

IDX 70

User Manual



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READ THIS FIRST

These instructions are intended for qualified technical personnel. Prior commencing with any activities...

- you must carefully read and understand this manual and
- you must follow the instructions given therein.

The IDX 70 drive is considered as partly completed machinery according to EU Directive 2006/42/EC, Article 2, Clause (g) and is intended to be incorporated into or assembled with other machinery or other partly completed machinery or equipment.

Therefore, you must not put the device into service,...

- unless you have made completely sure that the other machinery fully complies with the EU directive's requirements!
- unless the other machinery fulfills all relevant health and safety aspects!
- unless all respective interfaces have been established and fulfill the herein stated requirements!

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1 ABOUT

The «IDX drive» must be installed in a particular and specific way. Therefore, closely follow the described information in given order to achieve both safe and easy installation as well as reliable operational service.



The easiest and safest way of doing

- Do not engage with any task unless you have the knowledge to do so.
- Make sure that you have read and understood the safety precautions. Observe them, keep them in mind, and follow them at all times.
- Follow the description in given order. Work your way through the document. Do not skip nor cut short any sections.
- Read the «General Rules» at the beginning of a chapter closely. Observe them, keep them in mind, and follow them at all times.

1.1 About this Document

1.1.1 Intended Purpose

Use the document to...

- stay safe,
- be fast,
- end up with set up and ready-to-go equipment.

The purpose of the present document is to familiarize you with the IDX drive. It will highlight the tasks for safe and adequate installation and commissioning. Follow the described instructions ...

- to avoid dangerous situations,
- to keep installation and/or commissioning time at a minimum,
- to increase reliability and service life of the described equipment.

The present document is part of a documentation set and contains performance data and specifications, information on fulfilled standards, details on connections and pin assignment, and wiring examples. The below overview shows the documentation hierarchy and the interrelationship of its individual parts:

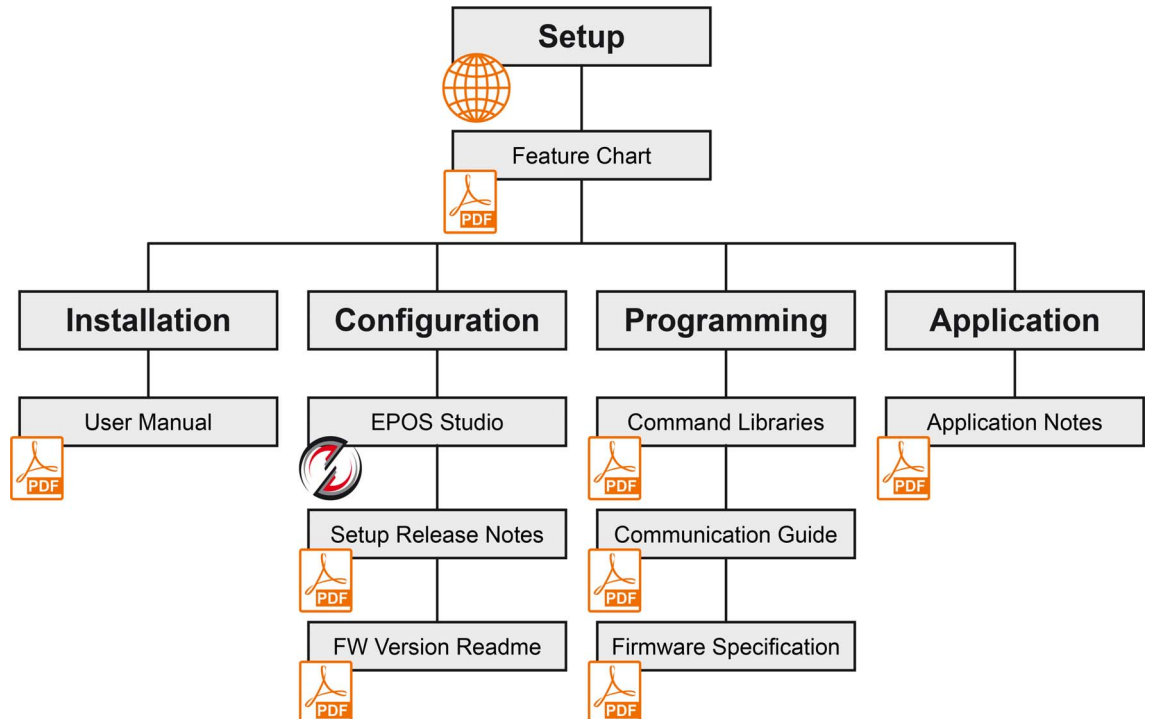


Figure 1-1 Documentation structure

1.1.2 Target Audience

The present document is intended for trained and skilled personnel. It conveys information on how to understand and fulfill the respective work and duties.

1.1.3 How to use

Throughout the document, the following notations and codes will be used.

Notation	Meaning
(n)	refers to an item (such as part numbers, list items, etc.)
→	denotes “see”, “see also”, “take note of” or “go to”

Table 1-1 Notation used

1.1.4 Symbols and Signs

In the course of the present document, the following symbols and signs will be used.







Type	Symbol	Meaning	
Safety alert	 (typical)	DANGER	Indicates an imminent hazardous situation . If not avoided, it will result in death or serious injury .
		WARNING	Indicates a potential hazardous situation . If not avoided, it can result in death or serious injury .
		CAUTION	Indicates a probable hazardous situation or calls the attention to unsafe practices. If not avoided, it may result in injury .
Prohibited action	 (typical)	Indicates a dangerous action. Hence, you must not!	
Mandatory action	 (typical)	Indicates a mandatory action. Hence, you must!	
Information		Requirement / Note / Remark	Indicates an activity you must perform prior continuing, or gives information on a particular item you need to observe.
		Best practice	Indicates an advice or recommendation on the easiest and best way to further proceed.
		Material damage	Indicates information particular to possible damage of the equipment.

Table 1-2 Symbols and signs

1.1.5 Trademarks and Brand Names

For easier legibility, registered brand names are listed below and will not be further tagged with their respective trademark. It must be understood that the brands (the list below is not necessarily concluding) are protected by copyright and/or other intellectual property rights even if their legal trademarks are omitted in the later course of this document.

Brand name	Trademark owner
Adobe® Reader®	© Adobe Systems Incorporated, USA-San Jose, CA
CANopen® CiA®	© CiA CAN in Automation e.V, DE-Nuremberg
EtherCAT®	© EtherCAT Technology Group, DE-Nuremberg, licensed by Beckhoff Automation GmbH, DE-Verl
Loctite®	© Henkel AG & Co. KGaA, DE-Düsseldorf
NORD-LOCK®	© Nord-Lock International AB, SE-Malmö
SPEEDCON	© PHOENIX CONTACT GmbH & Co. KG, DE-Blomberg

Table 1-3 Brand names and trademark owners

1.1.6 Copyright

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1.2 About the Devices

Capabilities of the device, included features.

maxon's «IDX 70» are compact, high-performance, IP65-protected, brushless DC drives with either integrated positioning controller or speed controller particularly suitable for the use in harsh environmental conditions. They deliver up to 3.2 Nm of continuous torque and come in a wide range of configurable options that allow full adaption to suit specific needs.

The IDX drives are designed to be commanded and controlled as a slave node in a CANopen or EtherCAT network. They fully integrate into the maxon EPOS4 environment and possess outstanding position control and speed control capabilities. Latest technology, such as field-oriented control (FOC), acceleration/velocity feed forward in combination with highest control cycle rates and a broad range of other functionalities allow sophisticated, ease-of-use motion or speed control. The IDX drives are available in different lengths and various winding versions:

- **IDX 70 Drive with Positioning Controller**
70 mm square drive with integrated positioning controller and CANopen or EtherCAT interface
- **IDX 70 Drive with Speed Controller**
70 mm square drive with integrated servo controller, commanded with analog and digital inputs

For detailed information on the full range of functions, features, and usable modes, consult the additionally available document →«IDX 70 Feature Chart».

The IDX drives are especially designed to suit high demands, such as in...

- Robotics
- Handling devices
- Equipment engineering
- Automation
- Special-purpose machinery engineering
- or similar products

The IDX drives may only be used as components in electrical equipment or machinery and may only be commissioned as an integrated part of such equipment or machinery. Any other use is not permitted.

The IDX drives must be operated only within the limits specified in the present document.

For easier legibility, in the later course of this document naming of components will be as follows:

Short form	Meaning
EPOS4	hardware and/or firmware functionalities based on maxon EPOS4 platform
IDX	any type of IDX drive
IDX 70	any type of IDX 70 drive
IDX 70 CANopen	IDX drive with positioning controller and CANopen interface
IDX 70 EtherCAT	IDX drive with positioning controller and EtherCAT interface
IDX 70 I/O	IDX drive with speed controller, commanded with analog and digital inputs

Table 1-4 Abbreviations

SOURCES FOR ADDITIONAL INFORMATION



idx.maxongroup.com

Find the latest edition of the present document and other information on IDX here:

→ <http://idx.maxongroup.com/>



In addition, you may wish to browse the EPOS video library. It features video tutorials that provide easy to follow instructions on how to get started with «EPOS Studio» and shows you tips and tricks on how to setup communication interfaces, and so on. Explore on Vimeo:

→ <https://vimeo.com/album/4646388/>

Find the latest information on the EPOS4 platform here:

→ <http://epos.maxongroup.com/>



epos.maxongroup.com

If you should encounter any problems or if you have any questions, feel free to contact the maxon Support Center:

→ <https://support.maxongroup.com/hc/en-us/>



support.
maxongroup.com

1.3 About the Safety Precautions

*Keep in mind:
Safety first!*

- Make sure that you have read and understood the note “READ THIS FIRST” on page A-2.
- Do not engage with any work unless you possess the stated skills (→ chapter “1.1.2 Target Audience” on page 1-6).
- Refer to → chapter “1.1.4 Symbols and Signs” on page 1-6 to understand the subsequently used indicators.
- Make sure that you observe any regulation with regard to health, safety, and accident prevention as well as to environmental protection applicable in your country and at the site of implementation.
- Make sure to read and understand the «General Rules» at the beginning of a chapter closely. Observe them, keep them in mind, and follow them at all times.



DANGER

High voltage and/or electrical shock

Touching live wires causes death or serious injuries!

- Consider any power cable as connected to live power, unless having proven the opposite!
- Make sure that neither end of cable is connected to live power!
- Make sure that power source cannot be engaged while work is in process!
- Obey lock-out/tag-out procedures!
- Make sure to securely lock any power engaging equipment against unintentional engagement and tag it with your name!



WARNING

Draw in/pull in/entanglement hazard

Rotating shaft and drive elements attached to it can cause serious injuries!

- Stay clear of the drive's driven end and do not touch while in operation.
- Keep clothes and other objects away from the drive's driven end and make sure that no loose objects can entangle or be drawn-in with any rotating part.



WARNING

Burst or break hazard

Ejected or slung away parts can cause serious injuries!

- Make sure that the produced centrifugal force at the drive's driven end cannot cause any part to become loose.
- Install suitable safety guards to protect the vicinity around the drive's driven end from possibly ejected or slung away parts or components.



CAUTION

Risk of burns and scalding

Touching hot surfaces may cause serious injuries!

- Do not touch the drive during operation or shortly thereafter.
- Allow the drive to cool down and test the temperature before you touch the casing.



Requirements

- *Make sure that all associated devices and components are installed according to local regulations.*
 - *Be aware that, by principle, an electronic apparatus can not be considered fail-safe. Therefore, you must make sure that any machine/apparatus has been fitted with independent monitoring and safety equipment. If the machine/apparatus should break down, if it is operated incorrectly, if the control unit breaks down or if the cables break or get disconnected, etc., the complete drive system must return – and be kept – in a safe operating mode.*
 - *Be aware that you are not entitled to perform any repair on components supplied by maxon.*
-



Electrostatic sensitive device (ESD)

- *Wear working cloth and use equipment in compliance with ESD protective measures.*
 - *Handle device with extra care.*
-

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2 SPECIFICATIONS

2.1 Technical Data

Parameter	Unit	IDX 70 S IDX 70 M IDX 70 L			
		24 V	48 V	60 V	
Drive data	Nominal power supply voltage [a]	VDC	24	48	60
	Nominal speed [a]	rpm	3'870 — —	3'800 3'038 2'424	4'000 3'022 2'505
	Nominal torque (max. continuous torque)	mNm	1'069 [b] 928 [a] — —	1'339 [b] 1'163 [a] 2'096 [b] 1'820 [a] 2'890 [b] 2'510 [a]	1'530 [b] 1'329 [a] 2'441 [b] 2'120 [a] 3'167 [b] 2'750 [a]
	Recommended speed control range	—	From standstill up to nominal speed		
	Maximum permissible drive speed	rpm	6'000 — —	5'125 4'000 3'200	4'280 3'195 2'630
	Maximum torque (short-time)	mNm	2'208 (<10 s) — —	4'416 (<10 s) 5'750 (<10 s) 7'268 (<10 s)	5'290 (<10 s) 7'084 (<10 s) 8'602 (<10 s)
	Nominal efficiency (without options)	%	88		
Electrical rating	Nominal supply voltage V_{CC} [c]	VDC	12...60		
	Logic supply voltage $+V_C$	VDC	12...60		
	Absolute supply voltage $+V_{min} / +V_{max}$	VDC	10 / 70		
	Pulse width modulation frequency	kHz	50		
	Sampling rate PI current controller	kHz	25 (40 μ s)		
	Sampling rate PI speed controller	kHz	2.5 (400 μ s)		
	Sampling rate PID positioning controller	kHz	2.5 (400 μ s)		
Sampling rate analog input	kHz	2.5 (400 μ s)			
Motor characteristics	Max. motor voltage	—	0.9 x $+V_{CC}$		
	Torque constant	mNm/A	47.7 — —	95 124 164	114 153 186
	Speed constant	rpm/V	200 — —	101 77 58	84 62 51
	Speed / torque gradient	rpm/ mNm	0.101 — —	0.0912 0.0443 0.254	0.0957 0.0397 0.028

Continued on next page.

Parameter		Unit	IDX 70 S	IDX 70 M	IDX 70 L
			24 V	48 V	60 V
Mechanical data	Dimensions (L x W x H)	mm	141 x 70 x 70 176 x 70 x 70 211 x 70 x 70		
	Weight (approximate)	g	1'600 2'300 3'000		
	Mounting	—	Flange-mounted (flange «A» or «C» to choose from)		
	Rotor inertia [d]	gcm ²	568 1'050 1'534		
	Axial play at axial load	mm	0.22		
	Radial play		Preloaded ball bearings		
	Max. axial load, dynamic	N	22		
	Max. radial load, 15 mm from flange	N	300		
Environment	Protection class	—	IP65 (IP54) [e]		
	Max. housing temperature	°C	100		
	Operation temperature	°C	-30...+85 [f]		
	Storage temperature	°C	-40...+35 (condensation not permitted)		
	Operation altitude [g]	m MSL	0...1'000 [f]		
Holding brake (optional)	Type	—	Spring-loaded brake, integrated into motor casing		
	Fall time (release time until brake torque decreases)	ms	75		
	Rise time (engaging time until brake torque is attained)	ms	75		
	Max. permissible static torque	mNm	5'000		
	Backlash	°m	max. ±1		
	Length	mm	38 [h]		
	Weight	kg	0.460 [h]		
	Inertia (friction disk / hub)	gcm ²	11 / 13 [h]		

Continued on next page.

Parameter	Unit	IDX 70 S IDX 70 M IDX 70 L		
		24 V	48 V	60 V
Encoder	Type	Absolute single-turn encoder		
	Resolution	12 bit single-turn (4'096 increments)		
	Position resolution	0.09		
	Integral nonlinearity (INL)	typically <1		
	Repeatability (Jitter)	± 0.1		
	Type	Absolute multi-turn encoder		
	Resolution	14 bit single-turn / 16 bit multi-turn		
	Position resolution	0.02		
	Integral nonlinearity (INL)	typically <1		
	Repeatability (Jitter)	± 0.2		
Interfaces	CAN	I/O	—	
		CANopen	max. 1 Mbit/s	
		EtherCAT	—	
	EtherCAT	I/O	—	
		CANopen	—	
		EtherCAT	Full duplex (100 Mbit/s) as to IEEE 802.3 100 Base T	
USB 2.0 / USB 3.0		Full speed		
Inputs & Outputs	Nominal I/O supply voltage +V _{I/O}	VDC	24	
	Absolute min. I/O supply +V _{I/O} (externally supplied)	VDC	20 or open	
	Absolute max. I/O supply +V _{I/O} (externally supplied)	VDC	30	
	I/O supply voltage +V _{I/O} (internally supplied)	VDC	19 (@ V _{CC} ≥ 24 V)	
	Digital Input 1 (general purpose) Digital Input 2 (general purpose) Digital Input 3 (general purpose) Digital Input 4 (general purpose)	VDC	PLC: +9...+30	
	Digital Output 1 (general purpose) Digital Output 2 (general purpose)	—	+V _{I/O} / I _L ≤ 250 mA (externally sourced, each) I _L ≤ 35 mA (internally sourced, combined) (high-side switch to +V _{I/O})	
	Analog Input 1 Analog Input 2	—	Resolution 12-bit, -10...+10 V, 10 kHz, differential	

Continued on next page.

Parameter	Unit	IDX 70 S	IDX 70 M	IDX 70 L
		24 V	48 V	60 V
Status indicators	Device status	Operation (green LED) / Error (red LED)		
	NET status	I/O	—	
		CANopen	—	
		EtherCAT	RUN state (green LED) Error (red LED)	
	NET port	I/O	—	
		CANopen	—	
EtherCAT		Link activity (green LED)		
Connections	X1 IN	I/O	—	
		CANopen	Bus connector M8, male, 5 poles, B-coded	
		EtherCAT	Bus connector M8, female, 4 poles, A-coded	
	X2 OUT	I/O	—	
		CANopen	Bus connector M8, female, 5 poles, B-coded	
		EtherCAT	Bus connector M8, female, 4 poles, A-coded	
	X3 I/O	M12, male, 12 poles, A-coded		
	X4 Supply	M23x1, male, 6 poles		
X5 USB	USB Type micro B, female			

- [a] Values at nominal speed and ambient temperature $T_a = 40\text{ °C}$
- [b] Values at nominal speed and ambient temperature $T_a = 25\text{ °C}$
- [c] With optional holding brake: the minimal power supply voltage $+V_{CC}$ is 24 VDC
- [d] If equipped, the inertia of the holding brake (→page 2-14) must be added
- [e] The stated protection class refers to the motor housing with plugged original connectors and installed shaft sealing. The adequate shaft sealing must be provided by the customer. Without shaft sealing or with a shaft sealing falling short of the stated protection class, the device will only support the protection class stated in brackets. The protective caps fitted on delivery do not provide IP65 protection.
- [f] From 40 °C and above 1'000 m MSL (Mean Sea Level), a derating of the stated performance data must be expected. The maximum achievable operating points must be determined by testing.
- [g] Operating altitude in meters above Mean Sea Level, MSL
- [h] In addition to the drive's mechanical data

Table 2-5 Technical data

2.2 Limitations

Protection functionality	Switch-off threshold	Recovery threshold
Undervoltage	8.0 V	8.5 V
Overvoltage	74.3 V	73.3 V
Overcurrent	±96 A	—
Thermal power stage overload	100 °C	90 °C
Thermal motor overload	150 °C	140 °C
Thermal motor derating	<p>Safeguarded by self-regulating output power limitation; the maximum output current I_{\max} is linearly decreased between an electronics temperature of +140...+150 °C:</p> $I_{\max} @ -30 \dots +140 \text{ °C}: I_{\max} [\text{A}]$ $I_{\max} @ +150 \text{ °C}: 0 \text{ A}$	

Table 2-6 Limitations

2.3 Dimensional Drawings

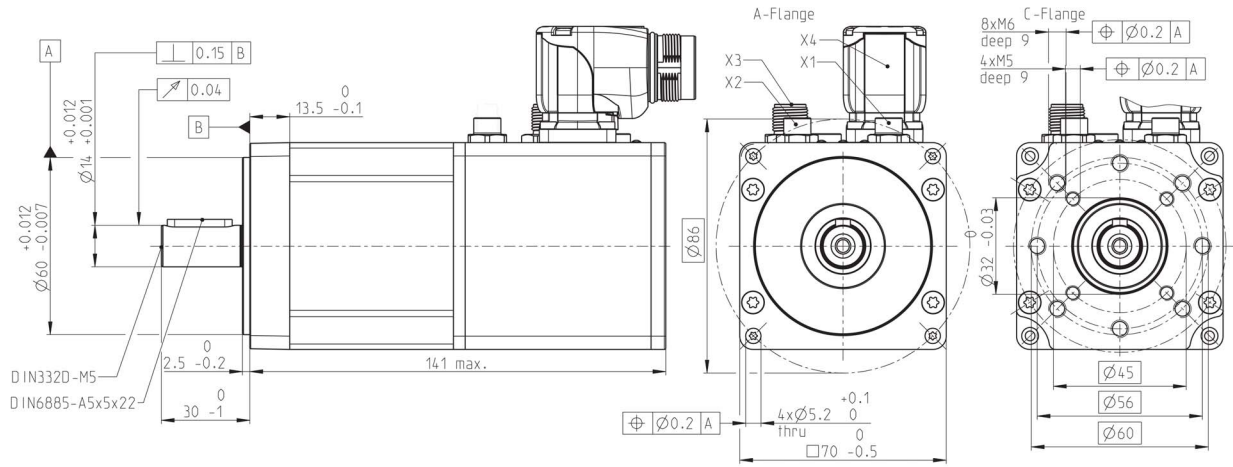


Figure 2-2 IDX 70 S | Dimensional drawing [mm]

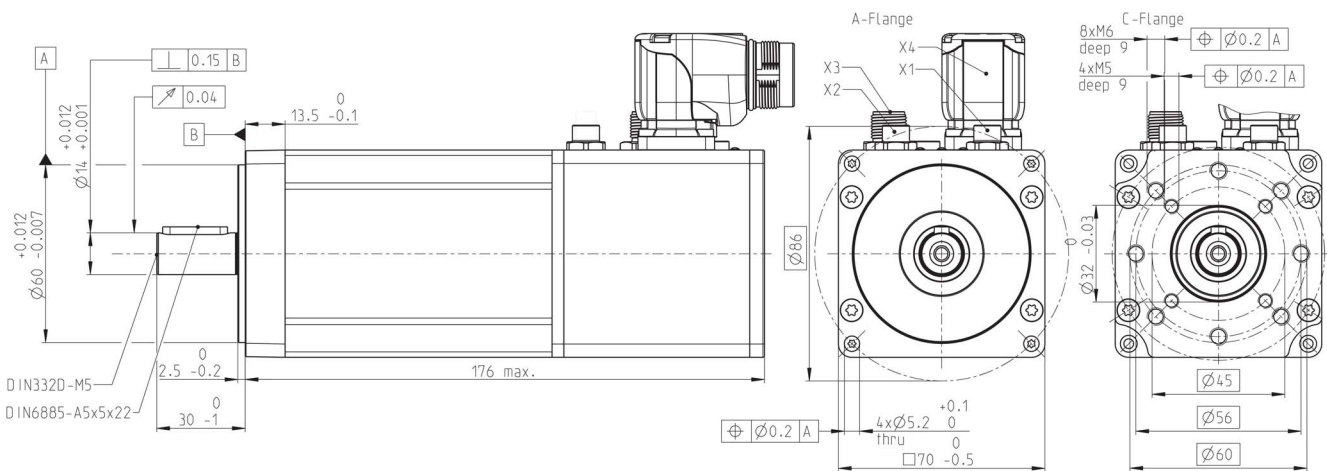


Figure 2-3 IDX 70 M | Dimensional drawing [mm]

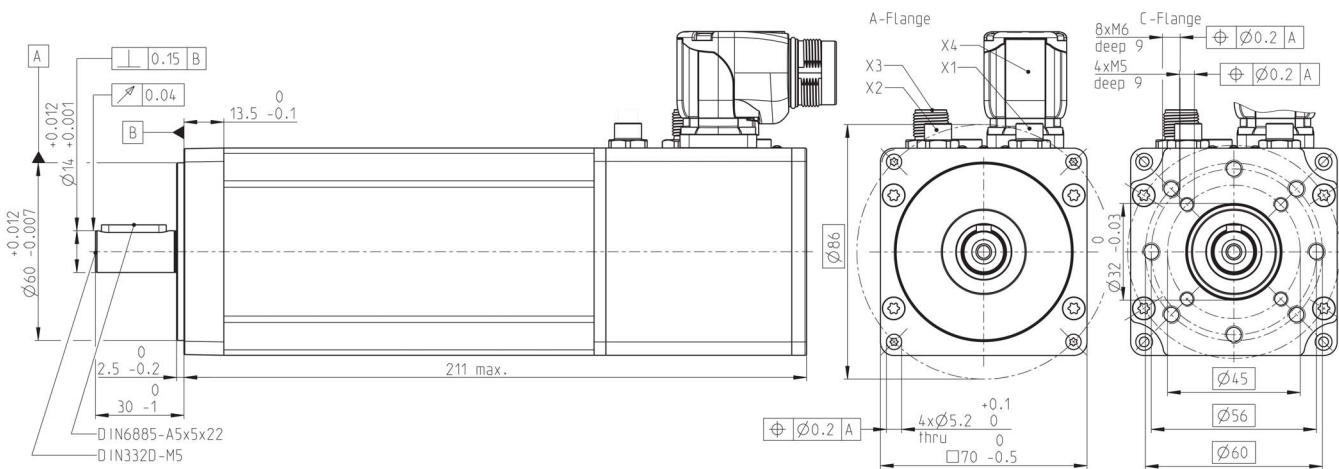


Figure 2-4 IDX 70 L | Dimensional drawing [mm]

2.4 Nameplate

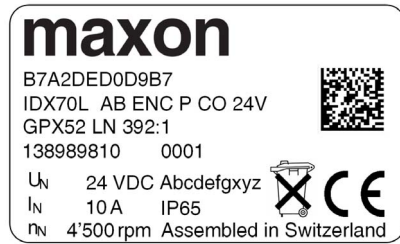


Figure 2-5 Nameplate (typical)

2.5 Identification Keys

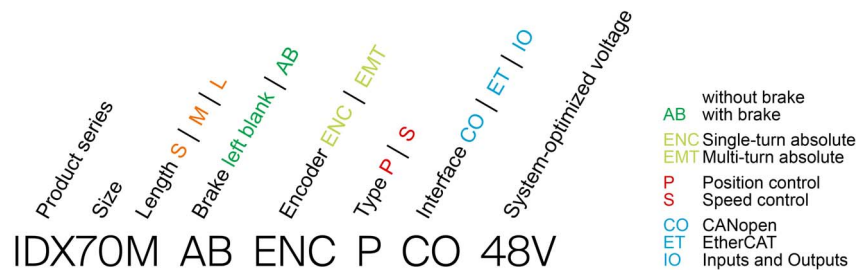


Figure 2-6 Identifiers for drive (examples)



Figure 2-7 Identifiers for cable (examples)

2.6 Standards

The described device has been successfully tested for compliance with the below listed standards. In practical terms, only the complete system (the fully operational equipment comprising all individual components, such as motor, controller, power supply unit, EMC filter, cabling etc.) can undergo an EMC test to ensure interference-free operation.



EMC compliance

The device's compliance with the mentioned standards does not imply its compliance within the final, ready to operate setup. In order to achieve compliance of your operational system, you must perform EMC testing of the involved equipment as a whole.

Electromagnetic compatibility		
Generic	IEC/EN 61000-6-2	Immunity for industrial environments
	IEC/EN 61000-6-4	Emission standard for industrial environments
Applied	IEC/EN 55032 (CISPR32)	Radio disturbance characteristics / radio interference
	IEC/EN 61000-4-2	Electrostatic discharge immunity test 8 kV/6 kV
	IEC/EN 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test >10 V/m
	IEC/EN 61000-4-4	Electrical fast transient/burst immunity test ±2 kV
	IEC/EN 61000-4-6	Immunity to conducted disturbances, induced by radio-frequency fields 10 Vrms
	IEC/EN 61000-4-8	Power frequency magnetic field 30 A/m

Others		
Environment	DIN/EN 60068-2-27 :2010-02	Environmental testing – Test Ea: Shock / Wheeled vehicle and heavy industry appliance, table A.1, row 3 (semi-sinusoidal, 500 m/s ² peak, 11 ms, ±3 shocks each axis, T _{amb} 298 K (25 °C))
	DIN/EN 60068-2-64 :2010-02	Environmental testing – Test Fh: Vibration, broadband random and guidance / Equipment in wheeled vehicles (Motor vehicle, chassis assembly), table A.6, category 1 (sinusoidal, 10...1000 Hz; 33.8 m/s ² ; T _{amb} 298 K (25 °C))
	IEC/EN 60529: :1991+A1 :2000+A2 :2013	Degrees of protection provided by enclosures (IP Code; Ingress Protection Code)
Safety	UL File Number	Unassembled printed circuit board E76251; E207844

Table 2-7 Standards

3 MECHANICAL INSTALLATION

3.1 General Rules



WARNING

Risk of injury

Unintentional or automatic operation can lead to serious injury

- Make sure that the surrounding system is protected from automatic start-up.
- Make sure to apply all necessary safeguards against unintentional operation.



Improper handling can cause irreversible hardware damage

- Handle the components with particular care.
- Pay special attention to cleanliness.
- Make sure that no impurities, foreign objects, or particles can penetrate the drive.



Exceeding forces and loads can cause irreversible hardware damage

- Make sure not to exceed the permitted axial and radial forces while handling the device.
- Make sure that the permitted axial and radial loads will not be exceeded while the drive is in operation.

3.2 Mounting Position

The IDX drive may be mounted in any position provided that the stated environmental conditions (→page 2-14) are complied with.



Protection against ingress moisture

With the shaft end facing upward mounting position (→Figure 3-8; «B»), you must consider precautionary measures when preparing the system for long standstill periods. Thereby, you must remove residue moisture around the drive's radial shaft seal to prevent humidity from entering the casing.

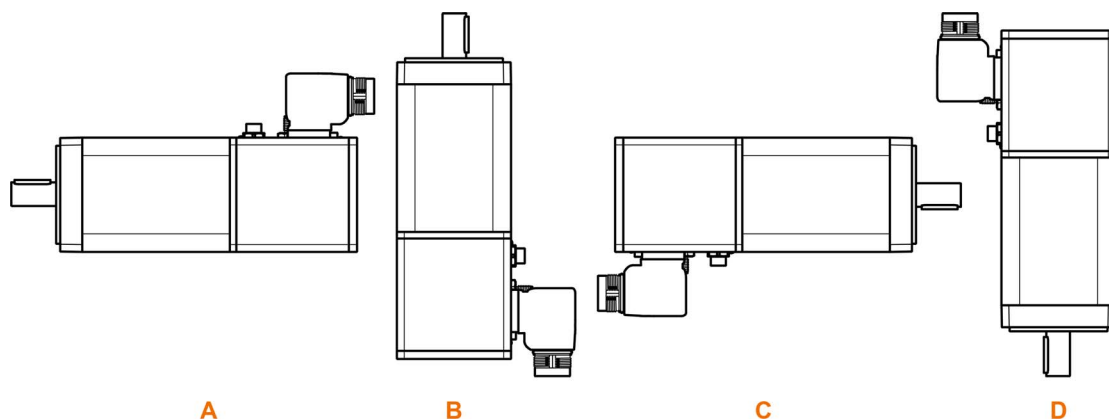


Figure 3-8 Mounting positions

3.3 Fixation

The IDX drive comes in two types of fixation flanges to choose from. They feature individual centering collars, bore patterns, and fixations. For dimensions and tolerances → page 2-18.

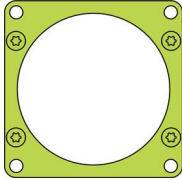
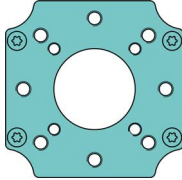
Characteristic	A-Flange	C-Flange
Shape		
Centering collar	Ø60 mm	Ø32 mm
Centering tolerance	+0.012 / -0.007	0 / -0.03
Fixation	4 through bores Ø5.2 mm	4 threads M5 TK 45 or 4 threads M6 TK 56 or 4 threads M6 TK 60
Suitable bolts	M5	M5 or M6
	Strength class: 6.8, or higher / stainless steel 70, or higher	
Tightening torque	4 Nm	M5: 4 Nm M6: 7 Nm
Screw lock	Medium strength threadlocker (for example Loctite 243) or NORD-LOCK safety washer	

Table 3-8 Flange types and fixation

3.4 Alignment and Coupling

The drive's free shaft end must be connected to the surrounding system by a force-fit, free of play, zero-backlash coupling.

First choices are, for example, metal bellow, collet chucks, or shaft-hub joint coupling. They form a frictional connection and are capable to transmit the occurring torque. As with all rigid couplings, an adequately accurate radial, axial, and angular alignment of the two connecting shaft ends is essential.

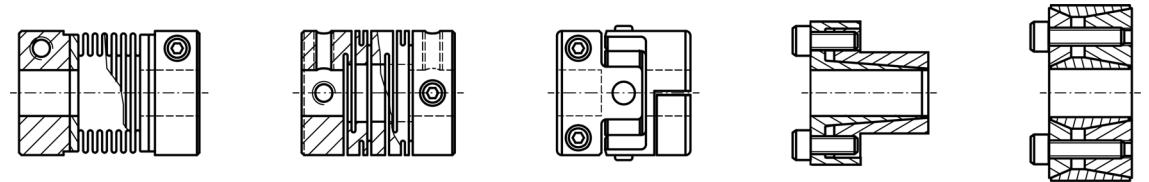


Figure 3-9 Couplings and shaft-hub joints – typically suitable designs (examples)



Check original manufacturer's specifications

Consult the specifications of the coupling manufacturer prior installation.



Comply with original manufacturer's specifications and respect permissible loads

- Make sure to not exceed the permissible axial force of 270 N during assembly or disassembly.
- Make sure to align the coupling according to the manufacturer's specifications.
- Make sure that the axial and radial forces that are going to occur during operation will not exceed the limits stated (→ "Mechanical data" on page 2-14).

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4 ELECTRICAL INSTALLATION

4.1 General Rules



WARNING

Risk of injury

Unintentional or automatic operation can lead to serious injury

- Make sure that the surrounding system is protected from automatic start-up.
- Make sure to apply all necessary safeguards against unintentional operation.



Improper handling can cause irreversible hardware damage

- Handle all components with care.
- Pay special attention to cleanliness.
- Make sure that no impurities, foreign objects, or particles can penetrate the drive.
- Handle connectors and cables with special care; do not kink, bend, strain, or route around sharp edges.



Maximal permitted supply voltage

- Make sure that supply power is between 12...60 VDC.
- Supply voltages above 74.3 VDC, or wrong polarity will destroy the unit.
- Note that the necessary output current is depending on the load torque. Yet, the output current limits are as follows:
 - continuous max. 30 A
 - short-time (acceleration) max. 48 A (<10 s)



Hot plugging can cause irreversible hardware damage

Hot plugging (connecting or disconnecting while the power supply is on) can lead to damaged hardware.

- Do not connect/disconnect the drive under voltage.
- Connect the drive before switching on the power supply.



EMC compliance

The device's compliance with the mentioned standards does not imply its compliance within the final, ready to operate setup. In order to achieve compliance of your operational system, you must perform EMC testing of the involved equipment as a whole.



Heat dissipation and electrical grounding

The IDX's fixation flange is made of aluminum. It is therefore perfectly suitable for both, good heat removal and thorough electrical grounding contact.

For proper electrical grounding, we recommend to connect the fixation flange to the surrounding system's grounding.

4.2 Cabling

To make installation easy, fast, and error-free, a wide selection of prefab cable assemblies is available. They are made to meet all requirements in respect to electromagnetic compatibility and guarantee interference-free operation of the IDX. You can find information on the available cables in → Table 4-9 and on their identifier key in → Figure 2-7.



Wrong cabling can cause unexpected electromagnetic disturbances

Using other cables may possibly cause unexpected electromagnetic disturbances that can jeopardize EMC-conform, error-free operation.

Connector			Prefab cable assembly			
IDX CANopen	IDX EtherCAT	IDX I/O	Designation Identifier key → Figure 2-7	Connector #1 Connector #2	Length [m]	Part number
CANopen						
X1	—	—	CO M08B05F0 PUR S PK 0150	M8, female, 5 poles, B-coded Open end	1.5	662951
X1	—	—	CO M08B05F0 PUR S PK 0300	M8, female, 5 poles, B-coded Open end	3	662935
X1	—	—	CO M12A05M0 PUR S PK 0015 M08B05F0	M8, female, 5 poles, B-coded M12, male, 5 poles, A-coded	0.15	662946
X2	—	—	CO M08B05M0	M8, male, 5 poles, B-coded, (built-in termination) Termination	—	662933
X2	—	—	CO M08B05M0 PUR S PK 0150	M8, male, 5 poles, B-coded open end	1.5	662950
X2	—	—	CO M08B05M0 PUR S PK 0300	M8, male, 5 poles, B-coded Open end	3	662934
X2	—	—	CO M08B05M0 PUR S PK 0300 M08B05F0	M8, male, 5 poles, B-coded M8, female, 5 poles, B-coded	3	662959
X2	—	—	CO M12A05F0 PUR S PK 0015 M08B05M0	M8, male, 5 poles, B-coded M12, female, 5 poles, A-coded	0.15	662947
EtherCAT						
—	X1 X2	—	ET M08A04M0 PUR S GN 0150	M8, male, 4 poles, A-coded Open end	1.5	662961
—	X1 X2	—	ET M08A04M0 PUR S GN 0300	M8, male, 4 poles, A-coded Open end	3	662941
—	X1 X2	—	ET M08A04M0 PUR S GN 0150 R45004M0	M8, male, 4 poles, A-coded RJ45	1.5	662956
—	X1 X2	—	ET M08A04M0 PUR S GN 0300 R45004M0	M8, male, 4 poles, A-coded RJ45	3	662942
—	X1 X2	—	ET M08A04M0 PUR S GN 0300 M08A04M0	M8, male, 4 poles, A-coded M8, male, 4 poles, A-coded	3	662960

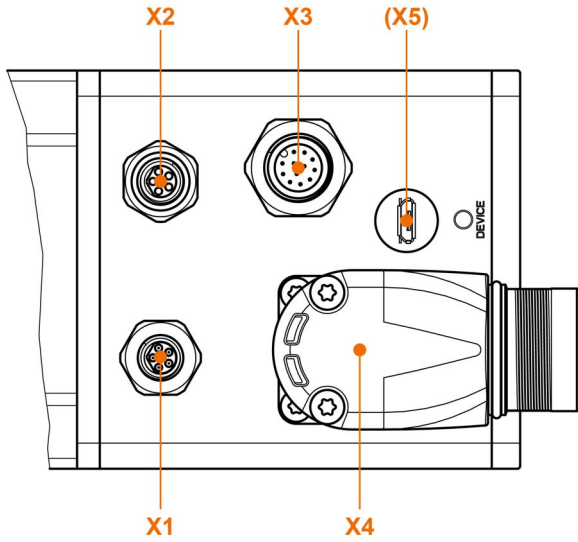
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Connector			Prefab cable assembly			
IDX CANopen	IDX EtherCAT	IDX I/O	Designation Identifier key → Figure 2-7	Connector #1 Connector #2	Length [m]	Part number
I/O						
X3	X3	X3	IO M12A12F0 PUR S BK 0150	M12, female, 12 poles, A-coded, straight Open end	1.5	662957
X3	X3	X3	IO M12A12F0 PUR S BK 0300	M12, female, 12 poles, A-coded, straight Open end	3	662954
X3	X3	X3	IO M12A12F9 PUR S BK 0150	M12, female, 12 poles, A-coded, 90° Open end	1.5	662952
X3	X3	X3	IO M12A12F9 PUR S BK 0300	M12, female, 12 poles, A-coded, 90° Open end	3	662948
Power						
X4 [i]	X4 [i]	X4 [i]	PR M230F50 PUR S OG 0300	M23, female, 6 poles, N-coded, straight Open end	3	711319
USB						
X5	X5	X5	USB Type A - micro B Cable	USB Type "micro B", male USB Type "A", male	1.5	403968

- [i] The IDX can be ordered in two types—with straight or with angled power connector X4. The angled type can be rotated up to 90°. Make sure that the rotated power connector and the attached outgoing cable do not block out or damage any other connector.

Table 4-9 Prefab cables

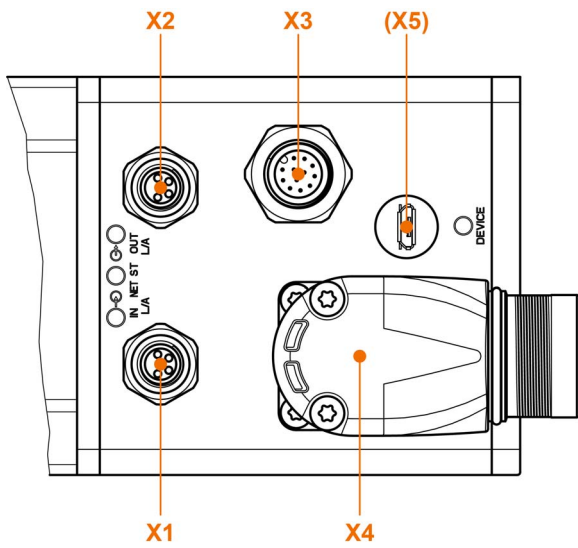
4.3 Connections



CANopen

- X1 CAN IN** →page 4-30
- X2 CAN OUT** →page 4-31
- X3 I/O** →page 4-33
- X4 Supply** →page 4-37
- X5 USB** →page 4-40
(behind the sealing cap)

Figure 4-10 Connectors | IDX 70 CANopen



EtherCAT

- X1 EtherCAT IN** →page 4-32
- X2 EtherCAT OUT** →page 4-32
- X3 I/O** →page 4-33
- X4 Supply** →page 4-37
- X5 USB** →page 4-40
(behind the sealing cap)

Figure 4-11 Connectors | IDX 70 EtherCAT

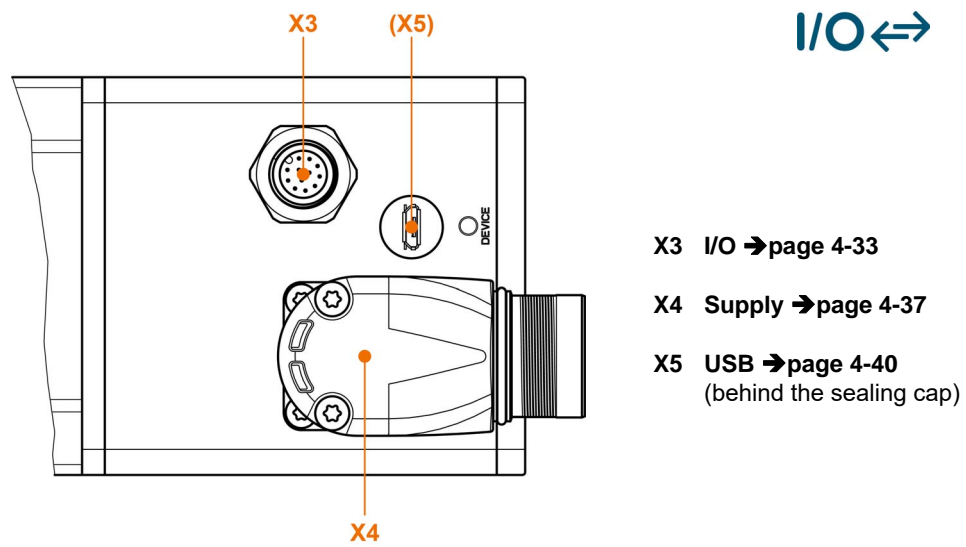


Figure 4-12 Connectors | IDX 70 I/O



How to read pin assignment tables

- The first column describes both the pin number of the connector and of the matching prefab maxon cable's Head A.
- The second column describes the cable core color of the prefab maxon cable.

4.3.1 CAN IN (X1)



Figure 4-13 CAN IN connector X1

CAN IN connector X1	
Type	M8, male, 5 poles, B-coded

Table 4-10 CAN IN connector X1 – Specification

X1 Head A Pin	Prefab cable Color	Signal	Description
1	red	CAN_V+	CAN external supply voltage
2	—	CAN_SHLD	CAN shield
3	white	CAN_H	CAN high bus line
4	blue	CAN_L	CAN low bus line
5	black	CAN_GND	CAN ground

Table 4-11 CAN IN connector X1 – Pin assignment

For suitable prefab cable assemblies see → Table 4-9 on page 4-27.

CAN interface	
Standard	ISO 11898-2:2003
Max. bit rate	1 Mbit/s
Max. number of CAN nodes	127 (via software setting)
Protocol	CiA 301 version 4.2.0
Node-ID setting	By software

Table 4-12 CAN interface specification



CAN master settings and CAN bus termination

- Consider the CAN master's maximal bit rate.
- The standard bit rate setting (factory setting) is 1 Mbit/s.
- Use 120 Ω termination resistor at both ends of the CAN bus.
- For detailed information see separate document → «IDX Communication Guide».

4.3.2 CAN OUT (X2)

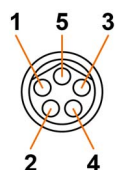


Figure 4-14 CAN OUT connector X2

CAN IN connector X2	
Type	M8, female, 5 poles, B-coded

Table 4-13 CAN OUT connector X2 – Specification

X2 Head A Pin	Prefab cable Color	Signal	Description
1	red	CAN_V+	CAN external supply voltage
2	—	CAN_SHLD	CAN shield
3	white	CAN_H	CAN high bus line
4	blue	CAN_L	CAN low bus line
5	black	CAN_GND	CAN ground

Table 4-14 CAN OUT connector X2 – Pin assignment

For specifications on the CAN interface and details on CAN bus termination see →chapter “4.3.1 CAN IN (X1)” on page 4-30.

For suitable prefab cable assemblies see →Table 4-9 on page 4-27.

4.3.3 EtherCAT IN (X1) and EtherCAT OUT (X2)



Wrong plugging can cause irreversible hardware damage

Even though both EtherCAT sockets are prepared for identical external wiring, make sure to always connect them as follows.

- For suitable prefab cable assemblies see → Table 4-9 on page 4-27.
- Use EtherCAT IN (X1) as «Input».
- Use EtherCAT OUT (X2) as «Output».

For detailed information see separate document → «IDX Communication Guide».

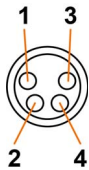


Figure 4-15 EtherCAT IN connector X1 & EtherCAT OUT connector X2

EtherCAT IN connector X1 EtherCAT OUT connector X2	
Type	M8, female, 4 poles, A-coded

Table 4-15 EtherCAT IN connector X1 & EtherCAT OUT connector X2 – Specification

X1 Head A Pin	Prefab cable Color	Signal	Description
1	yellow	IN_TX+	EtherCAT IN transmission data+
2	white	IN_RX+	EtherCAT IN receive data+
3	blue	IN_RX-	EtherCAT IN receive data-
4	orange	IN_TX-	EtherCAT IN transmission data-

Table 4-16 EtherCAT IN connector X1 – Pin assignment

X2 Head A Pin	Prefab cable Color	Signal	Description
1	yellow	OUT_TX+	EtherCAT OUT transmission data+
2	white	OUT_RX+	EtherCAT OUT receive data+
3	blue	OUT_RX-	EtherCAT OUT receive data-
4	orange	OUT_TX-	EtherCAT OUT transmission data-

Table 4-17 EtherCAT OUT connector X2 – Pin assignment

For suitable prefab cable assemblies see → Table 4-9 on page 4-27.

4.3.4 I/O (X3)

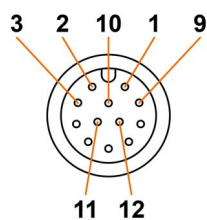


Figure 4-16 I/O connector X3

I/O connector X3	
Type	M12, male, 12 poles, A-coded

Table 4-18 I/O connector X3 – Specification

X3 Head A Pin	Prefab cable Color	Signal	Description
1	brown	AnIN1+	Analog input 1, positive signal
2	blue	GND	I/O ground
3	white	AnIN1-	Analog input 1, negative signal
4	green	AnIN2+	Analog input 2, positive signal
5	pink	DigIN1	Digital input 1
6	yellow	AnIN2-	Analog input 2, negative signal
7	black	DigOUT1	Digital output 1
8	gray	DigIN2	Digital input 2
9	red	DigIN3	Digital input 3
10	violet	DigOUT2	Digital output 2
11	gray/pink	DigIN4	Digital input 4
12	red/blue	+V/I/O	I/O supply voltage (+20...+30 VDC)

Table 4-19 I/O connector X3 – Pin assignment

For suitable prefab cable assemblies see → Table 4-9 on page 4-27.

Continued on next page.

Digital inputs 1...4	
Input voltage	0...30 VDC
Max. input voltage	±30 VDC
Logic 0	<5.5 V
Logic 1	>9 V
Input current at logic 1	>2 mA @ 9 VDC typically 3.5 mA @ 24 VDC
Switching delay	<300 μs @ 24 VDC

Table 4-20 Digital input specification

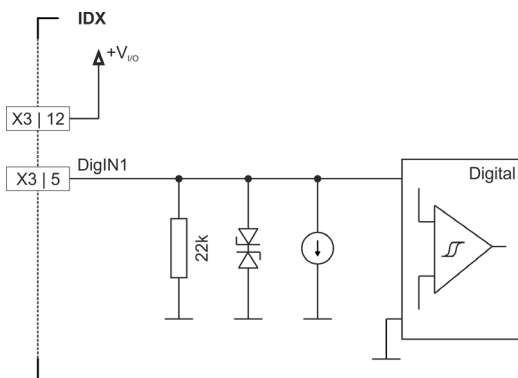


Figure 4-17 DigIN1 circuit (analogously valid for DigIN2...4)

Digital outputs 1...2	
Circuit	High-side switch to +V _{I/O}

Table 4-21 Digital output specification

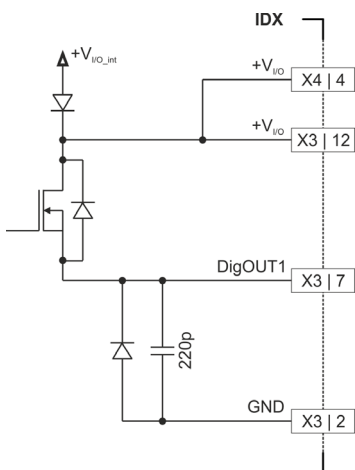


Figure 4-18 DigOUT1 circuit (analogously valid for DigOUT2)

Continued on next page.

WIRING EXAMPLES

DigOUT (internally supplied)	
Output voltage	$U_{Out} = \text{approx. } 19 \text{ V (@ } V_{CC} \geq 24 \text{ V)}$
Max. load current	$I_{Load} \leq 35 \text{ mA}$

Table 4-22 Digital output, internally supplied

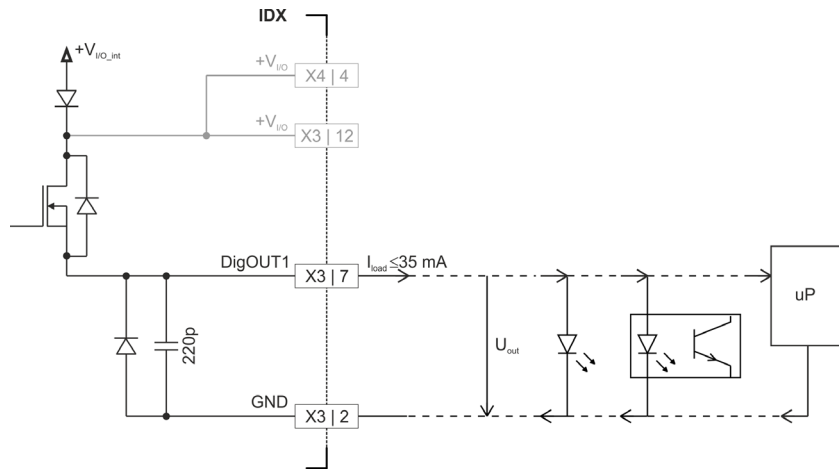


Figure 4-19 DigOUT1, internally supplied (analogously valid for DigOUT2)

DigOUT (externally supplied)	
Input voltage	$+V_{IO}$
Max. load current	250 mA
Max. voltage drop	0.5 V @ 250 mA

Table 4-23 Digital output, externally supplied

Continued on next page.

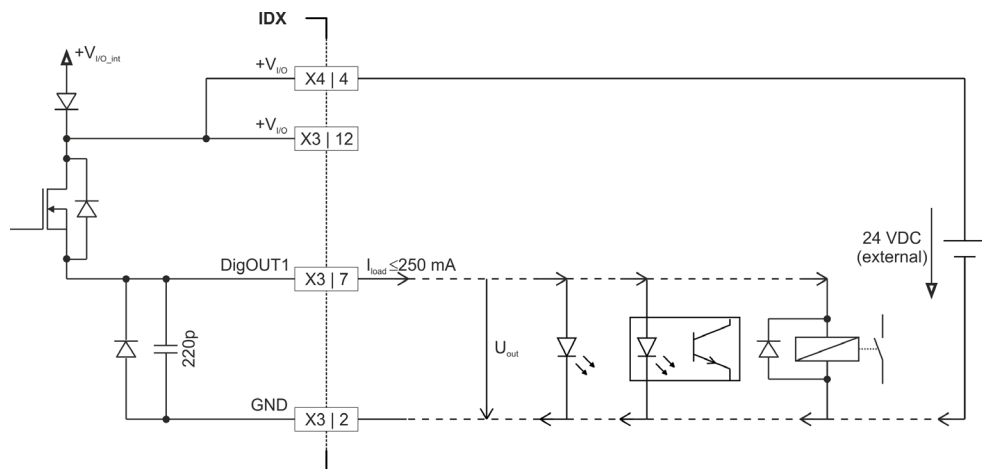


Figure 4-20 DigOUT1, externally supplied (analogously valid for DigOUT2)

Continued on next page.

Analog inputs 1...2	
Input voltage	±10 VDC (differential)
Max. input voltage	±24 VDC
Common mode voltage	-5...+10 VDC (referenced to GND)
Input resistance	80 kΩ (differential) 65 kΩ (referenced to GND)
A/D converter	12-bit
Resolution	5.64 mV
Bandwidth	10 kHz

Table 4-24 Analog input specification

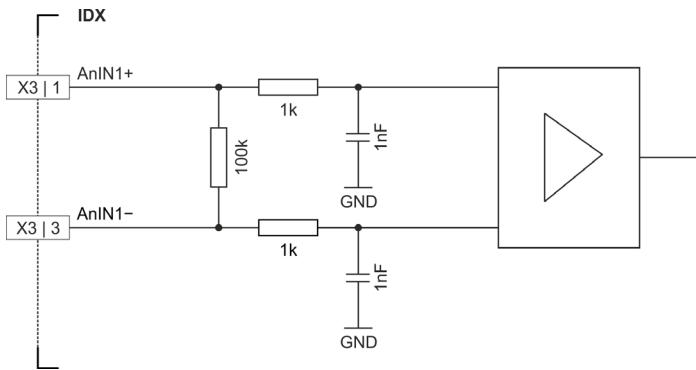


Figure 4-21 AnIN1 circuit (analogously valid for AnIN2)

4.3.5 Supply (X4)



Adjustable power connector

The IDX can be ordered in two types—with straight or with angled power connector X4. The angled type can be rotated up to 90°.

Make sure that the rotated power connector and the attached outgoing cable do not block out or damage any other connector.



Figure 4-22 Power connector X4

Power connector X4	
Type	M23x1, male, 6 poles

Table 4-25 Power connector X4 – Specification

X4 Head A Pin	Prefab cable Color	Signal	Description
1	black	+VCC	Power supply voltage (+12...+60 VDC)
2	black	GND	Ground
3	green/ yellow	FE	Functional earth
4	brown	+VC	Logic supply voltage (+12...+60 VDC)
5	white	+VI/O	I/O supply voltage (+20...+30 VDC)
6	black	—	Not connected
—	Housing	Shield	Cable shield

Table 4-26 Power connector X4 – Pin assignment

For suitable prefab cable assemblies see → Table 4-9 on page 4-27.

Continued on next page.

4.3.5.1 Power Supply Voltage +V_{CC}

Power supply requirements	
Output voltage	+V _{CC} 12...60 VDC
Absolute output voltage	min. 10 VDC; max. 70 VDC
Output current	Depending on load <ul style="list-style-type: none"> • continuous max. 30 A • short-time (acceleration, <10 s) max. 48 A

Table 4-27 Power supply requirements

- 1) Use the formula below to calculate the required voltage under load.
- 2) Choose a power supply according to the calculated voltage. Thereby consider:
 - a) During braking of the load, the power supply must be capable of buffering the recovered kinetic energy (for example, in a capacitor).
 - b) If you are using an electronically stabilized power supply, make sure that the overcurrent protection circuit is configured inoperative within the operating range.



The formula already takes the following into account:

- Maximum PWM duty cycle of 90 %
- Controller's max. voltage drop of 1 V @ 12 A

KNOWN VALUES:

- Operating torque M [mNm]
- Operating speed n [rpm]
- Nominal motor voltage U_N [Volt]
- Motor no-load speed at U_N; n_O [rpm]
- Speed/torque gradient of the motor Δn/ΔM [rpm/mNm]

SOUGHT VALUE:

- Supply voltage +V_{CC} [Volt]

SOLUTION:

$$V_{CC} \geq \left[\frac{U_N}{n_O} \cdot \left(n + \frac{\Delta n}{\Delta M} \cdot M \right) \cdot \frac{1}{0.9} \right] + 1 [V]$$

Continued on next page.

4.3.5.2 Logic Supply Voltage $+V_C$ (optional)

By default, the logic is powered by the regular supply voltage. Optionally, you may wish to feed the logic supply voltage separately, permitting a safe and economical power backup feature.

Basically, any power source may be used, provided it meets the below stated minimal requirements.

Logic supply requirements			
Output voltage	$+V_C$ 12...60 VDC		
Absolute output voltage	min. 10 VDC; max. 70 VDC		
Min. output power	CANopen	EtherCAT	I/O
	2.7 W	3.5 W	2.7 W

Table 4-28 Logic supply requirements

4.3.5.3 Input/Output Supply Voltage $+V_{I/O}$ (optional)

Basically, any power source may be used, provided it meets the below stated minimal requirements.

Input/output supply requirements	
Output voltage	$+V_{I/O}$ 24 VDC
Absolute output voltage	min. 20 VDC; max. 30 VDC
Output current	Min: Depending on load at DigOUT1 and DigOUT2 Max: 1.5 A

Table 4-29 Input/output supply requirements

4.3.6 USB (X5)



For commissioning only

The USB interface is for commissioning purposes only and must not remain connected during operational service.

The USB connector X5 is located inside the drive housing behind the sealing cap (Figure 4-23; «A»).

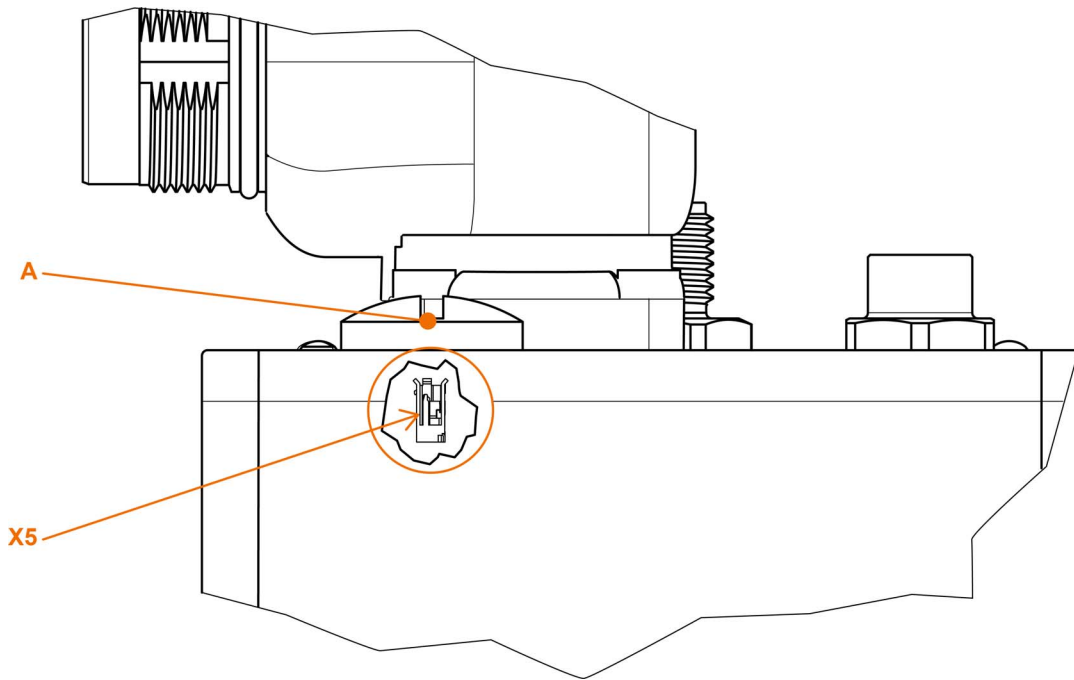


Figure 4-23 USB (X5) – Location



Contaminating the housing's interior can cause irreversible hardware damage

To access the USB connector you will need to remove the sealing cap. This will break the IP65 protection of the drive. It is essential that you protect the drive's interior against contaminants and foreign particles.

- Wipe off any moisture or dirt before you unscrew the sealing cap.
- Keep the area clean while the sealing cap is removed and cover the access to prevent contamination.
- After you have removed the USB cable, mount the sealing cap and screw tight.



Hot plugging the USB interface can cause irreversible hardware damage

If the USB interface is being hot-plugged (connecting while the power supply is on), the possibly high potential differences of the two power supplies of drive and PC/Notebook can lead to damaged hardware.

- Avoid potential differences between the power supply of drive and PC/Notebook or, if possible, balance them.
- Insert the USB connector first, then switch on the power supply of the drive.



USB adapter

The use of a galvanic isolated USB adapter is highly recommend.

Continued on next page.

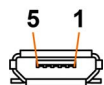


Figure 4-24 USB connector X5

USB connector X5	
Type	USB Type "micro B", female

Table 4-30 USB connector X5 – Specification

X5 Pin	PC's USB Terminal	Signal	Description
1	1	VBUS	USB bus supply voltage (+5 VDC)
2	2	USB_D-	USB data- (twisted pair with data+)
3	3	USB_D+	USB data+ (twisted pair with data-)
4	–	ID	Not connected
5	4	GND	USB ground

Table 4-31 USB connector X5 – Pin assignment

USB	
USB Standard	USB 2.0 / USB 3.0 (full speed)
Max. bus supply voltage	+5.25 VDC
Max. DC data input voltage	-0.5...+3.8 VDC

Table 4-32 USB interface specification

For suitable prefab cable assemblies see → Table 4-9 on page 4-27.

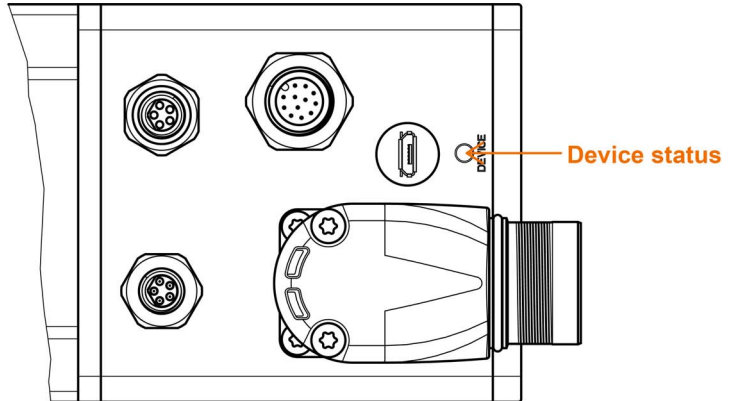
4.4 Status Indicators

The IDX features LED indicators to display the device condition.

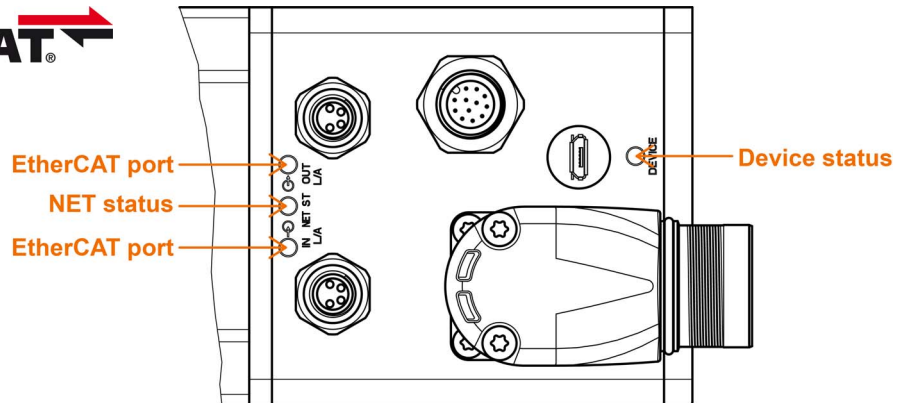
- A NET status**; the LED displays communication RUN states and errors conditions
- B Device status**; the LED displays the device's operation status and error conditions
- C EtherCAT port**; the LEDs display the NET link activity

For detailed information see separate document → «IDX Firmware Specification».

CANopen



EtherCAT



I/O

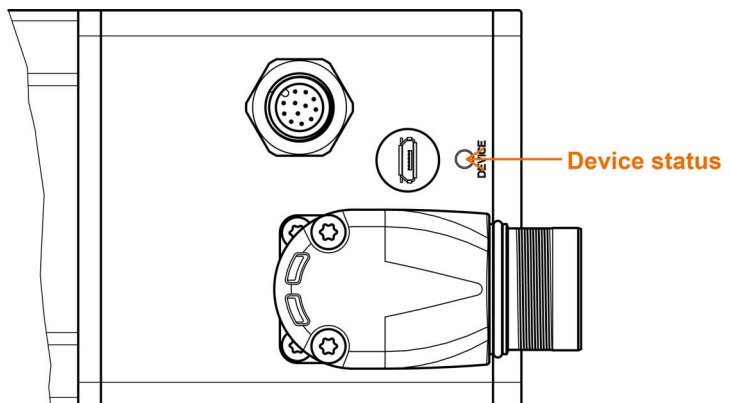


Table 4-33 LEDs

4.4.1 NET Status

The LED displays the actual status and possible errors of the IDX in respect to the NET network:

- Green LED shows the RUN state
- Red LED indicates errors

LED		Description
Green	Red	
OFF	—	IDX is in state INIT
Blink	—	IDX is in state PRE-OPERATIONAL
Single flash	—	IDX is in state SAFE-OPERATIONAL
ON	—	IDX is in state OPERATIONAL
Flicker	—	IDX is in state BOOTSTRAP
—	OFF	IDX is in operating condition
—	Double flash	An application watchdog timeout has occurred <i>Example: Timeout of Sync Manager Watchdog</i>
—	Single flash	IDX has changed the COM state due to an internal error <i>Example: Change of state “Op” to “SafeOpError” due to Sync Error</i>
—	Blink	General Configuration Error <i>Example: State change commanded by master is not possible due to actual settings (register, object, hardware configuration)</i>

Blink = continuous blinking (≈ 2.5 Hz)

Flash = flashing (≈ 0.2 s), followed by pause of 1 s

Flicker = continuous flickering (≈ 10 Hz)

Table 4-34 NET status LEDs

4.4.2 Device Status

The LED displays the actual status and possible errors of the IDX:

- Green LED shows the status
- Red LED indicates errors

LED		Description
Green	Red	
Slow	OFF	Power stage is disabled. The IDX is in status... • “Switch ON Disabled” • “Ready to Switch ON” • “Switched ON”
ON	OFF	Power stage is enabled. The IDX is in status... • “Operation Enable” • “Quick Stop Active”
OFF	ON	FAULT state. The IDX is in status... • “Fault”
ON	ON	Power stage is enabled. The IDX is in temporary status... • “Fault Reaction Active”
Flash	ON	No valid firmware or firmware download in progress

Flash = flashing (≈ 0.9 s OFF/ ≈ 0.1 s ON)

Slow = slow blinking (≈ 1 Hz)

Table 4-35 Device status LEDs

4.4.3 EtherCAT Port

The LEDs display the link activity of the EtherCAT port (applies for both ports, X1 "IN" and X2 "OUT"):

- Green LED indicates link activity

LED Green	Description
OFF	Port is closed
Flicker	Port is open / activity is present
ON	Port is open
—	Data rate is 100 Mbit/s

Flicker = continuous flickering (≈ 10 Hz)

Table 4-36 EtherCAT port LED

4.5 Wiring Diagrams



USB adapter

The use of a galvanic isolated USB adapter is highly recommend.

4.5.1 IDX 70 Drive / Positioning Controller / CANopen

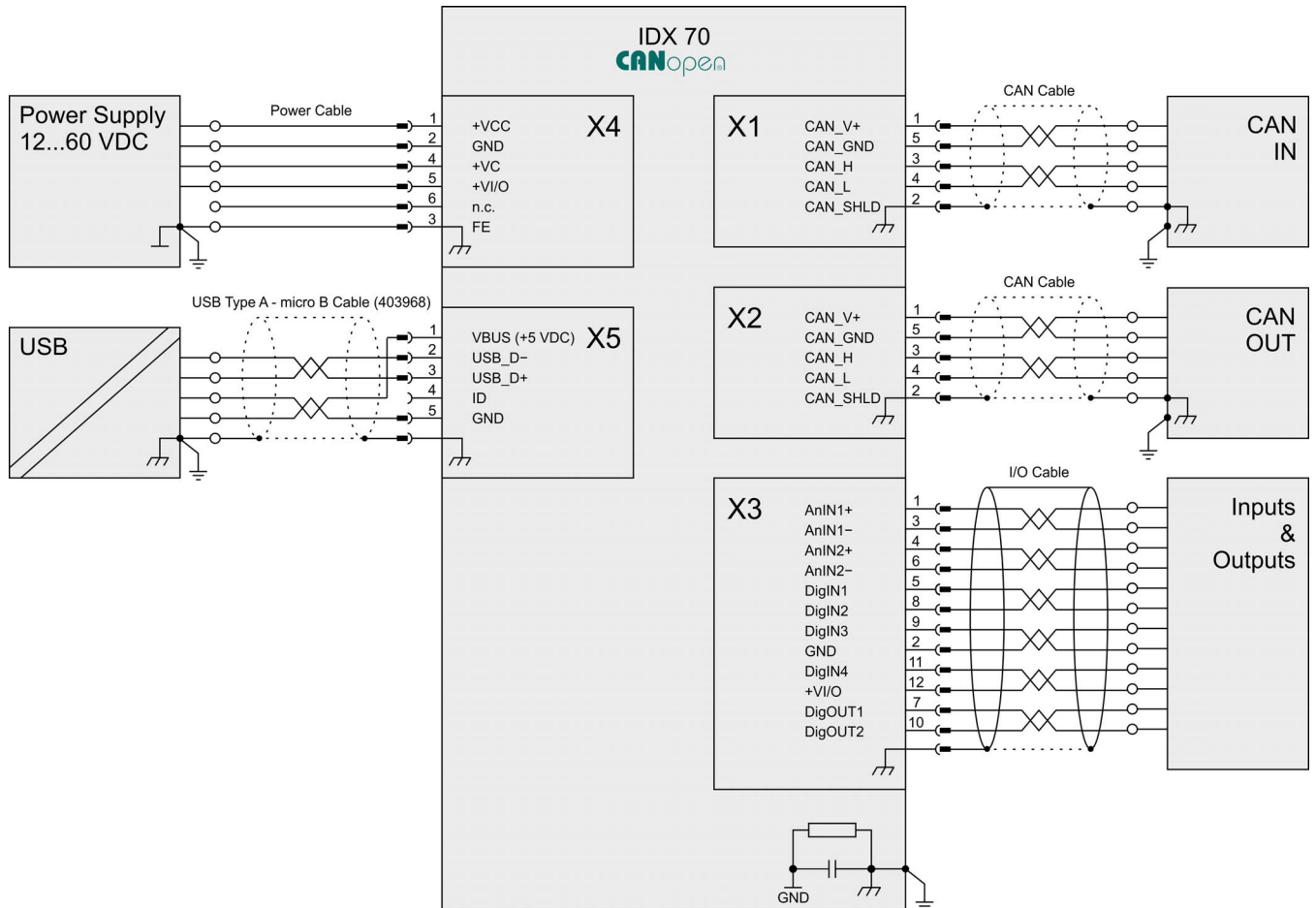


Figure 4-25 IDX 70 Drive with positioning controller and CANopen interface – wiring diagram

4.5.2 IDX 70 Drive / Positioning Controller / EtherCAT

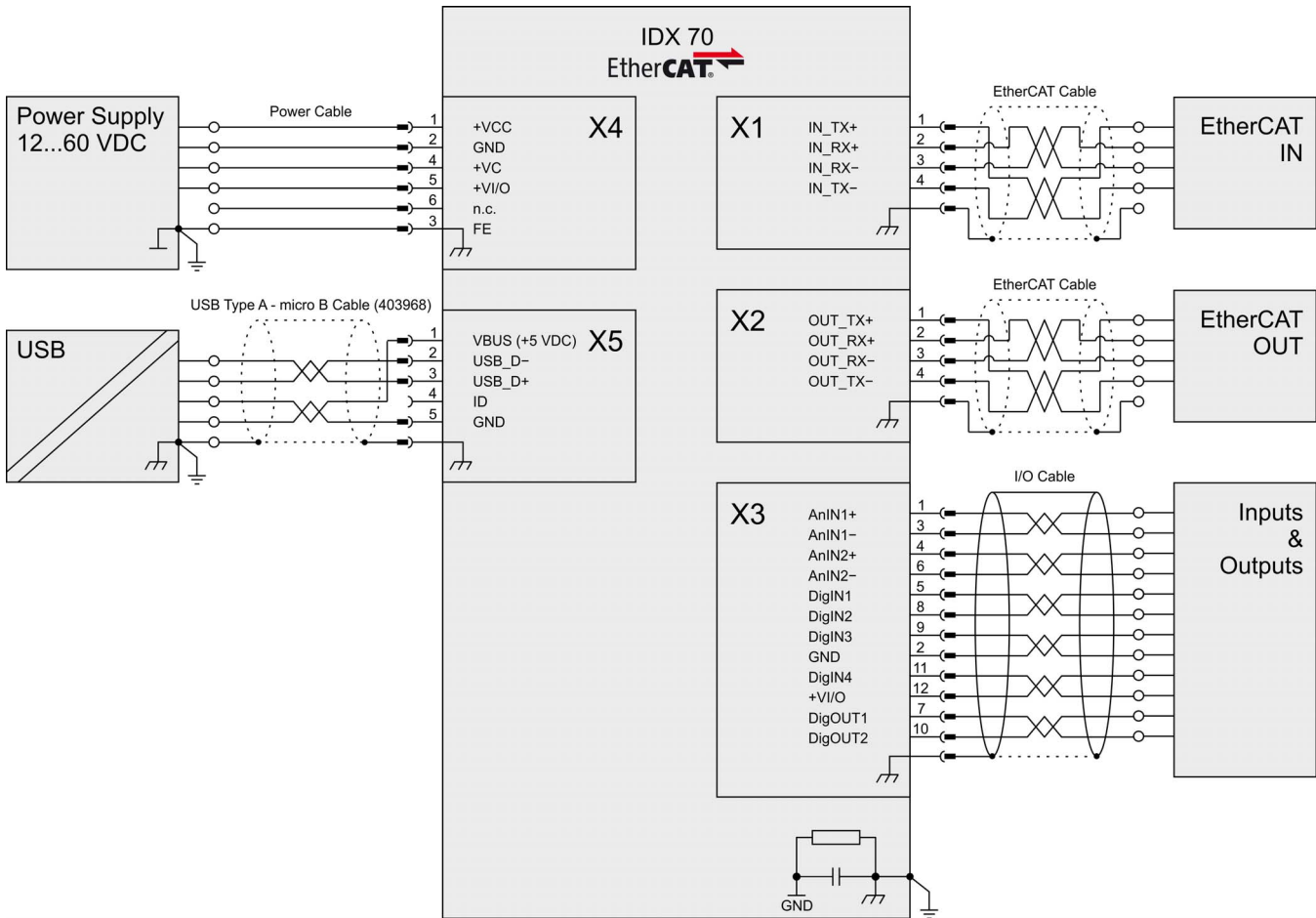


Figure 4-26 IDX 70 Drive with positioning controller and EtherCAT interface – wiring diagram

4.5.3 IDX 70 Drive / Speed Controller / I/O

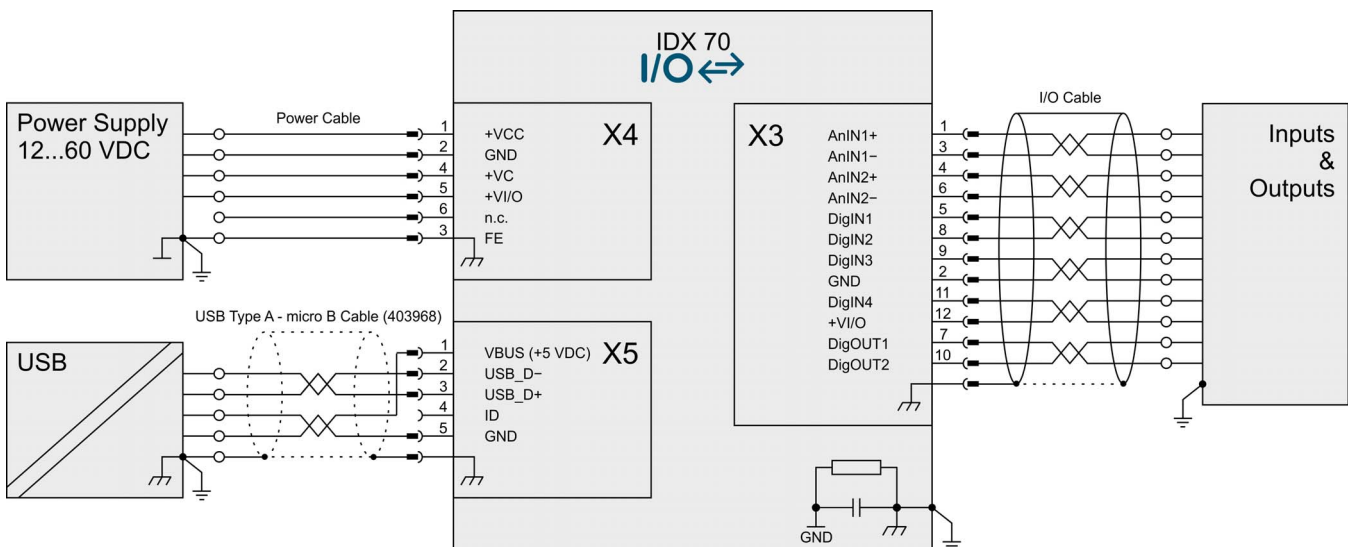


Figure 4-27 IDX 70 Drive with speed controller and I/O interface – wiring diagram

5 COMMISSIONING

5.1 General Rules

IMPORTANT NOTICE: PREREQUISITES FOR PERMISSION TO COMMENCE INSTALLATION

The **IDX 70** drive is considered as partly completed machinery according to EU Directive 2006/42/EC, Article 2, Clause (g) and **is intended to be incorporated into or assembled with other machinery or other partly completed machinery or equipment.**



WARNING

Risk of injury

Operating the device without the full compliance of the surrounding system with the EU Directive 2006/42/EC may cause serious injuries!

- Do not operate the device, unless you have made completely sure that the other machinery fully complies with the EU directive's requirements!
- Do not operate the device, unless the other machinery fulfills all relevant health and safety aspects!
- Do not operate the device, unless all respective interfaces have been established and fulfill the requirements stated in this document!



CAN master settings and CAN bus termination

- Consider the CAN master's maximal bit rate.
- The standard bit rate setting (factory setting) is 1 Mbit/s.
- Use a 120 Ω termination resistor (available with maxon P/N 662933) at both ends of the CAN bus.
- For detailed information see separate document →«IDX Communication Guide».



Best practice

Keep the drive mechanically disconnected during setup and adjustment phase.

5.2 Final Checks prior Commissioning

Check below listed items and make sure that all operative conditions are met before you commence with any commissioning task.

MECHANICAL

- 1) Make sure that you have worked your way through the entire chapter → «Mechanical Installation» and that you have completed all described tasks.
- 2) Make sure that the drive is correctly mounted and aligned as specified.
- 3) Make sure that all driven elements of the surrounding system can move freely and that they are set and ready for operation.

ELECTRICAL

- 4) Make sure that you have worked your way through the entire chapter → «Electrical Installation» and that you have completed all described tasks.
- 5) Make sure that electrical connections and electrical grounding are setup as specified.
- 6) Make sure that all junction boxes are properly closed and safe against unintentional contact.

FUNCTION

- 7) Remove mechanical interlocks, deadlocks, or other locking mechanisms, if any.
- 8) Make sure that the IDX drive and the attached system can freely move without being mechanically blocked.
- 9) Make sure that all protection systems and safety guards are in place and ready for operation.
- 10) Inform any person standing nearby on the possible automatic start-up of the system and make them stay clear.
- 11) Remove locks and tags (if any) as to any applicable lock-out/tag-out procedures. Release all power engaging equipment that you have locked against unintentional engagement.
- 12) Check for proper function of all involved elements of the surrounding system. Do not continue unless the surrounding system fully complies with its operative conditions.



Compliance of operative conditions of the surrounding system

Do not continue unless the surrounding system fully complies with its operative conditions and fulfills all requirements asked for in its operating license.

5.3 Parameterization and Programming



- 1) To set the IDX drive for service, you will need to install the «EPOS Studio» on your PC. You may download the software and a comprehensive documentation set free of charge (find sources here: →chapter “1.2 About the Devices” on page 1-8).
- 2) For setup, parameterization, programming, and testing of the drive, follow the descriptions given in the «EPOS Studio» Online Help.

6 MAINTENANCE

6.1 General Rules



WARNING

Risk of injury

The attempt to open the device can lead to serious injury

- The device does not contain any user-serviceable parts.
- Do not attempt to open the device.
- Any attempt to open the device will lead to permanent damage of the device.
- Any attempt to open the device will void any possible warranty.



Prior commencing any work

Before you commence with any work, be aware of the necessary safety precautions (→page 1-10) and strictly follow them.

6.2 Periodic Inspection

The IDX drive as a whole and its individual parts are maintenance-free.

If you perform maintenance on adjacent components.

The adjacent components, such as motor mount, fixations, couplings and output elements, electrical supply, etc. are customer-made parts. For the point of time for their maintenance and repair consult the relevant instructions. Thereby, also consider the following items.

When?	Where?	What?
Every 500 service hours	Motor mount	Check bolted connection between the drive's fixation flange and the motor mount for tight fit. Tighten again to the specified torque if necessary.
	Coupling	Check for tight fit and correct alignment. Realign and/or tighten again if necessary.
	Cable connectors	Check for tight fit. Tighten again if necessary.
	Connection cables	Check cables for signs of wear, tear, or damage. Check for correct routing. Restore original conditions if necessary.
Every 12 months if not in use or During long-term storage or After extended stand-still periods	Storage location	Check for proper conditions at the storage location (→page 6-50). Reestablish correct conditions if necessary.

Table 6-37 Maintenance plan

6.3 Long-term Storage

The IDX drive is intended for operation in new condition. Nevertheless, it can be stored over a longer period of time without suffering permanent damage provided that you consider the following.

SHELF LIFE

- The lubricants used have a manufacturer-specific expiration date.
- Some lubricants are subject to oiling-out which can reduce characteristic properties of the lubricant.
- Provided that the below stated recommended storage conditions are met, the drive can be stored over several years. Exemplary lifetime tests have confirmed operability even after several years of storage time.
- Upon commissioning, the specified no load data may vary.

PACKAGING

- The drive's packaging has a manufacturer-specific expiration date in respect to ESD protection. We recommend to store electrostatic sensitive drive components in ESD-safe containers.

RECOMMENDED STORAGE CONDITIONS

- Storage temperature: $-40\dots+35\text{ }^{\circ}\text{C}$
- Relative humidity: 20...80 %, non-condensing
- Free from noxious gas, no vibrations, no shocks

6.4 Decommissioning

Dismantling follows basically the Installation in reverse order:

- a) →chapter "4 Electrical Installation" on page 4-25
- b) →chapter "3 Mechanical Installation" on page 3-21

6.5 Disposal



In no case dispose used components with normal domestic waste.

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