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Operating Instructions

VLT® Integrated Servo Drive ISD® 510 System

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THE REAL DRIVE

Contents

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1 Introduction

1.1 Purpose of the Operating Instructions

The purpose of these operating instructions is to describe the VLT® Integrated Servo Drive ISD® 510 System.

These operating instructions contain information about:

- Installation
- Commissioning
- Programming
- Operation
- Troubleshooting
- Service and maintenance

These operating instructions are intended for use by qualified personnel. Read it in full to use the ISD 510 servo system safely and professionally, and pay particular attention to the safety instructions and general warnings. These operating instructions are an integral part of the ISD 510 servo system and also contains important service information. Therefore, keep it available with the ISD 510 servo system at all times.

Compliance with the information in these operating instructions is a prerequisite for:

- Trouble-free operation.
- Recognition of product liability claims.

Therefore, read these operating instructions before working with the ISD 510 servo system.

1.2 Additional Resources

Available manuals for the ISD 510 servo system:

Document	Contents
VLT® Integrated Servo Drive ISD® 510 System Operating Instructions	Information about the installation, commissioning, and operation of the ISD 510 servo system.
VLT® Integrated Servo Drive ISD® 510 System Design Guide	Information about the set-up of the ISD 510 servo system and detailed technical data.
VLT® Integrated Servo Drive ISD® 510 System Programming Guide	Information about the programming of the ISD 510 servo system.

Table 1.1 Available Documents for the ISD 510 Servo System

Technical literature for Danfoss drives is also available online at *vlt-drives.danfoss.com/Support/Technical-Documentation/*.

1.3 Copyright

1.4 Approvals and Certifications

The ISD 510 servo system fulfills the standards listed in *Table 1.2*.

IEC/EN 61800-3	Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods.
IEC/EN 61800-5-1	Adjustable speed electrical power drive systems. Part 5-1: Safety requirements - Electrical, thermal and energy.
IEC/EN 61800-5-2	Adjustable speed electrical power drive systems. Part 5-2: Safety requirements - Functional.
IEC/EN 61508	Functional safety of electrical/electronical/ programmable electronic safety-related systems.
EN ISO 13849-1	Safety of machinery - Safety-related parts of control systems. Part 1: General principles for design.
EN ISO 13849-2	Safety of machinery - Safety-related parts of control systems. Part 2: Validation.
IEC/EN 60204-1	Safety of machinery - Electrical equipment of machines. Part 1: General requirements.
IEC/EN 62061	Safety of machinery - Functional safety of safety-related electrical, electronic, and programmable electronic control systems.
IEC/EN 61326-3-1	Electrical equipment for measurement, control, and laboratory use – EMC requirements. Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) – General industrial applications.
UL508C	UL Standard for Safety for Power Conversion Equipment.
2006/42/EC	Machinery Directive
CE	CE
2014/30/EU	EMC Directive
2014/35/EU	Low Voltage Directive
RoHS (2002/95/EC)	Restriction of hazardous substances.

EtherCAT®	Ethernet for Control Automation Technology. Ethernet-based fieldbus system (see *chapter 12.1 Glossary* for further information).
Ethernet POWERLINK®	Ethernet-based fieldbus system:
PLCopen®	Technical specification. Function blocks for motion control (formerly Part 1 and Part 2) Version 2.0 March 17, 2011.

Table 1.2 Approvals and Certifications

1.5 System Overview

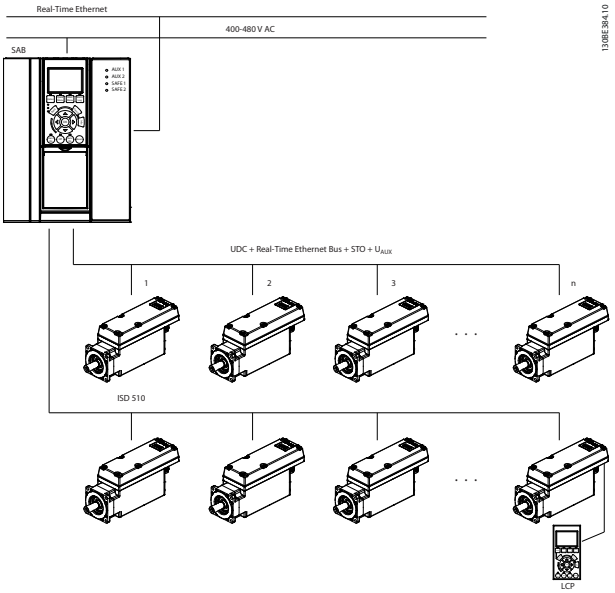

Illustration 1.1 Overview of the ISD 510 Servo System

The servo drives are self-contained distributed drives, whereby the drive electronics is housed together with the motor in the same casing. There are 2 versions of the ISD 510 servo drive:

Standard	With 2 hybrid connectors (M23) that connect power and communication signals from a hybrid cable.
Advanced	As standard plus 3 additional interfaces for external encoder or I/Os, fieldbus devices, and for the local control panel (LCP) to be connected directly.

Table 1.3 ISD 510 Servo Drive Versions

In this decentral system, the servo drives are operated in a DC group and controlled by a PLC. The motion control software runs independently in the servo drive, reducing the load on the PLC.
The ISD 510 servo system requires hybrid cables that contain the DC supply voltage, the Real-Time Ethernet, U_{AUX}, and STO signals.
The Servo Access Box (SAB®) is the central power supply for the ISD 510 servo system.

The ISD 510 servo system is designed to accommodate up to 64 ISD 510 servo drives and consists of:

- ISD 510 servo drives
- Servo Access Box (SAB)
- 1 PLC (not included)
- Cabling
- Blind caps
- Software:

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- Firmware for the servo drive
- Firmware for the SAB
- PC software tool: ISD Toolbox
- PLC libraries
    - Danfoss Motion library for VLT® Integrated Servo Drive ISD 510 system for AutomationStudio™
    - Danfoss Motion library for VLT® Integrated Servo Drive ISD 510 system for TwinCAT® 2

NOTICE

The ISD 510 servo drives cannot be used in servo systems from other manufacturers without changing the cabling infrastructure. Contact Danfoss for further information.
Drives from other manufacturers cannot be used in the ISD 510 servo system when using Danfoss hybrid cables.

1.5.1 Areas of Application

Potential areas of application are:

- Food and beverage machines
- Packaging machines
- Pharmaceutical machines
- Applications running with a group of decentral servo drives.

1.6 Software

Updates to the firmware, ISD Toolbox software, and PLC libraries may be available. When updates are available, they can be downloaded from the *danfoss.com* website. The ISD Toolbox software or the PLC libraries can be used to install the firmware on the servo drives or on the SAB.

1.7 Terminology

ISD	Integrated servo drive
ISD 510 Servo Drive	Decentral servo drive
VLT® Servo Access Box (SAB)	Unit that generates the DC-link voltage and passes the U_{AUX}, Real-Time Ethernet, and STO signals to the ISD 510 servo drives via a hybrid cable.
PLC	External device for controlling the ISD 510 servo system.
Loop cable	Hybrid cable for connecting drives in daisy-chain format.
Feed-in cable	Hybrid cable for connection from the SAB to the 1st servo drive.

Table 1.4 Terminology

An explanation of all terminology and abbreviations can be found in *chapter 12.1 Glossary*.

2 Safety

2.1 Symbols Used in this Manual

The following symbols are used in this manual:

⚠WARNING

Indicates a potentially hazardous situation that could result in death or serious injury.

⚠CAUTION

Indicates a potentially hazardous situation that could result in minor or moderate injury. It can also be used to alert against unsafe practices.

NOTICE

Indicates important information, including situations that can result in damage to equipment or property.

2.2 General

The following safety instructions and precautions relate to the ISD 510 servo system.
Read the safety instructions carefully before starting to work in any way with the ISD 510 servo system or its components.
Pay particular attention to the safety instructions in the relevant sections of this manual.

⚠WARNING

HAZARDOUS SITUATION

If the servo drive, SAB, or the bus lines are incorrectly connected, there is a risk of death, serious injury, or damage to the unit.
Always comply with the instructions in this manual and national and local safety regulations.

2.3 Safety Instructions and Precautions

Compliance with the safety instructions and precautions is necessary at all times.

- Orderly and proper transport, storage, fitting, and installation, as well as careful operation and maintenance, are essential for the trouble-free and safe operation of the ISD 510 servo system and its components.
- Only suitably trained and qualified personnel may work on the ISD 510 servo system and its components or in its vicinity. See *chapter 2.5 Qualified Personnel*.
- Only use accessories and spare parts approved by Danfoss.
- Comply with the specified ambient conditions. For further information, see *chapter 11.1.5 General Specifications and Environmental Conditions* and *chapter 11.2.4 General Specifications and Environmental Conditions*.
- The information in this manual about the use of available components is provided solely by way of examples of applications and suggestions.
- The plant engineer or system engineer is personally responsible for checking the suitability of the supplied components and the information provided in this manual for the specific application concerned:
  - For compliance with the safety regulations and standards relevant to the specific application.
  - For implementing the necessary measures, changes, and extensions.
- Commissioning the ISD 510 servo system or its components is not allowed until it has been ascertained that the machine, system, or plant in which they are installed conforms to the statutory provisions, safety regulations, and standards that apply to the application in the country of use.
- Operation is only allowed in compliance with the national EMC regulations for the application concerned.
- Compliance with the limit values specified by national regulations is the responsibility of the producer of the plant, system, or machine.
- Compliance with the specifications, connection conditions, and installation conditions in this manual is mandatory.
- The safety regulations and safety provisions of the country in which the equipment is used must be observed.
- To protect the user against electrical shock and to protect the servo drive and the SAB against overload, protective grounding is obligatory and must be performed in accordance with local and national regulations.

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⚠WARNING

GROUNDING HAZARD

The ground leakage current is >3.5 mA. Improper grounding of the ISD 510 servo system components may result in death or serious injury.

- **For reasons of operator safety, ground the components of the ISD 510 servo system correctly in accordance with national or local electrical regulations and the information in this manual.**

Operational safety

- Safety-related applications are only allowed if they are explicitly and unambiguously mentioned in this manual.
- All applications that can cause hazards to people or damage to property are safety-related applications.
- The stop functions implemented in the software of the PLC do not interrupt the mains supply to the SAB. Therefore, they must not be used as safety switches for the ISD 510 servo system.
- The servo drive can be brought to a stop by a software command or a zero speed setpoint, however DC voltage remains present on the servo drive and/or mains voltage in the SAB. Also when the servo drive is stopped, it may start up again on its own if the circuitry of the servo drive is defective or after the elimination of a temporary overload, a problem with the supply voltage, or a problem with the servo drive. If personal safety considerations (for example, risk of personal injury caused by contact with moving machine parts after an unintended start) make it necessary to ensure that an unintended start cannot occur, these stop functions are not sufficient. In this case, ensure that the ISD 510 servo system is detached from the mains network, or that a suitable stop function is implemented.
- The servo drive may start running unintentionally during parameter configuration or programming. If this poses a risk to personal safety (for example, risk of personal injury due to contact with moving machine parts), prevent unintended motor starting, for example by using the Safe Torque Off function, or by safe disconnection of the servo drives.
- In addition to the L1, L2, and L3 supply voltage inputs on the SAB, the ISD 510 servo system has other supply voltage inputs, including external auxiliary voltage. Before commencing repair work, check that all supply voltage inputs have been switched off and that the necessary discharge time for the DC-link capacitors has elapsed (see the discharge safety warning in *chapter 2.4 Important Safety Warnings*).

2.4 Important Safety Warnings

⚠WARNING

HIGH VOLTAGE

The ISD 510 servo system contains components that operate at high voltage when connected to the electrical supply network.
A hazardous voltage is present on the servo drives and the SAB whenever they are connected to the mains network.
There are no indicators on the servo drive or SAB that indicate the presence of mains supply.
Incorrect installation, commissioning, or maintenance can lead to death or serious injury.

- **Installation, commissioning, and maintenance may only be performed by qualified personnel (see *chapter 2.5 Qualified Personnel*).**

⚠WARNING

UNINTENDED START

The ISD 510 servo system contains servo drives and the SAB that are connected to the electrical supply network and can start running at any time. This may be caused by a fieldbus command, a reference signal, or clearing a fault condition. Servo drives and all connected devices must be in good operating condition. A deficient operating condition may lead to death, serious injury, damage to equipment, or other material damage when the unit is connected to the electrical supply network.

- **Take suitable measures to prevent unintended starts.**

⚠WARNING

DISCHARGE TIME

The servo drives and the SAB contain DC-link capacitors that remain charged for some time after the mains supply is switched off at the SAB. Failure to wait the specified time after power has been removed before performing service or repair work could result in death or serious injury.

- **To avoid electrical shock, fully disconnect the SAB from the mains and wait for at least the time listed in *Table 2.1* for the capacitors to fully discharge before carrying out any maintenance or repair work on the ISD 510 servo system or its components.**

Number	Minimum waiting time (minutes)
0–64 servo drives	10

Table 2.1 Discharge Time

NOTICE

Never connect or disconnect the hybrid cable to or from the servo drive when the ISD 510 servo system is connected to mains or auxiliary supply, or when voltage is still present. Doing so damages the electronic circuitry. Ensure that the mains supply is disconnected and the required discharge time for the DC-link capacitors has elapsed before disconnecting or connecting the hybrid cables or disconnecting cables from the SAB.

2.5 Qualified Personnel

Installation, commissioning, and maintenance of the ISD 510 servo system may only be carried out by qualified personnel.
For the purposes of this manual and the safety instructions in this manual, qualified personnel are trained personnel who are authorized to fit, install, commission, ground, and label equipment, systems, and circuits in accordance with the standards for safety technology and who are familiar with the safety concepts of automation engineering. Additionally, the personnel must be familiar with all the instructions and safety measures described in this manual. They must have suitable safety equipment and be trained in first aid.

2.6 Due Diligence

The operator and/or fabricator must ensure that:

- The ISD 510 servo system and its components are used only as intended.
- The components are operated only in a perfect operational condition.
- The operating instructions are always available near the ISD 510 servo system in complete and readable form.
- The ISD 510 servo system and its components are fitted, installed, commissioned, and maintained only by adequately qualified and authorized personnel.
- These personnel are regularly instructed on all relevant matters of occupational safety and environmental protection, as well as the contents of the operating instructions and the instructions it contains.
- The product markings and identification markings applied to the components, as well as safety and warning instructions, are not removed and are always kept in a legible condition.
- The national and international regulations regarding the control of machinery and equipment, that are applicable at the place of use of the ISD 510 servo system, are complied with.
- The users always have all current information relevant to their interests about the ISD 510 servo system and its use and operation.

2.7 Intended Use

The components of the ISD 510 servo system are intended to be installed in machines used in industrial environments in accordance with local laws and standards.

NOTICE

In a domestic environment, this product may cause radio interferences, in which case supplementary mitigation measures may be required.

To ensure that the product is used as intended, the following conditions must be fulfilled before use:

- Everyone who uses Danfoss products in any manner must read and understand the corresponding safety regulations and the description of the intended use.
- Hardware must be left in its original state.
- Software products must not be reverse-engineered and their source code must not be altered.
- Damaged or faulty products must not be installed or put into operation.
- It must be ensured that the products are installed in conformance with the regulations mentioned in the documentation.
- Any specified maintenance and service intervals must be observed.
- All protective measures must be complied with.
- Only the components described in these operating instructions may be fitted or installed. Third-party devices and equipment may be used only in consultation with Danfoss.

The ISD 510 servo system **may not** be used in the following application areas:

- Areas with potentially explosive atmospheres.
- Mobile or portable systems.
- Floating or airborne systems.
- Inhabited facilities.
- Sites where radioactive materials are present.

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- Areas with extreme temperature variations or in which the maximum rated temperatures may be exceeded.
- Under water.

2.8 Foreseeable Misuse

Any use not expressly approved by Danfoss constitutes misuse. This also applies to failure to comply with the specified operating conditions and applications.
Danfoss assumes no liability of any sort for damage attributable to improper use.

2.9 Service and Support

Contact the local service representative for service and support:
vlt-drives.danfoss.com/Support/Service/

3 System Description

3.1 Overview

The VLT® Integrated Servo Drive ISD® 510 system is a high-performance decentral servo motion solution.

It comprises:

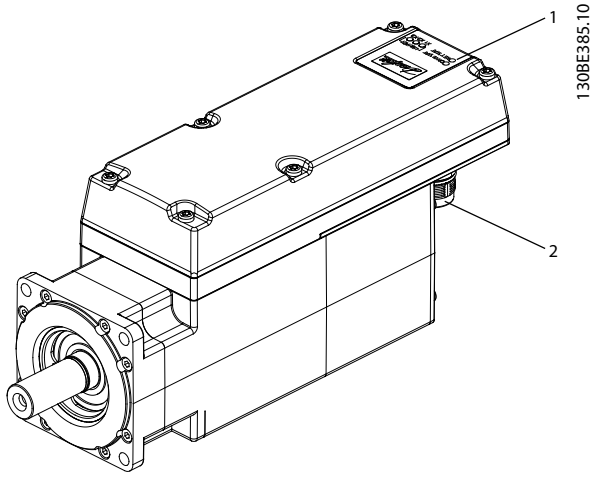
- A central power supply VLT® Servo Access Box (SAB®).
- VLT® Integrated Servo Drives ISD® 510.
- Cabling infrastructure.

The decentralization of the drive unit offers benefits in mounting, installation, and operation. Depending on the application, the SAB can power up to 64 drives in a servo drive system when using 2 hybrid lines. It generates a DC-link voltage of 565–680 V DC ±10% and guarantees high power density. It has a removable local control panel (LCP), and is based on the proven quality of a Danfoss frequency converter.
The motion control is integrated into the servo drive so that the motion sequences can take place independently. This reduces the required computing power of the central PLC and offers a highly flexible drive concept. Danfoss offers libraries for various IEC 61131-3 programmable PLCs. Due to the standardized and certified fieldbus interfaces of the ISD devices, any PLC with an EtherCAT® master functionality or Ethernet POWERLINK® managing node functionality according to the standards can be used. Hybrid cables are used to connect the drives, making installation fast and simple. These hybrid cables contain the DC-link supply, the Real-Time Ethernet, U_{AUX} and STO signals.

3.2 Servo Drive

ISD is the abbreviation of integrated servo drive, which is a compact drive with an integrated permanent magnet synchronous motor (PMSM). This means the entire power drive system consisting of motor, position sensor, mechanical brake, and also power and control electronics is integrated into 1 housing. Additional circuits, such as main low voltage supply, bus drivers, and functional safety are implemented within the servo drive electronics. All servo drives have 2 hybrid connectors (M23) that connect power and communication signals from a hybrid cable. The advanced version has 3 additional interfaces for external encoder or I/Os, fieldbus devices, and for the local control panel (LCP) to be connected directly.

LEDs on the top of the servo drive show the current status (see *chapter 7.2 Operating Status Indicators* for further information). Data transfer takes place via Real-Time Ethernet.



1	Operating LEDs (see *chapter 7.2.1 Operating LEDs on the Servo Drive* for further information).
2	Connectors

Illustration 3.1 ISD 510 Servo Drive

The ISD 510 servo drive has the following flange sizes: 76 mm, 84 mm.

Further flange sizes of 108 mm and 138 mm are in planning.

	Size 1, 1.5 Nm	Size 2, 2.1 Nm	Size 2, 2.9 Nm	Size 2, 3.8 Nm
Flange size	76 mm	84 mm		

Table 3.1 Motor and Flange Sizes

All dimensions of the servo drive are listed in *chapter 11.1.3 Dimensions*.

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3.2.1 Servo Drive Types

Pos.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Fixed	I	S	D	5	1	0		T					D	6																												
Variant							A		0	1	C	5			E	5	4	F	R	X	P	L	S	X	X	T	F	0	7	6	S	X	N	4	6	X	S	X	S	X
							S		0	2	C	1			E	6	7	F	S	1	E	C	S	C	O	F	F	0	8	4	C	0	N	4	0	B	K	S	C	X
									0	2	C	9						F	M	1	P	N					F	1	0	8			N	2	9		C			
									0	3	C	8									E	N					F	1	3	8			N	2	4					

Table 3.2 Type Code

[01–03]	Product group	[21–22]	Bus system	[33–35]	Motor speed
ISD	VLT® Integrated Servo Drive	**PL**	Ethernet POWERLINK®	**N46**	Rated speed 4600 RPM
[04–06]	Product variant	**EC**	EtherCAT®	**N40**	Rated speed 4000 RPM
510	ISD® 510	**PN**	PROFINET®[1]	**N29**	Rated speed 2900 RPM
[07]	Hardware configuration	**EN**	Ethernet/IP™[1]	**N24**	Rated speed 2400 RPM
A	Advanced	[23–25]	Firmware	[36]	Mechanical brake
S	Standard	**SXX**	Standard	**X**	Without brake
[08]	Drive torque	**SC0**	Customized version	**B**	With brake
T	Torque	[26]	Safety	[37]	Motor shaft
[09–12]	Torque	**T**	Safe Torque Off (STO)	**S**	Standard smooth shaft
01C5	1.5 Nm	**F**	Functional safety[1]	**K**	Standard fitted key[1]
02C1	2.1 Nm	[27–30]	Flange size	**C**	Customized
02C9	2.9 Nm	**F076**	76 mm	[38]	Motor sealing
03C8	3.8 Nm	**F084**	84 mm	**X**	Without sealing
[13–14]	DC voltage	**F108**	108 mm[1]	**S**	With sealing
D6	600 V DC-link voltage	**F138**	138 mm[1]	[39–40]	Surface coating
[15–17]	Drive enclosure	[31–32]	Flange type	**SX**	Standard
E54	IP54	**SX**	Standard	**CX**	Customized
E67	IP67 (shaft IP65)	**C0**	Customized version		
[18–20]	Drive feedback				
FRX	Resolver				
FS1	Single-turn feedback				
FM1	Multi-turn feedback				

Table 3.3 Legend to Type code

1) In preparation

3.2.2 Motor Components

3.2.2.1 Shaft

The shaft transfers the motor force (torque) to the machine coupled to the shaft.
The shaft material is C45+C or equivalent according to EN 10277-2.
The ISD 510 servo drives can be sealed by a shaft seal (optional) to achieve IP65 on the A-side of the motor (see *chapter 11.1.5 General Specifications and Environmental Conditions* for further information).

3.2.2.2 Brake (Optional)

The optional mechanical holding brake is designed as a single-disc brake. The emergency stop function can be initiated at most once every 3 minutes and up to 2000 times in total, depending on the load.

The effective holding torque is:

- Size 1: 2.5 Nm
- Size 2: 5.3 Nm

The brake operates as a holding brake according to the fail-safe principle *closed when no current*. It is powered from the 24–48 V DC auxiliary supply. This enables low-backlash load holding when no current is present.

Electrical data: Power consumption:

- Size 1: 1.5 W
- Size 2: 1.8 W

NOTICE

Do not misuse the holding brake as a working brake because this causes increased wear, resulting in premature failure.

NOTICE

Using servo drives with brakes can reduce the number of drives allowed, depending on the total length of each hybrid line. See the shell diagram in the *VLT® Integrated Servo Drive ISD® 510 System Design Guide* for further information.

3.2.2.3 Cooling

The servo drives are self-cooling.

Cooling (heat dispersal) is primarily via the flange, with a small amount dispersed by the housing.

3.2.2.4 Thermal Protection

Thermal sensors monitor the maximum allowable temperature of the motor winding and switch the motor off if the limit of 140 °C is exceeded. Thermal sensors are also present in the drive to protect the electronics against overtemperature. An error message is sent via Real-Time Ethernet to the higher-level PLC and is also shown on the LCP.

3.2.2.5 Built-In Feedback Devices

The built-in feedback device measures the rotor position.

There are 3 feedback variants available:

- Resolver
- 17-Bit single-turn encoder
- 17-Bit multi-turn encoder

Table 3.4 summarizes the characteristic data of each variant.

Data/type	Resolver	Single-turn encoder	Multi-turn encoder
Signal	Sin/cos	BiSS-B	BiSS-B
Accuracy	±10 arc min	±1.6 arc min	±1.6 arc min
Resolution	14 bit	17 bit	17 bit
Maximum number of turns	–	–	4096 (12 bit)

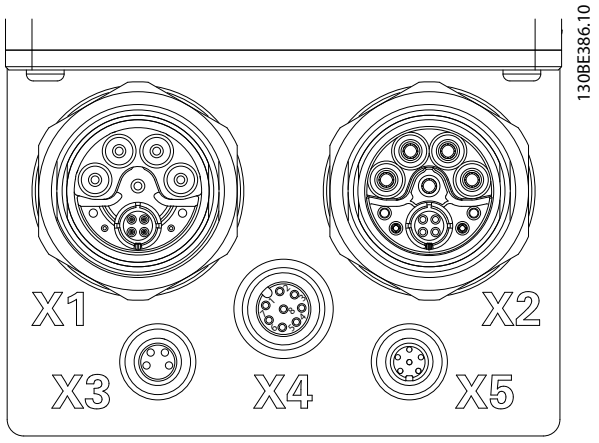
Table 3.4 Characteristic Data of Available Feedback Devices

3.2.3 Drive Components

3.2.3.1 Connectors on the Servo Drives

This chapter details all possible connections for the standard and advanced servo drive. Refer to the tables in this chapter for maximum cable lengths, ratings, and other limits.

There are 5 connectors on the servo drives.



Connector	Description
X1	M23 Feed-in or loop hybrid cable input
X2	M23 Loop hybrid cable output or fieldbus extension cable
X3 (advanced version only)	M8 Ethernet cable (minimum CAT5, shielded)
X4 (advanced version only)	M12 I/O and/or encoder cable (shielded)
X5 (advanced version only)	M8 LCP cable (shielded)

Illustration 3.2 Connectors on the ISD 510 Servo Drive

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X1 and X2: Hybrid connector (M23)

The hybrid cable provides the supply (mains and auxiliary), the communication lines, and the safety supply for each line of servo drives. Input and output connectors are connected inside the servo drive.

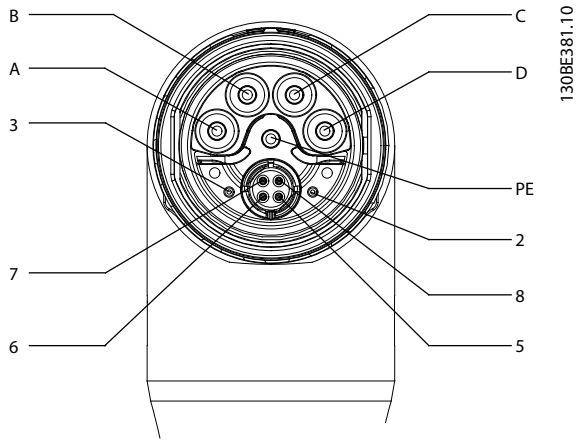


Illustration 3.3 X1: Male Hybrid Connector (M23)

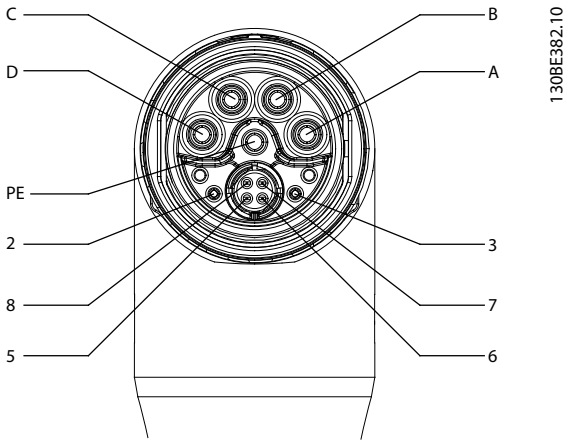


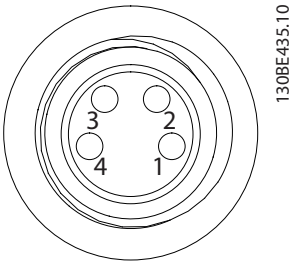
Illustration 3.4 X2: Female Connector (M23)

Pin	Description	Notes	Rating/parameter
A	UDC–	Negative DC mains supply	Operating voltage: Negative DC supply (maximum –15 A)
B	UDC+	Positive DC mains supply	Operating voltage: Positive DC supply (maximum 15 A)
C	AUX+	Auxiliary supply	24–48 V DC, 15 A Absolute maximum 55 V DC
D	AUX–	Auxiliary supply ground	15 A
PE	PE	PE connector	15 A
2	STO+	Safety supply	24 V DC ±10%, 1 A
3	STO–	Safety supply ground	1 A
5	TD+	Positive Ethernet transmit	According to standard 100BASE-T
6	RD+	Positive Ethernet receive	
7	TD–	Negative Ethernet transmit	
8	RD–	Negative Ethernet receive	

Table 3.5 Pin Assignment of X1 and X2 Hybrid Connectors (M23)

X3: 3rd Ethernet connector (M8, 4 pole)

The ISD 510 advanced servo drive has an additional fieldbus port (M8) for connecting a device that communicates via the selected fieldbus.



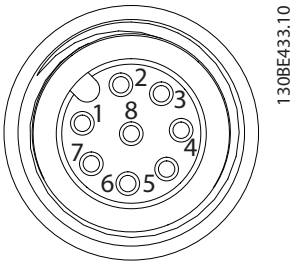
Pin	Description	Notes	Rating/parameter
1	TD+	Positive Ethernet transmit	According to standard 100BASE-T
2	RD+	Positive Ethernet receive	
3	TD–	Negative Ethernet transmit	
4	RD–	Negative Ethernet receive	

Illustration 3.5 Pin Assignment of X3 3rd Ethernet Connector (M8, 4 pole)

X4: M12 I/O and/or encoder connector (M12, 8-pole)

The M12 I/O and/or encoder connector is available on the advanced servo drive and can be used or configured as:

- Digital output
- Digital input
- Analog input
- 24 V supply
- External encoder interface (SSI or BiSS).

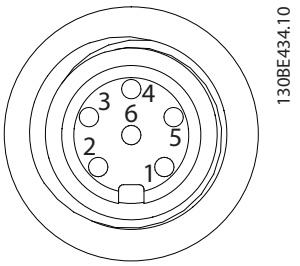


Pin	Description	Notes	Rating/parameter
1	Digital output	Switched 24 V as digital output or supply (24 V/150 mA)	Nominal voltage 24 V ±15% Maximum current 150 mA Maximum switching frequency 100 Hz
2	Ground	Ground isolated	–
3	Input 1	Analog/Digital input	Digital input: Nominal voltage 0–24 V Bandwidth: ≤ 100 kHz Analog input: Nominal voltage 0–10 V Input impedance 5.46 kΩ Bandwidth: ≤ 25 kHz
4	/SSI CLK	Negative SSI/BiSS clock out	SSI: Bus Speed: 0.5 Mbit with 25 m cable BiSS: Fulfills the RS485 specification. Maximum cable length (SSI & BiSS): 25 m
5	SSI DAT	Positive SSI/BiSS data in	
6	SSI CLK	Positive SSI/BiSS clock out	
7	Input 2	Analog/Digital input	Digital input: Nominal voltage 0–24 V Bandwidth: ≤ 100 kHz Analog input: Nominal voltage 0–10 V Input impedance 5.46 kΩ Bandwidth: ≤ 25 kHz
8	/SSI DAT	Negative SSI/BiSS data in	SSI: Bus Speed: 0.5 Mbit with 25 m cable BiSS: Fulfills the RS485 specification. Maximum cable length (SSI & BiSS): 25 m

Illustration 3.6 Pin Assignment of X4 M12 I/O and/or Encoder Connector (M12)

X5: LCP connector (M8, 6 pole)

The X5 connector is used to connect the LCP directly to the advanced servo drive via a cable.



Pin	Description	Notes	Rating/ parameter
1	Not connected	–	–
2	/LCP RST	Reset	Active at <0.5 V
3	LCP RS485	Positive RS485 signal	Speed: 38.4 kBd The levels fulfill the RS485 specification.
4	/LCP RS485	Negative RS485 signal	
5	GND	GND	–
6	VCC	5 V Supply for LCP	5 V ±10% at 120 mA maximum load

Illustration 3.7 Pin Assignment of X5 LCP Connector (M8, 6-pole)

3.3 Servo Access Box (SAB)

The SAB is the power supply and central interface/gateway to the ISD 510 servo system. It guarantees the connection of the servo drives to the fieldbus, generates the DC-link voltage for the ISD 510 servo system, and delivers a high-density output. It can be controlled using the local control panel (LCP) or via Ethernet-based fieldbus.
The LEDs on the front of the unit show the operating status and warnings (see *chapter 7.2.2 Operating LEDs on the Servo Access Box* for further information).

3

NOTICE

The SAB has an IP-rating of IP20. It is only designed for use within a control cabinet. The SAB may be damaged if exposed to fluids.

All power and signal cables are wired into the SAB and 2 independent lines of servo drives can be connected.

Service functions, such as voltage measuring, are performed by the SAB.

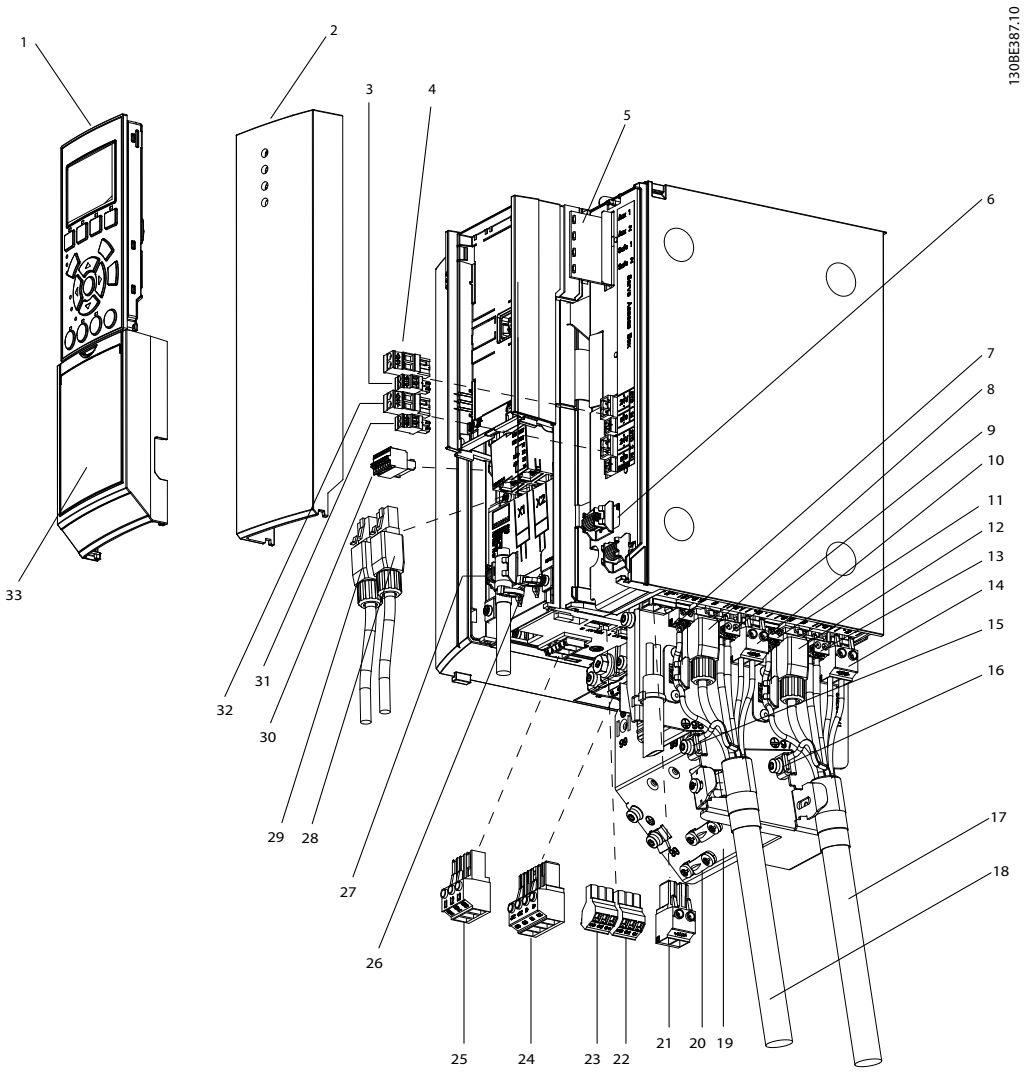


Illustration 3.8 Explosion Drawing of the Servo Access Box

Number	Description/connector name	Name on corresponding connector	Number	Description/connector name	Name on corresponding connector
1	Local control panel (LCP)	–	18	Hybrid cable line 2	–
2	Front cover	–	19	Decoupling plate	–
3	STO 1 IN: STO (Used for STO input voltage 1)	+STO–	20	Shielded cable grounding clamp and strain relief	–
4	STO 1 IN: 24 V (Used for bridging when the STO function is not required, see *chapter 3.3.1.1 STO Connectors*)	+24V–	21	24/48 V IN (Auxiliary input terminal)	+AUX–
5	LEDs for status of auxiliary output and STO	–	22	Relay 1	Relay 1
6	Decoupling clamp for STO cable	–	23	Relay 2	Relay 2
7	ISD Line 2: STO 2 (STO output to hybrid cable line 2)	+STO–	24	Brake	R– (81), R+ (82)
8	ISD Line 2: NET 2 X4 (Ethernet output to hybrid cable line 2)	RJ45 connector (without label)	25	Mains (Input terminal)	L1 (91), L2 (92), L3 (93)
9	ISD Line 2: AUX 2 (Auxiliary output to hybrid cable line 2)	+AUX–	26	Decoupling fixture for Ethernet inputs	–
10	ISD Line 2: UDC 2 (UDC output to hybrid cable line 2)	+UDC–	27	Decoupling clamp for encoder cable	–
11	ISD Line 1: STO 1 (STO output to hybrid cable line 1)	+STO–	28	X1 (Ethernet input line 1)	RJ45 connector (not included)
12	ISD Line 1: NET 1 X3 (Ethernet output to hybrid cable line 1)	RJ45 connector (without label)	29	X2 (Ethernet input line 2)	RJ45 connector (not included)
13	ISD Line 1: AUX 1 (Auxiliary output to hybrid cable line 1)	+AUX–	30	GND, 24 V, GX, /RS422 TXD, RS422 TXD, /RS422 RXD, RS422 RXD (Encoder terminal)	Not labeled
14	ISD Line 1: UDC 1 (UDC output to hybrid cable line 1)	+UDC–	31	STO 2 IN: STO (Used for STO input voltage 2)	+STO–
15	Grounding PE clamp for hybrid cable line 2	–	32	STO 2 IN: 24 V (Used for bridging when the STO function is not required, see *chapter 3.3.1.1 STO Connectors*)	+24V–
16	Grounding PE clamp for hybrid cable line 1	–	33	Cover	–
17	Hybrid cable line 1	–	–	–	–

Table 3.6 Legend to *Illustration 3.8*

3.3.1 Connections on the SAB

All required connectors are included with the SAB.

All cabling must comply with national and local regulations on cable cross-sections and ambient temperature. Use shielded/armored cables to comply with EMC emission specifications.

3

3.3.1.1 STO Connectors

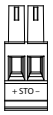
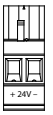
Item	Position on SAB	Description	Drawing/ pins	Ratings
STO 1 IN: STO	Front	Used for STO input voltage 1.	 Pins (left to right): STO+ STO-	Nominal voltage: 24 V DC ±10% Nominal current: Depends on the number of servo drives in the application. Maximum current: 1 A Maximum cross-section: 1.5 mm²
STO 2 IN: STO	Front	Used for STO input voltage 2.		
STO 1 IN: 24 V	Front	These connectors can only be used to make a bridge to STO 1 IN: STO and STO 2 IN: STO if the STO function is not required in the application. This connector cannot be used for any other function.	 Pins (left to right): 24+ 24-	Nominal voltage: 24 V DC ±10% Nominal current: 1 A Maximum cross-section: 1.5 mm²
STO 2 IN: 24 V	Front			
ISD Line 1: STO 1	Underside	Used for STO output voltage 1.	 Pins (left to right): STO+ STO-	Nominal voltage: 24 V DC ±10% Nominal current: Depends on the number of servo drives in the application. Maximum current: 1 A Maximum cross-section: 0.5 mm²
ISD Line 2: STO 2	Underside	Used for STO output voltage 2.		

Table 3.7 STO Connectors

3.3.1.2 Mains Connectors

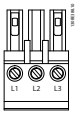
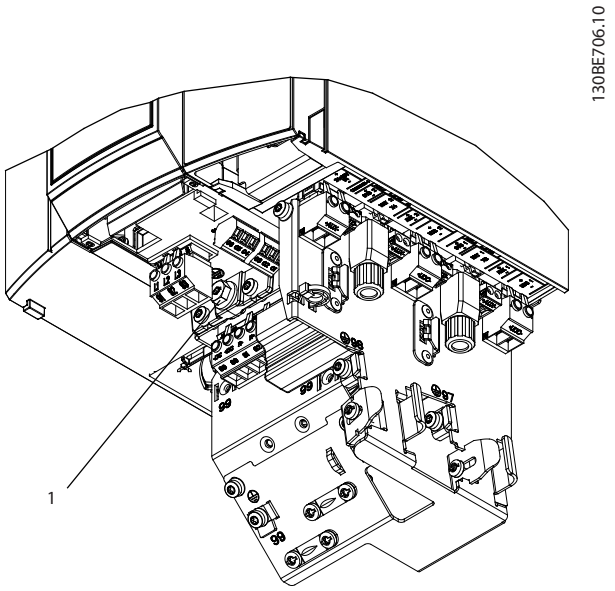
Item	Description	Drawing/ pins	Ratings
AC mains supply	Used to connect L1/L2/L3	 Pins (left to right): L1 L2 L3	Nominal voltage: 400–480 V AC Nominal current: 12.5 A Maximum cross-section: 4 mm²
Mains PE	The PE screw is used to connect the protective earth, see *Illustration 3.9*.	–	Cross-section: 10 mm² See *chapter 5.4 Grounding* for further information.

Table 3.8 Mains Connectors



1	PE screw

Illustration 3.9 PE Screw

3.3.1.3 Brake Connectors

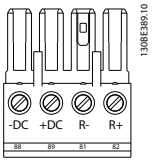
Item	Description	Drawing/pins	Ratings
Brake	Used for connecting a brake resistor	 –DC (88) = Do not use +DC (89) = Do not use R– (81) = Brake – R+ (82)= Brake +	Nominal voltage: 565–778 V DC Maximum brake current: 14.25 A Maximum cross-section: 4 mm²

Table 3.9 Brake Connectors

NOTICE

The maximum length of the brake cable is 20 m (shielded).

3.3.1.4 Relay Connectors

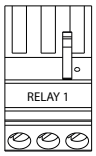
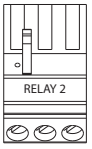
Item	Description	Drawing/pins	Ratings
Relay 1	Used for a customer-defined reaction. For example, the relay can be triggered if the SAB issues a warning.	 Pins (left to right): 1: Common 2: Normally open 3: Normally closed	Pin 1: Common Pin 2: 240 V AC Pin 3: 240 V AC Nominal current: 2 A Maximum cross-section: 2.5 mm²
Relay 2		 Pins (left to right): 4: Common 5: Normally open 6: Normally closed	Pin 4: Common Pin 5: 400 V AC Pin 6: 240 V AC Nominal current: 2 A Maximum cross-section: 2.5 mm²

Table 3.10 Relay Connectors

3.3.1.5 Encoder Connectors

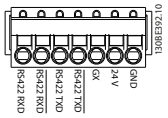
Item	Description	Drawing/pins	Ratings
Encoder connector	Used to connect SSI or BiSS encoders.	 Pins (left to right on SAB label): RS422 RXD /RS422 RXD RS422 TXD /RS422 TXD GX 24 V GND	Maximum cross-section: 0.5 mm². See *Table 3.12*.

Table 3.11 Encoder Connectors

NOTICE

The maximum length of the encoder cable is 25 m (shielded).

Number	Description	Notes		Rating/ parameter
		SSI	BiSS	
1	RS422 RXD	Positive data		Bus speed: SSI: 0.5 Mbit with 25 m cable BiSS: Fulfills the RS485 specification
2	/RS422 RXD	Negative data		
3	RS422 TXD	Positive clock		
4	/RS422 TXD	Negative clock		
5	GX	Isolated ground If encoders are powered externally, the ground of the external supply must be connected to GX.		–
6	24 V	24 V DC ±10% (used for powering the encoder)		Maximum current: 250 mA
7	GND	Ground for pin 6		–

Table 3.12 Pin Assignment for SSI and BiSS Encoders

3

3.3.1.6 Ethernet Connectors (not included)

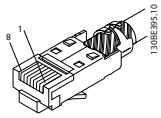
Connector name	Description	Drawing/pins	Ratings
Ethernet X1	Connection to fieldbus	 Pins: 1: TD+ 2: TD– 3: RD+ 6: RD–	Fulfill the 100BASE-T specification
Ethernet X2	Connection to fieldbus		
Ethernet X3	Connection to servo line 1		
Ethernet X4	Connection to servo line 2		

Table 3.13 Ethernet Connectors

NOTICE

The maximum length of the X1 and X2 shielded Ethernet cables is 30 m.

3.3.1.7 AUX Connectors

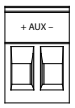
Connector name	Description	Drawing/pins	Ratings
ISD Line 1: AUX 1	Used to connect the AUX output from the SAB to the hybrid cable.	 Pins (left to right): AUX+ AUX–	Nominal voltage: 24–48 V DC±10% Nominal current: Depends on the number of servo drives in the application Maximum current: 15 A Maximum cross-section: 2.5 mm²
ISD Line 2: AUX 2			

Table 3.14 AUX Connectors

3.3.1.8 24/48 V IN Connector

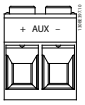
Connector name	Description	Drawing/pins	Ratings
24/48 V IN Connector	Used for 24–48 V DC input to the SAB.	 Pins (left to right): AUX+ AUX–	Nominal voltage: 24–48 V DC ±10% Nominal current: Depends on the number of servo drives in the application Maximum current: 34 A Maximum cross-section: 4 mm² Maximum cable length: 3 m

Table 3.15 24/48 V IN Connector

3.3.1.9 UDC Connectors

Connector name	Description	Drawing/pins	Ratings
ISD Line 1: UDC 1	Used to connect the DC-link voltage from the SAB to the hybrid cable.	 Pins (left to right): UDC+ UDC–	Nominal voltage: 565–778 V DC Nominal current: Depends on the number of servo drives in the application Maximum current: 15 A Maximum cross-section: 2.5 mm²
ISD Line 2: UDC 2			

Table 3.16 UDC Connectors

3.3.1.10 Hybrid Cable PE

Item	Description	Drawing/pins	Ratings
Hybrid cable PE	Used to connect the PE wire from the hybrid cable to the decoupling plate.	See callout 15 in *Illustration 3.8*.	Maximum cross-section: 2.5 mm²

Table 3.17 Hybrid Cable PE

3.4 Local Control Panel (LCP)

3.4.1 Overview

The LCP is the graphical user interface on the SAB for diagnostic and operating purposes. It is included as standard with the SAB but can also be connected to the advanced version servo drives using an optional cable (M8 to LCP D-SUB extension cable).

The LCP display provides the operator with a quick view of the state of the servo drive or SAB, depending on which device it is connected to. The display shows parameters and alarms/errors and can be used for commissioning and troubleshooting. It can also be used to perform simple functions, for example activating and deactivating the output lines on the SAB. The LCP can be mounted on the front of the control cabinet and then connected to the SAB via SUB-D cables (available as an accessory).

3.4.2 Local Control Panel (LCP) Layout

The local control panel is divided into 4 functional groups (see *Illustration 3.10*).

A. Display area.

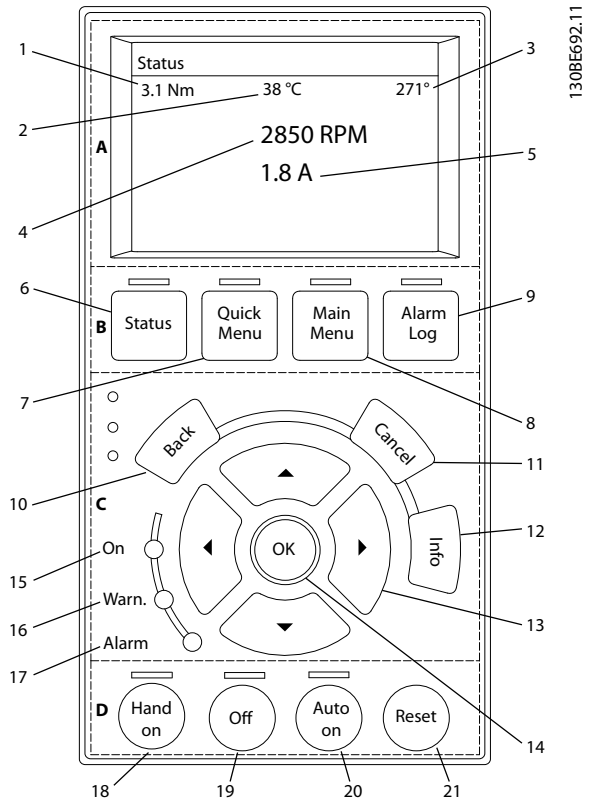
B. Display menu keys.

C. Navigation keys and indicator lights (LEDs).

D. Operation keys and reset.

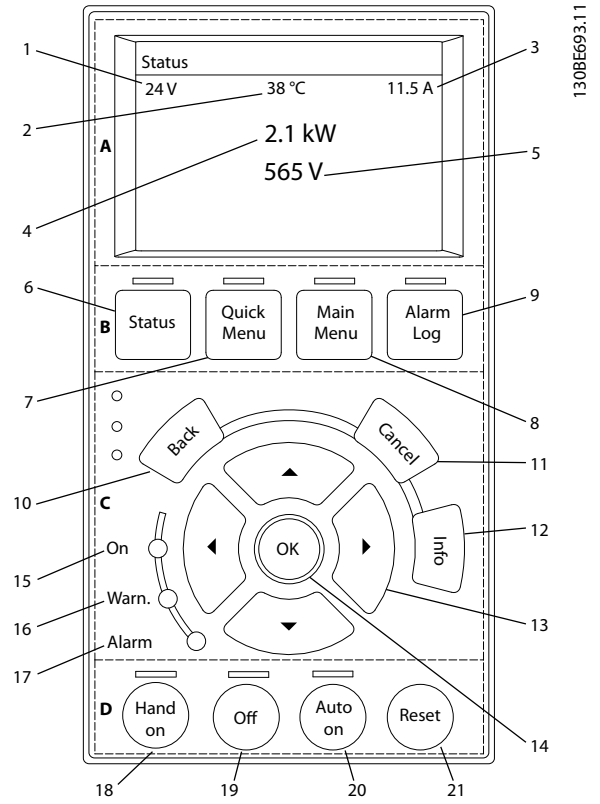
A. Display area
The values in the display area differ depending on whether the LCP is connected to an ISD 510 servo drive or the SAB as shown in *Illustration 3.10* and *Illustration 3.11*.

The display area is activated when the ISD 510 servo drive or SAB it is connected to receives power from the mains supply, a DC bus terminal, or U_{AUX}.



Display	Description
1	Actual torque
2	Temperature drive module
3	Position
4	Speed
5	Current

Illustration 3.10 Display Area when Connected to an ISD 510 Servo Drive



Display	Description
1	U_{AUX} line voltage
2	Temperature
3	Actual UDC (current)
4	ISD power consumption
5	Actual UDC (voltage)

Illustration 3.11 Display Area when Connected to the SAB

B. Display menu keys

Menu keys are used for menu access for parameter set-up, toggling through status display modes during normal operation, and viewing fault log data.

	Key	Function
6	Status	Shows operational information.
7	Quick Menu	Allows access to parameters.
8	Main Menu	Allows access to parameters.
9	Alarm Log	Shows the last 10 alarms.

Table 3.18 Display Menu Keys

C. Navigation keys and indicator lights (LEDs)

Navigation keys are used for moving the display cursor and provide operation control in local operation. There are also 3 status LEDs in this area.

	Key	Function
10	Back	Reverts to the previous step or list in the menu structure.
11	Cancel	Cancels the last change or command as long as the display mode is not changed.
12	Info	Press for a definition of the function being shown.
13	Navigation keys	Use the 4 navigation keys to move between items in the menu.
14	OK	Use to access parameter groups or to enable a selection.

Table 3.19 Navigation Keys

	LED	Color	Function
15	On	Green	The *On* LED activates when the ISD 510 servo drive or SAB it is connected to receives power from the mains or auxiliary supply, or a DC bus terminal.
16	Warn	Yellow	When warning conditions are met, the yellow *Warn* LED activates and text appears in the display area identifying the problem.
17	Alarm	Red	A fault condition causes the red *Alarm* LED to flash and an alarm text is shown.

Table 3.20 Indicator Lights (LEDs)

D. Operation keys and reset
Operation keys are located at the bottom of the LCP.

	Key	Function
18	Hand On	Enables the connected ISD 510 servo drive or SAB to be controlled via the LCP. Switching between *Hand On* and *Auto On* modes is only possible in certain states (see the *VLT® Integrated Servo Drive ISD® 510 System Programming Guide* for further information).
19	Off	Puts the SAB into state *Standby* and the drive to state *Switch on Disabled*. This only works in *Hand On* mode. *Off* mode enables transition from *Hand On* mode to *Auto On* mode.
20	Auto On	Puts the system in remote operational mode. • In *Auto On* mode, the device is controlled by fieldbus (PLC). Note that switching between *Auto On* and *Hand On* modes is only possible when the drive is in state *Switch on disabled* and/or the SAB is in state *Standby*.
21	Reset	Resets the ISD 510 servo drive or SAB after a fault has been cleared. The reset is only possible when in *Hand On* mode

Table 3.21 Operation Keys and Reset

NOTICE

To adjust the display contrast, press [Status] and the [▲]/[▼] keys.

3.5 Cables

3.5.1 Hybrid Cable

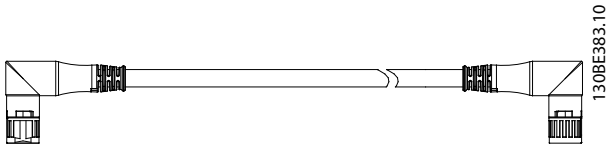


Illustration 3.12 Hybrid Loop Cable

There are 2 types of hybrid cables that are available with both angled and straight M23 connectors:

- Feed-in cable for connecting the 1st servo drive of a group to the connection point on the SAB.
- Loop cable for connecting the ISD 510 servo drives in daisy-chain format in an application.

Both these cables are provided by Danfoss and are available in various lengths. See the *VLT® Integrated Servo Drive ISD® 510 System Design Guide* for further information.

Both ends of the loop cable are fitted with M23 connectors.

The feed-in cable is fitted with an M23 connector at the output end for connection to the 1st servo drive. At the input end it is pigtailed with individual connectors for connection to the corresponding terminals on the SAB.

Minimum bending radius
The maximum number of bending cycles is 5 million at 7.5 x cable diameter (15.6 mm).

- Permanently flexible: 12 x cable diameter
- Permanently installed: 5 x cable diameter

Description	Shielded/ unshielded	Maximum cable length	Port	Notes
Feed-in cable	Shielded	40 m[1)]	Signal/ control	Hybrid cable (overall shield with additional fieldbus and safety section shield).
Loop cable	Shielded	25 m[1)]	Signal/ control	Hybrid cable (overall shield with additional fieldbus and safety section shield).

Table 3.22 Hybrid Cables

1) Maximum 100 m total length for each line.

3.5.2 I/O and/or Encoder Cable

This cable connects the I/O and/or encoder to the servo drive (see X4 in *chapter 3.2.3.1 Connectors on the Servo Drives*). The cable is not included with the servo drives. I/O and/or encoder cables with M12 connectors can be used for the ISD 510 servo system if they comply with the form factor defined in IEC 61076-2-101.

3.5.3 Additional Cables

Fieldbus extension cable
If this cable is not used, fit the M23 blind cap to the X2 female connector on the last servo drive in the application.

LCP cables

There are 2 kinds of cable for the LCP module that can be purchased from Danfoss (see the *VLT® Integrated Servo Drive ISD® 510 System Design Guide*):

- To connect the LCP to the servo drive.
- To connect the LCP to the SAB.

3

3.6 Connection Cables/Cabling

3.6.1 Layout and Routing

The servo drives are interconnected by hybrid loop cables. A hybrid feed-in cable with quick-release connectors provides the supply voltage from the SAB to the 1st servo drive.

Routing in drag chains
The hybrid cable is compatible with drag chains and therefore suitable for use in moving systems. The number of bending cycles is dependent on individual conditions and must therefore be determined in advance for each application, see *chapter 3.5.1 Hybrid Cable* for further information.

Maximum cable lengths

M23 Feed-in cable	40 m
M23 Loop cable	25 m
Fieldbus extension cable	Length: 2 m Maximum length to next port: 100 m
Maximum cable length per line	100 m

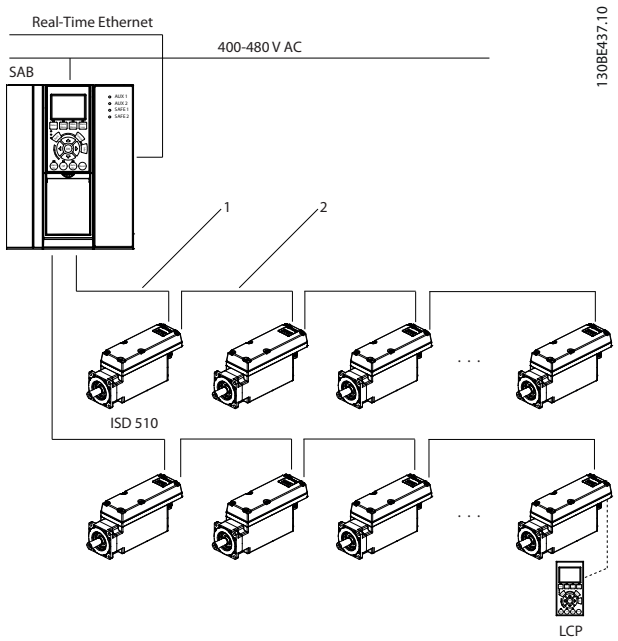
Table 3.23 Maximum Cable Lengths

Chapter 3.6.1.1 Standard Cabling Concept for 2 Lines and *chapter 3.6.1.2 Standard Cabling Concept for 1 Line* show the standard cabling concept without redundancy that can be used to connect 1 or 2 lines, each with up to 32 servo drives in an application.

NOTICE

For cabling with redundancy, see the *VLT® Integrated Servo Drive ISD® 510 System Design Guide*.

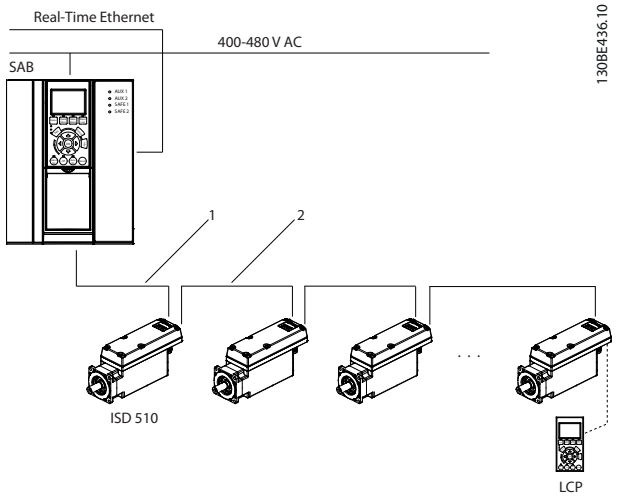
3.6.1.1 Standard Cabling Concept for 2 Lines



1	M23 Feed-in cable
2	M23 Loop cable

Illustration 3.13 Standard Cabling Concept for 2 Lines

3.6.1.2 Standard Cabling Concept for 1 Line



1	M23 Feed-in cable
2	M23 Loop cable

Illustration 3.14 Standard Cabling Concept for 1 Line

3.7 Software

The software for the ISD 510 servo system comprises:

- The firmware of the VLT® Integrated Servo Drive ISD® 510 that is already installed on the device and provides the functionality described in *chapter 7 Operation*.
- The firmware of the VLT® Servo Access Box that is already installed on the device.
- A package of PLC libraries for Automation Studio™ for operating the ISD 510 devices (see *chapter 6.4.1 Programming with Automation Studio ™* for further information).
- A PLC library for TwinCAT® 2 for operating the ISD 510 devices (see *chapter 6.4.2 Programming with TwinCAT®* for further information).
- ISD Toolbox: A Danfoss PC-based software tool for commissioning and debugging the devices (see *chapter 6.5 ISD Toolbox* for further information).

3.8 Fieldbus

The ISD 510 servo system has an open system architecture realized by fast Ethernet (100BASE-T) based communication. The system supports both EtherCAT® and Ethernet POWERLINK® fieldbuses. See the *VLT® Integrated Servo Drive ISD® 510 System Programming Guide* for further information.

In productive environments, communication to the devices always takes place via a PLC that acts as a master. The servo drives and the SABs can be controlled by these communication methods:

- Using the ISD library (available for TwinCAT® and Automation Studio™).
- Using the NC axis functionality of TwinCAT®.
- Using the CANopen® CiA DS 402 standard by reading and writing to objects.

The servo drives and the SABs can be operated with the following cycle times (for both fieldbuses):

- 400 µs and multiples of it (for example, 800 µs, 1200 µs, and so on).
- 500 µs and multiples of it (for example, 500 µs, 1 ms, and so on).

When the cycle time is a multiple of 400 µs and 500 µs, the time base of 500 µs is used.

The servo drive and the SAB are certified for both fieldbuses according to the corresponding rules and regulations. The servo drive conforms to the CANopen® CiA DS 402 Drive Profile.

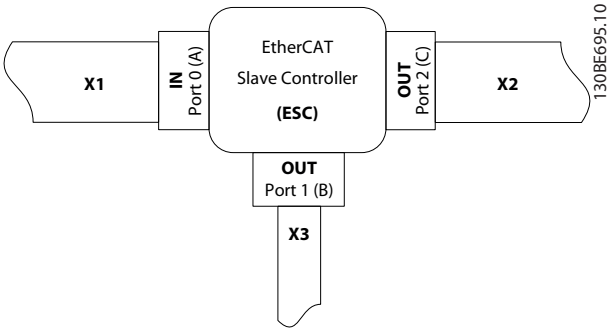
3.8.1 EtherCAT®

The servo drive and the SAB support the following EtherCAT® protocols:

- CANopen over EtherCAT® (CoE)
- File Access over EtherCAT® (FoE)
- Ethernet over EtherCAT® (EoE)

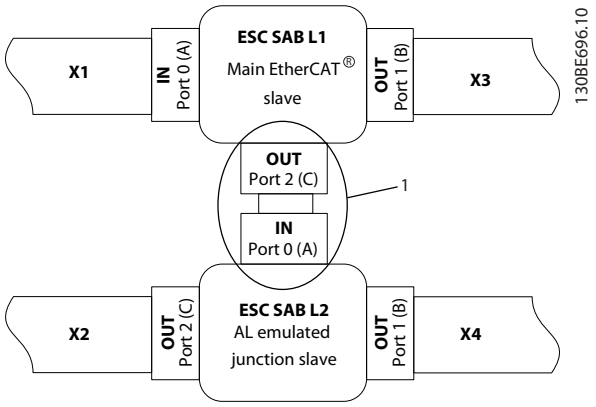
The servo drive and the SAB support distributed clocks. To compensate for the failure of a communication cable section in the system, cable redundancy is available for both fieldbuses. See the *VLT® Integrated Servo Drive ISD® 510 System Design Guide* for further information.

The EtherCAT® port assignment for the servo drive and SAB are shown in *Illustration 3.15* and *Illustration 3.16*.



X1	M23 hybrid cable connector to SAB or previous servo drive.
X2	M23 hybrid cable connector to the next servo drive.
X3	M8 Ethernet cable connector to other EtherCAT® slaves, for example EtherCAT® encoder. The connector is only available on the advanced servo drive.

Illustration 3.15 EtherCAT® Port Assignment for the Servo Drive



X1	RJ45 cable connector to the PLC or previous slave.
X2	RJ45 cable connector to the PLC or next slave.
X3	RJ45 to M23 hybrid adapter cable to the 1st servo drive on line 1.
X4	RJ45 to M23 hybrid adapter cable to the 1st servo drive on line 2.
1	Ports always connected internally in the SAB.

Illustration 3.16 EtherCAT® Port Assignment for the SAB in Line Topology Mode (default)

3.8.2 Ethernet POWERLINK®

The ISD drive and the SAB are certified according to DS301 V1.1.0. The following features are supported for the ISD servo drive and the SAB:

- Work as controlled node.
- Can be operated as multiplexed stations.
- Support of cross-communication.
- Ring redundancy is supported for media redundancy.

Specific ports are not assigned for Ethernet POWERLINK®.

4 Mechanical Installation

4.1 Transport and Delivery

4.1.1 Items Supplied

The items supplied for the ISD 510 servo system are:

- ISD 510 servo drives
- Servo Access Box (SAB) including connectors
- This manual
- Feed-in (hybrid) cable
- Loop (hybrid) cable
- Blind caps for connectors M8, M12, and M23

The packaging unit depends on the number of servo drives delivered. Save the packaging for use in the event of product return.

4.1.2 Transport

- Always use means of transport and lifting gear with sufficient load capacity to transport the servo drives and the SAB.
- Avoid vibration during transport.
- Avoid heavy impacts and blows.

4.1.3 Inspection on Receipt

1. After receiving the delivery, immediately check whether the items supplied match the shipping documents. Danfoss does not honor claims for faults registered later.
2. Register a complaint immediately:
    - With the carrier if there is visible transport damage.
    - With the responsible Danfoss representative if there are visible defects or the delivery is incomplete.

4.2 Safety Measures during Installation

Always observe the safety instructions in *chapter 2 Safety* during installation.

Pay particular attention to ensuring that the following points are always observed:

- Installation may only be performed by qualified personnel - see *chapter 2.5 Qualified Personnel*.
- Installation must be performed with due care and attention.
- All safety regulations and protective measures must be complied with, and the environmental conditions must be observed.
- The manual is read and understood.

4.3 Installation Environment

The installation must provide the following environmental conditions to allow the ISD 510 servo system to be operated safely and efficiently.

Servo Drive

- The allowable operating ambient temperature range and vibration levels must not be exceeded (see *chapter 11.1.5 General Specifications and Environmental Conditions* for further information).
- The allowable relative humidity range is 3–93%, non-condensing.
- Unrestricted ventilation must be available.
- The mounting structure must be suitable for the application, adequately rigid, and so on.

SAB

- The allowable operating ambient temperature range and vibration levels must not be exceeded (see *chapter 11.2.4 General Specifications and Environmental Conditions* for further information).
- The allowable relative humidity range is 5–93%, non-condensing.
- Minimum 100 mm space is required above and below the SAB (see *chapter 4.5.1 Installation and Space Requirements* for further information).

Contact Danfoss if it is not possible to comply with these environmental conditions.

4.4 Preparation for Installation

4.4.1 Servo Drive

Make the following preparations to ensure that the ISD 510 servo system can be installed reliably and effectively.

1. Provide a suitable mounting arrangement for the application. This depends on the type, weight, and torque of the servo drives.
2. Seat the motor flange flush against the mounting surface before fixing the servo drive. Misalignment shortens the life of the bearing and the coupling components and reduces heat transfer from the servo drive.
3. Provide contact protection according to local regulations if hot surfaces can be expected during operation.
4. Ground the servo drive as described in *chapter 5.4 Grounding*.

Always fit couplings and other transfer components in accordance with local regulations.

4.4.2 Servo Access Box (SAB)

Drill the holes for the mounting screws according to the template.
All dimensions are in mm.

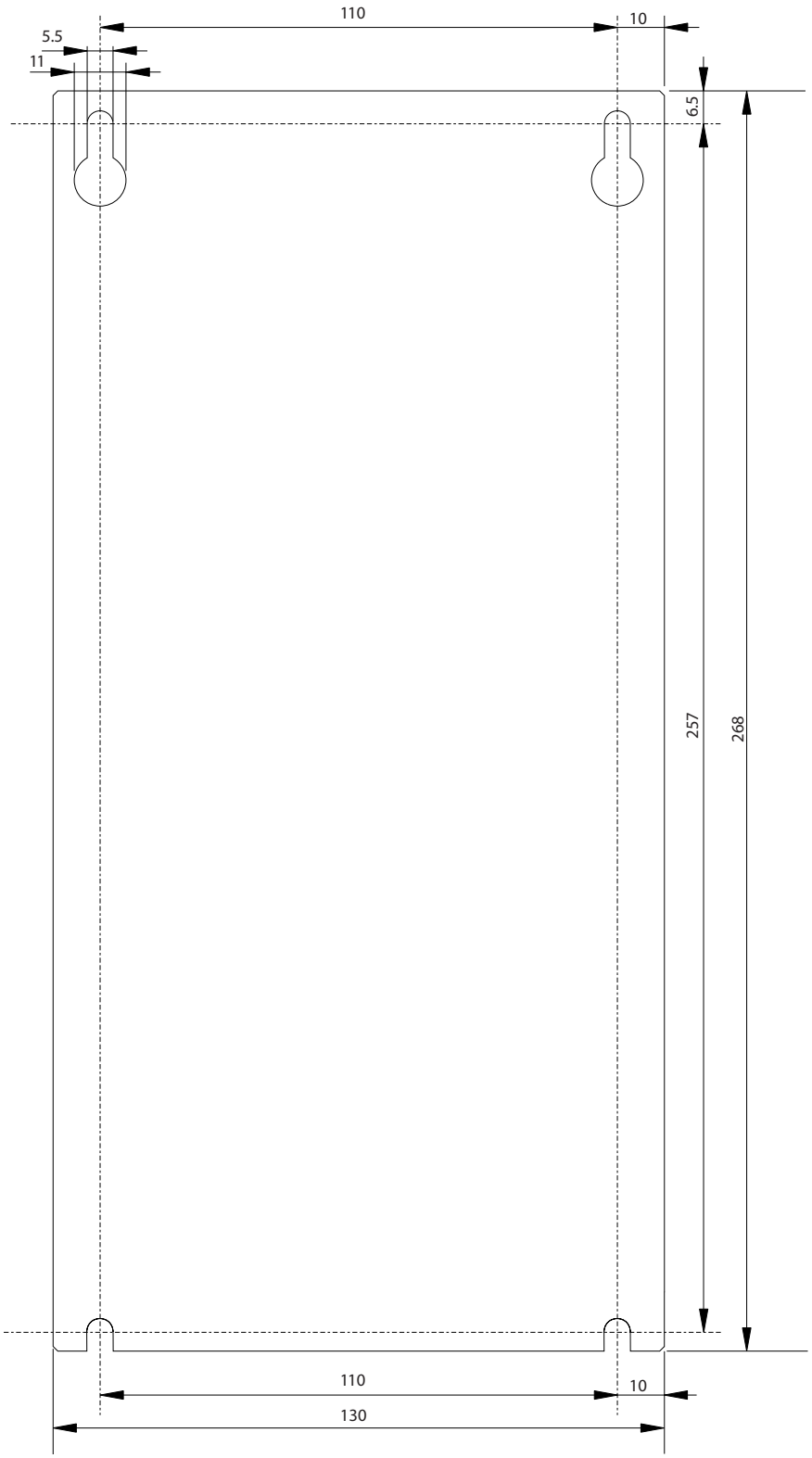


Illustration 4.1 SAB Mounting Template

4.5 Installation Procedure

4.5.1 Installation and Space Requirements

Servo Access Box

- The SABs can be mounted next to each other but require a minimum space of 100 mm at the top and bottom for cooling.
- In addition to its own dimensions, the SAB needs 100 mm space between the SAB decoupling plate and cable duct for connecting cables.

Servo Drive

- In addition to its own dimensions, the servo drive needs space for the hybrid cable. *Illustration 4.2* shows the necessary space when using the angled connector. *Illustration 4.3* shows the necessary space when using the straight connector.
- The amount of space necessary for installation depends on the tool used.

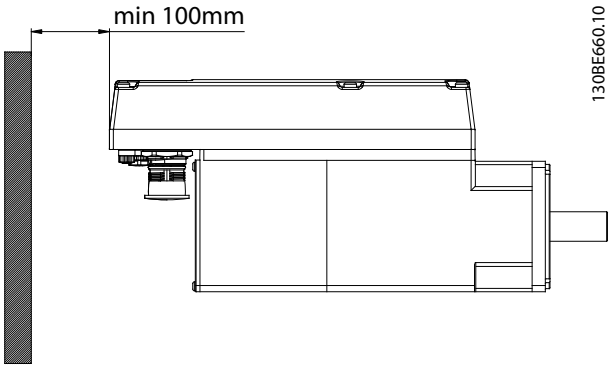


Illustration 4.2 Required Horizontal Space

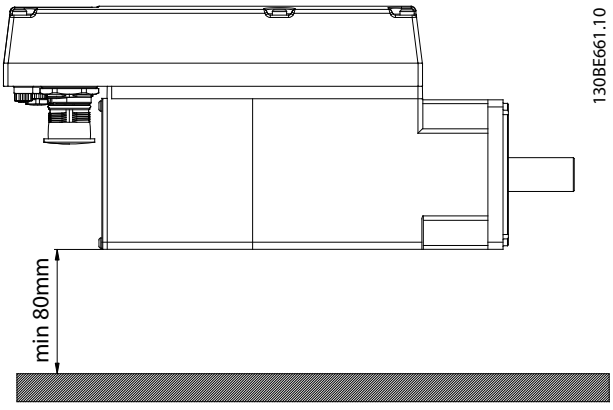


Illustration 4.3 Required Vertical Space

4.5.2 Installation Aids and Tools Required

For installation of the servo drives, the tools corresponding to the fixing screws (not included) are required.

4.5.3 Fitting Instructions Servo Drive

The servo drives are delivered with an M23 transport protection cap. The M23 blind cap used for IP protection must be ordered separately. The advanced servo drive is delivered additionally with M8 and M12 blind caps. These blind caps prevent contamination of the servo drive and are necessary to achieve the relevant IP protection rating. Always mount these caps if the connector is not used.

NOTICE

Ensure the machine surface that comes in contact with the servo flange is unpainted in order to guarantee good thermal behavior of the servo drive. The surface contact must also provide sufficient grounding protection.

Clamping

Observe the following fitting instructions to ensure reliable and effective fitting of the servo drive:

1. Check the counterface of the motor mount and ensure that it has sufficient heat dispersion capacity. An unpainted surface is mandatory.
2. Remove the protective end cap from the shaft.
3. Fix the servo drive with 4 screws using the 4 mounting holes provided for this purpose in the machine unit (see *Illustration 4.4* and *Illustration 4.5*).
    - Always use the designated mounting holes in the mounting flange to fix the servo drive.
    - Do not modify the mounting holes.
    - Always use all 4 mounting holes. The motor may run unevenly if fewer mounting holes are used.
    - See *chapter 4.5.4 Tightening Torques* for tightening torques.

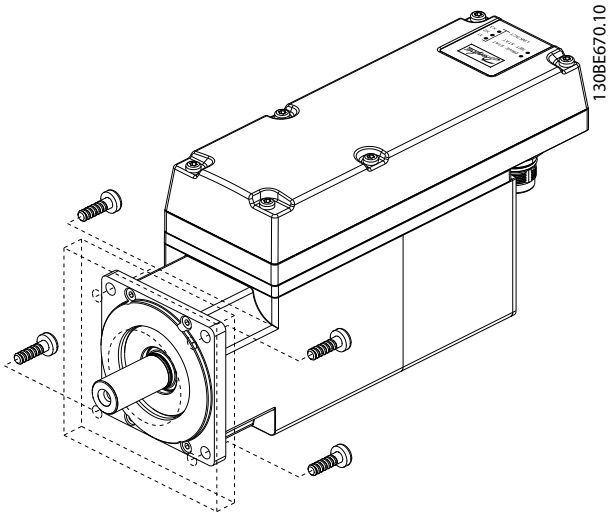


Illustration 4.4 Mounting of Size 1, 1.9 Nm, Size 2, 2.9 Nm, and Size 2, 3.8 Nm Servo Drives

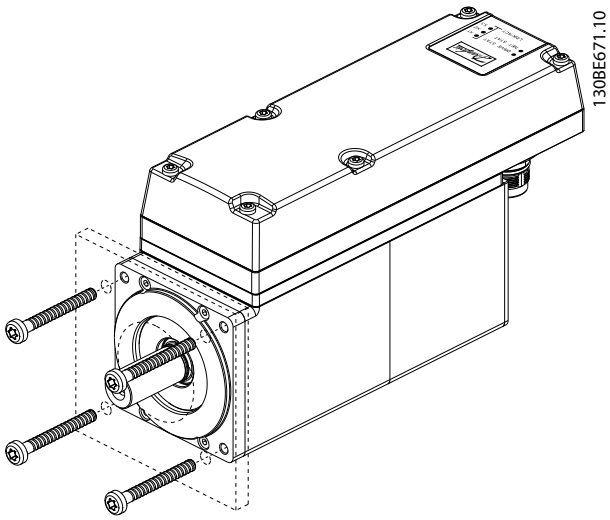


Illustration 4.5 Mounting of Size 2, 2.1 Nm Servo Drive

Coupling

NOTICE

Do not machine the shaft.
Do not use the servo drive if the shaft does not match the coupling arrangement.

General instructions

NOTICE

Do not use excessive force during the fitting procedure:

- **Do not exceed the vibration limits as detailed in *chapter 11.1.5 General Specifications and Environmental Conditions*.**
- **Do not exceed the permitted forces as detailed in *chapter 11.1.4 Permitted Forces*.**

1. Align the clamping set to the axis of the servo drive.
2. Insert the shaft in the clamping set.
3. Screw the clamping set together.

4.5.4 Tightening Torques

Table 4.1 lists the tightening torque values for the fixing screws. Always tighten the fixing screws uniformly and crosswise.

Servo drive size	Thread type/ hole size	Maximum thread length	Tightening torque
Size 1, 1.5 Nm	∅ 5.8 mm	–	–
Size 2, 2.1 Nm	M6 pitch 1 mm	23 mm	6 Nm
Size 2, 2.9 Nm	∅ 7 mm	–	–
Size 2, 3.8 Nm	∅ 7 mm	–	–

Table 4.1 Tightening Torques

NOTICE

The fixing screws are not supplied and must be selected according to the machine fixings.

4.5.5 Fitting Instructions Servo Access Box (SAB)

Step 1: Mount the decoupling plate
Mount the decoupling plate as shown in *Illustration 4.6*.

1. Slide the decoupling plate [3] into position, ensuring that the lips [2] are correctly inserted into the corresponding slots on the base plate.
2. Tighten the screw [1] at the top of the decoupling plate with 2 Nm.
3. Tighten the screws [4] at the bottom of the decoupling plate with 2 Nm.

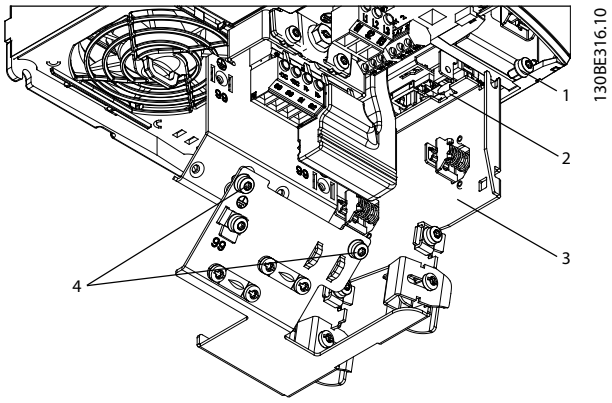


Illustration 4.6 Mounting the Decoupling Plate

Step 2: Mount the SAB in the control cabinet using the holes drilled as described in *chapter 4.4.2 Servo Access Box (SAB)* (preparation for installation).

- Hook the SAB onto the holding screws on the backplate of the control cabinet.
- Tighten the holding screws.
- Tighten the screws at the bottom of the SAB.

NOTICE

A remote mounting kit is available to mount the LCP in the control cabinet door. See the *VLT® Integrated Servo Drive ISD® 510 System Design Guide* for further information.

5 Electrical Installation

5.1 Warnings

During electrical installation, observe the relevant local and national regulations in addition to the information in this manual.

⚠WARNING

LEAKAGE/GROUNDING CURRENT HAZARD

Leakage/grounding currents are >3.5 mA. Failure to ground the SAB and the ISD servo drives properly could result in death or serious injury.

- **Ensure the correct grounding of the devices by a certified electrical installer in accordance with applicable national and local electrical standards and directives and the instructions contained in this manual.**

⚠WARNING

HIGH VOLTAGE

The SAB contains high voltage when connected to the supply that could result in death or serious injury.

- **Ensure that installation, start-up, and maintenance are only performed by qualified personnel.**

5.2 Electrical Environmental Conditions

Compliance with the following electrical environmental conditions is necessary to enable safe and effective operation of the ISD 510 servo system:

- Grounded 3-phase mains network, 400–480 V AC
- 3-phase frequency 47–63 Hz
- 3-phase lines and PE line
- External controller supply input, 24–48 V DC (PELV)
- Observe the national statutory provisions.
- The leakage current is >3.5 mA. Therefore use a type B residual current device (RCD).
- The SAB must be mounted in a control cabinet.

5.3 EMC-Compliant Installation

To obtain an EMC-compliant installation, follow the instructions provided in *chapter 5.4 Grounding* and *chapter 5.8 Connecting the Components*.

5.4 Grounding

Grounding for electrical safety

- Ground the ISD servo drive with the PE wire of the feed-in cable (see *chapter 5.8 Connecting the Components*).
- Ensure that the machine frame has a proper electrical connection to the flange of the servo drive. Use the front side flange surface. Ensure PE connection on that part of the machine. Refer to the *VLT® Integrated Servo Drive ISD® 510 System Design Guide* for further information.
- Use a dedicated ground wire for input power and control wiring.
- Do not ground 1 SAB to another in a daisy-chain format.
- Keep the ground wire connections as short as possible.
- Follow the wiring requirements in this manual.
- Ensure a minimum ground wire cross-section of at least 10 mm^2 or 2 separate ground wires both complying with the dimensioning rules. See EN/IEC 61800-5-1 for further information.

Grounding for EMC-compliant installation

- Establish electrical contact between the cable shield and the SAB enclosure by using metal cable glands, or by using the clamps provided on the SAB (see *chapter 5.8 Connecting the Components*).
- Use high-strand wire to reduce electrical interference.
- Do not use pigtails.
- Ensure a minimum distance of 200 mm between signal and power cables.
- Only cross cables at 90°.

NOTICE

POTENTIAL EQUALIZATION

There is a risk of electrical interference when the ground potential between the ISD 510 servo system and the machine is different. Install equalizing cables between the system components. The recommended cable cross-section is 16 mm^2.

NOTICE

EMC INTERFERENCE

Use shielded cables for control wiring and separate cables for power and control wiring. Failure to isolate power and control wiring can result in unintended behavior or reduced performance. Ensure a minimum clearance of 200 mm between signal and power cables.

5.5 Mains Supply Requirements

In addition to the electrical environmental conditions stated in *chapter 5.2 Electrical Environmental Conditions*, ensure that the supply has these properties:

- Grounded 3-phase mains network, 400–480 V AC
- 3-phase frequency: 47–63 Hz
- 3-phase lines and PE line
- Mains supply: 400–480 V ±10%
- Continuous input current SAB: 12.5 A
- Intermittent input current SAB: 20 A

NOTICE

Use fuses and/or circuit breakers on the supply side of the SAB to comply with CE or UL as detailed in *Table 5.1*.

CE Compliance (IEC 60364)			UL Compliance (NEC 2014)
Recommended fuse size	Recommended circuit breaker	Maximum trip level in [A]	Recommended maximum fuse size
gG-16	Eaton/Moller PKZM0-16	16	• Littelfuse® KLSR015 • Littelfuse® FLSR015

Table 5.1 Fuses and Circuit Breakers

5.6 Auxiliary Supply Requirements

Supply the SAB with a power supply unit with an output range of 24–48 V DC ±10%. The output ripple of the power supply unit must be <250 mV_{pp}. Only use supply units that conform to the PELV specification.
Refer to the *VLT® Integrated Servo Drive ISD® 510 System Design Guide* for power ratings shell diagrams.

NOTICE

Use a supply that is CE-marked according to the standards EN 61000-6-2 and EN 61000-6-4 or similar for industrial use.

The power supply unit must be dedicated to the ISD 510 servo system, meaning that the supply is used exclusively for powering the SAB. The maximum cable length between the supply unit and the SAB is 3 m.

5.7 Safety Supply Requirements

Supply the STO line with a 24 V DC supply with the following properties:

- Output range: 24 V DC ±10%
- Maximum current: 1 A

NOTICE

Use a 24 V supply unit that is CE marked according to the standards EN 61000-6-2 and EN 61000-6-4 or similar for industrial use. The supply must only be used for the ISD 510 safety input. The supply must fulfill the PELV specification.
It is possible to use the auxiliary supply for the STO function if the following conditions are met:

- **Output range: 24 V DC ±10%**
- **Maximum cable length: 3 m**

5.8 Connecting the Components

5.8.1 Servo Access Box

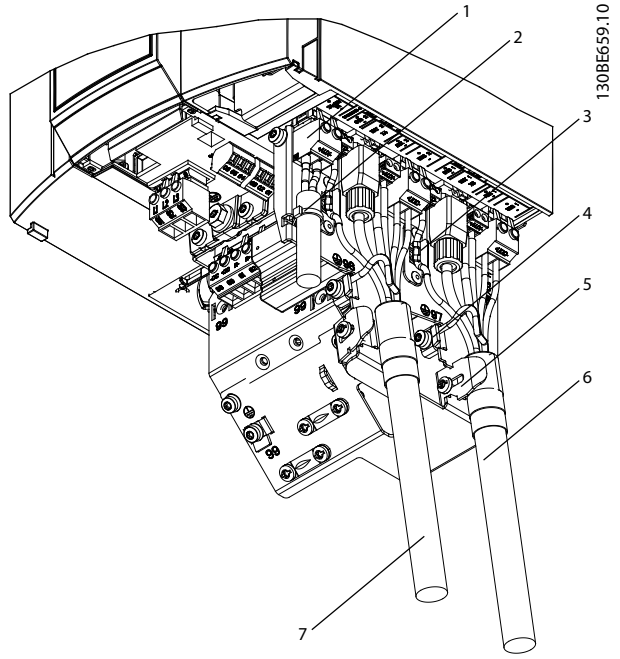
⚠WARNING

HIGH VOLTAGE

Potentially lethal voltage is present on the connectors.

- **Before working on the power connectors (disconnecting or connecting the cable), disconnect the SAB from the mains and wait for the discharge time to elapse.**

Step 1: Connect the feed-in cable



1	24/48 V IN (auxiliary input terminal)
2	Cable tie
3	Cable clamp for ISD Line 1: STO 1 (STO output to hybrid cable line 1)
4	PE grounding
5	Cable clamp for feed-in cable
6	Feed-in cable for line 1
7	Feed-in cable for line 2

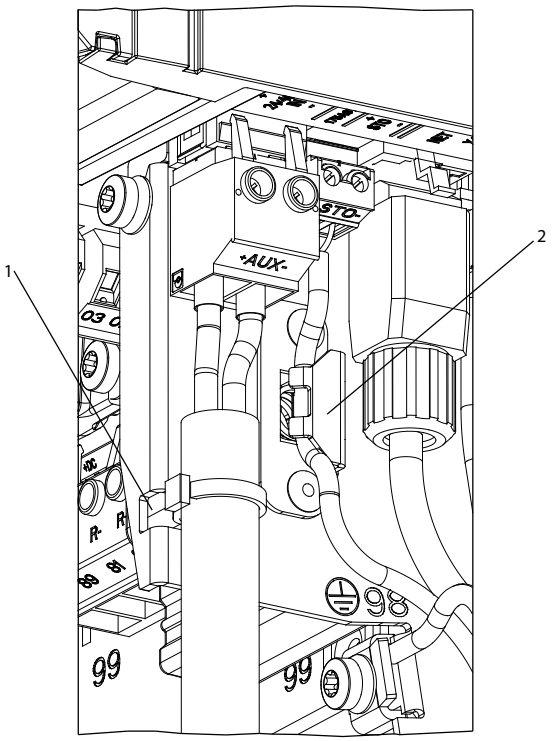
Illustration 5.1 Connecting the Feed-In Cable

1. Insert the 4 connectors on the feed-in cable into their corresponding terminal block on the SAB.
2. Secure the feed-in cable [6] using the cable clamp [5], ensuring that the shield is positioned exactly under the clamp.
3. Secure the STO cable using the cable clamp [3], ensuring that the shield is positioned exactly under the clamp.
4. Ground the PE wire using the PE terminal [4].

NOTICE

If using 2 lines of servo drives, repeat the process for the 2nd line [7].

Step 2: Connect the AUX cable



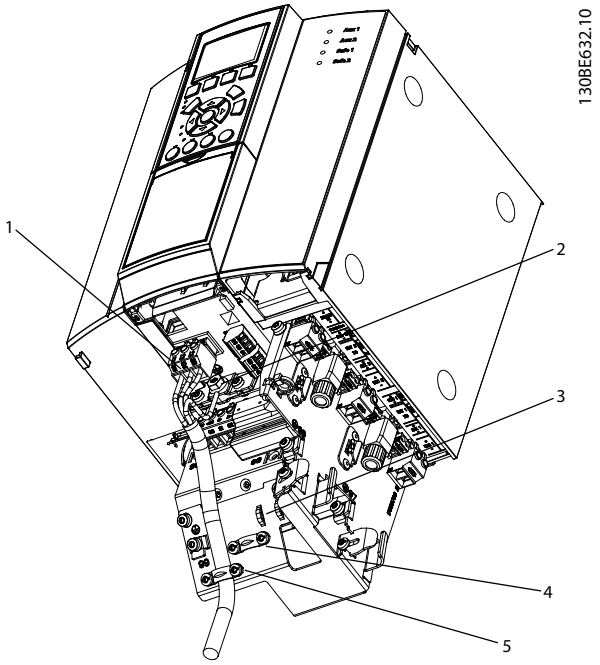
1	Cable tie
2	Cable clamp for ISD Line 2: STO 2 (STO output to hybrid cable line 2)

Illustration 5.2 AUX Connector on the SAB

1. Insert the wires into the 24/48 V IN (auxiliary input) connector as described in *chapter 3.3.1.7 AUX Connectors*.
2. Insert the 24/48 V IN (auxiliary input) connector into the SAB and secure the cable using the cable tie [1].

5

Step 3: Connect the mains cable



1	Mains connector
2	PE screw
3	Cable tie fixing
4	Cable clamp for brake resistor cable (optional)
5	Cable clamp for mains cable

Illustration 5.3 Mains Connector on the SAB

1. Insert the wires into the mains connector as described in *chapter 3.3.1.2 Mains Connectors*.
2. Connect the PE wire to the PE screw [2].
3. Insert the mains connector [1].
4. Secure the mains cable using the cable clamp [5].
5. If using a brake resistor, decouple the cable using the brake cable clamp [4].
6. If using a relay, decouple the cable with a cable tie to the fixing [3].

Step 4: Connect the encoder, Real-Time Ethernet, and STO cables

1. Open the terminal cover and the front cover with a screwdriver as shown in graphics *Illustration 5.4* and *Illustration 5.5*.

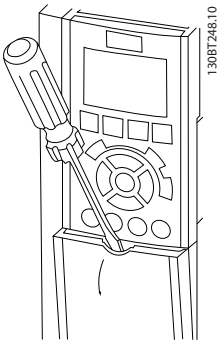


Illustration 5.4 Opening the Terminal Cover

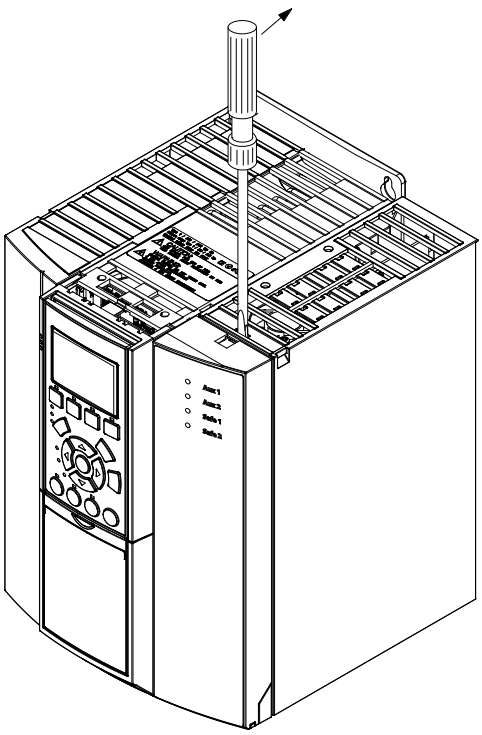
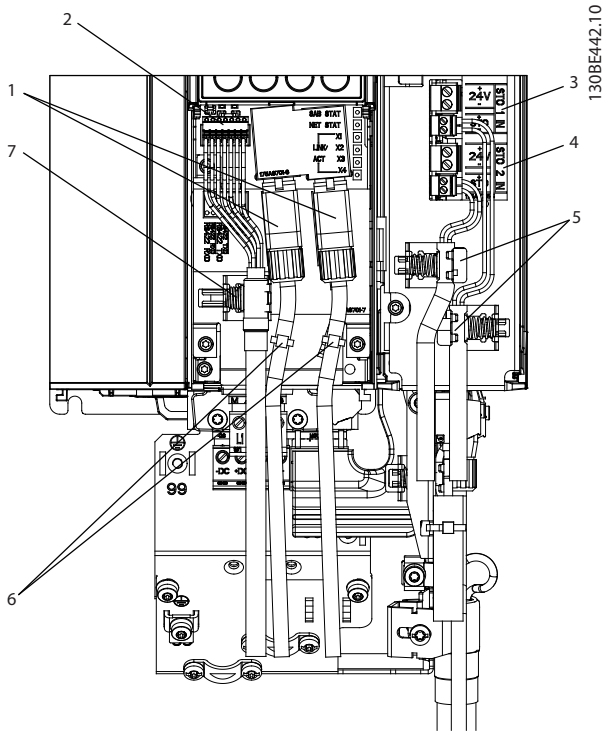


Illustration 5.5 Opening the Front Cover



1	Ethernet input X1 & X2
2	Encoder terminal
3	STO 1 IN: 24 V & STO 1 IN: STO
4	STO 2 IN: 24 V & STO 2 IN: STO
5	Cable clamps for STO cables
6	Cable ties for Ethernet cables
7	Cable clamp for encoder cable

Illustration 5.6 Encoder, Real-Time Ethernet, and STO Cables

1. Connect the Ethernet cables [1] and fix them in position using cable ties [6] as shown in *Illustration 5.6*.
2. Connect the STO wires to the STO connectors *STO 1 IN: 24 V* [3] and *STO 2 IN: 24 V* [4] as described in *chapter 3.3.1.1 STO Connectors* and refer to the installation instructions in *chapter 8.6 Installation*.
3. Plug the connectors into the SAB and clamp the cables in position using the cable clamps [5].
4. If using an encoder:
   - 4a Connect the encoder wires to the relevant connector as described in *chapter 3.3.1.5 Encoder Connectors*.
   - 4b Insert the encoder connector into the encoder terminal [2] on the SAB and clamp the cable in position using the cable clamp [7]. Ensure that the shield is positioned exactly under the clamp.

5.8.2 Servo Drive

5.8.2.1 Connecting/Disconnecting Hybrid Cables

⚠WARNING

HIGH VOLTAGE

Potentially lethal voltage is present on the connectors.

- **Before working on the power connectors (disconnecting or connecting the cable), disconnect the SAB from the mains and wait for the discharge time to elapse.**

⚠WARNING

DISCHARGE TIME

The servo drives and the SAB contain DC-link capacitors that remain charged for some time after the mains supply is switched off at the SAB. Failure to wait the specified time after power has been removed before performing service or repair work could result in death or serious injury.

- **To avoid electrical shock, fully disconnect the SAB from the mains and wait for at least the time listed in *Table 5.2* before carrying out any maintenance or repair work on the ISD 510 servo system or its components.**

Number	Minimum waiting time (minutes)
0–64 servo drives	10

Table 5.2 Discharge Time

General instructions for cable installation

- Avoid mechanical tension for all cables, especially regarding the range of motion of the installed servo drive.
- Secure all cables in accordance with regulations and depending on conditions on site. Ensure that cables cannot come loose, even after prolonged operation.
- If the X3, X4, and X5 connectors are not used, always mount the corresponding blind cap.

NOTICE

Never connect or disconnect the hybrid cables to or from the servo drive when the supply voltage is present. Doing so damages the electronic circuitry. Observe the discharge time for the DC-link capacitors.
Do not forcefully connect or fit the connectors. Incorrect connection causes permanent damage to the connector.

5

Connecting cables

1. Align the female connector of the M23 feed-in cable to the male input connector (X1) of the 1st servo drive.
2. Fully rotate the threaded ring of the cable connector counterclockwise. Use the marking *OPEN* as a reference for the cable connector.
3. Ensure the marking *OPEN* on the cable connector is facing the servo drive.
4. Press the connector towards the electronic housing on the servo drive until the sealing on the servo connector is covered entirely by the cable connectors.
5. Tighten the M23 feed-in cable connector by rotating the threaded ring clockwise out of the flat area around the *OPEN* marking.

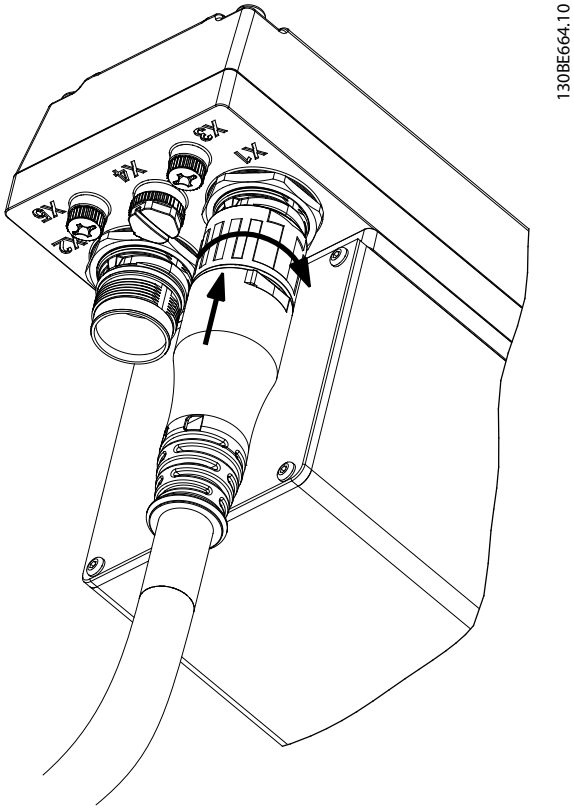
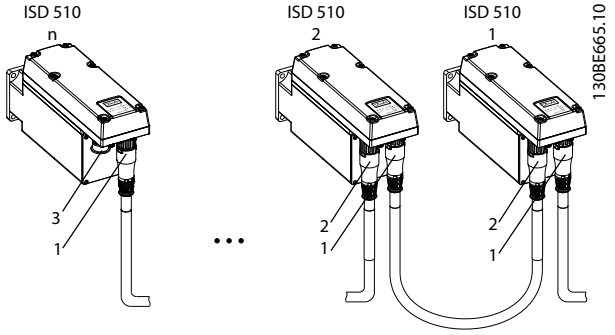


Illustration 5.7 Connecting the M23 Feed-In Cable

6. To add more servo drives in daisy-chain format, connect the male connector of the loop cable to the female connector (X2) of the 1st servo drive.
7. Connect the female connector of the loop cable to the male connector (X1) of the next servo drive, and so on.
8. Tighten the threaded rings by hand as described in step 5.
9. Ensure that there is no mechanical tension on the cables.



1	X1 Male connector
2	X2 Female connector
3	M23 Metal blind cap

Illustration 5.8 Adding Servo Drives in Daisy-Chain Format

10. Screw the M23 metal blind cap onto the unused M23 female output connector (X2) on the last servo drive in the ISD 510 servo system.
11. Tighten the metal blind cap until the sealing on the servo connector is covered.

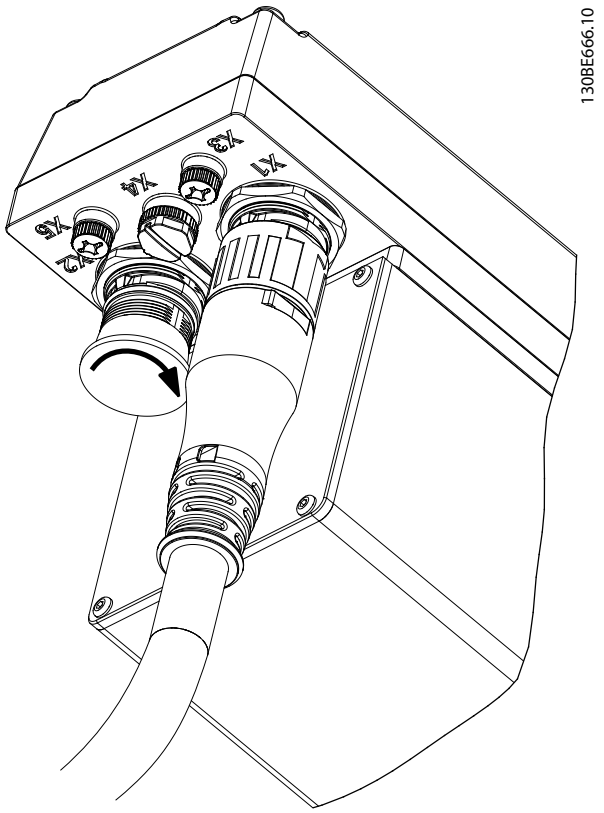


Illustration 5.9 Mounting the M23 Blind Cap

⚠CAUTION

RISK OF INJURY AND/OR EQUIPMENT DAMAGE

Failure to use the M23 metal blind cap may result in injury to the operator and/or damage to the servo drive.

- **Always fit the M23 metal blind cap as described in steps 10 and 11.**

NOTICE

An angled version of the M23 connector is also available. The procedure for connecting the angled M23 connector is the same as for the straight connector.

Disconnecting hybrid cables

1. Disconnect the SAB from its power source (mains network and U_{AUX}).
2. Wait for the minimum discharge time to elapse.
3. Remove the connector of the feed-in cable from the SAB.
4. Rotate the threaded ring on the feed-in cable connector on the servo drive counterclockwise until the marking *OPEN* on the cable connector is facing the servo drive.
5. Pull the connector away from the electronic housing.
6. Protective blind caps are provided for the X1 and X2 connectors. Mount the blind caps after removing the corresponding connector.

5.8.2.2 Connecting/Disconnecting Cables from Ports X3, X4, and X5

Cable routing

1. Avoid mechanical tension for all cables, especially regarding the range of motion of the installed servo drive.
2. Secure all cables in accordance with regulations and depending on conditions on site. Ensure that cables cannot come loose, even after prolonged operation.

Connecting I/O and/or encoder cables

1. Align the connector on the cable with the connector marked *X4* on the servo drive.
2. Press the connector towards the electronic housing of the servo drive and tighten the threaded ring of the connector by turning it clockwise.

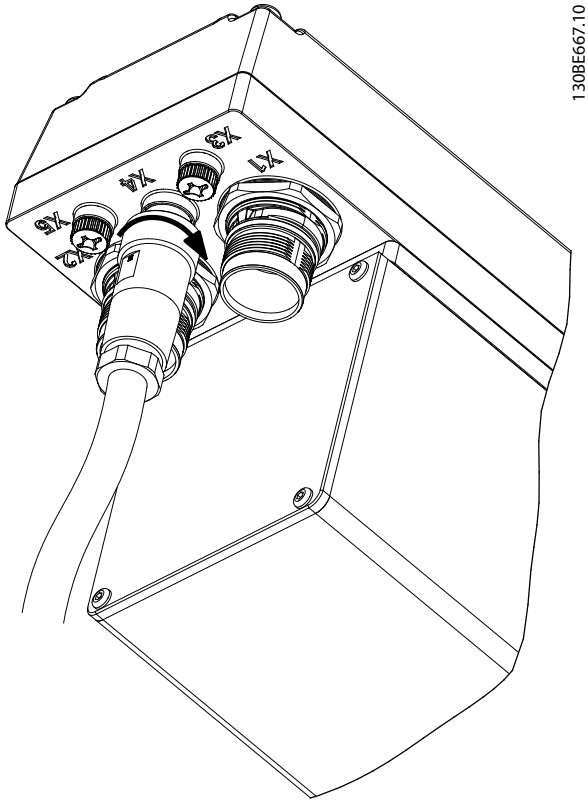


Illustration 5.10 Connecting the I/O and/or Encoder Cable

Illustration 5.10 shows the connection of an I/O or encoder cable with straight connector to *X4* on the servo drive.

NOTICE

The I/O and encoder cable is not supplied.

5

Connecting the LCP cable

1. Align the connector on the cable with the LCP connector marked *X5* on the servo drive.
2. Press the connector towards the electronic housing of the servo drive and tighten the threaded ring of the connector by turning it clockwise.

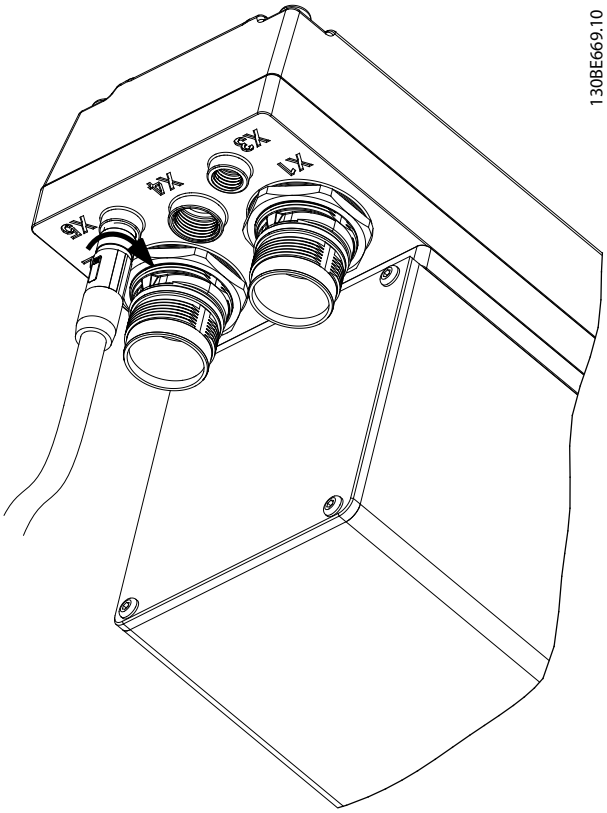


Illustration 5.11 Connecting the LCP Cable

NOTICE

The LCP cable is not supplied. It can be ordered as an accessory.

Connecting the 3rd Ethernet device cable

1. Align the connector on the cable with the Ethernet connector marked *X3* on the servo drive.
2. Press the connector towards the electronic housing of the servo drive and tighten the threaded ring by turning it clockwise.

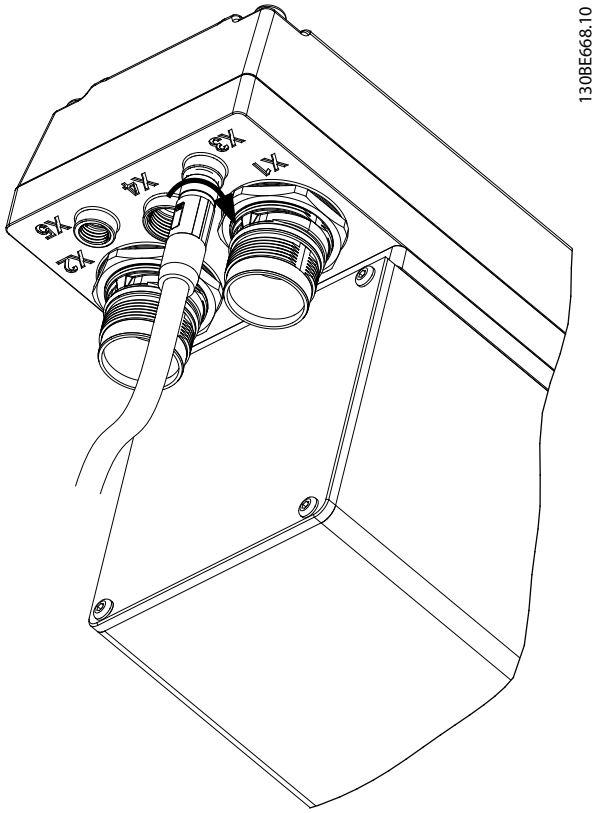


Illustration 5.12 Connecting the 3rd Ethernet Device Cable

Disconnecting cables from ports X3, X4, and X5

1. Loosen the threaded ring of the connector by turning it counterclockwise.
2. Disconnect the cable from the servo drive.
3. Protective blind caps are provided for the X3, X4, and X5 connectors. Mount the blind caps after removing the corresponding connector.

6 Commissioning

⚠WARNING

UNINTENDED START

The ISD 510 servo system contains servo drives that are connected to the electrical supply network and can start running at any time. This may be caused by a fieldbus command, a reference signal, or by clearing a fault condition. Servo drives and all connected devices must be in good operating condition. A deficient operating condition may lead to death, serious injury, damage to equipment, or other material damage when the servo drive is connected to the electrical supply network.

- **Take suitable measures to prevent unintended starts.**

6.1 Pre-Commissioning Checklist

Always check the following before initial commissioning and before commencing operation after extended downtime or storage:

- Are all threaded connectors of mechanical and electrical components firmly tightened?
- Is the free circulation of cooling air (inlet and outlet) assured?
- Are the electrical connections correct?
- Is contact protection in place for rotating parts and surfaces that can become hot?

6.2 ID Assignment

6.2.1 EtherCAT®

EtherCAT® needs no special ID assignment (IP address). Special ID assignment is only required, when using indirect communication via the ISD Toolbox software (see *chapter 6.5.4 ISD Toolbox Communication* for further information).

6.2.2 Ethernet POWERLINK®

Ethernet POWERLINK® master communication cannot be active when using the ISD Toolbox to assign IDs to the devices. ID assignment via the ISD Toolbox is only possible when acyclic Ethernet POWERLINK® communication is used. If cyclic communication is already started, send an *NMT reset* command to all devices manually or perform a power cycle to stop the cyclic Ethernet POWERLINK® communication.

6.2.2.1 Single Device ID Assignment

When assigning an ID to a single device, the *Device Information* window in the ISD Toolbox can be used (see the *VLT® Integrated Servo Drive ISD® 510 System Programming Guide* for more information). Setting an ID to a device can also be done via the LCP.

Setting the node ID directly on a servo drive or on the SAB

All IP-related parameters are located in parameter group *12-0* IP Settings*. According to the Ethernet POWERLINK® standard, the IP address is fixed to 192.168.100.xxx. The last number is the value in parameter *12-60 Node ID*. For parameter *12-02 Subnet Mask*, the IP address is fixed to 255.255.255.0 and cannot be changed.

Attach the LCP to the servo drive or SAB for which the *Node ID* should be changed. Change the value in parameter *12-60 Node ID* to select the desired IP address.

Setting the Node ID for a single servo drive via the SAB

It is also possible to change the *Node ID* of a servo drive when the LCP is connected to the SAB. This functionality is contained in parameter group *54-** ID Assignment* on the SAB in sub-group *54-1* Manual*.

1. Attach the LCP to the SAB that is connected to the servo drive for which the *Node ID* should be changed.
2. Configure the parameters:
   - 2a *54-10 EPL ID assignment line*
   - 2b *54-11 Drive index* (position of the servo drive in the line)
   - 2c *54-12 EPL ID assignment assign ID*
3. Set parameter *54-13 EPL ID assignment start* to *[1] start*.

6.2.2.2 Multiple Device ID Assignment

When assigning IDs to several devices (for example, when setting up a new machine), the ISD Toolbox sub-tool *SAB ID assignment* can be used (see the *VLT® Integrated Servo Drive ISD® 510 System Programming Guide* for more information). Setting the IDs of all the servo drives connected to an SAB at the same time can also be done via the LCP when it is connected to the SAB.

Setting the Node IDs of all servo drives on an SAB line

The automatic SAB ID assignment is used for automatically setting the *Node IDs* on all servo drives for a specified SAB line. This functionality is contained in parameter group *54-** ID Assignment* on the SAB in sub-group *54-0* Automatic*.

1. Attach the LCP to the SAB that is connected to the servo drives for which the *Node IDs* should be changed.
2. Configure the parameters:
   2a *54-02 EPL ID assignment line*
   2b *54-03 EPL ID assignment start ID*
3. Set parameter *54-04 EPL ID assignment start* to *[1] start*.

6.3 Switching on the ISD 510 Servo System

Complete the cabling of the ISD 510 servo system before applying power to the servo drives. This cabling provides the supply voltage and the communication signals for the ISD 510 servo system. This is a fundamental requirement for operation of the servo drives.

6

The ISD 510 servo system can be switched on in 3 ways:

- If the SAB is supplied with mains, STO, and U_{AUX}, communication to the SAB internal controller is established and U_{AUX} is automatically passed on to the connected servo drives.
- If the SAB is only powered by U_{AUX}, then the SAB and servo drive control units are running.
- If the SAB is only supplied with mains power, then only the SAB control unit is running and power is not passed on to the connected servo drives.

Procedure for switching on the ISD 510 servo system

1. Switch on U_{AUX} power to enable communication to the SAB and servo drives to be established.
2. Switch on the mains.
3. Set the SAB to state *Normal operation* (see *chapter 6.5.5 ISD Toolbox Commissioning* and *chapter 6.6.2 Simple Programming Template*).

Now the SAB and servo drives are ready for operation.

6.4 Basic Programming

The libraries provided for the ISD 510 servo system can be used in TwinCAT® V2 and in the Automation Studio™ (Version 3.0.90 and 4.x, supported platform SG4) environment to easily integrate the functionality without the need of special motion runtime on the controller. The provided function blocks conform to the PLCopen® standard. Knowledge of the underlying fieldbus communication and/or the CANopen® CiA DS 402 profile is not necessary.

The library contains:

- Function blocks for controlling and monitoring the servo drive and the SAB.
- Function blocks for all available motion commands of the servo drive.
- Function blocks and structures for creating *Basic CAM* profiles.
- Function blocks and structures for creating *Labeling CAM* profiles.

6.4.1 Programming with Automation Studio™

6.4.1.1 Requirements

The following files are needed to integrate the VLT® Integrated Servo Drive ISD® 510 and the VLT® Servo Access Box into an Automation Studio™ project:

- Package of libraries for the ISD 510 servo system: *Danfoss_VLT_ISD_510.zip*
- XDD file (XML Device Description) for the servo drive: *0x0300008D_ISD510.xdd*
- XDD file (XML Device Description) for the SAB: *0x0300008D_SAB.xdd*

6.4.1.2 Creating an Automation Studio™ Project

The following instructions are for Automation Studio™ 3.0.90.

Information on how to install Automation Studio™ can be found in detail in the Automation Studio™ help. Open the *B&R Help Explorer* and go to [Automation software → Software Installation → Automation Studio].

Information on how to create a new project in Automation Studio™ can be found in detail in the Automation Studio™ help. Open the *B&R Help Explorer* and go to [Automation Software → Getting Started → Creating programs with Automation Studio → First project with X20 CPU].

How to include the ISD 510 libraries into an Automation Studio™ project:

1. In the *Logical View*, open the menu entry [File → Import…].
2. In the next window, select the *Danfoss_VLT_ISD_510.zip* file (according to the location on the hard drive).
3. Click on *Open*.
4. Assign the libraries to the CPU in the next window.
5. Click on *Finish*. Now the libraries are integrated into the Automation Studio™ project.

A new folder containing the ISD libraries is created during integration:

- ISD_51x

- Contains program organization units (POUs) that are defined by PLCopen® (name starting with MC_) and POUs that are defined by Danfoss (name starting with DD_). The Danfoss POUs provide additional functionality for the servo drive.
- It is possible to combine POUs defined by PLCopen® with POUs defined by Danfoss.
- The names of the POUs that target the servo drive all end with _ISD51x.

- SAB_51x
  - Contains POUs that are defined by Danfoss (name starting with DD_) and provide the functionality for the SAB.
  - The names of the POUs that target the SAB all end with _SAB.
- BasCam_51x
  - Contains POUs for the creation of basic CAMs.
- LabCam_51x
  - Contains POUs for the creation of labeling CAMs.
- Intern_51x
  - Contains POUs that are needed internally for the libraries.
  - Do not use these POUs in an application.

When integrating the ISD_51x package, some standard libraries are integrated automatically, unless they are already part of the project.

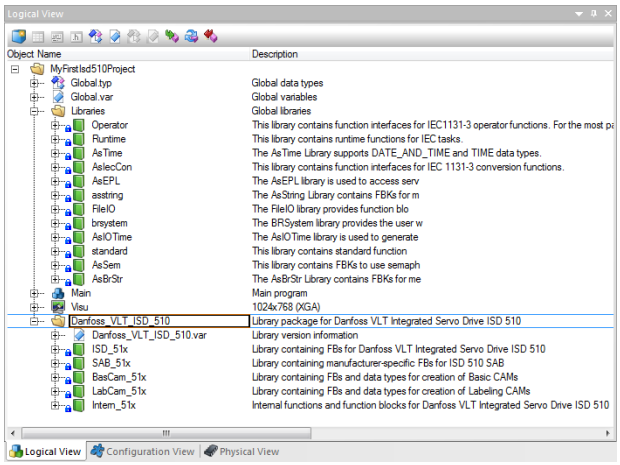


Illustration 6.1 Standard Libraries

NOTICE

Do not remove these libraries otherwise the ISD libraries will not work.

Inside the library, the following lists of constants are defined:

- AxisErrorCodes
  - Constants for error codes of the axis.
  - Error codes can be read using the function block *MC_ReadAxisError_ISD51x* and/or *DD_ReadAxisWarning_ISD51x*.
- AxisTraceSignals
  - Constants for the trace signals of the axis.
  - Intended to be used with the function block *DD_Trace_ISD51x*.
- BasCam_51x
  - Constants for the creation of basic CAMs.
- CamParsingErrors
  - Constants for parsing problems of a CAM.
  - Error reason is returned by function block *MC_CamTableSelect_ISD51x*.
- Danfoss_VLT_ISD510
  - Contains the version information of the library
- FB_ErrorConstants
  - Constants for errors inside POUs.
  - The reason is given in an output *ErrorInfo.ErrorID* that is available in all POUs.
- Intern_ISD51x
  - Constants which are needed internally for the library.
  - They are not intended to be used in an application.
- LabCam_51x
  - Constants for the creation of labeling CAMs.
- SabErrorCodes
  - Constants for error codes of the SAB.
  - Error codes can be read using the function block *DD_ReadSabError_SAB* and/or *DD_ReadSabWarning_SAB*.
- SabTraceSignals

- Constants for the trace signals of the SAB.
- Intended to be used with the function block *DD_Trace_SAB*.

- SdoAbortCodes
  - Constants for errors concerning reading and writing of parameters.
  - The reason is given in an output *AbortCode* that is available in several POUs.

Instantiating AXIS_REF_ISD51x

Inside the library *ISD_51x* there is a function block called *AXIS_REF_ISD51x*. Create 1 instance of this function block for every servo drive that has to be controlled or monitored. To create a link to the physical servo drive, link each instance to 1 physical servo drive. This is done (in the *Logical View*) by initializing each instance with its node number and the slot name (for example, 'IF3') it is connected to.
Each instance of *AXIS_REF_ISD51x* is the logical representation of 1 physical servo drive.

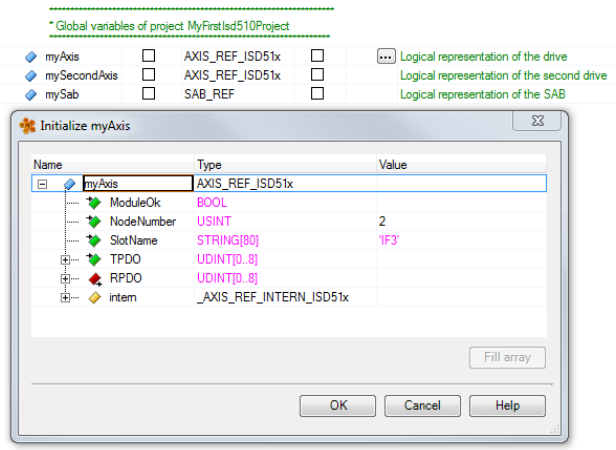


Illustration 6.2 Instantiation of AXIS_REF and Setting of Initial Values

Instantiating SAB_REF

Inside the library *SAB_51x* there is a function block called *SAB_REF*. Create 1 instance of this function block for every SAB that has to be controlled or monitored. To create a link to the physical SAB, link each instance to 1 physical SAB. This is done (in the *Logical View*) by initializing each instance with its node number and the slot name (for example, *IF3*) it is connected to.
Each instance of *SAB_REF* is the logical representation of 1 physical SAB.

Import fieldbus device and add to Physical View

The next step is to import the ISD 510 servo drive into Automation Studio™:

1. Select the menu entry [Tools → Import Fieldbus Device…].
2. Select the XDD file *0x0300008D_ISD510.xdd* from its location on the hard drive.
   This import only has to be done once per project. The device is then known to Automation Studio™.
3. The ISD 510 servo drive can now be added to the Ethernet POWERLINK® interface of the controller in the *Physical View*:
   - 3a Right-click on the controller in the *Physical View* and select [Open → POWERLINK].
   - 3b Right-click on the interface and select *Insert*….
   - 3c In the *Select controller module* window, select the ISD 510 in the group *POWERLINK Devices*.
   - 3d Click on *Next*.
   - 3e In the next window, enter the node number of the servo drive.

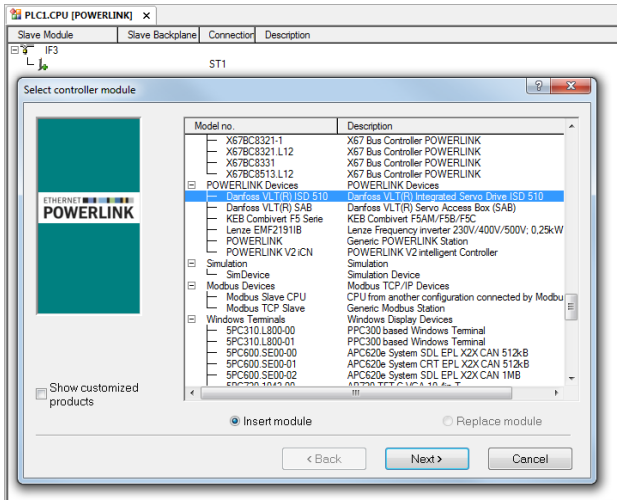


Illustration 6.3 Add an ISD 510 Servo Drive to the Project

NOTICE

The procedure described here applies to Automation Studio™ Version 3.0.90. Refer to the Automation Studio™ Help for the corresponding steps with V4.x.

For each physical servo drive, add 1 entry to the Physical View of Automation Studio™.

The next step is to import the Servo Access Box into Automation Studio™:

1. Select the menu entry [Tools → Import Fieldbus Device…].
2. Select the XDD file *0x0300008D_SAB.xdd* from its location on the hard drive. This import only has to be done once per project. The device is then known to Automation Studio™.
3. The SAB can now be added to the Ethernet POWERLINK® interface of the controller in the *Physical View*:
   - 3a Right-click on the controller in the *Physical View* and select [Open → POWERLINK].
   - 3b Right-click on the interface and select *Insert…*.
   - 3c In the *Select controller module* window, select the SAB in the group *POWERLINK Devices*.
   - 3d Click on *Next*.
   - 3e In the next window, enter the node number of the SAB.

For each physical SAB, add 1 entry to the *Physical View* of Automation Studio™.

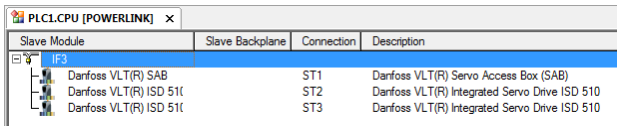


Illustration 6.4 1 SAB and 2 ISD 510 Servo Drives Added to the Ethernet POWERLINK® Interface

I/O configuration and I/O mapping

The *I/O Configuration* of the servo drive has to be parameterized in a way that the library has access to all necessary objects:

1. Right-click on the entry of the ISD 510 and select *Open I/O Configuration*.
2. In the *Channels* section, change the *Cyclic transmission* of the following objects:
   - 2a All subindexes of object *0x5050* (Lib pdo rx_I5050 ARRAY[]) to *Write*.
   - 2b All subindexes of object *0x5051* (Lib pdo tx_I5051 ARRAY[]) to *Read*.

The *I/O Configuration* of the SAB has to be parameterized in a way that the library has access to all necessary objects:

1. Right-click on the entry of the SAB and select *Open I/O Configuration*.
2. In the *Channels* section, change the *Cyclic transmission* of the following objects:
   - 2a All subindexes of object *0x5050* (Lib pdo rx_I5050 ARRAY[]) to *Write*.
   - 2b All subindexes of object *0x5051* (Lib pdo tx_I5051 ARRAY[]) to *Read*.

These settings configure the cyclic communication with the device. These parameters are needed to make the library work.

NOTICE

It is possible to use copy & paste to apply the same *I/O Configuration* to multiple devices of the same type.

NOTICE

Set *Module supervised* to *off* for the servo drives and the SAB. The parameter is found in the *I/O Configuration* of the device.

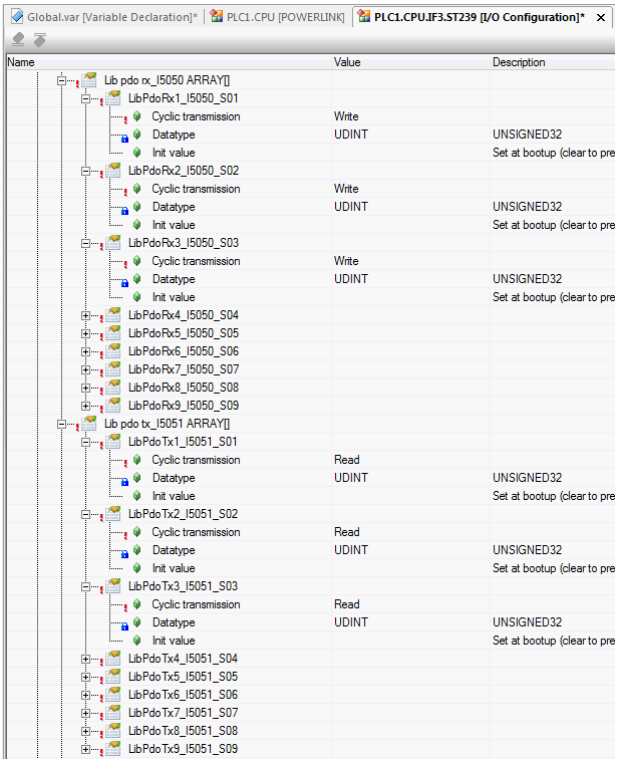


Illustration 6.5 I/O Configuration of an ISD 510 Device

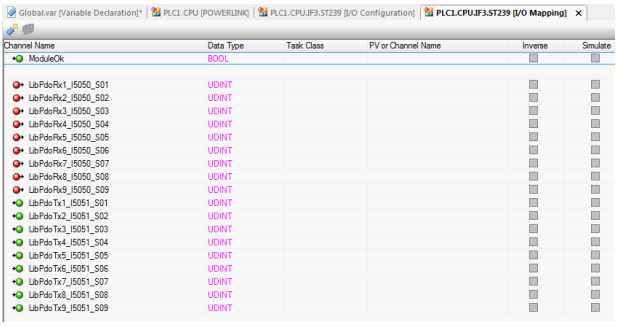


Illustration 6.6 I/O Mapping after Successful Configuration

Map the inputs and outputs of the instance of the *AXIS_REF_ISD51x* function block and the physical data points of the servo drive according to *Illustration 6.7* (here *myAxis* is an instance of *AXIS_REF_ISD51x*):

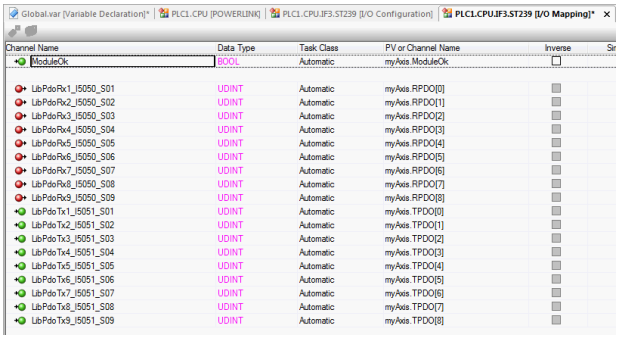


Illustration 6.7 I/O Mapping of an ISD 510 Servo Drive

Map the inputs and outputs of the instance of the *SAB_REF* function block and the physical data points of the SAB accordingly.

Cycle time settings

The minimum cycle time is 400 µs. The ISD 510 devices can run Ethernet POWERLINK® cycle times in multiples of 400 µs and multiples of 500 µs. The devices are automatically parameterized by the PLC on start-up, depending on the Ethernet POWERLINK® configuration of the physical interface. The Ethernet POWERLINK® configuration can be accessed by right-clicking [CPU → Open IF3 POWERLINK Configuration] in the *Physical View*.

NOTICE

The task cycle time of the PLC program should be the same as the Ethernet POWERLINK® cycle time. Otherwise, data could be lost and performance may be reduced.

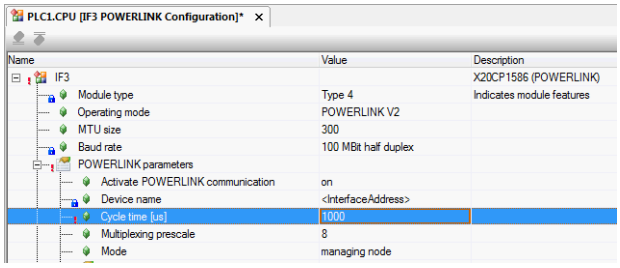


Illustration 6.8 Ethernet POWERLINK® Configuration Window to Parameterize Ethernet POWERLINK® Cycle Time

Set the PLC cycle time in Automation Studio™:

1. Right-click [CPU → Open Software Configuration] in the *Physical View*.
2. Ensure that the PLC cycle time is the same as the Ethernet POWERLINK® cycle time.

6.4.1.3 Connecting to the PLC

Information on how to connect to the PLC can be found in detail in the Automation Studio™ Help. Open the *B&R Help Explorer* and go to [Automation Software → Getting Started → Creating programs with Automation Studio → First project with X20 CPU → Configure online connection].

6.4.2 Programming with TwinCAT®

6.4.2.1 ISD Deliverables

To integrate the servo drive and the SAB into a TwinCAT® project, the following files are needed:

- Library for the ISD 510 servo system: *Danfoss_VLT_ISD_510.lib*
- ESI file (EtherCAT® Slave Information) for the servo drive and the SAB: *Danfoss ISD 500.xml*

6.4.2.2 Creating a TwinCAT® Project

Information on how to install TwinCAT® can be found in detail in the Beckhoff Information System (infosys.beckhoff.com). Open the information system and select [TwinCAT 2 → TwinCAT Quick Start → Installation].

Information on how to create a new project in TwinCAT® can be found in detail in the Beckhoff Information System (http://infosys.beckhoff.com). Open the information system and select [TwinCAT 2 → TwinCAT Quick Start or TwinCAT 2 → TX1200 TwinCAT PLC → TwinCAT PLC Control].

How to include the ISD 510 library into a TwinCAT® project:

1. In the *Resources* tab of TwinCAT® PLC Control, open the *Library Manager*.
2. In the upper left area of the *Library Manager* window, right-click and select *Additional Library ….*
3. Select the *Danfoss_VLT_ISD_510.lib* file (according to the location on the hard drive).
4. Click on *Open*. Now the libraries are integrated into the TwinCAT® PLC control project.

Inside the library, the POUs are organized into folders:

- BasCam_51x
  - Contains POUs for the creation of basic CAMs.
- ISD_51x
  - Contains POUs defined by PLCopen® (Name starting with MC_) and POUs defined by Danfoss (name starting with DD_). The POUs defined by Danfoss provide additional functionality for the axis.
  - It is possible to combine POUs defined by PLCopen® with POUs defined by Danfoss.
  - The names of the POUs that target the servo drive all end with _ISD51x.
- Intern_51x
  - Contains POUs that are needed internally for the libraries.
  - Do not use these POUs in an application.
- LabCam_51x
  - Contains POUs for the creation of labeling CAMs.
- SAB_51x
  - Contains POUs that are defined by Danfoss (Name starting with DD_) and provide the functionality for the SAB.
  - The names of the POUs that target the SAB all end with _SAB.

When integrating the ISD 510 library, some standard libraries are integrated automatically, unless they are already part of the project.

NOTICE

Do not remove these libraries otherwise the ISD libraries will not work.

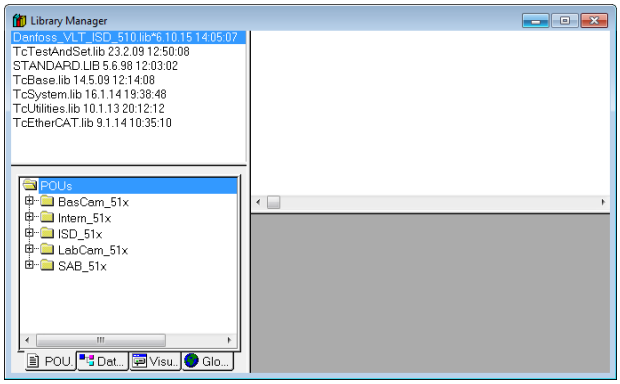


Illustration 6.9 Library Manager after Including the ISD 51x Library

Inside the library, the following lists of constants are defined:

- AxisErrorCodes
  - Constants for error codes of the axis.
  - Error codes can be read using the function block *MC_ReadAxisError_ISD51x* and/or *DD_ReadAxisWarning_ISD51x*.
- AxisTraceSignals
  - Constants for the trace signals of the axis.
  - Intended to be used with the function block *DD_Trace_ISD51x*.
- BasCam_51x
  - Constants for the creation of basic CAMs.
- CamParsingErrors
  - Constants for parsing problems of a CAM.
  - Error reason is returned by function block *MC_CamTableSelect_ISD51x*.
- Danfoss_VLT_ISD510
  - Contains the version information of the library.
- FB_ErrorConstants
  - Constants for errors inside POUs.
  - The reason is given in an output *ErrorInfo.ErrorID* that is available in all POUs.
- Intern_51x
  - Constants that are needed internally for the library.
  - They are not intended to be used in an application.
- LabCam_51x

- Constants for the creation of labeling CAMs.

- SabErrorCodes
  - Constants for error codes of the SAB.
  - Error codes can be read using the function block *DD_ReadSabError_SAB* and/or *DD_ReadSabWarning_SAB*.
- SabTraceSignals
  - Constants for the trace signals of the SAB.
  - Intended to be used with the function block *DD_Trace_SAB*.
- SdoAbortCodes
  - Constants for errors concerning reading and writing of parameters.
  - The reason is given in an output *AbortCode* that is available in several POUs.

Instantiating AXIS_REF_ISD51x

Inside the folder *ISD_51x* in library *Danfoss_VLT_ISD_510* there is a function block called *AXIS_REF_ISD51x*. Create 1 instance of this function block for every servo drive that has to be controlled or monitored. Each instance of *AXIS_REF_ISD51x* is the logical representation of 1 physical servo drive.

Instantiating SAB_REF

Inside the folder *SAB_51x* in library *Danfoss_VLT_ISD_510* there is a function block called *SAB_REF*. Create 1 instance of this function block for every SAB that has to be controlled or monitored.

Each instance of SAB_REF is the logical representation of 1 physical SAB.

NOTICE

When compiling the library, check that the option *Replace constants* under [Project → Options... → Build] is activated.

Afterwards, save and compile the project to update the automatically generated variable information for the *TwinCAT® System Manager*.

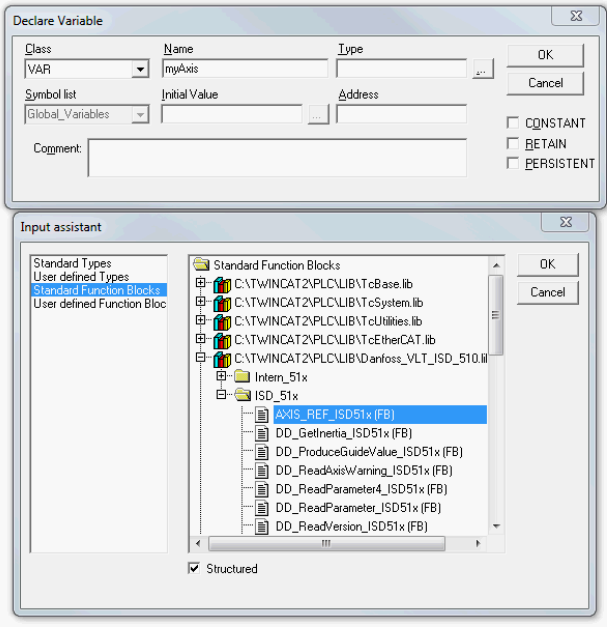


Illustration 6.10 Instantiation of AXIS_REF_ISD51x

Append a PLC Project into TwinCAT® System Manager

To create a link between the *TwinCAT® PLC Control* project and the *TwinCAT® System Manager*, connect the saved project, especially the inputs and outputs, to the *TwinCAT® System Manager*:

1. To add the project information to the *TwinCAT® System Manager*, right-click on *PLC-Configuration* and select *Append PLC project*....
2. In the *Insert IEC1131 Project* window, select the project information file according to the location on the hard drive. The file has the same name as the PLC project, but with the file extension *.tpy*.
3. Click on *Open*.

Import fieldbus device and add to TwinCAT®

The next step is to import the servo drive and the SAB into the *TwinCAT® System Manager* software:

1. Copy the ESI file *Danfoss ISD 500.xml* into the folder *TwinCAT Installation Folder\Io\EtherCAT* on the hard drive. This only has to be done once per project. The *TwinCAT® System Manager* automatically searches for ESI files at this location on the hard drive during startup.
2. To add an EtherCAT® master, right-click on [I/O-Configuration → I/O Devices] and select *Append Device*....
3. In the following window, select [EtherCAT → EtherCAT] (see *Illustration 6.11*).
4. Click on *OK*.
5. Select *Device 1 (EtherCAT®)* and select the correct *Network Adapter* on the right side of the window in the *Adapter* tab.

6. To add an SAB, right-click on *Device1 (EtherCAT®)* and select *Append Box*….
7. In the *Insert EtherCAT Device* window, select [Danfoss GmbH → VLT® ISD Series → VLT® Servo Access Box L1] for Line 1 of the SAB (and/or VLT® Servo Access Box L2 for Line 2 of the SAB).
8. Click on *OK*.
9. To add a servo drive to line 1 of the SAB, right-click on *Box 1 (VLT® Servo Access Box L1)* and select *Append Box*...
10. In the *Insert EtherCAT Device* window, select [Danfoss GmbH → VLT® ISD Series → VLT® ISD 510 Integrated Servo Drive].
11. Click on *OK*.
12. Answer the question if the drive is used as an NC axis with *No*. If the drive should be used as an NC axis, see *chapter 6.4.2.3 Configuration as a TwinCAT® NC Axis*.

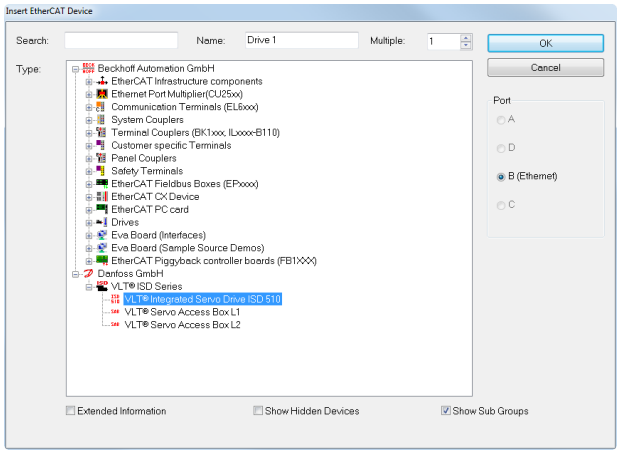


Illustration 6.12 Add an ISD 510 Servo Drive to the Project

6

NOTICE

Add 1 entry to the EtherCAT® master of the *TwinCAT® System Manager* for each physical servo drive and SAB. Add the servo drive to the correct SAB line.

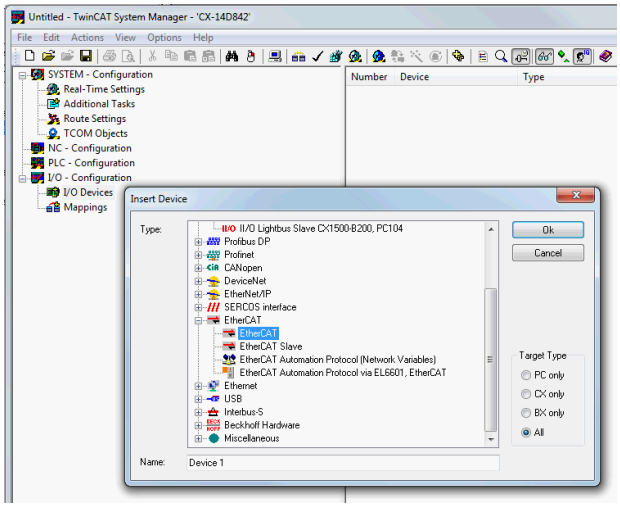


Illustration 6.11 Add an EtherCAT® Master to the Project

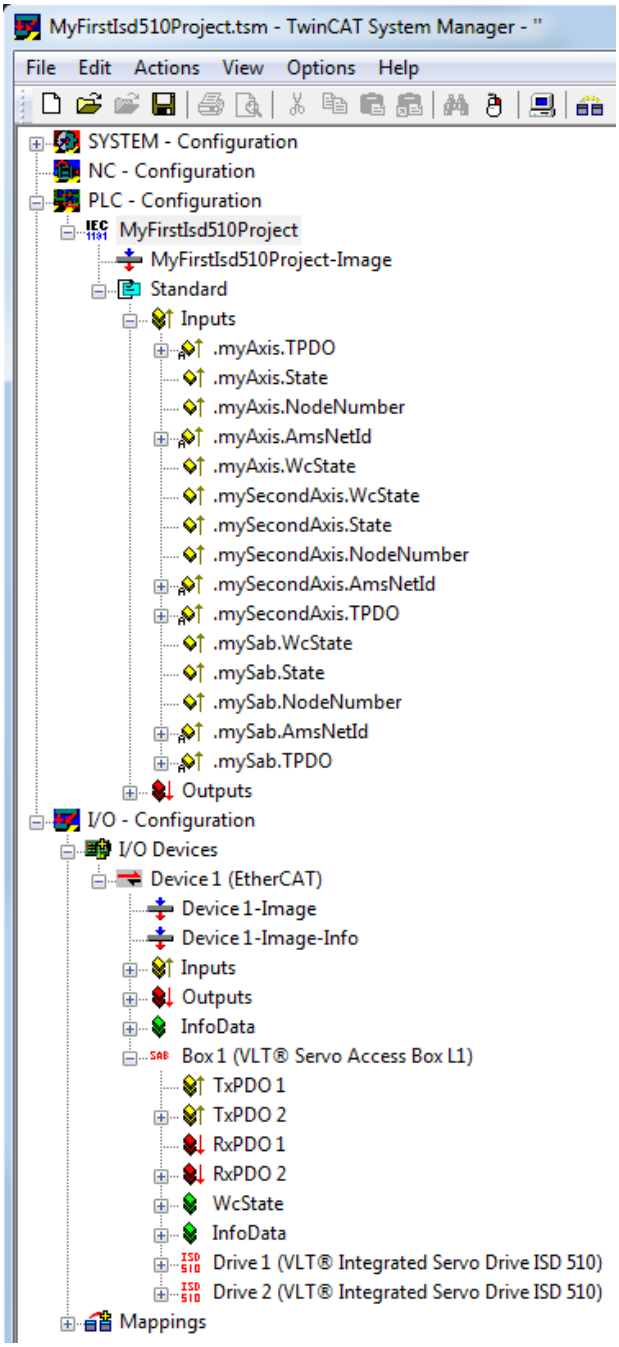


Illustration 6.13 TwinCAT® System Manager after Appending the PLC Project and Adding an SAB and 2 Servo Drives

I/O configuration and I/O mapping

When connecting >1 servo drive, connect port C (X2) of the previous drive to port A (X1) of the next servo drive. The SAB port assignment must also be followed, see *chapter 3.8.1 EtherCAT®*. If the hardware set-up is already present, the TwinCAT® System Manager *Scan devices* function can be used to automatically add the connected devices to the configuration in the correct order.

The servo drive has to be configured so that the PDO mapping matches the requirements of the library. This is done inside the *TwinCAT® System Manager*.

1. Click on the ISD servo drive entry.
2. Select the *Slots* tab on the right side of the window.
3. Remove the current PDO configuration by selecting the entry *Module 1 (CSV PDO)* in the *Slot* box.
4. Click on *X*.
5. Select Library PDO in the Module box.
6. Click on <.

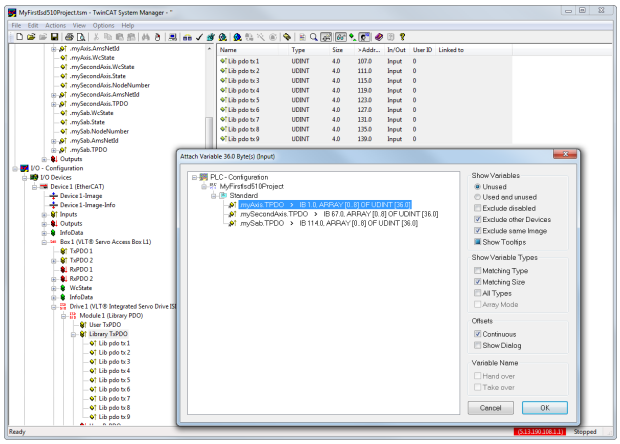


Illustration 6.14 ISD 510 Servo Drive with Correct I/O Configuration

Attach the input and output variables of the PLC program to the physical inputs and outputs of the device. This is done inside the *TwinCAT® System Manager* so that the library has access to all necessary objects.

1. Select *Library TxPDO* via menu [I/O-Configuration → I/O Devices → Device1 (EtherCAT®) → Box 1 (VLT® Servo Access Box L1) → Drive 2 (VLT® ISD 510 Integrated Servo Drive) → Module 1 (Library PDO) → Library TxPDO].
2. Select all entries *Lib pdo tx1* to *Lib pdo tx9* on the right side of the window (see *Illustration 6.15*).
3. Right-click and select *Change Multi Link*….
4. In the *Attach Variable 36.0 Byte(s) (Input)* window, select [PLC-Configuration → MyFirstIsd510Project → Standard → .myAxis.TPDO].
   Ensure that the *Matching Size* option is selected in the *Attach Variable* window.
5. Click *OK*.
6. Click on Library *RxPDO* via menu [I/O-Configuration → I/O Devices → Device1 (EtherCAT®) → Box1 (VLT® Servo Access Box L1) → Drive2 (VLT® ISD 510 Integrated Servo Drive) → Module1 (Library PDO) → Library RxPDO].
7. Select all entries *Lib pdo rx1* to *Lib pdo rx9* on the right side of the window.

8. Right-click and select *Change Multi Link…*.
9. In the *Attach Variable 36.0 Byte(s) (Output)* window select [PLC-Configuration → MyFirstIsd510Project → Standard → .myAxis.RPDO].
10. Click on *OK*.
11. Right-click on *WcState* via [I/O-Configuration → I/O Devices → Device1 (EtherCAT®) → Box1 (VLT® Servo Access Box L1) → Drive2 (VLT® ISD 510 Integrated Servo Drive) → WcState] and select *Change Link…*.
12. In the *Attach Variable State (Input)* window select [PLC-Configuration → MyFirstIsd510Project → Standard → .myAxis.WcState.
13. Click on *OK*.
14. Right-click on *State* via [I/O-Configuration → I/O Devices → Device1 (EtherCAT®) → Box1 (VLT® Servo Access Box L1) → Drive2 (VLT® ISD 510 Integrated Servo Drive) → InfoData] and select *Change Link…*.
15. In the *Attach Variable State (Input)* window select [PLC-Configuration → MyFirstIsd510Project → Standard → .myAxis.State.
16. Click on *OK*.
17. Right-click on *netId* via [I/O-Configuration → I/O Devices → Device1 (EtherCAT®) → Box1 (VLT® Servo Access Box L1) → Drive2 (VLT® ISD 510 Integrated Servo Drive) → InfoData → AdsAddr] and select *Change Link…*.
18. In the *Attach Variable netId (Input)* window select [PLC-Configuration → MyFirstIsd510Project → Standard → .myAxis.AmsNetId.].
19. Click on *OK*.
20. Right-click on *port* via [I/O-Configuration → I/O Devices → Device1 (EtherCAT®) → Box1 (VLT® Servo Access Box L1) → Drive2 (VLT® ISD 510 Integrated Servo Drive) → InfoData → AdsAddr] and select *Change Link…*.
21. In the *Attach Variable port (Input)* window select [PLC-Configuration → MyFirstIsd510Project → Standard → .myAxis.NodeNumber.].
22. Click on *OK*.

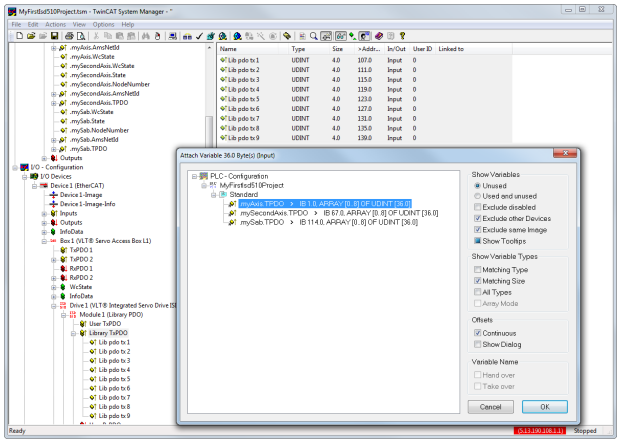


Illustration 6.15 Attaching Inputs and Outputs to the Physical Data Points

6

NOTICE

Repeat the steps 2–22 for Box 1 (VLT® Servo Access Box L1) and the instance mySAB.

To transfer the mappings back to the PLC program, select *Activate Configuration…* in menu item *Actions*.
After a rebuild in *TwinCAT® PLC Control*, the TwinCAT® configuration is according to *Illustration 6.16* (here *myAxis* and *mySecondAxis* are instances of *AXIS_REF_ISD51x* and *mySAB* is an instance of *SAB_REF*). The concrete addresses can be different.

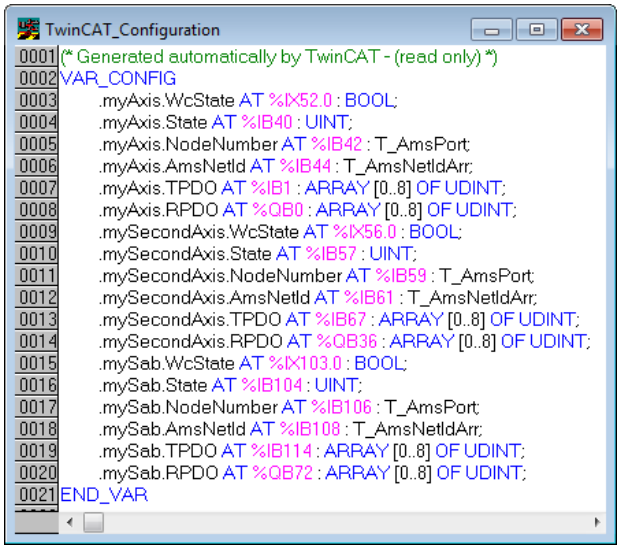


Illustration 6.16 TwinCAT® Configuration: I/O Mapping of 2 Servo Drives and an SAB

NOTICE

It is recommended to put the SAB to a separate SYNC unit so that the communication to the SAB is not interrupted if the U_{AUX} supply to the servo drives is switched off due to an error.

Cycle time settings

The minimum cycle time is 400 µs. The ISD 510 devices can run EtherCAT® cycle times in multiples of 400 µs or 500 µs. The devices are automatically parameterized by the PLC on start-up, depending on the EtherCAT® configuration of the physical interface. The system base time can be accessed by selecting [SYSTEM-Configuration → Real-Time Settings] in the *TwinCAT® System Manager*. Multiples of this base time can then be used as EtherCAT® cycle times.

NOTICE

Set the task cycle time of the PLC program to be the same as the EtherCAT® cycle time. Otherwise data can get lost and performance is reduced.

Set the PLC cycle time in *TwinCAT® PLC Control*:

1. Double-click *Task configuration* in the *Resources* tab.
2. Ensure that the PLC cycle time is the same as the EtherCAT® cycle time.

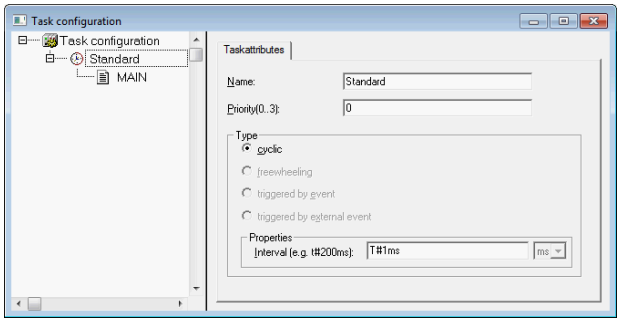


Illustration 6.17 Task Configuration to Parameterize PLC Cycle Time

NOTICE

After changing the task cycle time in *TwinCAT® PLC Control*, carry out a *ReScan* of the PLC configuration inside the *TwinCAT® System Manager* to update the settings. Afterwards, activate the configuration in the PLC.

6.4.2.3 Configuration as a TwinCAT® NC Axis

It is possible to use the servo drives with the built-in NC functionality of TwinCAT®. Everything that is related to the SAB needs to be done as described in *chapter 6.4.2.2 Creating a TwinCAT® Project*.

1. In addition to the *Danfoss_VLT_ISD_510.lib* file, include the *TcMC2.lib* file (the *Danfoss_VLT_ISD_510.lib* file is still needed for the SAB to be operated).
2. Create 1 instance of *AXIS_REF* (instead of *AXIS_REF_ISD51x*) for each servo drive that is used as an NC axis.
3. Append the PLC project into the TwinCAT® System Manager, import the devices and add them to TwinCAT® as described in *chapter 6.4.2.2 Creating a TwinCAT® Project*, however in the last step, answer the question if the servo drive is used as an NC axis with *Yes*. Then an NC task is created automatically.

In the TwinCAT® System Manager a different *I/O Configuration* needs to be selected for the drives that are used as NC axes.

1. Depending on the mode of operation to be used, select either the slot *CSP PDO* or *CSV PDO*. Per default, *CSV PDO* is mapped and pre-selected. If the drive should work with *CSP PDO*, the variables need to be mapped:
   1a In the *Settings* Tab of the NC Axis select [NC-Configuration → NC-Task 1 SAF → Axes → Axis 1]. Click on the *Link To (all Types)…* button and select the desired servo drive.
2. In the same tab, select the preferred *Unit*.
3. Depending on the selected *Unit*, adjust the *Scaling Factor* for the axis encoder via menu [NC-Configuration → NC-Task 1 SAF → Axes → Axis 1 → Axis 1_Enc] in the *Parameter* tab.
   Example: When the unit *Degrees* is selected, the scaling factor is $360°/2^{20}$ = 0.00034332275390625.
4. Set the *Reference Velocity* in the *Parameter* tab via menu [NC-Configuration → NC-Task 1 SAF → Axes → Axis 1 → Axis 1_Enc.
5. Set the *Output Scaling Factor* (Velocity) to *125*.
6. Test the functionality and the configuration in the *Online* tab of the axis.

6.4.2.4 Connecting to the PLC

Information on how to connect to the PLC can be found in detail in the Beckhoff Information System (*http://infosys.beckhoff.com*). Open the information system and go to [TwinCAT 2 → TwinCAT System Manager → Operation → Controls → Choose Target System].

6.4.3 Programming Guidelines

Recommendations for implementation:

- Initialize parameters that usually do not change only once at the beginning of the program. In Automation Studio™, use the *_INIT* section.
- Call up function blocks that provide status or error information with *Enable* input at the beginning of the program.
- It is recommended to have 1 instance of the function block *MC_Power_ISD51x* for every axis in order to control its power stage. Call up this function block in every PLC cycle.
- It is recommended to have 1 instance of the function block *DD_Power_SAB* for every SAB to control the DC-link voltage on the output lines. Call up this function block in every PLC cycle.
- Call up function blocks that execute (motion) commands at the end of the program.
- Do not use any POUs of the library (folder) *Intern_51x*.
- Do not change the reference to the axis on a function block while it is busy.

Illustration 6.18 shows sample code for TwinCAT®.

MAIN (PRG-ST)

```
0001 PROGRAM MAIN
0002 VAR
0003     InitDone: BOOL;
0004     MC_ReadAxisInfo_ISD51x_0: MC_ReadAxisInfo_ISD51x;
0005     MC_ReadStatus_ISD51x_0: MC_ReadStatus_ISD51x;
0006     MC_MoveVelocity_ISD51x_0: MC_MoveVelocity_ISD51x;
0007     MC_Stop_ISD51x_0: MC_Stop_ISD51x;
0008     MC_Power_ISD51x_0: MC_Power_ISD51x;
0009     MC_ReadAxisError_ISD51x_0: MC_ReadAxisError_ISD51x;
0010 END_VAR
```

```
0001 IF NOT(InitDone) THEN
0002     (*Initialize inputs that usually do not change*)
0003     MC_ReadAxisInfo_ISD51x_0.Enable := TRUE;
0004     MC_ReadStatus_ISD51x_0.Enable := TRUE;
0005
0006     MC_MoveVelocity_ISD51x_0.Acceleration := 720000;
0007     MC_MoveVelocity_ISD51x_0.Deceleration := 360000;
0008     MC_MoveVelocity_ISD51x_0.TorqueLimit:= 800;
0009     MC_Stop_ISD51x_0.Deceleration := 360000;
0010
0011     InitDone := TRUE;
0012 END_IF
0013
0014 (*********************************************************)
0015 (* Read out status information                           *)
0016 (*********************************************************)
0017 MC_ReadAxisInfo_ISD51x_0(Axis := myAxis);
0018 MC_ReadStatus_ISD51x_0(Axis := myAxis);
0019 MC_ReadAxisError_ISD51x_0(Axis := myAxis);
0020
0021
0022 (*********************************************************)
0023 (* Application logic                                     *)
0024 (*********************************************************)
0025 (*If the drive is ready to be powered on, then enable FB MC_Power*)
0026 IF MC_ReadAxisInfo_ISD51x_0.ReadyForPowerOn THEN
0027     MC_Power_ISD51x_0.Enable := TRUE;
0028 END_IF
0029
0030 IF MC_ReadStatus_ISD51x_0.ErrorStop THEN
0031     MC_ReadAxisError_ISD51x_0.Enable := TRUE;
0032 END_IF
0033
0034
0035 (*********************************************************)
0036 (* Execute motion commands                               *)
0037 (*********************************************************)
0038 MC_Power_ISD51x_0(Axis := myAxis);
0039 MC_MoveVelocity_ISD51x_0(Axis := myAxis);
0040 MC_Stop_ISD51x_0(Axis := myAxis);
0041
```

Illustration 6.18 Sample Code for TwinCAT®

NOTICE

The full parameter list can be found in the *VLT® Integrated Servo Drive ISD® 510 System Programming Guide*.

6.5 ISD Toolbox

6.5.1 Overview

The ISD Toolbox is a standalone PC software designed by Danfoss. It is used for parameterization and diagnostics of the servo drives and the SAB. It is also possible to operate the devices in a non-productive environment. The ISD Toolbox contains several functionalities, called sub-tools, which in turn provide various functionalities.

The most important sub-tools are:

- *Scope* for visualization of the tracing functionality of the servo drives and SAB.
- *Parameter list* for reading/writing parameters.
- *Firmware update*
- *Drive control/SAB control* to operate the servo drives and/or SAB for testing purposes.
- *CAM editor* for designing CAM profiles for the servo drives.

The detailed description of the ISD Toolbox functionality and the full list of parameters can be found in the *VLT® Integrated Servo Drive ISD® 510 System Programming Guide*.

6.5.2 System Requirements

To install the ISD Toolbox software, the PC must meet the following requirements:

- Supported hardware platforms: 32-bit, 64-bit.
- Supported operating systems: Windows XP Service Pack 3, Windows 7, Windows 8.1.
- .NET framework version: 3.5 Service Pack 1.
- Minimum hardware requirements: 512 MB RAM, Intel Pentium 4 with 2.6 GHz or equivalent, 20 MB hard disk space.
- Recommended hardware requirements: Minimum 1 GB RAM, Intel Core i5/i7 or compatible.

6.5.3 Installation

Administrator rights are required for installing the software with the Windows operating system. Contact your administrator if necessary.

1. Check that your system meets the system requirements as described in *chapter 6.5.2 System Requirements*.
2. Download the ISD Toolbox installation file (http://vlt-drives.danfoss.com/products/engineering-software/software-download/).
3. Right-click on the *.exe* file and select *Run as administrator*.
4. Follow the on-screen instructions to complete the installation process.

6.5.4 ISD Toolbox Communication

This chapter describes the Ethernet specific network interface settings needed by the ISD Toolbox. There are 2 basic communication methods: direct communication and indirect communication. Their particular network settings are described in the respective sections.

Read and perform the steps with care - incorrect network configurations can lead to loss of connectivity of a network interface.

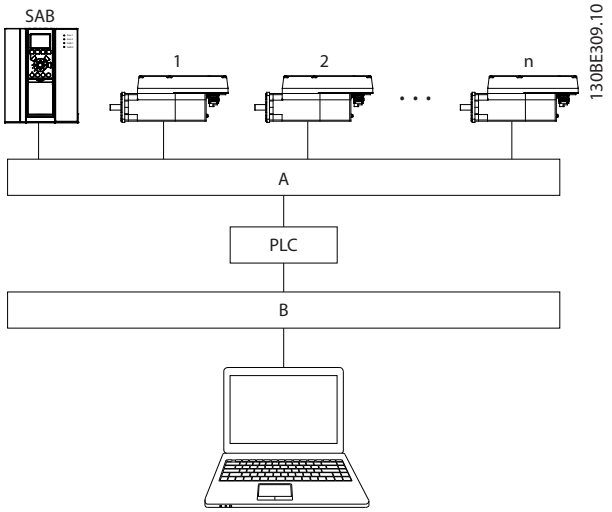
Firewall
Depending on the firewall settings and the fieldbus used, the messages sent and received by the ISD Toolbox may be blocked by the firewall on the ISD Toolbox host system. This may lead to a loss of communication and the inability to communicate with the devices on the fieldbus. Therefore, ensure that the ISD Toolbox is allowed to communicate through the firewall on the ISD Toolbox host system. Read and perform the steps with care - inappropriate changes to firewall settings may lead to security issues.

NOTICE

When using a dedicated network interface, the ISD Toolbox should be allowed to communicate specifically through this network interface.

Indirect communication
Communication between ISD 510 devices and the ISD Toolbox through a PLC is called indirect communication. Between the PLC and the ISD 510 devices there is Ethernet-based fieldbus communication (marked A in *Illustration 6.19*), whereas there is non-fieldbus communication between the PLC and the ISD Toolbox host system (marked B in *Illustration 6.19*).

In the scenario in *Illustration 6.19*, the PLC has the master function and uses cyclic communication with the devices. Therefore, not all functionalities of the ISD Toolbox, for example the drive control, can be used. The restrictions when using indirect communication are detailed in the *VLT® Integrated Servo Drives ISD® 510 Programming Guide*.



A	Fieldbus
B	General purpose network

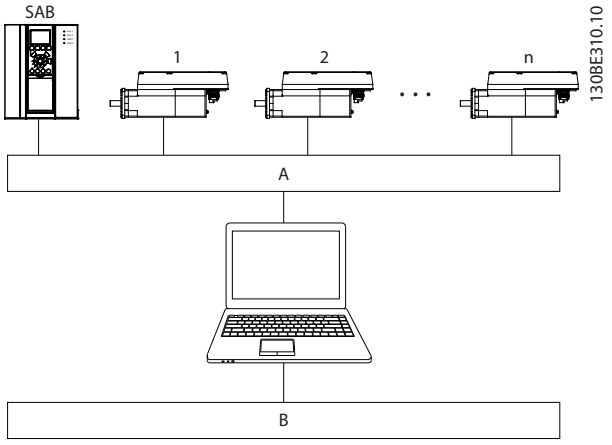
Illustration 6.19 Logical View of Indirect Ethernet-based Fieldbus Communication (Communication via PLC)

NOTICE

The logical view only shows the connectivity from a high-level software perspective and does not reflect the actual physical topology of the network.

Direct communication

For Ethernet-based fieldbus communication (direct communication), the ISD Toolbox must use a dedicated network interface on the ISD Toolbox host system. This network interface should not simultaneously be used for any other communication.



A	Fieldbus
B	General purpose network

Illustration 6.20 Logical View of Direct Ethernet-based Fieldbus Communication

NOTICE

The logical view only shows the connectivity from a high-level software perspective and does not reflect the actual physical topology of the network.

6.5.4.1 Network Settings for Indirect Communication

Any network interface can be used to communicate through a PLC and a dedicated network interface is not needed.

When establishing the communication through a PLC, the ISD Toolbox configures a routing table using the selected *Network Address Translation (NAT)*. Adding a route to the Windows routing table requires administrator privileges. Therefore, administrator credentials may be requested when initializing the connection.

Carry out the following steps to enable indirect communication.

Disable IPv6 on the network interfaces used for communication on the PC:

1. Open the *Network and Sharing Center*.
2. Select *Change adapter settings*.
3. Right-click on the network interface used for fieldbus communication and select *Properties*.
4. If the *TCP/IPv6* is available for the network interface, disable it.

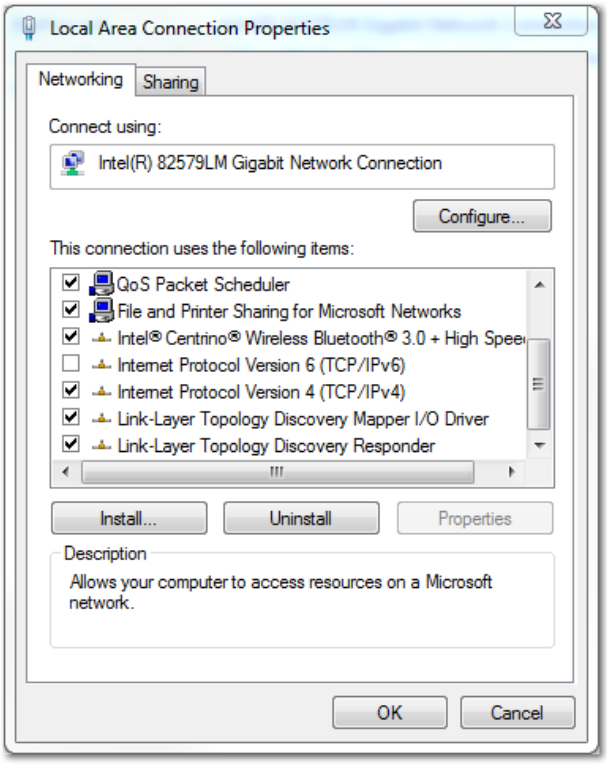


Illustration 6.21 Local Area Connection Properties

6

NOTICE

When observing the network packets via Wireshark®, checksum offloading often causes confusion as the network packets to be transmitted are handed over to Wireshark® before the checksums have been calculated. Wireshark® shows these empty checksums as invalid, even though the packets contain valid checksums when they leave the network hardware later.

Use 1 of these 2 methods to avoid this checksum offloading problem:

- **Turn off the checksum offloading in the network driver if possible.**
- **Turn off the checksum validation of the specific protocol in the Wireshark® preferences.**

6

Additional settings for indirect communication over EtherCAT®

Set the IP address of the EtherCAT® Master:

1. Open the *TwinCAT® System Manager*.
2. Select [I/O-Configuration → I/O Devices → Device1 (EtherCAT®)] and check the IP-address in the *Adapter* tab.
   The IP-address of the PLCs network adapter may not be a link-local address (so not in the range of 169.254.0.1 to 169.254.255.254).
3. If necessary, change the IP-address inside the *IPv4 Protocol* properties according to the given operating system. This can be done on the controller locally or via *Remote Desktop*.

Activate IP routing on the EtherCAT® Master:

NOTICE

The procedure described here may vary depending on the type of PLC and operating system installed.

1. Open the *TwinCAT® System Manager*.
2. Click on *Advanced Settings…* under [I/O-Configuration → I/O Devices → Device1 (EtherCAT®)] in the *EtherCAT* tab.
3. Select *EoE Support* in the *Advanced Settings* window.
4. Enable *Connect to TCP/IP Stack* in the *Windows Network* section.
5. Enable *IP Enable Router* in the *Windows IP Routing* section.
6. Reboot the PLC for the changes to take effect.

Set the IP address of the EtherCAT® slave (servo drive or SAB):

1. Open the *TwinCAT® System Manager*.
2. Click on *Advanced Settings…* under [I/O-Configuration → I/O Devices → Device1 (EtherCAT®) → Box 1 (VLT® Servo Access Box L1 → Drive 2 (VLT® Integrated Servo Drive ISD 510)] in the *EtherCAT* tab.
3. Select [Mailbox → EoE] in the *Advanced Settings* window.
4. Enable *Virtual Ethernet Port* and enter a valid IP Address.
5. Each slave in the configuration requires an IP-address. This address is reassigned with every transition from *INIT* to *Pre-Operational* state of the slave state machine. The IP communication of the slaves is deactivated per default.

NOTICE

The last number of the IP address is the ID that is used in the ISD Toolbox to identify the device.

6.5.4.2 Network Settings for Direct Communication with Ethernet POWERLINK®

Disable all network protocols except TCP/IPv4 on the network interface used for direct Ethernet POWERLINK® communication. This prevents other PC software or the operating system using this network interface for other tasks, such as file and printer sharing and network discovery. Disabling these protocols reduces the number of non-relevant packets sent over the network interface and thus reduces the overall network load.

How to disable all unused protocols on the network interface on the PC:

1. Open the *Network and Sharing Center*.
2. On the left, click on *Change adapter settings*.
3. Right-click on the network interface used for fieldbus communication and select *Properties*.
4. Uncheck all checkboxes except the one for *Internet Protocol Version 4 (TCP/IPv4)*.

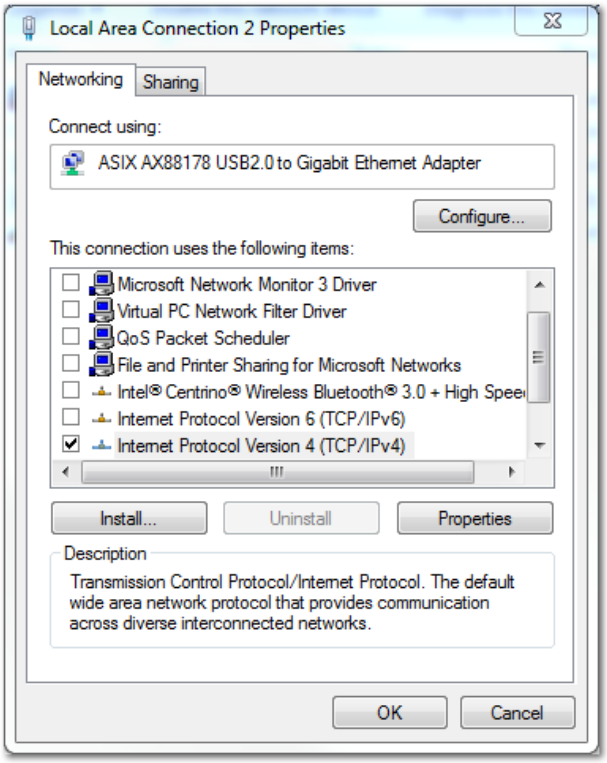


Illustration 6.22 Local Area Connection 2 Properties

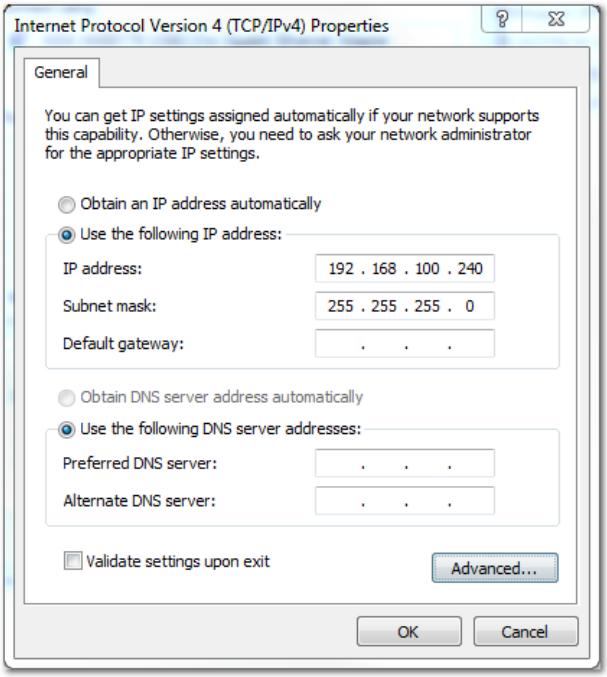


Illustration 6.23 Internet Protocol Version 4 (TCP/IPv4) Properties

Disable the *IPv4 Checksum offload* on the network interfaces as described in *chapter 6.5.4.1 Network Settings for Indirect Communication*.

How to set the correct Ethernet POWERLINK® master IP address:

1. Open the *Network and Sharing Center*.
2. On the left, click on *Change adapter settings*.
3. Right-click on the network interface used for fieldbus communication and select *Properties*.
4. Click on *Internet Protocol Version 4 (TCP/IPv4)* (the checkbox must be checked) and then click on *Properties*.
5. Select *Use the following IP address* and use 192.168.100.240 as the IP address and 255.255.255.0 as the subnet mask. Leave all other fields empty.

6.5.4.3 Network Settings for Direct Communication with EtherCAT®

No EtherCAT®-specific network interface configuration needs to be performed on the ISD Toolbox host PC.

6

6.5.5 ISD Toolbox Commissioning

STEP 1: Open the main window

The *Main Window* is the basis for all ISD Toolbox functionalities. It consists of the following components:

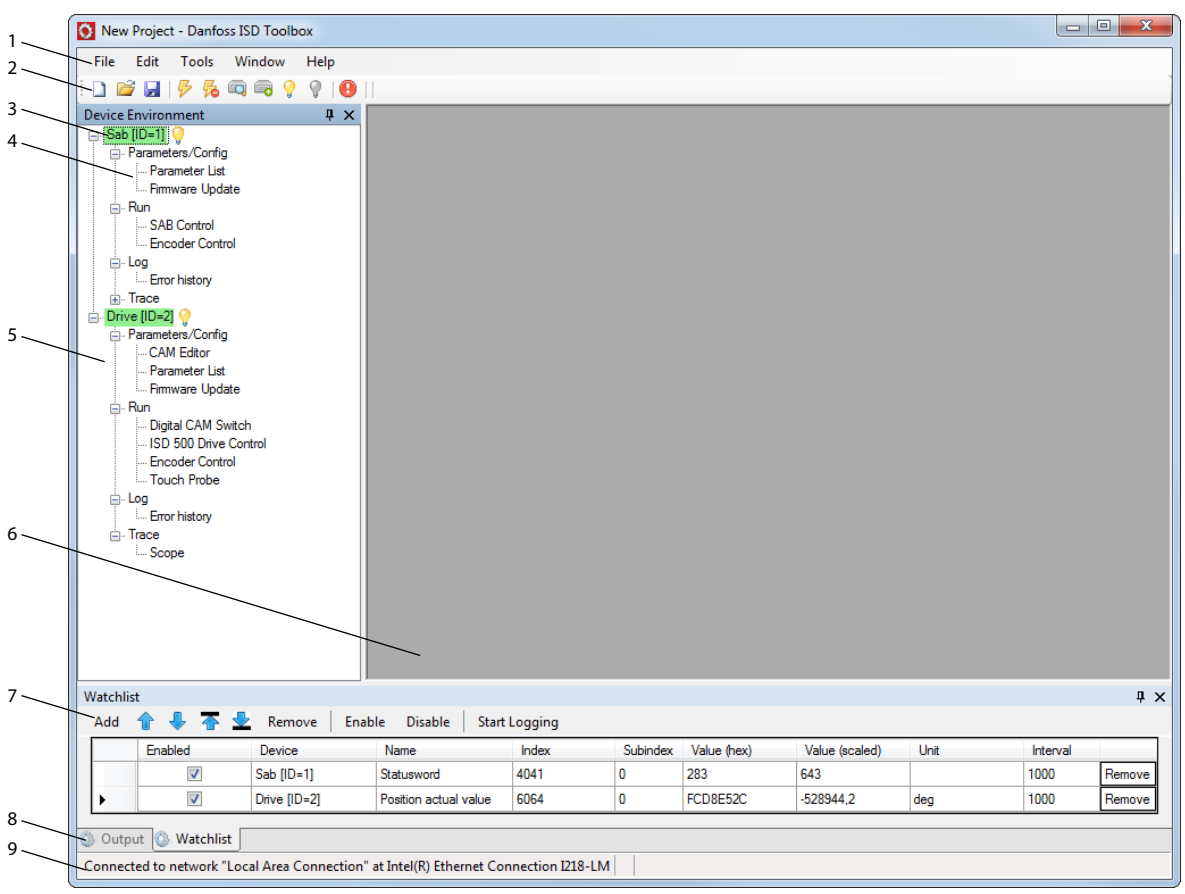


Illustration 6.24 Main Window

1	Menu bar	Contains the general functionalities for saving and loading projects, managing connections, showing and changing settings, managing open sub-tools, and showing help contents.
2	Tool bar	Contains shortcuts for saving and loading projects, connecting to and disconnecting from networks, automatic searching for online devices, or manually adding devices.
3	Online/Offline status and state information	• *Online* devices are indicated by a glowing light bulb next to the device ID. - An online device is a logical device for which a physical device exists, which the ISD Toolbox is currently connected to. - The color indicates the state of the device and is device–specific. • *Offline* devices are indicated by a gray light bulb next to the device ID. - An offline device is a logical device without a corresponding physical device. An offline device can represent a saved device configuration or state, for example for offline analysis or troubleshooting. It also contains pre-configured parameter values to be written to a physical device.
4	Available sub-tools	A sub-tool is opened by double-clicking the left mouse button on its name in the *Device Environment*, or by selecting the entry and pressing the *Enter* key on the keyboard.
5	Device environment	The *Device Environment* section of the *Main Window* lists all logical devices managed by the ISD Toolbox, visualizes their states, and serves as the user interface for accessing the device functionalities. The *Device Environment* window lists all available sub-tools for each added device. See the *VLT® Integrated Servo Drive ISD® 510 System Programming Guide* for further information on the sub-tools.
6	Workspace	This is the space for hosting the sub-tools and its size depends on the *Main Window* size. The sub-tools can be maximized, minimized, horizontally or vertically aligned, or cascaded.
7	Watchlist window	Evaluates the parameter values of 1 or more devices by cyclically reading them from the devices. Allows parameter values to be logged and saved to a text file. It is also possible to modify/write values in the watchlist.
8	Output window	Shows operating information, warnings, and errors. Depending on the user settings, shows messages of up to 3 different logging levels (high, medium, and low). Used for showing advanced error and warning information.
9	Status strip	Shows the communication state of the ISD Toolbox. If connected to a network, it shows the used hardware interface (for example, network adapter) and the network name.

Table 6.1 Legend to *Illustration 6.24*

STEP 2: Connect to network

NOTICE

Pre-configure the appropriate communication settings to connect to a network. See *chapter 6.5.4 ISD Toolbox Communication* for further information.

1. In the *Main Window* toolbar, click on the *Connect to bus* icon to open the *Connect to Network* window.
2. Select the fieldbus type and the network interface to connect to.
3. Click on *OK* to connect.
4. Verify that the connection is successful by checking the status strip in the *Main Window*.

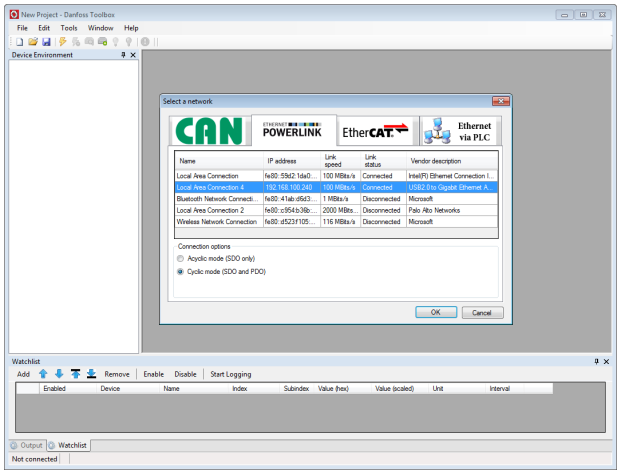


Illustration 6.25 Connect To Network Window (Ethernet POWERLINK®)

STEP 3: Scan for devices

1. After verifying that the ISD Toolbox is connected to the selected network, click on the *Scan for Devices* icon in the toolbar to trigger the device scan procedure.

NOTICE

If connected to an Ethernet POWERLINK® network in cyclic mode, select the scan range (minimum and maximum IDs) in the next window to reduce the time needed for scanning. In all other cases, the complete ID range is scanned.

2. When the scan is complete, a list of available devices is showed in the *Select Devices* window. Select which devices to add to the *Device Environment* and click on *OK*.
3. All selected devices appear in the *Device Environment* window and automatically go online (indicated by a glowing light bulb next to each device name).

NOTICE

See the *VLT® Integrated Servo Drive ISD® 510 System Programming Guide* for further information on the ISD Toolbox software.

6.6 Motion Library

6.6.1 Function Blocks

The PLC library provides function blocks that support the functionality of the ISD devices and comply with this standard:

PLCopen® Technical Specification Function blocks for motion control (Formerly Part 1 and Part 2) Version 2.0 March 17, 2011.

Additionally, specific ISD function blocks provide the functionality that is not described by PLCopen®.

The following PLCopen® characteristics apply to all function blocks:

- Commanding (using the inputs)
- Signaling (behaviour of the outputs)
- General calling conventions

NOTICE

See the *VLT® Integrated Servo Drive ISD® 510 System Programming Guide* for further information on the available function blocks and their behavior.

6.6.2 Simple Programming Template

Automation Studio™

Detailed information on how to open the sample project within the ISD package in Automation Studio™ can be found in the Automation Studio™ Help. Open the B&R Help Explorer and go to [Programming → Examples → Adding sample programs] and follow the instructions for library samples.

TwinCAT®

A basic sample PLC application for starting up the ISD 510 servo system with 1 SAB and 2 axes is provided. The project *ISD_System_SampleProject* can be downloaded from the Danfoss website.

7 Operation

7.1 Operating Modes

The servo drive implements several modes of operation. The behavior of the servo drive depends on the activated mode of operation. It is possible to switch between the modes while the servo drive is enabled. The supported modes of operation are according to CANopen® CiA DS 402 and there are also ISD-specific modes of operation. All supported modes of operation are available for EtherCAT® and Ethernet POWERLINK®. The various modes of operation are described in detail in the *VLT® Integrated Servo Drive ISD® 510 System Programming Guide*.

Mode	Description
ISD Inertia measurement mode	This mode measures the inertia of an axis. It is used to measure the inertia of the servo drive and the external load, and to optimize the control loop settings. The friction effects are eliminated automatically.
Profile velocity mode	In profile velocity mode, the servo drive is operated under velocity control and executes a movement with constant speed. Additional parameters, such as acceleration and deceleration, can be parameterized.
Profile position mode	In profile position mode, the servo drive is operated under position control and executes absolute and relative movements. Additional parameters, such as velocity, acceleration, and deceleration, can be parameterized.
Profile torque mode	In profile torque mode, the servo drive is operated under torque control and executes a movement with constant torque. Linear ramps are used. Additional parameters, such as torque ramp and maximum velocity, can be parameterized.
Homing mode	In homing mode, the application reference position of the servo drive can be set. Several homing methods, such as homing on actual position, homing on block, limit switch, or home switch are available.
CAM mode	In CAM mode, the servo drive executes a synchronized movement based on a master axis. The synchronization is done by means of a CAM profile that contains slave positions corresponding to master positions. CAMs can be designed graphically with the ISD Toolbox software, or can be parameterized via the PLC. The guide value can be provided by an external encoder, virtual axis, or the position of another axis. The different CAM profile types are described in the *VLT® Integrated Servo Drive ISD® 510 System Programming Guide*.
Gear mode	In gear mode, the servo drive executes a synchronized movement based on a master axis by using a gear ratio between the master and the slave position. The guide value can be provided by an external encoder, virtual axis, or the position of another axis.
Cyclic synchronous position mode	In cyclic synchronous position mode, the trajectory generator of the position is located in the control device, not in the servo drive.
Cyclic synchronous velocity mode	In cyclic synchronous velocity mode, the trajectory generator of the velocity is located in the control device, not in the servo drive.

Table 7.1 Operating Modes

7.1.1 Motion Functions

Function	Description
Digital CAM switch	This functionality controls whether the digital output is enabled or disabled, depending on the axis position. It performs a function comparable to switches on a motor shaft. Forward and backward movements of the axis position are allowed. On and off compensation and hysteresis can be parameterized.
ISD touch probe	This functionality stores the position actual value after a rising or falling edge at the configured digital input.

Table 7.2 Motion Functions

7.2 Operating Status Indicators

The operating status of the servo drive and SAB is indicated via the LEDs on each device.

7.2.1 Operating LEDs on the Servo Drive

Illustration 7.1 shows the operating LEDs on the servo drive.

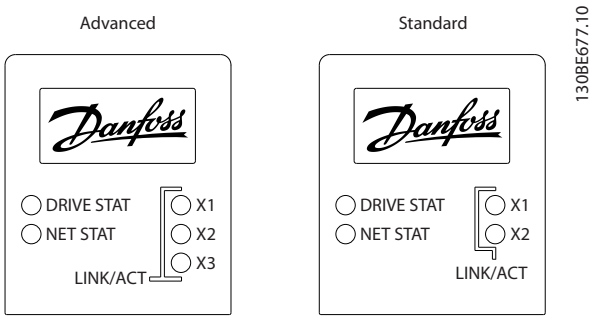


Illustration 7.1 Operating LEDs on the Servo Drive

LED	Color	Flash status	Description
DRIVE STAT	Green	On	Servo drive is in state *Operation enabled*.
		Flashing	Auxiliary voltage is applied.
	Red	On	Servo drive is in *Fault* or *Fault reaction active* state.
		Flashing	DC-link voltage is not applied.
NET STAT	Green/ red	Fieldbus dependent	Network status of the device (see corresponding fieldbus standard).
Link/ACT X1	Green	–	Link/activity status of *Hybrid In* (X1)
		On	Ethernet link established.
		Flashing	Ethernet link established and active.
		Off	No link.
Link/ACT X2	Green	–	Link/activity status of *Hybrid Out* (X2)
		On	Ethernet link established.
		Flashing	Ethernet link established and active.
		Off	No link.
Link/ACT X3[1)]	Green	–	Link/activity status of the Ethernet port (X3).
		On	Ethernet link established.
		Flashing	Ethernet link established and active.
		Off	No link.

Table 7.3 Legend to *Illustration 7.1*

1) Advanced version only

7.2.2 Operating LEDs on the Servo Access Box

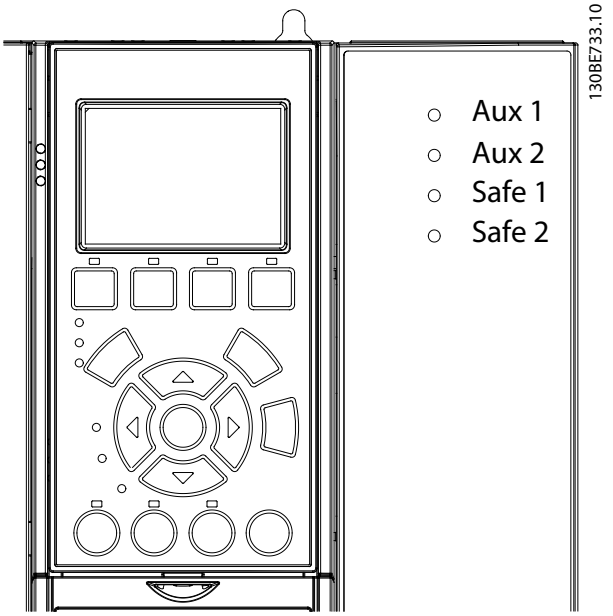


Illustration 7.2 Operating LEDs on the SAB

LED	Color	Flash status	Description
Aux 1	Green	–	State of the auxiliary voltage on line 1.
		On	Statemachine is in state *Standby*, *Power up*, or *Operation enabled*. Auxiliary voltage is applied to the output connectors on line 1.
		Off	Statemachine is in state U_{AUX} *disabled* or *Fault*. Auxiliary voltage is not applied to line 1.

LED	Color	Flash status	Description
Aux 2	Green	–	State of the auxiliary voltage on line 2.
		On	Statemachine is in state *Standby*, *Power up*, or *Operation enabled*. Auxiliary voltage is applied to the output connectors on line 2.
		Off	Statemachine is in state U_{AUX} *disabled* or *Fault*. Auxiliary voltage is not applied to line 2.
Safe 1	Green	On	24 V for STO is present on line 1.
		Off	24 V for STO is not present on line 1.
Safe 2	Green	On	24 V for STO is present on line 2.
		Off	24 V for STO is not present on line 2.
SAB STAT	Green	On	SAB is in state *Operation enabled*.
		Flashing	Auxiliary voltage is applied at the input.
		Off	No auxiliary voltage is applied at the input.
	Red	On	The SAB is in state *Fault*.
		Flashing	Mains is not applied at the input.
NET STAT	Green/ red	Fieldbus dependent.	Network status of the device (see corresponding fieldbus standard).
Link/A CT X1	Green	–	Link/activity status of *In*.
		On	Ethernet link established.
		Flashing	Ethernet link established and active.
		Off	No link.
Link/A CT X2	Green	–	Link/activity status of *Out*.
		On	Ethernet link established.
		Flashing	Ethernet link established and active.
		Off	No link.
Link/A CT X3	Green	–	Link/activity status of line 1.
		On	Ethernet link established.
		Flashing	Ethernet link established and active.
		Off	No link.
Link/A CT X4	Green	–	Link/activity status of line 2.
		On	Ethernet link established.
		Flashing	Ethernet link established and active.
		Off	No link.

Table 7.4 Legend to *Illustration 7.2*

7

8 ISD Safety Concept

8.1 Applied Standards and Compliance

Use of the STO function requires that all provisions for safety, including relevant laws, regulations, and guidelines, are satisfied.

The integrated STO function complies with the following standards:

- EN 60204-1: 2006 Stop Category 0 – uncontrolled stop
- IEC/EN 61508: 2010 SIL 2
- IEC/EN 61800-5-2: 2007 SIL 2
- IEC/EN 62061: 2005 SIL CL2
- EN ISO 13849-1: 2008 Category 3 PL d

The ISD 510 servo system has been tested for higher EMC immunity as described in IEC/EN 61326-3-1.

8

8.2 Abbreviations and Conventions

Abbreviation	Reference	Description
Cat.	EN ISO 13849-1	Category, level B, 1–4
DC	–	Diagnostic coverage
FIT	–	Failure in time Failure rate: 1E-9/hour
H	EN IEC 61508	Hardware fault tolerance H = n means that n + 1 faults may lead to a loss of the safety function.
MTTFd	EN ISO 13849-1	Mean time to failure – dangerous Unit: years
PFH	EN IEC 61508	Probability of dangerous failures per hour Take this value into account if the safety device is operated in high demand mode or in continuous operating mode, where the frequency of demands for operation made on a safety-related system occurs more than once per year.
PFD	EN IEC 61508	Average probability of failure on demand. This value is used for low demand operation.
PL	EN ISO 13849-1	Performance level A discrete level used to specify the capability of safety-related parts of a system to perform safety-oriented functions under foreseeable conditions. Levels: a–e.
SFF	EN IEC 61508	Safe Failure Fraction [%] Proportion of safe failures and detected dangerous failures of a safety function or a subsystem as a percentage of all possible failures.
SIL	EN IEC 61508 EN IEC 62061	Safety Integrity Level
STO	EN IEC 61800-5-2	Safe Torque Off
SS1	EN IEC 61800-5-2	Safe stop 1
SRECS	EN IEC 62061	Safety-related electrical control system
SRP/CS	EN ISO 13849-1	Safety-related parts of control systems
PDS/SR	EN IEC 61800-5-2	Power drive system (safety-related)

Table 8.1 Abbreviations and Conventions

8.3 Qualified Personnel for Working with the STO Function

The STO function may only be installed, programmed, commissioned, maintained, and decommissioned by qualified personnel. Qualified personnel for the STO function are qualified electrical engineers, or persons who have received training from qualified electrical engineers and are suitably experienced to operate devices, systems, plant, and machinery in accordance with the general standards and guidelines for safety technology.

Furthermore they must:

- Be familiar with the basic regulations concerning health and safety/accident prevention.
- Have read and understood the safety guidelines given in this manual.
- Have a good knowledge of the generic and specialist standards applicable to the specific application.

Users of power drive systems (safety-related) (PDS(SR)) are responsible for:

- Hazard and risk analysis of the application.
- Identifying safety functions required and allocating SIL or PLr to each of the functions, other subsystems, and the validity of signals and commands from them.
- Designing appropriate safety-related control systems (hardware, software, parameterization, and so on).

Protective measures

- Install the ISD 510 servo system components with a protective rating of less than IP54 in an IP54 cabinet as per IEC 60529 or in an equivalent environment. In special applications, higher IP protection may be necessary.
- If external influences can influence the motor axis, for example suspended loads, use additional measures, such as a safety holding brake, to eliminate hazards.

8.4 Safety Precautions

NOTICE

After installing the STO function, perform a commissioning test as described in *chapter 8.9 Commissioning Test*. A passed commissioning test is mandatory after initial installation and after each change to the safety installation.

⚠WARNING

UNCONTROLLED MOVEMENT

External forces on the motor could cause an uncontrolled and hazardous movement that could result in death or serious injury.

- **Equip the motor with additional measures for preventing uncontrolled and hazardous movement, for example mechanical brakes.**

⚠WARNING

RISK OF ELECTRICAL SHOCK

The STO function itself does not supply electrical safety and is not sufficient to implement the *Emergency-Off* function as defined by EN 60204-1, resulting in risk of death or serious injury.

- **Ensure electrical isolation for *Emergency-Off*, for example by switching off the mains via an additional contactor.**

⚠WARNING

RISK OF ELECTRICAL SHOCK

The STO function does not isolate mains voltage to the ISD 510 servo system or auxiliary circuits. Only perform work on electrical parts of the ISD510 system or the servo drive after isolating the mains voltage supply and waiting the length of time specified in *chapter 2 Safety*. Failure to isolate the mains voltage supply and waiting the time specified could result in death or serious injury.

- **Do not use the STO function to stop a running ISD 510 servo system in normal operation. When using the STO function the servo drive coasts to stop. Depending on the application, a mechanical brake may be required.**
- **Use the STO function when performing mechanical work on the ISD 510 servo system or affected area of a machine. The STO function does not provide electrical safety and must not be used as a control to start and/or stop the ISD 510 servo system.**

NOTICE

The ISD 510 servo system does not implement a manual reset function as required by ISO 13849-1. The standard failure reset from the PLC cannot be used for this purpose.
For automatic restart without manual reset, observe the requirements detailed in paragraph 6.3.3.2.5 of ISO 12100:2010 or equivalent standard.

⚠WARNING

RISK OF RESIDUAL ROTATION

Due to failures in the power semiconductor of the drive, a residual rotation can result from a fault that could result in death or serious injury. The rotation can be calculated to angle = 360°/(number of poles).

- **Take this residual rotation into consideration and ensure that it does not pose a safety risk.**

NOTICE

Take measures to ensure that common mode voltage disturbances, as described in EN/IEC 61000-4-16, do not occur in the installation. This can be done, for example, by installing according to the requirements of EN/IEC 60204-1.

NOTICE

Carry out a risk assessment to select the correct stop category for each stop function in accordance with EN 60204-1.

8

NOTICE

When designing the machine application, consider timing and distance for coast to stop (*Stop Category 2* or STO). See EN 60204-1 for further information.

NOTICE

All signals connected to the STO must be supplied by a SELV or PELV supply.

8.5 Functional Description

The STO function in the ISD 510 servo system features a separate STO function for each line of servo drives in daisy-chain format. The function is activated by inputs on the SAB. Using the STO function activates the STO for all servo drives on that line. Once the STO is activated, no torque is generated on the axes. Reset of the safety function and diagnostics can be carried out via the PLC.

8.6 Installation

8

Install the ISD 510 servo system as described in *chapter 4 Mechanical Installation* and *chapter 5 Electrical Installation*. Only Danfoss cables may be used for the installation of the servo system, however cables from other suppliers may be used for the user connection to the STO terminals (*STO 1 IN* and *STO 2 IN*) on the SAB.

NOTICE

If the application does not require the Safe Torque Off (STO) functionality, build a bridge by connecting +24 V from the connector *STO 1 IN: +24V* to *STO 1 IN: +STO*, and from *STO 1 IN: –24 V* to *STO 1 IN: –STO*. Repeat this process for STO line 2 if used.

Safety relays that have a plus and minus switching output signal can be directly connected to the ISD 510 servo system to activate STO (see *Illustration 8.1*). Route the wires for STO 1 and STO 2 separately and not in a single multicore cable.

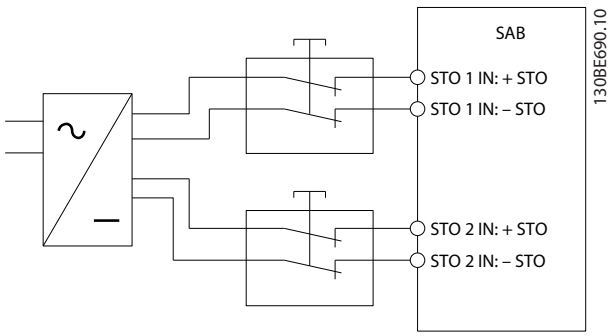


Illustration 8.1 Safety Relay with Plus and Minus Switching Output

Signals with test pulses must not have test pulses of >1 ms. Longer pulses may lead to reduced availability of the servo system.

The external supply must be a SELV/PELV supply.

8.7 Operation of the ISD Safety Concept

This chapter details the basic STO signals. Some of the signals can be reached in several ways, however only access via fieldbus is described here. See the *VLT® Integrated Servo Drive ISD® 510 System Programming Guide* for further information.

The STO function does not require any parameterization and is always enabled. To disable the function permanently, connect the STO inputs directly to the 24 V outputs *STO 1 IN: 24 V* or *STO 2 IN: 24 V* on the SAB.

The ISD 510 servo drive provides STO status signals via the fieldbus.

For general information on how to access and map data objects, see the *VLT® Integrated Servo Drive ISD® 510 System Programming Guide*.

Danfoss provides a library for ISD 510 to simplify the use of the fieldbus functions. See the *VLT® Integrated Servo Drive ISD® 510 System Programming Guide* for further information.

8.7.1 Statusword

The *statusword* in 0x6041 provides the STO status in bit 14. The bit is set to *1* if STO is active and *0* if STO is deactivated. All servo drives on each STO line must display the same information in this bit. Carry out a check via the PLC to compare the STO status of all servo drives on each line.

If STO is activated when the servo drive is disabled, and no attempt is made to enable the servo drive while STO is active, it is not necessary to reset the STO function after reapplying supply to the STO terminals.

If STO is activated when the servo drive is enabled, an error code is issued (see *chapter 8.7.2 Error Codes*).

8.7.2 Error Codes

If bit 3 of the *statusword* is set, this indicates any faults that occur on the servo drive. If the fault occurred because of the STO circuit, the cause of the fault can be found in object 0x603F.

Error code	Classification	Description	Reset
0xFF80	Fault	STO activated while the servo drive was enabled, or an attempt to enable the servo drive was made while STO was active.	Reset via the PLC.
0xFF81	Safety fault	Servo drive internal diagnostic fault.	Carry out a power cycle.
0xFF85	Safety fault	Internal STO supply on the power card is not within limits.	Carry out a power cycle.

Table 8.2 Error Codes

Error code 0xFF80 can be a normal status of the application. In this case, the servo drive requires a reset signal from the PLC. To use the STO function in an application that requires a control guard (see ISO 12100 for details), this reset information can be given automatically by the PLC.

Error code 0xFF81 means that there is a fault on the servo drive that can only be reset by carrying out a power cycle. Complete the commissioning test as described in *chapter 8.9 Commissioning Test* after the power cycle. Operation of the ISD 510 servo system can only be resumed if the test is completed successfully. If error code 0xFF81 or 0xFF85 is issued again, contact Danfoss Service.

8.8 Fault Reset

Change bit 7 of the *controlword* from *0* to *1* to reset faults. See the *VLT® Integrated Servo Drive ISD® 510 System Programming Guide* for further information.

8.9 Commissioning Test

NOTICE

Perform a commissioning test after installation of the STO function, after every change to the installed function, or after a safety fault (described in *chapter 8.7.2 Error Codes*). Perform the test for each STO line.

There are 2 ways to implement the commissioning test depending on the method used to program the PLC, however the steps of the test are the same:

- Using the Danfoss Library or the TwinCAT® Library.
- Bit-wise readout of the status.

Commissioning test using libraries

Depending on the application, 1 or both of the following libraries are required to program the commissioning test:

- Danfoss Library
  - MC_ReadAxisInfo_ISD51x
  - MC_ReadStatus_ISD51x
  - MC_ReadAxisError_ISD51x
  - MC_Reset_ISD51x
- TwinCAT® Library
  - MC_ReadStatus
  - MC_ReadAxisError
  - MC_Reset

	Test steps	Reason for the test step	Expected result for Danfoss library	Expected result for TwinCAT® library
1	Run the application (all the servo drives are enabled).	Check that the application can run.	Application runs as expected.	Application runs as expected.
2	Stop the application.	–	All servo drives are at speed 0 RPM.	All servo drives are at speed 0 RPM.
3	Disable all the servo drives.	–	All servo drives are disabled.	All servo drives are disabled.

	Test steps	Reason for the test step	Expected result for Danfoss library	Expected result for TwinCAT® library
4	Enable STO.	Check that STO can be activated without error.	*MC_ReadAxisInfo_ISD51x output SafeTorqueOff* = True for all servo drives on the corresponding line.	–
5	Disable STO.	Check that STO can be deactivated without error. No reset is required.	*MC_ReadAxisInfo_ISD51x output SafeTorqueOff* = False for all servo drives on the corresponding line.	–
6	Run the application (all the servo drives are enabled).	–	Application runs as expected.	Application runs as expected.
7	Enable STO.	Check that errors are generated correctly when STO is activated while the servo drives are running.	Motors are torque free. Motors coast and stop after some time. *MC_ReadAxisInfo_ISD51x output SafeTorqueOff* = True and *MC_ReadStatus_ISD51x output ErrorStop* = True and *MC_ReadAxisError_ISD51x output AxisErrorID* = 0xFF80 on all enabled servo drives.	Motors are torque free. Motors coast and stop after some time. For enabled motors: *MC_ReadStatus output ErrorStop* = True and *MC_ReadAxisError output AxisErrorID* = 0xFF80 on all enabled servo drives.
8	Try to run the application (enable 1 or more servo drives).	Checks that the STO function is working correctly.	Application does not run.	Application does not run.
9	Disable STO.	Check that the STO start is still inhibited by the error signal.	*MC_ReadAxisInfo_ISD51x output SafeTorqueOff* = False and *MC_ReadStatus_ISD51x output ErrorStop* = True	*MC_ReadStatus output ErrorStop* = True
10	Try to run the application (enable 1 or more servo drives).	Check whether reset is required.	Application does not run.	Application does not run.
11	Send a reset signal via *MC_Reset(_ISD51x)*.	–	*MC_ReadAxisInfo_ISD51x output SafeTorqueOff* = False and *MC_ReadStatus_ISD51x output ErrorStop* = False	*MC_ReadStatus output ErrorStop* = False
12	Try to run the application (all servo drives are enabled).	–	Application runs as expected.	Application runs as expected.

Table 8.3 Commissioning Test using Libraries

Commissioning test using bit-wise readout

	Test steps	Reason for the test step	Expected result
1	Run the application (all the servo drives are enabled).	Check that the application can run.	Application runs as expected.
2	Stop the application.	–	All servo drives are at speed 0 RPM.
3	Disable all the servo drives.	–	All servo drives are disabled.
4	Enable STO.	Check that STO can be activated without error.	*Statusword* bit 3 = 0 and bit 14 =1 in all servo drives.
5	Disable STO.	Check that STO can be deactivated without error. No reset is required.	*Statusword* bit 3 = 0 and bit 14 =0 in all servo drives.

	Test steps	Reason for the test step	Expected result
6	Run the application (all the servo drives are enabled).	–	Application runs as expected.
7	Enable STO.	Check that errors are generated correctly when STO is activated while the servo drives are running.	Motors are torque free. Motors coast and stop after some time. *Statusword* bit 3 = 1, bit 14 = 1 and object 0x603F shows fault 0xFF80 in all servo drives.
8	Try to run the application (enable 1 or more servo drives).	Checks that the STO function is working correctly.	Application does not run.
9	Disable STO.	Check that the STO start is still inhibited by the error signal.	*Statusword* bit 3 = 1, bit 14 = 0 and object 0x603F shows fault 0xFF80 in all servo drives.
10	Try to run the application (enable 1 or more servo drives).	Check whether reset is required.	Application does not run.
11	Send a reset signal via the PLC.	–	*Statusword* bit 3 = 0 in all servo drives.
12	Try to run the application (all servo drives are enabled).	–	Application runs as expected.

Table 8.4 Commissioning Test using Bit-Wise Readout

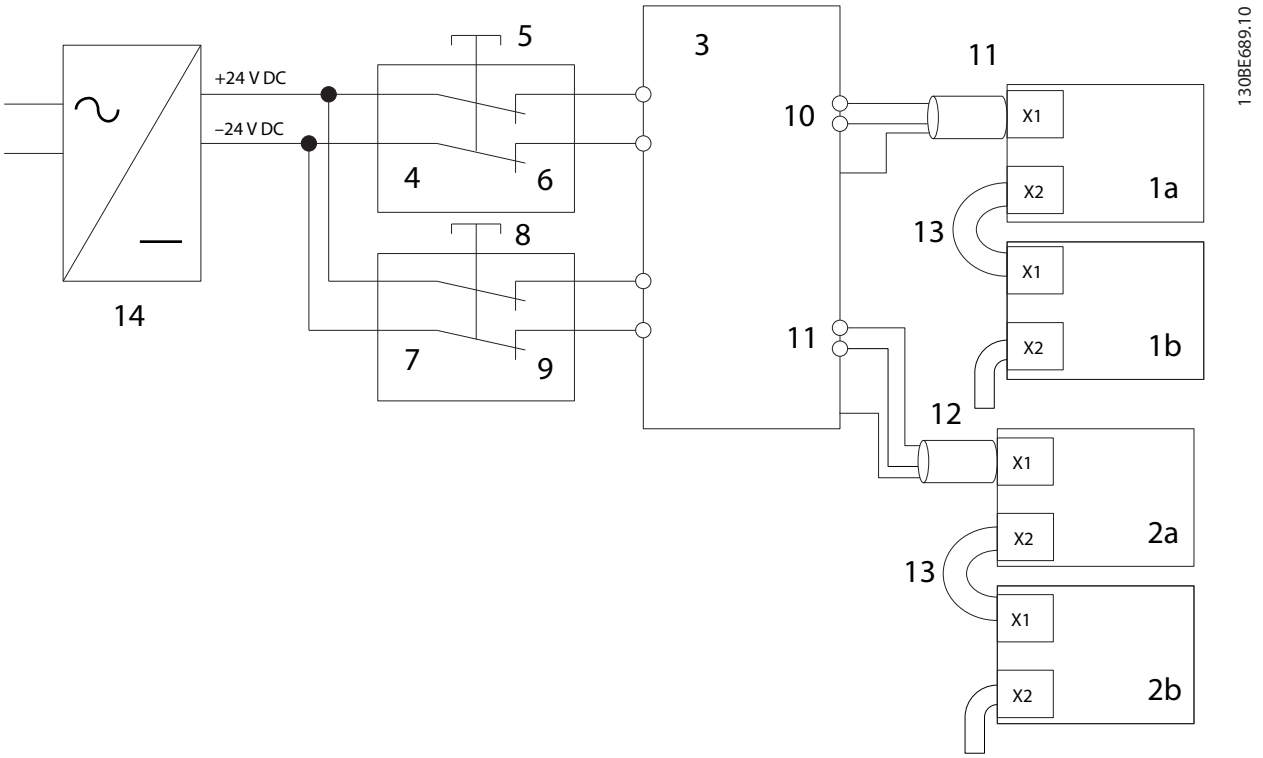
8.10 Application Example

Illustration 8.2 shows an example of an installation for 2 lines that can be put in Safe Torque Off mode by separate safety circuits for each line.

The safety circuits may be remote from each other and are not supplied from the ISD 510 servo system.

The 2 lines in the example are controlled separately. If the Safe Torque Off function is triggered on line 1, line 2 remains in normal operation and the servo drives on this line are not affected. There may still be a hazard from the servo drives on line 2.

Select the safety switch devices in accordance with the requirements of the application.



1a/1b	ISD 510 servo drive on line 1	7	Safety device on line 2
2a/2b	ISD 510 servo drive on line 2	8	Line 2 emergency stop button
3	Servo Access Box (SAB)	9	Line 2 safety device contacts
4	Safety device on line 1	10	Line 1 hybrid cable
5	Line 1 emergency stop button	11	Line 2 hybrid cable
6	Line 1 safety device contacts	12	24 V DC supply

Illustration 8.2 Application Example: Safe Torque Off Function with 2 Lines

8.11 Safety Function Characteristic Data

General information	
Response time (from switching on the input until torque generation is disabled)	<100 ms
Lifetime	20 years
Data for EN/ISO 13849-1	
Performance level (PL)	d
Category	3
Mean time to dangerous failure ($MTTF_d$) for maximum system size of 32 servo drives on each STO line	233 years (limited to 100 years if the ISD 510 servo system forms an entire safety channel)
Diagnostic coverage (DC)	60%
Data for EN/IEC 61508 and EN/IEC 62061	
Safety integrity level (SIL)	2
Probability of failure per hour (PFH) for maximum system size of 32 servo drives on each STO line	$<5 \times 10^{-8}$/h
Safe Failure Fraction (SFF)	>95%
Hardware fault tolerance (H)	0
Subsystem classification	Type A
Proof test interval	1 year

Table 8.5 Safety Function Characteristic Data

8.12 Maintenance, Security, and User Accessibility

Maintenance
Operate the STO function at least once per year.

Security
If security risks exist, take suitable measures to prevent them.

User accessibility
Restrict access to the servo drives, SAB, and other ISD 510 servo system components if access to them could result in safety risks.

9 Diagnostics

9.1 Faults

If faults occur during servo system operation, check:

- The LEDs on the servo drive for general problems relating to communication or device status.
- The LEDs on the SAB for general problems with communication, auxiliary supply, or STO voltage.

The error codes can be read using the ISD Toolbox software, the LCP, or the PLC. The LCP only shows faults relating to the device it is connected to.

NOTICE

If the fault cannot be eliminated by 1 of the measures listed in *Table 9.1* or *Table 9.3*, notify Danfoss Service.

Have the following information available to enable Danfoss to provide help quickly and effectively:

- Type number
- Error code
- Firmware version
- System set-up (for example, number of servo drives and lines).

9.2 Servo Drive

9.2.1 Troubleshooting

First use *Table 9.1* to check the possible causes of the fault and possible solutions. The error codes are listed in *chapter 9.2.2 Error Codes*.

Fault	Possible cause	Possible solution
LCP display dark or has no function.	Missing input power.	Check the input power source.
	Missing or open fuses or circuit breaker tripped.	Check the fuses and circuit breaker.
	No power to the LCP.	• Check the LCP cable for proper connection or damage. • Replace any faulty LCP or connection cables.
	Incorrect contrast setting.	Press [Status] + [▲]/[▼] to adjust the contrast.
	Display is defective.	Replace the faulty LCP or connection cable.
Servo drive overheats (high surface temperature).	Excessive load.	Check the torques.
Servo drive not running.	No drive communication or drive in error mode.	Check the fieldbus connection and the status LEDs on the servo drive.
Servo drive does not run or only starts up slowly or with difficulty.	• Bearing wear. • Incorrect parameter settings. • Incorrect control loop parameters. • Incorrect torque settings.	• Check the bearings and shaft. • Check the parameter settings.
Drive hums and draws high current.	Drive defective.	Contact Danfoss.
Drive stops suddenly and does not restart.	• No drive communication. • Servo drive in error mode.	Check the fieldbus connection and the status LEDs on the servo drive.
Wrong motor rotation direction.	Parameter error.	• Check the parameter settings. • Change the rotation direction if appropriate.
Drive runs normally, but does not generate the expected torque.	• Drive defective. • Parameter error.	• Check the parameter settings. • Contact Danfoss.
Drive screaming.	• Incorrect calibration. • Faulty current measurement. • Incorrect control loop parameters.	• Check the parameter settings. • Contact Danfoss.
Uneven running.	Defective bearing.	Check the shaft.
Vibration.	• Defective bearing. • Incorrect control loop parameters.	• Check the shaft. • Check the parameter settings.

Fault	Possible cause	Possible solution
(Unusual) running noises	• Defective bearing. • Defects on connected mechanics. • Incorrect control loop parameters.	• Check the shaft. • Check for loose mechanical components on the attached mechanics. • Check the parameter settings.
System fuse blows, circuit breaker trips, or drive protection trips immediately.	• Short circuit. • Incorrect control loop parameters.	• Check the wiring. • Contact Danfoss.
Drive speed drops sharply under load.	• Drive is running at current limit. • Drive is running with incorrect parameters.	• Check the application. • Check the parameter settings.
Brake does not release.	Brake control defective.	Contact Danfoss.
Holding brake does not hold the servo drive.	• Mechanical brake defective. • Shaft load exceeds the holding torque of the brake.	Contact Danfoss.
Brake engagement delayed.	Software error.	Contact Danfoss.
Noises when power-off brake engaged.	Mechanical brake damaged.	Contact Danfoss.
LEDs do not light up.	No power supply.	Check the power supply.
Error 0xFF91 occurs.	Increments between succeeding values too big.	Check for velocity or guide value plausibility distance.

Table 9.1 Troubleshooting Servo Drive

9.2.2 Error Codes

Code	Name	Severity (Warning/ Error/Trip lock)	Description	LCP name
0x0000	No error	Error	No error.	–
0x1000	Generic application error	Error	Generic application error.	generic err
0x2310	Overcurrent on output	Error	Overcurrent on output.	overcurr out
0x239B	Overload on output (I2T)	Warning, error	I^2t thermal state.	overload
0x3210	DC link overvoltage	Error	Overvoltage on DC-link voltage	UDC overvolt
0x3220	DC link undervoltage	Error	Undervoltage on DC-link voltage.	UDC undervolt
0x4290	Overtemperature: Power module	Error	Overtemperature on power module.	overtemp PM
0x4291	Overtemperature: Control card	Error	Overtemperature on control PCB.	overtemp CC
0x4295	Overtemperature: Power card	Error	Overtemperature on power PCB.	overtemp PC
0x4310	Overtemperature: Motor	Error	Overtemperature on motor.	overtemp motor
0x5112	UAUX undervoltage	Error, trip lock	Undervoltage on auxiliary voltage.	undervolt UAUX
0x5530	EE Checksum Error (parameter missing)	Trip lock	Missing parameter in internal drive configuration.	config err
0x6320	Parameter error	Trip lock	An internal parameter has an invalid value.	param err
0x7320	Internal position sensor error	Trip lock	Absolute position sensor error.	int sensor err
0x7380	External position sensor error	Error	External encoder data could not be read.	ext sensor err
0x8693	Homing error on entering homing mode	Warning	Could not enter homing mode (for example velocity not 0).	Homing mode fail

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Code	Name	Severity (Warning/ Error/Trip lock)	Description	LCP name
0x8694	Homing error on start homing method	Warning	Could not start homing method (for example drive not in standstill).	Homing method fail
0x8695	Homing error distance	Warning	Homing distance reached.	Homing distance
0xFF01	Mechanical brake failure	Trip lock	No brake or wire failure.	brake mech fail
0xFF02	Short circuit in mechanical brake control	Trip lock	Short circuit in brake control.	brake mech short
0xFF0A	External interface power failure	Error	External interface power supply failure.	ext IF pwr fail
0xFF60	Timing violation 1	Trip lock	Contact Danfoss.	timing err 1
0xFF61	Timing violation 2	Trip lock	Contact Danfoss.	timing err 2
0xFF62	Timing violation 3	Trip lock	Contact Danfoss.	timing err 3
0xFF63	Timing violation 4	Trip lock	Contact Danfoss.	timing err 4
0xFF64	Timing violation 5	Trip lock	Contact Danfoss.	timing err 5
0xFF65	Timing violation 6	Trip lock	Contact Danfoss.	timing err 6
0xFF70	Firmware: Package description mismatch	Trip lock	Firmware found does not match the package description.	FW pack err
0xFF71	Firmware: Power cycle needed	Warning, error	Firmware update transfer is completed but a power cycle is required before the new firmware is active.	need powercycle
0xFF72	Firmware: Update started	Warning, error	Firmware update in progress. The warning becomes an error when an attempt is made to enable the drive in this state.	FW update
0xFF80	STO active while drive enabled	Error	STO activated while servo drive was enabled or tried to enable while STO active.	STO active
0xFF81	STO mismatch	Trip lock	Dual diagnosis of STO voltage not plausible.	STO mismatch
0xFF85	P_STO error	Trip lock	P_STO voltage on power card not within limits.	P_STO error
0xFF90	Guide value reversed	Error	Position guide value went backwards while servo drive in CAM mode.	guide val rev
0xFF91	Guide value implausible	Error	Increments between succeeding values too big.	guide val impl

Table 9.2 Error Codes for Servo Drive

9.3 Servo Access Box (SAB)

9.3.1 Troubleshooting

Table 9.3 lists potential faults on the SAB, their possible causes, and actions for correcting the faults.

Fault	Possible cause	Possible solution
LCP display dark or has no function.	Missing input power.	Check the input power source.
	Missing or open fuses or circuit breaker tripped.	Check the fuses and circuit breaker.
	No power to the LCP.	• Check the LCP cable for proper connection or damage. • Replace any faulty LCP or connection cables.
	Incorrect contrast setting.	Press [Status] + [▲]/[▼] to adjust the contrast.
	Display is defective.	Replace the faulty LCP or connection cable.
Open power fuses or circuit breaker trip.	Phase-to-phase short.	• Check the cabling. • Check for loose connections.
DC-link voltage too high.	Brake resistor not connected.	Check the brake resistor cabling.
	Brake resistor too high resistance.	Check if the lowest resistance value has been entered.
	Several servo drives are decelerating with insufficient ramp time.	• Avoid simultaneous deceleration of several servo drives. • Change the deceleration speed of the servo drives.
	Brake resistor functionality not activated.	Activate the brake function.
DC-link voltage too low.	Incorrect mains supply.	Check supply voltage matches the allowed specification detailed in *chapter 8 ISD Safety Concept*.
DC overcurrent.	The sum of the servo drive current exceeds the maximum rating of the SAB.	• Check the servo drive current consumption. • Avoid simultaneous acceleration of all servo drives.
U_{AUX} overcurrent.	The servo drives are consuming more power on the U_{AUX} line than allowed.	• Check the number of attached servo drives with the shell diagrams in the *VLT® Integrated Servo Drive ISD® 510 System Design Guide.* • Avoid simultaneous lifting of the servo drive brakes.
U_{AUX} overvoltage.	Incorrect U_{AUX} supply.	Check that the supply matches the allowed specification detailed in *chapter 5.6 Auxiliary Supply Requirements*.
U_{AUX} undervoltage.	Incorrect U_{AUX} supply.	• Check that the supply voltage matches the allowed specification detailed in *chapter 5.6 Auxiliary Supply Requirements*. • Check that the output power of the supply is sufficient.
Mains phase loss.	A phase is missing on the supply side, or the voltage imbalance is too high.	Check the supply voltages and supply currents to the SAB.
Grounding fault.	Grounding fault.	• Check for proper grounding and loose connections. • Check the hybrid cables for short circuits or leakage currents.
Brake resistor error.	Faulty brake resistor.	Remove the power to the SAB, wait for the discharge time to elapse then replace the brake resistor.
Brake chopper error.	Faulty brake chopper.	Check the setting in parameter *2-15 Brake Check*.

Table 9.3 Troubleshooting SAB

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9.3.2 Error Codes

Code	Name	Severity (Warning/ error/trip lock)	Description	LCP name
0x0000	No error	Error	No error.	–
0x1000	Generic application error	Error	Generic application error.	generic err
0x2120	Ground fault	Error	There is current from the output phases to ground.	ground fault
0x2340	Short circuit	Error	There is a short circuit in UDC output from SAB (DC Line1 and/or DC Line2). Remove power to the SAB and repair the short circuit.	short circuit
0x2391	AUX 1 overcurrent	Error	Current on AUX Line 1 reached overcurrent limit.	AUX1 overcurr
0x2392	AUX 2 overcurrent	Error	Current on AUX Line 2 reached overcurrent limit.	AUX2 overcurr
0x2393	AUX 1 user limit current	Warning, error	Current on AUX Line 1 reached user-defined limit.	AUX1 curr limit
0x2394	AUX 2 user limit current	Warning, error	Current on AUX Line 2 reached user-defined limit.	AUX2 curr limit
0x2395	AUX 1 fuse failure	Error	HW fuse failure. Current or voltage above limit on AUX Line 1.	AUX1 fuse fail
0x2396	AUX 2 fuse failure	Error	HW fuse failure. Current or voltage above limit on AUX Line 2.	AUX2 fuse fail
0x2397	DC 1 overcurrent	Error	Overcurrent on DC Line 1. The SAB peak current limit (approximately 200% of the rated current) is exceeded.	DC1 overcurr
0x2398	DC 2 overcurrent	Error	Overcurrent on DC Line 2. The SAB peak current limit (approximately 200% of the rated current) is exceeded.	DC2 overcurr
0x2399	DC overcurrent	Error	Overcurrent. The SAB has reached the current limit and shuts down to prevent any damage to the hardware.	DC overcurr
0x239B	Overload on output (I2T)	Warning, error	The SAB is about to cut out due to an overload (more than 100% for too long). The counter for electronic, thermal SAB protection triggers a warning at 90% and trips with an error at 100%.	overload
0x239D	DC overcurrent	Warning, error	Overcurrent. The SAB has reached the current limit and shuts down to prevent any damage to the hardware.	DC overcurr
0x3130	Mains phase loss	Warning, error	Mains phase loss detected. This occurs when a phase on mains is missing, or when the mains is imbalanced.	phase loss
0x3210	DC link overvoltage	Error	The DC-link voltage exceeds the limit and the SAB trips.	UDC overvolt
0x3220	DC link undervoltage	Error	The DC-link voltage is below the limit and the SAB trips.	UDC undervolt
0x3291	U_{AUX} high voltage	Warning	U_{AUX} above warning limit.	UAUX high volt
0x3292	U_{AUX} overvoltage	Error	U_{AUX} above overvoltage limit.	UAUX overvolt

Code	Name	Severity (Warning/ error/trip lock)	Description	LCP name
0x3293	U_{AUX} low voltage	Warning	U_{AUX} below warning limit.	UAUX low volt
0x3294	U_{AUX} undervoltage	Error	U_{AUX} below undervoltage limit.	UAUX undervolt
0x3295	UDC high voltage	Warning	The DC-link voltage (DC) is higher than the high-voltage warning limit.	UDC high volt
0x3296	UDC low voltage	Warning	The DC-link voltage (DC) is lower than the low-voltage warning limit.	UDC low volt
0x4220	Too low temperature: Heat sink	Warning	Heat sink temperature low. The SAB is too cold to operate. This warning is based on the temperature sensor in the IGBT module. This warning only occurs when DC-link voltage is >250 V.	low temp PM
0x4290	Overtemperature: Heat sink	Warning, Error	The maximum temperature of the heat sink has been exceeded. The temperature fault does not reset until the temperature drops below a defined heat sink temperature (115 °C).	overtemp PM
0x4291	Overtemperature: Control card	Warning, Error	Control card overtemperature. The cutout temperature of the control card is 80 °C.	overtemp CC
0x4292	Overtemperature: SAB card	Warning, Error	SAB card overtemperature. The cutout temperature of the SAB card is 80 °C.	overtemp SC
0x4293	Inrush overtemperature: SAB card	Error	Inrush fault. Too many transitions into state *Normal operation* have occurred within a short time period.	inrush SC
0x4294	Inrush overtemperature: power module	Error	Inrush fault. Too many power-ups have occurred within a short time period.	inrush PM
0x4410	Overtemperature: SAB	Error	Logic OR of control card temperature (see 0x4291) and/or heat sink temperature (see 0x4290) and/or SAB card temperature (see 0x4292).	overtemp SAB
0x6320	Parameter error	Trip lock	A parameter has an invalid value.	param err
0x6380	Configuration error (parameter missing)	Trip lock	A parameter is missing.	config err
0x6381	Reinitialization of parameters from powercard	Trip lock	Configuration reinitialization. Configuration parameter for power unit has been reinitialized.	config reinit
0x7111	Brake chopper short circuit	Error	The brake chopper is monitored during operation. This error appears if a short circuit occurs.	brake ch short
0x7181	Brake resistor failure	Error	The brake resistor is monitored during operation. This error appears if a short circuit occurs.	brake r short

Code	Name	Severity (Warning/ error/trip lock)	Description	LCP name
0x7182	Brake resistor power limit	Error	Brake resistor power limit exceeded. The power transmitted to the brake resistor is calculated as an average value over the last 120 s of run time. The calculation is based on the DC-link voltage and the brake resistor value set in parameter *2-16* (Brake resistor power 120 s). The error is reported when the value is exceeded within 120 s.	brake r pwr lim
0x7183	Brake chopper check failed	Error	Brake check failed. The brake resistor is not connected or not working.	brake ch check
0x7380	External position sensor error	Error	External encoder data could not be read.	ext sensor err
0xFF21	Internal fan fault	Warning	Internal fan fault. The fan warning function checks if the fan is running/ mounted.	fan fault
0xFF31	AUX Line 1 min off time	Warning	The minimum off time required to protect the internal hardware has not been met.	AUX1 min off
0xFF32	AUX Line 2 min off time	Warning	The minimum off time required to protect the internal hardware has not been met.	AUX2 min off
0xFF51	Internal error 1	Trip lock	Internal error 1, contact Danfoss.	PM int err 1
0xFF52	Internal error 2	Trip lock	Internal error 2, contact Danfoss.	PM int err 2
0xFF53	Internal error 3	Trip lock	Internal error 3, contact Danfoss.	PM int err 3
0xFF54	Internal error 4	Trip lock	Internal error 4, contact Danfoss.	PM int err 4
0xFF55	Internal error 5	Trip lock	Internal error 5, contact Danfoss.	PM int err 5
0xFF56	Internal error 6	Trip lock	Internal error 6, contact Danfoss.	PM int err 6
0xFF70	Firmware: Package description mismatch	Trip lock	Firmware found does not match package description.	FW pack err
0xFF71	Firmware: Power cycle needed	Warning, error	Firmware update transfer is completed but a power cycle is required before the new firmware is active.	need powercycle
0xFF72	Firmware: Update started	Warning, error	Firmware update in progress. The warning becomes an error when an attempt is made to enable the drive in this state.	FW update

Table 9.4 Error Codes for SAB

10 Maintenance, Decommissioning, and Disposal

⚠WARNING

HIGH VOLTAGE

Potentially lethal voltage is present on the connectors. Before working on the power connectors (disconnecting or connecting the cable), disconnect the SAB from the mains and wait for the discharge time to elapse.

⚠WARNING

DISCHARGE TIME

The servo drives and the SAB contain DC-link capacitors that remain charged for some time after the mains supply is switched off at the SAB. Failure to wait the specified time after power has been removed before performing service or repair work could result in death or serious injury.

- **To avoid electrical shock, fully disconnect the SAB from the mains and wait for at least the time listed in *Table 10.1* for the capacitors to fully discharge before carrying out any maintenance or repair work on the ISD 510 servo system or its components.**

Number	Minimum waiting time (minutes)
0–64 servo drives	10

Table 10.1 Discharge Time

10.1 Maintenance Tasks

The servo drives are largely maintenance free. Only the shaft seal (if used) is subject to wear.

The maintenance tasks listed in *Table 10.2* can be performed by qualified personnel (see *chapter 2.5 Qualified Personnel*). No other tasks are required.

Component	Maintenance task	Maintenance interval	Instruction
Servo drive	Carry out a visual inspection.	Every 6 months	Check for any abnormalities on the surface of the servo drive.
Shaft seal	Check the condition and check for leakage.	Every 6 months[1)]	If damaged, replace the shaft seal.
Hybrid cable	Check for damage and wear.	Every 6 months	If damaged or worn: Replace the hybrid cable (see *chapter 10.3.1 Cable Replacement*).
Mechanical holding brake (optional)	Check the brake.	Every 6 months	Ensure that the brake can achieve the holding torque as detailed in *chapter 3.2.2.2 Brake (Optional)*.
Functional safety	Perform a system power cycle and check the STO function.	Every 12 months	Activate STO and check the status with the PLC. See *chapter 8 ISD Safety Concept* for further information.
SAB	Check the fan.	Every 12 months	Check that the fan can turn and remove any dust or dirt.

Table 10.2 Overview of Maintenance Tasks

1) A shorter interval may be necessary depending on the application. Contact Danfoss for more information.

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10.2 Inspection during Operation

Servo drives
Carry out regular inspections during operation. Check the servo drives at regular intervals for anything unusual.

Pay particular attention to:

- Unusual noises.
- Overheated surfaces (temperatures up to 100 °C can occur in normal operation).
- Uneven running.
- Strong vibrations.
- Loose fastenings.
- Condition of electrical wiring and cables.
- Poor heat dispersion.

If irregularities or problems occur, see *chapter 9.2 Servo Drive*.

SAB
Carry out regular inspections during operation.

Ensure that:

- The cooling vents are not blocked.
- The fan is not making any unusual noises.

If irregularities or problems occur, see *chapter 9.3 Servo Access Box (SAB)*.

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10.3 Repair

NOTICE

Always return defective equipment to the local Danfoss sales company.

The repair tasks listed in this chapter can be performed by qualified personnel (see *chapter 2.5 Qualified Personnel*).

10.3.1 Cable Replacement

Replace the cables when the rated number of bending cycles has been reached or the cable is damaged.

NOTICE

Never disconnect or connect the cable from the servo drive with the supply voltage connected. Doing so damages the electronic circuitry. Observe the discharge time for the DC-link capacitors.

NOTICE

Do not forcefully connect or fit the connectors. Incorrect connection causes permanent damage to the connectors.

10.3.1.1 Feed-In Cable Replacement

Proceed as follows:

Disconnecting cables

1. Disconnect the SAB from its power source (mains network and all auxiliary supplies).
2. Wait for the necessary discharge time to elapse.
3. Disconnect any cables connected to the X3, X4, or X5 ports on the servo drive for easier access to the feed-in cable.
4. Disconnect the PE wire from the decouping plate on the SAB.
5. Open the cable clamp holding the STO cable.
6. Open the cable clamp holding the feed-in cable on the SAB.
7. Loosen the feed-in cable connectors on the SAB.
8. Dismount the feed-in cable on the SAB.
9. Loosen the threaded ring of the connector on the servo drive.
10. Disconnect the feed-in cable from the servo drive.

Cable replacement
Replace the feed-in cable with a cable of identical type and length. See the *VLT® Integrated Servo Drive ISD® 510 System Design Guide* for ordering numbers.

Connecting cables

1. Connect the female connector of the feed-in cable to the male connector of the 1st servo drive.
2. Turn the threaded rings of the connectors hand tight.
3. Ensure that there is no mechanical tension on the cables.
4. Insert the feed-in cable connectors into the correct position on the SAB (see *chapter 5.8.1 Servo Access Box*).
5. Secure the feed-in cable ensuring that the shield is positioned exactly under the clamp.
6. Secure the STO cable in the cable clamp ensuring that the shield is positioned exactly under the clamp.
7. Connect the PE wire to the decoupling plate.
8. Reconnect any cables that were connected to the X3, X4, or X5 ports.

10.3.1.2 Loop Cable Replacement

Proceed as follows:

Disconnecting cables

1. Disconnect the SAB from its power source (mains network).
2. Wait for the necessary discharge time to elapse.
3. Disconnect any cables connected to the X3, X4, or X5 ports on both servo drives for easier access to the loop cable.
4. Loosen the threaded rings of the loop cable connectors on both servo drives.
5. Disconnect the loop cable from the servo drives.

Cable replacement

Replace the loop cable with a cable of identical type and length. See the *VLT® Integrated Servo Drive ISD® 510 System Design Guide* for part numbers.

Connecting cables

1. Connect the male connector of the loop cable to the female connector on the servo drive (see *chapter 5.8.2.1 Connecting/Disconnecting Hybrid Cables*).
2. Connect the female connector of the loop cable to the male connector on the adjacent servo drive (see *chapter 5.8.2.1 Connecting/Disconnecting Hybrid Cables*).
3. Turn the threaded rings hand tight on both servo drives.
4. Ensure that there is no mechanical tension on the cables.
5. Tighten the threaded rings of the connectors on both servo drives.
6. Reconnect any cables that were connected to the X3, X4, or X5 ports on both servo drives.

10.4 Servo Drive Replacement

10.4.1 Dismounting

The procedure for dismounting the servo drive is the reverse of the fitting procedure described in chapter *chapter 5 Electrical Installation*.

Proceed as follows:

1. Disconnect the supply and wait for the discharge time to elapse.
2. Disconnect the electrical cables.
3. Dismount the servo drive.
4. Replace the ISD 510 servo drive with an ISD 510 servo drive of the same type. See the *VLT® Integrated Servo Drive ISD® 510 System Design Guide* for part numbers.

10.4.2 Fitting and Commissioning

The procedure for fitting and commissioning the servo drive is described in *chapter 4.5.3 Fitting Instructions Servo Drive* and *chapter 6 Commissioning*.

Proceed as follows:

1. Check if preparation is required (see *chapter 4.4.1 Servo Drive*).
2. Fit the servo drive (see *chapter 4.5.3 Fitting Instructions Servo Drive*).
3. Connect the hybrid cables (see *chapter 5.8.2.1 Connecting/Disconnecting Hybrid Cables*).
4. Connect the I/O and/or encoder cables (see *chapter 5.8.2.2 Connecting/Disconnecting Cables from Ports X3, X4, and X5*).
5. Configure the servo drive parameters according to the fieldbus used (see *chapter 6.2 ID Assignment*).
6. Conduct a test run.

10.5 SAB Replacement

10.5.1 Dismounting

The procedure for dismounting the SAB is as follows:

1. Disconnect the supply and wait for the discharge time to elapse.
2. Disconnect the electrical cables.
3. Remove the decoupling plate.
4. Dismount the SAB.

10.5.2 Fitting and Commissioning

The procedure for fitting and commissioning the SAB is described in *chapter 4.5.5 Fitting Instructions Servo Access Box (SAB)* and *chapter 6 Commissioning*.

Proceed as follows:

1. Check if preparation is required (see *chapter 4.4.2 Servo Access Box (SAB)*).
2. Fit the SAB as described in *chapter 4.5.5 Fitting Instructions Servo Access Box (SAB)*.
3. Connect the electrical cables as described in *chapter 5.8.1 Servo Access Box*.
4. Switch on the system as described in *chapter 6.3 Switching on the ISD 510 Servo System*.
5. Configure the SAB parameters according to the fieldbus used (see *chapter 6.2 ID Assignment*).
6. Conduct a test run.

10.6 Decommissioning of the ISD 510 Servo System

The procedure for decommissioning the servo system is the reverse of the installation procedure described in *chapter 4 Mechanical Installation*.

Proceed as follows:

1. Disconnect all supplies to the servo system and wait for the discharge time to elapse.
2. Disconnect the electrical cables.
3. Dismount the servo drive.
4. Dismount the SAB.

10.7 Product Returns

Danfoss products can be returned for disposal at no charge. A prerequisite for this is that they are free of deposits, such as oil, grease, or other types of contamination that hamper disposal.
Furthermore, foreign materials or third-party components cannot be included with the returned product.
Ship the products free on board to the local Danfoss sales company.

10.8 Recycling and Disposal

10.8.1 Recycling

Take metals and plastics to recycling stations.

The entire servo drive and the SAB are classified as electronic waste, and the packaging is classified as packaging waste.

10.8.2 Disposal

Devices containing electronic components cannot be disposed of as normal domestic waste.

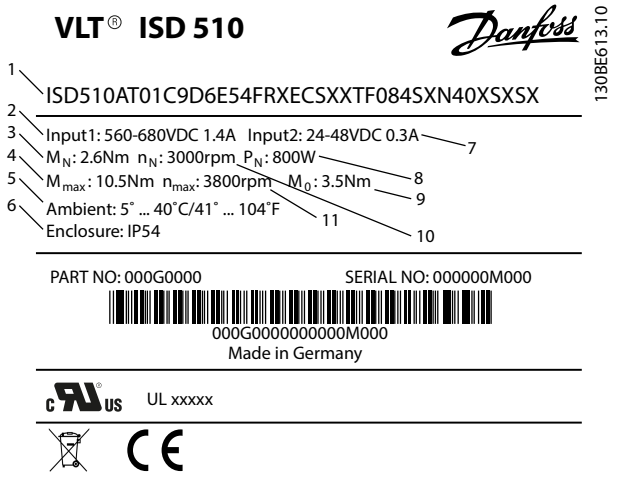
Dispose of the servo drives and the SAB as hazardous waste, electrical waste, recyclable waste, and so on, in accordance with applicable local regulations.

11 Specifications

11.1 Servo Drive

11.1.1 Nameplate

Check the nameplate and compare it with the order data.
Use the part number for reference.
The part number uniquely identifies the drive type (see *chapter 3.2.1.1 Types*).
Ensure that the nameplate is clearly legible.
The servo drives can be identified externally only by the original Danfoss nameplate.
The following data is shown on the servo drive nameplate:



1	Typecode	7	U_{AUX} supply
2	Supply voltage	8	Rated power
3	Rated torque	9	Standstill torque
4	Maximum torque	10	Rated speed
5	Ambient temperature range	11	Maximum speed
6	Protection rating	–	–

Illustration 11.1 Servo Drive Nameplate

11.1.2 Characteristic Data

Table 11.1 and *Table 11.2* provide a summary of typical servo drive characteristics.

Specifications	Unit	Size 1 1.5 Nm	Size 2 2.1 Nm	Size 2 2.9 Nm	Size 2 3.8 Nm
Rated speed n_N	RPM	4600	4000	2900	2400
Rated torque M_N	Nm	1.5	2.1	2.9	3.8
Rated current I_N	A DC	1.4	1.7		1.8
Rated power P_N	kW	0.72	0.88		0.94
Standstill (Stall) torque M_0	Nm	2.3	2.8	3.6	4.6
Standstill (Stall) current I_0	A DC	2.1	2.3	2.1	2.2
Peak torque M_{max}	Nm	6.1	7.8	10.7	12.7
Peak current (rms value) I_{max}	A DC	5.7	6.4		
Rated Voltage	V DC	560/680			
Inductance L 2ph	mH	18.5	26.8	32.6	33.9
Resistance R 2ph	Ω	9.01	7.78	8.61	8.64
Voltage constant EMK	V/krms	70.6	80.9	111.0	132.0
Torque constant K_t	Nm/A	1.10	1.26	1.72	2.04
Inertia	kgm^2	0.000085	0.00015	0.00021	0.00027
Shaft diameter	mm	14	19		

Specifications	Unit	Size 1 1.5 Nm	Size 2 2.1 Nm	Size 2 2.9 Nm	Size 2 3.8 Nm
Pole pairs	–	4	5		
Flange size	mm	76	84		
Weight	kg	3.5	4.0	5.0	6.0

Table 11.1 Characteristic Data for Servo Drive without Brake

Specifications	Unit	Size 1 1.5 Nm	Size 2 2.1 Nm	Size 2 2.9 Nm	Size 2 3.8 Nm
Brake inertia	kgm^2	0.0000012	0.0000068	0.0000068	0.0000068
Brake weight	kg	0.34	0.63		
Rated torque derating	%	8	6		7

Table 11.2 Characteristic Data for Servo Drive with Brake

11.1.3 Dimensions

Flange

Servo drive	Flange thickness
Size 1, 1.5 Nm	7 mm
Size 2, 2.1 Nm	–
Size 2, 2.9 Nm	8 mm
Size 2, 3.8 Nm	8 mm

Table 11.3 Flange Thickness

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All dimensions are in mm (in).

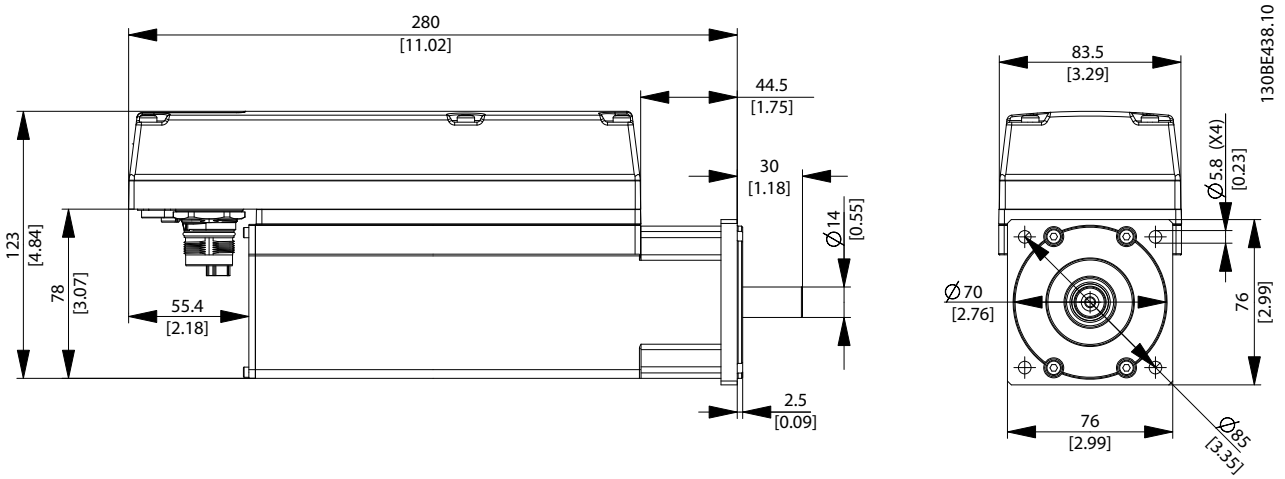

Illustration 11.2 Dimensions of ISD 510 Size 1, 1.5 Nm

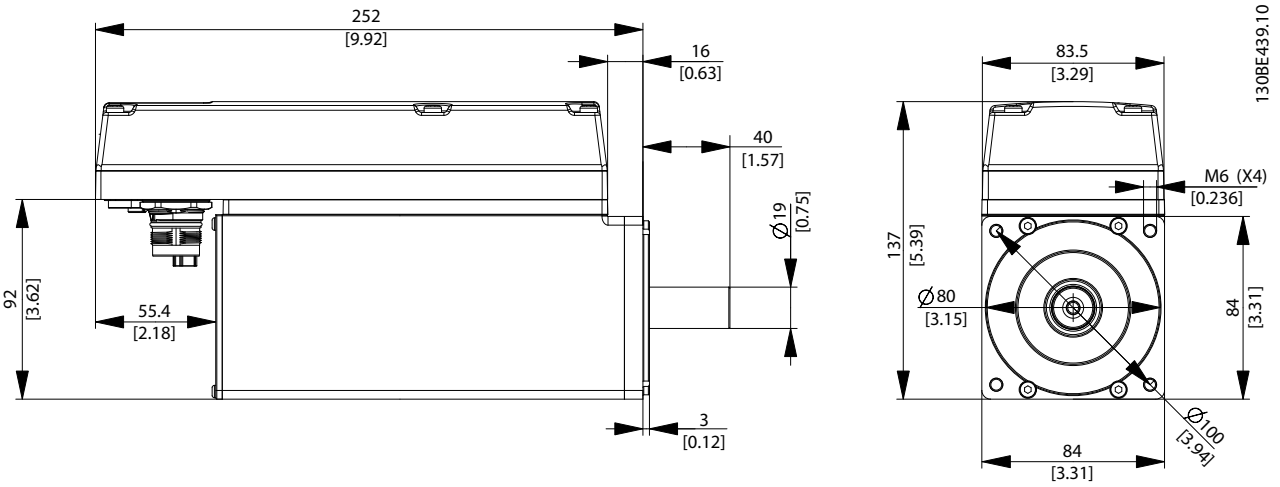

Illustration 11.3 Dimensions of ISD 510 Size 2, 2.1 Nm

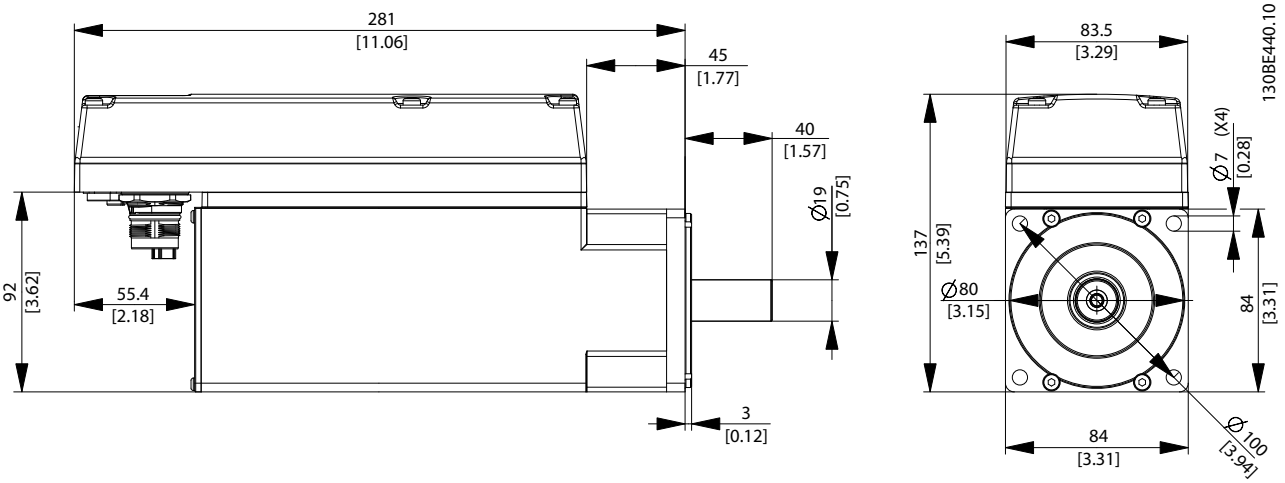

Illustration 11.4 Dimensions of ISD 510 Size 2, 2.9 Nm

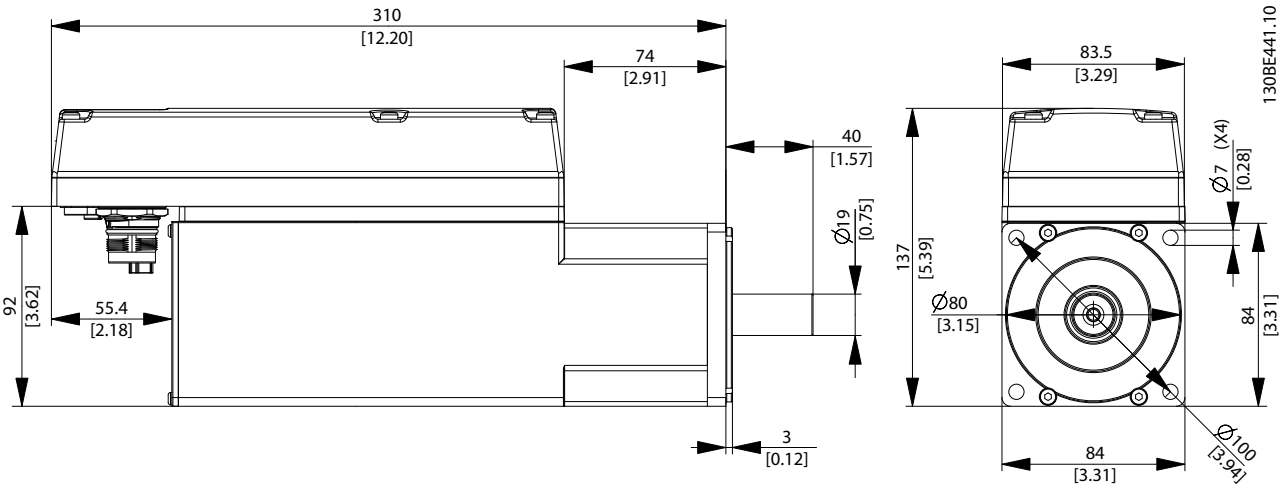

Illustration 11.5 Dimensions of ISD 510 Size 2, 3.8 Nm

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11.1.4 Permitted Forces

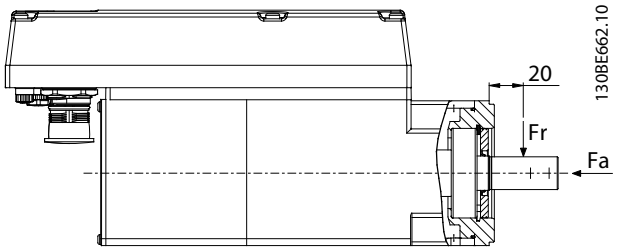

Illustration 11.6 Permitted Forces

Illustration 11.6 shows the maximum permitted forces on the motor shaft.

The maximum axial and radial load while assembling the motor and for any mechanical device connected to the shaft, must not exceed the values shown in *Table 11.4*. The shaft must be loaded slowly and in a constant manner: Avoid pulsating loads.

See the *VLT® Integrated Servo Drive ISD® 510 System Design Guide* for bearing load curves.

NOTICE

The bearing could be permanently damaged if the maximum permitted forces are exceeded.

Motor size	Radial Force (Fr) in N	Axial Force (Fa) in N
Size 1	450	1050
Size 2	900	1700

Table 11.4 Permitted Forces

11.1.5 General Specifications and Environmental Conditions

Vibration test	Random vibration: 7.54 g (2h/axis according to EN 60068-2-64) Sinusoidal vibration: 0.7 g (2h/axis according to EN 60068-2-6)
Maximum relative humidity	Storage/transport: 5–93% (non-condensing) Stationary use: 15–85% (non-condensing)
Ambient temperature range	5–40 °C above derating, maximum 55 °C (24-hour average maximum 35 °C) Transport: -25 to +70 °C Storage: -25 to +55 °C
Installation elevation	Maximum 1000 m above sea level
EMC standard for emission and immunity	EN 61800-3

Table 11.5 General Specifications and Environmental Conditions for Servo Drive

Protection ratings

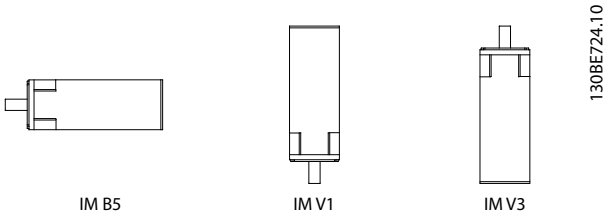

Illustration 11.7 Mounting Positions

	Mounting position of servo drive (according to DIN 42 950)	IP rating (according to EN 60529)
Housing	All positions	IP67
Shaft without shaft seal	IM B5 & IM V1	IP54
	IM V3	IP50
Shaft with shaft seal	IM B5 & IM V1	IP65
	IM V3	IP60

Table 11.6 Protection Ratings

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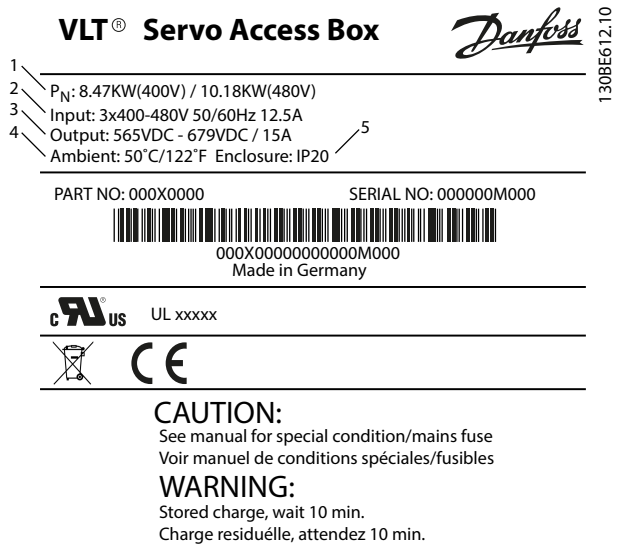
11.2 Servo Access Box

11.2.1 Nameplate

The following data is shown on the SAB nameplate:



1	Rated power	4	Ambient temperature
2	Supply voltage	5	Protection rating
3	Output voltage	–	–

Illustration 11.8 SAB Nameplate

Ensure that the nameplate is clearly legible.

11.2.2 Characteristic Data

Definition	Value and unit
Input	
Input voltage	400–480 V ±10%
Efficiency	98.5% at 400 V
Input current	12.5 A continuous 20 A intermittent
Output	
Output voltage ISD Line 1: UDC 1 & ISD Line 2: UDC 2	565–679 V ±10%[2)]
Output voltage ISD Line 1: STO 1 & ISD Line 2: STO 2	24 V ±10%
Output voltage ISD Line 1: AUX 1 & ISD Line 2: AUX 2	24–48 V ±10%
Output current ISD Line 1: AUX 1 & ISD Line 2: AUX 2	15 A
Output current UDC	15 A
Output current ISD Line 1: STO 1 & ISD Line 2: STO 2	1 A[1)]
Output power	8.47–10.18 kW[2)]
Housing	
Dimensions (W x H x D)	130 x 268 x 80 mm
Weight	8.3 kg

Table 11.7 Servo Access Box Characteristic Data

1) Depends on the number of servo drives connected in the application. The current per drive is 6.7 mA

2) Depends on the input voltage.

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11.2.3 Dimensions

All dimensions are in mm (in).

Front view

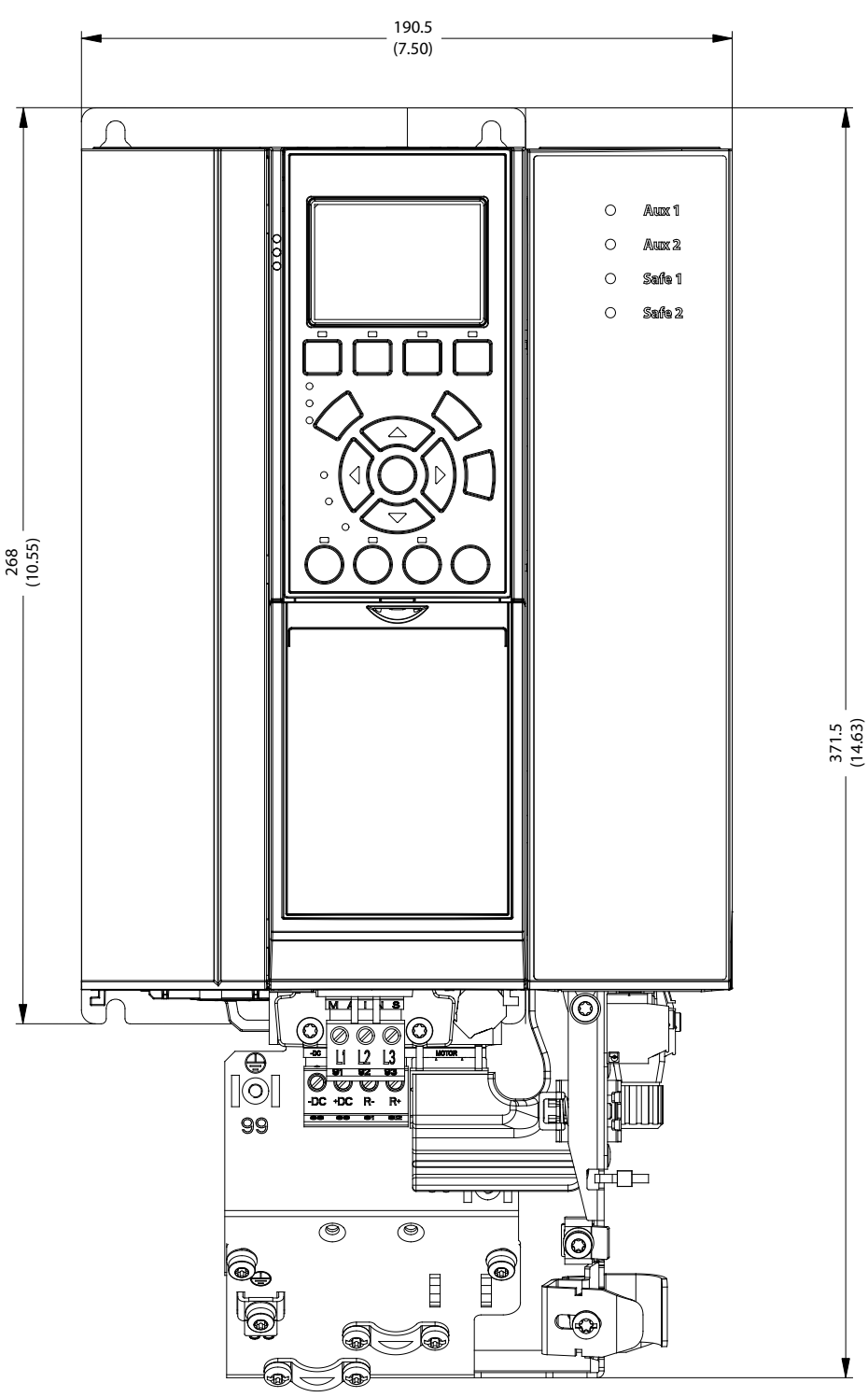


Illustration 11.9 Dimensions: Front View

Side view

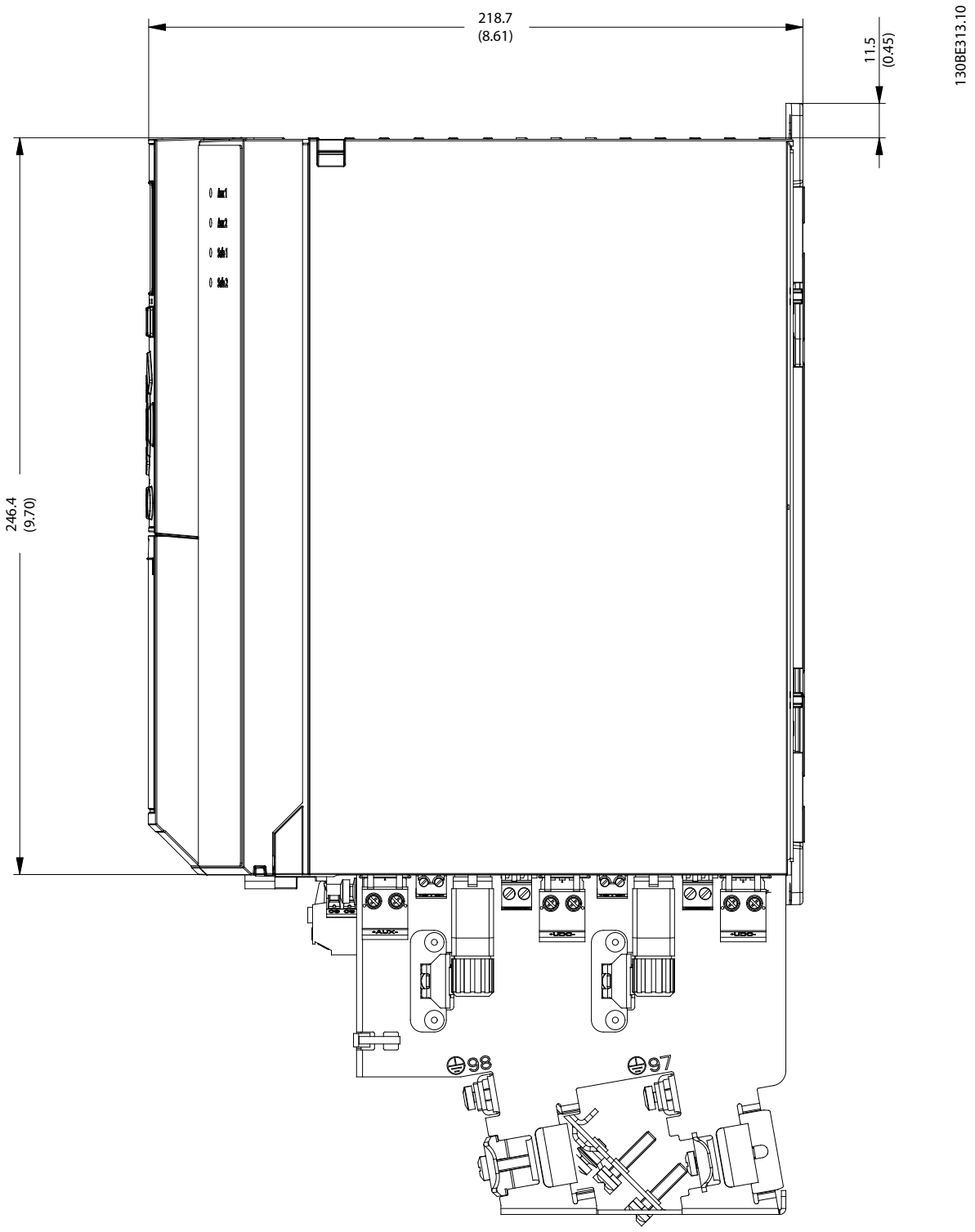


Illustration 11.10 Dimensions: Side View

11.2.4 General Specifications and Environmental Conditions

Protection rating	IP20
Vibration test	Random vibration: 1.14 g (2h/axis according to EN 60068-2-64) Sinusoidal vibration: 0.7 g (2h/axis according to EN 60068-2-6)
Maximum relative humidity	Storage/transport and stationary use: 5–93% (non-condensing)
Ambient temperature range	5–50 °C operating temperature (24 hour average maximum 45 °C) Transport: -25 to +70 °C Storage: -25 to +55 °C
Installation elevation	Maximum 1000 m above sea level
EMC standard for emission and immunity	EN 61800-3

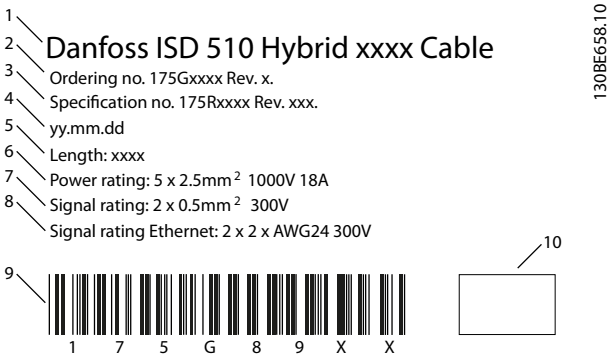
Table 11.8 General Specifications and Environmental Conditions SAB

11.3 Cables

NOTICE

See the *VLT® Integrated Servo Drive ISD® 510 System Design Guide* for cable dimensions and drawings.

All cables supplied by Danfoss have a nameplate as per the example in *Illustration 11.11*.



1	Cable type
2	Ordering code
3	Revision of specification
4	Manufacturing date
5	Length
6	Power rating
7	Signal rating
8	Signal rating for Ethernet
9	Barcode
10	Manufacturer logo

Illustration 11.11 Example of a Cable Nameplate

11.4 Storage

Store the servo drives and the SAB in a dry, dust-free location with low vibration (v_{eff} ≤0.2 mm/s).
Do not store the packaged system components on top of each other.
The storage location must be free from corrosive gases.
Avoid sudden temperature changes.

11.4.1 Long-Term Storage

NOTICE

To recondition the electrolytic capacitors, servo drives and SABs not in service must be connected to a supply source once per year to allow the capacitors to charge and discharge. Otherwise the capacitors could suffer permanent damage.

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12 Appendix

12.1 Glossary

A flange
The A side is the shaft side of the servomotor.

Ambient temperature
The temperature in the immediate vicinity of the servo system or component.

Automation Studio™
Automation Studio™ is a registered trademark of B&R. It is the integrated software development environment for B&R controllers.

Axial force
The force in newton-metres acting on the rotor axis in the axial direction.

Bearings
The ball bearings of the servomotor.

Beckhoff®
Beckhoff® is a registered trademark of and licensed by Beckhoff Automation GmbH, Germany.

B&R
Multi-national company, specialising in factory and process automation software and systems for a wide range of industrial applications.

B side
The rear side of the servo drive with the plug-and-socket connectors.

Brake
Mechanical holding brake on the servo drive.

CANopen®
CANopen® is a registered community trademark of CAN in Automation e.V.

CE
European test and certification mark.

CiA DS 402
Device profile for drives and motion control.
CiA® is a registered community trademark of CAN in Automation e.V.

Clamping set
A mechanical device, which, for example, can be used to secure gears to a motor shaft.

Connector (M23)
Servo drive hybrid connector.

Cooling
ISD servo drives are cooled by convection (without fans).

DC-link
Each servo drive has its own DC-link, consisting of capacitors.

DC-link voltage
A DC voltage shared by several servo drives connected in parallel.

DC voltage
A direct constant voltage.

EPSG
Ethernet POWERLINK® Standardization Group.

ETG
EtherCAT® Technology Group

EtherCAT®
EtherCAT® (Ethernet for Control Automation Technology) is an open high performance Ethernet-based fieldbus system. EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

Illustration 12.1 EtherCAT® Logo

Ethernet POWERLINK®
Ethernet POWERLINK® is a deterministic real-time protocol for standard Ethernet. It is an open protocol managed by the Ethernet POWERLINK® Standardization Group (EPSG). It was introduced by Austrian automation company B&R in 2001.

Feed-in cable
Hybrid connection cable between the SAB and servo drive.

Feedback system
Feedback systems for servo drives in general.

Fieldbus
Communication bus between controller and servo axis and SAB; in general between controller and field nodes.

Firmware
Software in the unit; runs on the control board.

Function block
Device functionalities are accessible via the engineering environment software.

IGBT
The insulated-gate bipolar transistor is a 3 terminal semiconductor device, primarily used as an electronic switch to combine high efficiency and fast switching.

Installation elevation
Installation elevation above normal sea level, typically associated with a derating factor.

ISD
Integrated servo drive.

ISD devices
Refers to both the ISD 510 servo drives and the SAB.

ISD servomotor
Designates the ISD servomotor (without the drive electronics).

ISD Toolbox
A Danfoss PC software tool used for parameter setting and diagnostics of ISD servo drives and the SAB.

LCP
Local control panel.

Loop cable
Hybrid connection cable between 2 servo drives, with 2 M23 connectors.

M8 connectors
Fully functional real-time Ethernet port (X3) on the B side of the advanced servo drive.
Connector (X5) for connection of the LCP to the B side of the advanced servo drive.

M12 connector
Connector (X4) for connecting I/O and/or encoder on the B side of the advanced servo drive.

M23 connectors
Connectors (X1 & X2) for connecting the hybrid feed-in and loop cables on the B side of the standard and advanced servo drive.

Motor shaft
Rotating shaft on the A side of the servo motor, typically without a key groove.

Multi-turn encoder
Describes a digital absolute encoder, in which the absolute position remains known after several revolutions.

PLC
A programmable logic controller is a digital computer used for automation of electromechanical processes, such as control of machinery on factor assembly lines.

PELV
Protected extra low voltage. Low voltage directive regarding voltage levels and distances between lines.

PLCopen®
The name PLCopen® is a registered trademark and, together with the PLCopen® logos, is owned by the association PLCopen®. PLCopen® is a vendor- and product-independent worldwide association, which defines a standard for industrial control programming.

POU
Program organization unit. This can be a program, function block, or function.

PWM
Pulse width modulation.

Radial force
The force in newton-metres acting at 90° to the longitudinal direction of the rotor axis.

RCCB
Residual current circuit breaker.

Resolver
A feedback device for servomotors, typically with 2 analog tracks (sine and cosine).

Safety (STO)
A servo drive safety circuit that switches off the voltages of the driver components for the IGBTs.

Scope
Is part of the ISD Toolbox software and is used for diagnosis. It enables internal signals to be depicted.

Servo Access Box (SAB)
Generates the DC-link supply for the ISD 510 servo system and can host up to 64 servo drives.

SIL 2
Safety Integrated Level II.

Single-turn encoder
Describes a digital absolute encoder, in which the absolute position for 1 revolution remains known.

SSI
Synchronous serial interface.

STO
Safe Torque Off function. On activation of STO, the servo drive is no longer able to produce torque in the motor.

TwinCAT®
TwinCAT® is a registered trademark of and licensed by Beckhoff Automation GmbH, Germany. It is the integrated software development environment for controllers from Beckhoff.

U_{AUX}
Auxiliary supply, provides power to the control electronics of the drives and SAB.

Wireshark®
Wireshark® is a network protocol analyzer released under the GNU General Public License version 2.

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