power supply unit for power and logic



Connection diagram with two power supply units for power and logic



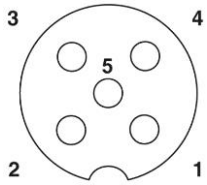
6.4.3 X1/X2: Ethernet-based fieldbus interface

Figure	Pin no.	Signal name	Function
	1	TD+	Transmit Data +
	2	RD+	Receive Data +
	3	TD-	Transmit Data -
	4	RD-	Receive Data -
Plug type on drive system: M12, 4-pin, female, D-coded at X1 and X2			

Connection	Feature	Unit	Minimum value	Nominal value	Maximum value
	Transmission speed	MBit/s		100	

6.4.4 X1: CANopen fieldbus interface (output)

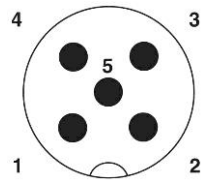
– The CAN ground reference is identical to the logic ground reference.

Figure	Pin no.	Signal	Function
	1	Shield	Screen
	2	N.C.	
	3	CAN_GND	CAN ground reference
	4	CAN_H	CAN High
	5	CAN_L	CAN Low
Plug type on drive amplifier: M12, 5-pin, female, A-coded at X1			

Connection	Feature	Unit	Minimum value	Nominal value	Maximum value
	Baud rate	kbaud	100	500	1000

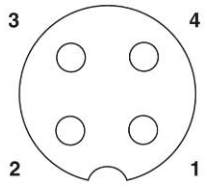
6.4.5 X2: CANopen fieldbus interface (input)

– The CAN ground reference is identical to the logic ground reference.

Figure	Pin no.	Signal	Function
	1	Shield	Screen
	2	N.C.	
	3	CAN_GND	CAN ground reference
	4	CAN_H	CAN High
	5	CAN_L	CAN Low
Plug type on drive amplifier: M12, 5-pin, male, A-coded at X2			

Connection	Feature	Unit	Minimum value	Nominal value	Maximum value
	Baud rate	kbaud	100	500	1000

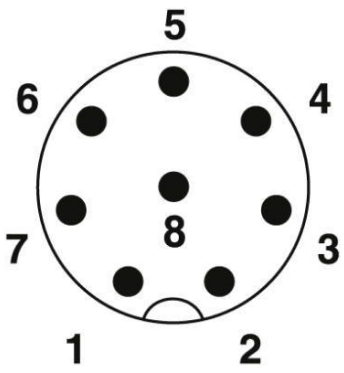
6.4.6 X3: USB diagnostic interface

Figure	Pin no.	Signal name	Function
	1	USB VCC	5 V USB supply
	2	D-	Data -
	3	D+	Data +
	4	USB_GND	USB ground reference
Plug type on drive system: M12, 4-pin, female, A-coded			

Connection	Feature	Unit	Minimum value	Nominal value	Maximum value
USB 2.0					

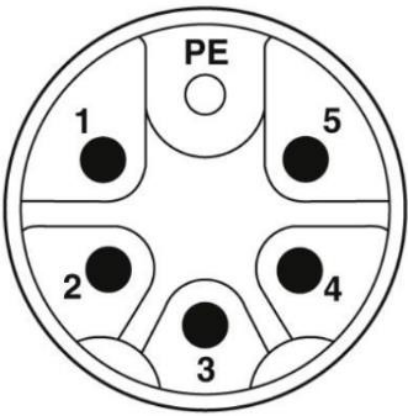
6.4.7 X4: Digital inputs/outputs

- An external reference potential most be connected to supply the digital inputs.
  - The digital inputs are galvanically isolated from the logic and power of the drive amplifier.
- An external power supply most be connected to supply the digital outputs.
  - The digital outputs are galvanically isolated from the logic and power of the drive amplifier.
  - The digital outputs are short-circuit proof.

Figure	Pin no.	Signal name	Function	Input / output
	6	DIN1	Digital input 1	Input
	1	DIN2	Digital input 2	Input
	8	DIN3	Digital input 3	Input
	2	DIN4	Digital input 4	Input
	7	GND	Ground reference	
	3	DOUT1	Digital output 1	Output
	4	DOUT2	Digital output 2	Output
	5	VCC24	Digital output supply	Input
Plug type on drive system: M12, 8-pin, male, A-coded				

Connection	Feature	Unit	Minimum value	Nominal value	Maximum value
DINx	Input voltage	V DC	20	24	28
	Input current	mA DC	3	4	5
	Input resistance	kOhm		5.6	
	Sample time	msec			1
DOUTx	Output voltage	V DC	18	24	26
	Output current	mA DC			40
	Output resistance	kOhm	1	1.5	2
	Refresh rate	Hz			1
VCC24	Voltage	V DC	20	24	28
	Current	mA DC			80

6.4.8 X5: Power supply

Figure	Pin no.	Signal name	Function	Input / output
	1	DC Bus+	Intermediate circuit voltage +	Input
	2	DC Bus-/GND	Intermediate circuit voltage - / earth	Input
	3	LOGIC	Logic supply	Input
	4	STO_VCC	Safe torque off input	Input
	5	STO_GND	STO ground reference	Input
	FE	FE	Functional earth	Functional earth
Plug type on drive system: M12, 6-pin, male, M-power				

Connection	Feature	Unit	Minimum value	Nominal value	Maximum value
DC Bus	Current	A DC	0	4 (3,3 A +22%)	14 (11,5 A +22%)
	Voltage	V DC	12	48	60

	VDC	12	24	48	60
LOGIC, without brake, output stage inactive	mA DC	220	110	60	50
LOGIC, without brake, output stage aktiv	mA DC	230	115	65	55
STO, output stage inactive	mA DC	14	8	6	5
STO, output stage active	mA DC	20	11	9	7

6.5 Fuses

- The power supplies are to be secured with the fuses specified in the table:

Fuses	
Logic supply (F2) X5 (pin 3)	Fuse or similar with max. 4 AT
Power supply (F1) X5 (pin 1)	Fuse or similar with max. 10 AT

Further requirements regarding NRTL compliance are listed in chapter 2.1.2 “Conformity with TÜV NRTL”.

Circuit breaker hardware to protect the drive system is not required as the drive system is protected from overloading by an I^2t function in the software.

7 Startup and operation

7.1 Safety information and environmental conditions

For secure application of the drive system, the following regulations must be observed:

- Connection and operating instructions
- Local regulations
- EC regulations and the EC Machinery Directive

- If the drive system is equipped with a holding brake, ensure that the instructions in chapter 7.3 “Holding brake” are observed.

⚠ CAUTION

- The housing temperature on the drive system can reach 80 °C during operation.
- Wait until the housing temperature has cooled down to 40 °C before touching the drive system.

⚠ CAUTION

- Before startup, the machine manufacturer must prepare a risk assessment for the machine and take appropriate action so that unforeseen movements cannot lead to personal injury or property damage.

⚠ CAUTION

- Only technicians with extensive experience with electrical and electronic systems and drive technology may start up the drive system.

7.2 Data for the electrical startup

NOTICE

Moving the drive system during the switch-on process of the encoder system can lead to malfunctions.

- When commissioning the drive system, make sure that the motor shaft is not moved during the switch-on process of the encoder system.
- The switch-on process is complete as soon as the encoder system supplies valid position data.
- The drive system may be moved.

- For additional information, please contact our Sales department. Always state the serial number (SN) when doing so.

7.3 Holding brake

The following instructions apply exclusively to electrical holding brakes.

- If the drive system is equipped with a holding brake, ensure that this brake is vented during startup, and that the drive system is never operated with the brake applied.

ⓘ The brake is applied in a currentless state. Control of the brake is performed by the customer using the regulating device. Technical data on the brake can be found on the name plate and in the technical documentation.

ⓘ The holding brake is not a safety brake (compare DIN EN 13849-1 or leaflet on vertical axles from SMBG, the South German Wood and Metal Trade Association), and is not suitable for personal protection or as a service brake.

Emergency stop

The effective braking torques of a holding brake differ due to physical factors, and it is necessary to consider use during a malfunction as well as normal operation:

- In normal use, the operating principle when using the holding brake to clamp / secure an axle in standstill is a static friction with the friction coefficient μ_H. This means the “static holding torque” M_4 as specified in the specification sheets is reached.
- In the case of a malfunction, the operating principle when using the holding brake to shut down a moving axle (emergency stop) is a dynamic friction with the friction coefficient μ_G. This means the “dynamic braking torque” is reached. The dynamic braking torque is lower than the static holding torque M_4.
  - Observe the design of the axle to ascertain if the holding brake may be used for an emergency stop
    - The maximum occurring load torque,
    - The maximum distance available,
    - The mass moment of inertia of the entire axle, and
    - The maximum energy in the entire axle.

ⓘ Otherwise the delay effect of the brake may not be enough to stop the axle.

	The holding brake may become worn if used for emergency stop. For this reason, it is recommended that the required holding torque for the axle is at most 60% of the static holding torque M4 of the holding brake used.

Running in the holding brake

The holding brake may no longer reach the specified holding torque M_4 due to the effects of storage, conditions or type of use, overvoltage or high temperature, combined with ambient conditions (soiling, humidity, etc.).

If no data is available for your drive system regarding the run-in process, we recommend that you use the following data for the run-in process.

- Grind in the brake as follows:
  - at a speed of 300 min-1
  - for a duration of 60 s
  - Brake must be opened and closed on a clocked basis in this period
  - Duty cycle brake 80 ms; currentless break 80 ms
  - Ambient temperature between 0 °C and +40 °C
- In the event of a falling holding torque, the brake is to be reactivated as follows:
  - at a speed of 300 min-1
  - for a duration of 30 s
  - Brake must be opened and closed on a clocked basis in this period
  - Duty cycle brake 80 ms; currentless break 80 ms
  - Ambient temperature between 0 °C and +40 °C

Commissioning the holding brake

To make sure the holding brake is functioning, it has to be tested during startup.

- If the regulating device has a function for integrated testing of the holding torque during secure limited movement and secure limited speed, then use this function and observe the instructions from the regulating device's manufacturer.

If no such function is present, we recommend that the user proceed as follows:

- Limit the permitted range of movement and the maximum speed using the parameters in the regulating device so that no danger to persons or property can arise from movement of the axle.
- Calculate the power of the drive system I_{M4} required to achieve the holding torque M_4 with the torque constant, and limit the maximum current of the regulating device to this value.
- Apply current to the drive system with the holding brake applied, gradually increasing the current to I_{M4}. During this, the drive system must not move. Observe the permitted time for applying current of I_{M4} to the drive system.
- If movement does occur, the user should ideally switch off the current supply automatically to avoid uncontrolled movement of the axle.
- If the holding torque M_4 is not reached, perform the grinding-in process described by the brake manufacturer.
- After the grinding-in process check again the holding torque M_4.

If the holding torque M_4 specified in the brake's technical data is reached, then the holding brake is ready for operation.

If the holding torque M_4 specified in the brake's technical data is **not** reached then:

- Repeat the grinding-in procedure.

ⓘ The grinding-in process may only be repeated twice during a testing procedure for the holding torque M_4.

If the holding torque M_4 is not reached after the third grinding-in process then the holding brake is **not functioning properly**:

- Do **not** start up the drive system. Contact our Sales department.

ⓘ Always state the serial number (SN) when doing so.

Testing the holding brake regularly

To ensure the permanent functioning of the holding brake, it has to be regularly applied and checked.

- It is recommended that the holding brake is released and applied at least twice daily, for example by deactivating the controller.
- It is recommended that the holding torque M_4 of the brake is checked at least once a day.

7.4 Operation

NOTICE

Due to oxygen in the air, UV rays, and cable movements, the bearing grease and the insulation materials age.

- Consult our Sales department in case of excessive wear.

Circumferential radial forces on the shaft are not permitted.

ⓘ If this requirement cannot be fulfilled, please contact our sales department. Always state the serial number (SN) when doing so.

NOTICE

Due to various components and seals, a new drive can be noticeably more difficult to move. To ensure optimum grease distribution and running-in of the moving components, the drive should run in as follows:

- 15 min at slow speed load-free (approx. 10 % vmax)
- 10 min at medium speed load-free (approx. 30 % vmax)
- 5 min with increased speed load-free (approx. 60 % vmax)

ⓘ If a stop occurs as a result of the switch-off due to excessive heating, a pause between the individual stroke cycles is recommended.

Due to the stroke movement of the piston rod, a certain amount of lubricant leakage is possible with the CDSL version.

7.5 Startup software

For parameterization and startup of the drive, the startup software Motion GUI 2 is available as well as an interactive, html-based guide.

The startup software Motion GUI 2 is used to change and save the operating parameters of the drive system. The integrated drive system can be put into operation with the help of software.

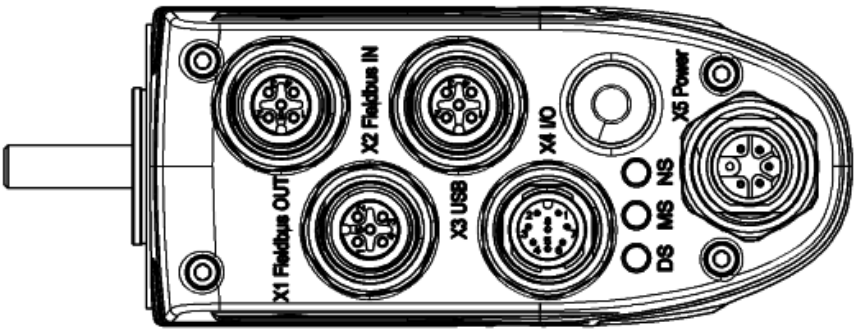
In the html-based help, all parameters and the function of the drive system are described.

⚠ CAUTION

- Nonconforming parameterization can cause uncontrolled movements. For this reason, never change parameters whose meaning you do not completely understand.

7.6 Displays on the drive system

Three multicolor LEDs (DS, MS, NS) in the colors green, yellow and red are available on the drive system for status and fault messages.



LED	EtherCAT	Ethernet/IP	PROFINET
DS	Drive Status	Drive Status	Drive Status
MS	RUN-LED (EtherCAT Drive Statemachine)	Module State	System Failure
NS	ERR-LED (EtherCAT Error State)	Fieldbus State	Bus Failure
DS	Drive Status	Drive Status	Drive Status

Table 7: Displays on the drive system

7.6.1 LED codes DS

LED DS is the drive LED which is identical for all bus system types.

Status LED	LED DS	Meaning
Off		Drive amplifier has no power supply or drive is defective
Flash: Green		Drive amplifier is in functional state but output stage is disabled
Flash: Red		Drive amplifier is in fault state and output stage is disabled
Flash: Yellow		Drive amplifier is in warning state and output stage is disabled
Flash: Yellow, Green		Drive amplifier is in warning state and output stage is enabled
Constant: Green		Drive amplifier is in functional state and output stage is enabled
Flash: Red, Green		Drive amplifier is in Firmware Update state

Table 8: LED codes DS

7.6.2 LED codes MS

LED MS is dependent on the bus system type.

EtherCAT: LED MS indicates the EtherCAT state machine state

Status LED	LED MS	Meaning
Off		The EtherCAT bus is in INIT (or the drive amplifier has no power supply or is defective)
Flash: Green (2,5 Hz)		The EtherCAT bus is in PRE-OPERATIONAL
Flash: Green (single flash)		The EtherCAT bus is in SAFE-OPERATIONAL
Constant: Green		The EtherCAT bus is in OPERATIONAL

Table 9: LED codes MS EtherCAT

Ethernet/IP: LED MS indicates the module state

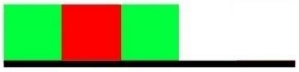
Stauts LED	LED MS	Meaning
Off		The bus module has no power supply or is defective
Flash: Green, Red, Green		The bus module is performing its power up testing
Flash: Green		Standby: The bus module is not configured (e. g. no network cable connected)
Flash: Red		The bus module is in fault state but fault can be reset
Constant: Red		The bus module is in fault state and fault can't be reset. Restart drive.
Constant: Green		The bus module is operating correctly.

Table 10: LED codes MS Ethernet/IP

PROFINET: LED MS (SF) indicates the system failure

Status LED	LED MS	Meaning
Off		The device has no error (or has no power supply or is defective).
Flash: Red (1 Hz, 3 s)		DCP signal service is initiated via the bus.
Constant: Red		Watchdog timeout; channel, generic or extended diagnosis present; system error

Table 11: LED codes MS PROFINET

7.6.3 LED codes NS

LED NS is dependent on the bus system type.

EtherCAT: LED NS indicates the error state

Status LED	LED NS	Meaning
Off		The device has no error (or has no power supply or is defective)
Flash: Red (2,5 Hz)		Invalid configuration: Maybe the master has sent a configuration which can not be activated by the slave
Flash: Red (single flash)		Local error: The slave changed its state independent. Maybe a host watchdog timeout or synchronisation error occured
Flash: Red (double flash)		Process data watchdog timeoug

Table 12: LED codes NS EtherCAT

Ethernet/IP: LED NS indicates the fieldbus state

Status LED	LED NS	Meaning
Off		The bus module has no IP addrress (or has no power supply or is defective)
Flash: Green, Red, Off		The bus module is performing ist power up testing
Flash: Green		An IP address is configured but no CIP connection is active
Flash: Red		An IP address is configured but the timeout limit was exceeded
Constant: Red		The bus module has detected that its IP address is already in use
Constant: Green		The bus has an IP address ant at least one CIP connection is active (without timeout)

Table 13: LED codes NS Ethernet/IP

PROFINET: LED NS (BF) indicates the bus failure

Status LED	LED NS	Meaning
Off		The device has no error (or has no power supply or is defective).
Flash: Red (2 Hz)		No data exchange
Constant: Red		No configuration; or low speed physical link; or no physical link

Table 14: LED codes NS PROFINET

8 Maintenance and disposal

- Opening the drive system voids the warranty.
- Read the general safety instructions before beginning to work (see 2.13 “General safety instructions”).

8.1 Maintenance work

8.1.1 Cleaning

- Clean the drive system with a grease-dissolving, non-aggressive detergent.

8.1.2 Checking the holding brake

The drive system can be optionally equipped with a holding brake.
To ensure the permanent functioning of the holding brake, it has to be regularly applied and checked.

- It is recommended that the holding brake is released and applied at least twice daily by deactivating the controller.
- It is recommended that the holding torque M_4 of the brake is checked at least once a day.

ⓘ Details can be found in chapter 7.3 “Holding brake”.

8.1.3 Visual inspection

Perform a **monthly** visual inspection:

- Check the drive system and moving cables for damage.
- Check whether the cable ends are completely labeled.

8.2 Repairs

The drive system may only be repaired by the manufacturer. Opening the drive system voids the warranty and safety according to the specified standards is no longer ensured.

8.3 Information about the lubricant

	It is not necessary to change the lubricant with this kind of drive system. All motor bearings, gearboxes, and threaded spindles are permanently lubricated at the factory.

8.4 Disposal

In accordance with WEEE 2002/96/EC directive, we take back old equipment for proper disposal as long as the transport costs are paid by the sender.

9 Malfunctions

NOTICE

Changed operational behavior can be an indication of existing damage to the drive system or can cause damage to the drive system.

- Do not put the drive system back into operation until the cause of the malfunction has been rectified.

Fault	Possible cause	Remedy
Drive system does not start	Connected incorrectly	Check the connection using the list of signals.
	Contact pin of the plug is bent	Check the connections.
	Parameter set does not correspond to the drive system	Check the motor data record in the power electronics.
Increased operating temperature	Drive system is heavily soiled	Clean the outside of the drive system.
	Ambient temperature too high / air pressure too low due to altitude	Ensure adequate cooling.
	Drive system becomes very hot	Consult our Customer Service department.
	Threaded spindle heavily worn	Consult our Customer Service department.
Increased operating noises	Damaged bearings	Consult our Customer Service department.
	Threaded spindle or gearbox damage	
Sporadic failure	Cable break	Consult our Customer Service department.

Table 15: Malfunctions

The contact information of our Customer Service department can be found at the beginning of this manual (inside cover page). Always state the serial number (SN) when doing so.

10 Appendix

10.1 Tightening torques for common thread sizes in general mechanical engineering

The specified tightening torques for headless screws and nuts are calculated values and are based on the following conditions:

- Calculation in accordance with VDI 2230 (February 2003 version)
- Friction value for thread and contact surfaces μ=0.10
- Utilization of the yield stress 90%
- Torque tools type II classes A and D in accordance with ISO 6789

The settings are values rounded to usual commercial scale gradations or settings.

- Use the **exact** values in this table to set your tools.

	Tightening torque [Nm] with thread					
Property class of screw/nut	**M1.6**	**M2**	**M2.5**	**M3**	**M4**	**M5**
A2-70	0.109	0.227	0.460	0.806	1.86	3.68

Table 16: Tightening torques for set screws and nuts

	Tightening torque [Nm] with thread													
Property class	**M3**	**M3.5**	**M4**	**M5**	**M6**	**M8**	**M10**	**M12**	**M14**	**M16**	**M18**	**M20**	**M22**	**M24**
12.9	2.15	3.3	4.95	9.7	16.5	40	81	140	220	340	470	660	890	1140

Table 17: Tightening torques

11 STO safety function instructions

The STO safety function (**S**afe **T**orque **O**ff) is used for safe torque shutdown and to reliably protect drives from restarting. The drive system is fitted with a two-channel STO function as standard in the basic model.

Advantages of the STO safety function:

- Intermediate circuit and main circuit can remain active
- No contact wear because only control voltages are switched on and off
- Less wiring required
- Single-channel or two-channel control possible
- SIL 2 or SIL 3 systems possible

The STO safety function equates to stop category 0 (uncontrolled stoppage) defined by EN 60204-1. The STO safety function of the server amplifier can be triggered by external safety relays or by an external safety control with safe outputs.

The circuit design has been tested and subsequently assessed by TÜV. According to that assessment, the circuit design used for the “Safe Torque Off” safety function in the cyber® dynamic system series drive systems are suitable for meeting the requirements for SIL 3 in accordance with EN 61508 and category 4 PLe in accordance with EN ISO 13849-1:2015.

11.1 Important information for STO

⚠ CAUTION

If the STO function is actuated during operation, the drive will coast to a stop in an uncontrolled manner and the drive system reports the “Error_amp_sto_active” fault. Controlled braking of the drive will not be possible.

- If an application requires controlled braking before the use of STO, the drive must first be braked under control and then the STO function must be triggered with a time delay.

⚠ CAUTION

Danger from short-term limited movements when STO function is activated.

Simultaneous breakdown of two power transistors in the output stage can cause short-term movement up to 180° / pole pair number of the drive system.

- Make sure that a limited movement of this kind cannot cause any damage.

11.2 Intended use of STO

The STO function is designed only for functionally safe switching of a drive to torque OFF and to prevent restarting. In order to achieve functional safety, the wiring of the safety circuit must meet the safety requirements of EN 60204, EN 12100, EN 61508 and/or EN 13849-1

11.3 Improper use of STO

The STO function must not be used if the drive needs to be stopped for the following reasons:

1. Cleaning, maintenance, or repair work; long interruptions in operation:
   In such cases the entire machine or system should be de-energized and secured (at the main switch).
2. Emergency stop situations:
   In emergency stop situations the power supply must be cut off by a line contactor (Emergency stop push-button).

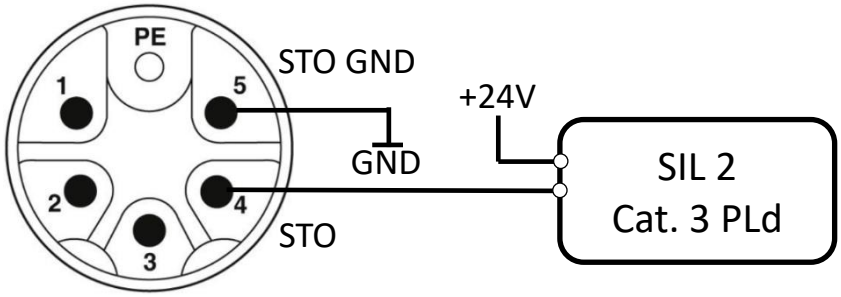
11.4 Technical data and STO pin assignment

STO input	Data
STO inactive input voltage	12 ... 60 VDC
STO active input voltage	Open
Input current	25 ... 45 mA
Response time (time between activation of STO function and drive system being free of torque)	< 16 ms
Test time for STO dark test at 24 VDC STO power supply	< 3 ms

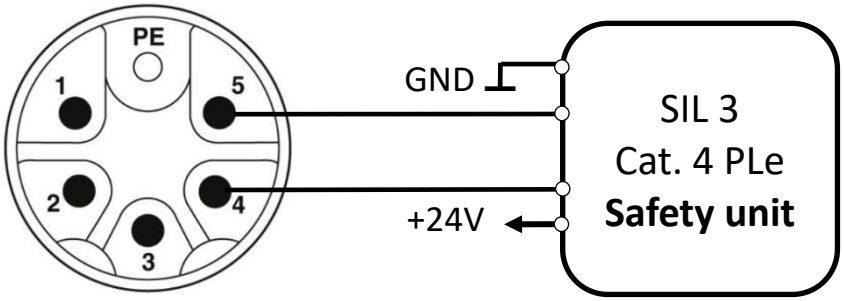
Table 18: Technical data and STO pin assignment

11.5 STO pin assignment

SIL 2 / category 3 PLd:



SIL 3 / category 4 PLe:



11.6 Function description

Use of the STO safety function requires the inputs STO and STO GND to be connected to the outputs of a safety control or safety relay that fulfills at least the requirements of PLd to EN 13849-1 or SIL 2 to EN 61508.

Single-channel control SIL 2 / PLd:
With single-channel control of the STO safety function, the STO input is switched on by an output of a safety relay. The STO GND is permanently connected to the GND of the safety relay.

STO +24 V status	STO GND status	Motor torque possible
Open	0 VDC	No
+24 VDC	0 VDC	Yes

Two-channel control SIL 3 / PLe:
With two-channel control of the STO safety function, the STO and STO GND shutdowns are switched separately by two outputs of a safety control.

STO +24 V status	STO GND status	Motor torque possible
Open	Open	No
+24 VDC	0 VDC	Yes

NOTICE

- When wiring the STO inputs inside an installation space, make sure that both the wiring used and the installation space itself meet the requirements of EN 60204-1.
- If the wiring is outside the installation space, it must be routed in a permanent installation and protected from external damage.

NOTICE

- If the STO safety function is not required in an application, the STO input must be permanently connected directly to +24 VDC and the STO GND input must be permanently connected directly to GND. The STO function is thus shunted out and cannot be used. The drive system is then no longer a safety component as defined by the Machinery Directive.

11.7 Safe operation sequence

If an application requires controlled braking before the use of the STO function, the drive must be braked first and the STO function must be triggered with a time delay:

1. Controlled braking of drive
2. Once standstill is reached, disable the drive system
3. In the case of a suspended load, mechanically lock the drive as well
4. Trigger STO

⚠ CAUTION

The drive system cannot hold the load with the STO function activated because the drive system no longer supplies any torque. Risk of injury from suspended load.

- Drives with a suspended load must be securely locked mechanically as well (e.g. with a suitable holding brake)

⚠ CAUTION

If the STO function is actuated during operation, the drive will coast to a stop in an uncontrolled manner. Controlled braking of the drive will not be possible. Danger from uncontrolled movement.

11.8 Functional check

NOTICE

- The STO function must be checked at initial startup, after any work on the system's wiring, and after replacing one or more components of the system.

Steps to follow for a functional check:

1. Stop the drive. The drive system remains enabled and under control.
2. Activate the STO function by triggering an emergency stop of the machine. The drive system should enter its fault state and should issue the “ERROR_AMP_STO_ACTIVE” fault.
3. Reset the fault using the “clear fault” function.
4. Acknowledge the emergency stop and deactivate the STO function.
5. Enable the drive and check that the drive is functioning.

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