ENGINEERING
TOMORROW

Danfoss

Design Guide

VLT® Servo Drive System ISD® 510, DSD 510, MSD 510 (VLT® FlexMotion™)

Contents

1 Introduction

1.1 Purpose of the Design Guide

This design guide for Danfoss VLTÆ Servo Drive System ISD 510, DSD 510, MSD 510 (VLTÆ FlexMotionô) is intended for:

- Project and systems engineers.
- Design consultants.
- Application and product specialists.

The design guide provides technical information to understand the capabilities of the VLTÆ Servo Drive System ISD 510, DSD 510, MSD 510, and to provide design considerations and planning data for integration of the system into an application.
Also included are:

- Safety features.
- Fault condition monitoring.
- Operational status reporting.
- Real-time Ethernet communication capabilities.
- Programmable options and features.

Design details, such as site requirements, cables, fuses, control wiring, the size and weight of units, and other important information necessary to plan for system integration are also provided.
The design guide caters for the selection of VLTÆ Servo Drive System ISD 510, DSD 510, MSD 510 components and options for a diversity of applications and installations. Reviewing the detailed product information in the design stage enables the development of a well-conceived system with optimal functionality and efficiency.

1.2 Copyright

VLTÆ, ISDÆ, and FlexMotionô are Danfoss registered trademarks.

1.3 Additional Resources

Table 1: Additional Resources

Manual	Description
VLTÆ Servo Drive System ISD 510/DSD 510 Operating Guide	Information about the installation, commissioning, and operation of the VLTÆ Servo Drive System ISD 510/DSD 510.
VLTÆ Servo Drive System MSD 510 Operating Guide	Information about the installation, commissioning, and operation of the VLTÆ Servo Drive System MSD 510.
VLT Servo Drive System ISD 510, DSD 510, MSD 510 (VLTÆ FlexMotionô) Programming Guide	Information about the programming of the VLTÆ Servo Drive Systems ISD 510, DSD 510, MSD 510.

1.4 Manual Version

This design guide is regularly reviewed and updated. All suggestions for improvement are welcome.
The original language of this design guide is English.

Table 2: Manual Version

Version	Remarks
AJ427630281294, version 0101	First edition.

1.5 Terminology

Table 3: Terminology

Term	Description
ACM 510	Auxiliary Capacitors Module
DAM 510	Decentral Access Module that connects the Danfoss decentral servo drives (ISD 510 and DSD 510) to the servo system via a hybrid cable.
EXM 510	Expansion module for splitting system modules between 2 control cabinets.
Feed-in cable	Hybrid cable for connection from the DAM 510 to the 1st decentral drive.
FlexMotionô	Multi-purpose universally compatible servo drive concept combining the ISD 510, DSD 510, and MSD 510 servo drive systems.
FlexMotionô system components	Includes the ISD 510 and DSD 510 servo drives, the SDM 511/SDM 512 modules, PSM 510. DAM 510, ACM 510, and EXM 510.
ISD 510	Integrated Servo Drive
LCP	Local control panel
Loop cable	Hybrid cable for connecting servo drives in daisy-chain format.
MSD 510	Multiaxis Servo Drive
PLC	Programmable Logic Controller (external device for controlling the servo system).
PSM 510	Power Supply Module that generates a 565–680 V DC supply.
SDM 511	Servo Drive Module (single axis)
SDM 512	Servo Drive Module (double axis)
System modules	Includes PSM 510, DAM 510, and the optional ACM 510 and EXM 510.
V_{IN} PSM	Input of PSM 510 (V AC).
V_{OUT} PSM	Output of PSM 510 (V DC).

2 Safety

2.1 Safety Symbols

The following symbols are used in this guide:

W A R N I N G

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

C A U T I O N

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

N O T I C E

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

2.2 Qualified Personnel

Installation, commissioning, and maintenance 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.

2.3 Important Safety Warnings

The following safety instructions and precautions relate to the ISD 510, DSD 510, and MSD 510 servo systems. Read the safety instructions carefully before starting to work in any way with the servo system or its components.

W A R N I N G

HAZARDOUS SITUATION

If the system components, 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.

W A R N I N G

HIGH VOLTAGE

The servo system contains components that operate at high voltage when connected to the electrical supply network. There are no indicators on the components that indicate the presence of mains supply. Incorrect installation, commissioning, or maintenance may lead to death or serious injury.

- Installation, commissioning, and maintenance may only be performed by qualified personnel.

W A R N I N G

LEAKAGE/GROUNDING CURRENT HAZARD

Leakage/grounding currents are >3.5 mA. Improper grounding of the servo system modules and components may result in death or serious injury.

Leakage/grounding currents are >3.5 mA. Improper grounding of the ISD 510/DSD 510 servo drives and the system modules may result in death or serious injury.

- For reasons of operator safety, use a certified electrical installer to ground the system correctly in accordance with the applicable local and national electrical standards and directives, and the instructions in this manual.

⚠ WARNING ⚠

DISCHARGE TIME

The servo system contains DC-link capacitors that remain charged for some time after the mains supply is switched off at the Power Supply Module (PSM 510). 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 Power Supply Module (PSM 510) from the mains and wait for the capacitors to fully discharge before carrying out any maintenance work on the servo system or replacing components.

Minimum waiting time (minutes)
15

⚠ DANGER ⚠

- Risque du choc électrique. Une tension dangereuse peut être présentée jusqu'à 15 min après avoir coupé l'alimentation.

⚠ WARNING ⚠

UNINTENDED START

- Take suitable measures to prevent unintended starts.

⚠ WARNING ⚠

UNINTENDED MOVEMENT

Unintended movement may occur when parameter changes are carried out immediately, which may result in death, serious injury, or damage to equipment.

- When changing parameters, take suitable measures to ensure that unintended movement cannot pose any danger.

⚠ CAUTION ⚠

DANGER OF BURNS

The surface of the servo drives can reach high temperatures of over 90 °C during operation.

- Do not touch the servo drives until they have cooled down.

NOTICE

RCD COMPATIBILITY

The servo system contains components that can cause a DC current in the protective earthing conductor, which may result in malfunction in any devices connected to the system.

- Where a residual current-operated protective (RCD) or monitoring (RCM) device is used for protection in case of direct or indirect contact, use a type B RCD or RCM device on the supply side of the system components.

3 Approvals and Certifications

3.1 Approvals and Certifications

The VLT® Servo Drive Systems ISD 510, DSD 510, MSD 510 comply with the standards and directives detailed in Table 4.

Table 4: Product and System Approvals and Certifications

Certification	Description
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 61508-1	Functional safety of electrical/electronic/programmable electronic safety-related systems. Part 1: General requirements.
IEC/EN 61508-2	Functional safety of electrical/electronic/programmable electronic safety-related systems. Part 2: Requirements for electrical/electronic/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.
IEC/EN 60529	Degrees of protection provided by enclosures (IP Code).
UL 508C	UL Standard for Safety for Power Conversion Equipment. (Only applies to ISD 510 servo drive sizes 1 and 2.)
UL 61800-5-1	Adjustable speed electrical power drive systems. Part 5-1: Safety requirements - Electrical, thermal, and energy. ISD 510 servo drive sizes 3 and 4 and DSD 510:

Certification	Description
	MSD 510:
CSA C22.2 No. 274-13 (2013)	Standard specifying requirements for adjustable speed drives with regard to electrical, thermal, and energy safety considerations. Applies to ISD 510 sizes 1 and 2.
CSA C22.2 No. 274-17 (2017)	Standard specifying requirements for adjustable speed drives with regard to electrical, thermal, and energy safety considerations. Applies to: • ISD 510 sizes 3 and 4 • DSD 510 • MSD 510
CE	
2014/30/EU	Electromagnetic Compatibility (EMC) Directive.
2014/35/EU	Low Voltage Directive (LVD).
(2011/65/EU) amended (EU) 2015/863	Restriction of Hazardous Substances (RoHS).
2006/42/EC	Machinery Directive (MD).
EtherCATÆ	Ethernet for Control Automation Technology. Ethernet-based fieldbus system.
Ethernet POWERLINKÆ	Ethernet-based fieldbus system.
PROFINET RT/IRTÆ	Ethernet-based fieldbus system.
PLCopenÆ	Technical specification. Function blocks for motion control (formerly Part 1 and Part 2) Version 2.0 March 17, 2011.

3.2 Low Voltage Directive

The aim of the Low Voltage Directive is to protect persons, domestic animals, and property against dangers caused by the electrical equipment, when operating electrical equipment that is installed and maintained correctly, in its intended application. The directive applies to all electrical equipment in the 50–1000 V AC and the 75–1500 V DC voltage ranges.

3.3 EMC Directive

The purpose of the EMC (electromagnetic compatibility) Directive is to reduce electromagnetic interference and enhance immunity of electrical equipment and installations. The basic protection requirement of the EMC Directive states that devices that generate electromagnetic interference (EMI), or whose operation could be affected by EMI, must be designed to limit the generation of electromagnetic interference and shall have a suitable degree of immunity to EMI when properly installed, maintained, and used as intended. Electrical equipment devices used alone or as part of a system must bear the CE mark. Systems do not require the CE mark, but must comply with the basic protection requirements of the EMC Directive.

3.4 Machinery Directive

The aim of the Machinery Directive is to ensure personal safety and avoid property damage to mechanical equipment used in its intended application. The Machinery Directive applies to a machine consisting of an aggregate of interconnected components or devices of which at least 1 is capable of mechanical movement. Drives with an integrated functional safety function must comply with the Machinery Directive. Drives without a functional safety function do not fall under the Machinery Directive. If a drive is integrated into a machinery system, Danfoss can provide information on safety aspects relating to the drive. When drives are used in machines with at least 1 moving part, the machine manufacturer must provide a declaration stating compliance with all relevant statutes and safety measures.

4 System Overview

4.1 General Description

Danfoss VLT® FlexMotion™ is a multi-purpose universally compatible servo drive concept. The modules can be combined and scaled to meet specific application needs. The central and decentral modules allow a multitude of functions to be achieved and facilitate maximum flexibility in machine design and system integration.

The high-performance central servo motion solution is an open system and supports the real-time Ethernet protocols EtherCATÆ, Ethernet POWERLINKÆ, and PROFINETÆ.

Open system architecture gives total freedom to integrate preferred motors and PLC.

To optimize the space requirements, some of the modules are available in 50 mm (1.97 in)/100 mm (3.94 in) enclosure sizes as detailed in Table 5.

Table 5: VLT® FlexMotion System Components

Component	Description
ISD 510 servo drive	Motors with integrated signal and power electronics. They are mounted decentrally in the application and have advanced motion control functionality on board.
DSD 510 servo drives	Servo drive for mounting close to the servo motor. It delivers rated power up to 4.5 kW and can be used with a wide range of permanent magnet servo motors and motor feedback encoders.
Power Supply Module (PSM 510)	Power supply to the servo system. It supplies a DC power voltage and guarantees high-density output. (100 mm enclosure)
Decentral Access Module (DAM 510)	Central interface/gateway to the decentral servo system. It supplies the decentral servo drives with DC-link, U_{AUX}, STO, and the Ethernet-based fieldbus via the hybrid feed-in cable. (50 mm enclosure)
Auxiliary Capacitors Module (ACM 510)	Used to store energy, enabling a controlled machine stop in emergency situations. (50 mm enclosure)
Expansion Module (EXM 510)	Supports modular machine setup by splitting the system modules into 2 control cabinets or multiple rows within 1 control cabinet. (50 mm enclosure)
Servo Drive Module SDM 511	Single-axis Servo Drive Module (50/100 mm enclosure) It supplies the connected motor with the 3-phase line, is equipped with digital I/Os and Safe Torque Off (STO), and supports several motor feedback encoders.
Servo Drive Module SDM 512	Double-axis Servo Drive Module (50 mm enclosure) It supplies the connected motor with the 3-phase line, is equipped with digital I/Os and Safe Torque Off (STO), and supports several motor feedback encoders.
Hybrid cable	There are 2 types of hybrid cable: • Feed-in cable: Connects the DAM 510 to the 1st servo drive. • Loop cable: Connects the servo drives in an application in daisy-chain format. Speed connectors (M23) minimize installation time, cost, and risk of failures.
Local Control Panel (LCP)	Graphical user interface that can be connected to ISD 510, DSD 510 SDM 511, SDM 512, PSM 510, DAM 510, and ACM 510 for diagnostic and operating purposes using an optional cable (M8 to LCP D-SUB extension cable).
External encoder	An external encoder can be connected as follows:

Component	Description
	• Method 1: via the X3 fieldbus port on ISD 510/DSD 510. • Method 2: via the X4 connector on ISD 510/DSD 510 and the external encoder connector on SDM 511/SDM 512.
PLC	PLC with Ethernet POWERLINKÆ, EtherCATÆ, and PROFINETÆ fieldbus master functionality.
STO	Safe Torque Off feature can be provided via external safety circuits.
Analog/Digital Sensor	Connection to the servo drives is possible.
3rd-party fieldbus device	Connection to the M8 4-pole fieldbus port on the servo drive (not supported for PROFINETÆ).
Software	• Firmware for the servo drive modules (SDM 511 and SDM 512) • Firmware for the PSM 510, DAM 510, and ACM 510 • VLTÆ Servo Toolbox: A Danfoss PC-based software tool for commissioning and debugging the devices. • PLC libraries for AutomationStudioô , TwinCATÆ 2 and 3, SIMOTION Scout, and TIA Portal.

4.2 Application Examples

4.2.1 Typical Applications

There are numerous possible applications for the ISD 510, DSD 510, and MSD 510 systems as per the following examples:

- Beverage machines
  - Labeling
  - Capping
  - Filling
  - PET blow-mounting
  - Digital bottle printing
- Food and beverage packaging machines
  - Flow wrapping
  - Bag maker
  - Tray sealing
  - Shrink wrapping
- Industrial and pharmaceutical packaging machines
  - Palletization
  - Top loader
  - Cartoning
  - Tube filling
  - Blister machine
  - Liquid filling
  - Solid dosing

4.3 VLT® Integrated Servo Drive ISD 510

4.3.1 Overview of the ISD 510 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 that the entire power drive system consisting of motor, position sensor, optional mechanical brake, and also power and control electronics is integrated into 1 housing. Additional circuits, such as low voltage supply, bus drivers, and functional safety are implemented within the servo drive electronics. All ISD 510 servo drives have 2 hybrid connectors (M23) that connect power and communication signals from a hybrid cable. There are 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 ISD 510 servo drive show the current status. Data transfer takes place via Real-Time Ethernet.

See 8.2.1 Characteristic Data for ISD 510 Servo Drive without Brake and 8.2.2 Characteristic Data for ISD 510 Servo Drive with Brake for technical information.

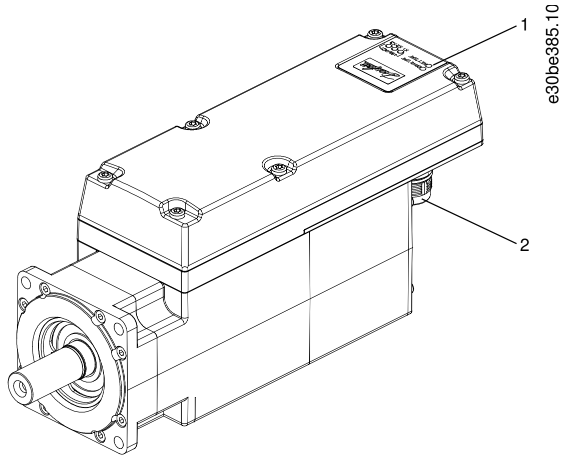

Illustration 1: ISD 510 Servo Drive

1	Operating LEDs
2	Connectors

4.3.2 Motor and Flange Sizes

Table 6: Motor and Flange Sizes

	Size 1, 1.5 Nm	Size 2, 2.1 Nm	Size 2, 2.9 Nm	Size 2, 3.8 Nm	Size 3, 5.2 Nm	Size 3, 6.0 Nm	Size 4, 11.2 Nm
Flange size	76 mm	84 mm			110 mm		138 mm

4.4 VLT® Decentral Servo Drive DSD 510

4.4.1 Overview of the DSD 510 Servo Drive

DSD is the abbreviation of decentral servo drive, which is a servo drive for mounting close to the servo motor. In this way, the servo motor has no impact to the servo drive from a thermal point of view.

The servo drive extends the selection of a decentral servo drive concept. It delivers rated power up to 4.5 kW and can be used with a wide range of permanent magnet servo motors and motor feedback encoders.

AC induction motors are supported as well as open-loop U/f control and open-loop flux control (FC-SFOC).

LEDs on the top of the servo drive show the current status. Data transfer takes place via Real-Time Ethernet.

See 8.2.3 Characteristic Data for DSD 510 Servo Drive for technical information.

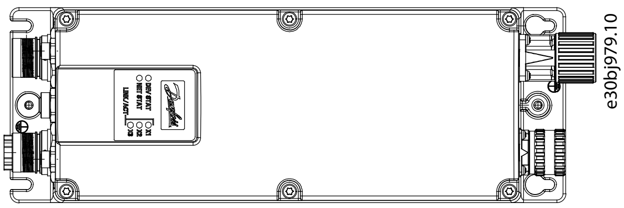

Illustration 2: DSD 510 Servo Drive

4.5 VLT® Multiaxis Servo Drive System MSD 510

4.5.1 Overview of the VLT® Multiaxis Servo Drive System MSD 510

The VLTÆ Multiaxis Servo Drive System MSD 510 is a high-performance central servo motion solution.

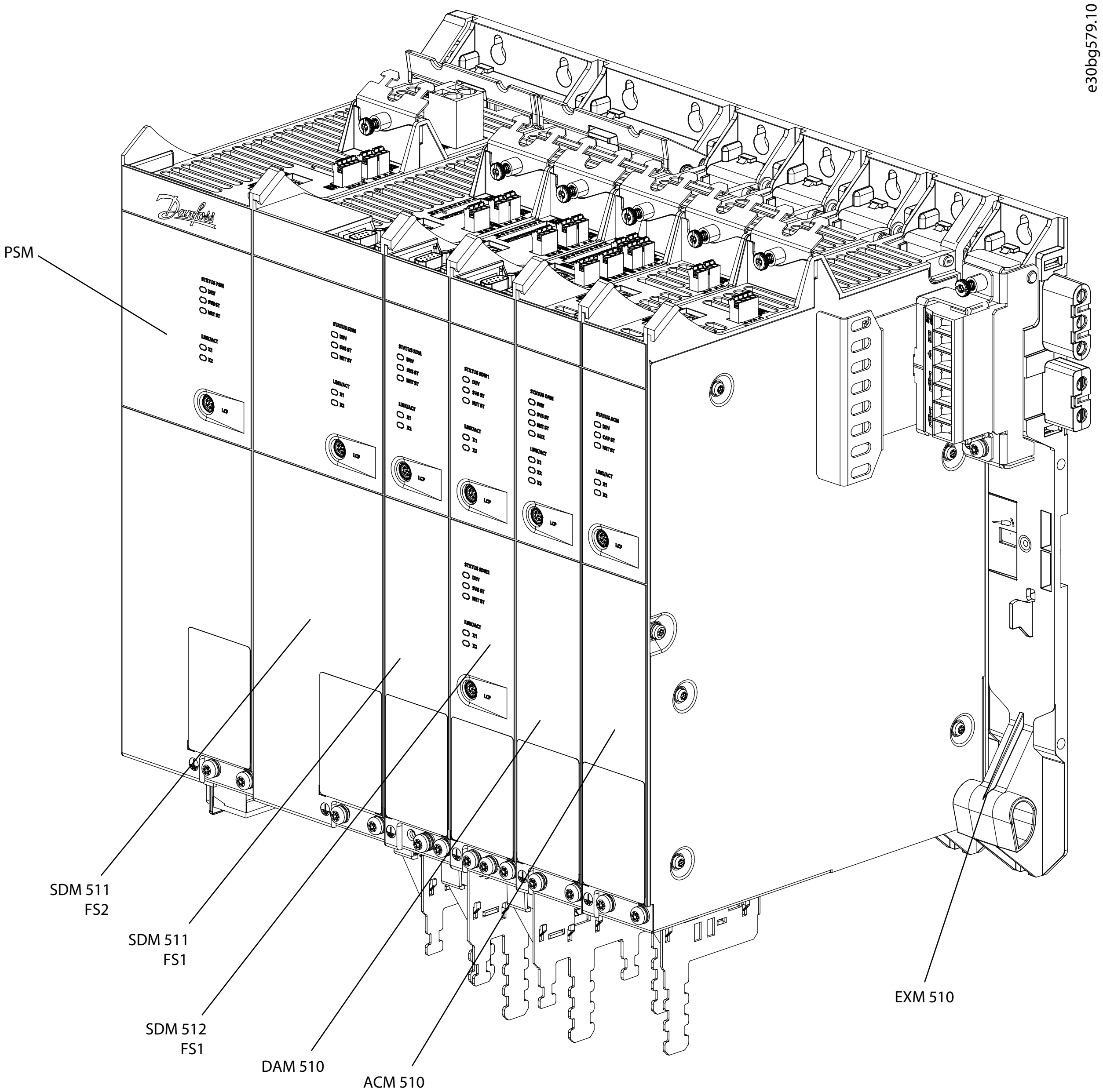

Illustration 3: MSD Modules

The system comprises:

- Power Supply Module (PSM 510)
- Drive Modules:
  - Single-axis Servo Drive Module (SDM 511)
  - Double-axis Servo Drive Module (SDM 512)
- Decentral Access Module (DAM 510)
- Auxiliary Capacitors Module (ACM 510)

- Expansion Module (EXM 510)
- Software:

Some modules are available in 2 enclosure (frame) sizes with widths of 50 mm (FS1) or 100 mm (FS2) depending on the power size.

Depending on the application, the system can be used exclusively in a central system, or together with Danfoss Decentral Servo Drives (ISD 510 and DSD 510) in a mixed system. Use of an AC choke is mandatory.

The system modules PSM 510, DAM 510, ACM 510, EXM 510, and drive modules SDM 511/SDM 512 are mounted to a backplate located in the control cabinet. DC-link and the control voltage supply are integrated in the backplate. The 'click and lock' backplate concept offers easy mounting and installation.

The SDM 511/SDM 512 delivers rated power up to 22 kW and can be used with a wide range of permanent magnet servo motors and induction motors with and without motor feedback encoders. Open-loop U/f control and open-loop flux control (FC-SFOC) are also supported.

N O T I C E

- The VLTÆFlexMotionô modules cannot be used in servo systems from other manufacturers. Drives from other manufacturers cannot be used in the VLTÆFlexMotionô system.
- Contact Danfoss for further information.

N O T I C E

- The system modules have a protection rating of IP20 according to IEC/EN 60529 (except connectors, which are IP00). They are only designed for use within a control cabinet. The system modules may be damaged if exposed to fluids. If the STO function is used, the control cabinet must be rated at least IP54.

4.6 System Wiring

4.6.1 Overview

N O T I C E

- Avoid mixing different size ISD 510 servo drives on 1 line. However, if the application requires this, place the largest size ISD 510 servo drive closest to the DAM 510 and then add the other sizes in descending order. For example, DAM 510 ➞ ISD size 3 ➞ ISD size 2.

4.6.2 Ethernet POWERLINK® without Redundancy

4.6.2.1 Standard Cabling Concept

This is an example of a cabling concept for 2 lines without redundancy for ISD 510/DSD 510 servo drives in an application. For each additional line of servo drives, 1 additional DAM 510 is required. For cabling concepts with only 1 line, only 1 DAM 510 is required.

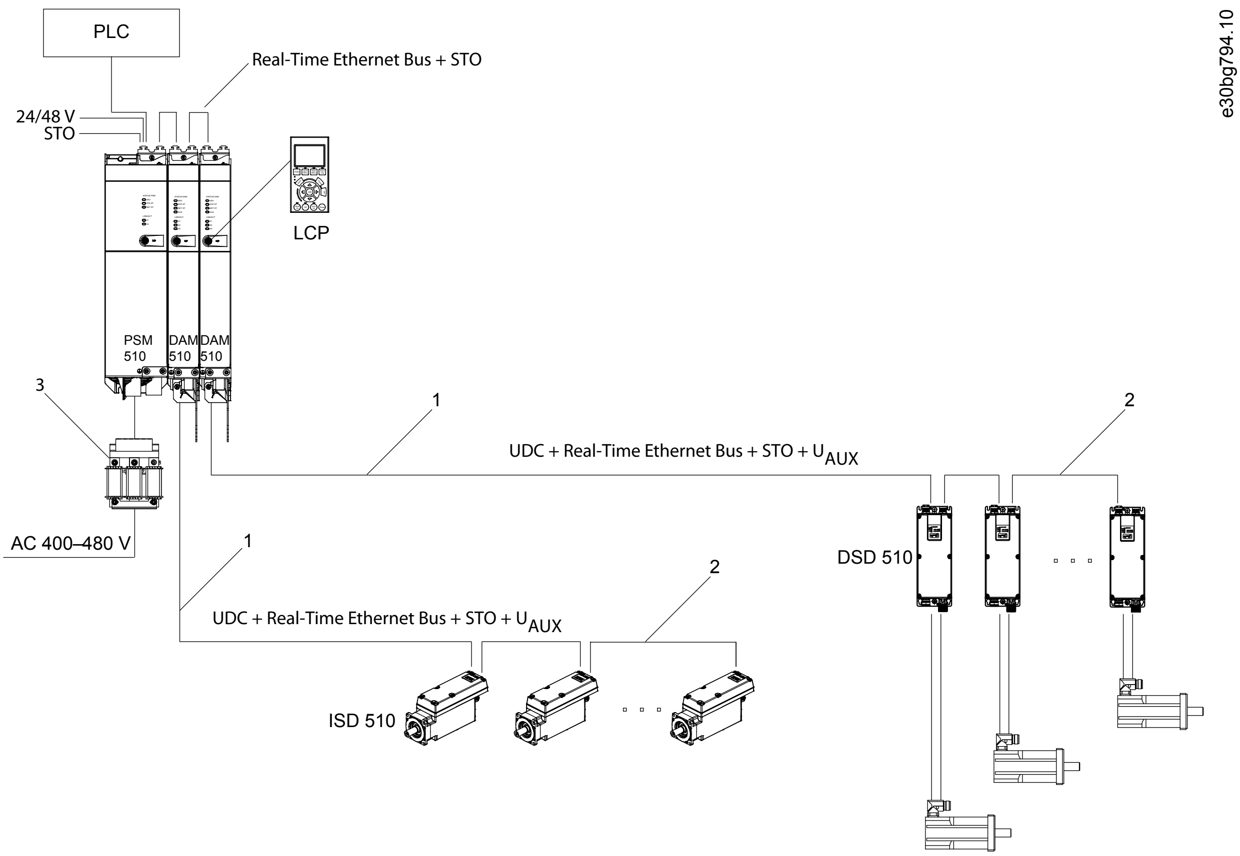

Illustration 4: Standard Cabling Concept for 2 Lines

1	M23 feed-in cable	3	AC line choke
2	M23 loop cable		

4.6.3 Ethernet POWERLINK® with Redundancy

There are 2 methods to use Ethernet POWERLINK® with redundancy:

- Via a fieldbus extension cable (see Illustration 5)
- Via the PLC (see Illustration 6)

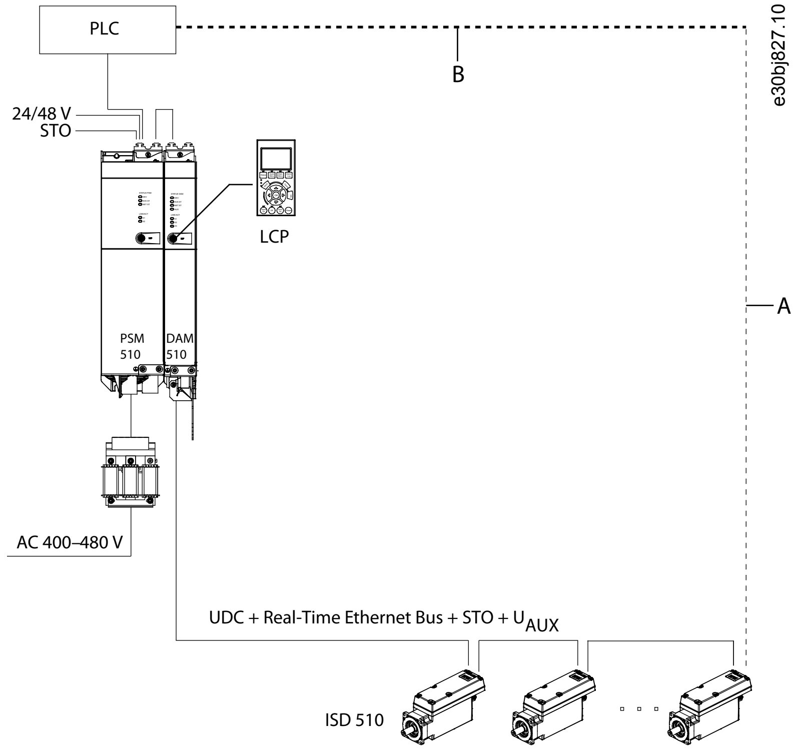

Illustration 5: Ethernet POWERLINK® with 1 line

A	Fieldbus extension cable
B	3rd-party network cable

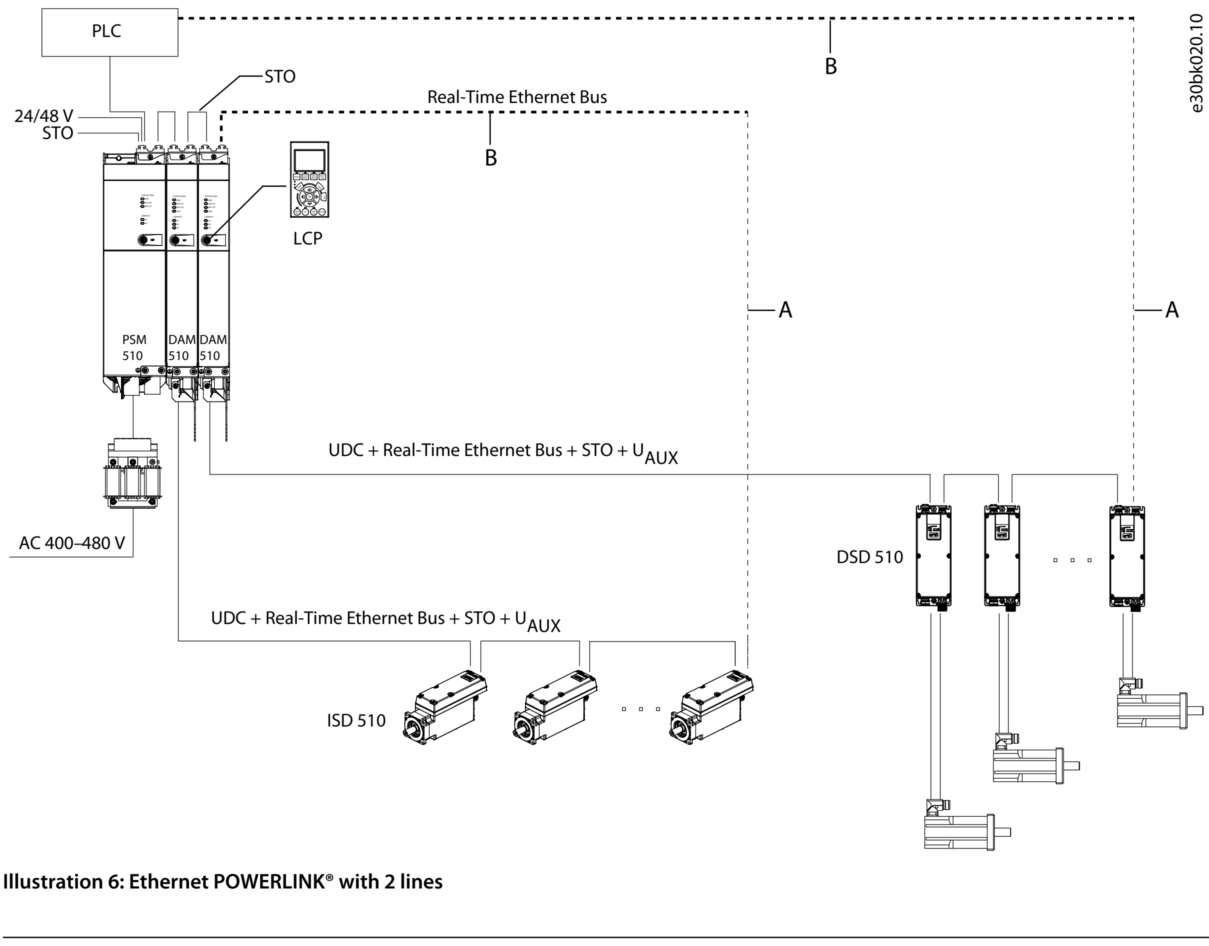

Illustration 6: Ethernet POWERLINK® with 2 lines

A	Fieldbus extension cable
B	3rd-party network cable

4.6.4 EtherCAT® with Redundancy

Ring redundancy can be achieved using the same cabling scheme as the Ethernet POWERLINKÆ with 2 lines and an Ethernet port multiplier. Connect the fieldbus extension cable to the last servo drive on the line and connect the other end of the cable with an Ethernet CAT5 cable. Settings must also be made in the engineering environment; see the corresponding online help for further information.

4.6.5 PROFINET® with Redundancy

There are 2 types of redundancy that are supported for the PROFINETÆ fieldbus.

Table 7: Redundancy Types for PROFINET®

MRP (Media Redundancy Protocol)	MRP is a data network protocol standardized by the International Electrotechnical Commission as IEC 62439-2. It allows rings of Ethernet switches to overcome any single failure with a fast recovery time.
MRPD (Media Redundancy with Planned Duplication of frames)	MRPD is even faster than MRP as it sends real-time frames already in both directions on the ring to the recipient of the data.

MRP is used with PROFINETÆ Real Time (RT), while MRPD is used with PROFINETÆ Isochronous Real Time (IRT).

4.7 System Splitting with EXM 510

4.7.1 Allowed System Splitting for 2 PSM 510 with 2 Chokes

If 2 AC chokes are used (1 per PSM 510) and both PSM 510 modules are mounted at the same side of the system splitting, the setup is allowed with derating equal to the AC choke's tolerance referred to 60 kW. For example, 10% derating means maximum power of 54 kW.

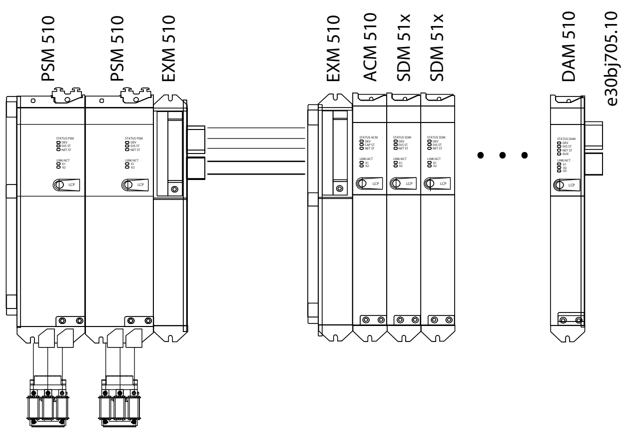

Illustration 7: System Splitting Option 1

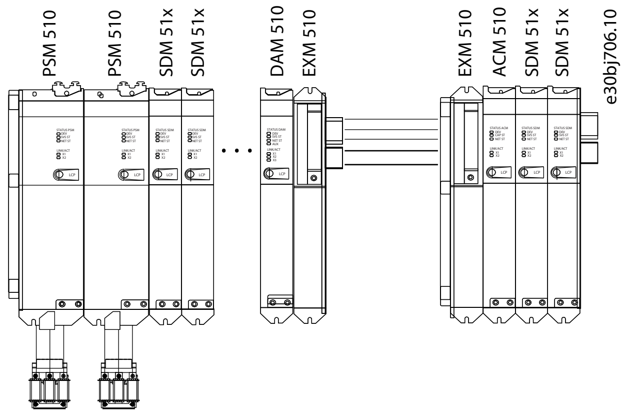

Illustration 8: System Splitting Option 2

If 2 AC chokes are used (1 per PSM 510) where 1 PSM 510 module is mounted before and 1 after the splitting, the loads must be balanced equally. Otherwise, the derating of both PSM 510 modules is equal to the AC choke's tolerance. For example, tolerance 10% + 10% means –20% derating, resulting in maximum power of 48 kW.

If 2 AC chokes are used (1 per PSM 510) and 1 PSM 510 module is mounted before the splitting and 1 after the splitting and half of the loads are set before the system splitting and half are set after the system splitting, the setup is allowed with derating equal to the AC choke's tolerance referred to 60 kW. For example, 10% derating means maximum power of 54 kW.

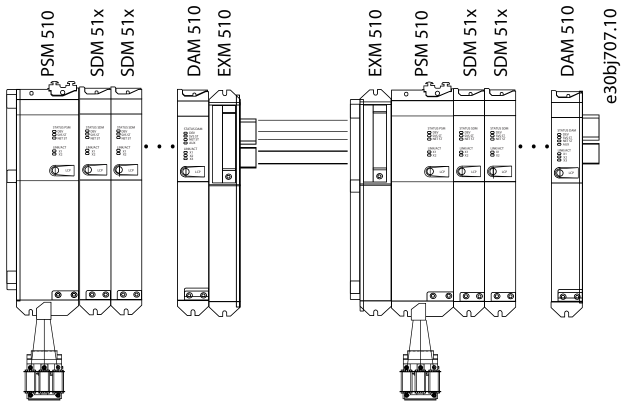

Illustration 9: System Splitting Option 3

N O T I C E
– The maximum cable length for the extension cable is detailed in 5.5.1 Maximum Cable Lengths.

4.7.2 Allowed System Splitting for 2 PSM 510 with 1 Choke

Illustration 7 and Illustration 11 show the allowed splitting for systems with 2 PSM 510 modules and 1 choke. The wiring between the AC line choke and each PSM 510 must be the same length within a tolerance of 0.5 m.

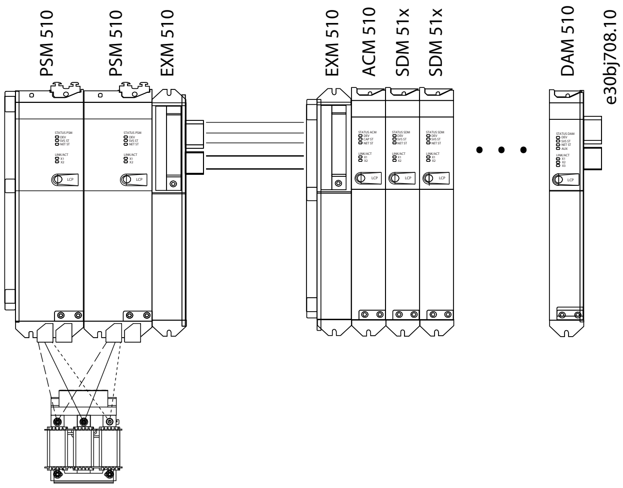

Illustration 10: System Splitting Option 1

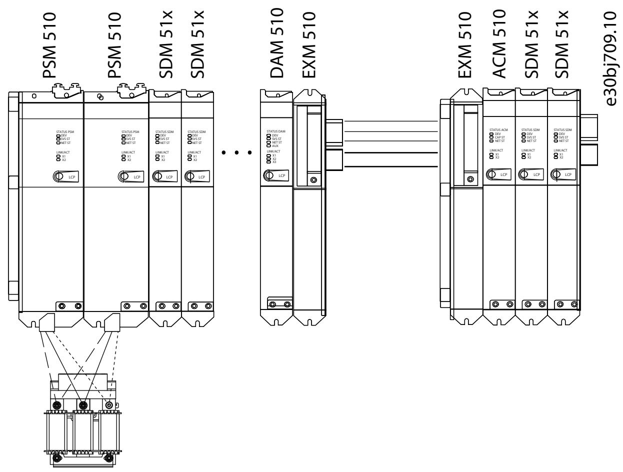

Illustration 11: System Splitting Option 2

4.8 Functional Safety Concept

4.8.1 Functional Description

The VLTÆFlexMotionô system has Safe Torque Off (STO) built in as standard. Along with other safety functions, STO enhances application safety. The drive-based functional safety offering complies with the requirements of international standards and requirements, including European Union Machinery Directive 2006/42/EC.

The servo system integrates the safety function Safe Torque Off (STO). The safety function is available in daisy-chain format, which is possible between the PSM 510, DAM 510, and SDM 511/SDM 512 modules (cables are not included). The hybrid cable passes the STO signal from the Decentral Access Module (DAM 510) to all ISD 510/DSD 510 servo drives in the chain. Once STO is activated (safe state), no torque is generated on the ISD 510 servo drives, or on any motors connected to DSD 510, SDM 511, or SDM 512. Reset of the safety function and diagnostics can be carried out via the PLC.

Further information on Functional Safety can be found in the relevant operating guide.

NOTICE

- Use STO shielded wiring.
- Use the STO function when performing mechanical work on the servo system or affected area of a machine to avoid a mechanical hazard. However, the STO function does not provide electrical safety.

4.8.2 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:

- IEC/EN 61508: 2010 SIL 2
- IEC 61800-5-2: 2016 SIL 2
- EN 61800-5-2: 2017 SIL 2
- IEC 62061: 2005 and A1: 2012 and A2: 2015
- EN 62061: 2005 and Cor.:2010 and A1: 2013 and A2: 2015
- IEC/EN 62061: 2015 SIL CL2
- EN ISO 13849-1: 2015 Category 3, PL d
- EN ISO 13849-2: 2012

The VLTÆ FlexMotionô products can be used where Stop Category 0 (uncontrolled stop), according to IEC 60204-1:2016 or EN 60204-1:2018, is needed.

4.8.3 Abbreviations and Conventions

Table 8: Safety-related Abbreviations and Conventions

Abbreviation	Reference	Description
Cat.	EN ISO 13849-1	Category B, 1–4
DC	–	Diagnostic coverage
FIT	–	Failure in time Failure rate: 1E-9/hour
HFT	EN IEC 61508	Hardware fault tolerance HFT = n means that n + 1 faults may lead to a loss of the safety function.
$MTTF_D$	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.
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

4.8.4 Functional Safety Characteristic Data

Table 9: Functional Safety Characteristic Data

Data	PSM 510	DAM 510	ISD 510/DSD 510	SDM 511	SDM 512
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 ($MTTF_D$)	–	–	>5000 years		>5000 years[1]
Diagnostic coverage (DC)	–	–	60%		
Data for IEC 61508 and EN/IEC 62061					
Safety integrity level (SIL)	–	–	2		
Probability of failure per hour (PFH)	0 /h	0 /h	<4 x 10^{-9}/h		
Subsystem classification	Type A				
Diagnostic test interval	1 year				

[1] For each axis

N O T I C E

- The PSM 510, DAM 510, and ACM 510 do not contribute to the dangerous failure rate of the Danfoss system and can therefore be excluded from safety-related calculations.
- Compliance to the claimed SIL and PL is only possible if the diagnostic test is executed once per year.

4.8.5 Maintenance, Security, and User Accessibility

Maintenance: Test the STO safety function at least once per year as follows:

- Remove the STO input voltage.
- Verify that the motors stop running.
- Verify that no unexpected error codes appear.

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

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

4.9 Communication

4.9.1 Fieldbus

The servo system has an open system architecture realized by fast Ethernet (100BASE-T) based communication. The system supports EtherCATÆ, Ethernet POWERLINKÆ, and PROFINETÆfieldbuses. See the **VLT® Servo Drive System ISD 510, DSD 510, MSD 510 (VLT® Flexmotionô) Programming Guide** for further information.

In productive environments, communication to the devices always takes place via a PLC that acts as a master. The ISD 510/DSD 510 servo drives, the servo drive modules SDM 511/SDM 512, and the system modules can be controlled by these communication methods:

- Using the VLTÆ Servo Motion libraries (available for TwinCATÆ, Automation Studioô , SIMOTION SCOUTÆ, and TiA Portal).
- Using the NC axis functionality of TwinCATÆ (ISD 510/DSD 510 and SDM 511/SDM 512 only).
- Using the CANopenÆ CiA DS 402 standard by reading and writing to objects.
- Using application class 1 (AC1) and class 4 (AC4 and AC4 with dynamic servo control) PROFINETÆ technology objects.

The ISD 510/DSD 510 servo drives, the servo drive modules SDM 511/SDM 512, and the system modules can be operated with the following cycle times.

- EtherCATÆ and Ethernet POWERLINKÆ fieldbuses:
  - 400 µs and multiples of it (for example, 800 µs and 1200 µs).
  - 500 µs and multiples of it (for example, 1 ms).
- PROFINETÆ fieldbus
  - 1 ms, 2 ms, or 4 ms.

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

The ISD 510/DSD 510 servo drives, the servo drive modules SDM 511/SDM 512, and the system modules are suitable for fieldbuses according to the corresponding rules and regulations. The servo drives conform to the PROFIdrive profile.

4.9.1.1 EtherCAT®

The ISD 510/DSD 510 servo drives, servo drive modules SDM 511/SDM 512, and the system modules support the following EtherCATÆ protocols:

- CANopen over EtherCATÆ (CoE)
- File Access over EtherCATÆ (FoE)
- Ethernet over EtherCATÆ (EoE)

The ISD 510/DSD 510 servo drives, servo drive modules SDM 511/SDM 512, and the system modules support distributed clocks. To compensate for the failure of a communication cable section in the system, cable redundancy is available for all fieldbuses.

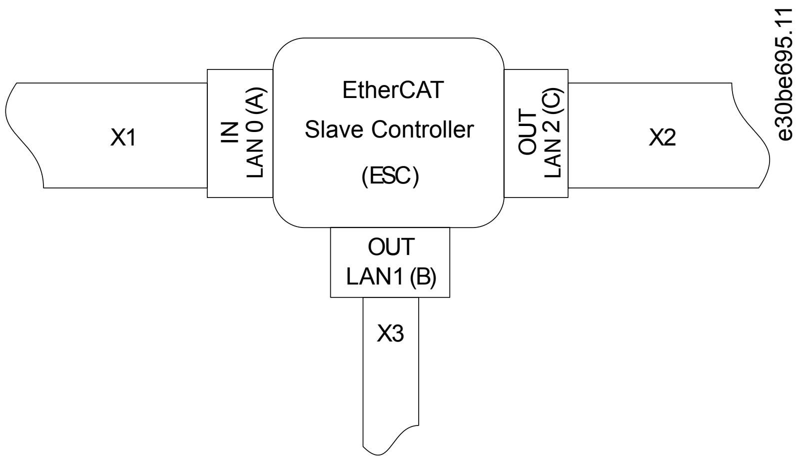

Illustration 12: EtherCATô Port Assignment for the ISD 510/DSD 510 Servo Drive

X1	M23 hybrid cable connector to Decentral Access Module (DAM 510) or previous servo drive.	X3	M8 Ethernet cable connector to other EtherCATÆ slaves, for example EtherCATÆ encoder.
X2	M23 hybrid cable connector to the next servo drive.		

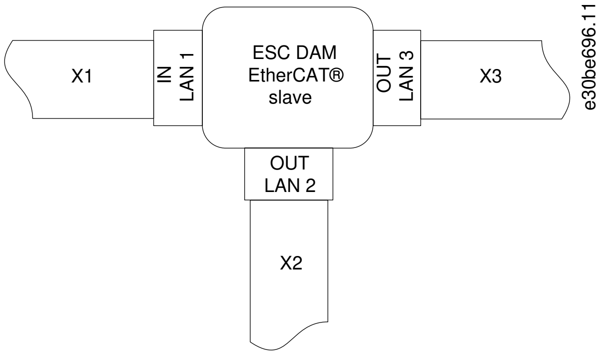

Illustration 13: EtherCATô Port Assignment for the Decentral Access Module (DAM 510)

X1	RJ45 cable connector to the previous slave.	X3	RJ45 cable connector to the PLC (cable redundancy) or next slave.
X2	RJ45 to M23 hybrid feed-in cable to the 1st ISD 510/ DSD 510 servo drive.		

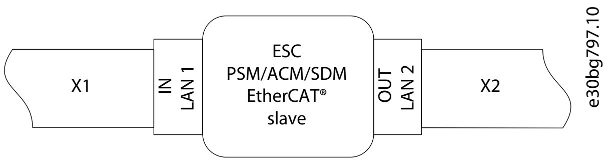

Illustration 14: EtherCATô Port Assignment for the Power Supply Module (PSM 510), Auxiliary Capacitors Module (ACM 510), and Servo Drive Module SDM 511/SDM 512

X1	RJ45 cable connector to the PLC or previous slave.
X2	RJ45 cable connector to the PLC (cable redundancy) or next slave.

4.9.1.2 Ethernet POWERLINK®

The ISD 510/DSD 510 servo drives, servo drive modules SDM 511/SDM 512, and the system modules are certified according to DS 301 V1.4.0 and support the following features:

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

Specific ports are not assigned for Ethernet POWERLINKÆ.

4.9.1.3 PROFINET®

The ISD 510/DSD 510 servo drive, servo drive modules SDM 511/SDM 512, and system modules support PROFINETÆ conformance class C as per IEC 61158-5-10:2014, IEC 61158-6-10:2014, IEC 61784-2:2014, and IEC 61784-5-3:2013. All the system components (servo drives and system modules) act as I/O devices in a PROFINETÆ network.

The following features are supported:

- I/O-Device - Device that is being controlled by I/O-Controller
- Dynamic module configuration
- Net load class III
- Ring redundancy (MRPD) as client

PROFINETÆ fieldbus devices are always connected as network components via switches that are integrated in the fieldbus device. There are 2 ports on the ISD 510/DSD 510 servo drives, servo drive modules SDM 511/SDM 512, the PSM 510, and the ACM 510. There are 3 ports on the DAM 510. Only 2 can be used for Isochronous Real-Time (IRT) protocol, whereas all 3 can be used for Real-Time (RT) protocol. If the DAM 510 with IRT is ordered, a RJ45 cover will be mounted to the X3 OUT port. Remove this cover to enable use of the X3 OUT port required for switching to RT protocol. Different GSDML files and firmware must be used for DAM 510 2 port IRT and DAM 510 3 port.

The wiring concept for the use of multiple DAM 510 modules in a single application is shown in Illustration 15.

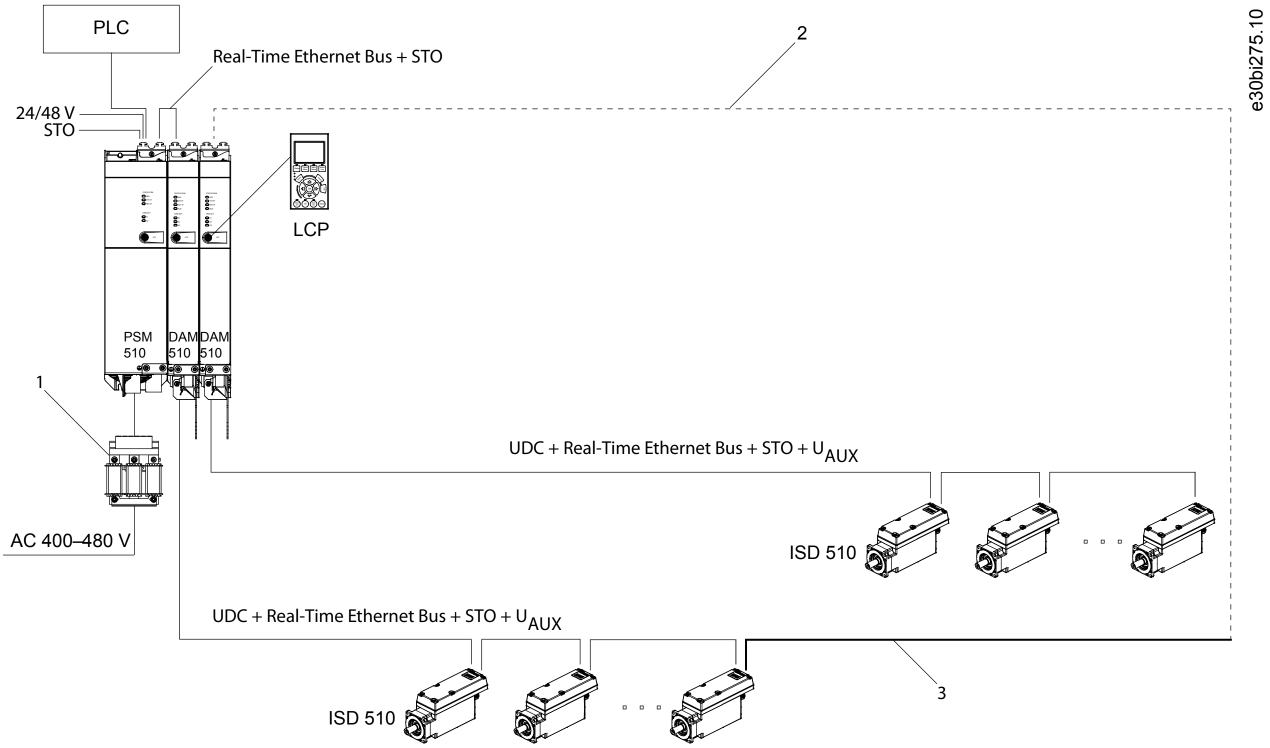

Illustration 15: Wiring Concept for Multiple DAM 510 Modules

1	AC line choke	3	Fieldbus extension cable
2	Customer cable		

4.9.2 Software

The software for the servo system comprises:

- The firmware of the ISD 510/DSD 510 servo drive that is already installed on the system components (except EXM 510).
- The firmware of the system modules that is already installed on PSM 510, DAM 510, ACM 510, and SDM 511/SDM 512.
- A package of PLC libraries for Automation Studioô for operating the system components (except EXM 510).
- A PLC library for TwinCATÆ2 and 3 for operating the system components (except EXM 510).
- A PLC library for SIMOTION SCOUTÆfor operating the ISD 510/DSD 510 servo drives, the SDM 511/SDM 512 modules, and the system modules.
- A PLC library for TIA Portal for operating the ISD 510/DSD 510 servo drives, the SDM 511/SDM 512 modules, and the system modules.
- VLTÆServo Toolbox: A Danfoss PC-based software tool for commissioning and debugging the devices.
- VLTÆBackup Tool: A Danfoss PC-based software tool for backing up the devices.

4.9.3 PC-Software: VLT® Servo Toolbox

4.9.3.1 Overview

The VLTÆServo Toolbox is a standalone PC software designed by Danfoss. It is used for parameterization and diagnostics of the VLTÆ FlexMotionô system. It is also possible to operate the devices in a non-productive environment.

NOTICE

- The VLT® Servo Toolbox software must be allowed for every firewall profile (private/public/domain).

The VLTÆ Servo Toolbox contains several subtools that provide various functionalities.

Table 10: Important Subtools

Subtool	Description
Scope	For visualization of the tracing functionality of the ISD 510/DSD 510, PSM 510, DAM 510, ACM 510, and SDM 511/SDM 512.
Parameter list	For reading/writing parameters.
Firmware update	For updating the firmware on the devices.
Drive control	For operating the servo drives for testing purposes.
PSM control	For operating the Power Supply Module (PSM 510) for testing purposes.
DAM control	For operating the Decentral Access Module (DAM 510) for testing purposes.
ACM control	For operating the Auxiliary Capacitors Module (ACM 510) for testing purposes.
Configuration parameter	For setting up the motor and feedback parameters, and PID settings.
Drive commissioning	For motor feedback adjustment, inertia measurement, automated model adaptation, and resolver amplitude calibration.

4.9.3.2 System Requirements

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

- Supported hardware platforms: 32-bit, 64-bit.
- Supported operating systems: Windows 10, Windows 11.
- .NET framework version: 4.7.
- Minimum hardware requirements: 512 MB RAM, Intel Pentium 4 with 2.6 GHz or equivalent, 100 MB hard disk space.
- Recommended hardware requirements: Minimum 1 GB RAM, Intel Core i5/i7 or compatible.

4.9.4 PC-Software VLT® Backup Tool

The VLTÆ Servo Backup Tool is a standalone PC software designed by Danfoss. It is used for creating configuration back-up files of the VLTÆ FlexMotionô system to facilitate restoring of configurations if a module is replaced.

NOTICE

- The VLTÆ Servo Backup Tool must be allowed for every firewall profile (private/public/domain).

The VLTÆ Servo Backup Tool creates a configuration back-up using a 3-step guided user interface:

- The tool connects to an existing network of system modules.
- The user chooses the devices for which a back-up shall be carried out.
- The back-up runs.

The same interface also allows parameters to be restored on selected devices.

4.10 Operating Modes

The servo drives implement 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 CANopenÆCiA DS 402, PROFIdrive, and ISD-specific and MSD-specific modes of operation. All supported modes of operation are available for EtherCATÆ, Ethernet POWERLINKÆ, and PROFINETÆ.

The various modes of operation are described in detail in the **VLT® Servo Drive System ISD 510, DSD 510, MSD 510 (VLT® FlexMotionô) Programming Guide**.

Inertia measurement mode	This mode measures the inertia of an axis. It is used to measure the mechanical inertia and friction of the servo drive and the external load to optimize the control loop settings.
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 takes place via a CAM profile that contains slave positions corresponding to master positions. CAMs can be designed graphically with the VLT® Servo 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. It is used as the master position within the synchronous modes.
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. It is used as the master position within the synchronous modes.
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.
AC1	In application class 1 (AC1) mode a main setpoint (for example speed setpoint) is used to control the servo drive in PROFINETÆI/O. Speed control is handled entirely within the servo drive.
AC4 and AC4 with dynamic servo control	Application class 4 (AC4) defines an interface between the speed setpoint interface and actual position value interface, where speed control is executed on the servo drive and position control on the controller. The motion control for multiple axes is performed centrally, for example by numerical control (NC). The position control loop is closed by the fieldbus. Clock synchronization is required to synchronize the clocks for the position control in the controller and for the speed control in the drives (PROFINETÆwith IRT).

4.10.1 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.
Touch probe	This functionality stores the position actual value at a rising or falling edge of the configured digital input.

4.11 Automated Operational Functions

4.11.1 Current Limit Protection

Current limit protection is implemented. It monitors the currents and protects both the servo drive and the machinery attached to its shaft.

If an overcurrent occurs, an error message is sent via Real-Time Ethernet to the higher-level PLC and is also shown on the LCP, and the servo drive coasts to stop as default. For servo drives with the mechanical brake option, the brake engages.

4.11.2 Ground Fault Protection

When a ground fault current of >5 A is present, a warning is issued immediately. If the warning is present for 10 s, the PSM 510 sends an error message via Real-Time Ethernet to the higher-level PLC and shows it on the LCP.

4.11.3 Temperature-controlled Fans

The PSM 510 and SDM 511/SDM 512 have a built-in forced air convection fan to ensure optimum cooling. The fan is controlled by the internal temperature and speed increases. The fan not only ensures maximum cooling when required, but also reduces noise and energy consumption when the workload is low. If overtemperature occurs in the PSM 510 or SDM 511/SDM 512, an error/warning is issued, resulting in a coast and trip lock. The error message is sent via Real-Time Ethernet to the higher-level PLC and is also shown on the LCP.

4.11.4 Thermal Protection

Thermal sensors monitor the maximum allowable temperature of the motor winding and switch the motor off if the limit of 150 °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.

See 5.4.3 Thermal Protection for further information.

4.11.5 Additional Protection Features

4.11.5.1 Protection Features on the ISD 510 Servo Drive

The ISD 510 servo drive has the additional protection features detailed in Table 11.

Table 11: Additional Protection Features on the ISD 510 Servo Drives

Function	Description	Limits/errors
UDC overvoltage	When the DC-link voltage rises above a certain level, a warning/error is issued.	• Warning: >806 V • Error: >821 V
UDC undervoltage	When the DC-link voltage falls below a certain level, a warning/error is issued.	• Warning: <407 V • Error: <372 V
Overcurrent at output	To protect the servo drive and any machinery attached to the servo drive shaft, a current limit protection is implemented. The current limit protection on the servo drive is available for motor phase current. All 3-phase currents are constantly monitored. If an overcurrent occurs, the servo drive stops the actual operation. The servo drive stops the shaft rotation, engages the brake (if present), and an error is issued.	• Size 1: >8 A • Size 2: >9 A • Size 3, 5.2 Nm: >25 A • Size 3, 6.0 Nm: >28 A • Size 4, 11.2 Nm: >30 A
Motor position	CRC check of each encoder value, resolver amplitude, and consistency check.	–
Brake control	The brake current is controlled by the servo drive firmware.	–
Maximum shaft speed	The shaft speed of each servo drive type is limited to protect the motor mechanical parts.	Maximum motor speed: • Size 1, 1.5 Nm: 6000 RPM • Size 2, 2.1 Nm: 5400 RPM

Function	Description	Limits/errors
		• Size 2, 2.9 Nm: 4000 RPM • Size 2, 3.8 Nm: 3200 RPM • Size 3, 5.2 Nm: 5000 RPM • Size 3, 6.0 Nm: 4000 RPM • Size 4, 11.2 Nm: 2800 RPM
Torque limit	The application peak torque limit [M_{max}] can be set via parameters 52-15, 52-23, and 52-36 Application Torque Limit (0x2053). The maximum torque per servo drive is calculated as: *Maximum phase current* x *torque factor*	Peak torque M_{max}: • Size 1, 1.5 Nm: 6.1 Nm • Size 2, 2.1 Nm: 7.8 Nm • Size 2, 2.9 Nm: 10.7 Nm • Size 2, 3.8 Nm: 12.7 Nm • Size 3, 5.2 Nm: 21.6 Nm • Size 3, 6.0 Nm: 29.9 Nm • Size 4, 11.2 Nm: 38.6 Nm
Thermal protection	The power module, the control boards, and power boards are protected by corresponding temperature sensors. These prevent excessive heating of the drive components.	Power module: >130 °C **Power board** Size 1, 1.5 Nm: 90 °C Size 2, 2.1 Nm: 85 °C Size 2, 2.9 Nm: 83 °C Size 2, 3.8 Nm: 85 °C Size 3, 5.2 Nm: 84 °C Size 3, 6.0 Nm: 84 °C Size 4, 11.2 Nm: 84 °C **Control board** Size 1, 1.5 Nm: 85 °C Size 2, 2.1 Nm: 80 °C Size 2, 2.9 Nm: 78 °C Size 2, 3.8 Nm: 78 °C Size 3, 5.2 Nm: 84 °C Size 3, 6.0 Nm: 84 °C Size 4, 11.2 Nm: 84 °C

4.11.5.2 Protection Features on Servo Drive Modules SDM 511/SDM 512 and Servo Drive DSD 510

The SDM 511/SDM 512 servo drive modules and the DSD 510 servo drives have the additional protection features detailed in Table 12.

Table 12: Additional Protection Features on the SDM 511/SDM 512 Servo Drive Modules and DSD 510 Servo Drives

Function	Description	Limits/errors
UDC overvoltage	When the DC-link voltage rises above a certain level, a warning/error is issued.	• Warning: >806 V • Error: >821 V
UDC undervoltage	When the DC-link voltage falls below a certain level, a warning/error is issued.	• Warning: <407 V • Error: <372 V
UDC unbalanced	*UDC unbalance (error code 0x3280)* is a warning and a locking fault to track a possible issue (either aging or breakdown) on the DC capacitor.	–

Function	Description	Limits/errors
Overcurrent at output	*Over current trip (error code 0x2310)* The fast overcurrent detection which turns of the energy flow from the drive to the motor on the output connector within the µs time range. This protection was implemented to protect from faults like short circuits on the drive output along the motor cable, connectors or within the motor.	–
	High current overload, continuous (error code 0x2311) The protection works for the high overload range (see 4.11.5.2.1 Overcurrent Protection for Servo Drive Modules SDM 511/SDM 512 and Decentral Servo Drive DSD 510).	• Warning: >90% of specified trip value (deactivated when the level returns to <80% of the trip value). • Error: 100% of specified trip value
	I2t current overload, continuous (error code 0x2312) The protection works for the low overload range (see 4.11.5.2.1 Overcurrent Protection for Servo Drive Modules SDM 511/SDM 512 and Decentral Servo Drive DSD 510).	• Warning: >90% of specified trip value (deactivated when the level returns to <80% of the trip value). • Error: 100% of specified trip value
	Over current, trip (SW) (error code 0x2396) The protection was introduced to protect the device if the current is not high enough to generate the *Over current trip error 0x2310* but higher than the allowed overload.	Trip: See 4.11.5.2.1 Overcurrent Protection for Servo Drive Modules SDM 511/SDM 512 and Decentral Servo Drive DSD 510.
Earth leakage protection	Detection of the error (0x2330) determines earth leakage currents on the drive output. The sum of all 3 output phase currents is expected to be 0 if no ground current is present.	**SDM** Warning: If the sum is >3 A Alarm trip: • If the warning is active >5 s • If the ground current is >5 A **DSD 510** Warning: If the sum is >1 A Alarm trip: • If the warning is active >10 s • If the ground current is >3 A
Motor position	CRC check of each encoder value, resolver amplitude, and consistency check. Using a resolver as motor feedback offers an additional check on the analog signal quality.	–
Brake control	The holding brake current is controlled by the servo drive firmware.	–
Motor thermal protection	Select between a protection based on temperature measurement inside the motor windings, or a model-based protection mechanism. Configurable parameters: • 0: none, use thermal model • 1: KTY83-110 • 2: KTY84-130 • 3: PT1000 • 4: PTC The model-based protection calculates the motor power dissipation, loadability, and thermal time constant for the motor temperature estimation. **Overtemperature protection**	–

Function	Description	Limits/errors
	An overtemperature trip occurs when the total model temperature is higher than the configured maximum windings temperature *MaxWindingsTemp*. For motors without a mounted temperature sensor, the model-based error code 0x239B is issued. If a motor temperature sensor is mounted and the measured temperature is higher than the trip level, then error code 0x4310 is issued.	
Device overtemperature protection	*Device over temperature (error code 0x4210)* is triggered when the maximum temperature of the main device component (IGBT Module) exceeds the defined limit.	120 °C
Device undertemperature	*Device under temperature (error code 0x4220)* is triggered if the temperature of the main device component (IGBT Module) drops below the defined limit.	–10 °C
Control board overtemperature	*Control board overtemperature (error code 0x4291)* is triggered if the ambient temperature on the control board reaches the defined limit. A warning is generated at 5 °C below the error trip level.	90 °C
Power board overtemperature	*Power board overtemperature (error code 0x4292)* is triggered if the ambient temperature on the control board reaches the defined limit. A warning is generated at 5 °C below the error trip level.	90 °C

4.11.5.2.1 Overcurrent Protection for Servo Drive Modules SDM 511/SDM 512 and Decentral Servo Drive DSD 510

Current protections for SDM 511/SDM 512 and DSD 510 devices comprise:

- Trip levels
- Current overload
- Earth leakage detection

Current overload protection is realized in terms of a certain overload which cannot be exceeded for a pre-defined amount of time. Therefore, the protection combines a low overload current region with slow integration, together with a high overload current range with fast integration. Furthermore, the various hardware frame sizes of different devices are considered, yielding the ratings as shown in Table 13. An immediate trip occurs at the current level indicated by I_{trip} (see Table 13).

As the overload integration time highly depends on the applied load, the remaining capability of the overloaded device can be monitored using the *device overload monitoring* parameter (0x2038), which indicates the percentage of consumed overload capability. The higher the overload current, the faster the integration rate of the indicated value. The I_{trip} value is detailed in Table 13.

Table 13: Rated Current Overloads

Device	I_{nom} [A](switching frequency 4/5 kHz)	I_{nom} [A] (switching frequency 8 kHz)	I_{nom} [A] (switching frequency 10 kHz)	I_{max} [A]	Low overload range [%]	High overload range [%]	I*trip* [%]
SDM, FS2S	40	36	32	80	104–140	140–200	210
SDM, FS1S	20	18	16	40	104–140	140–200	210
SDM, FS1S	10	9	8	30	111–300	–	315
SDM, FS1S	5	4.5	4	20	111–400	–	420
SDM, FS1S	2.5	2.25	2	10	111–400	–	420
SDM, FS1D	10	9	8	20	104–140	140–200	210

Device	I_{nom} [A](switching frequency 4/5 kHz)	I_{nom} [A] (switching frequency 8 kHz)	I_{nom} [A] (switching frequency 10 kHz)	I_{max} [A]	Low overload range [%]	High overload range [%]	I*trip* [%]
SDM, FS1D	5	4.5	4	15	111–300	–	315
SDM, FS1D	2.5	2.25	2	10	111–400	–	420
DSD, FS1	8	5	4.4	16	104–140	140–200	210

4.11.5.2.1.1 Integration Times and Overload Cycles

An overload cycle is defined using high current I_H and the corresponding integration time t_H until a fault trip occurs. To recover from an overload cycle, the de-integration current must be lower than nominal. The corresponding de-integration time depends both on the current level and the preceding overload intensity. The *Device overload monitoring* parameter (0x2038) tracks the overload condition.

Typical integration times and overload cycles are shown in Table 14, Table 15, and Table 16.

Table 14: Overload Cycles for 200% Overloadable Devices

Device	Cycle	fs = 4/5 kHz		fs = 8 kHz		fs = 10 kHz	
		I_H [%]	t_H [s]	I_H [%]	t_H [s]	I_H [%]	t_H [s]
SDM FS2S 40 A SDM FS1S 20 A SDM FS1D 10 A DSD FS1 8 A	A	200	2.6	200	2.4	200	2.1
	B	180	11.6	180	8.1	180	5.7
	C	160	53	160	27	160	19
	D	140	240	140	90	140	60
	E	120	592	120	190	120	127

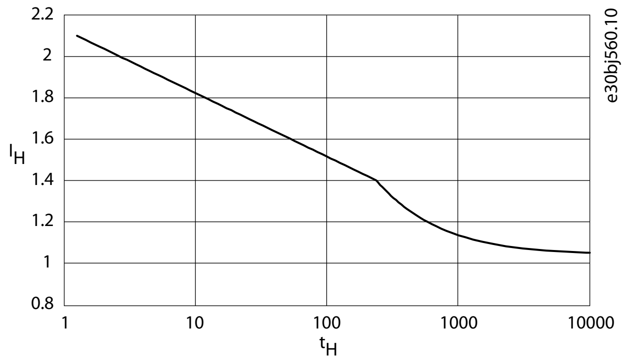

Illustration 16: Overload Curve for 200% Overloadable Devices at 4/5 kHz

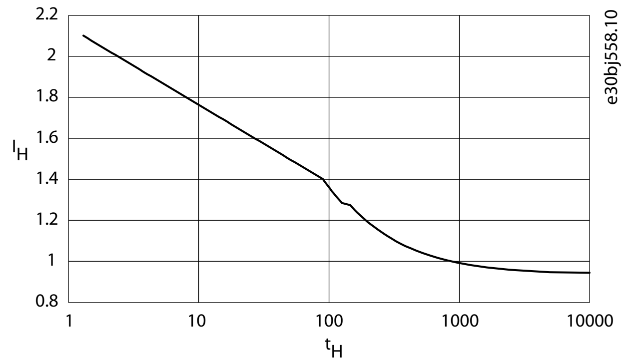

Illustration 17: Overload Curve for 200% Overloadable Devices at 8 kHz

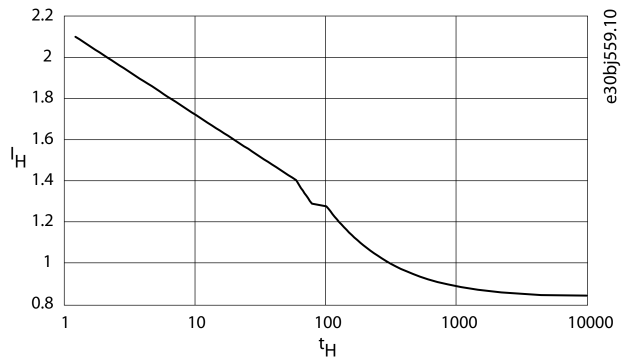

Illustration 18: Overload Curve for 200% Overloadable Devices at 10 kHz

Table 15: Overload Cycles for 300% Overloadable Devices

Device	Cycle	fs = 4/5 kHz		fs = 8 kHz		fs = 10 kHz	
		I_H [%]	t_H [s]	I_H [%]	t_H [s]	I_H [%]	t_H [s]
SDM FS1S 10 A SDM FS1D 5 A	A	300	26	300	13	300	11
	B	260	37	260	18	260	16
	C	220	56	220	27	220	23
	D	180	98	180	46	180	37
	E	140	240	140	100	140	73

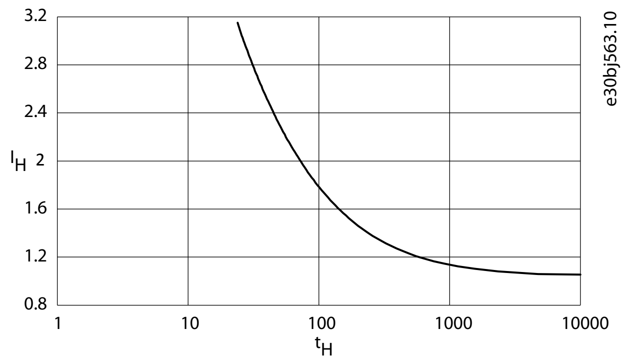

Illustration 19: Overload Curve for 300% Overloadable Devices at 4/5 kHz

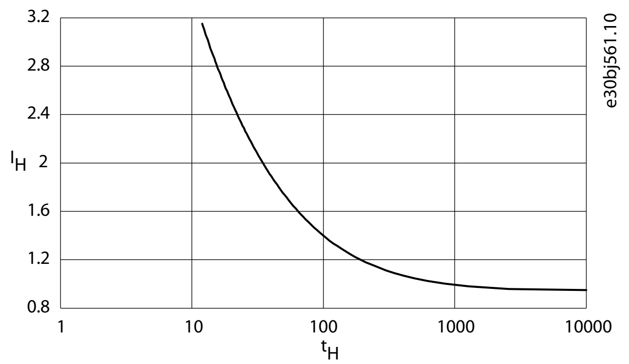

Illustration 20: Overload Curve for 300% Overloadable Devices at 8 kHz

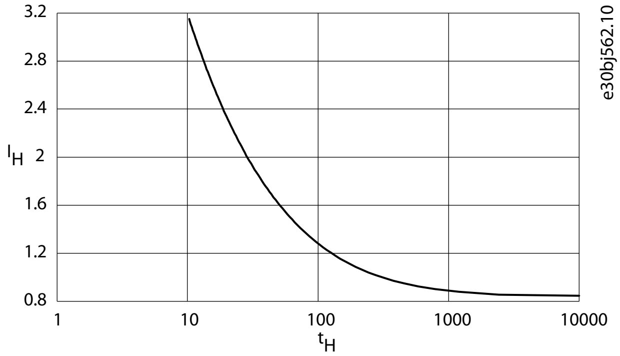

Illustration 21: Overload Curve for 300% Overloadable Devices at 10 kHz

Table 16: Overload Cycles for 400% Overloadable Devices

Device	Cycle	fs = 4/5 kHz		fs = 8 kHz		fs = 10 kHz	
		I_H [%]	t_H [s]	I_H [%]	t_H [s]	I_H [%]	t_H [s]
SDM FS1S 5 A SDM FS1S 2.5 A SDM FS1D 2.5 A	A	400	14	400	7.1	400	6.2
	B	340	20	340	10	340	8.8
	C	280	31	280	15	280	13
	D	220	55	220	27	220	22
	E	160	140	160	66	160	50

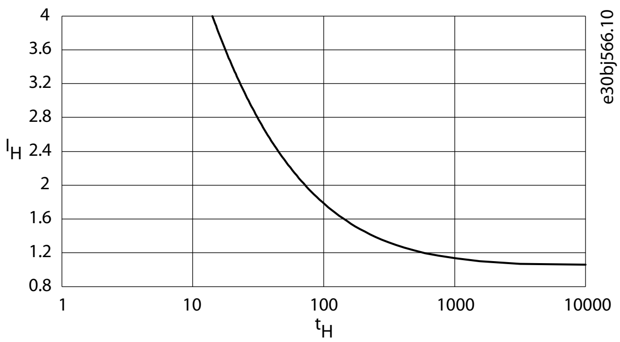

Illustration 22: Overload Curve for 400% Overloadable Devices at 4/5 kHz

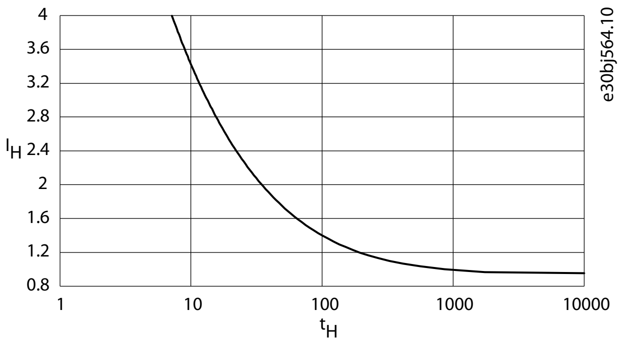

Illustration 23: Overload Curve for 400% Overloadable Devices at 8 kHz

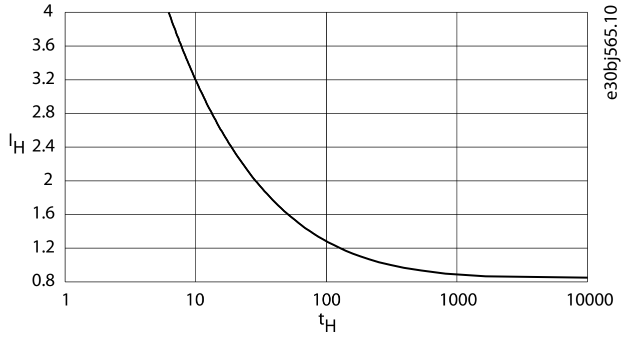

Illustration 24: Overload Curve for 400% Overloadable Devices at 10 kHz

Various fault reactions have been defined for the overload protection:

- Fast overcurrent trip (0x2310)
  - Detects current spikes.
  - Triggered if the dedicated current detection logic on the FPGA reaches 95% of the full scale on any 1 of the 3 measured phase currents.
- Software overcurrent trip (0x2396)
  - Defined as alarm trip.
  - Triggered when the output current exceeds the trip level I_{trip} (see 4.11.5.2.1 Overcurrent Protection for Servo Drive Modules SDM 511/SDM 512 and Decentral Servo Drive DSD 510).
- High current overload fault (0x2311)
  - Defined as alarm trip.
  - Reflects the high overload region defined in 4.11.5.2.1 Overcurrent Protection for Servo Drive Modules SDM 511/SDM 512 and Decentral Servo Drive DSD 510.
  - A trip occurs when 100% is reached.
  - At 90% of the integration limit, the same alarm code is shown as a warning. The warning is deactivated once the integration limit returns to 80%.
  - The overload condition can be monitored using the *Device overload monitoring* object (0x2038), which indicates the percentage of consumed overload capability. The higher the overload current, the faster the integration of the indicated value.
- Earth leakage protection (0x2330)
  - Determines earth leakage currents on the drive output.
  - The sum of all 3 output phase currents is expected to be 0 if no earth current is present. A warning is issued if the sum is greater than the configurable threshold (I_{earth}). An alarm trip occurs if the warning is active longer than a pre-defined time

(t_{earth}). An immediate alarm trip occurs if the earth current is greater than the high limit ($I_{earth, high}$). See Table 17 for the current thresholds.

- Low output frequency protection
  - An additional time derating is applied to low output frequencies of 0–10 Hz of motor electrical revolutions.
  - The additional heating effect on the IGBT junctions is considered and the overload integration multiplied be a derating factor. The derating factor is 32 at 0 Hz and decreases linearly to 1 at 10 Hz.
  - The low output frequency protection reduces the integration time to fault trip and is only applied with 8 Hz and 10 Hz switching frequency. The effect is shown in Illustration 25.

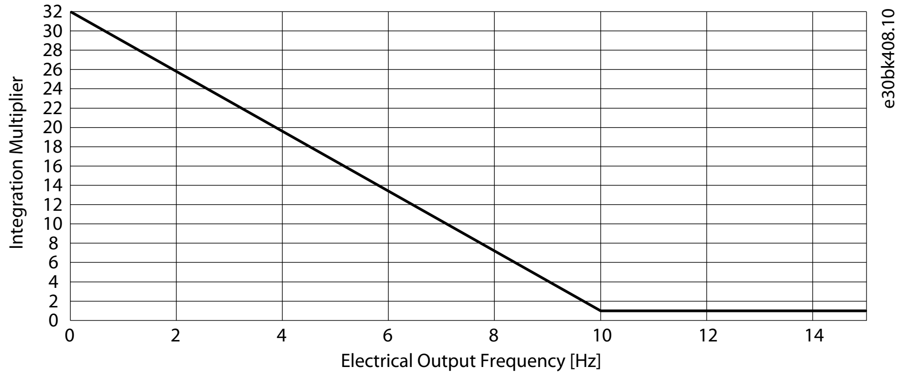

Illustration 25: Overload Multiplier for Low Electrical Output Frequency

Table 17: Earth Current Detection Levels

Device	$I_{earth, high}$ [A]	I_{earth} [A]	t_{earth} [s]
SDM 511/SDM 512: FS1S, FS2S, FS1D	5	3	5
DSD 510: FS1	3	1	10

4.11.5.2.2 Fault Reactions

From the described overload protection, different fault reactions have been defined:

Table 18:

Fault	Description	Reaction
Fast overcurrent trip (0x2310)	Detects current spikes.	Triggered if the dedicated current detection logic on the FPGA reaches 95% of the full scale range on either one of the 3 measured phase currents
Software over current trip (0x2396)	Alarm trip.	Triggered immediately when the output current is greater than the trip level I_{trip}.
High current overload fault (0x2311)	Alarm trip.	Reflects the high overload range. At 90% of the integration limit, the same alarm code is shown as warning. The warning is de-activated again when the integration limit has returned to 80%.
Low current overload fault (0x2312)	Defined for continuous overloads above nominal.	At 90% of the integration limit, the same alarm code is shown as warning. The warning is de-activated again when the integration limit has returned to 80%. The overload condition can be monitored using the *device overload monitoring* parameter (0x2038), which indicates the percentage of consumed overload capability. The higher the overload current, the faster the integration of the indicated value. A trip occurs when reaching 100%. For typical overload cycles, refer to the tables in 4.11.5.2.1.1 Integration Times and Overload Cycles .

4.11.5.3 Protection Features on PSM 510, DAM 510, and ACM 510

The PSM 510, DAM 510, and ACM 510 have the additional protection features detailed in Table 19.

Table 19: Additional Protection Features on PSM 510, DAM 510, and ACM 510

Function	Description	Limits/errors
UDC overvolt-age	When the DC-link voltage rises above a certain level, a warning/error is issued.	• Warning: >806 V • Error: >821 V
UDC under-voltage	When the DC-link voltage falls below a certain level, a warning/error is issued.	• Warning: <407 V • Error: <372 V
Overcurrent/ overload on output	Different maximum load cycles have been defined for different modules. These are mostly specified in terms of either current cycles (for DAM 510) or power cycles (for PSM 510), At 90% of the integration limit, a warning is shown. The warning is de-activated when the integrator counter is <80%. When exceeding 100% of the integration overcurrent/overload limit, an immediate fault is trig-gered. For the PSM 510, if the brake resistor starting voltage level is set to a low-er voltage than the expected DC-link voltage, an overload fault could be triggered. See 4.11.5.3.1 Overload Cycle Definition.	–
Fast overcur-rent/overload trip	An immediate fault is triggered when the nominal current (for DAM510) or the nominal power (for PSM510) is >215%.	• Error: 215% of nominal cur-rent/power
Inrush UDC overtempera-ture	An alarm is triggered when >2 PSM 510, DAM 510, or ACM 510 power-up cycles have occurred within a time interval of 1 minute.	–
UAUX over-voltage	When the auxiliary voltage rises above a certain level, a warning/error is issued.	Warning: >56 V Fault: >53 V
UAUX under-voltage	When the auxiliary voltage falls below a certain level, a warning/error is issued.	Warning: <21.6 V Fault: <15 V
UAUX supply fault	This is a DAM 510 specific alarm which is hardware triggered and raised when UAUX cannot be activated or a short-circuit occurs while the supply line is enabled.	–
IAUX overcur-rent	Continuous monitoring of the supply current on the AUX line. If the cur-rent is >105% of the nominal value for >2 s, an alarm is triggered.	PSM 510: Iaux,nom = 50 A DAM 510: Iaux,nom = 15 A
Inrush UAUX overtempera-ture	Alarm triggered when >1 DAM 510 power-up cycle has occurred within a time interval of 30 s.	–
IAUX user overcurrent	Monitors the AUX supply current and triggers an alarm if it exceeds the user limit for >10 s. The threshold can be adjusted and is always lower than the nominal current on the AUX line.	Warning: >90% of user limit for >0.5 s.
Mains loss pro-tection	Supervises the 3 mains voltages inputted to the PSM 510 and triggers an alarm if 1 of the input phases is not connected properly during normal operation.	–

Function	Description	Limits/errors
Device over-temperature protection	*Device over temperature (0x4210)* is triggered when the maximum temperature of the main device component exceeds the defined limit.	PSM 510: 118 °C DAM 510: 110 °C ACM 510: 118 °C
Device under-temperature	*Device under temperature (0x4220)* is triggered if the temperature of the main device component (IGBT Module for SDM 511/SDM 512) drops below the defined limit.	PSM 510, DAM 510, and ACM 510: –10 °C
Control board overtemperature	*Control board overtemperature (0x4291)* is triggered if the ambient temperature on the control board reaches the defined limit. A warning is generated at 5 °C below the error trip level.	PSM 510, DAM 510, and ACM 510: 80 °C
Power board overtemperature	*Power board overtemperature (0x4292)* is triggered if the ambient temperature on the control board reaches the defined limit. A warning is generated at 5 °C below the error trip level.	PSM 510: 110 °C DAM 510: 80 °C ACM 510: 80 °C

4.11.5.3.1 Overload Cycle Definition

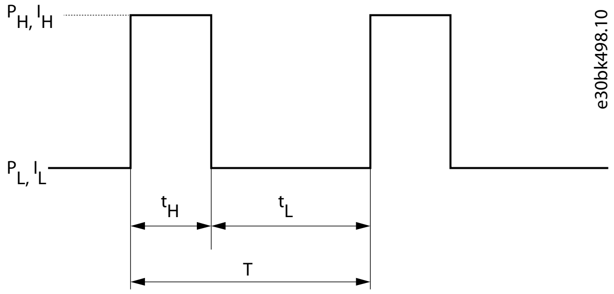

Illustration 26: Overload Cycle Definition

Table 20: Overload Cycle Definition for PSM 510

Cycle	P_H [%]	t_H [s]	P_L [%]	t_L [s]	T [s]
P-1	200	0.3	90	9.7	10
P-2	200	3	70	17	20
P-3	140	240	40	360	600

Table 21: Overload Cycle Definition for DAM 510 and SDM 511/SDM 512

Module	Cycle	I_H [%]	t_H [s]	I_L [%]	t_L [s]	T [s]
DAM 510	D-1	200	1	80	9	10
	D-2	160	60	67	170	230
SDM 511 SDM 512	S-1	200	0.25	100	9.75	10
	S-2	200	2.65	0	7.35	10
	S-3	150	30	85	270	300
	S-4	130	60	85	240	300
	S-5	140	240	70	360	600

4.12 Custom Application Features

4.12.1 Brake Resistor for Power Supply Module (PSM 510)

When the servo drives are decelerating, the motors act like a generator. This means that the energy coming back from the servo drives is collected in the DC-link and this is referred to as regenerative power.

The function of the brake resistor is to provide a load on the DC-link during braking, thereby ensuring that the regenerative power is absorbed by the brake resistor. This avoids any potential damage to the system modules connected to the same DC-link due to an overvoltage event.

All the system modules have dedicated DC-link protections, consisting of voltage and current protection mechanisms. This ensures that the system modules do not operate under conditions that could be critical for electrical components, or significantly impact on the device lifetime.

If no brake resistor is used, or it is incorrectly configured, and the servo drives are decelerating, the DC-link voltage will quickly rise to a dangerous level and a fault will be triggered. In this case, the system modules stop their activity leading to a shutdown procedure when the fault is triggered.

To avoid such a scenario, the PSM 510 is equipped with an internal brake resistor that provides standard braking capability. This internal brake resistor can be disconnected and an external brake resistor connected.

4.12.1.1 Mechanical Installation

The PSM 510 is connected to the internal brake resistor as standard. If an external brake resistor is used, disconnect the internal brake resistor and place the connector in the holder provided [1].

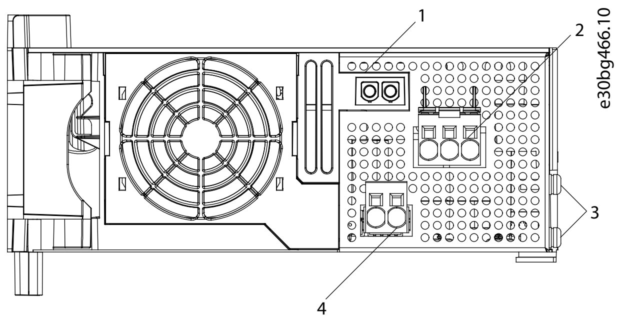

Illustration 27: Brake Resistor Connector on the Bottom of PSM 510

1	Holder for internal brake resistor connector (when not in use)	3	PE screws
2	AC mains supply connector	4	Internal/external brake resistor connector

When using 2 PSM 510 modules, each PSM 510 must be connected to its own internal or external brake resistor. Alternative allowed configurations are:

- 1 PSM 510 module is connected to the internal brake resistor and 1 PSM 510 module is connected to an external brake resistor.
- Both PSM 510 modules are connected to separate external brake resistors. In this case, the internal brake resistor must be disconnected and the connecters placed in the holders provided (see Illustration 27).

N O T I C E

- Paralleling or series of brake resistors is not allowed.

4.12.1.1.1 Ventilation

The internal brake resistor on the PSM 510 is cooled by the built-in fan, which is activated at the maximum speed once the brake chopper has operated for more than 100 ms. It runs for at least 2 s after the brake chopper terminates its operation.

If an external brake resistor is used, the ventilation must be efficient enough to dissipate the heat due to the regenerative power in the brake resistor. The PSM 510 starts the built-in fan at 25% of the rated speed to avoid excessive heat inside the PSM 510.

N O T I C E

- For an external brake resistor, refer to the manufacturer's manual for compliance to any recommendations related to installation and ventilation.

4.12.1.2 Electrical Installation

4.12.1.2.1 EMC Precautions

The following EMC precautions are recommended to achieve interference-free operation of fieldbus cables, and digital and analog inputs and outputs.

Observe any relevant national and local regulations, for example regarding protective earth connection.

Keep the fieldbus cables away from the brake resistor cables to avoid coupling of high frequency noise from one cable to the other. A minimum distance of 200 mm is sufficient, however a greater distance between the cables is recommended, especially where the cables run in parallel over long distances. When crossing is unavoidable, ensure that the fieldbus cables cross the brake cable at an angle of 90°.

4.12.1.2.2 Cable Connection

To comply with the EMC emission and immunity specification, only use shielded/armored cables.

4.12.1.2.3 Brake Cable

Maximum length: 30 m shielded cable.

Recommended ratings:

- Conductor cross-section range: 0.75–16 mm^2 (AWG 18–AWG 4)
- Nominal voltage: 560–800 V DC
- Maximum brake current: 80 A

Ensure that the connection cable to the brake resistor is shielded. Use cable clamps to connect the shielding to the conductive decoupling plate and to the brake resistor metal cabinet.

4.12.1.3 Brake Resistor Calculation

To select the most suitable brake resistor for a given application, the following information is required:

- Number of servo drives in the application.
- Inertia connected to the servo drives.
- Braking/accelerating profile.

4.12.1.3.1 Brake Setup

The servo system brake setup is shown in Illustration 28.

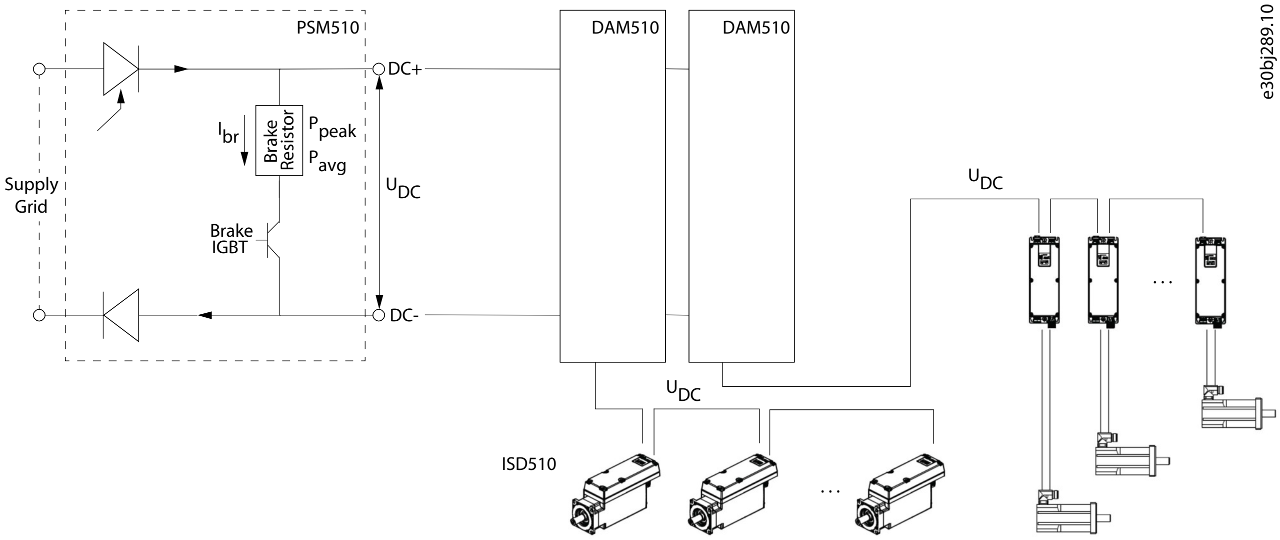

Illustration 28: Brake Setup

I_{br}	Current flowing through the brake resistor	U_{DC}	DC-link bus voltage
P_{peak}	Peak power on the brake resistor	P_{avg}	Average power on the brake resistor.

N O T I C E

- Illustration 28 is just an example of the various systems that are allowed. The brake resistor shown represents both the internal and external brake resistor.

4.12.1.3.2 Brake Resistance

The brake resistor values for the internal brake resistor are factory settings and the main parameters are:

- Nominal resistance: 15 Ω
- Instantaneous peak power: 46 kW
- Cyclic power: 8 kW (for maximum 1 s)
- Rated power: 150 W

If an external brake resistor is used, ensure it has the following characteristics:

- Minimum resistance: 10 Ω
- Maximum instantaneous peak power: 67 kW
- Rated power: 7.5 kW
- Operating voltage: 1000 V

N O T I C E

- For the instantaneous peak power calculation, the maximum DC-link voltage that the system modules can be charged before triggering the overvoltage fault is 820 V.
- The PSM 510 is set to start braking when the DC-link voltage exceeds 750 V.

During the start-up of the PSM 510, the correct function of the brake chopper is tested by activating a test pulse.

Evaluating the described test pulses, a brake failure (0x7111) can be triggered out of 3 different fault situations:

- The brake resistor does not operate properly when a certain current is observed when the brake is inactive. This may indicate a short circuit on the brake internal circuitry.
- The brake resistor current is lower than the expected value, calculated by the user settings and set at 85% of the nominal current. This may indicate faulty wiring or a missing brake resistor.
- The brake resistor current is larger than the expected value, calculated by the user settings and set at 115% of the nominal current. This may indicate incorrect brake resistor value settings or connection to the wrong brake resistor.

To prevent the PSM 510 from cutting out for protection when the servo drives are decelerating, select brake resistor values based on the peak braking power and the DC-link voltage at which the brake is activated.

$$R_{br} = \frac{U_{DC}^2}{P_{peak}} \ [\Omega]$$

N O T I C E

- Consider the maximum brake resistor peak power in order to correctly design the system to account for the worst-case scenario.
- If a higher brake resistor value is selected than the value calculated using the formula stated, the maximum braking torque cannot be reached. This results in the risk that the servo drives will stop operating due to DC-link overvoltage protection.

4.12.1.3.3 Calculation of Brake Power

When calculating the brake power, ensure that the brake resistor is scaled for the average power as well as for the peak power.

- The peak brake power (P_{peak}) depends on the number of servo drives that are in acceleration mode and deceleration mode. The torque used to accelerate and decelerate is also important.
- The average power (P_{avg}) is determined by the process period time, for example the length of the braking time in relation to the process period time.

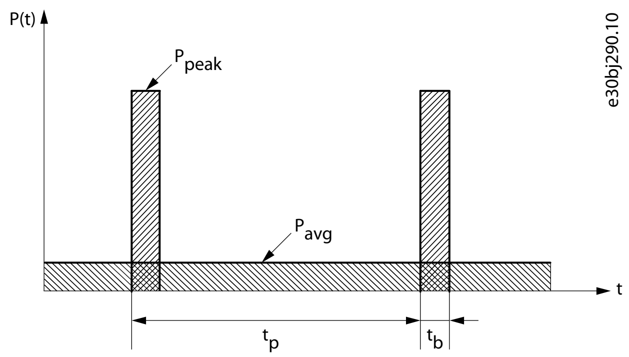

Illustration 29: Relationship between Average Power and Peak Power

P_{peak}	Peak power on the brake resistor	t_p	Braking process period time
P_{avg}	Average power on the brake resistor	t_b	Braking time

The relationship shown in Illustration 29 is:

$$P_{avg} = \frac{P_{peak} \times t_b}{t_p} \ [\omega]$$

4.12.1.3.4 Calculation of Brake Resistor Peak Power

The brake resistor peak power is calculated as follows:

$$P_{peak} = P_{motor} \times T_{br}(\%) \times \eta_{motor} \ [\omega]$$

Where:

$P_{motor} = T_{motor} \times \omega_{motor}$ is the motor rated power

T_{br}(%) is the braking torque in percentage of the nominal torque (typical values are >100%)

n_{motor} is the motor efficiency

This calculation is a reference for a single motor configuration only. For a larger system, the sum of each peak power related to each motor in the system must be considered to ascertain the brake resistor value capable of braking the effective total regenerative power in the worst case scenario.

The brake chopper activation voltage for the PSM 510 is 750 V. Therefore, when using the minimal brake resistance of 10 Ω, a current of about 75 A will flow through the brake resistor at about 750 V.

If the application does not require braking with the maximum current, a higher brake resistance can be selected. A higher brake resistance results in a lower brake peak power.

When the servo drives are accelerating, P_{motor} is conventionally positive. When the servo drives are decelerating, P_{motor} is negative. If the sum of all the P_{motor} connected to the servo drive is a negative value, the energy must be absorbed in the brake resistor. If the sum of all P_{motor} is a positive value, the energy from the mains is converted into rotation energy and the brake resistor does not need to absorb energy.

To calculate the peak brake power, select the scenario where the most servo drives are decelerating and the fewest servo drives are accelerating.

Calculation of brake resistor peak power - shaft inertia

The brake resistor peak power can also be calculated based on the shaft inertia (j [kgm^2]), ramp-down angular speed ▵ω [rad/sec]), and ramp-down time (▵t [sec]) parameters for the application.

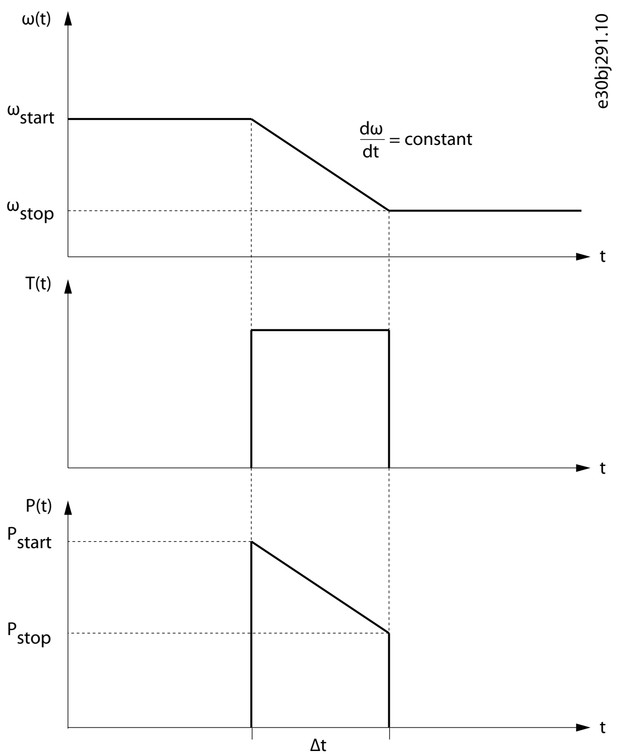

Illustration 30: Decelerating Servo Drive

The general formula for the power calculation during the deceleration event shown in Illustration 30 is:

$$P(t) = T(t) \times \omega(t) = j \times \alpha(t) \times \omega(t) = j \times \frac{d\omega(t)}{dt} \times \omega(t) = j \times \frac{\Delta\omega}{\Delta t} \times [\omega_{Start} + \frac{\Delta\omega}{\Delta t} \times t]$$

where:

- $t \in [t_{start}, t_{stop}]$
- T(t) is the torque value in [Nm]
- ω(t) is the angular speed [rad/sec]
- j is the shaft inertia [kgm^2]
- α(t) is the angular acceleration [rad/sec^2]

N O T I C E

- The suffix *stop* refers to the general status at the end of the deceleration event, meaning that the end could also be different
- from the zero speed status.

Therefore, referring to the plot in Illustration 30, and considering the additional term related to the motor efficiency, the brake resistor peak power can be calculated using the following formulae:

$$P_{start} = \eta_{motor} \times j \times \frac{\Delta\omega}{\Delta t} \times \omega_{start} = \eta_{motor} \times j \times \frac{\Delta V \times 2\pi}{60} \times \frac{1}{\Delta t} \times \frac{V_{start} \times 2\pi}{60}$$

$$P_{stop} = \eta_{motor} \times j \times \frac{\Delta\omega}{\Delta t} \times \omega_{stop} = \eta_{motor} \times j \times \frac{\Delta V \times 2\pi}{60} \times \frac{1}{\Delta t} \times \frac{V_{stop} \times 2\pi}{60}$$

$$P_{peak} = \frac{(P_{start} + P_{stop}) \times \Delta t}{2}$$

where:

- n_{motor} is the motor efficiency
- ω_{start} is the starting angular speed [rad/sec]
- ω_{stop} is the angular speed at the end of the deceleration event [rad/sec]
- j is the shaft inertia [kgm^2]
- Δω is the ramp-down angular speed [rad/sec]
- Δt is the ramp-down time [s]
- v_{start} is the starting angular speed [RPM]
- v_{stop} is the angular speed at the end of the deceleration event [RPM]
- Δv is the ramp-down angular speed [RPM]

N O T I C E

- The brake resistor peak power is calculated as the average braking power during the deceleration event.

4.12.1.3.5 Calculation of Brake Resistor Average Power

The brake chopper load monitor implemented on PSM 510 observes the power consumption of the brake resistor during operation.

Different average braking power profiles are allowed, depending on the choice of internal or external brake resistor. These profiles are the maximum power per time, repeated every cycle time. Any other profile defined by the usage in the field must not exceed such maximum profiles (taking into account both the maximum peak values and the average power over the entire cycle time).

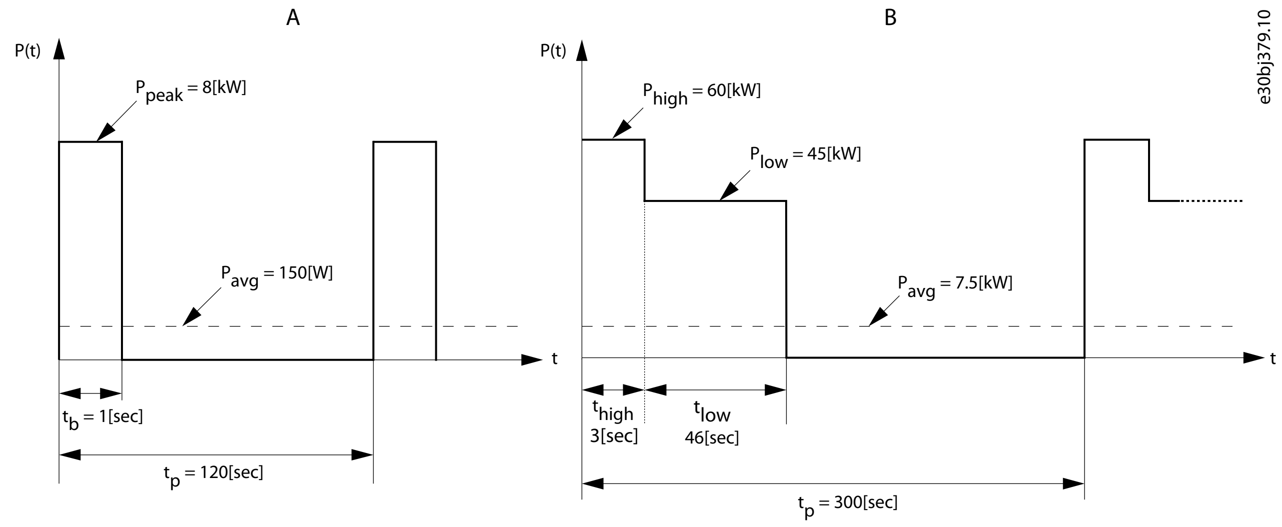

Illustration 31: Brake Chopper Maximum Load Profiles for Internal (A) and External (B) Brake Resistor

The average power is calculated using the P_t calculation. The overall sum of the average applied power per time normalized over the cycle time gives the total average power for the brake resistor during that cycle.

Example of the maximum allowed profile for the external brake resistor:

- $P_{high} = 60$ kW
- $P_{low} = 45$ kW
- $t_{high} = 3$ s
- $t_{low} = 46$ s
- $t_p = 300$ s

The average power is calculated as follows:

$$Pavg = \frac{\sum_{n=1}^{N} P_n \times t_n}{t_p} = \frac{P_{high} \times t_{high} + P_{low} \times t_{low}}{t_p} = \frac{60\,[kW] \times 3\,[sec] + 45\,[kW] \times 46\,[sec]}{300\,[sec]} = 7.5\,[kW]$$

N O T I C E

- For the internal brake resistor, the formula cannot be applied to the maximum profile detailed in Illustration 31. The internal brake resistor allows a continuous average power of 150 W, while an average peak power of 8 kW can last for a maximum of 1 s, after which 119 s at zero load are required.

4.12.2 External Encoder and Sensors

4.12.2.1 External Encoder

An external encoder can be connected to the X4 connector on the ISD 510/DSD 510 servo drive or the encoder connector on SDM 511/SDM 512. The encoder value can be used as guide value provider for other devices.

4.12.2.2 Sensor

The M12 I/O and/or encoder connector (X4) is available on the ISD 510/DSD 510 servo drives. See 8.7.1 Connectors on the ISD 510 Servo Drives for pin assignment.

On the SDM 511/SDM 512 modules, the I/O connectors is separate to the external encoder connector. See 8.7.3 Connectors on SDM 511 and 8.7.4 Connectors on SDM 512 for position and pin assignment.

On the ACM 510, the I/O connector is on the top. See 8.7.7.1 Connectors on the Top of ACM 510 for position and pin assignment.

4.12.3 Relays

The relay connector is used for a user-defined reaction and is available on the PSM 510, ACM 510, and SDM 511/SDM 512. See 8.8.2.9 Relay Connector for positioning and pin assignment.

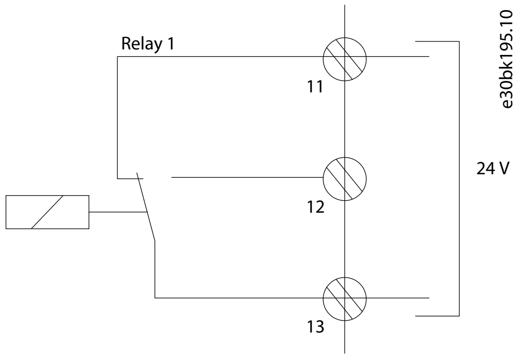

Illustration 32: Relay Output 1

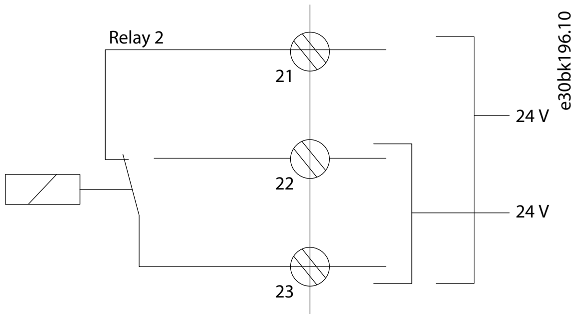

Illustration 33: Relay Output 2

4.12.4 Mechanical Brake Control

Mechanical brake control can be enabled and configured on the SDM 511/SDM 512 modules and on DSD 510. The mechanical brake is closed by default but opens automatically when drive operation is enabled and the motor is energized.

For valid brake configuration, 4 parameters must be configured via the dedicated *Configuration Parameter* Subtool of the VLT® Servo Toolbox:

- *Brake Control Mode* for enabling the mechanical brake control. (At the moment, *PI-controlled* is the only available control mode for handling the mechanical brake.)
- *Brake Current* for specifying the brake current that keeps the mechanical brake open. If the brake current cannot be reached or if it is exceeded too much, a fault is triggered.
- *Brake Opening Time* for specifying the delay time to consider the mechanical brake as open.
- *Brake Closing Time* for specifying the delay time to consider the mechanical brake as closed.

The parameter information is usually available in the technical information for the motor.

N O T I C E

- For cable lengths <10 m, use 24 V auxiliary voltage. For cable lengths ≥10 m, use 48 V auxiliary voltage.
- If a mechanical brake is connected, always supply the servo system with 48 V auxiliary voltage.

4.13 User Interfaces

4.13.1 Overview

The LCP is the graphical user interface for diagnostic and operating purposes. It can be connected to the ISD 510/DSD 510 servo drives using an optional cable (M8 to LCP SUB-D extension cable).

The LCP display provides the operator with a quick view of the state of the servo drive or 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 PSM 510, DAM 510, and ACM 510.

The LCP can be mounted on the front of the control cabinet and then connected to the PSM 510, DAM 510, or ACM 510 via SUB-D cables (available as an accessory).

N O T I C E

- Do not permanently connect the LCP to the servo drive. Doing so reduces the protection rating (IP).

4.13.2 VLT® Servo Toolbox Software

The VLT® Servo Toolbox is a standalone PC-based software designed by Danfoss. It is used for commissioning and debugging the servo drives and system modules.

4.13.3 Libraries

The libraries provided for the servo system can be used in TwinCAT® V2 and V3 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 run-time 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, PSM 510, DAM 510, and ACM 510.
- 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.

Function block libraries are also available for Siemens TIA Portal and SIMOTION Scout.

4.13.4 TwinCAT® NC Axis

The ISD 510/DSD 510 servo drives and Servo Drive Modules SDM 511/SDM 512 can be operated with the built-in NC functionality of TwinCAT®. This means that the trajectory calculations are all done within the PLC. The servo drive can be used with cyclic synchronous position mode or cyclic synchronous velocity mode to follow the setpoints given by the controller. The features are provided by the TwinCAT® library. To use this functionality, the controller must have an NC-PTP-Runtime system installed.

Information on how to configure the servo drive to use this functionality can be found in the *VLT® Servo Drive System ISD 510, DSD 510, MSD 510 (FlexMotion) Programming Guide*.

N O T I C E

- A servo drive can either be controlled by the Danfoss VLT® Servo Motion library, or operated as a TwinCAT® NC axis. However, it is possible to mix both types of operation within 1 application.

4.13.5 PROFIdrive Application Classes

The ISD 510/DSD 510 and SDM 511/SDM 512 can be operated using PROFIdrive application class AC1, AC4, or AC4 with Dynamic Servo Control (DSC). In this case, the trajectory calculations are all done within the Siemens PLC.

The servo drive is commanded with technology objects or cyclic telegrams to follow the setpoints given by the controller. The telegrams are selected within TIA Portal.

Information on how to configure the servo drive to use this functionality can be found in the **VLT® Servo Drive System ISD 510, DSD 510, MSD 510 (FlexMotion) Programming Guide**.

4.13.6 B&R Mapp Technology

The ISD 510/DSD 510 and SDM 511/SDM 512 can be operated using Automation Studio mapp technology. In this case, the trajectory calculations are all done within the B&R PLC.

The servo drive is commanded with cyclic synchronous position mode or cyclic synchronous velocity mode to follow the setpoints given by the controller. The features are provided by the Automation Studio library.

Information on how to configure the servo drive to use this functionality can be found in the **VLT® Servo Drive System ISD 510, DSD 510, MSD 510 (FlexMotionô) Programming Guide**.

5 System Integration

5.1 Operating Environment

5.1.1 Humidity

Although the FlexMotionô system components can operate properly at high humidity, avoid condensation. There is a specific risk of condensation when the unit is colder than moist ambient air. Moisture in the air can also condense on the electronic components and cause short circuits. Condensation occurs in units without power. Avoid installation in areas subject to frost. The risk of condensation can be reduced by:

- Operating the ISD 510/DSD 510 servo drive in standby mode (with the servo drive connected to the auxiliary supply via the PSM 510).
- Operating the PSM 510 in standby mode (with the unit connected to mains).

Ensure that the power dissipation is sufficient to keep the servo drive or PSM 510 circuitry free of moisture.

5.1.2 Ambient Temperature

Minimum and maximum ambient temperature limits are specified for the ISD 510/DSD 510 servo drives in 8.3.1 ISD 510/DSD 510 Servo Drive and for the system modules in 8.3.2 System Modules and SDM 511/SDM 512.

Avoiding extreme ambient temperatures prolongs the life of the equipment and maximizes the overall system reliability. Follow the recommendations listed for maximum performance and equipment longevity.

- Although the servo drives and system modules can operate at temperatures as low as 0 °C, proper operation at rated load is only guaranteed at ≥5 °C.
- Do not exceed the maximum temperature limit.
- The lifetime of electronic components decreases by 50% for every 10 °C operated above the design temperature.
- Devices with IP54, IP65, or IP67 protection ratings must also adhere to the specified ambient temperature ranges.
- Additional air conditioning of the cabinet or installation site may be required.

5.1.3 Cooling

5.1.3.1 Servo Drives

The ISD 510/DSD 510 servo drives are self-cooling. Cooling (heat dispersal) is primarily via the flange, with a small amount dispersed by the housing. The following recommendations are necessary for effective cooling of the units.

- Maximum air temperature to enter enclosure must never exceed 55 °C (131 °F).
- Day/night average temperature must not exceed 35 °C (95 °F).
- Allow for free cooling airflow when mounting the unit.
- Ensure the minimum front and rear clearance requirements for cooling airflow are observed.

It is possible to install 2 or more servo drives next to each other, however the surfaces of the servo drives must not be in contact with each other. Ensure there is a minimum gap of 1.2 mm between the servo drives to provide adequate ventilation of the servo drives and to allow sufficient heat transfer to take place in the surrounding areas.

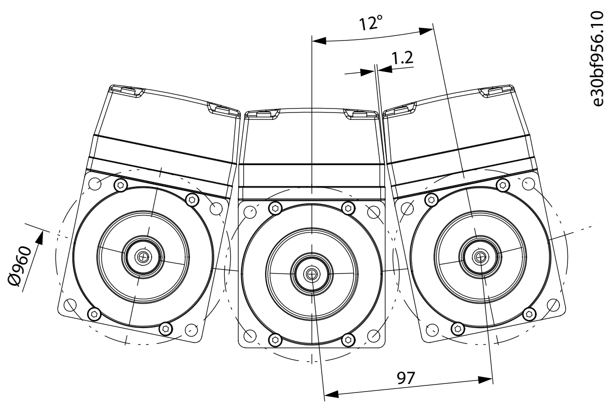

Illustration 34: Example of Servo Drive Installation on the same Flange

5.1.3.2 System Modules

The system modules dissipate power in the form of heat. Cooling (heat dispersal) is primarily via the integrated fans. The following recommendations are necessary for effective cooling of the units.

- Maximum air temperature to enter enclosure must never exceed 50 °C (122 °F).
- Day/night average temperature must not exceed 45 °C (113 °F).
- Allow for free cooling airflow through the cooling fins when mounting the unit. See 8.10.3 Space Requirements for System Modules.
- Ensure that the minimum clearance requirements for cooling airflow are observed. See the VLT® Servo Drive System ISD 510/DSD 510 Operating Guide for the installation requirements.

5.1.3.2.1 Cooling Fans

The PSM 510 and the SDM 511/SDM 512 modules have built-in fans to ensure optimum cooling. The fan forces the airflow along the cooling fins on the heat sink, ensuring cooling of the internal air.

The fan is controlled by the internal temperature in the module and the speed gradually increases along with temperature. This reduces noise and energy consumption when the need is low, and ensures maximum cooling when needed.

If there is overtemperature inside the module, an alarm or warning is issued and a coast and trip lock occurs.

5.1.3.2.2 Calculation of Airflow Required for Cooling the PSM 510 and SDM 511/SDM 512

The airflow required to cool the PSM 510 (or multiple PSM 510 or system modules in 1 control cabinet) can be calculated using the following formula:

$$V = \frac{f \times Q}{T_i - T_A}$$

Procedure

1. Determine the power loss at maximum output for all system modules.
2. Add the power loss values of all system modules that can operate at same time. The resulting sum is the heat Q to be transferred. Multiply the result with the factor f, read from Table 22. For example, f = 3.1 m^3 x kWh at sea level.
3. Determine the highest temperature of the air entering the enclosure. Subtract this temperature from the required temperature inside the enclosure, for example 45 °C (113 °F).
4. Divide the total from step 2 by the total from step 3.

N O T I C E

- Specific heat of air (cp) and density of air (ρ) are not constants, but depend on temperature, humidity, and atmospheric pressure. Therefore, they depend on the altitude above sea level. Table 22 shows typical values of the factor f, calculated for different altitudes.

Table 22: Factor f, Calculated for Various Altitudes

Altitude [m]	Specific heat of air (cp) [kJ/kgK]	Density of air (p) [kg/m3]	Factor (f) [m3K/Wh]
0	0.9480	1.225	3.1
500	0.9348	1.167	3.3
1000	0.9250	1.112	3.5
1500	0.8954	1.058	3.8
2000	0.8728	1.006	4.1
2500	0.8551	0.9568	4.4
3000	0.8302	0.9091	4.8

5.1.3.2.2.1 Example Calculation

How to calculate the airflow required to cool 2 modules (with heat losses of 295 W and 1430 W) running simultaneously, mounted in an enclosure with an ambient temperature peak of 37 °C, and an installation altitude of 500 m:

Procedure

1. Calculate the sum of the heat losses of both frequency converters (295 W + 150 W) = 445 W.
2. Multiply 445 W by 3.3 m^3 x K/Wh = 1468.5 m^3 x K/h.
3. Subtract 37 °C from 45 °C = 8 °C (=8 K).
4. Divide 1468.5 m^3 x K/h by 8 K = 183.56 m^3/h.

If the airflow is required in CFM (cubic feet per minute), use the conversion 1 m^3/h = 0.589 CFM. For the example given, 183.56 m^3/h = 108.1 CFM.

5.1.4 Motor-generated Overvoltage

The DC voltage in the DC-link (DC bus) increases when the servo drive acts as a generator. This can occur in 2 ways:

- The load drives the servo drive when it is operated at a constant speed. This is referred to as an overhauling load.
- During deceleration, if the inertia of the servo drives is high and the deceleration of the servo drives is set to a high value.

The PSM 510 cannot regenerate energy back to the grid. It has an internal brake resistor and an external brake resistor can be connected to the PSM 510 that can consume some power if the DC-link voltage becomes too high. If this is unsuccessful, or if the load drives the servo drive, the PSM 510 shuts down and shows a fault when a critical DC bus voltage level is reached. The servo drive cannot regenerate energy back to the input. Therefore, it limits the energy accepted from the motor. If this is unsuccessful, or if the load drives the motor, the servo drive shuts down and shows a fault when a critical DC bus voltage level is reached.

5.1.5 Acoustic Noise

5.1.5.1 Servo Drives

Acoustic noise from the servo drive comes from the following sources:

- Shaft seal
- Ball bearings
- Speed
- Brake

5.1.5.2 System Modules

Acoustic noise from the system modules comes from 3 sources:

- DC-link coils
- RFI filter choke
- Internal fans
- The acoustic noise ratings detailed in Table 23 were measured 1 m from the module.

Table 23: Acoustic Noise Ratings

	50% fan speed [dBA]	100% fan speed [dBA]
PSM 510	62	75
SDM 511, 40 A	62	75
SDM 511, 20 A, 10 A, 5 A, 2.5 A SDM 512	58	70
DAM 510, ACM 510, EXM 510	No fan	

5.1.6 Vibration and Shock

5.1.6.1 Servo Drives

The ISD 510/DSD 510 servo drives are tested according to a procedure based on IEC 60068-2-64 (see 8.3.1 ISD 510/DSD 510 Servo Drive).

The servo drives are intended for use on rotary parts/machines.

5.1.6.2 System Modules

The system modules are tested according to a procedure based on the IEC 60068-2-6 (see 8.3.2 System Modules and SDM 511/SDM 512). The system modules comply with requirements that correspond to these conditions when they are mounted within control cabinets.

5.1.7 Aggressive Atmospheres

5.1.7.1 Gases

Aggressive gases, such as hydrogen sulphide, chlorine, or ammonia can damage electrical and mechanical components. Contamination of the cooling air can also cause the gradual decomposition of PCB tracks and door seals. Aggressive contaminants are often present in sewage treatment plants or swimming pools. A clear sign of an aggressive atmosphere is corroded copper.

In aggressive atmospheres, use a cabinet with minimum IP54 rating for SDM 511/SDM 512 and the system modules.

Table 24: Conformal Coating Values

Gas type	Unit	Class 3C1	Class 3C2		Class 3C3	
		Maximum value[1]	Average value	Maximum value[1]	Average value	Maximum value[1]
Sea salt	–	–	Salt Mist	–	Salt mist	–
Sulphur dioxide	–	0.1	0.3	1.0	5.0	10.0
Hydrogen sulphide	mg/m^3	0.01	0.1	0.5	3.0	10.0
Chlorine	mg/m^3	0.01	0.1	0.3	0.3	1.0
Hydrogen chloride	mg/m^3	0.01	0.1	0.5	1.0	5.0
Hydrogen fluoride	mg/m^3	0.003	0.01	0.03	0.1	2.0
Ammonia	mg/m^3	0.3	1.0	3.0	10.0	35.0
Ozone	mg/m^3	0.01	0.05	0.1	0.1	0.3
Nitrogen	mg/m^3	0.1	0.5	1.0	3.0	9.0

[1] Maximum values are transient peak values not to exceed 30 minutes per day.

5.1.7.2 Exposure to Dust

Installation of the system components in environments with high dust exposure is often unavoidable. Dust affects:

- Servo drives with IP54, IP65, and IP67 protection ratings
- Wall or frame-mounted units
- Cabinet-mounted devices with IP20 protection ratings

Consider the aspects described in 5.1.7.2.1 Consequences when servo drives are installed in such environments.

5.1.7.2.1 Consequences

The consequences of dust build-up are:

- Reduced cooling
  - Dust forms deposits on the surface of the system components and inside on circuit boards and the electronic components. These deposits act as insulation layers and hamper heat transfer to the ambient air. This reduces the cooling capacity, re-

sulting in the components becoming warmer. This causes accelerated aging of the electronic components and reduced service life of the system component.

- Abrasion on the shaft seal
  - Dust can form deposits on the shaft and can lead to abrasion on the shaft seal. This can lead to a reduced lifetime of the shaft seal.
- Fan failure
  - The airflow for cooling the system modules is produced by cooling fans. The fan rotors have small bearings into which dust can penetrate and act as an abrasive. This leads to bearing damage and fan failure.

Under the conditions described, clean the system components during periodic maintenance. Remove dust from the housing, shaft, heat sink, and fans.

5.1.8 Electromagnetic Compatibility

5.1.8.1 Emission Requirements

The EMC product standard for frequency converters defines 4 categories (C1, C2, C3, and C4) with specified requirements for emission and immunity. Table 25 states the definition of the 4 categories and the equivalent classification from EN 55011. The servo system complies with the emission limits Category C3 according to EN 61800-3.

Table 25: Correlation between IEC 61800-3 and EN 55011

Category	Definition	Equivalent emission class in EN 55011
C1	AC drives installed in the first environment (home and office) with a supply voltage less than 1000 V.	Class B
C2	AC drives installed in the first environment (home and office) with a supply voltage less than 1000 V, which are not plug-in or movable and are intended to be installed and commissioned by a professional.	Class A Group 1
C3	AC drives installed in the second environment (industrial) with a supply voltage lower than 1000 V.	Class A Group 2
C4	AC drives installed in the second environment with a supply voltage equal to or above 1000 V or rated current equal to or above 400 A or intended for use in complex systems.	No limit line. Make an EMC plan.

5.1.8.2 Immunity Requirements

The immunity requirements for the FlexMotionô system components depend on the environment where they are installed. The requirements for the industrial environment are higher than the requirements for the home and office environment. All servo drives and system modules comply with the requirements for the industrial environment and therefore also comply with the lower requirements for home and office environment with a large safety margin.

The servo system complies with the emission limits Class A Group 2 according to EN 55011 and Category C3 according to EN 61800-3.

5.1.8.3 Grounding for Electrical Safety

5.1.8.3.1 Grounding ISD 510 and DSD 510

- Ensure that the machine frame has a proper ground connection to the ISD 510 and DSD 510 servo drives:
  - For ISD 510: Use the flange surface on the front side (see Illustration 35). Ensure PE connection on that part of the machine.

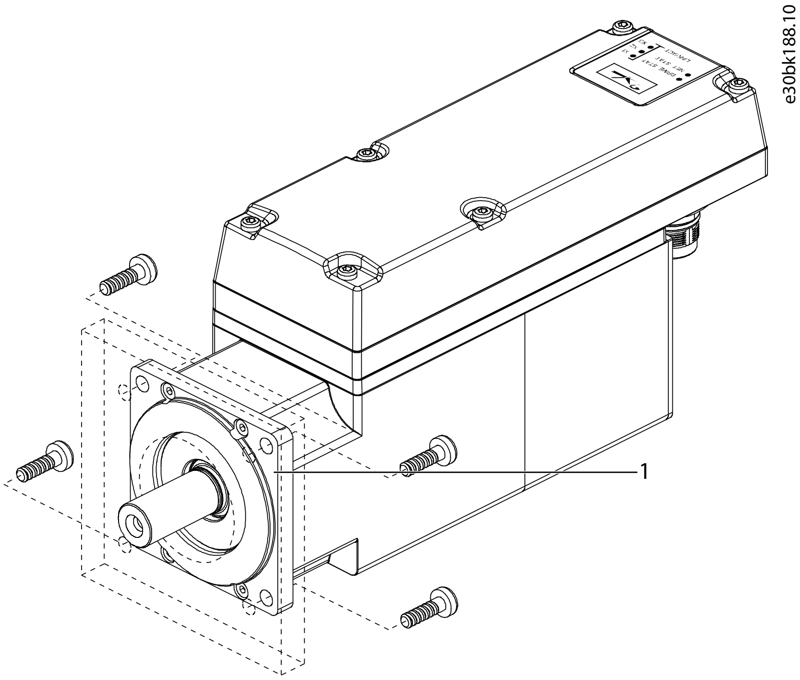

Illustration 35: Grounding the ISD 510 Servo Drive

1	Grounding area

- For DSD 510: Use the PE screw shown in Illustration 36. There is a dedicated PE screw on the front and another on the back of the DSD 510 servo drive.

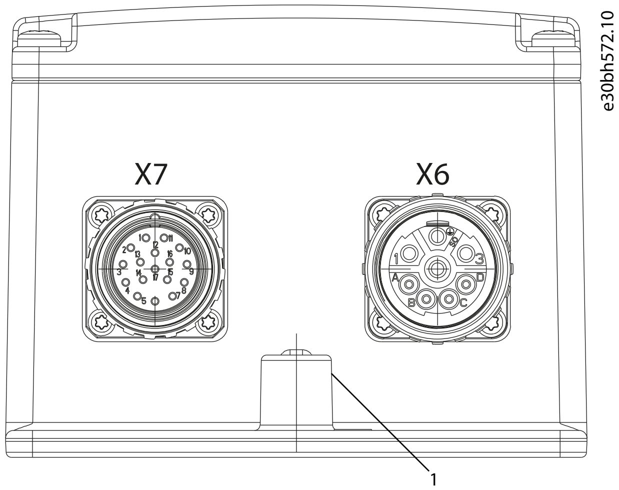

Illustration 36: Grounding the DSD 510 Servo Drive

1	PE Screw

- For the ISD 510/DSD 510 servo drives, ensure a minimum ground wire cross-section of at least 10 mm^2 (minimum 70 °C, Cu) or 2 separate ground wires both complying with the dimensioning rules. See EN/IEC 61800-5-1 for further information.
- Keep the ground wire connections as short as possible.
- Follow the wiring requirements in the VLT Æ Servo Drive System ISD 510/DSD 510 Operating Guide.

N O T I C E

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

5.1.8.3.2 Grounding the System Modules

- Do not ground the system modules in daisy-chain format. Use the grounding method depicted in Illustration 37.

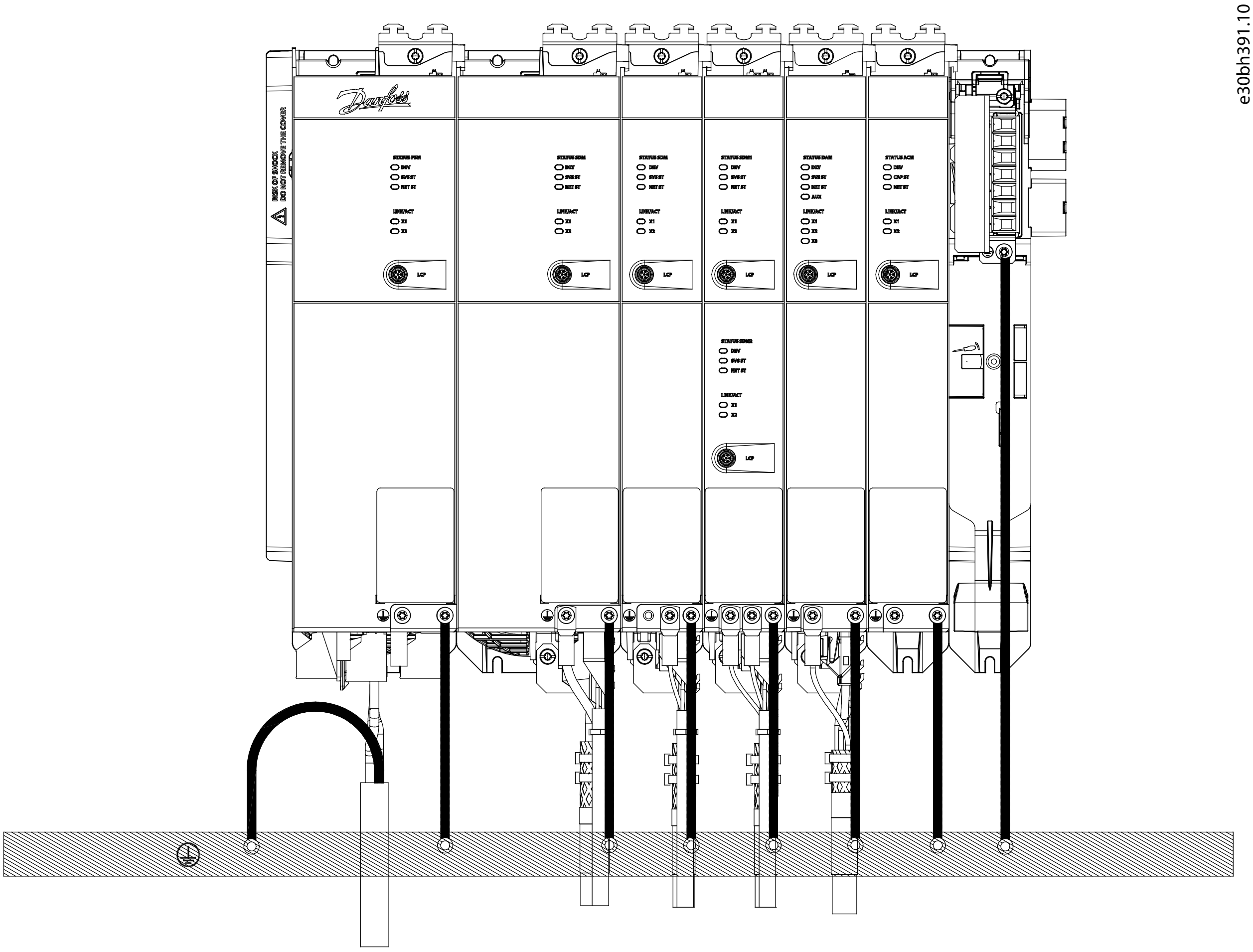

Illustration 37: Grounding for Electrical Safety

- Use a dedicated ground wire for input power and control wiring.
- To comply with CE requirements, ensure a minimum ground wire cross-section of at least 16 mm^2 (minimum 70 °C, Cu).
  To comply with UL requirements, ensure a minimum ground wire cross-section of at least 6 AWG (minimum 60 °C, Cu).
  If a PSM 510 module with 10 kW is used, the cable cross-section can be reduced to:
  - 10 mm^2 (minimum 70 °C, Cu) to comply with CE requirements
  - 8 AWG (minimum 60 °C, Cu) to comply with UL requirements
- Keep the ground wire connections as short as possible.
- If 2 separate backlinks are used (connected via 1 or 2 pairs of EXM 510 modules), the 2 grounding bars must also be connected with a 16 mm^2 (6 AWG) cable cross-section.

5.1.8.4 Grounding for EMC-Compliant Installation

- Establish electrical connection between the cable shield and the enclosure using the I/O shielding plate on each module.

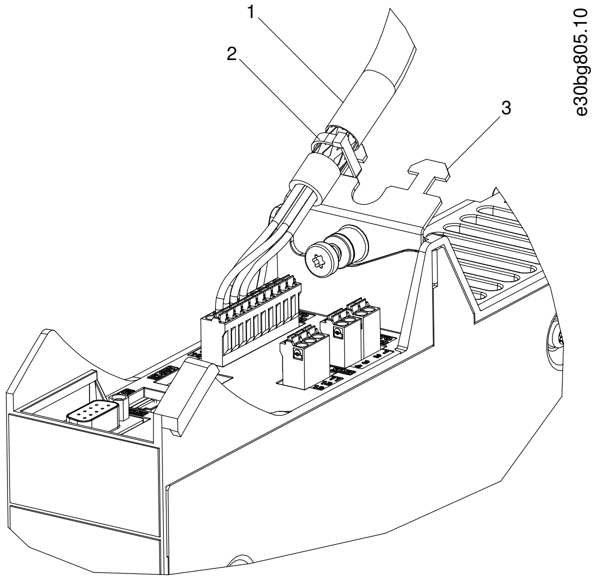

Illustration 38: Cable Shielding on the Top of the System Components

1	Cable	3	I/O shielding plate
2	Cable tie		

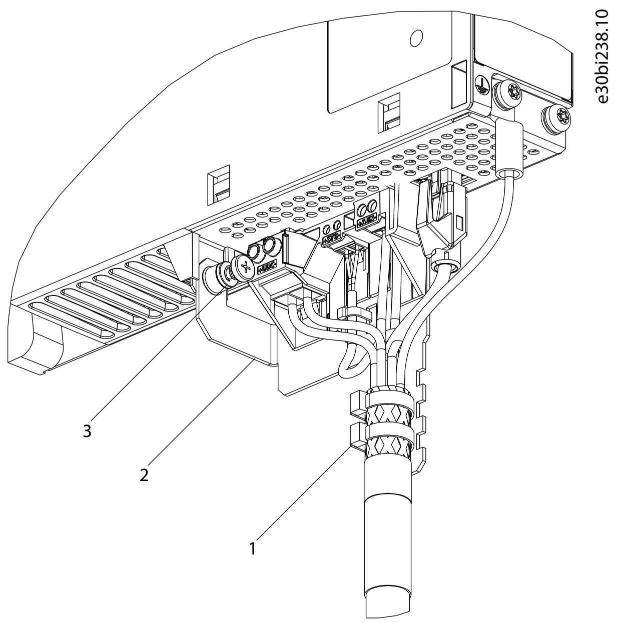

Illustration 39: Cable Shielding on the Bottom of the System Components

1	Cable tie	3	EMC plate screw
2	EMC metal shielding plate		

- Use a cable with a shielding that has a high-coverage to reduce electrical interference.
- Do not use pigtails to connect the shielding. A 360° wire connection is recommended.

N O T I C E

POTENTIAL EQUALIZATION

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

N O T I C E

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.
- Only cross cables at 90°.

5.1.8.5 Motor Bearing Currents

To minimize bearing and shaft currents, ground the following to the driven machine:

- System modules
- Servo drives ISD 510/DSD 510
- Driven machine

5.1.8.5.1 Measures to Minimize Bearing and Shaft Currents

Procedure

1. Apply rigorous installation procedures.
   - Ensure that the motor and motor load are aligned.
   - Strictly follow the EMC Installation guidelines.
   - Reinforce the PE so the high-frequency impedance is lower in the PE than the input power leads.
   - Provide a good high-frequency connection between the system components, for instance, by using shielded cable.
   - Make sure that the impedance from the servo system to building ground is lower that the grounding impedance of the machine.
   - Make a direct ground connection between the motor and load motor.
2. Install a shaft grounding system or use an isolating coupling.
3. Apply conductive lubrication.
4. Use minimum speed settings if possible.
5. Try to ensure that the line voltage is balanced to ground.

5.1.8.6 Earth Leakage Current

Follow national and local codes regarding protective earthing of equipment where leakage currents are >3.5 mA. High frequency switching at high power generates a leakage current in the ground connection.

The earth leakage current is made up of several contributions and depends on various system configurations, including:

- RFI filtering
- Cable length
- Cable shielding
- Frequency converter power

Compliance with EN/IEC61800-5-1 (power drive system product standard) requires special care if the leakage current is >3.5 mA. Reinforce grounding with the following protective earth connection requirements:

- Ground wire of at least 10 mm^2 cross-section.
- 2 separate ground wires, both complying with the dimensioning rules.

See EN/IEC 61800-5-1 and EN 50178 for further information.

5.1.8.6.1 Using RCDs

Where residual current devices (RCDs), also known as earth leakage circuit breakers (ELCBs), are used, comply with the following:

- Only use type B RCDs, as they are capable of detecting AC and DC currents.
- Use RCDs with a delay to prevent faults due to transient ground currents.
- Dimension RCDs according to the system configuration and environmental considerations.

The leakage current includes several frequencies originating from both the mains frequency and the switching frequency. Whether the switching frequency is detected depends on the type of RCD used.

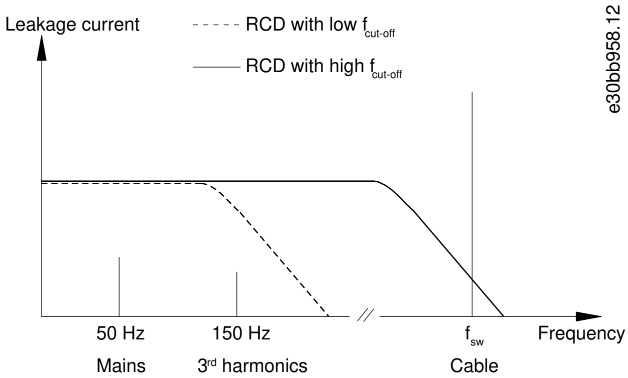

Illustration 40: Main Contributions to Leakage Current

The amount of leakage current detected by the RCD depends on the cut-off frequency of the RCD.

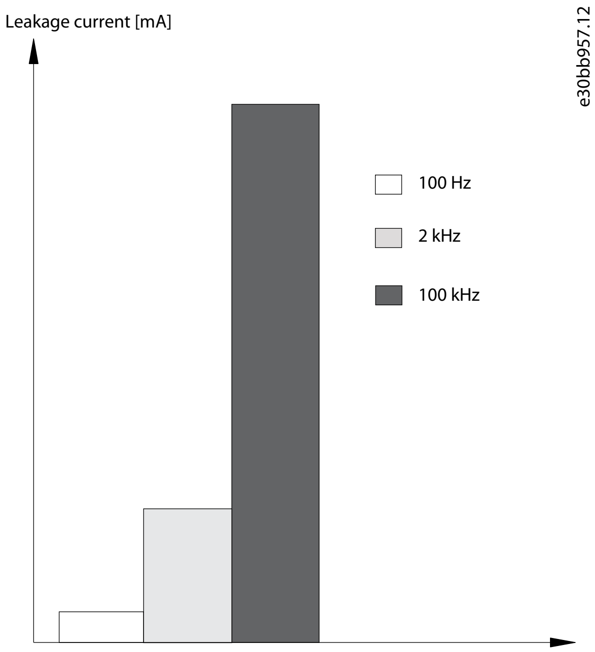

Illustration 41: Influence of RCD Cut-off Frequency on Leakage Current

5.1.8.7 Touch Current

The purpose of the touch current is to test the level of the leakage current in the protective earth (PE) of the power drive system.

If the leakage current is below or equal to 3.5 mA AC or 10 mA DC, no special measures relating to the PE connection are required.

If the leakage current of the servo system is greater than 3.5 mA AC or 10 mA DC, a fixed connection is required and 1 or more of the following conditions must be satisfied when installing the DUT:

- A cross-section of the protective earthing conductor of at least 10 mm^2 Cu or 16 mm^2 Al.
- Automatic disconnection of the supply if there is discontinuity of the protective earthing conductor.
- Provision of an additional terminal for a protective earthing conductor of the same cross-sectional area as the original protective earthing conductor.

WARNING

LEAKAGE/GROUNDING CURRENT HAZARD

Leakage/grounding currents are >3.5 mA. Improper grounding of the servo system modules and components may result in death or serious injury.

Leakage/grounding currents are >3.5 mA. Improper grounding of the ISD 510/DSD 510 servo drives and the system modules may result in death or serious injury.

- For reasons of operator safety, use a certified electrical installer to ground the system correctly in accordance with the applicable local and national electrical standards and directives, and the instructions in this manual.

5.1.9 Protection Ratings

5.1.9.1 Definitions

Table 26: IEC 60529 Definitions for Degrees of Protection (IP code)

First digit		Against penetration by solid foreign objects	Against access to hazardous parts by:
	0	(not protected)	(not protected)
	1	≥50 mm diameter	Back of hand
	2	12.5 mm diameter	Finger
	3	2.5 mm diameter	Tool
	4	≥1.0 mm diameter	Wire
	5	Dust protected	Wire
	6	Dust-tight	Wire
Second digit		Against water penetration with harmful effect	–
	0	(not protected)	–
	1	Drops falling vertically	–
	2	Drops at 15° angle	–
	3	Spraying water	–
	4	Splashing water	–
	5	Water jets	–
	6	Powerful water jets	–
	7	Temporary immersion	–
	8	Long-term immersion	–
	9	High pressure and temperature water jet	–
First letter		–	Additional Information

	A	–	Back of hand
	B	–	Finger
	C	–	Tool
	D	–	Wire
Additional letter		Additional information	–
	H	High voltage device	–
	M	Device moving during water test	–
	S	Device stationary during water test	–
	W	Weather conditions	–

5.1.9.2 Protection Ratings for ISD 510 Servo Drive

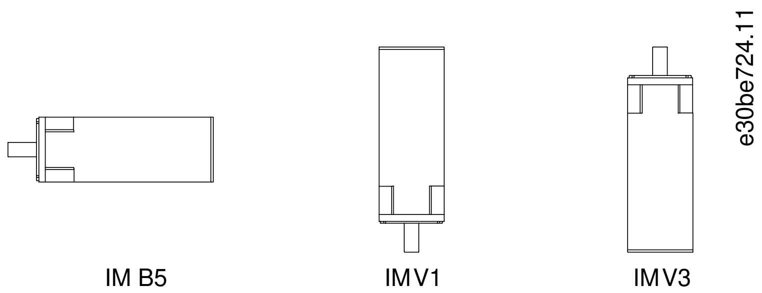

Illustration 42: Mounting Positions

Table 27: Protection Ratings for ISD 510 Servo Drive

	Mounting position of servo drive (according to DIN 42 950)	Protection rating (according to EN 60529)
Housing	All positions	IP65/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

NOTICE

- Install and connect the ISD 510 servo drives as described in this manual to achieve the ratings detailed in Table 27 in the final application.
- The ISD 510 servo drives are certified by UL as recognized components.

5.1.9.3 Protection Ratings for DSD 510 Servo Drive

All DSD 510 variants have a protection rating of IP65/IP67.

NOTICE

- Install and connect the DSD 510 servo drives as described in this manual to achieve the IP65/IP67 rating in the final application.
- The DSD 510 servo drives are certified by UL as recognized components.

5.1.9.4 Protection Ratings for the Servo Drive Modules SDM 511/SDM 512 and the System Modules

The SDM 511/SDM 512 and the system modules have a protection rating of IP20 according to IEC/EN 60529 (except connectors, which are IP00).

WARNING

RISK OF ELECTRICAL SHOCK

The IP20 rating of the servo system is not fulfilled if the system is operated with a module that is not connected to the backplate. This may result in death or serious injury.

- Do not touch the backplate when a module is removed from the backplate.

5.1.10 Radio Frequency Interference

To ensure that systems operate stably without radio frequency interference between components, an RFI filter (as specified in EN 61800-3), which conforms to the Class A limits of the general standard EN 55011 can be added at the input of the servo system.

Filters that are built in to the equipment take up space in the cabinet, but eliminate additional costs for fitting, wiring, and material. However, the most important advantage is the perfect EMC conformance and cabling of integrated filters.

5.1.11 PELV and Galvanic Isolation Compliance

PELV (Protective Extra Low Voltage) offers protection by using extra low voltage. Protection against electric shock is ensured when the electrical supply is PELV and the installation complies with local and national PELV regulations.

To maintain PELV at the control terminals, all connections must be PELV, such as thermistors being reinforced/double insulated. All PSM 510 control and relay terminals comply with PELV.

Galvanic (ensured) isolation is obtained by fulfilling requirements for higher isolation and by providing the relevant creepage/clearance distances. These requirements are described in EN 61800-5-1.

Electrical isolation is provided and the components comply with both PELV and galvanic isolation requirements. The components also comply with the requirements for higher isolation and the relevant test as described in EN 61800-5-1.

All control terminals and relay terminals 01-03/04-06 comply with PELV.

NOTICE

INSTALLATION AT HIGH ALTITUDE

Installations exceeding high altitude limits may not comply with PELV requirements. The insulation between components and critical parts could be insufficient. There is a risk of overvoltage. Reduce the risk of overvoltage using external protective devices or galvanic isolation.

- The maximum allowed altitudes can be found in 8.3.1 ISD 510/DSD 510 Servo Drive and 8.3.2 System Modules and SDM 511/SDM 512.
- For installations at high altitude, contact Danfoss regarding PELV compliance.

5.1.12 Maintenance Tasks

The ISD 510/DSD 510, SDM 511/SDM 512, and the system modules are largely maintenance free. Only the shaft seal on the ISD 510 (if used) is subject to wear. The maintenance tasks must be performed by qualified personnel. No other tasks are required.

Table 28: Overview of Maintenance Tasks

Component	Maintenance task	Maintenance interval	Instruction
All	Carry out a visual inspection.	Every 6 months	Check for any abnormalities on the surface.
Shaft seal on the ISD 510	Check the condition and check for leakage.	Every 6 months[1]	If damaged or worn: Replace the shaft seal.
Mechanical holding brake (optional)	Check the brake.	Every 6 months	Ensure that the brake can achieve the holding torque.
Flange connection on the ISD 510	Measure the resistance.	Every 12 months.	Measure the resistance of the flange connection on the ISD 510.
System modules	Check the fan.	Every 12 months	Check that the fan can turn and remove any dust or dirt.
Hybrid cable	Check for damage and wear.	Every 6 months	If damaged or worn: Replace the hybrid cable.
Functional safety	Perform a system power cycle and check the STO function.	Every 12 months	Activate STO and check the status with the PLC.

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

5.1.13 Storage

Store the servo system components in a dry, dust-free location with low vibration ($v_{eff} \leqq 0.2$ mm/s).

The storage location must be free from corrosive gases.

Avoid sudden temperature changes.

Long-term storage

To recondition the electrolytic capacitors, servo drives and system components that are 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.

5.2 Mains Input

5.2.1 Mains Supply Requirements

Ensure that the supply has the following properties:

- TN-S, TN-C, TN-CS, TT (not corner grounded) supply grounding system.
- For information on the use of an IT network with transformer, contact Danfoss.
- Prospective short circuit current: 5 kA.
- Protective class I.
- Grounded 3-phase mains network, 400–480 V AC ±10%.
- 3-phase lines and PE line.
- 3-phase frequency: 44–66 Hz
- Maximum input current for 1 PSM 510 at 30 kW: 55 A_{rms}

5.2.1.1 Fuses

N O T I C E

- Use fuses on the supply side of the Power Supply Module (PSM 510) that comply with CE and UL requirements (see Table 29).
- When 2 PSM 510 modules are used, each PSM 510 must have its own dedicated set of fuses.

Table 29: Fuses

Model and power rating	CE Compliance (IEC 60364)	UL Compliance (NEC 2014)
	Maximum fuse type	**Maximum fuse type**
PSM 510 (10 kW)	gG 25 A	30 A (class T or J only)
PSM 510 (20 kW)	gG 50 A	50 A (class T or J only)
PSM 510 (30 kW)	gG 63 A	80 A (class T or J only)

5.2.1.2 Circuit Breakers

Use a type B or type C circuit breaker with a capacity of 1.5 times the rated current of PSM 510 to fulfill CE requirements.

N O T I C E

- Circuit breakers are not allowed in installations where C-UL is required. Only UL recommended fuses are allowed.

5.2.1.3 Additional Specifications

Table 30: Additional Specification

Maximum imbalance temporary between mains phase	3% of the rated supply voltage
True power factor [λ]	≥0.9 at rated current
Switching on input supply	Maximum 2 times per minute
Environment according to EN 60664-1	• Overvoltage category III • Pollution degree 2
Mains dropout	During low mains or a mains dropout, the PSM 510 and the servo drives keep running until the DC-link voltage drops below 373 V. Full torque of the servo drives cannot be expected at mains voltage 10% below the rated supply voltage.

5.2.2 Auxiliary Supply Requirements

Supply the Power Supply Module (PSM 510) with a power supply unit with an output of 24/48 V DC ±10%. The output ripple of the power supply unit must be <250 mV_{pp}.

N O T I C E

- Only use supply units that conform to the PELV specification.
- 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 secondary circuit must be supplied from an external isolated source.

The power supply unit must be dedicated to the VLT® FlexMotionô system, meaning that the supply is used exclusively for powering the PSM 510. The maximum cable length between the supply unit and the PSM 510 is 3 m.

5.2.3 Harmonics

The servo system takes up non-sinusoidal current from the mains, which increases the input current I_{RMS}. A non-sinusoidal current is transformed by means of a Fourier analysis and split up into sine-wave currents with different frequencies, that is different harmonic currents IN with 50 Hz as the basic frequency.

The harmonics do not affect the power consumption directly, but increase the heat losses in the installation (transformer, cables). So in plants with a high percentage of rectifier load, maintain harmonic currents at a low level to avoid overload of the transformer and high temperature in the cables.

NOTICE

- Some of the harmonic currents could disturb communication equipment connected to the same transformer or cause resonance in connection with power factor correction units.

To ensure low harmonic currents, use a 3-phase AC line choke on the input side of the PSM 510.

5.2.3.1 Mains Configuration and EMC

Only TN mains systems are allowed for powering the servo system.

- TN-S: A 5-wire system with separate neutral (N) and protective earth (PE) conductors. It provides the best EMC properties and avoids transmitting interference.
- TN-C: A 4-wire system with a common neutral and protective earth (PE) conductor throughout the system. The combined neutral and protective earth conductor results in poor EMC characteristics.

IT mains systems and AC mains systems with a grounded mains are not allowed.

5.2.3.2 Mains Transients

Transients are brief voltage peaks in the range of a few thousand volts. They can occur in all types of power distribution systems, including industrial and residential environments.

Lightning strikes are a common cause of transients. However, they are also caused by switching large loads on line or off, or switching other mains transients equipment, such as power factor correction equipment. Transients can also be caused by short circuits, tripping of circuit breakers in power distribution systems, and inductive coupling between parallel cables.

EN 61000-4-1 describes the forms of these transients and how much energy they contain. There are various ways to limit their harmful effects:

- First level protection: Gas-filled surge arresters and spark gaps provide protection against high-energy transients.
- Second level protection: Use of voltage-dependent resistors (varistors) to attenuate transients.

5.3 System Concepts

5.3.1 Auxiliary Power Supply Selection

5.3.1.1 Shell Diagram

The number of ISD 510/DSD 510 servo drives allowed on a hybrid line is limited by the fact that voltage drops occur on the hybrid cable. These voltage drops involve the auxiliary voltage (24/48 V DC). The voltage drops on the cable depend on the power consumption of the servo drives on the hybrid line. The differences in power consumption are due to servo drives with integrated holding brake, servo drives without integrated holding brake, and servo drives with X3, X4, and X5 connectors.

The number of ISD 510 servo drives connected on 1 line depends on several conditions. The most important conditions are:

- Power required by the servo drives on the auxiliary supply
- Auxiliary voltage
- Cable length

The servo drives with brake must be connected at the beginning of the output line to lower the voltage drop for all servo drives.

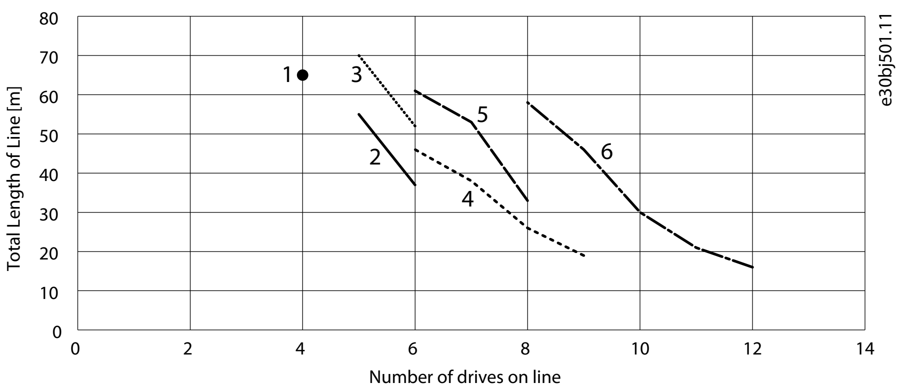

Illustration 43: Size 1, 24 V

1	Feed-in 40 m U_{AUX} 24 V with brake	4	Feed-in 10 m U_{AUX} 24 V with brake
2	Feed-in 25 m U_{AUX} 24 V with brake	5	Feed-in 25 m U_{AUX} 24 V without brake
3	Feed-in 40 m U_{AUX} 24 V without brake	6	Feed-in 10 m U_{AUX} 24 V without brake

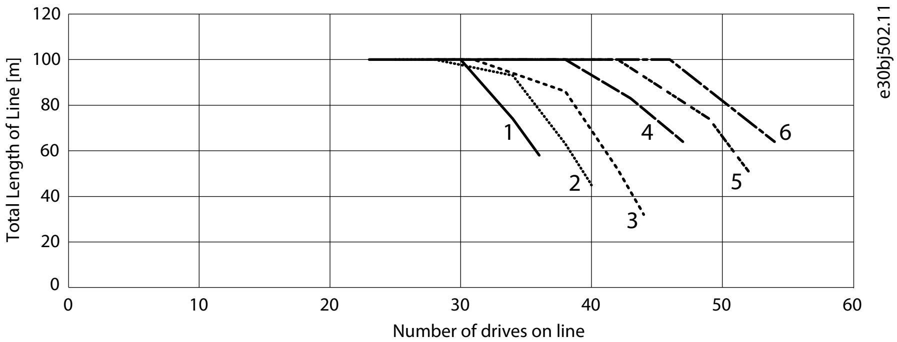

Illustration 44: Size 1, 48 V

1	Feed-in 40 m U_{AUX} 48 V with brake	4	Feed-in 40 m U_{AUX} 48 V without brake
2	Feed-in 25 m U_{AUX} 48 V with brake	5	Feed-in 25 m U_{AUX} 48 V without brake
3	Feed-in 10 m U_{AUX} 48 V with brake	6	Feed-in 10 m U_{AUX} 48 V without brake

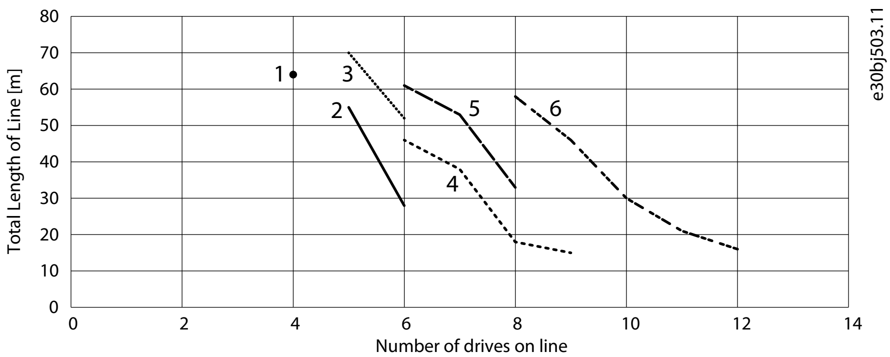

Illustration 45: Size 2, 24 V

1	Feed-in 40 m U_{AUX} 24 V with brake	4	Feed-in 10 m U_{AUX} 24 V with brake
2	Feed-in 25 m U_{AUX} 24 V with brake	5	Feed-in 25 m U_{AUX} 24 V without brake
3	Feed-in 40 m U_{AUX} 24 V without brake	6	Feed-in 10 m U_{AUX} 24 V without brake

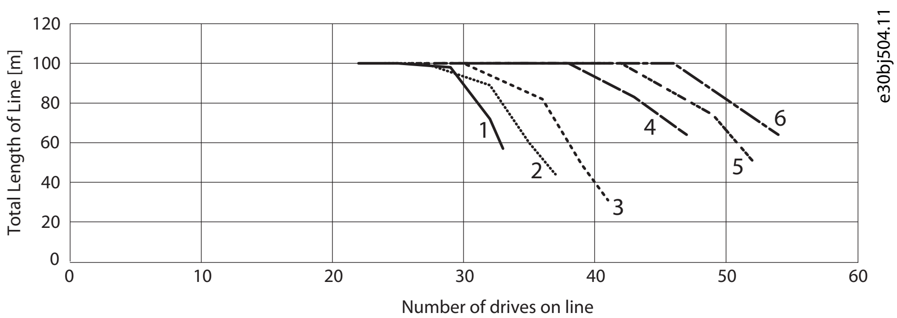

Illustration 46: Size 2, 48 V

1	Feed-in 40 m U_{AUX} 48 V with brake	4	Feed-in 40 m U_{AUX} 48 V without brake
2	Feed-in 25 m U_{AUX} 48 V with brake	5	Feed-in 25 m U_{AUX} 48 V without brake
3	Feed-in 10 m U_{AUX} 48 V with brake	6	Feed-in 10 m U_{AUX} 48 V without brake

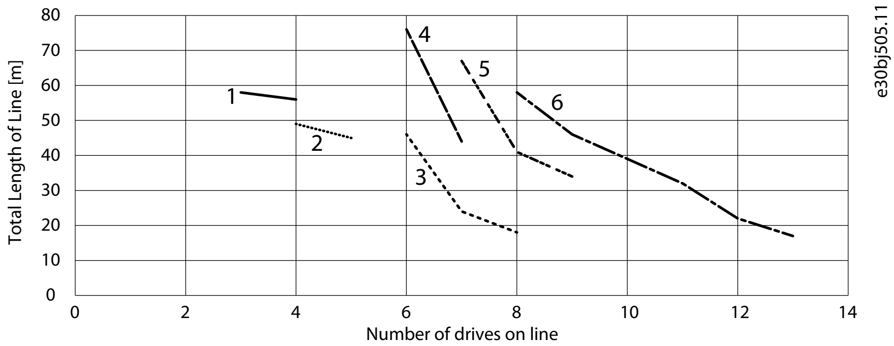

Illustration 47: Size 3, 24 V

1	Feed-in 40 m U_{AUX} 24 V with brake	4	Feed-in 40 m U_{AUX} 24 V without brake
2	Feed-in 25 m U_{AUX} 24 V with brake	5	Feed-in 25 m U_{AUX} 24 V without brake
3	Feed-in 10 m U_{AUX} 24 V with brake	6	Feed-in 10 m U_{AUX} 24 V without brake

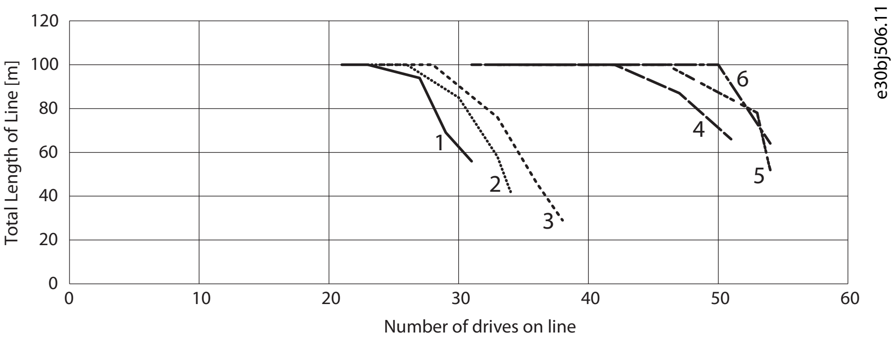

Illustration 48: Size 3, 48 V

1	Feed-in 40 m U_{AUX} 48 V with brake	4	Feed-in 40 m U_{AUX} 48 V without brake
2	Feed-in 25 m U_{AUX} 48 V with brake	5	Feed-in 25 m U_{AUX} 48 V without brake
3	Feed-in 10 m U_{AUX} 48 V with brake	6	Feed-in 10 m U_{AUX} 48 V without brake

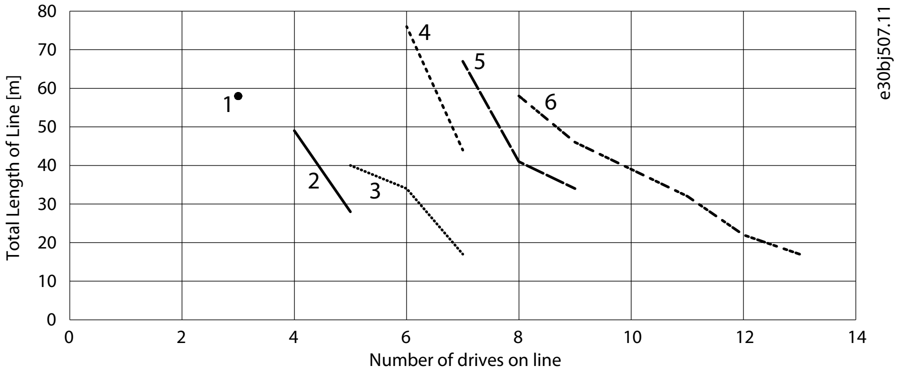

Illustration 49: Size 4, 24 V

1	Feed-in 40 m U_{AUX} 24 V with brake	4	Feed-in 40 m U_{AUX} 48 V without brake
2	Feed-in 25 m U_{AUX} 24 V with brake	5	Feed-in 25 m U_{AUX} 48 V without brake
3	Feed-in 10 m U_{AUX} 24 V with brake	6	Feed-in 10 m U_{AUX} 48 V without brake

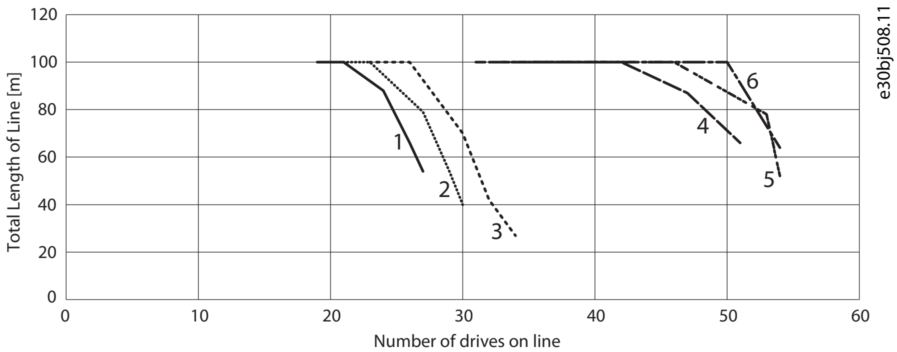

Illustration 50: Size 4, 48 V

1	Feed-in 40 m U_{AUX} 48 V with brake	4	Feed-in 40 m U_{AUX} 48 V without brake
2	Feed-in 25 m U_{AUX} 48 V with brake	5	Feed-in 25 m U_{AUX} 48 V without brake
3	Feed-in 10 m U_{AUX} 48 V with brake	6	Feed-in 10 m U_{AUX} 48 V without brake

5.3.1.2 24 V Auxiliary Supply

When 24 V AUX supply is used, the power losses on the cable are limited because only a limited number of servo drives can be connected. The maximum power loss on the cable is 6.4 W (when the servo drive draws 13.8 W and 8 servo drives are connected with 0.5 m loop cables). The nominal power of the servo drives is 8 x 13.8 W = 116.8 W. The AUX supply has to provide ≈6% more than the nominal power.

Table 31: ISD 510 Power Descriptions

Power ISD [W]	ISD 510 Type
7.5	ISD 510 sizes 3 and 4 without mechanical brake.
8.6	ISD 510 sizes 1 and 2 without mechanical brake.
12.2	ISD 510 size 1 with mechanical brake

Power ISD [W]	ISD 510 Type
13.3	ISD 510 size 2 with mechanical brake.
14.6	ISD 510 size 3 with mechanical brake.
16.9	ISD 510 size 4 with mechanical brake.

Table 32: 24 V Auxiliary Supply with 10 m Feed-in cable

Power ISD [W]	Cable length [m]	Number of servo drives	Overall cable length [m]	Overall power (cable losses inclu-ded) [W]
7.5	0.5	13	17	103.7
7.5	1.0	12	22	103.7
7.5	2.0	11	32	103.7
7.5	4.0	9	46	103.7
7.5	6.0	8	58	103.7
8.6	0.5	12	16	110.0
8.6	1.0	11	21	110.0
8.6	2.0	10	30	110.0
8.6	4.0	9	46	110.0
8.6	6.0	8	58	110.0
12.2	0.5	9	15	116.8
12.2	1.0	9	19	116.8
12.2	2.0	8	26	116.8
12.2	4.0	7	38	116.8
12.2	6.0	6	46	116.8
13.3	0.5	9	15	128.2
13.3	1	8	18	128.2
13.3	2	7	24	128.2
13.3	4	7	38	128.2
13.3	6	6	46	128.2
14.6	0.5	8	14	124.5
14.6	1.0	8	18	124.5
14.6	2.0	7	24	124.5
14.6	4.0	6	34	124.5
14.6	6.0	6	46	124.5
16.9	0.5	7	14	125.8
16.9	1.0	7	17	125.8

Power ISD [W]	Cable length [m]	Number of servo drives	Overall cable length [m]	Overall power (cable losses included) [W]
16.9	2.0	6	22	125.8
16.9	4.0	6	34	125.8
16.9	6.0	5	40	125.8

Table 33: 24 V Auxiliary Supply with 25 m Feed-in cable

Power ISD [W]	Cable length [m]	Number of servo drives	Overall cable length [m]	Overall power (cable losses included) [W]
7.5	0.5	9	30	72.1
7.5	1.0	9	34	72.1
7.5	2.0	8	41	72.1
7.5	4.0	7	53	72.1
7.5	6.0	7	67	72.1
8.6	0.5	8	29	73.3
8.6	1.0	8	33	73.3
8.6	2.0	7	39	73.3
8.6	4.0	7	53	73.3
8.6	6.0	6	61	73.3
12.2	0.5	6	28	78.0
12.2	1.0	6	31	78.0
12.2	2.0	6	37	78.0
12.2	4.0	5	45	78.0
12.2	6.0	5	55	78.0
13.3	0.5	6	28	85.6
13.3	1.0	5	30	85.6
13.3	2.0	5	35	85.6
13.3	4.0	5	45	85.6
13.3	6.0	5	55	85.6
14.6	0.5	5	28	77.5
14.6	1.0	5	30	77.5
14.6	2.0	5	35	77.5
14.6	4.0	5	45	77.5
14.6	6.0	4	49	77.5
16.9	0.5	5	28	90.6

Power ISD [W]	Cable length [m]	Number of servo drives	Overall cable length [m]	Overall power (cable losses included) [W]
16.9	1.0	4	29	90.6
16.9	2.0	4	33	90.6
16.9	4.0	4	41	90.6
16.9	6.0	4	49	90.6

Table 34: 24 V Auxiliary Supply with 40 m Feed-in cable

Power ISD [W]	Cable length [m]	Number of servo drives	Overall cable length [m]	Overall power (cable losses included) [W]
7.5	0.5	7	44	56.2
7.5	1.0	6	46	56.2
7.5	2.0	6	52	56.2
7.5	4.0	6	64	56.2
7.5	6.0	6	76	56.2
8.6	0.5	6	43	54.9
8.6	1.0	6	46	54.9
8.6	2.0	6	52	54.9
8.6	4.0	5	60	54.9
8.6	6.0	5	70	54.9
12.2	0.5	4	42	51.3
12.2	1.0	4	48	51.3
12.2	2.0	4	48	51.3
12.2	4.0	4	56	51.3
12.2	6.0	4	64	51.3
13.3	0.5	4	42	56.2
13.3	1.0	4	44	56.2
13.3	2.0	4	48	56.2
13.3	4.0	4	56	56.2
13.3	6.0	4	64	56.2
14.6	0.5	4	42	62.1
14.6	1.0	4	48	62.1
14.6	2.0	4	48	62.1
14.6	4.0	4	56	62.1
14.6	6.0	3	58	62.1

Power ISD [W]	Cable length [m]	Number of servo drives	Overall cable length [m]	Overall power (cable losses included) [W]
16.9	0.5	3	42	52.9
16.9	1.0	3	43	52.9
16.9	2.0	3	46	52.9
16.9	4.0	3	52	52.9
16.9	6.0	3	58	52.9

5.3.1.3 48 V Auxiliary Supply

When 48 V AUX supply is used, the power losses on the cable can be higher because up to 32 servo drives can be connected. The power losses of the feed-in cable have a higher influence. Therefore, the losses are calculated at 10 m, 25 m, or 40 m cable length.

Table 35: ISD 510 Power Descriptions

Power ISD [W]	ISD 510 Type
7.5	ISD 510 sizes 3 and 4 without mechanical brake.
8.6	ISD 510 sizes 1 and 2 without mechanical brake.
12.2	ISD 510 size 1 with mechanical brake
13.3	ISD 510 size 2 with mechanical brake.
14.6	ISD 510 size 3 with mechanical brake.
16.9	ISD 510 size 4 with mechanical brake.

Table 36: 48 V Auxiliary Supply with 10 m Feed-in Cable

Power ISD [W]	Cable length [m]	Number of servo drives	Overall cable length [m]	Overall power (cable losses included) [W]
7.5	0.5	54	37	497.4
7.5	1.0	54	64	540.0
7.5	2.0	50	100	589.2
7.5	4.0	40	100	453.9
7.5	6.0	35	100	419.6
8.6	0.5	54	37	602.9
8.6	1.0	54	64	703.4
8.6	2.0	46	100	597.9
8.6	4.0	37	100	471.1
8.6	6.0	32	100	404.8
12.2	0.5	44	32	697.9
12.2	1.0	42	52	702.8
12.2	2.0	38	86	699.1
12.2	4.0	31	100	572.7

Power ISD [W]	Cable length [m]	Number of servo drives	Overall cable length [m]	Overall power (cable losses included) [W]
12.2	6.0	27	100	501.5
13.3	0.5	41	31	697.7
13.3	1.0	39	49	691.4
13.3	2.0	36	82	708.2
13.3	4.0	30	100	636.7
13.3	6.0	26	100	540.7
14.6	0.5	38	29	701.1
14.6	1.0	36	46	684.7
14.6	2.0	33	76	669.2
14.6	4.0	28	100	606.6
14.6	6.0	24	100	499.4
16.9	0.5	34	27	715.6
16.9	1.0	32	42	686.9
16.9	2.0	30	70	690.7
16.9	4.0	26	100	657.0
16.9	6.0	23	100	610.1

Table 37: 48 V Auxiliary Supply with 25 m Feed-in Cable

Power ISD [W]	Cable length [m]	Number of servo drives	Overall cable length [m]	Overall power (cable losses included) [W]
7.5	0.5	54	52	569.1
7.5	1.0	53	78	659.3
7.5	2.0	46	100	577.1
7.5	4.0	37	100	417.9
7.5	6.0	33	100	401.9
8.6	0.5	52	51	680.6
8.6	1.0	49	74	718.5
8.6	2.0	42	100	570.5
8.6	4.0	35	100	491.4
8.6	6.0	30	100	385.3
12.2	0.5	40	45	702.2
12.2	1.0	38	63	699.8
12.2	2.0	34	93	651.5

Power ISD [W]	Cable length [m]	Number of servo drives	Overall cable length [m]	Overall power (cable losses included) [W]
12.2	4.0	28	100	512.0
12.2	6.0	25	100	471.1
13.3	0.5	37	44	690.4
13.3	1.0	35	60	671.2
13.3	2.0	32	89	652.6
13.3	4.0	27	100	557.3
13.3	6.0	24	100	505.4
14.6	0.5	34	42	682.5
14.6	1.0	33	58	697.4
14.6	2.0	30	85	661.8
14.6	4.0	26	100	636.2
14.6	6.0	23	100	565.8
16.9	0.5	30	40	682.1
16.9	1.0	29	54	681.3
16.9	2.0	27	79	670.1
16.9	4.0	23	100	573.2
16.9	6.0	21	100	562.5

Table 38: 48 V Auxiliary Supply with 40 m Feed-in Cable

Power ISD [W]	Cable length [m]	Number of servo drives	Overall cable length [m]	Overall power (cable losses included) [W]
7.5	0.5	51	66	630.5
7.5	1.0	47	87	572.5
7.5	2.0	42	100	537.0
7.5	4.0	35	100	423.8
7.5	6.0	31	100	376.3
8.6	0.5	47	64	705.7
8.6	1.0	43	83	604.5
8.6	2.0	38	100	522.5
8.6	4.0	32	100	431.0
8.6	6.0	28	100	360.8
12.2	0.5	36	58	713.3
12.2	1.0	34	74	691.1

Power ISD [W]	Cable length [m]	Number of servo drives	Overall cable length [m]	Overall power (cable losses included) [W]
12.2	2.0	30	100	573.2
12.2	4.0	26	100	508.0
12.2	6.0	23	100	431.5
13.3	0.5	33	57	675.3
13.3	1.0	32	72	706.9
13.3	2.0	29	98	652.5
13.3	4.0	25	100	571.0
13.3	6.0	22	100	458.7
14.6	0.5	31	56	706.5
14.6	1.0	29	69	650.3
14.6	2.0	27	94	643.9
14.6	4.0	23	100	521.2
14.6	6.0	21	100	498.6
16.9	0.5	27	54	679.4
16.9	1.0	26	66	670.1
16.9	2.0	24	88	629.8
16.9	4.0	21	100	552.6
16.9	6.0	19	100	499.9

The maximum power loss on the cable is 260.4 W when 40 m feed-in cable is used (the servo drives draw 13.8 W and 27 servo drives are connected with 2 m loop cables). The nominal power of the servo drives is 27 x 13.8 W = 372.6 W. The AUX supply must provide 70% more than the nominal power.

5.4 ISD 510 Servo Drives

5.4.1 Motor Selection Considerations

There are 64 different variants of the ISD 510 servo drive, allowing selection of the most appropriate servo drive for the application. Table 4.15 shows the available options. Refer to 6.2 ISD 510 Servo Drive Types for a detailed explanation of the available variants.

Table 39: Available Options for the ISD 510 Servo Drive

Motor option	Control electronics
• Torque/speed range • Mechanical holding brake • Feedback • Shaft seal	• Fieldbus

NOTICE

- ISD 510 sizes 1 and 2 can only be used with the 15 A variant of DAM 510.

5.4.2 Motor Grounding

To ensure electrical safety, minimize EMC disturbances and ensure good thermal behavior, the servo drive must be grounded properly using the following 2 methods:

- Via the PE wire of the feed-in or loop cable.
- Via the servo drive flange.

Ensure that the machine frame has a proper ground 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 5.1.8.3 Grounding for Electrical Safety for more information.

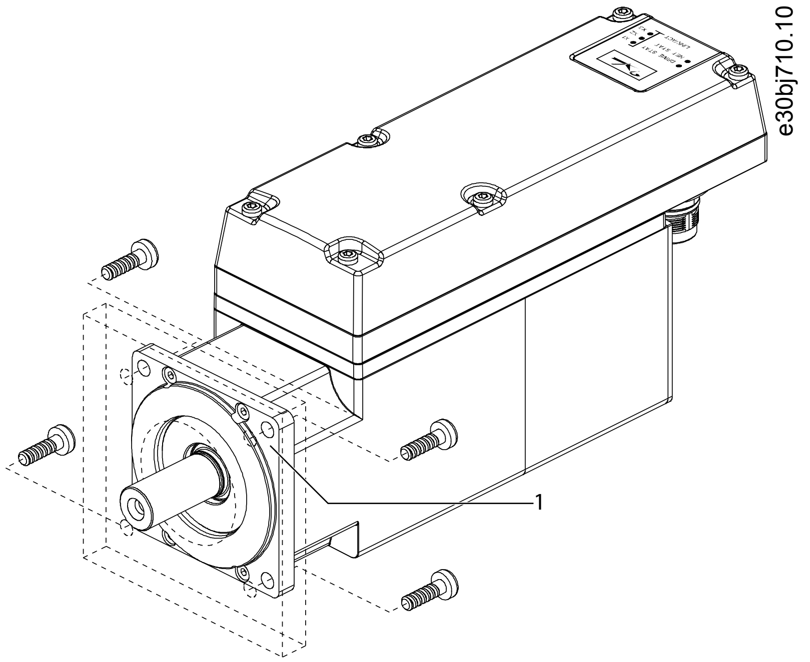

Illustration 51: Grounding via the Servo Drive Flange

1	Grounding area on ISD 510 Flange

WARNING

LEAKAGE/GROUNDING CURRENT HAZARD

Leakage/grounding currents are >3.5 mA. Improper grounding of the servo system modules and components may result in death or serious injury.

Leakage/grounding currents are >3.5 mA. Improper grounding of the ISD 510/DSD 510 servo drives and the system modules may result in death or serious injury.

- For reasons of operator safety, use a certified electrical installer to ground the system correctly in accordance with the applicable local and national electrical standards and directives, and the instructions in this manual.

5.4.2.1 Potential Equalization

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

5.4.3 Thermal Protection

Thermal sensors monitor the maximum allowable temperature of the motor winding and switch the motor off if the limit of 150 °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.

Table 40: Thermal Protection

Module overtemperature	During the operation of the servo drive, the power loss on the IGBT causes a temperature rise on the IGBT. The servo drive monitors the IGBT temperature constantly and, if there is overtemperature, stops operation and shows an IGBT overtemperature error.
Temperature power card	To protect the servo drive electronics from thermal destruction, the temperature on the power card is monitored. The servo drive shuts down if the threshold level is reached.
Temperature control card	To protect the servo drive electronics from thermal destruction, the temperature on the control card is monitored. The servo drive shuts down if the threshold level is reached.
Motor overtemperature	The motor winding temperature is protected against thermal runaway by constantly monitoring its temperature. The servo drive stops operation if the winding temperature limit is reached.

5.5 Cables

The servo systems use pre-configured hybrid cables to connect the Decentral Access Module (DAM 510) to the 1st servo drive on each line. This hybrid cable combines the DC link supply, the auxiliary supply, the STO signal, and the bus communication. The hybrid cables pass these signals on to further servo drives connected in daisy-chain concept. There are 2 types of hybrid cables available with both angled and straight M23 connectors:

- Feed-in cable
  For connecting the 1st servo drive of a line to the connection point on the DAM 510.
  - Input end: Pigtailed with individual connectors for connection to the corresponding terminals on the DAM 510.
  - Output end: M23 connector (for connection to the 1st servo drive on the line).
- Loop cable
  For connecting the servo drives in daisy-chain format in an application.

Both these cables are provided by Danfoss and are available in various lengths. See 8.9.1 Hybrid Cable for further information.

5.5.1 Maximum Cable Lengths

The maximum cable lengths are defined in Table 41.

Table 41: Maximum Cable Lengths

Cable	Unit	Maximum length
Feed-in cable (M23)	ISD 510, DSD 510	40 m (shielded)(1)
Loop cable (M23)	ISD 510, DSD 510	25 m (shielded)(1)
Motor cable	DSD 510	5 m
	SDM 511/SDM 512	Maximum length without additional output filter or choke: 30 m Maximum length with additional output filter or choke: 80 m
Motor feedback cable	SDM 511/SDM 512	80 m
	DSD 510	5 m
Brake chopper cable	PSM 510	30 m
Fieldbus extension cable	ISD 510/DSD 510	2 m(2)
I/O cable	ISD 510/DSD 510	5 m

Cable	Unit	Maximum length
	PSM 510, DAM 510, ACM 510, SDM 511/SDM 512	30 m
24/48 V IN connector cable	PSM 510	3 m
Mechanical brake and thermistor cable	SDM 511/SDM 512	80 m
LCP cable	All	2 m
Expansion module cable	EXM 510	5 m

[1] Maximum total length for each line: 100 m.

[2] Maximum length to next port: 100 m.

5.6 Peripheral Components

5.6.1 Auxiliary Supply

Supply the Power Supply Module (PSM 510) with a supply unit with an output range of 24–48 V DC ±10%. The output ripple of the supply unit must be <250 mVpp.

NOTICE

- Only use supply units that conform to the PELV specification.
- 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 secondary circuit must be supplied from an external isolated source.

The 24/48 V DC external supply for auxiliary voltage must be dedicated to the servo system, meaning that the supply is used exclusively for powering the PSM 510. The maximum cable length between the supply unit and the PSM 510 is 3 m.

5.6.2 Sensors

Table 42: Sensors

Digital input	Input range nominal	0–24 V
	Input range absolute maximum rating	-5–30 V
	Switching threshold high	10 V
	Switching threshold low	5 V
	Delay including ADC conversion: Rising edge 0–24 V Falling edge 24–0 V	 <8 µs <12 µs
	Input impedance 0–10.5 V	5.46 kΩ ±1%
	Input impedance 10.5–24 V	4.8–5.46 kΩ
	Sample rate for each channel	195 kHz ±1%
Analog input	Input range nominal	0–10 V
	Input range absolute maximum rating	-5–30 V
	Input impedance 0–10 V	5.46 kΩ ±1%
	ADC Resolution	12-bit

	ADC Accuracy	±250 mV
	Sample rate for each channel	8 kHz
Digital output	Switchable output voltage, controlled over fieldbus	0 V ±10% 24 V ±10%
	Maximum output current[1]	150 mA
	Maximum switching period	100 Hz
	Maximum switching delay (without load)	100 µs

[1] For SDM 511/SDM 512: Maximum output current for all 4 digital outputs together. If all 4 digital outputs are used, the maximum output current of each is 30 mA.

5.6.3 Safety Supply

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

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

Use a 24 V supply unit that is CE marked for industrial use. Ensure that the supply fulfills the PELV specification and is only used for the system safety input.

A common supply for auxiliary and safety supply can be used, provided the only connection point of the 2 circuits is near to the supply. This is intended to avoid interference due to a common voltage drop. The maximum cable length between the 24 V supply unit and the servo system is 3 m.

The safety supply can be looped from PSM 510 to the other system components except for ACM 510. The cable for this is not provided.

N O T I C E

– Ensure reinforced isolation between safety signals and other signals, supplies (mains supply), and exposed conductive parts.

6 Typecode and Selection

6.1 Drive Configurator

The Danfoss Drive Configurator (vltconfig.danfoss.com) is an advanced but easy-to-use tool to configure the drives that exactly match the requirements of the application.

NOTICE

- The Drive Configurator shows the valid configuration of servo drive variants. Only valid combinations are shown. Therefore, not all variants detailed in the type code are visible.

The Drive Configurator generates a unique code number for the drive required, preventing errors during order entry.

Decoding is also available: Enter a typecode and the Drive Configurator decodes the configuration and shows the configuration of the drive.

6.2 ISD 510 Servo Drive Types

NOTICE

- The Drive Configurator shows the valid configuration of servo drive variants. Only valid combinations are shown. Therefore, not all variants detailed in the type code are visible.

Table 43: Type Code ISD 510

1–3	4–6	7	8	9–12	13–14	15–17	18–20	21–22	23–25	26	27–30	31–32	33–35	36	37	38	39–40
ISD	510		T		D6					T		SX					

Table 44: Legend to Type Code

[01–03]	**Product group**	**[18–20]**	**Drive feedback**	**[33–35]**	**Motor speed**
ISD	VLTÆ Integrated Servo Drive	FRX	Resolver	N46	Rated speed 4600 RPM
[04–06]	**Product variant**	FS1	Single-turn feedback 17 bit	N40	Rated speed 4000 RPM
510	ISDÆ 510	FM1	Multi-turn feedback 17 bit	N30	Rated speed 3000 RPM
[07]	**Hardware configuration**	**[21–22]**	**Bus system**	N29	Rated speed 2900 RPM
A	Advanced	PL	Ethernet POWERLINKÆ	N24	Rated speed 2400 RPM
S	Standard	EC	EtherCATÆ	N20	Rated speed 2000 RPM
[08]	**Drive torque**	PN	PROFINETÆ	**[36]**	**Mechanical brake**
T	Torque	**[23–25]**	**Firmware**	X	Without brake
[09–12]	**Torque**	SXX	Standard	B	With brake
01C5	1.5 Nm	SC0	Customized	**[37]**	**Motor shaft**
02C1	2.1 Nm	**[26]**	**Safety**	S	Standard smooth shaft
02C9	2.9 Nm	T	Safe Torque Off (STO)	K	Standard fitted key
03C8	3.8 Nm	**[27–30]**	**Flange size**	**[38]**	**Motor sealing**
05C2	5.2 Nm	F076	76 mm	X	Without sealing
06C0	6.0 Nm	F084	84 mm	S	With sealing

11C2	11.2 Nm
[13–14]	**DC voltage**
D6	600 V DC-link voltage
[15–17]	**Drive enclosure**
E54	IP54
E67	IP67 (shaft IP65)

F108	108 mm
F138	138 mm
[31–32]	**Flange type**
SX	Standard
C0	Customized

[39–40]	**Surface coating**
SX	Standard
CX	Customized

6.3 DSD 510 Servo Drive Types

NOTICE

- The Drive Configurator shows the valid configuration of servo drive variants. Only valid combinations are shown. Therefore, not all variants detailed in the type code are visible.

Table 45: Type Code DSD 510

1–3	4–6	7	8–12	13–14	15–17	18–20	21–22	23–25	26	27–28	29–30	31–38	39–40
DSD	510		C08A0	D6	E67			SXX	T	F2		XXXXXXXX	

Table 46: Legend to Type Code

[01–03]	**Product group**
DSD	VLTÆ Decentral Servo Drive
[04–06]	**Product variant**
510	DSD 510
[07]	**Hardware configuration**
A	Advanced
S	Standard
[08–12]	**Current rating**
C08A0	8.0 A_{rms}
[13–14]	**DC voltage**
D6	600 V DC-link voltage
[15–17]	**Protection rating**
E67	IP67
[18–20]	**Drive feedback**
FXX	Without feedback/Sensorless()
FRX	Resolver
FS1	BiSS single-turn feedback 17 bit
FM1	BiSS multi-turn feedback 17 bit

[18–20] (continued)	**Drive feedback (continued)**
FHD	HIPERFACE® DSL(1)
[21–22]	**Bus system**
PL	Ethernet POWERLINKÆ
EC	EtherCATÆ
PN	PROFINETÆ
[23–25]	**Firmware**
SXX	Standard
[26]	**Safety**
T	Safe Torque Off (STO)
[27–28]	**Enclosure size**
F2	(F2) Enclosure size 2
[29–30]	**Motor connection**
S1	(S1) Single-plug version motor side
S2	(S2) Dual-plug version motor side
[31–38]	**Reserved**
–	Reserved
[39–40]	**Surface coating**

FE1	EnDat 2.1	SX	Standard
FE2	EnDat 2.2	CX	Customized
FHF	HIPERFACE®		

[1] In preparation

6.4 SDM 511/SDM 512 Types

NOTICE

- The Drive Configurator shows the valid configuration of servo drive variants. Only valid combinations are shown. Therefore, not all variants detailed in the type code are visible.

Table 47: Type Code MSD 510

1–6	7–12	13–14	15–16	17–21	22–23	24–26	27–29	30–31	32–34	35	36–40
MSD510					D6	E20				T	XXXXX

Table 48: Legend to Type Code

[01–06]	**Product group**	**[22–23]**	**DC voltage**	**[32–34]**	**Firmware**
MSD510	VLTÆ Multiaxis Servo Drive	D6	600 V DC-link voltage	SXX	Standard
[07–12]	**Product variant**	**[24–26]**	**Drive enclosure**	SC0	Customized
SDM511	MSD 510 Servo Drive Module 511	E20	IP20[1]	**[35]**	**Safety**
SDM512	MSD 510 Servo Drive Module 512	**[27–29]**	**Bus system**	T	Safe torque off (STO)
[13–14]	**Drive variant**	FXX	Without feedback	**[36–40]**	**Reserved**
SA	Single-axis servo drive	FRX	Resolver	XXXXX	Reserved
DA	Double-axis servo drive	FS1	BiSS ST feedback, 17 bit		
[15–16]	**Enclosure (frame) size**	FM1	BiSS MT feedback, 17 bit		
F1	Enclosure (frame) size 1, 50 mm	FE1	EnDat 2.1		
F2	Enclosure (frame) size 2, 100 mm	FE2	EnDat 2.2		
[17–21]	**Current rating**	FHF	HIPERFACE®		
C02A5	2.5 A_{rms}	FHD	HIPERFACE® DSL		
C005A	5 A_{rms}	**[30–31]**	**Bus system**		
C010A	10 A_{rms}	PL	POWERLINK		
C020A	20 A_{rms}	EC	EtherCAT		
C040A	40 A_{rms}	PN	PROFINET		

[1] IP20 according to IEC/EN 60529 (except connectors, which are IP00)

6.5 Power Supply Module (PSM 510)

Table 49: Ordering Numbers According to Fieldbus Type

Fieldbus type	PSM 510 10 kW	PSM 510 20 kW	PSM 510 30 kW
PROFINETÆ	175G0162	175G0165	175G0168
POWERLINKÆ	175G0160	175G0163	175G0166
EtherCATÆ	175G0161	175G0164	175G0167

6.6 Decentral Access Module (DAM 510)

Table 50: Ordering Numbers According to Fieldbus Type

Fieldbus type	DAM 510 15 A	DAM 510 25 A
PROFINETÆ	175G0171	175G0174
POWERLINKÆ	175G0169	175G0172
EtherCATÆ	175G0170	175G0173

6.7 Auxiliary Capacitor Module (ACM 510)

Table 51: Ordering Numbers According to Fieldbus Type

Fieldbus type	ACM 510
PROFINETÆ	175G0177
POWERLINKÆ	175G0175
EtherCATÆ	175G0176

6.8 Expansion Module (EXM 510)

The ordering number for the EXM 510 (2 pieces) is 175G0194.

7 Options and Accessories

7.1 Options for ISD 510 Servo Drives

7.1.1 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
- Size 3: 14.5 Nm
- Size 4: 25 Nm

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

Electrical data: Power consumption:

- Size 1: 3.3 W
- Size 2: 4.3 W
- Size 3: 6.5 W
- Size 4: 8.6 W

N O T I C E

- Do not misuse the holding brake as a working brake because this causes increased wear, resulting in premature failure.
- Using servo drives with brakes can reduce the number of drives allowed, depending on the total length of each hybrid line.

7.1.2 Built-in Feedback Devices

The built-in feedback device measures the rotor position. There are 3 feedback variants available:

- Resolver
- BiSS-B 17-bit single-turn encoder
- BiSS-B 17-bit multi-turn encoder

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

7.1.3 Customized Flange

A customized flange is available on request. Contact Danfoss for further information.

7.2 Accessories

7.2.1 Hybrid Feed-In Cable

Table 52: Feed-In Cable Ordering Numbers

Description	Length [m]	Ordering number
Hybrid feed-in cable M23, 90° angled connector	2	175G8920
	4	175G8921
	6	175G8922
	8	175G8923
	10	175G8924
	15	175G8925
	20	175G8926
	25	175G8927
	30	175G8928
	40	175G8929
Hybrid feed-in cable M23, straight connector	2	175G8930
	4	175G8931
	6	175G8932
	8	175G8933
	10	175G8934
	15	175G8935
	20	175G8936
	25	175G8937
	30	175G8938
	40	175G8939

N O T I C E

- Contact Danfoss for feed-in cables for use with the 25 A variant of DAM 510.

7.2.2 Hybrid Loop Cable

Table 53: Loop Cable Ordering Numbers

Description	Length [m]	Ordering number
Hybrid loop cable M23, 90° angled connector	0.5	175G8900
	1	175G8901
	2	175G8902

Description	Length [m]	Ordering number
	4	175G8903
	6	175G8904
	8	175G8905
	10	175G8906
	15	175G8907
	20	175G8908
	25	175G8909
Hybrid loop cable M23, straight connector	0.5	175G8910
	1	175G8911
	2	175G8912
	4	175G8913
	6	175G8914
	8	175G8915
	10	175G8916
	15	175G8917
	20	175G8918
	25	175G8919

NOTICE

- Contact Danfoss for feed-in cables for use with the 25 A variant of DAM 510.

7.2.3 Fieldbus Cables

Table 54: Fieldbus Cable Ordering Numbers

Description	Length [m]	Ordering number
Fieldbus extension cable, M23 angled to M12 straight	2	175G8940
Fieldbus extension cable, M23 straight to M12 straight	2	175G8941

The M8 Ethernet cable for the 3rd Ethernet port (X3) is not supplied by Danfoss.

7.2.4 LCP Cable

Table 55: Fieldbus Cable Ordering Number

Description	Length [m]	Ordering number
LCP Cable (SUB-D to M8)	3	175G8942

7.2.5 LCP Mounting Kit

Table 56: LCP Mounting Kit Ordering Numbers

Description	Ordering number
LCP remote mounting kit (IP21) including LCP, fasteners, 3 m cable, and gasket.	130B1170
LCP remote mounting kit (IP21) without LCP, but including fasteners, 3 m cable, and gasket.	130B1117

7.2.6 Blind Caps

Table 57: Blind Caps Ordering Numbers

Description	Ordering number
Blind cap for M23 connector, IP67	175G8805
Blind cap for M23 connector, IP40	175G8941
Blind cap for M12 connector	175G7162
Blind cap for M8 connector	175G8785

7.2.7 Sensor Cable

Other than the LCP cable (see 7.2.4 LCP Cable), the cables for the sensor interface (X4) on the ISD 510 and DSD 510 servo drives are not supplied by Danfoss.

7.2.8 AC Line Choke

It is mandatory to use a 3-phase AC line choke.

Table 58: Line Choke Characteristics for 1 PSM 510

Model	Minimum I_{rms} [A]	U_{rms} [V]	Inductance [mH]
PSM 510 (10 kW)	20	500	Minimum: 0.47 Maximum: 1.47
PSM 510 (20 kW)	40	500	Minimum: 0.47 Maximum: 1.47
PSM 510 (30 kW)	60	500	0.47 ±10%

If 2 PSM 510 modules are installed in parallel, use an AC choke as specified in Table 59.

Table 59: Line Choke Characteristics for 2 PSM 510 installed in parallel

Model	Minimum I_{rms} [A]	U_{rms} [V]	Inductance [mH]
PSM 510 (2 x 30 kW)	125	500	0.24 ±10%

Danfoss recommends mounting the AC line choke close to the PSM 510.
The maximum cable length depends on the cross-section, and the required voltage and current at the DC-link.
If the AC line chokes are mounted away from the PSM 510, the maximum cable distance is 5 m.

7.2.8.1 Ordering Numbers for AC Line Choke

Table 60: AC Line Choke Ordering Numbers

Model	Ordering number
3-phase line reactor 20 A for PSM 510 (10 kW)	175G0179
3-phase line reactor 40 A for PSM 510 (20 kW)	175G0192
3-phase line reactor 63 A for PSM 510 (30 kW)	175G0178
3-phase line reactor 125 A for PSM 510 (2 x 30 kW)	175G0299

7.3 Spare Parts

Table 61: Spare Parts Ordering Numbers

Description	Ordering number
The ISD 510 servo drives can be sealed by a shaft seal (optional) to achieve up to IP65 on the A-side of the motor.	
Shaft seal for size 1 ISD 510 servo drive (10 pieces)	175G8192
Shaft seal for size 2 ISD 510 servo drive (10 pieces)	175G8191
Shaft seal for size 3 ISD 510 servo drive (10 pieces)	175G8896
Shaft seal for size 4 ISD 510 servo drive (10 pieces)	175G8897
Fan assembly 12 VDC 40x40x28 for 50 mm modules (SDM 511/SDM 512)	141F8222
Fan assembly 12 VDC 80x80x38 for 100 mm modules (SDM 511 and PSM 150)	141F8223
Fuse 25 A, 800 VDC, 14x51mm for DAM 510	141F8224
Ethernet loop cable 300 mm for MSD 510 system modules	141F8225
I/O and power connectors kit for MSD 510 system modules	141F8227
EMC mounting plate including connectors for DAM 510	141F8229
EMC mounting plate including connectors for SDM 511/SDM 512	141F8230
Backplate assembly for 50 mm modules (SDM 511/SDM 512, DAM 510, and ACM 510)	141F8232
Backplate assembly for 100 mm modules (SDM 511 and PSM 510)	141F8231

8 Specifications

8.1 Dimensions

8.1.1 Dimensions of ISD 510 Servo Drive

All dimensions are in mm [in].

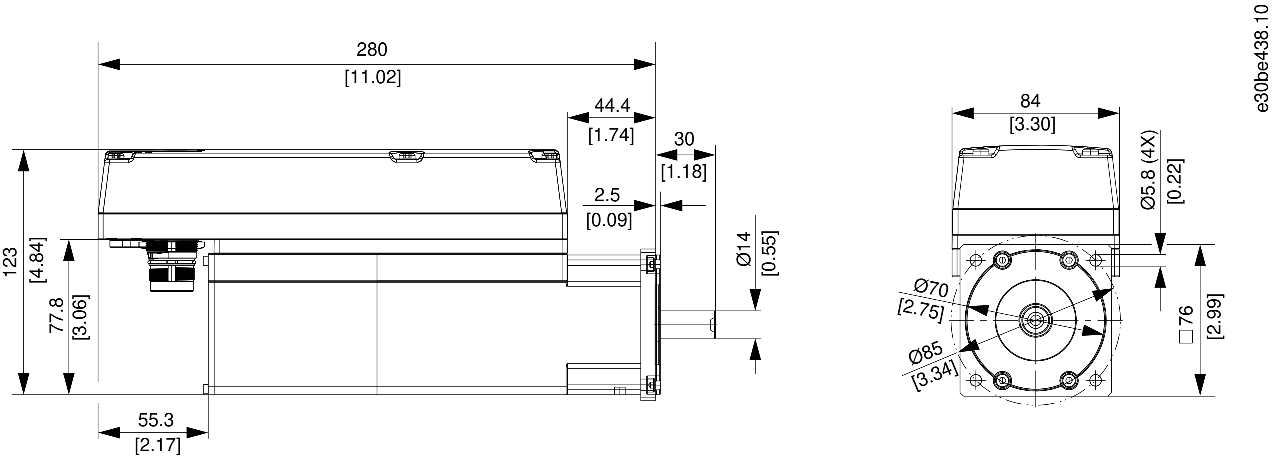

Illustration 52: Dimensions of ISD 510 Size 1, 1.5 Nm

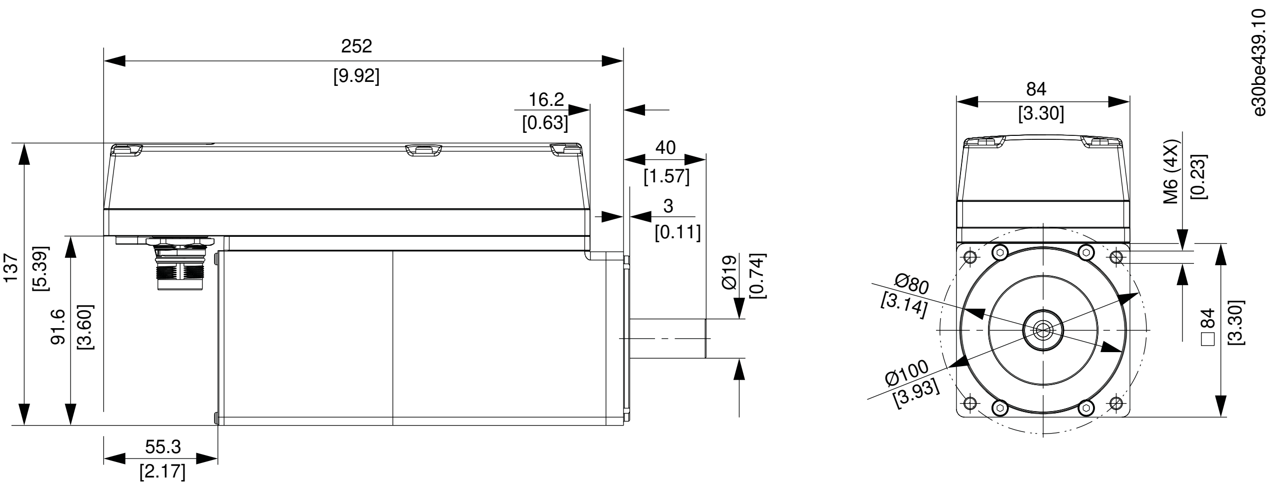

Illustration 53: Dimensions of ISD 510 Size 2, 2.1 Nm

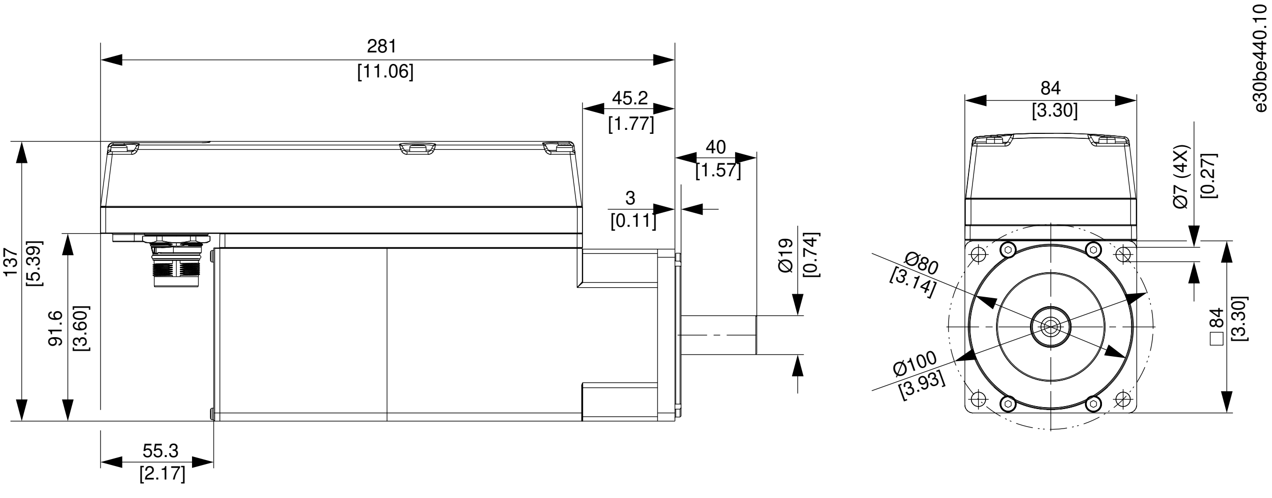

Illustration 54: Dimensions of ISD 510 Size 2, 2.9 Nm

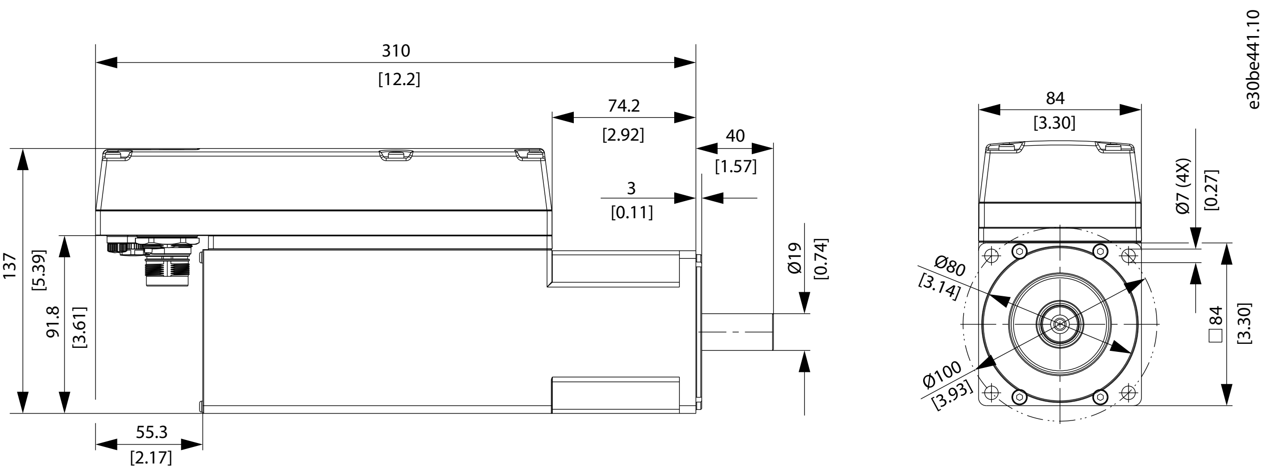

Illustration 55: Dimensions of ISD 510 Size 2, 3.8 Nm

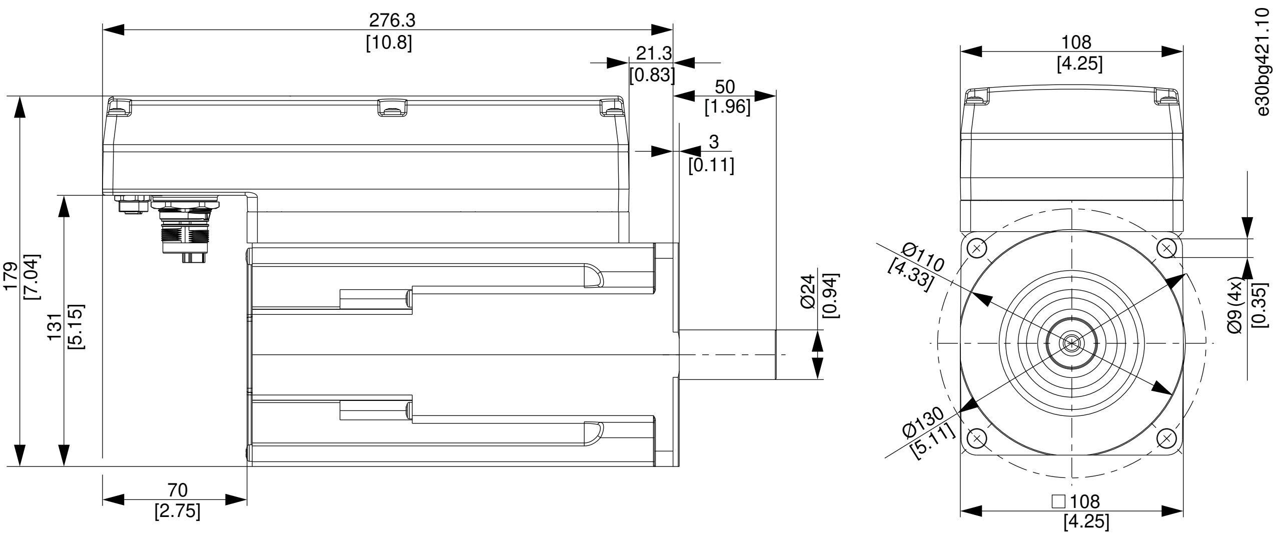

Illustration 56: Dimensions of ISD 510 Size 3, 5.2 Nm

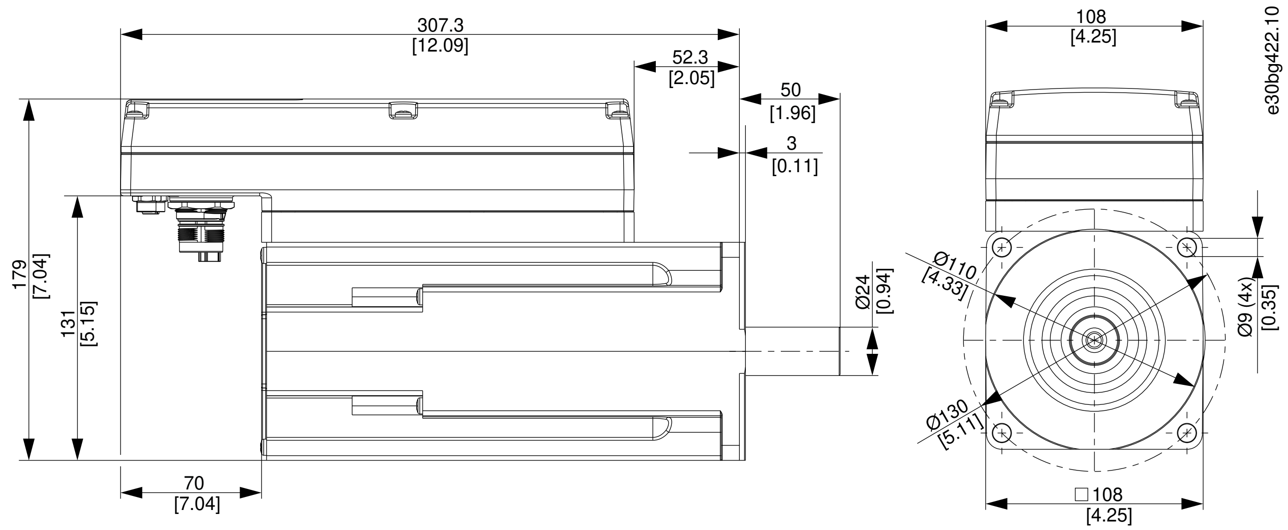

Illustration 57: Dimensions of ISD 510 Size 3, 6.0 Nm

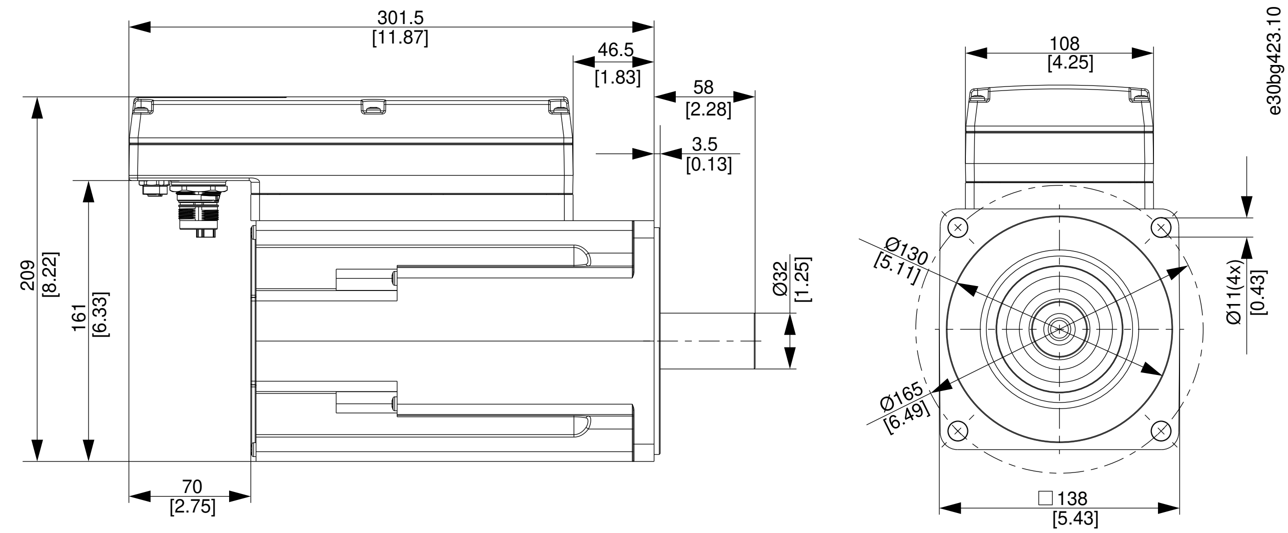

Illustration 58: Dimensions of ISD 510 Size 4, 11.2 Nm

8.1.2 ISD 510 Servo Drive Flange Dimensions

Size	Flange thickness [mm]
Size 1, 1.5 Nm	7
Size 2, 2.1 Nm	–
Size 2, 2.9 Nm	8
Size 2, 3.8 Nm	8
Size 3, 5.2 Nm	10.8
Size 3, 6.0 Nm	10.8
Size 4, 11.2 Nm	13.8

8.1.3 Dimensions of DSD 510 Servo Drive

All dimensions are in mm [in].

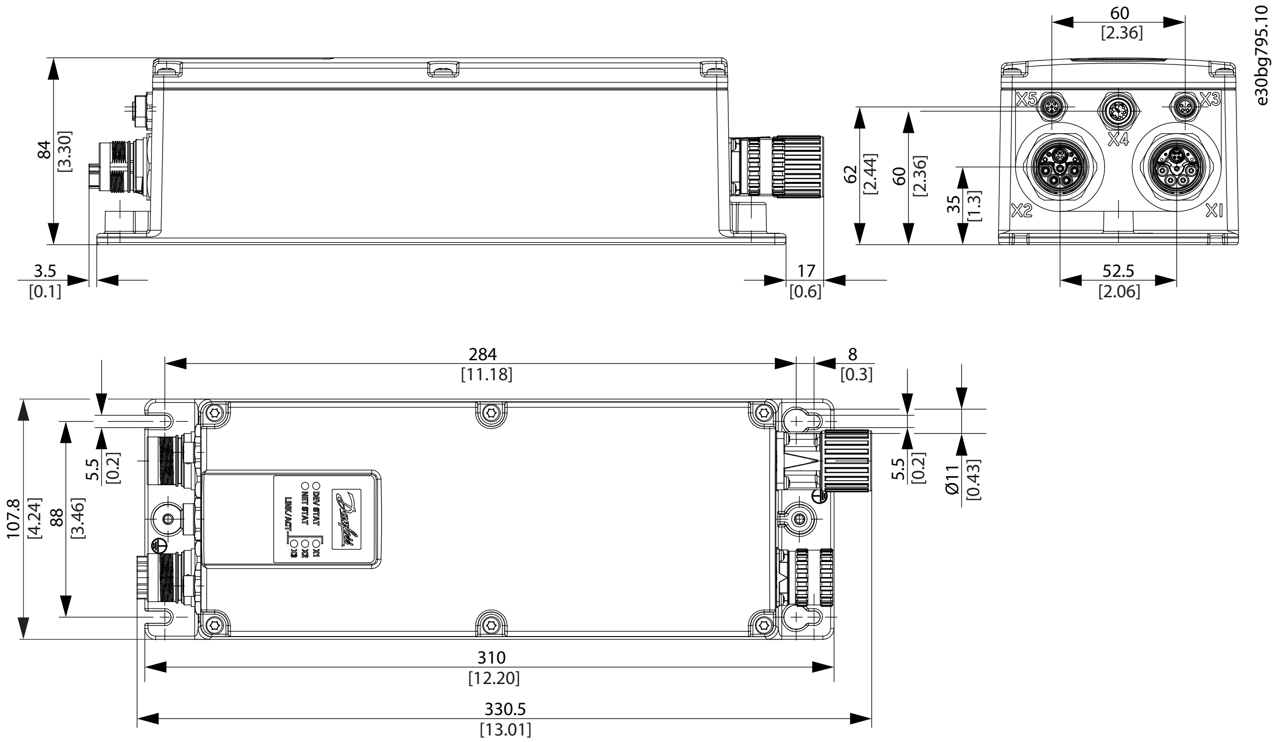

Illustration 59: Dimensions of DSD 510 Servo Drive

8.1.4 Dimensions of SDM 511/SDM 512

All dimensions are in mm [in].

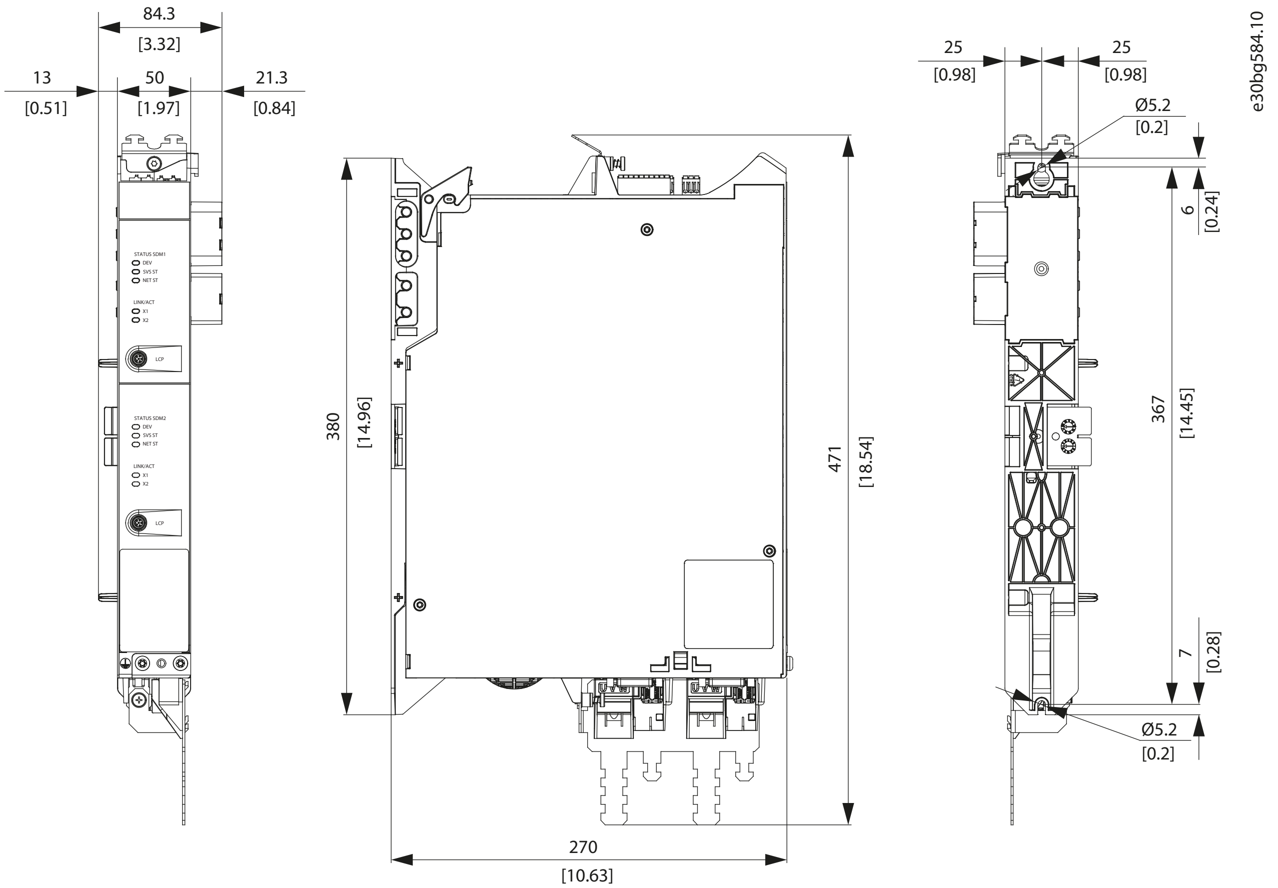

Illustration 60: Dimensions of SDM 511/SDM 512, Enclosure Size 1 (FS1)

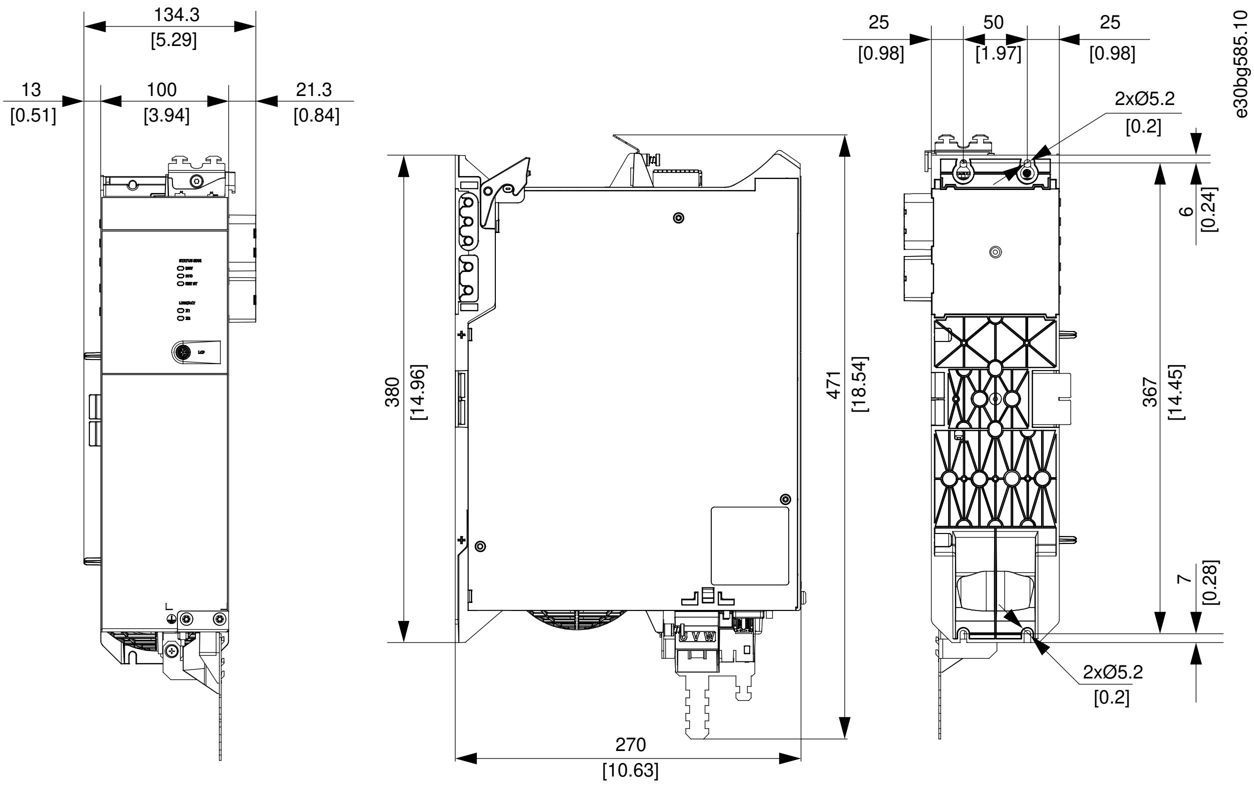

Illustration 61: Dimensions of SDM 511, Enclosure Size 2 (FS2)

8.1.5 Dimensions of Power Supply Module (PSM 510)

All dimensions are in mm [in].

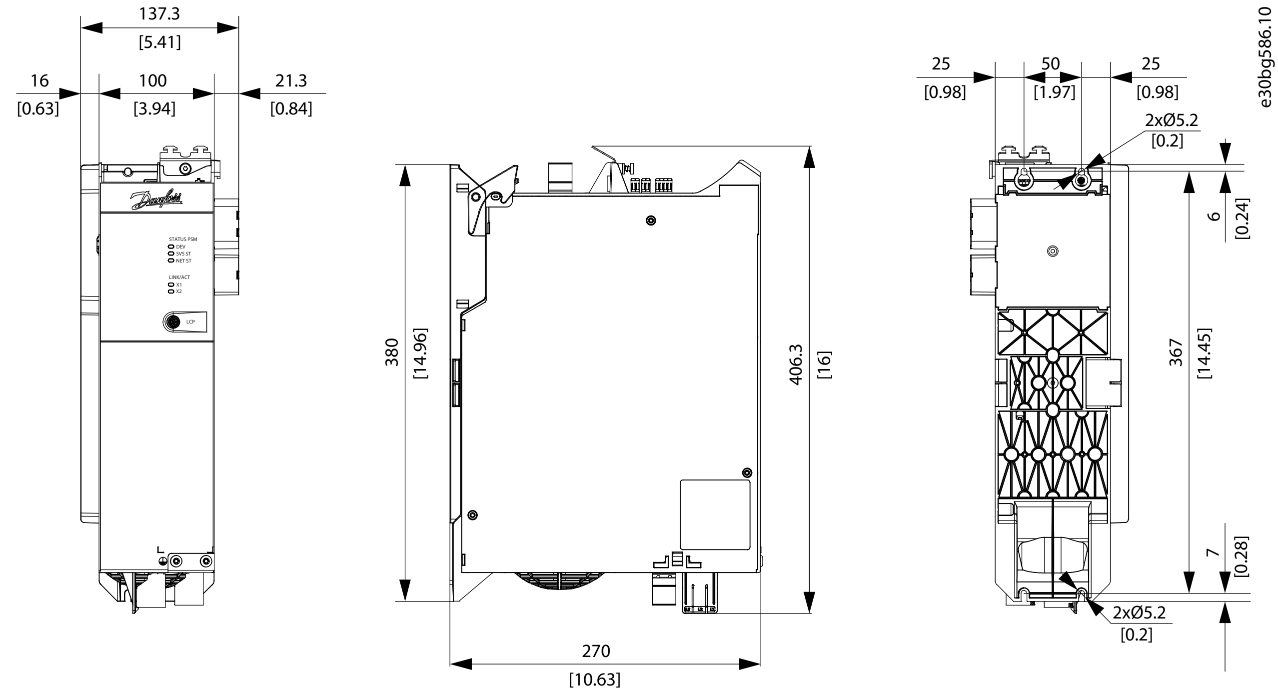

Illustration 62: Dimensions of PSM 510

8.1.6 Dimensions of Decentral Access Module (DAM 510)

All dimensions are in mm [in].

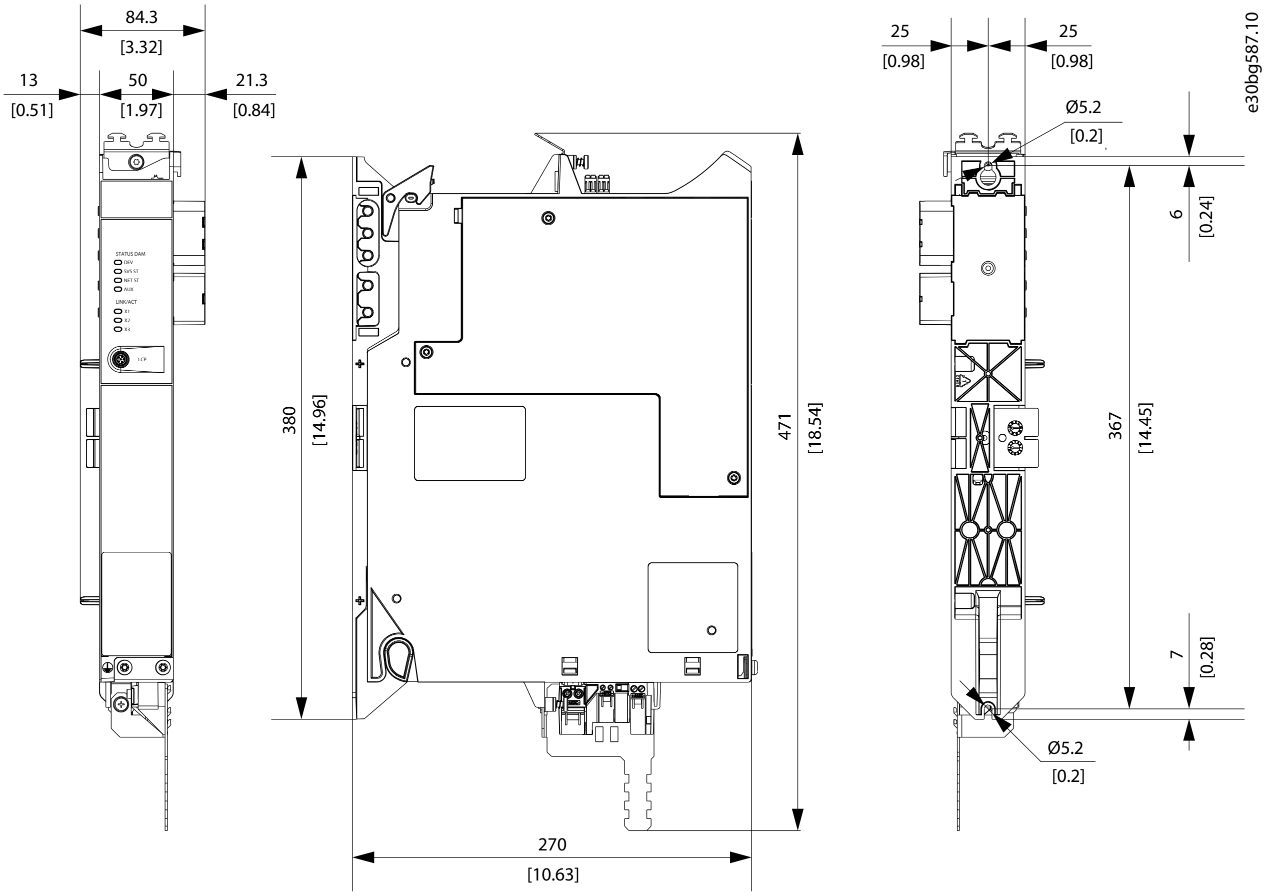

Illustration 63: Dimensions of DAM 510

8.1.7 Dimensions of Auxiliary Capacitors Module (ACM 510)

All dimensions are in mm [in].

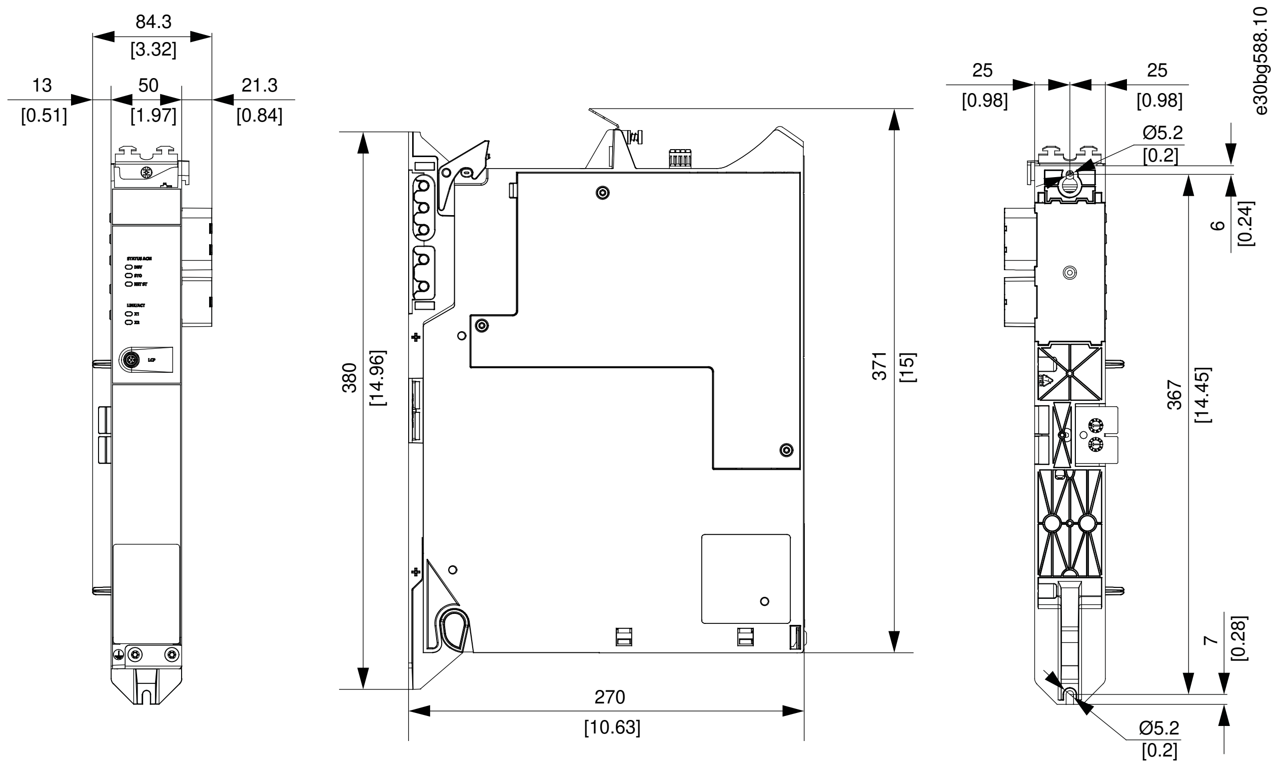

Illustration 64: Dimensions of ACM 510

8.1.8 Dimensions of Expansion Module (EXM 510)

All dimensions are in mm [in].

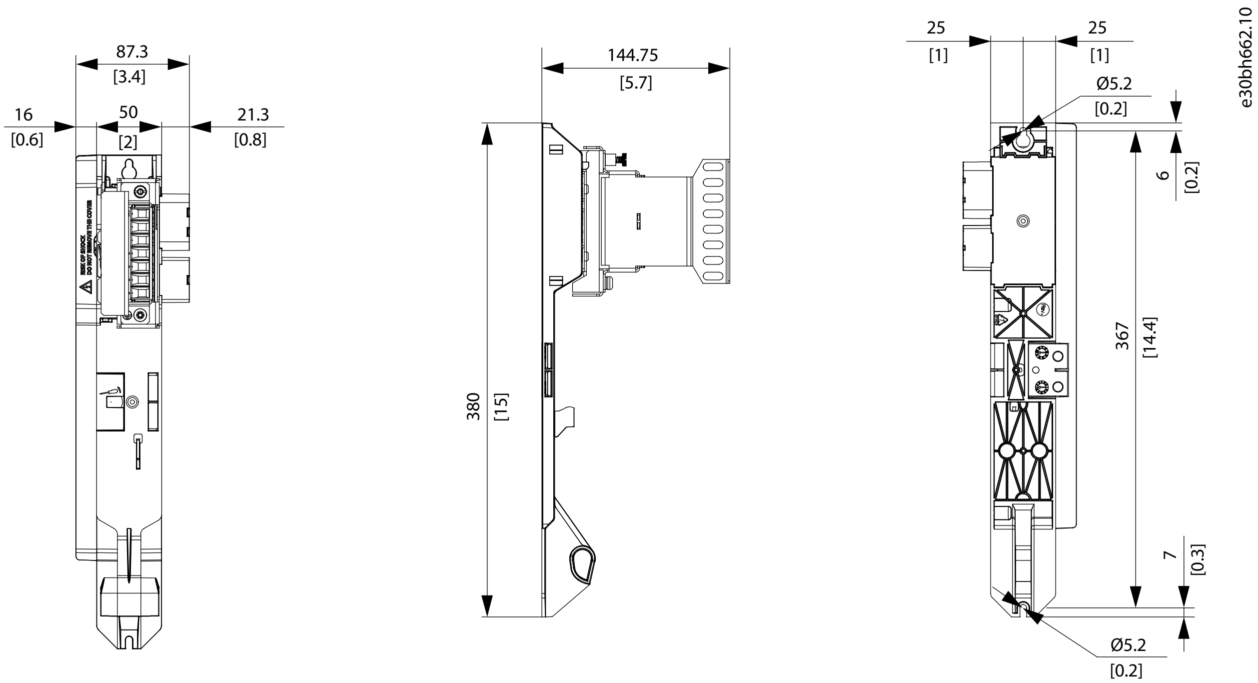

Illustration 65: Dimensions of EXM 510

8.2 Characteristic Data

8.2.1 Characteristic Data for ISD 510 Servo Drive without Brake

Table 62: Characteristic Data for ISD 510 Servo Drive without Brake (at 40 °C ambient temperature)

Specifications	Unit	Size 1, 1.5 Nm	Size 2, 2.1 Nm	Size 2, 2.9 Nm	Size 2, 3.8 Nm	Size 3, 5.2 Nm	Size 3, 6.0 Nm	Size 4, 11.2 Nm
Rated speed n_N	RPM	4600	4000	2900	2400	3000	3000	2000
Rated torque M_N	Nm	1.5	2.1	2.9	3.8	5.2	6.0	11.2
Rated current I_N	A DC	1.4	1.7		1.8	3.6	3.4	4.7
Rated power P_N	kW [hp]	0.72 [0.98]	0.88 [1.20]		0.94 [1.28]	1.6 [2.18]	1.9 [2.58]	2.3 [3.13]
Standstill (stall) torque M_0	Nm	2.3	2.8	3.6	4.6	6.6	8.6	13.3
Standstill (stall) current I_0	A DC	2.1	2.3	2.1	2.2	4.6	4.9	5.6
Peak torque M_{max}	Nm	6.1	7.8	10.7	12.7	21.6	29.9	38.6
Peak current (rms value) I_{max}	A DC	5.7	6.4			17.7	19.8	21.2
Rated voltage	V DC	565–680 ±10%						
Inductance L ph-ph	mH	18.5	26.8	32.6	33.9	11.9	11.4	18.0
Resistance R ph-ph	Ω	9.01	7.78	8.61	8.64	2.35	2.10	2.26
Voltage constant EMK	V/krpm	70.6	80.9	111.0	132.0	92.7	112.0	158.8
Torque constant K_t	Nm/A	1.10	1.26	1.72	2.04	1.22	1.51	1.82
Inertia	Kgm^2	0.000085	0.00015	0.00021	0.00027	0.00062	0.00091	0.0024
Protective measures	–	Overload, short circuit, and ground fault protection.						
Maximum output frequency	Hz	590						
Shaft diameter	mm [inch]	14 [0.55]	19 [0.75]			24 [0.94]		32 [1.26]
Pole pairs	–	4	5					
Flange size	mm [inch]	76 [2.99]	84 [3.31]			108 [4.25]		138 [5.43]
Functional safety	–	STO						

Specifications	Unit	Size 1, 1.5 Nm	Size 2, 2.1 Nm	Size 2, 2.9 Nm	Size 2, 3.8 Nm	Size 3, 5.2 Nm	Size 3, 6.0 Nm	Size 4, 11.2 Nm
Cooling	–	Via flange						
Mounting	–	Via flange						
Weight	kg [lbs]	3.5 [7.7]	4.0 [8.8]	5.0 [11.0]	6.0 [13.2]	8.3 [18.3]	10.0 [22.0]	13.8 [30.4]

8.2.2 Characteristic Data for ISD 510 Servo Drive with Brake

Table 63: Characteristic Data for Servo Drive with Brake

Specifications	Unit	Size 1, 1.5 Nm	Size 2, 2.1 Nm	Size 2, 2.9 Nm	Size 2, 3.8 Nm	Size 3, 5.2 Nm	Size 3, 6.0 Nm	Size 4, 11.2 Nm
Brake inertia	Kgm^2	0.0000012	0.0000068			0.000021		0.000072
Brake weight	kg [lbs]	0.34 [0.75]	0.63 [1.39]			1.1 [2.42]		2.0 [4.41]

8.2.3 Characteristic Data for DSD 510 Servo Drive

Table 64: Characteristic Data for DSD 510

Specifications	Unit	DSD 510
Input		
DC-link	V DC	565–680 ±10%
DC-link capacitance	μF	10
U_{AUX}	V DC	24/48 ±10%
U_{AUX} current consumption (at 24 V DC)	A DC	1
U_{AUX} current consumption (at 48 V DC)	A DC	0.5
Output		
Output number of phases	–	3
Output voltage	V AC	V_{IN} PSM
Rated current I_N	A DC	8.0 standalone
Rated power P_N	kW [hp]	4.4 [5.9] with mounting plate
Peak current (rms value) I_{max}	A rms	16.0
Nominal switching frequency	kHz	4/5
Possible switching frequency	kHz	8/10
Protective measures	–	Overload, short-circuit, and ground fault protection.
Maximum output frequency	Hz	590
Functional safety	–	STO
Cooling	–	Via mounting surface
Mounting	–	Screw-mounted via base

Specifications	Unit	DSD 510
Number of motor connectors	–	1
Weight	kg [lbs]	2.85 [6.28]
Dimensions (W x H x D)	mm	107.8 x 330.5 x 84

8.2.4 Characteristic Data for SDM 511

Table 65: Characteristic Data for SDM 511

Specifications	Unit	Enclosure size 1 (FS1), 2.5 A	Enclosure size 1 (FS1), 5 A	Enclosure size 1 (FS1), 10 A	Enclosure size 1 (FS1), 20 A	Enclosure size 2 (FS2), 40 A
Input						
DC-link	V DC	565–680 ±10%				
DC-link capacitance	µF	330				900
U_{AUX}	V DC	24/48 ±10%				
U_{AUX} current consumption (at 24 V DC)	A DC	1.8				2.5
U_{AUX} current consumption (at 48 V DC)	A DC	0.9				1.3
Output						
Output number of phases	–	3				
Output voltage	V AC	V_{IN} PSM				
Rated current I_N	A_{rms}	2.5	5	10	20	40
Rated power P_N	kW	0.5	2.2	4	11	22
Peak current (rms value) I_{max} t <2.65 s	A_{rms}	10	20	30	40	80
Nominal switching frequency	kHz	4/5				
Possible switching frequency	kHz	8/10				
Derating of nominal and peak current with 8 kHz/ 10 kHz switching frequency	%	See 4.11.5.2.1 Overcurrent Protection for Servo Drive Modules SDM 511/SDM 512 and Decentral Servo Drive DSD 510.				
Protective measures	–	Overload, short-circuit, and ground fault protection				
Maximum output frequency	Hz	590				
Functional safety	–	STO				
Cooling	–	Integrated fan				

Specifications	Unit	Enclosure size 1 (FS1), 2.5 A	Enclosure size 1 (FS1), 5 A	Enclosure size 1 (FS1), 10 A	Enclosure size 1 (FS1), 20 A	Enclosure size 2 (FS2), 40 A
Mounting	–	Wall-mounted on backplate using backlink connector				
Number of motor connectors	–	1				
Weight	kg	3.9				6.2
Dimensions (W x H x D)	mm	84.3 x 471 x 270				134.3 x 471 x 270

8.2.5 Characteristic Data for SDM 512

Table 66: Characteristic Data for SDM 512

Specifications	Unit	Enclosure size 1 (FS1), 2 x 2.5 A	Enclosure size 1 (FS1), 2 x 5 A	Enclosure size 1 (FS1), 2 x 10 A
Input				
DC-link	V DC	565–680 ±10%		
DC-link capacitance	μF	330		
U_{AUX}	V DC	24/48 ±10%		
U_{AUX} current consumption (at 24 V DC)	A DC	2.3		
U_{AUX} current consumption (at 48 V DC)	A DC	1.2		
Output				
Output number of phases	–	3		
Output voltage	V AC	V_{IN} PSM		
Rated current I_N	A_{rms}	2 x 2.5	2 x 5	2 x 10
Rated power P_N	kW	2 x 0.75	2 x 2.2	2 x 4
Peak current (rms value) I_{max} t <2.65 s	A_{rms}	2 x 10	2 x 15	2 x 20
Nominal switching frequency	kHz	4/5		
Possible switching frequency	kHz	8/10		
Derating of nominal and peak current with 8 kHz/10 kHz switching frequency	%	See 4.11.5.2.1 Overcurrent Protection for Servo Drive Modules SDM 511/SDM 512 and Decentral Servo Drive DSD 510.		
Protective measures	–	Overload, short-circuit, and ground fault protection		
Maximum output frequency	Hz	590		
Functional safety	–	STO		
Cooling	–	Integrated fan		
Mounting	–	Wall-mounted on backplate using backlink connector		

Specifications	Unit	Enclosure size 1 (FS1), 2 x 2.5 A	Enclosure size 1 (FS1), 2 x 5 A	Enclosure size 1 (FS1), 2 x 10 A
Number of motor connectors	–	2		
Weight	kg	4.0		
Dimensions (W x H x D)	mm	84.3 x 471 x 270		

8.2.6 Characteristic Data for Power Supply Module (PSM 510)

Table 67: Characteristic Data for PSM 510

Definition	Unit	Power size 1	Power size 2	Power size 3
Input				
Mains input voltage	V AC	400–480 ±10%, 3-phase		
Input current @ U_{MIN}	A	20	34	50
Input power	VA	12.5	22	32
U_{AUX} input voltage	V DC	24/48 ±10%		
U_{AUX} current consumption at 24 V DC	A DC	2.0		
U_{AUX} current consumption at 48 V DC	A DC	1.0		
Output				
DC-link voltage	V DC	565–680 ±10%		
DC-link capacitance	µF	1800		
Rated current I_N	A	20	40	60
Rated power P_N	kW	10	20	30
Peak power P_{max} t <3.0 s)	kW	20	40	60
Internal brake resistor(1)				
Peak power P_{max}	kW	8		
Rated power P_N	W	150		
Nominal resistance	Ω	15		
External brake resistor				
Peak power P_{max}	kW	60		
Rated power P_N	kW	7.5		
Minimum resistance	Ω	10		
General				
Protective measures	–	Overload, short-circuit, and ground fault protection		
Line filter in accordance with EN 61800-3	–	Category C3		

Definition	Unit	Power size 1	Power size 2	Power size 3
Cooling	–	Integrated fan		
Mounting	–	Wall-mounted on backplate using backlink connector		
Weight	kg	6		
Dimensions (W x H x D)	mm	137.3 x 406.3 x 270		

[1] An external brake resistor can be connected.

8.2.7 Characteristic Data for Decentral Access Module (DAM 510)

Table 68: Characteristic Data for DAM 510

Definition	Unit	Power size 1	Power size 2
Input			
DC-link	V DC	565–680 ±10%	
DC-link capacitance	µF	660	
Maximum input current	A DC	15	25
U_{AUX}	V DC	24/48 ±10%	
U_{AUX} current consumption at 24 V DC	A DC	0.5	
U_{AUX} current consumption at 48 V DC	A DC	0.3	
Output			
Output voltage	V DC	V_{OUT} PSM	
Output current DC-link	A DC	15	25
Peak current DC-link (rms value) t <1.0 s	A_{rms}	30 for <1 s	48 for <1 s
Output current U_{AUX}	A DC	15	
General			
Protective measures	–	Overload, short-circuit, and ground fault protection	
Cooling	–	Natural convection	
Mounting	–	Wall-mounted on backplate using backlink connector	
Weight	kg	3.05	
Dimensions (W x H x D)	mm	84.3 x 471 x 270	

8.2.8 Characteristic Data for Auxiliary Capacitors Module (ACM 510)

Table 69: Characteristic Data for ACM 510

Definition	Unit	Value
DC-link	V DC	565–680 ±10%
DC-link capacitance	µF	2750

Definition	Unit	Value
U_{AUX}	V DC	24/48 ±10%
U_{AUX} current consumption at 24 V DC	A DC	0.5
U_{AUX} current consumption at 48 V DC	A DC	0.3
Cooling	–	Natural convection
Mounting	–	Wall-mounted on backplate using backlink connector
Weight	kg	3.54
Dimensions (W x H x D)	mm	84 x 371 x 270

8.2.9 Characteristic Data for Expansion Module (EXM 510)

Table 70: Expansion Module (EXM 510) Characteristic Data

Definition	Unit	Value
DC-link	V DC	565–680 ±10%
Maximum current	A DC	62
Mounting	–	Wall-mounted on backplate using backlink connector
Weight	kg	0.6
Dimensions (W x H x D)	mm	87 x 380 x 145

8.3 General Specifications and Environmental Data

8.3.1 ISD 510/DSD 510 Servo Drive

Table 71: General Specifications and Environmental Conditions for ISD 510/DSD 510

Specification	Value
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	Operating: 5–40 °C nominal, up to 55 °C with derating
	Transport: –25 to +70 °C
	Storage: –25 to +55 °C
Installation altitude	No limitation up to 1000 m above sea level. Maximum 2000 m above sea level with derating. 9% derating up to 2000 m with normal supply voltage, 3-phase AC 400 V.
EMC standard for emission and immunity	EN 61800-3
EMC immunity functional safety	EN 61800-5-2 Annex E

Specification	Value
Degree of pollution according to EN 60664-1	2
Overvoltage category according to EN/IEC 61800-5-1	III
Protection ratings (IP)	See 5.1.9.2 Protection Ratings for ISD 510 Servo Drive and 5.1.9.3 Protection Ratings for DSD 510 Servo Drive.

8.3.2 System Modules and SDM 511/SDM 512

Table 72: General Specifications and Environmental Conditions for System Modules

Specification	Value
Protection rating	IP20 according to IEC/EN 60529 (except connectors, which are IP00). **W A R N I N G** **RISK OF ELECTRICAL SHOCK** The IP20 rating of the SDM 511/SDM 512, PSM 510, DAM 510, ACM 510, and EXM 510 modules is not fulfilled if the modules are not connected to the backplate. This may result in death or serious injury. – Do not touch the backplate when a module is removed from the backplate.
Vibration test	Random vibration: 1.14 g (2h/axis according to EN 60068-2-64)
	Sinusoidal vibration: 1.0 g (2h/axis according to EN 60068-2-6)
Maximum relative humidity	Storage/transport: 5–95% (non-condensing)
	Stationary use: 5–93% (non-condensing)
Ambient temperature range	Operating: 5–40 °C nominal, up to 55 °C with derating (see Illustration 81)
	Transport: –25 to +55 °C
	Storage: –25 to +55 °C
Installation altitude	Nominal current up to 1000 m above sea level. Derating of output current (1% / 100 m) from 1000 m to 3000 m. Operation above 3000 m is not allowed.
EMC standard for emission and immunity	EN 61800-3
EMC immunity for functional safety	EN 61800-5-2 Annex E
Degree of pollution according to EN 60664-1	2
Overvoltage category according to EN/IEC 61800-5-1	III

8.4 Motor Output and Data

8.4.1 ISD 510

8.4.1.1 Overview

Table 73 shows the nominal load points for motor sizes 1 and 2. Table 74 shows the nominal load points for sizes 3 and 4. The DC-link voltage is 560 V and the ambient temperature is 40 °C.

Table 73: Drive Load Points with 560 V DC and 40 °C Ambient Temperature for ISD 510 Sizes 1 and 2

	Unit	Size 1, 1.5 Nm	Size 2, 2.1 Nm	Size 2, 2.9 Nm	Size 2, 3.8 Nm
$N_{mech\ max}$	RPM	6000	5400	4000	3200
n_N	RPM	4600	4000	2900	2400
M_N	Nm	1.5	2.1	2.9	3.8
I_{Nrms}	A	1.4	1.7	1.7	1.8
P_N	kW [hp]	0.72 [0.98]	0.88 [1.20]		0.94 [1.28]
M_0	Nm	2.3	2.8	3.6	4.6
I_{0rms}	A	2.1	2.3	2.1	2.2
M_{0max}	Nm	6.1	7.8	10.7	12.7
$I_{0max\ pk}$	A	8.0	9.0		
$I_{0max\ r\ ms}$	A	5.7	6.4		

Table 74: Drive Load Points with 560 V DC and 40 °C Ambient Temperature for ISD 510 Sizes 3 and 4

	Unit	Size 3, 5.2 Nm	Size 3, 6 Nm	Size 4, 11.2 Nm
$N_{mech\ max}$	[RPM]	5000	4000	2800
n_N	[RPM]	3000	3000	2000
M_N	[Nm]	5.2	6.0	11.2
I_{Nrms}	[A]	3.6	3.46	4.7
P_N	[kW]	1.6	1.9	2.3
M_0	[Nm]	6.6	8.5	13.3
I_{0rms}	[A]	4.6	4.9	5.6
M_{0max}	[Nm]	21.6	29.9	38.6
$I_{0max\ pk}$	[A]	25.0	28.0	30.0
$I_{0max\ r\ ms}$	[A]	17.7	19.8	21.2

8.4.1.2 Speed-Torque Characteristics: Size 1, 1.5 Nm, 8 kHz, at 25 °C Ambient Temperature

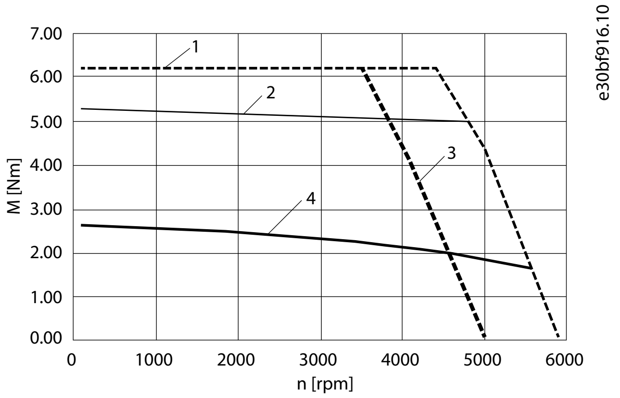

Illustration 66: Performance at 25 °C Ambient Temperature: Size 1, 1.5 Nm, 8 kHz

1	SOA 680 V	3	SOA 560 V
2	S3 (20% duty, maximum 12 s)	4	S1

8.4.1.3 Speed-Torque Characteristics: Size 1, 1.5 Nm, 8 kHz, at 40 °C Ambient Temperature

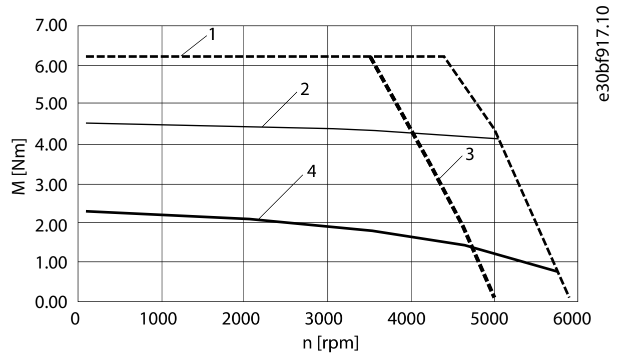

Illustration 67: Performance at 40 °C Ambient Temperature: Size 1, 1.5 Nm, 8 kHz

1	SOA 680 V	3	SOA 560 V
2	S3 (20% duty, maximum 12 s)	4	S1

8.4.1.4 Speed-Torque Characteristics: Size 2, 2.1 Nm, 8 kHz, at 25 °C Ambient Temperature

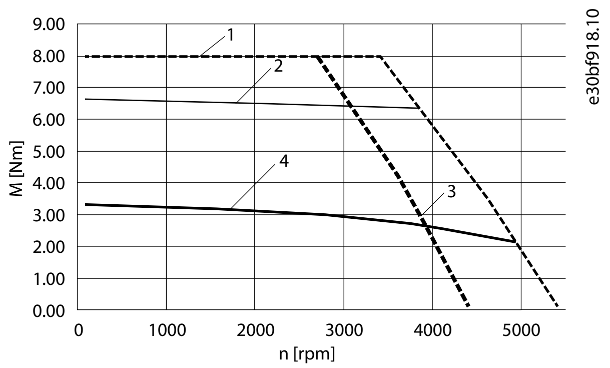

Illustration 68: Performance at 25 °C Ambient Temperature: Size 2, 2.1 Nm, 8 kHz

1	SOA 680 V	3	SOA 560 V
2	S3 (20% duty, maximum 12 s)	4	S1

8.4.1.5 Speed-Torque Characteristics: Size 2, 2.1 Nm, 8 kHz, at 40 °C Ambient Temperature

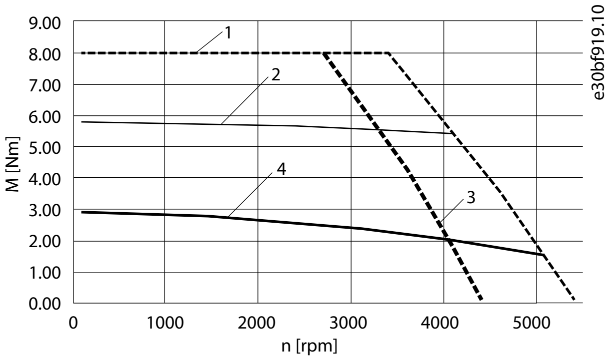

Illustration 69: Performance at 40 °C Ambient Temperature: Size 2, 2.1 Nm, 8 kHz

1	SOA 680 V	3	SOA 560 V
2	S3 (20% duty, maximum 12 s)	4	S1

8.4.1.6 Speed-Torque Characteristics: Size 2, 2.9 Nm, 8 kHz at 25 °C Ambient Temperature

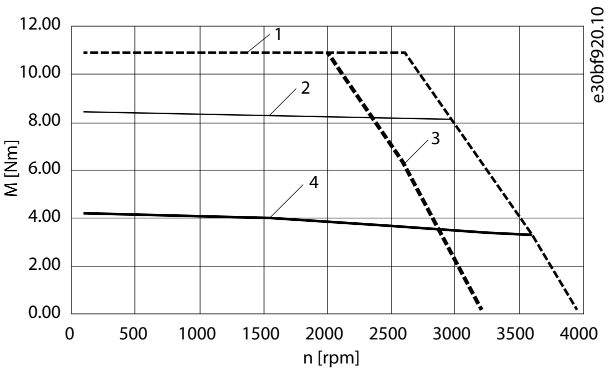

Illustration 70: Performance at 25 °C Ambient Temperature: Size 2, 2.9 Nm, 8 kHz

1	SOA 680 V	3	SOA 560 V
2	S3 (20% duty, maximum 12 s)	4	S1

8.4.1.7 Speed-Torque Characteristics: Size 2, 2.9 Nm, 8 kHz, at 40 °C Ambient Temperature

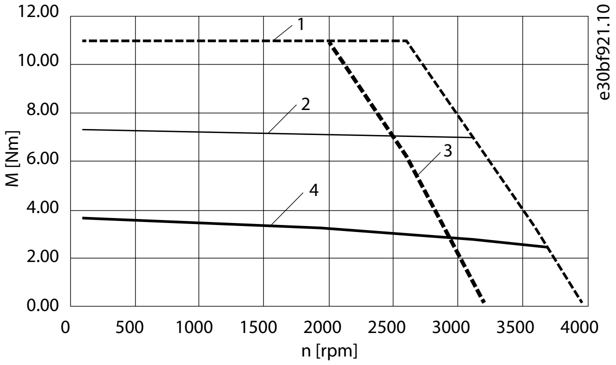

Illustration 71: Performance at 40 °C Ambient Temperature: Size 2, 2.9 Nm, 8 kHz

1	SOA 680 V	3	SOA 560 V
2	S3 (20% duty, maximum 12 s)	4	S1

8.4.1.8 Speed-Torque Characteristics: Size 2, 3.8 Nm, 8 kHz, at 25 °C Ambient Temperature

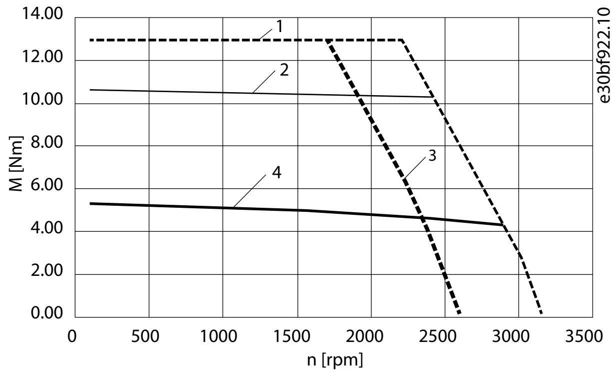

Illustration 72: Performance at 25 °C Ambient Temperature: Size 2, 3.8 Nm, 8 kHz

1	SOA 680 V	3	SOA 560 V
2	S3 (20% duty, maximum 12 s)	4	S1

8.4.1.9 Speed-Torque Characteristics: Size 2, 3.8 Nm, 8 kHz, at 40 °C Ambient Temperature

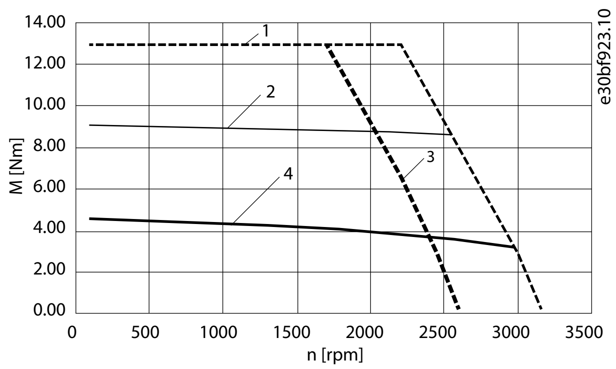

Illustration 73: Performance at 40 °C Ambient Temperature: Size 2, 3.8 Nm, 8 kHz

1	SOA 680 V	3	SOA 560 V
2	S3 (20% duty, maximum 12 s)	4	S1

8.4.1.10 Speed-Torque Characteristics: Size 3, 5.2 Nm, 4 kHz, at 25 °C Ambient Temperature

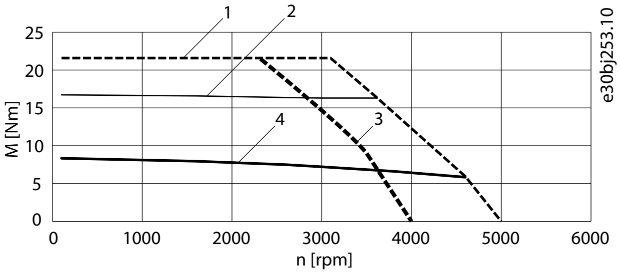

Illustration 74: Performance at 25 °C Ambient Temperature: Size 3, 5.2 Nm, 4 kHz

1	SOA 680 V	3	SOA 560 V
2	S3 (15% duty, maximum 9 s)	4	S1

8.4.1.11 Speed-Torque Characteristics: Size 3, 5.2 Nm, 4 kHz, at 40 °C Ambient Temperature

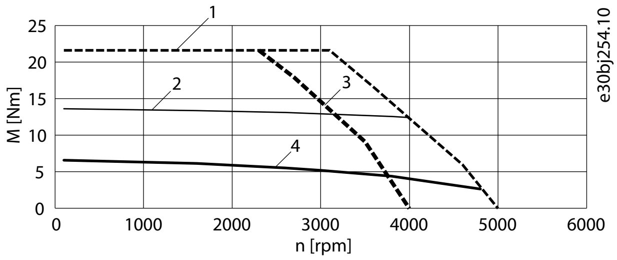

Illustration 75: Performance at 40 °C Ambient Temperature: Size 3, 5.2 Nm, 4 kHz

1	SOA 680 V	3	SOA 560 V
2	S3 (15% duty, maximum 9 s)	4	S1

8.4.1.12 Speed-Torque Characteristics: Size 3, 6.0 Nm, 4 kHz at 25 °C Ambient Temperature

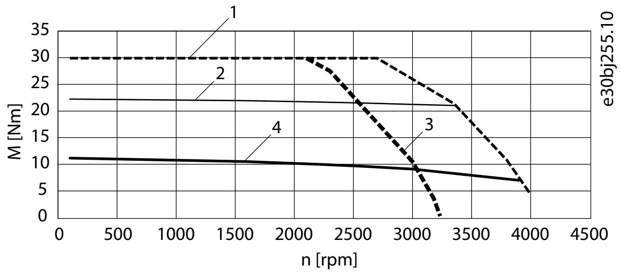

Illustration 76: Performance at 25 °C Ambient Temperature: Size 3, 6.0 Nm, 4 kHz

1	SOA 680 V	3	SOA 560 V
2	S3 (15% duty, maximum 9 s)	4	S1

8.4.1.13 Speed-Torque Characteristics: Size 3, 6.0 Nm. 4 kHz, at 40 °C Ambient Temperature

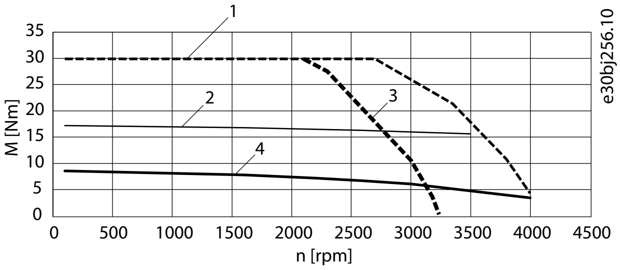

Illustration 77: Performance at 40 °C Ambient Temperature: Size 3, 6.0 Nm, 4 kHz

1	SOA 680 V	3	SOA 560 V
2	S3 (15% duty, maximum 9 s)	4	S1

8.4.1.14 Speed-Torque Characteristics: Size 4, 11.2 Nm, 4 kHz, at 25 °C Ambient Temperature

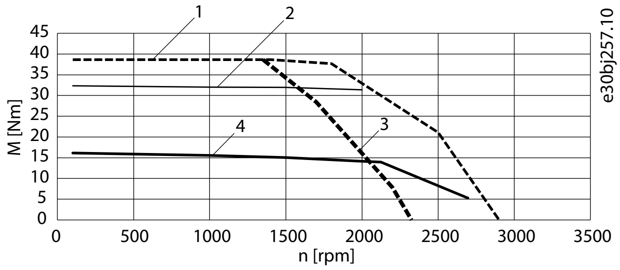

Illustration 78: Performance at 25 °C Ambient Temperature: Size 4, 11.2 Nm, 4 kHz

1	SOA 680 V	3	SOA 560 V
2	S3 (15% duty, maximum 9 s)	4	S1

8.4.1.15 Speed-Torque Characteristics: Size 4, 11.2 Nm, 4 kHz, at 40 °C Ambient Temperature

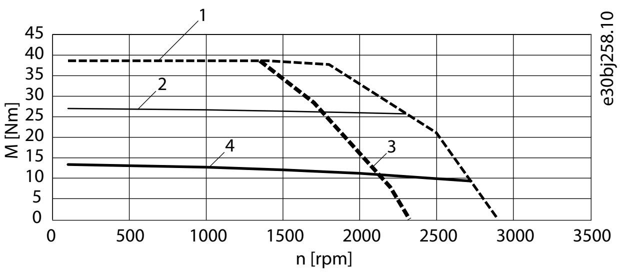

Illustration 79: Performance at 40 °C Ambient Temperature: Size 4, 11.2 Nm, 4 kHz

1	SOA 680 V	3	SOA 560 V
2	S3 (15% duty, maximum 9 s)	4	S1

8.5 Derating

8.5.1 Derating at High Altitude

Illustration 80 shows the derating factor when using the ISD 510 servo drives above 1000 m.

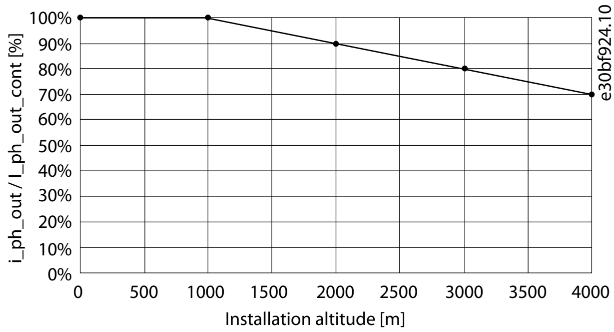

Illustration 80: Derating of Phase Output Current versus Installation Altitude

N O T I C E

- The components of the ISD 510 servo system are only approved for installation at altitudes up to 2000 m above sea level. Products used at altitudes above 2000 m above sea level means that such products are accepted "as is", and that Danfoss disclaims all warranties of quality, whether expressed or implied, including the warranties of merchantability and fitness for particular purpose. For any such products, Danfoss has no obligation to repair any damage to or defect in the products, replace the products, or otherwise remedy the products. Furthermore, Danfoss disclaims any liability for damage to person or property caused by the products due to the product being installed at altitudes above 2000 m above sea level.

8.5.2 Derating of ISD 510 Servo Drives at High Ambient Temperature

Table 75: Derating of ISD 510 Servo Drives at High Ambient Temperature

Servo drive size	Temperature derating factor
Size 1, 1.5 Nm	0.032 Nm/°C
Size 2, 2.1 Nm	0.048 Nm/°C
Size 2, 2.9 Nm	0.056 Nm/°C
Size 2, 3.8 Nm	0.081 Nm/°C
Size 3, 5.2 Nm	0.19 Nm/°C
Size 3, 6.0 Nm	0.3 Nm/°C
Size 4, 11.2 Nm	0.26 Nm/°C

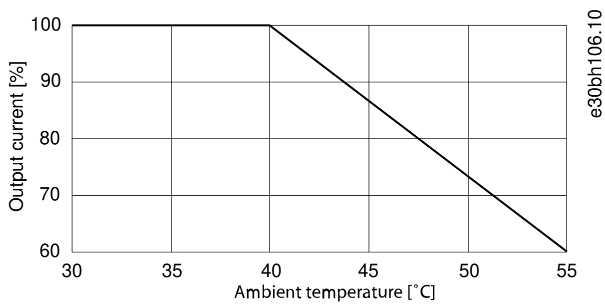

Illustration 81: Derating

8.5.3 Derating using ISD 510 Servo Drives with Shaft Seals

Table 76: Derating using ISD 510 Servo Drives with Shaft Seals

Servo drive size	Derating
Size 1, 1.5 Nm	15%
Size 2, 2.1 Nm	11%
Size 2, 2.9 Nm	8%
Size 2, 3.8 Nm	4%
Size 3, 5.2 Nm	10%
Size 3, 6.0 Nm	13%
Size 4, 11.2 Nm	8.3%

8.5.4 Derating using ISD 510 Servo Drives with Mechanical Holding Brake

Table 77: Derating using ISD 510 Servo Drives with Mechanical Holding Brake

Servo drive size	Derating
Size 1, 1.5 Nm	14%
Size 2, 2.1 Nm	14%
Size 2, 2.9 Nm	12%
Size 2, 3.8 Nm	10%
Size 3, 5.2 Nm	13%
Size 3, 6.0 Nm	14%
Size 4, 11.2 Nm	13%

8.5.5 Derating of DSD 510 Servo Drives at High Ambient Temperature

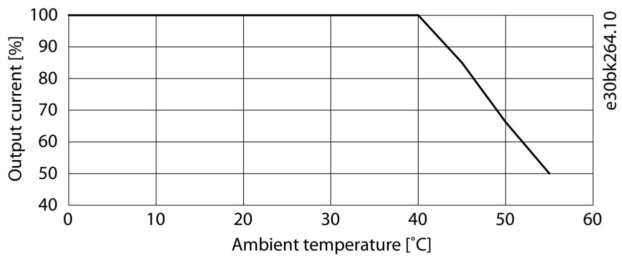

Illustration 82: Derating of DSD 510 Servo Drive at High Ambient Temperature

8.6 Connection Tightening Torques for the ISD 510 Servo Drives

8.6.1 Fixing Screws and Mounting of the ISD 510 Servo Drives

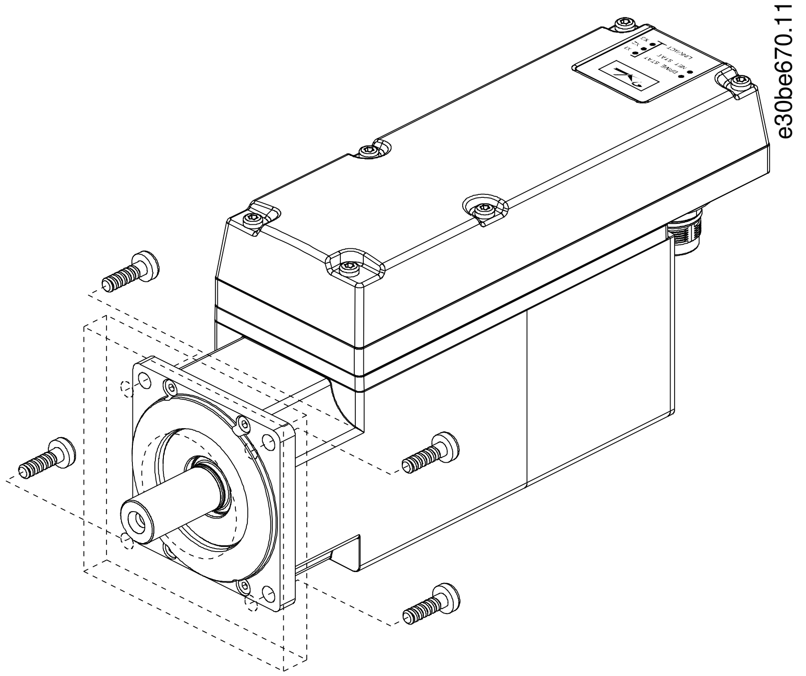

Illustration 83: Mounting of Size 1, 1.5 Nm, Size 2, 2.9 Nm, Size 2, 3.8 Nm, Size 3, and Size 4 ISD 510 Servo Drives

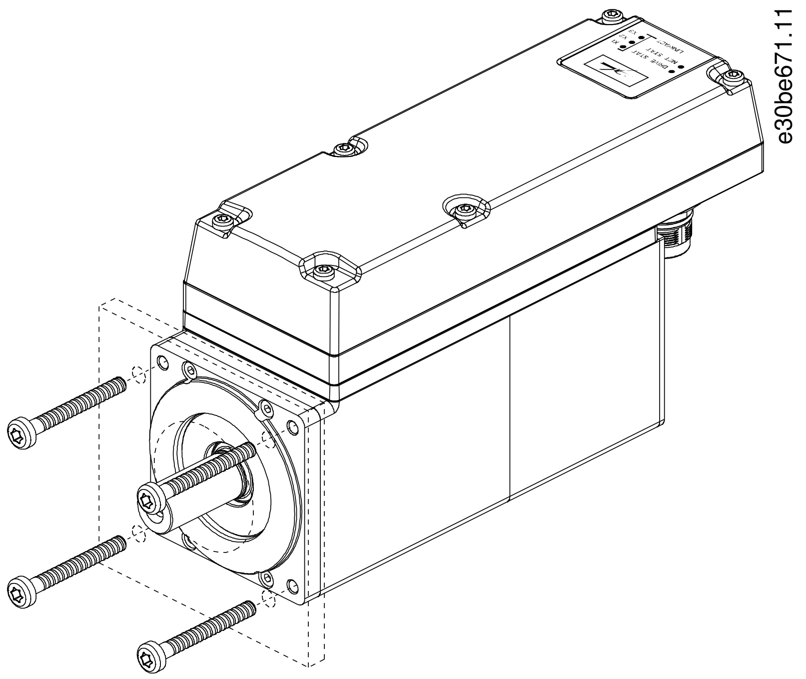

Illustration 84: Mounting of Size 2, 2.1 Nm ISD 510 Servo Drives

8.6.2 Tightening Torques for Fixing Screws

Always tighten the screws uniformly and crosswise.

Servo drive size	Thread type/ hole size	Maximum thread length	Tightening torque
Size 1, 1.5 Nm	Ø 5.8 mm	–	5 Nm
Size 2, 2.1 Nm	M6 pitch 1 mm	23 mm	6 Nm
Size 2, 2.9 Nm	Ø 7 mm	–	6 Nm
Size 2, 3.8 Nm	Ø 7 mm	–	6 Nm
Size 3, 5.2 Nm	Ø 9 mm	–	14 Nm
Size 3, 6.0 Nm	Ø 9 mm	–	14 Nm
Size 4, 11.2 Nm	Ø 11 mm	–	28 Nm

N O T I C E

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

8.7 Terminal Locations

8.7.1 Connectors on the ISD 510 Servo Drives

This section details all possible connections for the ISD 510 servo drives.

There are 5 connectors on the ISD 510 servo drives.

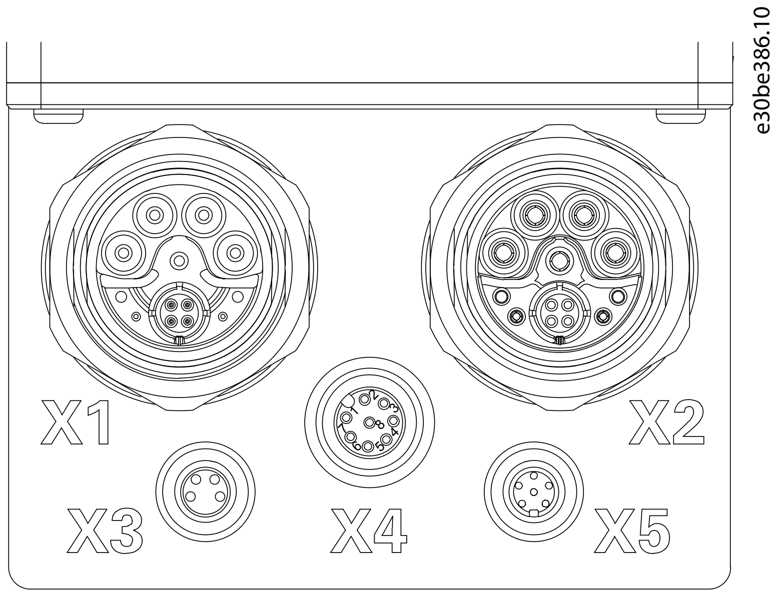

Illustration 85: Connectors on the ISD 510 Servo Drive

Table 78: Connectors on the ISD 510 Servo Drive

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

NOTICE

- Detailed information on each of the connectors can be found in 8.8.1 Connectors on the ISD 510/DSD 510 Servo Drive.

8.7.2 Connectors on the DSD 510 Servo Drives

The DSD 510 servo drives have the same X1–X5 connectors as the ISD 510 servo drives (see 8.7.1 Connectors on the ISD 510 Servo Drives). In addition to the X1–X5 connectors, the DSD 510 servo drives have 2 further connectors: X6 and X7.

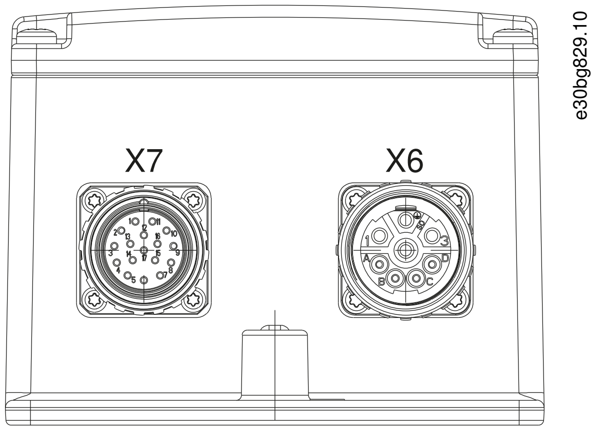

Illustration 86: X6 and X7 Connectors on the DSD 510 Servo Drive

Table 79: Connectors on the DSD 510 Servo Drive

Connector	Description
X6	M23 8-pole motor power connector
X7	M23 17-pole motor feedback connector

The maximum cable length from the DSD 510 to the motor is 5 m.

NOTICE

- The servo drives are available with single plug version for specifications HIPERFACE® DSL, and sensorless. This plug is for a hybrid cable containing both the motor and the feedback cables.
- All other specifications use the double plug version with separate motor and feedback cables.

8.7.3 Connectors on SDM 511

This section details all connectors on the SDM 511 in enclosure sizes 1 (FS1, 50 mm) and 2 (FS2, 100 mm).

8.7.3.1 Connectors on the Top of SDM 511

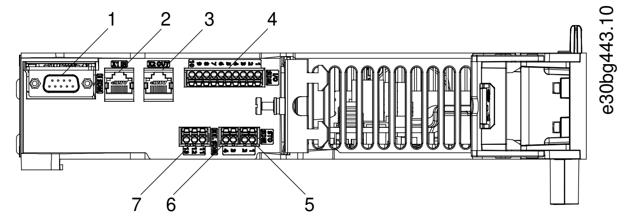

Illustration 87: SDM 511, Enclosure Size 1 (FS1)

1	External encoder connector	5	STO connector IN
2	Ethernet connector IN	6	STO connector OUT
3	Ethernet connector OUT	7	Relay connector
4	I/O connector		

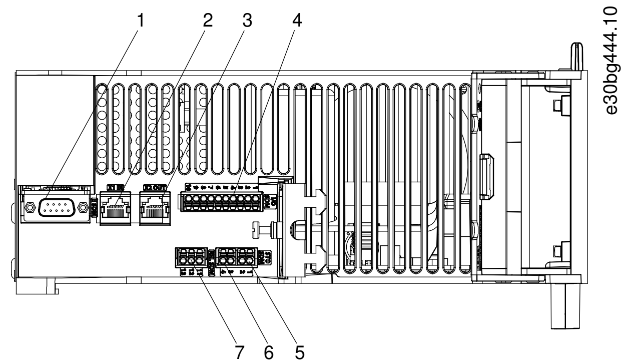

Illustration 88: SDM 511, Enclosure Size 2 (FS2)

1	External encoder connector	5	STO connector IN
2	Ethernet connector IN	6	STO connector OUT
3	Ethernet connector OUT	7	Relay connector
4	I/O connector		

8.7.3.2 Connectors on the Bottom of SDM 511

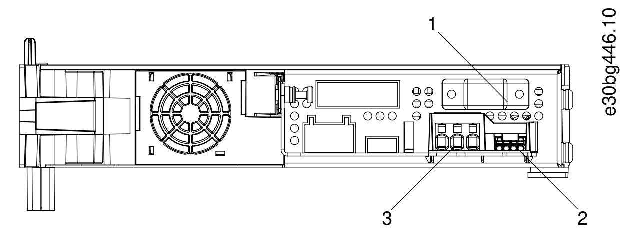

Illustration 89: SDM 511, Enclosure Size 1 (FS1)

1	Motor feedback connector	3	Motor connector
2	Motor brake and thermistor connector		

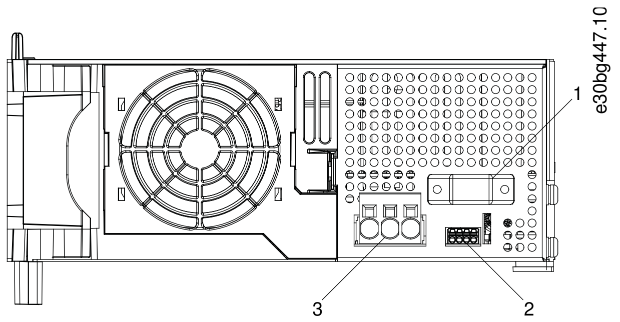

Illustration 90: SDM 511, Enclosure Size 2 (FS2)

1	Motor feedback connector	3	Motor connector
2	Motor brake and thermistor connector		

8.7.4 Connectors on SDM 512

This section details all connectors on SDM 512 in enclosure size 1 (FS1, 50 mm).

8.7.4.1 Connectors on the Top of SDM 512

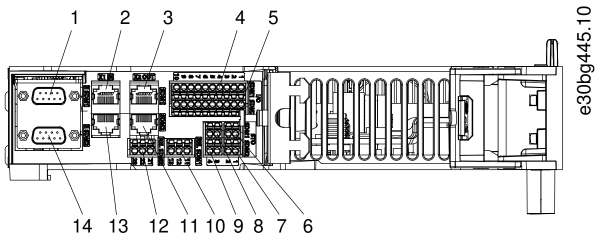

Illustration 91: SDM 512, Enclosure Size 1 (FS1)

1	External encoder connector SDM1	8	STO connector OUT SDM1
2	Ethernet connector IN SDM1	9	STO connector OUT SDM2
3	Ethernet connector OUT SDM1	10	Relay connector SDM1
4	I/O connector SDM1	11	Ethernet connector OUT SDM2
5	I/O connector SDM2	12	Relay connector SDM2
6	STO connector IN SDM1	13	Ethernet connector IN SDM2
7	STO connector IN SDM2	14	External encoder connector SDM2

8.7.4.2 Connectors on the Bottom of SDM 512

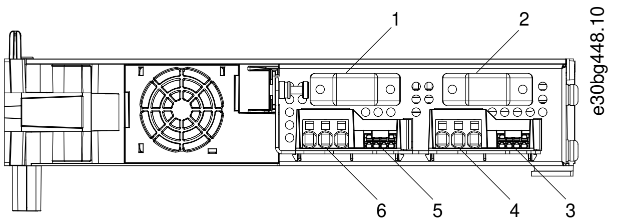

Illustration 92: SDM 512, Enclosure Size 1 (FS1)

1	Motor feedback connector SDM2	4	Motor connector SDM1
2	Motor feedback connector SDM1	5	Motor brake and thermistor connector SDM2
3	Motor brake and thermistor connector SDM1	6	Motor connector SDM2

8.7.5 Connectors on the Power Supply Module PSM 510

8.7.5.1 Connectors on the Top of PSM 510

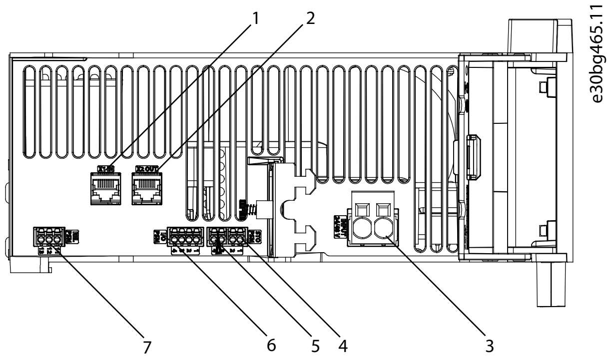

Illustration 93: Connectors on the Top of PSM 510

1	Ethernet connector IN	5	STO connector OUT
2	Ethernet connector OUT	6	I/O connector
3	24/48 V IN connector	7	Relay connector
4	STO connector IN		

8.7.5.2 Connectors on the Bottom of PSM 510

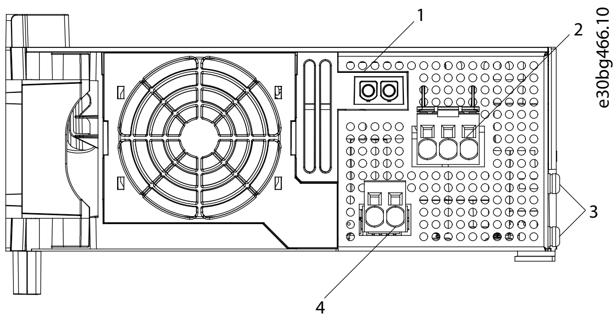

Illustration 94: Connectors on the Bottom of PSM 510

1	Holder for internal brake resistor connector when not in use	3	PE screws
2	AC mains supply connector	4	Internal/external brake resistor connector

8.7.6 Connectors on the Decentral Access Module DAM 510

8.7.6.1 Connectors on the Top of DAM 510

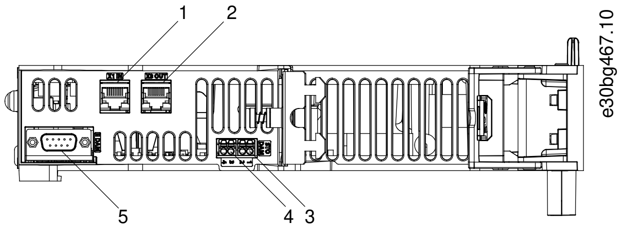

Illustration 95: Connectors on the Top of DAM 510

1	Ethernet connector IN	4	STO connector OUT
2	Ethernet connector OUT	5	Reserved
3	STO connector IN		

8.7.6.2 Connectors on the Bottom of DAM 510

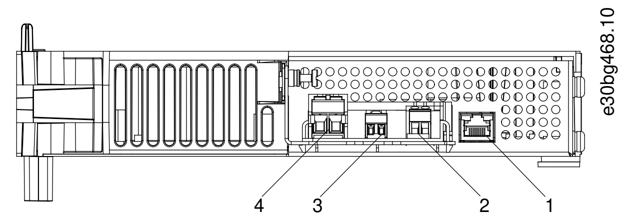

Illustration 96: Connectors on the Bottom of DAM 510

1	Ethernet connector	3	STO out connector
2	AUX connector	4	UDC connector

8.7.7 Connectors on the Auxiliary Capacitors Module ACM 510

8.7.7.1 Connectors on the Top of ACM 510

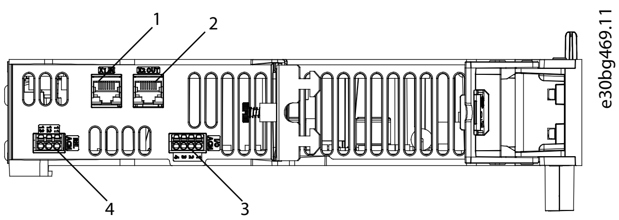

Illustration 97: Connectors on the Top of ACM 510

1	Ethernet connector IN	3	I/O connector
2	Ethernet connector OUT	4	Relay connector

8.7.8 Connector on the Expansion Module EXM 510

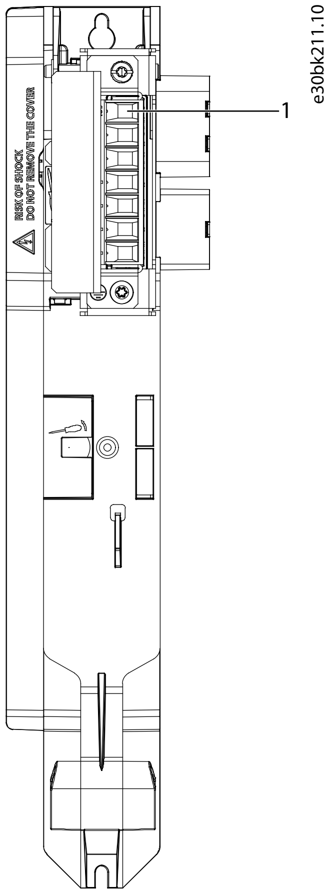

Illustration 98: Connector on EXM 510

1	Expansion module connector

8.8 Connector Pin Assignments

8.8.1 Connectors on the ISD 510/DSD 510 Servo Drive

8.8.1.1 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.

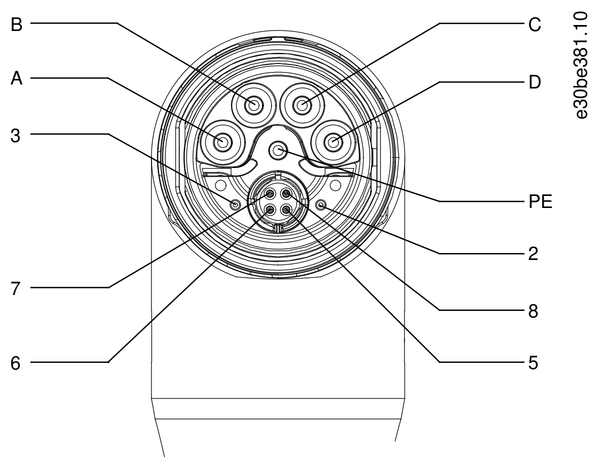

Illustration 99: Pin Assignment of X1 Male Hybrid Connector (M23)

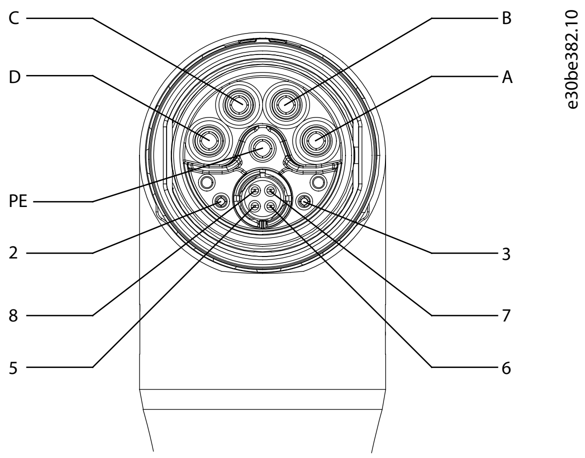

Illustration 100: Pin Assignment of X2 Female Hybrid Connector (M23)

Table 80: Pin Assignment of X1 and X2 Hybrid Connectors (M23)

Pin	Description	Notes	Rating/parameter
A	UDC–	Negative DC supply	Operating voltage: 565–680 V DC, maximum 778 V Negative DC supply (maximum -15 A/25 A)
B	UDC+	Positive DC supply	Operating voltage: 565–680 V DC, maximum 778 V Positive DC supply (maximum 15 A/25 A)
C	AUX+	Auxiliary supply	24–48 V DC±10%, 15 A Absolute maximum 55 V DC
D	AUX–	Auxiliary supply ground	
PE	PE	PE connector	15 A
2	STO+	Safety supply	24 V DC ±10%, 1 A
3	STO–	Safety supply ground	
5	TD+	Positive Ethernet transmit	According to standard 100BASE-T
6	RD–	Negative Ethernet receive	
7	TD–	Negative Ethernet transmit	
8	RD+	Positive Ethernet transmit	

8.8.1.2 X3: 3rd Ethernet Connector (M8, 4 pole)

The ISD 510/DSD 510 servo drives have an additional fieldbus port (X3) for connecting a device that communicated via the selected fieldbus.

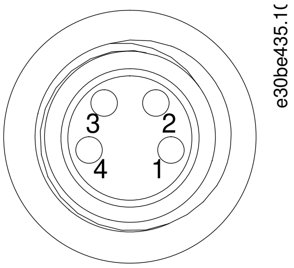

Illustration 101: Pin Assignment of X3 3rd Ethernet Connector (M8, 4 pole)

Table 81: Pin Assignment of X3 3rd Ethernet Connector (M8, 4 pole))

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

8.8.1.3 X4: I/O and/or Encoder Connector (M12, 8 pole)

The X4 connector is available on the ISD 510/DSD 510 servo drives and can be configured as:

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

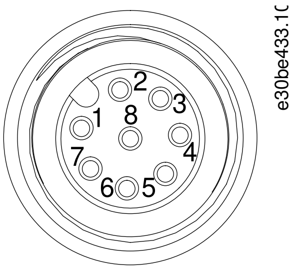

Illustration 102: Pin Assignment of X4 M12 I/O and/or Encoder Connector

Table 82: Pin Assignment of X4 M12 I/O and/or Encoder Connector

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:**

Pin	Description	Notes	Rating/parameter
			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

8.8.1.4 X5: LCP Connector (M8, 6 pole)

The X5 connector is used to connect the LCP directly to the ISD 510/DSD 510 servo drives via a cable.

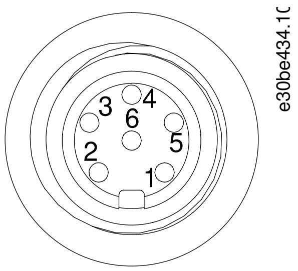

Illustration 103: Pin Assignment of X5 LCP Connector (M8, 6 pole)

Table 83: Pin Assignment of X5 LCP Connector

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

8.8.1.5 X6: Standard/HIPERFACE DSL Motor Connector

The standard/HIPERFACEÆDSL motor connector is an M23 female connector.

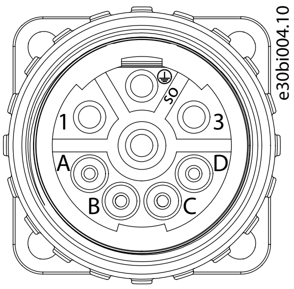

Illustration 104: Pin Assignment of X6 Motor Connector

Table 84: Pin Assignment of X6 Motor Connector

Pin	Description	Notes	Rating/parameter
1	U	Motor phase U	Nominal voltage: 400–480 V ±10% (see 8.2.3 Characteristic Data for DSD 510 Servo Drive) Conductor cross-section: 2.5 mm^2
PE	PE	Protective earth	
3	W	Motor phase W	
4	V	Motor phase V	
A	Brake+	Used to connect the motor's mechanical brake (if present).	Nominal voltage: 24 V Maximum (peak) voltage: 48 V ±10% Conductor cross-section: 0.75 mm^2 Maximum brake current: 1 A
B	Brake–		
C	Data–[1]	HIPERFACE® DSL negative line	–
D	Data+[1]	HIPERFACE®ÆDSL positive line	–

¹ The data+/– signals are only present on the HIPERFACE® DSL variant, otherwise both are not connected.

8.8.1.6 X7: Motor Feedback Connector

The motor feedback connector is an M23 female connector.

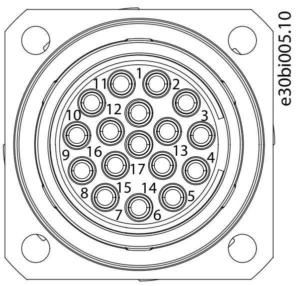

Illustration 105: Pin Assignment of X7 Motor Feedback Connector

Table 85: Pin Assignment of X7 Motor Feedback Connector

Pins	Description	Resolver	BISS B	HIPERFACE	EnDat 2.1 and 2.2	Rating/parameter
1	SIN+	X	–	X	(1)	Resolver positive sine input
2	GND	–	X	X	X	GND
3	COS+	X	–	X	(1)	Resolver positive cosine input
4	VEE	–	X	X	X	+5/11 V(2)
5	RXTX	–	X	X	X	Encoder positive data signal
6	\RESSY	X	–	–	–	Resolver negative exciter output
7	TEMP+	X	X	X	X	Motor temperature sensor input
8	ENC_CLK	–	X	–	–	Encoder positive clock signal
9	SIN–	X	–	X	(1)	Resolver negative sine input
10	–	–	–	–	–	–
11	COS–	X	–	X	(1)	Resolver negative cosine input
12	–	–	–	–	–	–
13	\RXTX	–	X	X	X	Encoder negative data signal
14	TEMP–	X	X	X	X	Motor temperature sensor input
15	\ENC_CLK	–	X	–	–	Encoder negative clock signal
16	–	–	–	–	–	–
17	RESSY	X	–	–	–	Resolver positive exciter output

[1] The SINE and COSINE signals are optional for EnDat. In this case, the SINE and COSINE signals are called A+/A– (SIN) and B+/B– (COS).

[2] The supply switches automatically between 5 V and 11 V depending on which feedback type is selected.

8.8.2 Connectors on the System Modules

8.8.2.1 Backlink Connector

The backlink connector is at the top of the backside of all the system modules.

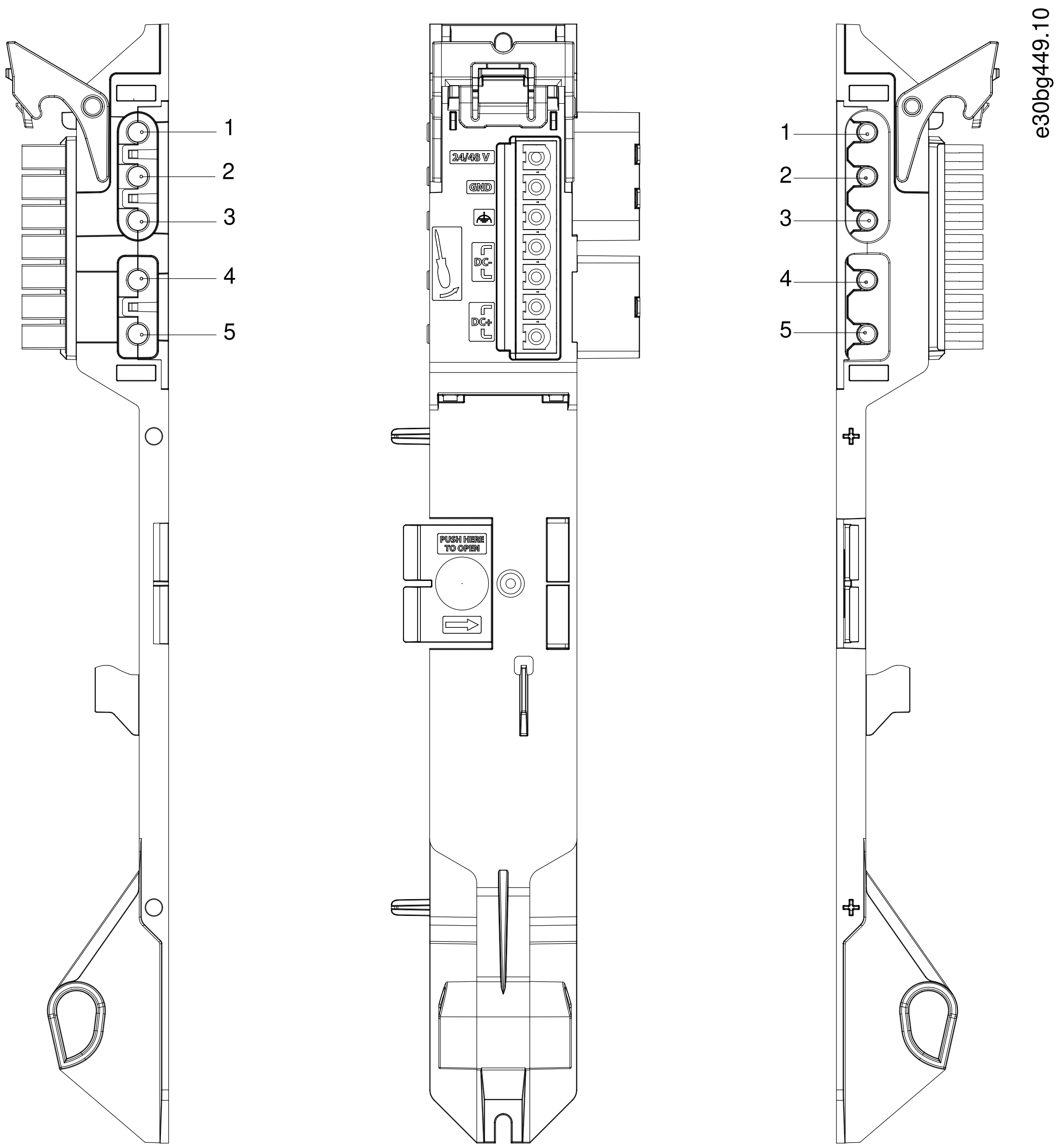

Illustration 106: Pin Assignment of Backlink Connector

Table 86: Pin Assignment of Backlink Connector

Pin	Description
1	24/48 V
2	GND
3	FE: Functional earth
4	DC–
5	DC+

8.8.2.2 Brake Connectors

There are brake connectors on the Power Supply Module (PSM 510) and the Servo Drive Modules (SDM 511/SDM 512).

8.8.2.2.1 Brake Resistor Connector on PSM 510

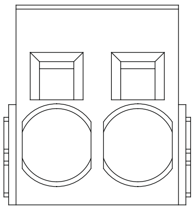

Illustration 107: Brake Connector on PSM 510

Table 87: Pin Assignment of Brake Connector on PSM 510

Pins (left to right)	Description	Notes	Ratings
1	DC+/R+	Used for connecting a brake resistor.	Nominal voltage: 560–800 V DC Maximum brake current: 80 A Conductor cross-section range: 0.75–16 mm^2 (AWG 18–AWG 4)
2	R–		

NOTICE

- The maximum length of the brake cable is 30 m (shielded).

8.8.2.2.2 Brake and Motor Temperature Sensor Connector on SDM 511/SDM 512

The brake connector on SDM 511/SDM 512 is used for both the mechanical brake and the temperature sensor (if present).

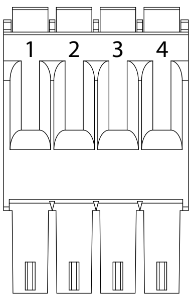

Illustration 108: Brake Connector on SDM 511/SDM 512

Table 88: Brake Connector on SDM 511/SDM 512

Connector name	Description	Pins	Ratings/Notes
Mechanical brake and motor temperature sensor connector	Used to connect the motor's mechanical brake (if present).	See Table 89.	Nominal voltage: 24 V Maximum (peak) voltage: 48 V ±10% Maximum brake current: 2.5 A Conductor cross-section range: 0.2–1.5 mm^2 (AWG 24–AWG 16)

Table 89: Pin Assignment of Mechanical Brake and Motor Temperature Sensor Connector on SDM 511/SDM 512

Pins	Description	Notes	Rating/parameter
1	TEMP–	Used to connect the motor's temperature sensor (if present).	KTY83–110

Pins	Description	Notes	Rating/parameter
2	TEMP+		KTY84–130 PT1000 PTC
3	BRAKE–	Used to connect the motor's mechanical brake (if present).	Nominal voltage: 24 V Maximum (peak) voltage: 48 V ±10% Maximum brake current: 2.5 A Conductor cross-section range: 0.2–1.5 mm^2 (AWG 24–AWG 16)
4	BRAKE+		

NOTICE

- The motor temperature measurement can either be connected to the motor feedback connector (see 8.8.2.13 Motor Feedback Connectors) or the brake and motor temperature sensor connector on the servo drive module SDM 511/SDM 512. The connectors cannot be connected in parallel.

NOTICE

- The signals on this connector are referred to GND and must therefore be reinforced insulated against the motor phases. The internal insulation must withstand 4240 V DC and an 8000 V_{peak} impulse.

NOTICE

- Only PELV potential can be connected to the temperature sensor input.

NOTICE

- The maximum length of the brake cable is 80 m (shielded).

8.8.2.3 Ethernet Connectors

There are ethernet connectors on all the system modules.

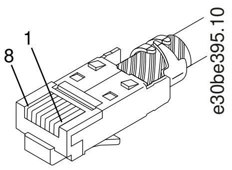

Illustration 109: Ethernet Connector

NOTICE

- Only PELV potential can be connected to the digital inputs and outputs.

8.8.2.3.1 Ethernet Connectors on PSM 510 and ACM 510

Table 90: Ethernet Connectors on PSM 510 and ACM 510

Connector name	Description	Pins	Ratings
X1 IN	Ethernet IN	1: TX+ 2: TX– 3: RX+	According to standard 100BASE-T.
X2 OUT	Ethernet OUT1		

Connector name	Description	Pins	Ratings
		4: – 5: – 6: RX– 7: – 8: –	

8.8.2.3.2 Ethernet Connectors on DAM 510

Table 91: Ethernet Connectors on DAM 510

Connector name	Description	Pins	Ratings
X1 IN	Ethernet IN	1: TX+ 2: TX– 3: RX+ 4: – 5: – 6: RX– 7: – 8: –	According to standard 100BASE-T.
X2 OUT	Ethernet OUT1 (connection to hybrid cable)		
X3 OUT	Ethernet OUT2		

8.8.2.3.3 Ethernet Connectors on SDM 511/SDM 512

Table 92: Ethernet Connectors

Connector name	Description	Pins	Ratings
SDM1 X1 IN	Ethernet IN1	1: TX+ 2: TX– 3: RX+ 4: – 5: – 6: RX– 7: – 8: –	According to standard 100BASE-T.
SDM1 X2 OUT	Ethernet OUT1		
SDM2 X1 IN[1]	Ethernet IN2		
SDM2 X2 OUT[1]	Ethernet OUT2		

[1] Only on SDM 512

8.8.2.4 I/O Connectors

8.8.2.4.1 I/O Connector on PSM 510/ACM 510

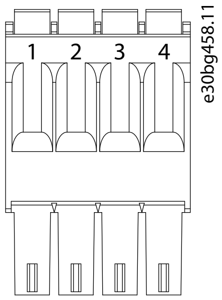

Illustration 110: I/O Connector on PSM 510 (I/O PSM) and ACM 510 (I/O ACM)

Table 93: Pin Assignment of I/O Connector on PSM 510/ACM 510

Pins	Description	Notes	Rating/parameter
1	DIN1–	Digital input	Galvanic isolated Input voltage: 0–30 V DC High (logic "1") voltage: 15–30 V DC Low (logic "0") voltage: <5 V DC Maximum input signal frequency: 50 Hz Maximum input current at 48 V: 11 mA Maximum input resistance: 4.5 KΩ
2	DIN1+		
3	DIG_OUT–	Digital output	Galvanic isolated Maximum voltage between terminals: 24 V DC or AC Maximum current: 1 A Maximum output switching frequency: 50 Hz
4	DIG_OUT+		

The conductor cross-section range is 0.2–1.5 mm^2 (AWG 24–AWG 16).

NOTICE

- Only PELV potential can be connected to the digital inputs and outputs.

8.8.2.4.2 I/O Connector on SDM 511/SDM 512

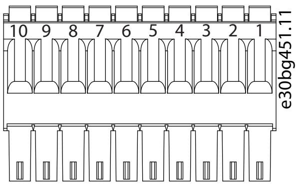

Illustration 111: I/O Connector on SDM 511/SDM 512

Table 94: Pin Assignment of I/O Connector on SDM 511/SDM 512

Pins	Description	Notes	Rating/parameter
1	24 V AUX	–	–
2	Ground	–	–
3	DigInOut1	Digital input/output (switchable via software)	**Digital input:** Galvanic isolated Nominal voltage: 0–24 V Bandwidth: ≦100 kHz **Digital output:** Nominal voltage: 24 V ±20% Maximum current: 120 mA(1) Maximum switching frequency: 100 Hz
4	DigOut1	Digital output	Galvanic isolated Nominal voltage: 24 V ±20% Maximum current: 150 mA(1) Maximum switching frequency: 100 Hz
5	DigOut2		
6	DigOut3		
7	DigIn4	Digital input	**Digital input:** Galvanic isolated

Pins	Description	Notes	Rating/parameter
8	DigIn3		High (logic "1") voltage: 10–30 V DC Low (logic "0") voltage: <5 V DC Nominal voltage: 0–24 V Maximum current: 3 mA Input resistance: 10 kΩ Maximum switching frequency: 100 Hz
9	DigIn2	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
10	DigIn1		

[1] Maximum output current for all 4 digital outputs together. If all 4 digital outputs are used, the maximum output current of each is 30 mA.

The conductor cross-section range is 0.2–1.5 mm^2 (AWG 24–AWG 16).

N O T I C E

- Only PELV potential can be connected to the digital inputs and outputs.

8.8.2.5 UAUX Connector

The U_{AUX} connector is on the Power Supply Module (PSM 510).

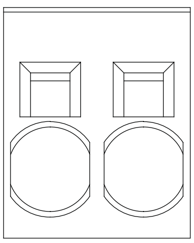

Illustration 112: U_{AUX} Connector

Table 95: Pin Assignment of U_{AUX} Connector

Pins (left to right)	Description	Notes	Rating/parameter
1	24 V AUX	Used for 24–48 V DC input to the Power Supply Module (PSM 510).	Nominal input voltage: 24 V/48 V DC ±10% Nominal current: Depends on the number of servo drives in the application. Maximum current: 50 A Maximum cross-section: 16 mm^2 Maximum cable length: 3 m Conductor cross-section range 0.75–16 mm^2, solid or flexible (AWG 18–AWG 4)
2	GND		

N O T I C E

- Only PELV potential can be connected to the U_{AUX} input.

CAUTION

POSSIBLE LOSS OF FUNCTIONAL SAFETY PROTECTION

The functional safety feature may be affected if the U_{AUX} input exceeds 60 V.

- Ensure that the U_{AUX} input remains below 60 V.

8.8.2.5.1 24/48 V Cable Cross-Sections for PSM 510

Minimum cable cross-section for CE (minimum 70 °C, Cu)	16 mm^2
Minimum cable cross-section for UL (minimum 60 °C, Cu)	4 AWG

8.8.2.6 LCP Connector (M8, 6-pole)

There is an LCP connector on the front of all the system modules. It is used to connect the LCP directly via a cable.

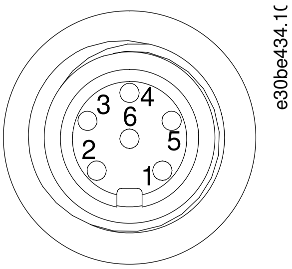

Illustration 113: LCP Connector (M8, 6 pole)

Table 96: Pin Assignment of LCP Connector

Pins	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

NOTICE

- Only PELV potential can be connected to the LCP input.

8.8.2.7 AC Mains Connector

The AC mains connector is on the bottom of the Power Supply Module (PSM 510).

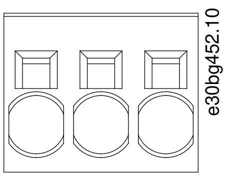

Illustration 114: AC Mains Connector

Table 97: Pin Assignment of AC Mains Connector

Pins (left to right)	Description	Notes	Rating/parameter
1	L3	Used to connect L1/L2/L3	Nominal voltage: 400–480 V AC ±10% Nominal power: 30 kW Maximum cross-section: 16 mm^2 (AWG 4) Conductor cross-section range 0.75–16 mm^2, solid or flexible (AWG 18–AWG 4)
2	L2		
3	L1		

8.8.2.7.1 Mains Cable Cross-Sections for PSM 510

Table 98: Mains Cable Cross-Sections for PSM 510

	PSM 510 (10 kW)	PSM 510 (20 kW)	PSM 510 (30 kW)
Minimum cable cross-section for CE	4 mm^2 (minimum 70 °C, Cu)	16 mm^2 (minimum 70 °C, Cu)	16 mm^2 (minimum 90 °C, Cu)
Minimum cable cross-section for UL	AWG 10 (minimum 60 °C, Cu)	AWG 6 (minimum 60 °C, Cu)	AWG 4 (minimum 75 °C, Cu)

8.8.2.8 Motor Connector

The motor connectors are located on the bottom of the Servo Drive Modules (SDM 511 and SDM 512).

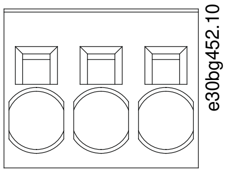

Illustration 115: Motor Connector

Table 99: Pin Assignment of Motor Connector

Pins (left to right)	Description	Notes	Rating/parameter
1	U	SDM 511 has 1 motor connector. SDM 512 has 2 motor connectors.	Nominal voltage: 400–480 V AC±10% Nominal power: Depends on the servo drive size. Conductor cross-section range: • SDM 511 2.5–20 A_{rms}: Conductor cross-section range 0.2–6 mm^2, flexible (AWG 24–AWG 8) • SDM 511 40 A_{rms}: Conductor cross-section range 0.75–16 mm^2, solid or flexible (AWG 18–AWG 4) • SDM 512 2.5–10 A_{rms}: Conductor cross-section range 0.2–6 mm^2, flexible (AWG 24–AWG 8)
2	V		
3	W		

8.8.2.8.1 Motor Cable Cross-Sections for SDM 511

Table 100: Motor Cable Cross-Sections for SDM 511

	SDM 511 (2.5 A_{rms})	SDM 511 (5 A_{rms})	SDM 511 (10 A_{rms})	SDM 511 (20 A_{rms})	SDM 511 (40 A_{rms})
Minimum cable cross-section for CE (min 70 °C, Cu)	1.5 mm^2			4 mm^2	10 mm^2
Minimum cable cross-section for UL (min 60 °C, Cu)	14 AWG			10 AWG	6 AWG

8.8.2.8.2 Motor Cable Cross-Sections for SDM 512

Table 101: Motor Cable Cross-Sections for SDM 511

	SDM 512 (2.5 A_{rms})	SDM 512 (5 A_{rms})	SDM 512 (10 A_{rms})
Minimum cable cross-section for CE (min 70 °C, Cu)	1.5 mm^2		
Minimum cable cross-section for UL (min 60 °C, Cu)	14 AWG		

8.8.2.9 Relay Connector

The relay connector is used for a user-defined reaction and is located as follows:

- Servo Drive Module SDM 511: 1 relay connector
- Servo Drive Module SDM 512: 2 relay connectors
- Power Supply Module PSM 510: 1 relay connector
- Auxiliary Capacitors Module ACM 510: 1 relay connector

N O T I C E

- Only PELV potential can be connected to the relay outputs.

8.8.2.9.1 Relay Connector on PSM 510/ACM 510

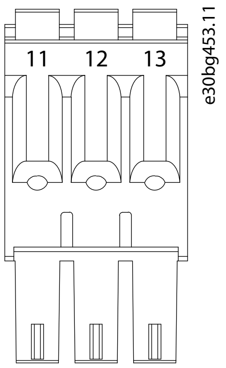

Illustration 116: Relay Connector on PSM 510/ACM 510

Table 102: Pin Assignment of Relay Connector on PSM 510 (REL PSM) and ACM 510 (REL ACM)

Pins	Description	Notes	Rating/parameter
11	NC	Normally closed, 24 V DC	Nominal current: 2 A
12	NO	Normally open, 24 V DC	

Pins	Description	Notes	Rating/parameter
13	COM	Common	Conductor cross-section range: 0.2–1.5 mm^2 (AWG 24–AWG 16)

8.8.2.9.2 Relay Connectors on SDM 511/SDM 512

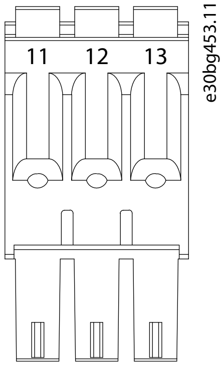

Illustration 117: Relay Connector for SDM 511 Enclosure Size 1 (FS1) andEnclosure Size 2 (FS2)

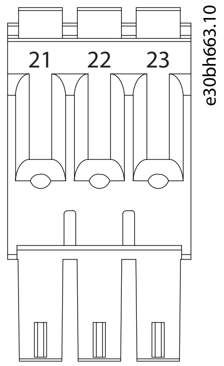

Illustration 118: Relay Connector for SDM 512 Enclosure Size 1 (FS1)

Table 103: Pin Assignment of Relay Connector on SDM 511/SDM 512

Name	Pins	Description	Notes	Rating/parameter
REL SDM1	11	NC	Normally closed, 24 V DC	Nominal current: 2 A Conductor cross-section range: 0.2–1.5 mm^2 (AWG 24–AWG 16)
	12	NO	Normally open, 24 V DC	
	13	COM	Common	
REL SDM2[1]	21	NC	Normally closed, 24 V DC	
	22	NO	Normally open, 24 V DC	
	23	COM	Common	

[1] Only on SDM 512.

8.8.2.10 STO Connectors

8.8.2.10.1 STO Connectors on SDM 511 and SDM 512

The STO connectors are on the Servo Drive Modules as follows:

- SDM 511: 1 input and 1 output STO connector
- SDM 512: 2 input and 2 output STO connectors

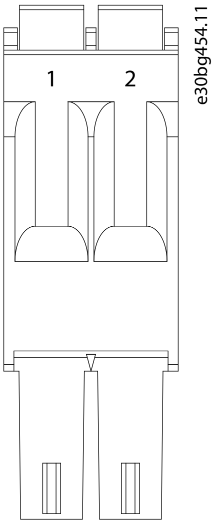

Illustration 119: STO Connectors on SDM 511/SDM 512

Table 104: Pin Assignment of STO Connectors on SDM 511/SDM 512

Connector name	Pins	Description	Notes	Rating/parameter
SDM511: • STO SDM SDM512: • STO SDM1 • STO SDM2	1	STO–	Used for STO output voltage 1/2 to the input of the PSM 510, DAM 510, or SDM 511/2.	Nominal voltage: 24 V DC ±10% Nominal current: Depends on the number of servo drives in the application. Maximum current: 1 A Conductor cross-section range: 0.2–1.5 mm^2 (AWG 24–AWG 16)
	2	STO+		
	3	STO–	Used for STO input voltage 1/2.	
	4	STO+		

N O T I C E

- Only PELV potential can be connected to the STO inputs.

8.8.2.10.2 STO Connectors on PSM 510

There is 1 input and 1 output STO connector on the Power Supply Module (PSM 510).

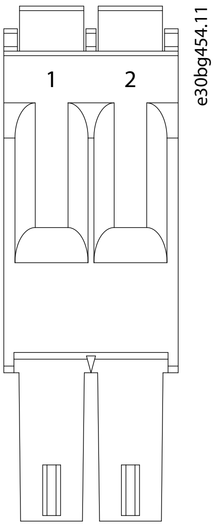

Illustration 120: STO Output Connector on PSM 510

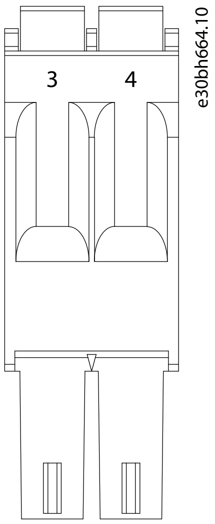

Illustration 121: STO Input Connector on PSM 510

Table 105: Pin Assignment of STO Connectors on PSM 510

Connector name	Pins	Description	Notes	Rating/parameter
STO PSM	1	STO–	Used for STO output voltage to the input of the other system modules.	Nominal voltage: 24 V DC ±10% Maximum current: 1 A Conductor cross-section range: 0.2–1.5 mm^2 (AWG 24–AWG 16)
	2	STO+		
	3	STO–	Used for STO input voltage.	
	4	STO+		

NOTICE

- Only PELV potential can be connected to the STO inputs.

8.8.2.10.3 STO Connectors on the DAM 510

8.8.2.10.3.1 STO Connectors on the Top of DAM 510

There is 1 input and 1 output STO connector on the top of the Decentral Access Module (DAM 510).

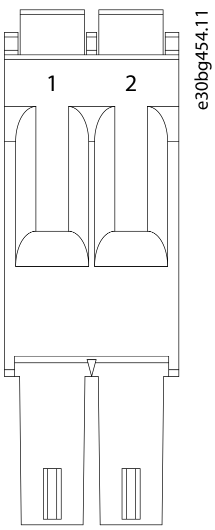

Illustration 122: STO Output Connector on the Top of DAM 510

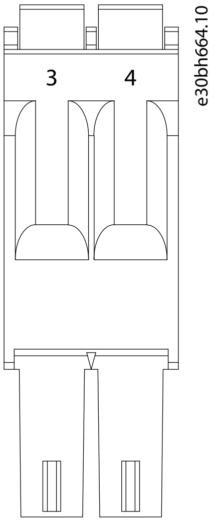

Illustration 123: STO Input Connector on the Top of DAM 510

Table 106: Pin Assignment of STO Connectors on the Top of DAM 510

Connector name	Pins	Descrip-tion	Notes	Rating/parameter
STO DAM	1	STO–	Used for STO output voltage to the input of the other system modules.	Nominal voltage: 24 V DC ±10% Maximum current: 1 A Conductor cross-section range: 0.2–1.5 mm^2 (AWG 24–AWG 16)
	2	STO+		
	3	STO–	Used for STO input voltage.	
	4	STO+		

NOTICE

- Only PELV potential can be connected to the STO inputs.

8.8.2.11 UDC Connector

The UDC connector is on the bottom of the Decentral Access Module (DAM 510).

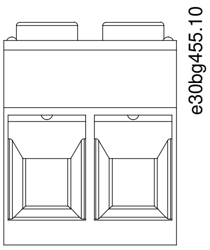

Illustration 124: UDC Connector

Table 107: Pin Assignment of UDC Connector

Pins (left to right)	Description	Notes	Rating/parameter
1	UDC+		Nominal voltage: 560–800 V DC Maximum current: 25 A Conductor cross-section range: 0.2–6 mm^2 (AWG 24–AWG 10)
2	UDC–		

Pins (left to right)	Description	Notes	Rating/parameter
			Plug terminal tightening torque: 0.5–0.8 Nm (4.43–7.08 in-lb)

8.8.2.12 AUX Connector

The AUX connector is on the bottom of the Decentral Access Module (DAM 510).

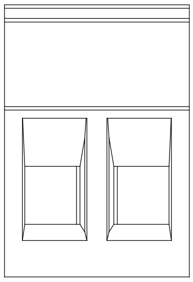

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Illustration 125: AUX Connector

Table 108: Pin Assignment of AUX Connector

Pins (left to right)	Description	Notes	Rating/parameter
1	AUX+ (24/48 V)		Nominal voltage: 24/48 V DC ±10% Maximum current: 15 A Conductor cross-section range: 0.2–2.5 mm^2 (AWG 24–AWG 12) Plug terminal tightening torque: 0.5–0.6 Nm (4.43–5.31 in-lb)
2	AUX– (GND)		

N O T I C E

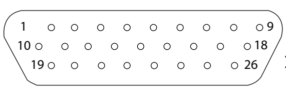
- Only PELV potential can be connected to the AUX output.

8.8.2.13 Motor Feedback Connectors

The motor feedback connectors allow the connection of an encoder or resolver to the Servo Drive Modules SDM 511/SDM 512.
SDM 511 has 1 motor feedback connector (E SDM1).
SDM 512 has 2 motor feedback connectors (E SDM1 and E SDM2).
The motor feedback connectors fulfill the following specifications:

- BISS B
- BISS C
- SSI
- Resolver
- HIPERFACE®
- HIPERFACE® DSL
- EnDat 2.1
- EnDat 2.2

Use a shielded feedback cable that fulfills the requirements for the used feedback type. The maximum cable length is 80 m.



e30bh407.10

Illustration 126: Motor Feedback Connector on SDM 511/SDM 512

Table 109: Pin Assignment of Motor Feedback Connectors E SDM1 and E SDM2

Pins	Description	Resolver	BISS B, BISS C, SSI	HIPER-FACE	HIPER-FACE DSL	EnDat 2.1 and 2.2	Rating/parameter
1	COS–	X	–	X	–	(1)	Resolver negative cosine input
2	COS+	X	–	X	–	(1)	Resolver positive cosine input
3	SUPPLY+(2)	–	X	X	–	X	+5/11 V (depending on feedback type), maximum 250 mA
4	\RXTX	–	X	X	–	X	Encoder negative data signal
5	RXTX	–	X	X	–	X	Encoder positive data signal
6	HIPERFACE_DSL+	–	–	–	X	–	HIPERFACE DSL positive line
7	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–
9	TEMP–	X	X	X	–	X	Motor temperature sensor input
10	SIN–	X	–	X	–	(1)	Resolver negative sine input
11	SUPPLY+(2)	–	–	–	–	–	+5/11 V (depending on feedback type), maximum 250 mA
12	SUPPLY–(2)	–	X	X	–	X	GND
13	\RESSY	X	–	–	–	(1)	Resolver negative exciter output
14	RESSY	X	–	–	–	(1)	Resolver positive exciter output
15	HIPERFACE_DSL–	–	–	–	X	–	HIPERFACE DSL negative line
16	–	–	–	–	–	–	–
17	–	–	–	–	–	–	–
18	TEMP+	X	X	X	–	X	Motor temperature sensor input
19	SIN+	X	–	X	–	(1)	Resolver positive sine input
20	ENC_CLK	–	X	–	–	X	Encoder positive clock signal
21	\ENC_CLK	–	X	–	–	X	Encoder negative clock signal
22	SUPPLY+(2)	–	X	X	–	X	+5/11 V (depending on feedback type), maximum 250 mA
23	SENS+(3)	–	X	X	–	X	Positive supply sense line
24	SENS–(3)	–	X	X	–	X	Negative supply sense line
25	SUPPLY–(2)	–	X	X	–	X	GND
26	–	–	–	–	–	–	–

[1] The SINE and COSINE signals are optional for EnDat. In this case the SINE and COSINE signals are called A+/A– (SIN) and B+/B– (COS).

[2] The supply switches automatically between 5 V and 11 V depending on which feedback type is selected. Pins 3, 11, and 22 are all equivalent and it is not necessary to connect all of them. To reduce the voltage drop over the feedback cable, it is possible to use multiple supply lines in parallel.

[3] To activate the internal power supply compensation, connect the 2 sense lines (SENS+ and SENS–) on the motor side to the supply (SUPPLY+ and SUPPLY–). This automatically adapts the supply voltage, depending on the cable length, and compensates the voltage drop over the feedback cable.

NOTICE

- The motor temperature measurement can either be connected to the motor feedback connector or the brake and motor temperature sensor connector on the servo drive module SDM 511/SDM 512 (see 8.8.2.2.2 Brake and Motor Temperature Sensor Connector on SDM 511/SDM 512). The connectors cannot be connected in parallel.

NOTICE

- Only PELV potential can be connected to the motor feedback connector.

8.8.2.14 External Encoder Connectors

The external encoder connector is on the Servo Drive Modules (SDM 511/SDM 512). It is used to connect an external encoder and provides a guide value for *CAM mode* and *Gear mode*.

- SDM 511: E SDM1
- SDM 512: E SDM1 and E SDM2

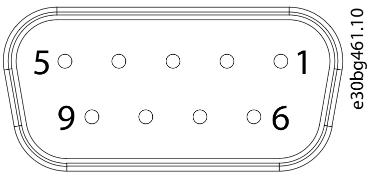


Illustration 127: External Encoder Connector

Table 110: External Encoder Connectors

Connector name	Description	Pins	Ratings/Notes
E SDM1/ E SDM2/	Used to connect the external encoder to SDM 511/SDM 512.	See Table 111.	Nominal voltage: 24 V DC, isolated (see Table 111) Nominal current: Depends on the number of servo drives in the application. Maximum current: 150 mA (see Table 111) Fulfill the following specifications: • BISS/SSI

Table 111: Pin Assignment of External Encoder Connectors (X1/X2)

Pins	Description	Notes SSI/BiSS	Notes
1	24 V	24 V DC ±10% (used for powering the encoder)	Maximum current: 150 mA
2	–	–	–
3	–	–	–
4	RS422 RXD	Positive data	Bus speed: SSI: Up to 10 Mhz clock frequency with 30 m cable. BiSS: Fulfills the RS485 specification.
5	RS422 TXD	Positive data	
6	GX	Isolated ground. If encoders are powered externally, the ground of the external supply must be connected to GX.	–

Pins	Description	Notes SSI/BiSS	Notes
7	–	–	–
8	/RS422 RXD	Negative data	Bus speed: SSI: 0.5 Mbit with 25 m cable. BiSS: Fulfills the RS485 specification.
9	/RS422 TXD	Negative data	

N O T I C E

– Only PELV potential can be connected to the external encoder.

8.8.2.15 Expansion Module Connector

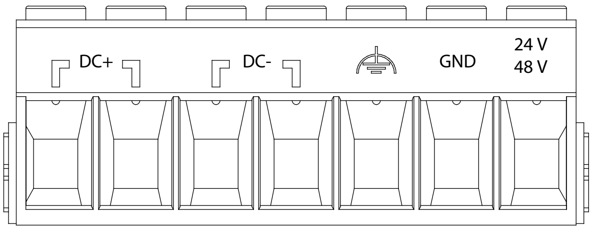


Illustration 128: Expansion Module Connector

Table 112: Pin Assignment of Expansion Module Connector

Pins (left to right)	Descrip-tion	Note	Rating/parameter
1	DC+	Shield the DC cables using the cable tie on the EXM 510 EMC plate.	Nominal voltage: 560–800 V DC Nominal current: Depends on the number of servo drives in the application. Maximum current: 62 A[1] Conductor cross-section range: 0.75–16 mm^2, solid or flexible (AWG 18–AWG 4) Only use with ferrule without plastic sleeve with CRIMPFOX 16 S. Use shielded conductors for UDC (DC+, DC–). Plug terminal tightening torque: 1.7–1.8 Nm (15.05–15.93 in-lb)
2			
3	DC–		
4			
5	FE (func-tional earth)	–	
6	GND	–	
7	24/48 V	–	

[1] The maximum current rating for 1 pair of EXM is 62 A. In systems with 2 PSM 510 modules, 2 pairs of EXM 510 modules can be used to achieve a maximum current rating of 124 A.

8.8.2.15.1 Cable Cross-Sections for EXM 510

Table 113: Minimum Cable Cross-Sections for EXM 510 Cables

Cable	CE	UL
DC+/DC–	16 mm^2 (minimum 70 °C, Cu)	6 AWG (minimum 75 °C, Cu)
24 V, functional PE	16 mm^2 (minimum 70 °C, Cu)	6 AWG (minimum 90 °C, Cu)[1]

[1] Minimum 75 °C is allowed if less than 45 A is measured on the cable.

8.9 Cables

8.9.1 Hybrid Cable

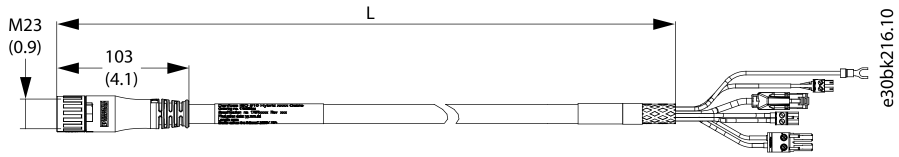


Illustration 129: Feed-in Cable with Straight Connector

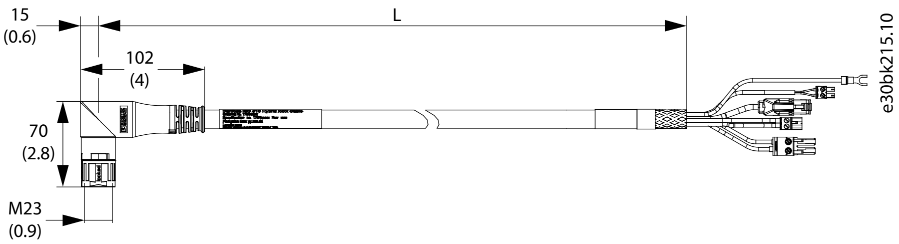


Illustration 130: Feed-in Cable with Angled Connector

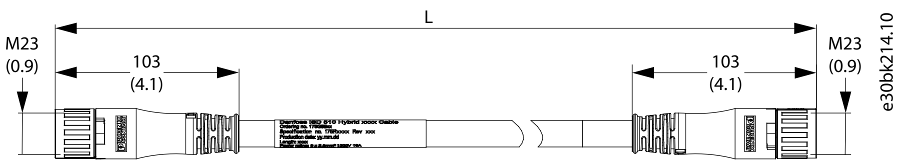


Illustration 131: Loop Cable with Straight Connector

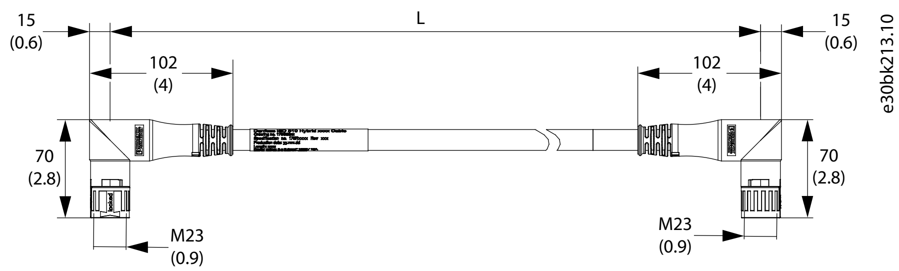


Illustration 132: Loop Cable with Angled Connector

Pre-configured hybrid cables are used to connect the decentral servo drives (when used) to the Decentral Access Module (DAM 510).

Pre-configured hybrid cables are used to connect the ISD 510/DSD 510 servo drives to the Decentral Access Module (DAM 510).

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

- Feed-in cable for connecting the 1st ISD 510/DSD 510 servo drive of a group to the connection point on the Decentral Access Module (DAM 510).
- Loop cable for connecting the ISD 510/DSD 510 servo drives in daisy-chain format in an application.

Both these cables are provided by Danfoss and are available in various lengths (see 7.2.1 Hybrid Feed-In Cable and 7.2.2 Hybrid Loop Cable.

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 ISD 510/DSD 510 servo drive. At the input end it is pigtailed and the connectors are mounted on the corresponding terminals on the Decentral Access Module (DAM 510).

Table 114: Hybrid Cables

Cable type	Shielded/unshielded	Notes
Feed-in cable	Shielded	Hybrid cable (overall shield with additional fieldbus and safety section shield).
Loop cable		

NOTICE

- Hybrid cables are available in 2 cross-sections: 2.5 mm^2 (15 A) and 4 mm^2 (25 A for CE and UL, 20 A for CSA).
- Select the appropriate hybrid cable according to the power size of the DAM 510:
  4 mm^2 hybrid cable for the 25 A variant of DAM 510.
  2.5 mm^2 hybrid cable for the 15 A variant of DAM 510.

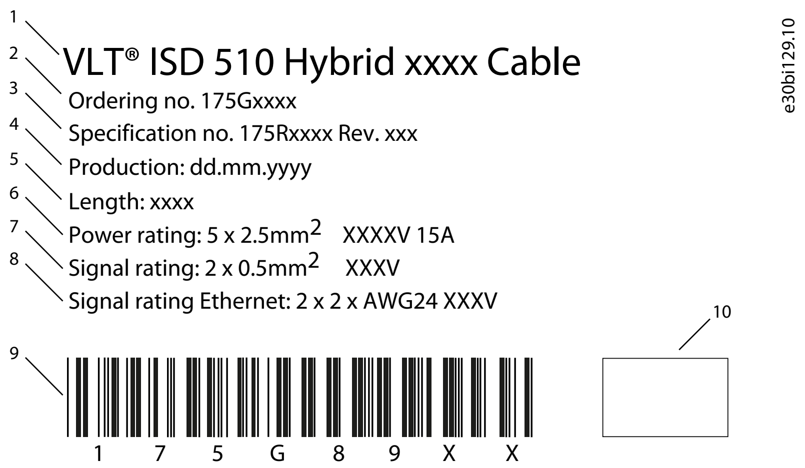


Illustration 133: Example of a Hybrid Cable Nameplate

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

8.9.1.1 Minimum Bending Radius for Hybrid Cable

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

8.9.2 Motor and Feedback Cable

Pre-configured motor and feedback cables are used to connect the DSD 510 servo drive to a PM motor. Both ends of the cable are fitted with M23 connectors.

These cables are provided by Danfoss and are available in 2.5 m and 5 m lengths.

The maximum length between the DSD 510 and the motor is 5 m.

There are different types of cables available according to the feedback and motor variant used. Refer to the following tables for details of the abbreviations used in the descriptions.

Table 115: Motor and Feedback Cable Types

Ordering number	Description
175G8945	Motor Cable DSD AKM CT01 XXX 2.5 m Orange
175G8946	Motor Cable DSD AKM CT01 XXX 5.0 m Orange
175G8947	Feedback Cable DSD AKM CT03 RES 2.5 m Green
175G8948	Feedback Cable DSD AKM CT03 RES 5.0 m Green
175G8949	Feedback Cable DSD AKM CT04 ENC 2.5 m Green
175G8950	Feedback Cable DSD AKM CT04 ENC 5.0 m Green

Table 116: Connector Types (CT)

Type	Variant	Description
CT0	–	M23
CT0	1	Motor standard with HIPERFACE® DSL
CT0	2	Reserved
CT0	3	M23 Resolver
CT0	4	M23 Encoder

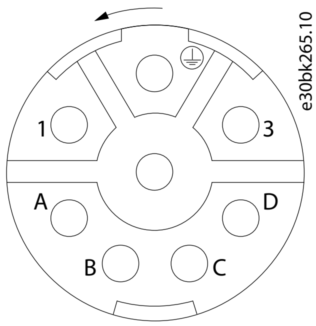


Illustration 134: DSD Motor Cable: Motor side female pinout (175G8945 and 175G8946)

Table 117: DSD Motor Cable: Motor side female pinout (175G8945 and 175G8946)

M23 male pin	Signal name
1	U
PE	PE
W	3
V	4
Brake +	A

M23 male pin	Signal name
Brake –	B
Data –	C
Data +	D

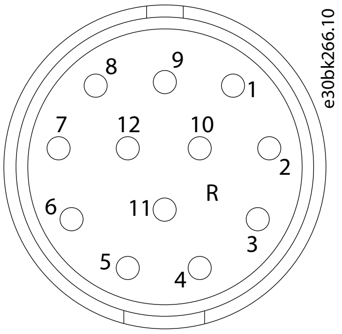


Illustration 135: DSD Feedback Cable: Motor side female pinout (175G8947 and 175G8948)

Table 118: DSD Feedback Cable: Motor side female pinout (175G8947 and 175G8948)

M23 female pin	Signal name
1	–
2	Temp +
3	Cos –
4	Sin –
5	Ressy –
6	Temp –
7	Cos +
8	Sin +
9	Ressy +
10	–
11	–
12	–

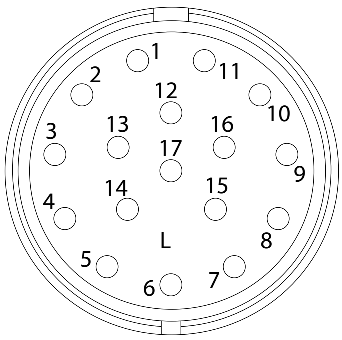


Illustration 136: DSD Feedback Cable: Motor side female pinout (175G8949 and 175G8950)

Table 119: DSD Feedback Cable: Motor side female pinout (175G8949 and 175G8950)

M23 female pin	Signal name
1	Sin +
2	GND
3	Cos +
4	VEE
5	Data +
6	–
7	Temp +
8	Clock +
9	Sin –
10	–
11	Cos–
12	–
13	Data –
14	Temp –
15	Clock –
16	–
17	–

8.9.2.1 Minimum Bending Radius for Motor Cable

The maximum number of bending cycles is 5 million at 7.5 x cable diameter (14.8 mm).

- Permanently flexible: 10 x cable diameter
- Permanently installed: 5 x cable diameter

8.9.2.2 Minimum Bending Radius for Feedback Cable

The maximum number of bending cycles is 5 million at 7.5 x cable diameter (11.7 mm).

- Permanently flexible: 7.5 x cable diameter
- Permanently installed: 5 x cable diameter

8.9.3 I/O and/or Encoder Cable

This cable connects the I/O and/or encoder to the ISD 510/DSD 510 servo drive (X4 connector). 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/DSD 510 system if they comply with the form factor defined in IEC 61076-2-101.

8.9.4 Fieldbus Extension Cable

Cable length: 2 m

Maximum length to next port: 100 m

If this cable is not used, fit the M23 metal blind cap to the X2 female connector on the last ISD 510/DSD 510 servo drive in the application.

8.9.5 LCP Cable

The LCP cable connects the LCP to the ISD 510/DSD 510 servo drive and the system modules via an M8 connector.

The LCP cable can be purchased from Danfoss (see 7.2.4 LCP Cable for further information and ordering numbers).

8.10 Space Requirements

8.10.1 Space Requirements for ISD 510 Servo Drive

In addition to its own dimensions, the ISD 510 servo drive needs space for the hybrid cable.

8.10.1.1 Minimum Distance for M23 Straight Connector on ISD 510 shows the straight connector installed on a size 2 ISD 510 servo drive.

8.10.1.2 Minimum Distance for M23 Angled Connector on ISD 510 shows the angled connector installed on a size 2 ISD 510 servo drive.

The illustrations show the minimum distance from the servo drive to the next object, and the minimum allowable bending radius R_{min} for permanently installed cable. For cable installation, allow the height of the connector plus an additional 30 mm for the cable.

The minimum distance is measured from the electronic housing as this is the same for all motor variants.

8.10.1.1 Minimum Distance for M23 Straight Connector on ISD 510

The space requirements vary depending on the ISD 510 size (see Table 120).

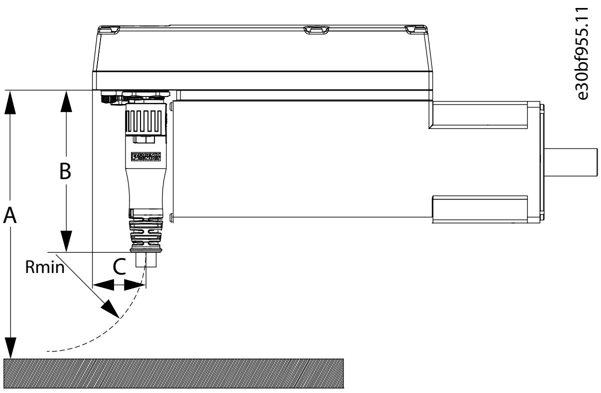


Illustration 137: Minimum Distance for M23 Straight Connector

Table 120: Dimensions

Dimension	Sizes 1 and 2 [mm (in)]	Sizes 3 and 4 [mm (in)]
A (minimum)	205 (8.07)	205 (8.07)
B	115 (4.53)	116 (4.57)
C	38 (1.50)	40 (1.57)

8.10.1.2 Minimum Distance for M23 Angled Connector on ISD 510

The space requirements vary depending on the ISD 510 size (see Table 121).

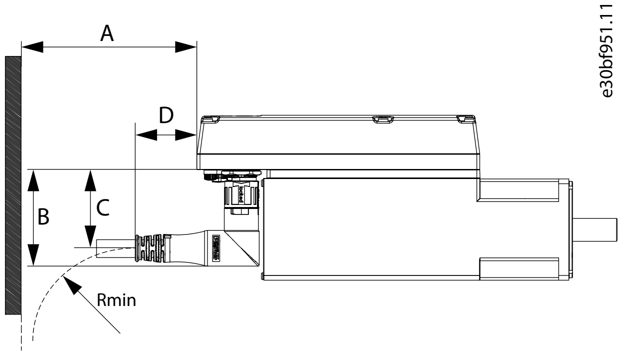


Illustration 138: Minimum Distance for M23 Angled Connector

Table 121: Dimensions

Dimension	Sizes 1 and 2 [mm (in)]	Sizes 3 and 4 [mm (in)]
A	140 (5.51)	135 (5.31)
B	82 (3.23)	84 (3.31)
C	68 (2.68)	69 (2.72)
D	51 (2.01)	48 (1.9)

8.10.2 Space Requirements for DSD 510 Servo Drive

In addition to its own dimensions, the DSD 510 servo drive needs space for the hybrid cable.

8.10.2.1 Minimum Distance for M23 Straight Connector on DSD 510 shows the straight connector installed on a DSD 510 servo drive.

8.10.2.2 Minimum Distance for M23 Angled Connector on DSD 510 shows the angled connector installed on a DSD 510 servo drive.

The illustrations show the minimum distance from the servo drive to the next object, and the minimum allowable bending radius R_{min} for permanently installed cable. For cable installation, allow the height of the connector plus an additional 30 mm for the cable.

8.10.2.1 Minimum Distance for M23 Straight Connector on DSD 510

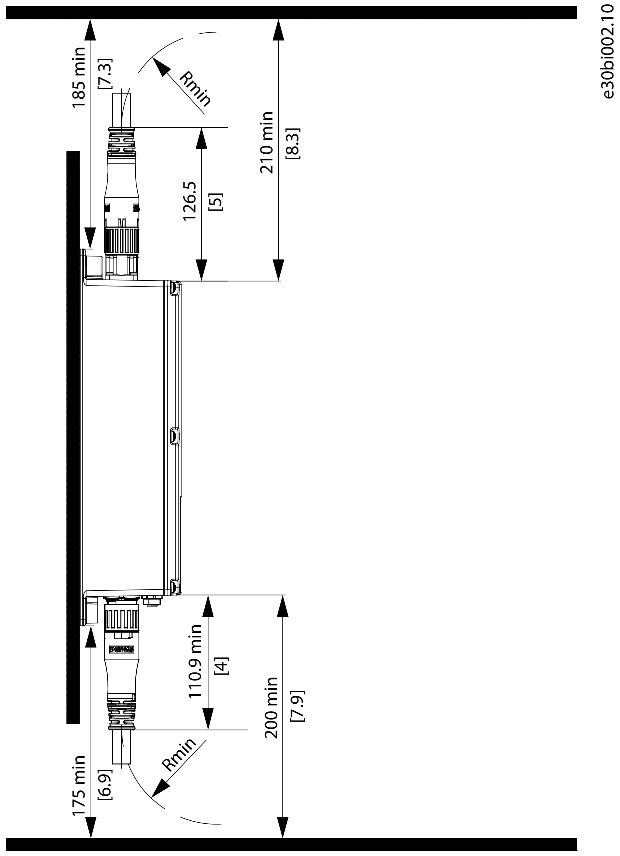


Illustration 139: Minimum Distance for M23 Straight Connector

8.10.2.2 Minimum Distance for M23 Angled Connector on DSD 510

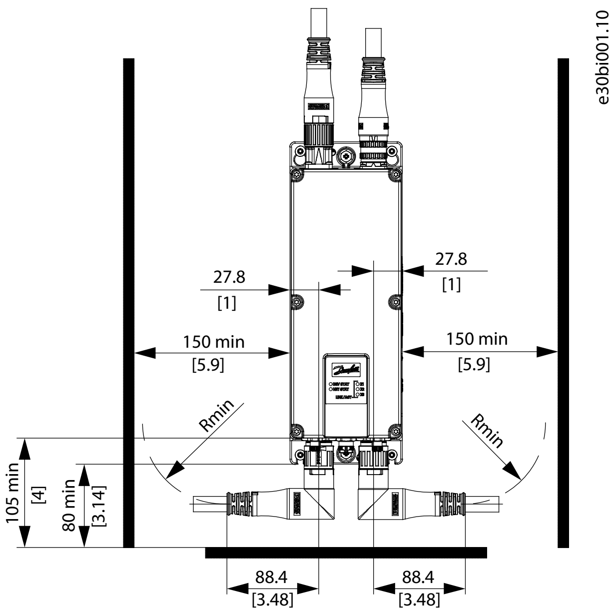


Illustration 140: Minimum Distance for M23 Angled Connector

8.10.3 Space Requirements for System Modules

The modules can be mounted next to each other but require a minimum space at the top and bottom for cooling.

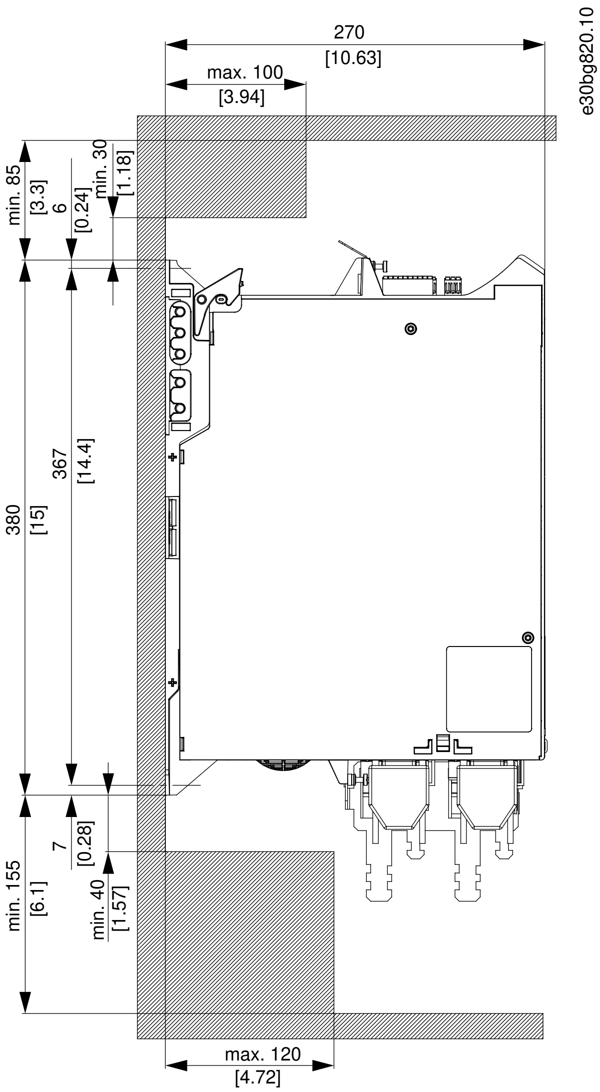


Illustration 141: Minimum Space Required at the Top and Bottom

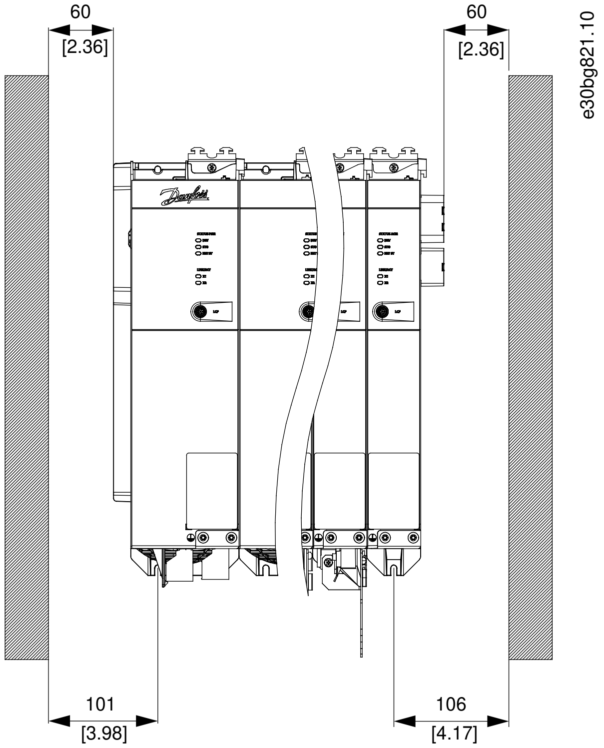


Illustration 142: Minimum Space Required at the Sides

9 Mechanical Installation Considerations

9.1 Allowed Forces on the ISD 510 Servo Drive Shaft

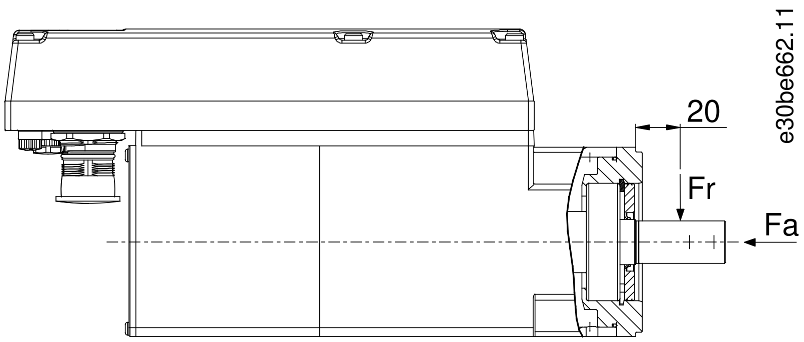


Illustration 143: Allowed Forces

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 122. The shaft must be loaded slowly and in a constant manner: Avoid pulsating loads.

N O T I C E

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

Table 122: Maximum Load Ratings

Motor size	Maximum radial force (Fr) in N	Maximum axial force (Fa) in N
Size 1	450	1050
Size 2	900	1700
Size 3	830	1740
Size 4	1940	2200

The maximum radial load ratings are based on the following assumptions:

- The servo drives are operated with peak torque of the longest member of the enclosure size.
- Fully reversed load is applied to the end of the smallest diameter standard mounting shaft extension.
- Infinite life with standard 99% reliability.
- Safety factor = 2

9.2 Bearing Load Curves for ISD 510 Servo Drives

This section shows the bearing load curves (L10h – 10% failure) for each servo drive variant. The bearing loads are calculated based on DIN ISO281. The curves show the maximum allowed radial force versus the maximum allowed axial force on the shaft end for different speeds. The estimated life-span of the bearing with this condition is 20000 h.

9.2.1 Bearing Load Curve for ISD 510 Size 1, 1.5 Nm

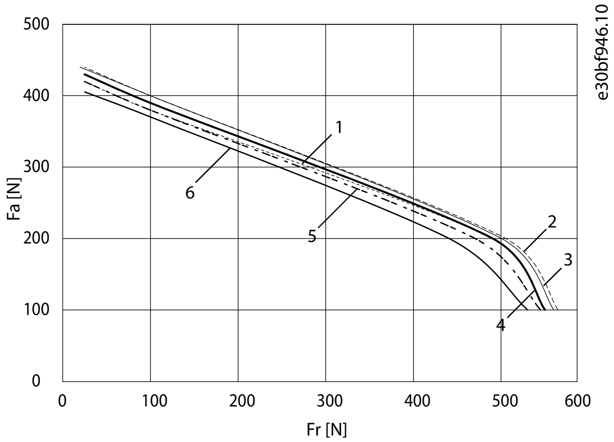


Illustration 144: Size 1, 1.5 Nm

1	500 RPM	4	3000 RPM
2	1000 RPM	5	4000 RPM
3	2000 RPM	6	5000 RPM

9.2.2 Bearing Load Curve for ISD 510 Size 2, 2.1 Nm

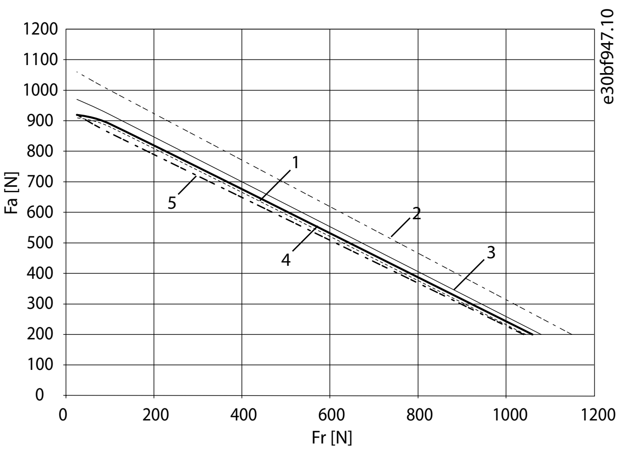


Illustration 145: Size 2, 2.1 Nm

1	500 RPM	4	3000 RPM
2	1000 RPM	5	4000 RPM
3	2000 RPM		

9.2.3 Bearing Load Curve for ISD 510 Size 2, 2.9 Nm

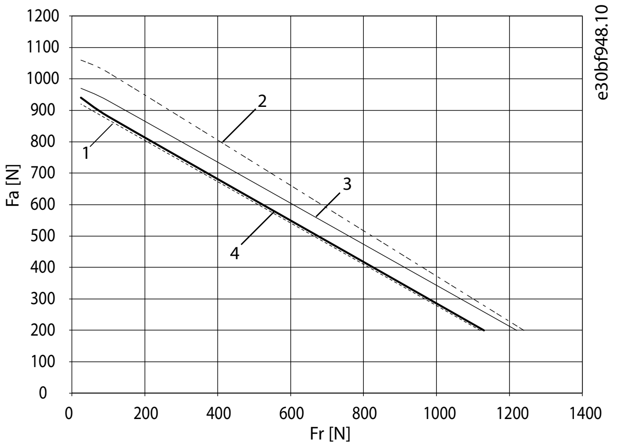


Illustration 146: Size 2, 2.9 Nm

1	500 RPM	3	2000 RPM
2	1000 RPM	4	3000 RPM

9.2.4 Bearing Load Curve for ISD 510 Size 2, 3.8 Nm

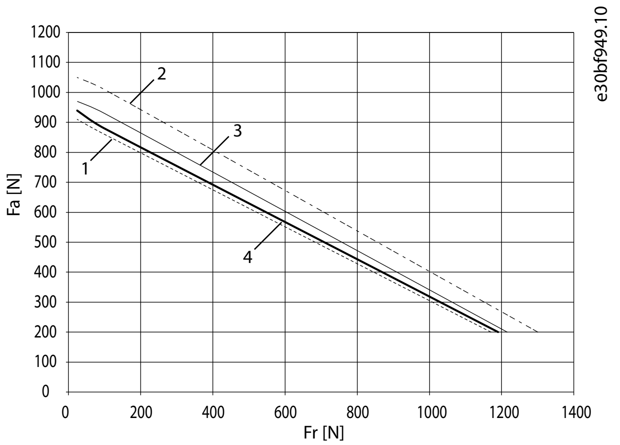


Illustration 147: Size 2, 3.8 Nm

1	500 RPM	3	2000 RPM
2	1000 RPM	4	3000 RPM

9.2.5 Bearing Load Curve for ISD 510 Size 3, 5.2 Nm

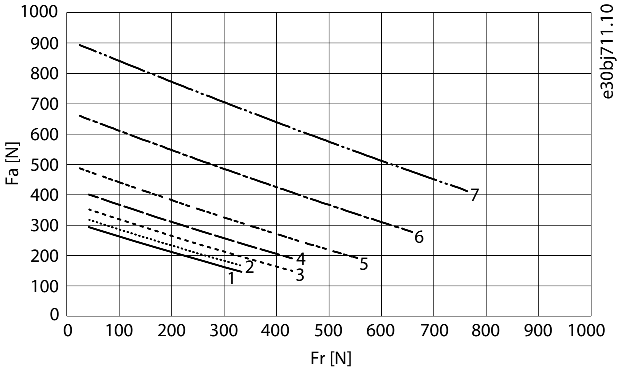


Illustration 148: Size 3, 5.2 Nm

1	6000 RPM	5	2000 RPM
2	5000 RPM	6	1000 RPM
3	4000 RPM	7	500 RPM
4	3000 RPM		

9.2.6 Bearing Load Curve for ISD 510 Size 3, 6.0 Nm

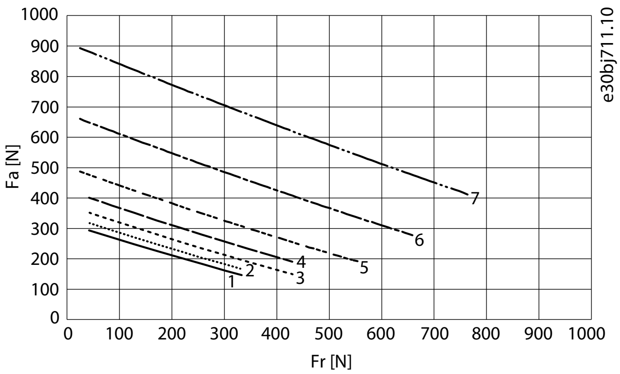


Illustration 149: Size 3, 5.2 Nm

1	6000 RPM	5	2000 RPM
2	5000 RPM	6	1000 RPM
3	4000 RPM	7	500 RPM
4	3000 RPM		

9.2.7 Bearing Load Curve for ISD 510 Size 4, 11.2 Nm

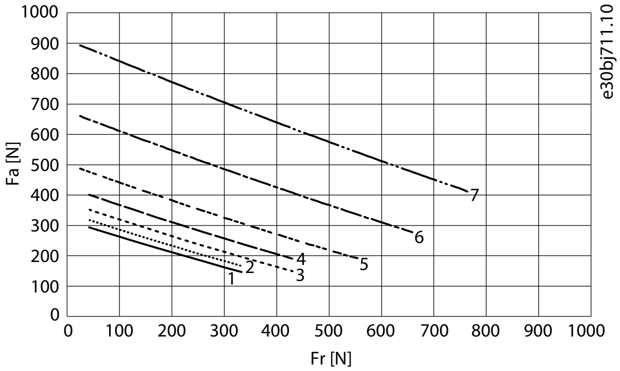


Illustration 150: Size 4, 11.2 Nm

1	6000 RPM	5	2000 RPM
2	5000 RPM	6	1000 RPM
3	4000 RPM	7	600 RPM
4	3000 RPM		

Index

VLT Servo Drive Systems Glossary

A

A-flange	The A side is the shaft side of the servomotor.
ACM	Auxiliary Capacitors Module.
Ambient temperature	The temperature in the immediate vicinity of the servo system or component.
Automation Studioô	Automation Studioô is a registered trademark of B&R. It is the integrated software development environment for B&R controllers.

B

B side	The rear side of the servo drive with the plug-and-socket connectors.
B&R	Multi-national company, specializing in factory and process automation software and systems for a wide range of industrial applications.
Bearings	The ball bearings of the servomotor.
BeckhoffÆ	BeckhoffÆ is a registered trademark of and licensed by Beckhoff Automation GmbH, Germany.
Brake	Mechanical holding brake on the servo drive.

C

CANopenÆ	CANopenÆ 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. CIAÆ is a registered community trademark of CAN in Automation e.V.
Connector (M23)	Servo drive hybrid connector.
Cooling	Decentral servo drives are cooled by natural convection (without fans). The Servo Drive Modules SDM 511/SDM 512 and all system modules except the DAM 510, ACM 510, and EXM 510 are cooled by an internal fan.

D

DAM	Decentral Access Module
DC voltage	A direct constant voltage.
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.
DSD	Decentral Servo Drive

E

EPSG	Ethernet POWERLINKÆ Standardization Group.
ETG	EtherCATÆ Technology Group
EtherCATÆ	EtherCATÆ (Ethernet for Control Automation Technology) is an open high-performance Ethernet-based fieldbus system. EtherCATÆ is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.
Ethernet POWERLINKÆ	Ethernet POWERLINKÆ is a deterministic real-time protocol for standard Ethernet. It is an open protocol managed by the Ethernet POWERLINKÆ Standardization Group (EPSG). It was introduced by Austrian automation company B&R in 2001.

F

Feed-in cable	Hybrid connection cable between the Decentral Access Module (DAM 510) and ISD 510/DSD 510 servo drive.
Feedback system	The feedback system measures the rotor position.
Fieldbus	Communication bus between controller and servo axis and system modules; 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.

I

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.
IRT	Isochronous Real-Time.
ISD	Integrated Servo Drive
ISD servomotor	Designates the ISD servomotor (without the drive electronics).
Installation elevation	Installation elevation above normal sea level, typically associated with a derating factor.

L

LCP	Local control panel.
Loop cable	Hybrid connection cable between 2 decentral servo drives, with 2 M23 connectors.

M

M12 connector	Connector (X4) for connecting I/O and/or encoder on the B side of the ISD 510/DSD 510 servo drive.
M23 connectors	Connectors (X1 & X2) for connecting the hybrid feed-in and loop cables on the B side of the ISD 510/DSD 510 servo drive.
M8 connectors	Fully functional real-time Ethernet port (X3) on the B side of the ISD 510/DSD 510 servo drive. Connector (X5) for connection of the LCP to the B side of the ISD 510/DSD 510 servo drive.
MSD	Multi-axis Servo Drive
Motor shaft	Rotating shaft on the A side of the servo motor, typically without a key groove.
Multi-turn encoder	Describes an absolute encoder, in which the absolute position remains known after several revolutions.

P

PELV	Protected extra low voltage is an electricity supply voltage in a range which carries a low risk of dangerous electrical shock.
PLC	A programmable logic controller is a digital computer used for automation of electromechanical processes, such as control of machinery on factor assembly lines.
PLCopenÆ	The name PLCopenÆ is a registered trademark and, together with the PLCopenÆ logos, is owned by the association PLCopenÆ. PLCopenÆ is a vendor- and product-independent worldwide association that defines a standard for industrial control programming.

POU	Program organization unit. This can be a program, function block, or function.
PSM	Power Supply Module.
PWM	Pulse width modulation.

R

RCCB	Residual current circuit breaker.
RT	Real-time.
Resolver	A feedback device for servomotors, typically with 2 analog tracks (sine and cosine).

S

SDM	Servo Drive Module.
SIL 2	Safety Integrated Level II.
SSI	Synchronous serial interface.
STO	Safe Torque Off function. On activation of STO, the ISD 510 servo drive is no longer able to produce torque in the motor.
Safety (STO)	A servo drive safety circuit that switches off the voltages of the driver components for the IGBTs.
Scope	Scope is part of the DDS Toolbox software and is used for diagnosis. It enables internal signals to be depicted.
Single-turn encoder	Describes an absolute encoder, in which the absolute position for 1 revolution remains known.
Standstill (servo drive)	Power is on, there is no error in the axis, and there are no motion commands active on the axis.
System modules	This term includes the Power Supply Module (PSM 510), the Decentral Access Module (DAM 510), and the optional Auxiliary Capacitors Module (ACM 510).

T

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

UAUX	Auxiliary supply, provides power to the control electronics of the ISD 510/ DSD 510 servo drives and the Power Supply Module (PSM 510), Decentral Access Module (DAM 510), and Auxiliary Capacitors Module (ACM 510).

V

VLT® Servo Toolbox	A Danfoss pc software tool used for parameter setting and diagnostics of VLT® Servo Drive systems

W

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

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