MSD Servo Drive

Operation Manual

AC-AC Servo Drive

Single-axis System
4 A to 450 A

MSD Servo Drive high-performance drives

The modularity of the MSD Servo Drive guarantees optimum integration into the machine process. Whether in high-speed field bus communication with the central multi-axis machine controller or with distributed programmable Motion Control intelligence in the servo drive, the MSD Servo Drive is a master of both.

MSD Servo Drive Operation Manual

AC-AC Single-Axis System

CA65642-001, Rev. 5.4

Date: 12/2024

Applicable as from firmware version: V2.20-01

Subject to technical change without notice

The content of our documentation was compiled with the greatest care and attention, and based on the latest information available to us.

We should nevertheless point out that this document cannot always be updated simultaneously with the on-going technical development of our products.

Information and specifications may be subject to change at any time. For information on the latest version please visit drives-support@moog.com.

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1 General

The product CD from Moog contains the complete documentation for the related product series. The documentation for a product series includes the Operation Manual (hardware description), device help (software description) as well as further user manuals (e.g. field bus description) and specifications. The documents are available in the format PDF, HTML or chm.

1.1 Target group

Dear user,

the documentation forms part of the device and contains important information on operation and service. It is aimed at all persons who undertake mounting, installation, commissioning and servicing work on the product.

1.2 Prerequisites

Prerequisites for the usage of devices from Moog:

- The documentation on the devices is to be stored so it legible, accessible at all times and for the entire life of the product.
- Read and ensure you understand the documentation on your device.
- Qualification to prevent injury or damage, personnel may only work on the device if they have electrical engineering qualifications
- Knowledge required:
  - National health and safety regulations (e.g. DGUV V3 in Germany)
  - Mounting, installation, commissioning and operation of the device

Work in other areas, for example transport, storage and disposal is only allowed to be undertaken by trained personnel.

NOTE
This operation manual applies to the AC-AC servo drive of the MSD Single-Axis System (referred to in the following as the servo drive or MSD Servo Drive for short).

1.3 Reference documents

Document	Contents	ID no. Format
MSD Single-Axis Servo Drive Compact- Operation Manual	Safety, mechanical installation, electrical installation, commissioning, diagnostics, specifications certification and applicable standards, technical data	CA97555-001 PDF
MSD Servo Drive AC-AC Servo Drive Single-Axis System - Operation Manual	Safety, mechanical installation, electrical installation, commissioning, diagnostics, specifications certification and applicable standards, technical data	CA65642-001 PDF
MSD Servo Drive DC-AC Servo Drive Multi-Axis System- Operation Manual	Safety, mechanical installation, electrical installation, commissioning, diagnostics, STO, operation with AC-AC Servo Drive as supply, planning, application example, specifications certification and applicable standards, technical data	CA97554-001 PDF
MSD Power Supply Unit Multi-Axis System- Operation Manual	Safety, mechanical installation, electrical installation, commissioning, diagnostics, specification certification and applicable standards technical data	CA97556-001 PDF
MSD Servo Drive Sercos II - User Manual	Safety, commissioning, communication phases, parameter interface, error, warning and status messages, operation modes, weighting, referencing, touchprobe, parameter lists	CA65648-001
MSD Servo Drive Sercos III - User Manual	Safety, installation and connection, commissioning and configuration setting parameters, data transmission, scaling and weighting, functionality, error message and diagnostics, parameter lists	CA97557-001 PDF
MSD Servo Drive Field bus systems CANopen/EtherCAT - User Manual	Safety, commissioning, data transmission, operation modes, referencing, parameters, technical data	CA65647-001 PDF
MSD Servo Drive Field bus systems Profibus/Profinet User Manual	Description and configuration of the parameters for the MSD Se vo Drive on the PROFIBUS/PROFINET field bus syste	CA65645-001
Modular Multi-Axis Servo Drive System - MSD - Ordering Catalog	Information, notes on ordering, specifications and technical data on: MSD Single-Axis Servo Drive Compact, MSD Single-Axis System, MSD Multi-Axis System, safety technology, communication, technology, function packages, accessories and motors	CDL 29950-en
MSD Servo Drive - Device Help	Description of the software functionality MSD Servo Drive, firmware versions: - MSD Single-Axis Servo Drive Compact from V1.30-xx - MSD Single-Axis System from V3.25-xx - MSD Multi-Axis System from V3.25-xx	CB40859-001 PDF and HTML
Program help Moog DriveAdminsitrator 5 PC user software	Context-sensitive help for Moog DriveAdministrator version 5.x graphic PC user software for initial commissioning and serial commissioning, operation, diagnostics and project management	CB19692-001

1.4 Order code

The MSD Servo Drive has the article designation G392-xxx-xxx-xxx and G395-xxx-xxx-xxx. This provides information on the related variant of the MSD Servo Drive supplied. The significance of the individual characters of the article designation is given in the following order code. You will find the complete order code with all values in the MSD Servo Drive Ordering Catalog.

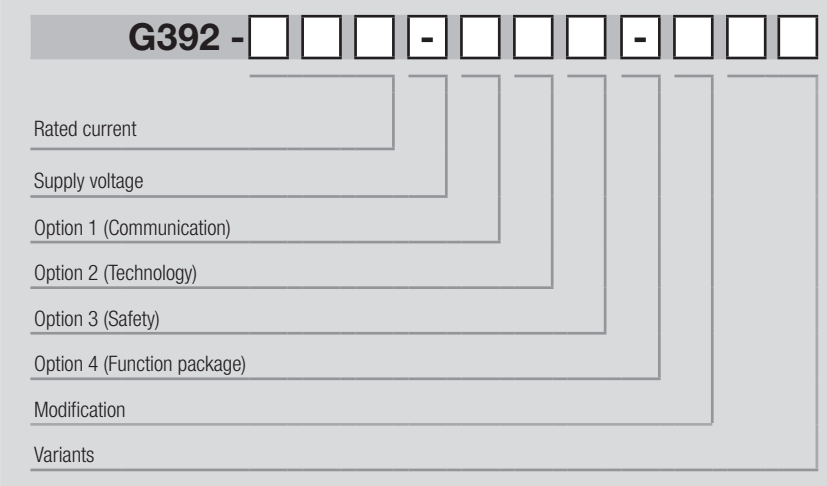

Figure 1.1 Order code MSD Servo Drive AC-AC (air-cooled)

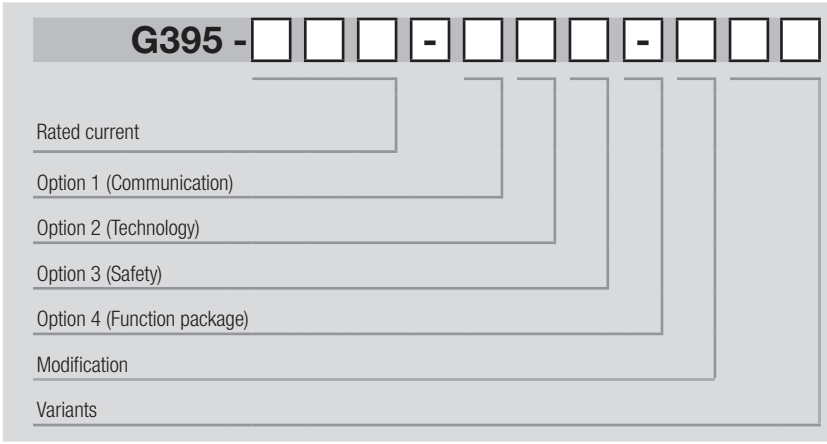

Figure 1.2 Order code MSD Servo Drive AC-AC (liquid-cooled)

1.5 Data on manufacture

On rating plates for the servo drives you will find the serial number, from which you can identify the date of manufacture based on the key (Figure 1.3). The location of the rating plate on the MSD Servo Drive can be found to the layouts for the respective Size 1 to Size 7.

Figure 1.3 MSD Servo Drive AC-AC hardware rating plate

1.6 Scope of supply

The scope of supply includes:

- MSD Servo Drive AC-AC
- Terminal kit for control and power terminals (depending on device power and variant)
- Set of grommets (for devices with liquid cooling)
- Product CD with booklet

1.7 Pictograms

The pictograms used in this operation manual signify the following for the user:

NOTE

Useful information or reference to other documents.

1.*(digit)*

ACTION TO BE TAKEN

Action undertaken by the user or the system.

You will find the pictograms used in this operation manual for "safety instructions and warnings" in *chapter 2 Safety.*

1.8 Disclaimer

Following the documentation on the devices from Moog is a prerequisite:

- For safe operation.
- To achieve stated performance features and product characteristics.

Moog does not accept any liability for injuries, damage or financial losses that result from the failure to follow the documentation.

1.9 Disposal

Follow the applicable national regulations! If necessary, dispose of individual parts, depending on their characteristics and existing national regulations, e.g. as:

- Electrical waste
- Plastic
- Metal

Or engage a certified disposal organisation with scrapping

1.10 Helpline/ Support & Service

Our Helpline will help you with fast, specific assistance if you have any technical queries relating to project planning or commissioning your device.

Address: Moog GmbH
Hanns-Klemm Straße 28
D-71034 Böblingen
Phone: +49 7031 622-0
E-mail: drives.support@moog.com

If you need service assistance, the Moog specialists will be pleased to be of assistance.

Service - Please contact us:

Phone: +49 7031 622-0
E-mail: info.gemany@moog.com

2 Safety

2.1 Overview

Our devices are state-of-the-art and comply with recognised safety regulations, nevertheless hazards can arise. In this chapter:

- We provide information on residual risks and hazards that can emanate from our devices on usage as intended.
- We warn about the foreseeable misuse of our devices.
- We refer to the necessary care and measures to be taken to prevent risks.

2.2 Measures for your safety

NOTE

Only install and place in operation your device taking into account the documentation for the related device family!

Our devices are quick and safe to operate. For your own safety and for the safe function of your device, please be sure to observe the following points:

1. **Follow safety instructions for the devices**:
Follow all safety instructions and warnings in the entire documentation related to the device series.

2. **Electric drives are dangerous:**

- Due to electrical voltages up to 480 V AC and up to 900 V DC
- Even 10 min. after switching off the mains supply, dangerously high voltages of ≥50 V may still be present (capacitor charge). So check that electrical power is not present! See also the warning label on the front panel on the device.
- Rotating parts
- Automatically starting drives.
- Hot components and surfaces

3. **Protection against magnetic and/or electromagnetic fields during installation and operation.**

Persons fitted with heart pacemakers metallic implants and hearing aids etc. must not be allowed access to the following areas:

- Areas in the immediate vicinity of electrical equipment!
- Areas where electronics components and servo drives are installed, repaired and operated!
- Areas where motors are installed, repaired and operated!
  Motors with permanent magnets pose particular hazards.

4. **During installation observe the following:**

- Comply with connection conditions and technical data as per the documentation and the rating plate!
- Comply with standards and directives on electrical installation, such as cable cross-section, shielding, etc.!
- Do not touch electronic components and contacts!
  Electrostatic discharge can harm people and destroy components!
- Take protection measures and use protective devices as per the applicable regulations (e.g. IEC/EN 60204 or IEC/EN 61800-5-1)!
- Take "device earthing" protection measure!

5. **Ambient conditions**

- Follow the instructions on the transport, storage and correct operation of the devices stated in the operation manual in "A Appendix".

2.3 General safety instructions and warnings

DANGER!	Risk of injury due to electrical power!
	• **Carelessness will result in serious injuries or death.** Follow safety instructions and warnings in this document and on the device.

WARNING!	Risk of injury due to electrical power!
	• **Carelessness may result in serious injuries or death.** Follow safety instructions and warnings in this document and on the device.

CAUTION!	Risk of injury or damage to the device due to incorrect operation!
	• **Carelessness may result in minor injuries or damage.** Follow safety instructions and warnings in this document and on the device.

WARNING!	Risk of injury due to hot surfaces and components!
	• **Carelessness may result in serious burns.** Electronic components may become hot during operation! Follow safety instructions and warnings in this document and on the device!

Caution!	Damage due to electrostatic discharge!
	• **Electrostatic discharge can destroy components.** Do not touch electronic components and contacts! Follow safety instructions and warnings in this document and on the device!

DANGER!	Risk of injury due to rotating parts on the motor!
	• **Carelessness will result in serious injuries or death.** Follow safety instructions and warnings in this document.

Pay attention to **special safety instructions and warnings** that are given here in the document before a specific action and that warn the user about a **specific hazard**!

NOTE:

The pictograms may also be used on their own with the signal word, e.g. in the connection diagrams, however they have the same function as in the complete warning.

DANGER	WARNING	CAUTION
		

2.4 Intended use

Our devices are components intended for stationary electrical systems and machines in the industrial and commercial sector.

CE The devices conform to the **Machinery Directive 2006/42/EC**

Tested and certified according to applicable standards (see declaration of conformity in chapter 2.8)

When installed in machines it is prohibited to start up intended operation until it has been ascertained that the completed machine fully complies with the provisions of the Machinery Directive (2006/42/EC); compliance with IEC/EN 60204 is mandatory.

Starting up intended operation is only permitted on compliance with the EMC Directive 2014/30/EU.

The devices meet the requirements of the harmonised product standard IEC/EN 61800-5-1.

You will find information on the installation of your device in chapter “3 Mechanical installation”.

2.4.1 Repair

Only have repairs undertaken by authorised repair shops. Unauthorised repairs could lead to death, injury or damage (see previous chapter). The warranty provided by Moog will be rendered void.

2.5 Misuse

Our devices are:

- Not intended for installation in vehicles. Deployment of the device in mobile equipment is classed as non-standard ambient conditions, and is permissible only by special agreement.
- Not intended for installation in environments with harmful oils, acids, gases, vapours, dusts, radiation etc.
- Not approved for usage in special applications (e.g. in potentially explosive atmospheres or areas in which there is a risk of fire).
- Not approved for usage outside a switch cabinet
- Not approved for the generation of high-frequency onboard networks for which the devices are not designed

2.6 Responsibility

Electronic devices are not fail-safe. The installer and/or operator of a complete machine or system is responsible:

- For ensuring the drive is rendered safe if the device fails.
- For ensuring the safety of personnel and machinery.
- For ensuring the complete machine is in correct working order.
- For the risk assessment on the complete machine or system according to EN ISO 12100 (formerly EN ISO 14121) and EN ISO 13849-1 (formerly DIN EN 954-1).

Pay attention to the topic of "Electrical equipment of machines" in EN 60204-1:2006 "Safety of machinery".

- The safety requirements on electrical machines defined there are intended to protect personnel and machinery or systems.

- The emergency stop function (as per IEC/EN 60204) shuts down the supply of power to a machine, which results in the drives coasting down in an uncontrolled manner. To avert hazards, check whether it is appropriate:
  - To keep individual drives in operation.
  - To initiate specific safety procedures
  - To incorporate a Safe Torque Off function (Safe Torque Off: movement stop by "switching off the electrical supply" - STO).

2.7 Relevant laws, standards and directives applied

For information on the laws, standards and directives applied by Moog, refer to the declaration of conformity.

NOTE:

Depending on the specific application for the devices, other laws, standards and directives with provisions on "Safety" may apply. If necessary, contact the machine or system manufacturer.

NOTE:

Due to possible output frequencies > 600 Hz, the servo drives fall under Dual Use Regulation (EU) no. 1382/2014 dated 22 October 2014 item 3A225. Export authorisation is therefore required for non-EU countries. Please note the information in the delivery documents.

2.8 Declaration of conformity

2.8.1 MSD Servo Drive AC-AC Size 1 to Size 7

EU DECLARATION OF CONFORMITY

IN ACCORDANCE WITH EN ISO/IEC 17050-1 | PAGE 1 OF 1

DOCUMENT NO. MRO37051-001-REV. H (TRANSLATION OF ORIGINAL)

The Manufacturer Moog GmbH	Hanns-Klemm-Str. 28 – 71034 Boeblingen - Germany +49 7031 622 0 +49 7031 622 100 info.germany@moog.com http://www.moog.de

DECLARES UNDER SOLE RESPONSIBILITY that the following products has been manufactured in conformity with the requirements of the Directive 2006/42/EC (Machinery-Directive) of the European Parliament and of the Council on machinery and the Directive 2014/30/EU (EMC-Directive) of the European Parliament and of the Council on the harmonization of the laws of the Member States relating to the making available on the market of electromagnetic compatibility.

MODULAR MULTI-AXIS SERVO DRIVE SYSTEM (MSD)	
Product types	G391/G393/G395/G397 BG 1 - 7 G394 C2 - C5
Following harmonized standards has been applied	EN ISO 13849-1:2008 + AC:2009 EN 62061:2005 + AC:2010 + A1:2013 EN 61800-3:2004 + A1:2012 EN 61800-5-1:2007 + A1:2017 EN 61800-5-2:2007 EN 61508 Parts 1-7:2010 EN 50178:1997 EN 60204-1:2006 + A1:2009 + AC:2010 (In extracts)
Quality Manager	R. Lohse Richard Lohse

March 01, 2023	Moog GmbH Boeblingen	Thomas Czeppel	Thomas Czeppel
Date	Site	Managing Director	Signature

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WHAT MOVES YOUR WORLD

MOOG

2.9 UK Conformity Assessed (UKCA)

UKCA (UK Conformity Assessed) is the UK product marking required for certain products placed on the market in the UK (England, Wales and Scotland).
Authorised representative is:

Moog Controls Ltd.

Ashchurch Parkway

Tewkesbury

GL20 8TU

UK

Authorised person to compile the technical file is Phil Williams, Moog Controls LtD.

2.9.1 Directives, Standards and Regulations

The table below provides a mapping of the EU Directives met to the applicable Directives in the UK.

European Union (EU)	United Kingdom (UK)
2006/42/EC - Machinery	Supply of Machinery (Safety) Regulations 2008
2014/30/EU - Electromagnetic Compatibility	Electromagnetic Compatibility Regulations 2016
2011/65/EU - Restriction of Hazardous Substances in Electrical and Electronic Equipment	The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

2.9.2 UKCA Declaration of conformity

The declaration of conformity of this product is available on request from Moog.

3 Mechanical installation

The device is designed only for installation in a stationary switch cabinet. The switch cabinet must as a minimum provide IP4x protection. According to EN ISO 13849-2 the switch cabinet must have IP54 protection or higher when using the safety function STO (Safe Torque Off).

3.1 Notes for installation

CAUTION	Damage to the device due to incorrect installation conditions!
	**The device may suffer irreparable damage.** For this reason • Moisture must not be allowed to enter the device • There must not be any aggressive or conductive substances in the ambient air • Foreign bodies such as drilling chips, screws, washers etc. must not be allowed to fall into the device • The ventilation openings must not covered

Note the following points:

- Cooling air must be able to flow through the device without restriction
- On installation in switch cabinets with convection (= heat loss is dissipated to the outside via the cabinet walls), always fit an internal fan
- The backing plate must be well-earthed.
- The device is intended only for vertical installation in switch cabinets. The switch cabinet must as a minimum provide IP4X protection.
- To attain the best result for effective EMC installation you should use a chromated or galvanised backing plate. If backing plates are varnished, remove the coating from the contact area! The devices themselves have an aluminium back panel (Size 1 to Size 4) or a back panel made of galvanised sheet steel (Size 5 to Size 7).
- Maximum pollution degree 2 according to IEC/EN 60664-1.
- The servo drives must not be installed in areas where they would be permanently exposed to vibration. You will find more information in the appendix Table A.20.
- The device heats up during operation and the temperature on the heat sink may reach +100 °C (+212 °F). Pay attention to this aspect for neighbouring components.

NOTE

According to EN ISO 13849-2 the switch cabinet must have IP54 protection or higher on using the STO (Safe Torque OFF) safety function.

3.2 Mounting (air and liquid cooling)

Step	Action	Comment
1.	Mark out the position of the tapped holes and the pipe fittings if necessary, on the backing plate. Drill holes and cut a thread for each fixing screw in the backing plate.	Pay attention to the mounting clearances! Pay attention to the bending radius of the connection cables! For dimensional drawings/hole spacing see Figure 3.2 to Figure 3.5
2.	Mount the servo drive vertically on the backing plate.	Observe the mounting clearances! The contact area must be bare metal.
3.	On devices with liquid cooling, while screwing the hose connections (not included in the scope of supply) into the pipe fittings lock the pipe fittings using a 22 mm (0.87 in) open-ended wrench to prevent damage due to the application of torque to the device.	Pay attention to a perfectly sealed connection without leaks (e.g. using Teflon sealing tape)
4.	Mount the other components, such as the mains filte , mains choke etc., on the backing plate.	The cable between mains filter and servo drive may be maximum 300 mm (11.81 in) long.

Table 3.1 Mechanical installation

NOTE:

Connect the flow from the liquid cooling for Size 7 to the connection correspondingly marked (Figure 3.6). For Size 3 to Size 6A the connection can be chosen as required.

3.3 Dimensions, devices with air cooling

MSD Servo Drive AC-AC	Size 1	Size 2	Size 3	Size 4	Size 5	Size 6	Size 6A
	G392-004A G392-004 G392-006	G392-008 G392-012	G392-016 G392-020	G392-024 G392-032	G392-045 G392-060 G392-072	G392-090 G392-110	G392-143 G392-170
Weight kg (lb)	3.4 (7.5)	4.9 (10.8)	6.5 (14.3)	7.5 (16.5)	13 (28.7)	28 (61.7)	32 (70.6)
B (width)	58.5 (2.3)	90 (3.54)	130 (5.12)	171 (6.73)	190 (7.48)	280 (11.02)	
H (height) [1]	295 (11.61)				345 (13.58)	540 (21.26)	
T (depth) [1]	224 (8.82)				238 (9.37)	242 (9.53)	322 (12.68)
A	29.25 (1.15)	50 (1.97)	80 (3.15)	120 (4.72)	150 (5.91)	200 (7.87)	
C	344.5 (13.56)				365 (14.37)	581 (22.87)	
C1	5 (0.2)				6 (0.24)	10 (0.39)	
D Ø	4.8 (0.19)				5.6 (0.22)	9.5 (0.37)	
Screws	2 x M4	4 x M4			4 x M5	4 x M8	
E	2 (0.07)				20 (0.78)	40 (1.57)	
F [2]	≥100 (3.94)		≥150 (5.91)		≥180 (7.09)		
G [2]	≥270 (10.63)				≥300 (11.81)		≥500 (19.68)
H1	355 (13.98)				382.5 (15.06)	600 (23.62)	
H2	38.5 (1.52)				15 (0.59)	20 (0.78)	

All dimensions in mm (in)

1) Without terminals, connectors and shield plates

2) If necessary take into account larger bending radii for connection cables.

Table 3.2 Dimensions, housing with air cooling, see Figure 3.1 and Figure 3.2

NOTE:

The minimum distance "E" specified in the table for sizes 1-4 applies for devices of the same power rating. On butt mounting devices with different drive powers, you should arrange the devices in order by power rating (e.g., viewed from the left, Size 4-Size 3-Size 2-Size 1). This arrangement will minimise the thermal interaction.

On butt mounting MSD Servo Drives with other devices, you should ensure there is no thermal interaction between the devices.

3.3.1 Mounting clearances

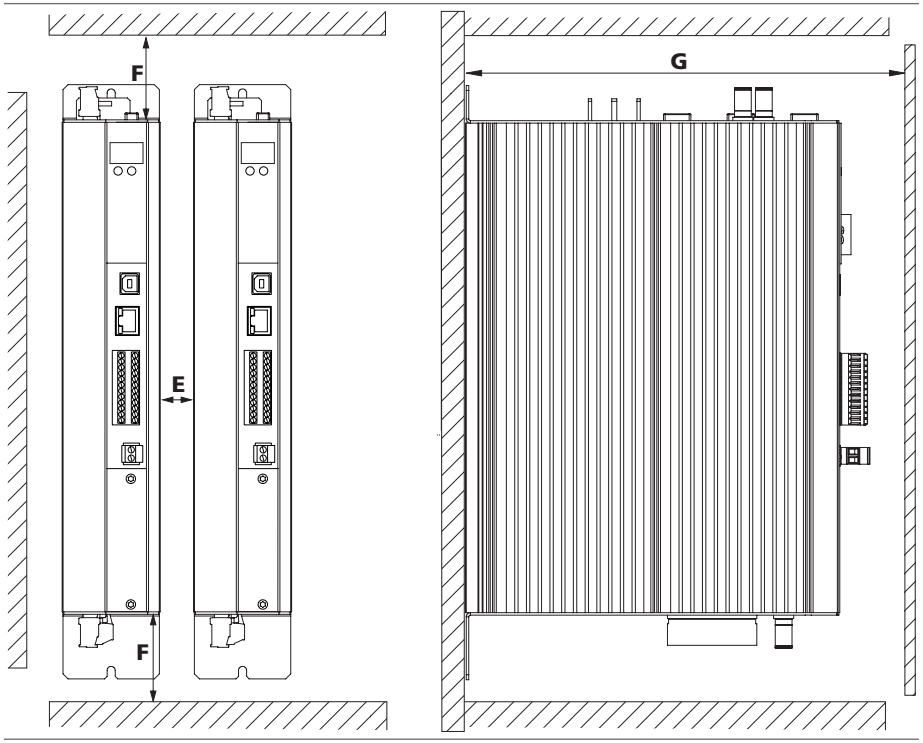


Figure 3.1 Mounting clearances for air cooling, schematic depiction for Size 1 to Size 6A

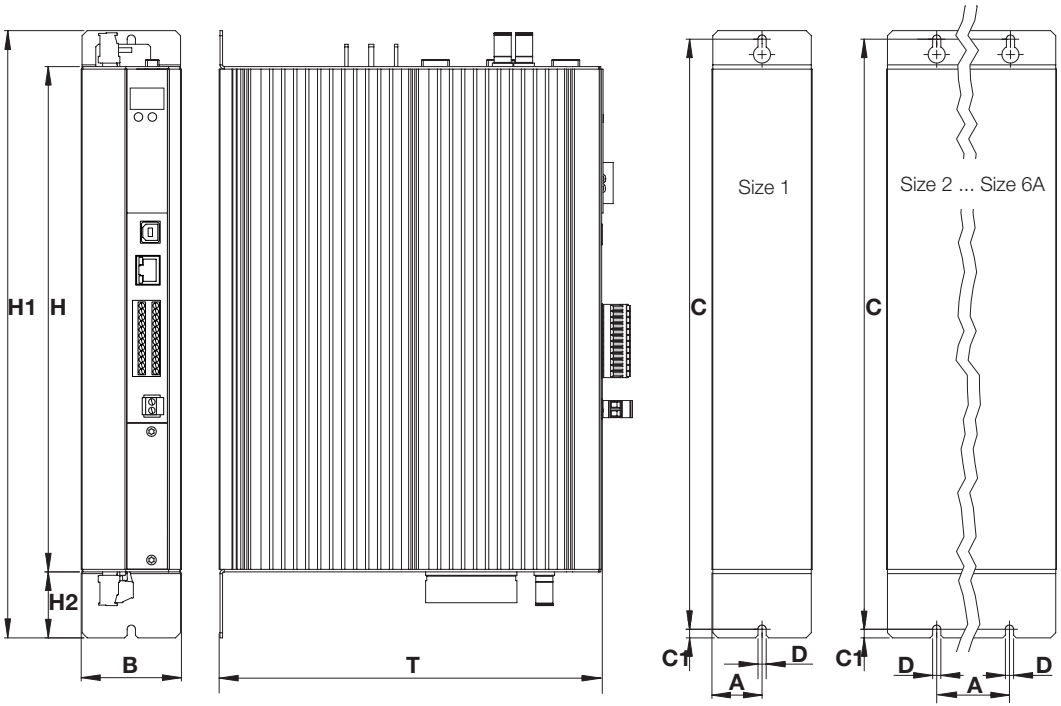


Figure 3.2 Dimensional drawing, housing with air cooling, schematic depiction for Size 1 to Size 6A

3.4 Dimensions, devices with liquid cooling

MSD Servo Drive AC-AC	Size 3		Size 4		Size 5	Size 6		Size 6A	Size 7
	G395-016 G395-020		G395-024 G395-032		G395-053 G395-070 G395-084	G395-110 G395-143		G305-170 G395-210	G395-250 G395-325 G395-450
Weight kg (lb)	6.5 (14.3)		7.5 (16.5)		16.5 (36.4)	31.5 (69.5)		41.1 (90.6)	100 (220.5)
B (width)	130 (5.12)		171 (6.73)		190 (7.48)	280 (11.02)			380 (14.96)
H (height) [1]	295 (11.61)				345 (13.58)	540 (21.26)			855 (33.66)
T (depth) [1]	224 (8.82)				198 (7.79)	202 (7.95)		282 (11.1)	287 (11.3)
A	80 (3.15)		120 (4.72)		148 (5.83)	200 (7.87)			150 (5.91)
A1	10 (0.39)		25 (0.98)		39 (1.54)	65 (2.56)			29 (1.14)
A2	60 (2.36)		70 (2.76)						
C	382 (15.04)				378 (14.88)	581 (22.87)			952 (37.48)
C1	5 (0.2)				8 (0.31)	10 (0.39)			14 (0.55)
H1	392 (15.43)				394 (15.51)	600 (23.62)			979/995 (38.54/39.17) [4]
H2	38.5 (1.52)				16.5 (0.65)	20 (0.79)			62 (2.44)
H3	75 (2.95)	70 (2.76)			53.5 (2.11)	56.5 (2.22)			124 (4.88)
T1	74 (2.91)				74 (2.91)				
D Ø	4.8 (0.19)				7 (0.28)	9.5 (0.37)			12 (0.47)
Screws	4 x M4				4 x M6	4 x M8			6 x M10
S	3/8 inch (female thread)								
D1 Ø	48 (1.89) (bore for pipe fitting)								
E	2 (0.08)								
F [2]	≥150 (5.91)				≥180 (7.09)				
G [2]	≥270 (10.63)				≥300 (11.81)			≥500 (19.69)	

All dimensions in mm (in)

1) Without terminals, connectors and shield plates

2) If necessary take into account larger bending radii for connection cables.

3) Without/with terminal covers and shield plates

4) Without/with busbars

Table 3.3 Dimensions, housing with liquid cooling, see Figure 3.3 to Figure 3.5

NOTE:

The minimum distance "E" specified in the table applies for devices of the same power rating. On butt mounting devices with different drive powers, you should arrange the devices in order by power rating (e.g., viewed from the left, Size 4-Size 3-Size 2-Size 1). This arrangement will minimise the thermal interaction.

On butt mounting MSD Servo Drives with other devices, you should ensure there is no thermal interaction between the devices.

3.4.1 Mounting clearances

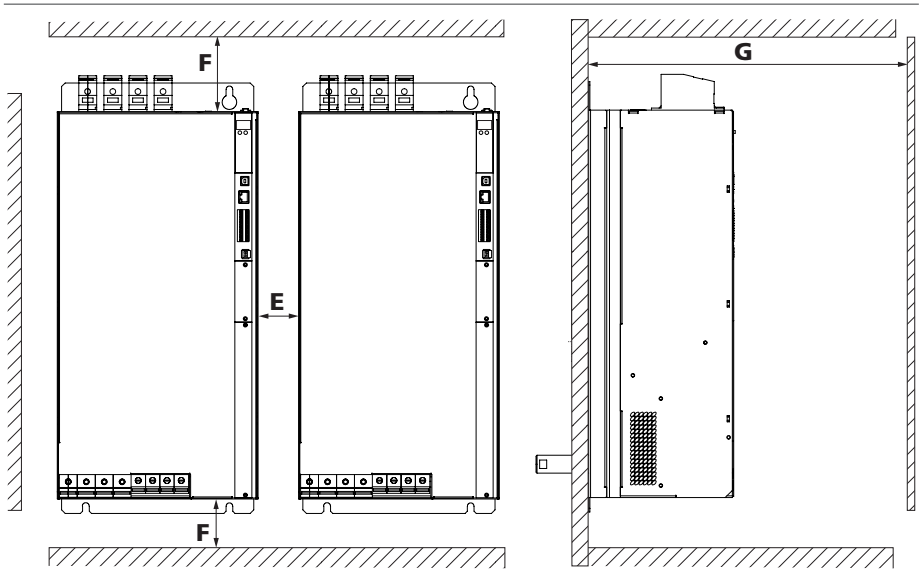


Figure 3.3 Mounting clearances for liquid cooling, schematic depiction for Size 3 to Size 7

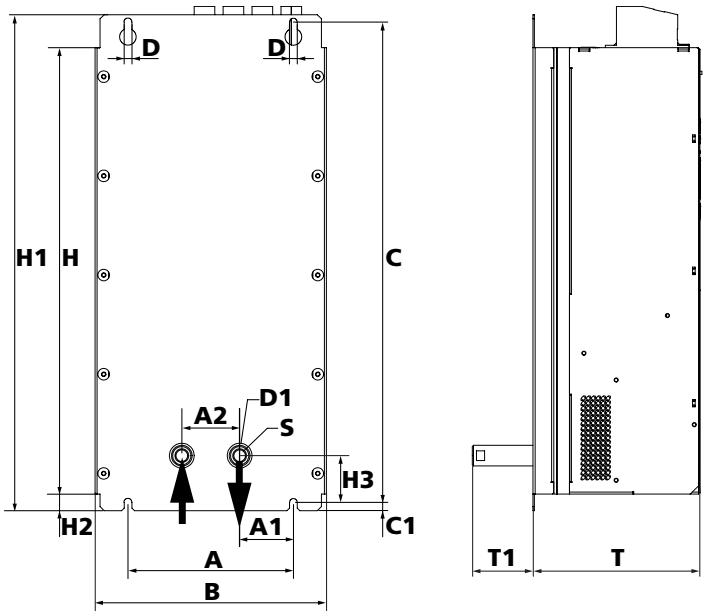


Figure 3.4 Dimensional drawing, housing with liquid cooling, schematic depiction for Size 3 to Size 6A

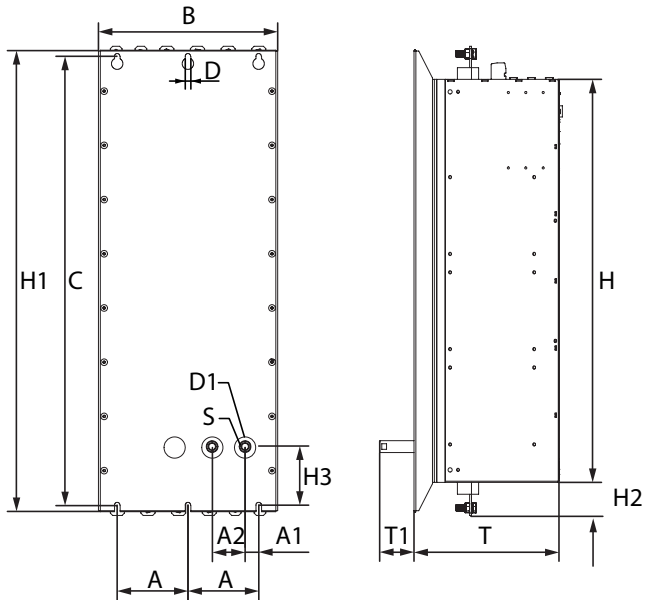
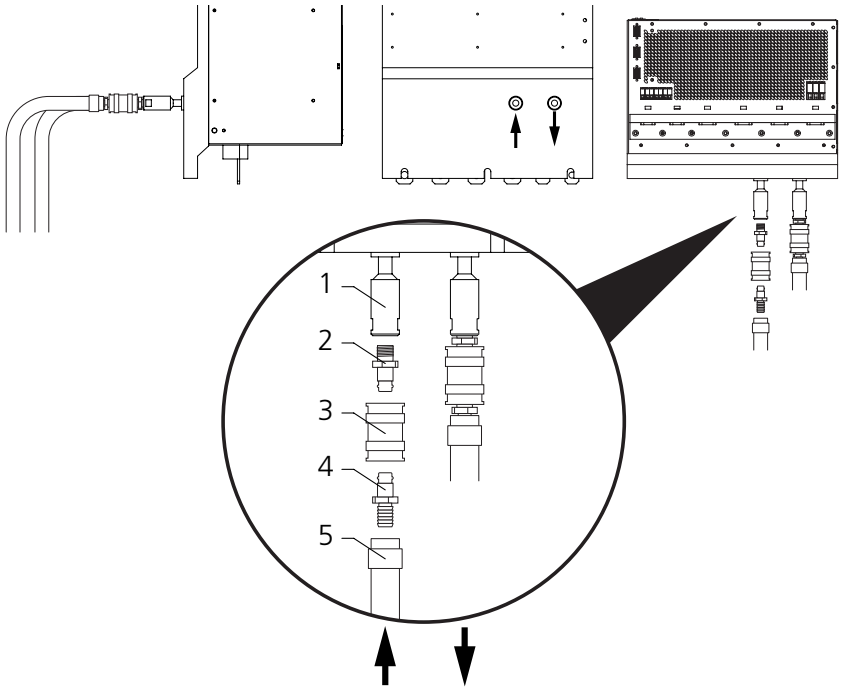


Figure 3.5 Dimensional drawing, housing with liquid cooling, schematic depiction for Size 7

3.5 Cooling circuit connection

The MSD Servo Drive has a capacity of up to 0.5 l of coolant depending on the size. After the disconnection of the connections, liquid may be left in the device and escape if the device is tipped. We recommend the usage of a self-sealing liquid coupling (not included in the scope of supply) to prevent the coolant escaping and to make it possible to disconnect and connect in the filled state.



Key

1) Liquid connection with 3/8 inch female thread
2) Self-sealing quick-release connection with 3/8 inch male thread
3) Self-sealing liquid coupling
4) Adapter for hose connection
5) PUR (polyurethane) hose with clip

NOTE:
Items 2 to 5 are **not** included in the scope of supply. You will find these in the cooling circuit connection set (CB37132-001). Please order seperately.

Figure 3.6 Cooling circuit connection (here: Size 7)

NOTE:
It is imperative the flow from the liquid cooling is connected to the connection correspondingly marked in Figure 3.4, Figure 3.5 or Figure 3.6.

NOTE:
Do not use material combinations with contact corrosion in the cooling circuit, such as aluminium and copper. This can lead to leaks and blockages of the cooling lines.

4 Electrical installation

4.1 Notes for installation

It is imperative you pay attention to the following warnings and safety instructions prior to and during installation.

DANGER!	**Risk of injury due to electrical power!**
	• **Carelessness will result in serious injuries or death.** Never make or disconnect electrical connections while they are electrically live! Always disconnect the power before working on the device. Even 10 min. (Size 1 to Size 4) / 30 min. (Size 5 to Size 7) after switching off the mains supply, dangerously high voltages of ≥50 V may still be present (capacitor charge). **So check that electrical power is not present!** Work on the device must only be carried out after the DC link voltage has dropped below a residual voltage of 50 V (on Size 1 to Size 6A to be measured on the terminals X11/L+ and L-, on Size 7 on the terminals X11/ZK- and X11/ZK+). Any existing additional DC link connections as well as all motor connections are to be checked in relation to each other and in relation to earth to ensure they are not carrying any electrical power. If necessary, all cable connections are to be discharged using suitable means. A dangerous voltage may be present at the device, even if the device does not emit any visual or audible signals/indications (e.g. with mains voltage applied to terminal X11 and missing control supply +24 V on X9/X10 and X44)!

WARNING!	**Risk of injury due to hot surfaces on the device (heat sink)!**
	• **Carelessness may result in serious burns.** The device and especially the heat sink heat up significantly during operation and can reach temperatures of up to +100 °C (+212 °C). Prior to starting work, make sure the device has cooled down. On touching there is a risk of burns to the skin. For this reason provide protection against touching. During mounting maintain an appropriate distance to neighbouring assemblies.

WARNING!	**Risk of injury due to hot coolant!**
	• **Carelessness may result in serious burns.** In operation the coolant reaches high temperatures. Prior to starting work, make sure the coolant has cooled down.

4.2 Effective EMC installation

4.2.1 Cable type

- Use only shielded mains, motor and signal cables. For all shielded connections, use cables with double copper braiding with 60 to 70 % coverage.
- If it is necessary to lay very large cable cross-sections, instead of shielded cables it is also possible to lay separate individually shielded wires. Please contact our application specialists on the Helpline.

4.2.2 Routing of cables

You should take into account the following points on laying the cables:

- Route mains, motor and signal cables separated from one another. Maintain a distance of at least 200 mm (7.87 in).
- For smaller distances use separators for shielding; fasten the separators directly and conductively to the backing plate.
- Route the cables close to ground potential. On the usage of cable ducts made of plastic, the cable ducts must be fastened directly to the backing plates or the frame. Open space must not be spanned, as otherwise the cables could act like antennae.
- Route motor cables without interruptions (e.g. not via terminals) and lay them by the shortest route out of the switch cabinet.
- If a motor contactor or a motor choke is used, the component should be positioned directly at the servo drive and the shielding on the motor cable should not be stripped back too far.
- Avoid unnecessary cable lengths and "loops of spare cable".
- Route long cables in places not be susceptible to interference. Otherwise coupling points may be created.
- Twist wires for the same electrical circuit.
- Ideally, route the signal cables separated from encoder cables.
- All signal cables should be combined and routed away upward.
- Avoid extending cables via terminals.

4.2.3 Usage with mains choke

The usage of mains chokes is:

- Required on all devices from and including Size 5
- Required on the usage of the servo drive in harsh industrial systems
- Recommended to increase the life of the DC link capacitors

4.2.4 Usage with internal mains filters

The servo drives Size 1 to Size 5 are equipped with integrated mains filters. With the measurement method specified by the standard, the servo drives meet the EMC protection goals according to IEC/EN 61800-3 for "First environment" (residential C2) and "Second environment" (industrial C3). For more detailed information see chapter A.6.

NOTE:

The servo drives described here are a restricted availability product in accordance with IEC/EN 61800-3. They can cause interference in residential areas. In such a case, the operator may need to take appropriate countermeasures.

4.2.5 Usage with external mains filters

External RFI filters (CA71188-001 to CA71190-001, CB09932-001) are available for the servo drives Size 6 and Size 6A. With the measurement method specified and the external mains filter, these servo drives also conform to the EMC product standard IEC/EN 61800-3 for "First environment" (residential C2) and "Second environment" (industrial C3).

Whether an external mains filter is required for the devices of size Size 7 depends on the type of connection and the local situation. For this reason the usage of a mains filter is to be considered in the specific case and decided during project planning.

To make it possible to use longer motor cables and achieve compliance with the EMC product standard IEC/EN 61800-3 for the "general availability" (residential C1), additional external mains filters are available for devices with an internal mains filter (Size 1 to Size 5).

4.2.6 Earthing measures

All earthed points and components must be routed directly to the central earthing point (e.g. PE rail, main earth) with as low an impedance as possible and with good conductivity. In this way an earthing system is produced that connects all connections to the earthing point in a star topology. This central earthing point is to be clearly defined. This earthing point can be extended to the entire backing plate with an effective EMC connection.

You should take into account the following points for the earthing:

- Earthed surfaces act as shielding measures and reduce electromagnetic fields in t e surrounding area. For this reason metal surfaces should be connected to ground with low-impedance HF connections. In terms of EMC it is not the cross-section of the cable that is defin tive, but the surface over which high-frequency currents caused by the skin effect can flow awa .
- Connect the protective earth conductors for the components in the switch cabinet using a star topology.
- Avoid the use of connectors.
- Also connect the walls and doors of the switch cabinet to ground.
- Earth unused cores at one end as a minimum so that there is no electrostatic charging.
- Free contact areas of paint and corrosion and make large area connections.
- The usage of tinned, galvanised, aluminised or cadmium-plated elements is to be preferred over painted components; it will then not be necessary to remove the paint. Connectors are to be avoided, or several contacts are to be used for the shield connection in the connector.

For further information on the cross-section of the protective earth conductor see “4.6 Connection of PE conductor”.

4.2.7 Shielding measures

You should take into account the following points for the shielding measures:

- Use only shielded mains, motor and signal cables. For all shielded connections, use cables with double copper braiding with 60 to 70 % coverage.
- Connect the shield at both ends using a large area connection. Extending the shield to the earthing point using a wire (pigtail) reduces the shielding effect by up to 90 %.

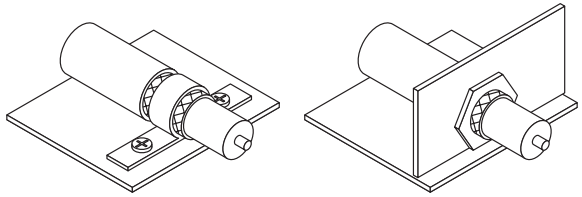


Figure 4.1 CORRECT shield connection

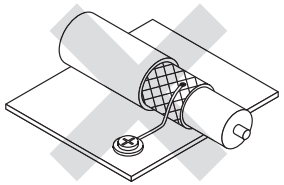


Figure 4.2 INCORRECT shield connection - do not extend to the earthing point (pigtail)

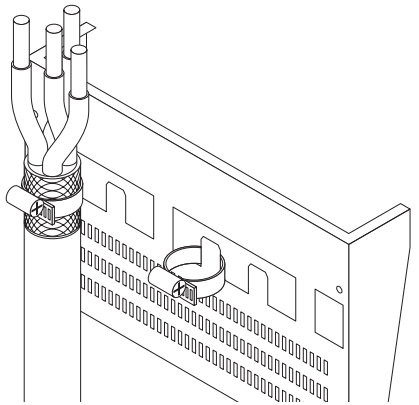


Figure 4.3 Shield connection

- Do not strip back too far the shield.
- Shields are not allowed to be used to carry power, e.g. as a substitute for the N or PE conductor.
- The shielding effect can be improved by laying in metal ducts/tubes.
- Shields must be connected at one end as a minimum. Connection at multiple points is recommended, otherwise potential equalisation currents may flow in physically exte sive installations.

4.2.8 External components

- Place larger loads near the supply.
- Contactors, relays, solenoid valves (switched inductances) must be wired with suppressors. The wiring must be directly connected to the respective coil.
- Any switched inductance should be at least 200 mm (7.87 in) away from the process controlled assemblies.

If you require further detailed information on installation, please contact the Moog Helpline, see chapter 1.10.

4.3 Overview of the connections, Size 1 to Size 4

In the following you will find the layout with the corresponding positions of the connectors and terminals. For improved clarity we have added an abbreviation to the designation for the connectors and terminals.

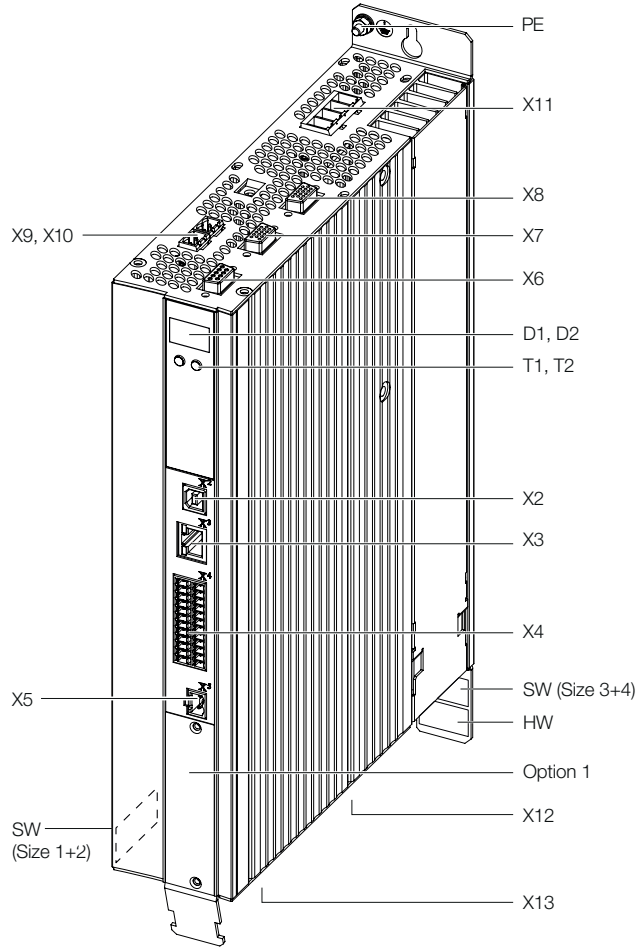


Figure 4.4 Layout, Size 1 to Size 4 (Size 1 air cooling variant)

4.3.1 Connection diagram

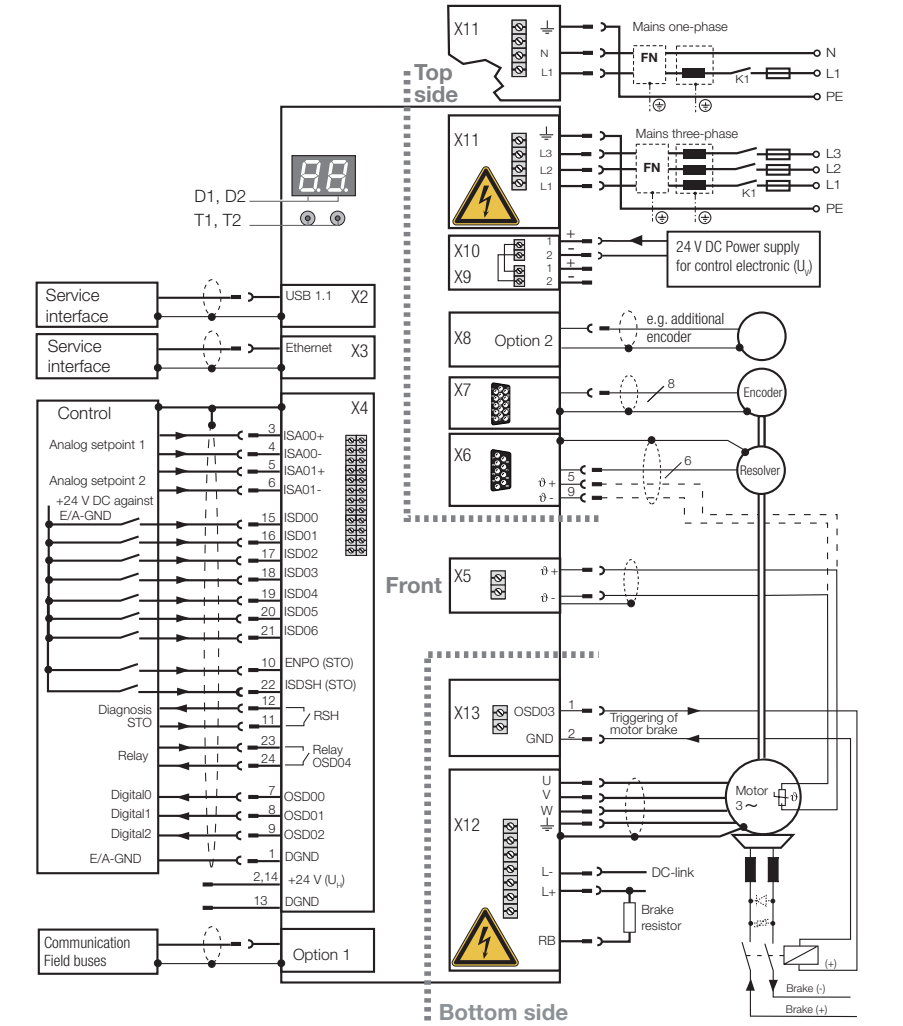


Figure 4.5 Connection diagram, Size 1 to Size 4

Key

Number	Designation
D1, D2	7-segment display
T1, T2	Button
X2	USB 1.1 interface
X3	Ethernet interface
X4	Control terminals
Option 1	Communication
X11	Connection for AC mains supply: 1 x 230 V = G392-004 (Size 1) 3 x 400/460/480 V G392-004/G395-016 to G392-032/G395-032 (Size 1 to Size 4)
PE	Connection for PE conductor
X9, X10	Connection for control supply
X8 (Option 2)	Technology
X7	Connection for high-resolution encoder
X6	Connection for resolver
X5	Connection for motor temperature monitoring
X13	Connection for motor brake
X12	Connection for motor, braking resistor and DC link
HW	Hardware rating plate
SW	Software rating plate

Table 4.1 Key to connection diagram, Size 1 to Size 4

4.4 Overview of the connections, Size 5 to Size 6A

In the following you will find the layout with the corresponding positions of the connectors and terminals. For improved clarity we have added an abbreviation to the designation for the connectors and terminals.

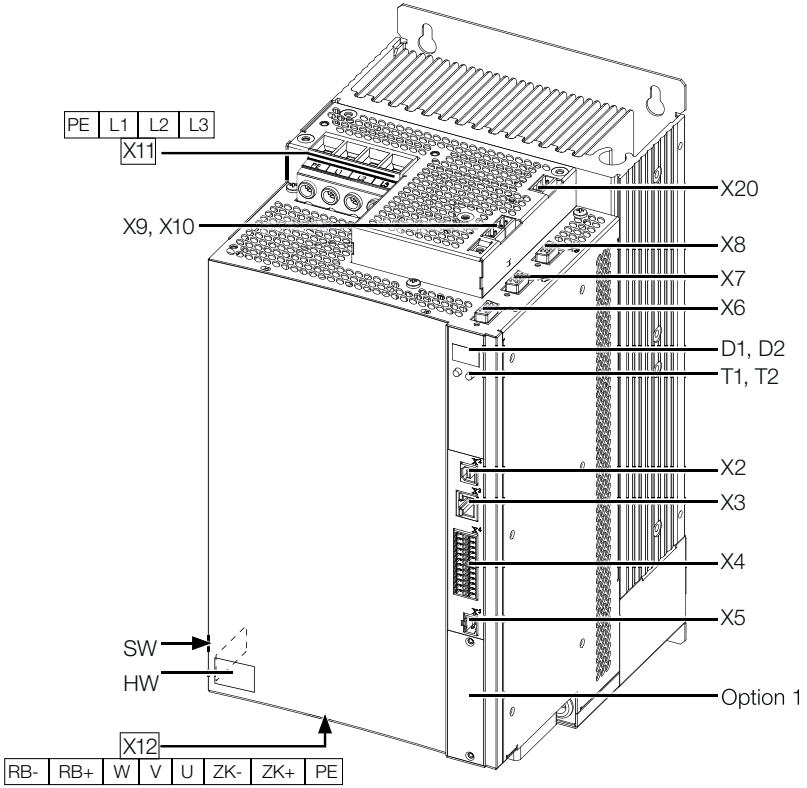


Figure 4.6 Layout, Size 5 (air cooling housing variant)

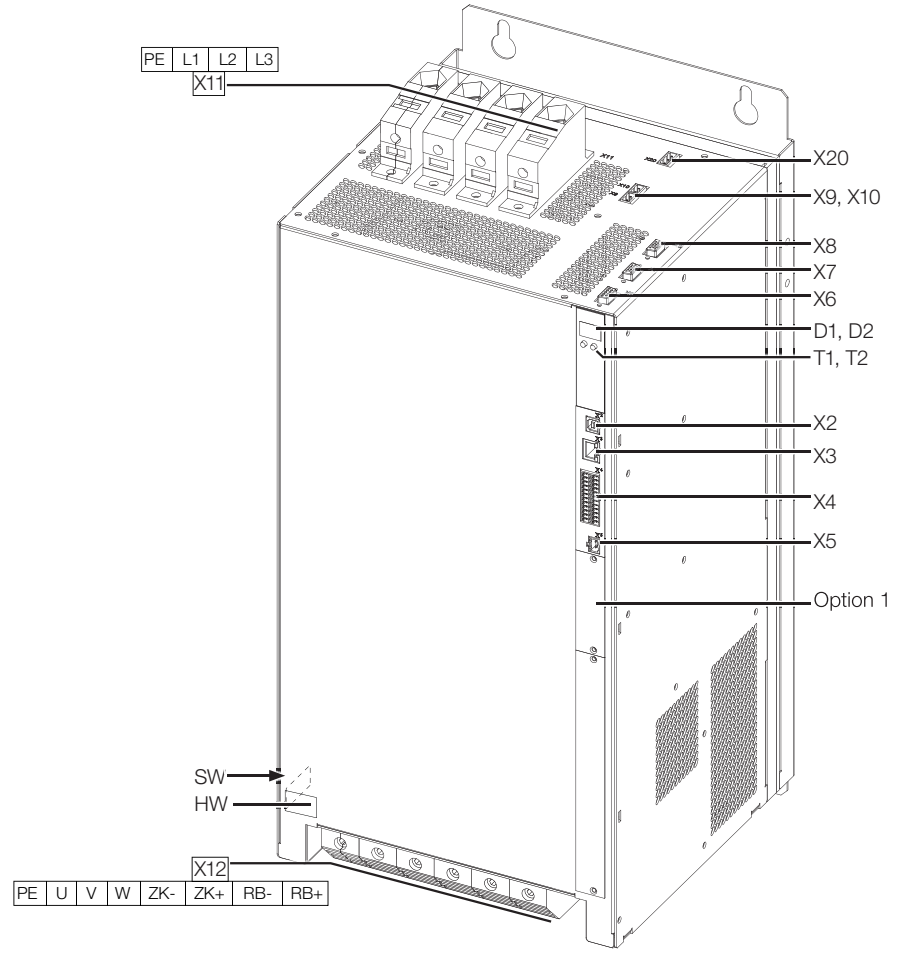


Figure 4.7 Layout, Size 6 and Size 6A (Size 6A, liquid cooling housing variant)

4.4.1 Connection diagram

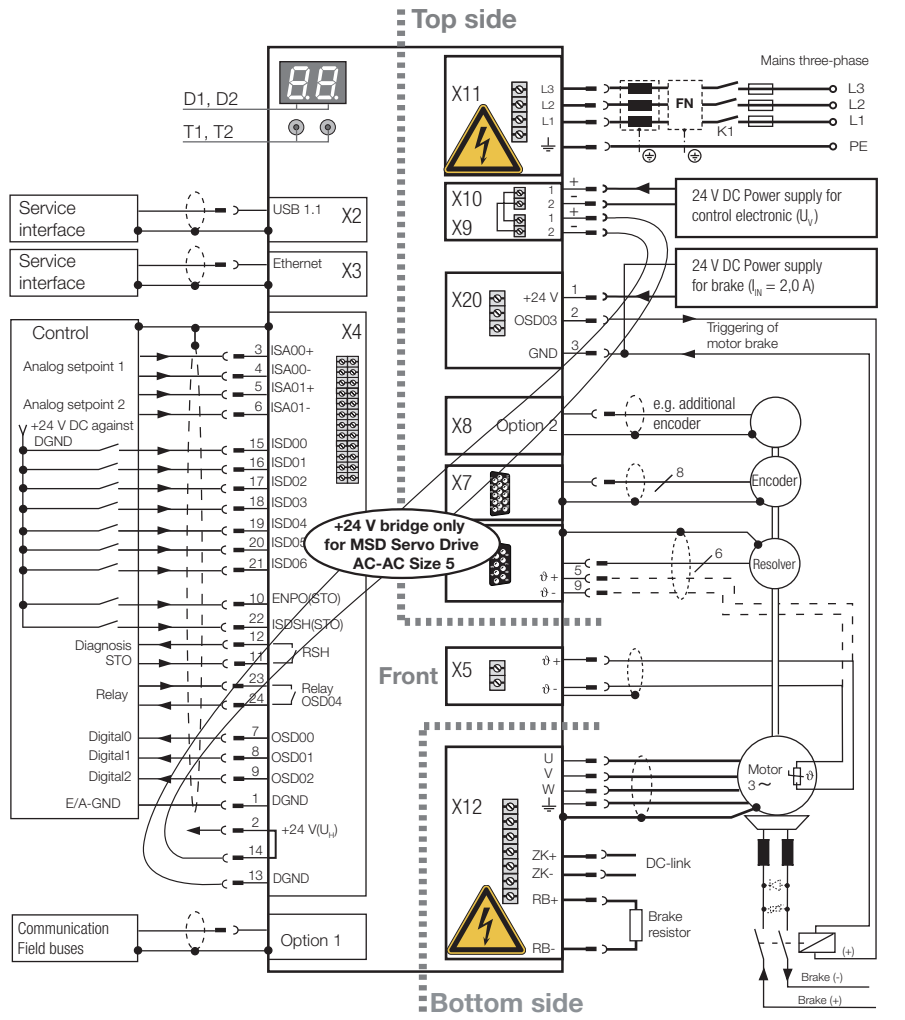


Figure 4.8 Connection diagram, Size 5 to Size 6A

NOTE:

There is a special aspect on the connection of the 24 V control supply for MSD Servo Drive Size 5. Please make sure that a connection (U_H) is made between X9/+ and X4/14 as well as between X9/- and X4/13. This is necessary to supply the digital control inputs/outputs with electrical power.

Key

Number	Designation
D1, D2	7-segment display
T1, T2	Button
X2	USB 1.1 interface
X3	Ethernet interface
X4	Control terminals
Option 1	Communication
X11	Connection for AC mains supply: 3 x 400/460/480 V G392-045/G395-053 to G392-170/G395-210 (Size 5 to Size 6A)
PE	Connection for PE conductor
X9, X10	Connection for control supply
X20	Connection for motor brake
X8 (Option 2)	Technology
X7	Connection for high-resolution encoder
X6	Connection for resolver
X5	Connection for motor temperature monitoring
X12	Connection for motor, braking resistor and DC link
HW	Hardware rating plate
SW	Software rating plate

Table 4.2 Key to connection diagram Size 5 to Size 6A

4.5 Overview of the connections, Size 7

The layout on the left shows the corresponding positions of connectors and terminals. For improved clarity we have added an abbreviation to the designation for the connectors and terminals.

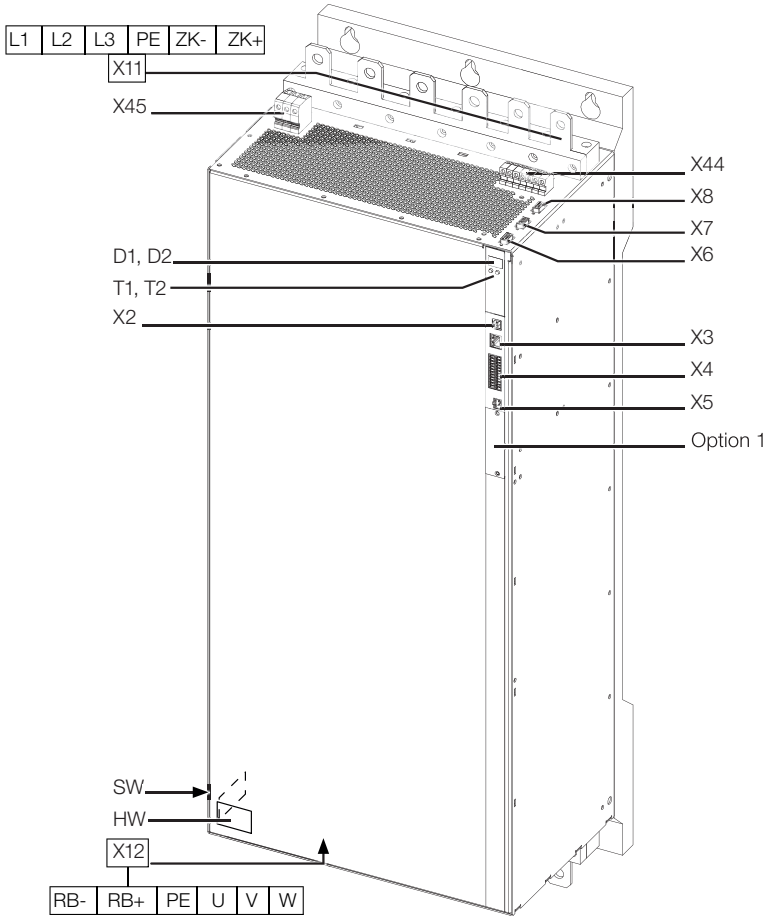


Figure 4.9 Layout, Size 7 (without shield plates and terminal covers on X11 and X12)

4.5.1 Connection diagram

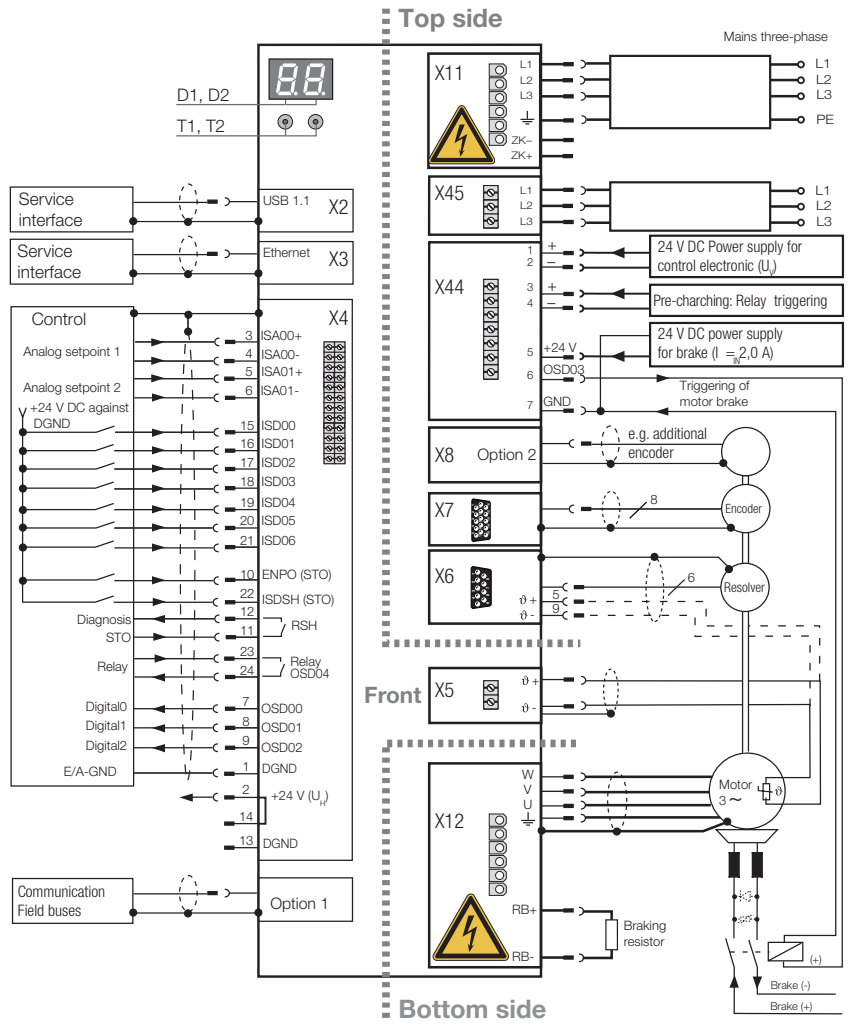


Figure 4.10 Connection diagram, Size 7

Key

No.	Designation
D1, D2	7-segment display
T1, T2	Button
X2	USB 1.1 interface
X3	Ethernet interface
X4	Control terminals
Option 1	Communication
X11	Connection for AC mains supply: 3 x 400/460/480 V G395-250 to G395-450 (Size 7) and DC link connection
PE	Connection for PE conductor
X45	Connection for DC link precharging, see chapter 4.8.6
X44	Connection for control supply, precharging relay and motor brake
X8 (Option 2)	Technology option
X7	Connection for high-resolution encoder
X6	Connection for resolver
X5	Connection for motor temperature monitoring
X12	Connection for motor phases and braking resistor
HW	Hardware rating plate
SW	Software rating plate

Table 4.3 Key to connection diagram, Size 7

4.6 Connection of PE conductor

Step	Action	PE mains connection according to IEC/EN 61800-5-1
1.	Earth each of the servo drives! Connect the terminal ⏚ in a **star configuration** and with a **large area connection** to the PE rail (main earth) in the switch cabinet.	As the leakage current >3.5 mA, the following applies to the PE connection: • Mains connection <10 mm² (0.015 in²) copper: protective earth conductor cross-section min. 10 mm² (0.015 in²) copper or two wires with the cross-section of the mains power cables (Size 1to Size 4). • Mains connection ≥10 mm² (0.015 in²) copper: protective earth conductor cross-section to suit the cross-section of the mains power cables (for Size 5 to Size 7). Also comply with local and national regulations and conditions for equipment with high leakage current.
2.	Also connect the PE conductor connections on all other components, such as mains choke, filte , etc. in a **star configuration** and with a **large area connection** to the PE rail (main earth) in the switch cabinet.	

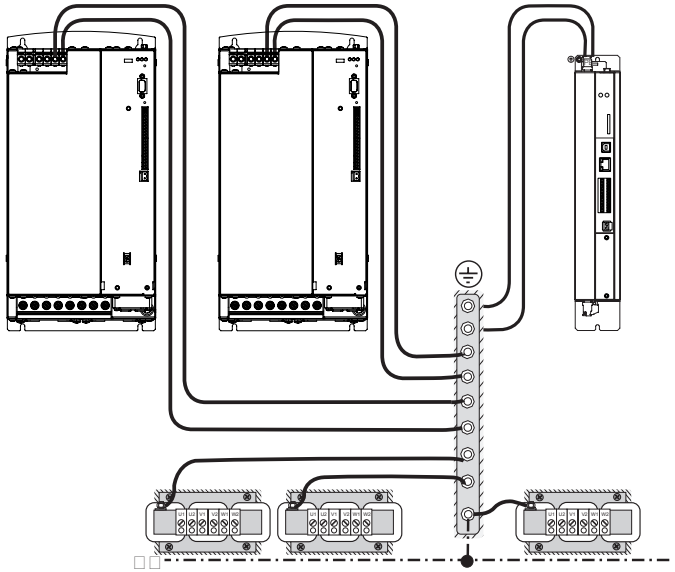


Figure 4.11 Star configuration layout for the PE conductor

4.7 Electrical isolation concept

The control electronics, with their logic (µP), the encoder terminals and the inputs and outputs, are electrically isolated from the power section (power supply/DC link). All control terminals are designed as safety extra low voltage/protective extra low voltage (SELV/PELV) circuits and must only be operated with such SELV/PELV voltages, as per the relevant specification. This provides reliable protection against electric shock on the control side.

A separate control supply, compliant with the requirements of a SELV/PELV, is therefore needed.

The overview opposite shows the potential references for the individual connections in detail.

This concept also delivers higher operational safety and reliability of the servo drive.

NOTE:

The terminal X5 (PTC for the motor) represents a special case in relation to insulation and isolation. On this topic follow the instructions in chapter 4.15.

SELV = Safety Extra Low Voltage

PELV = Protective Extra Low Voltage

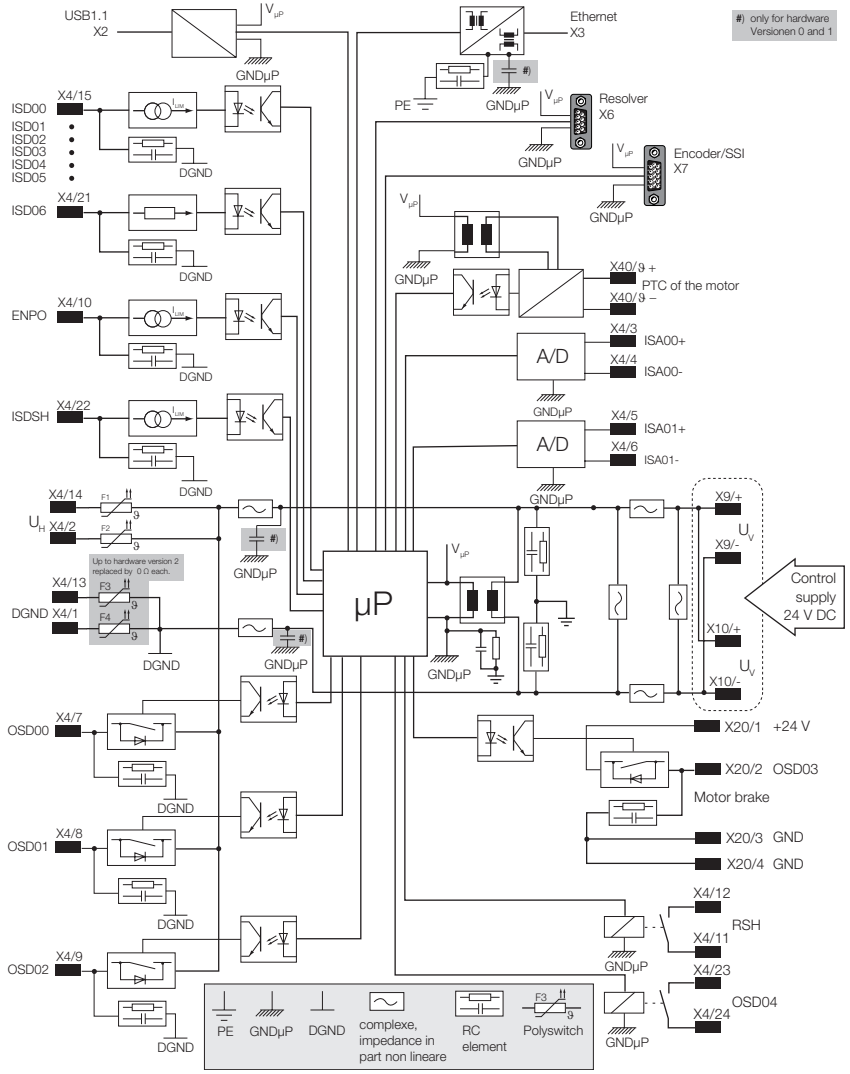
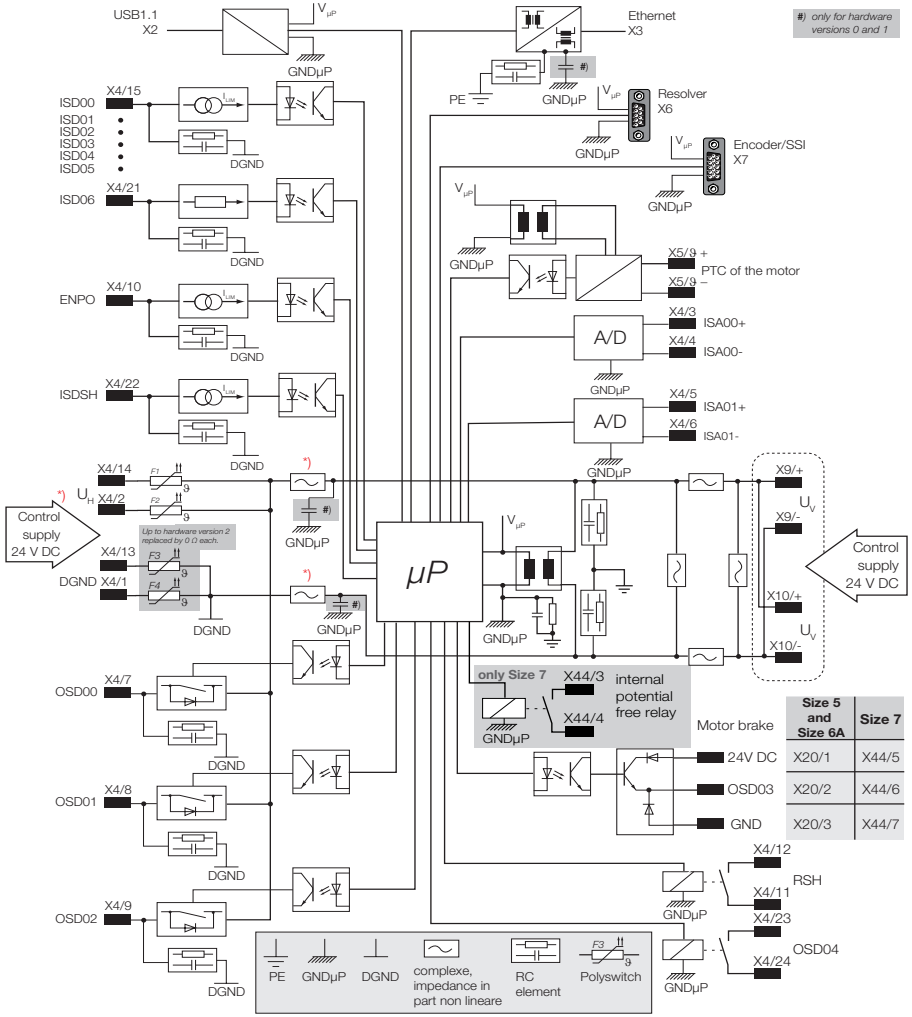


Figure 4.12 Electrical isolation concept for Size 1 to Size 4



*) For Size 5, also connect the 24 V DC control supply to control terminals. Internal connection is not available.

Figure 4.13 Electrical isolation concept for Size 5 to Size 7

4.8 Connection of the supply voltages

The supply of power to the MSD Servo Drive is separate for the control section and power section. The control supply is always to be connected **first** in the sequence so that the operation of the MSD Servo Drive can be checked first and the device parameters configured for the planned application.

CAUTION!	**Damage to the device due to incorrect operation!**
	• **Carelessness can cause damage to the device.** Only when the mains voltage has been pre-set in the device firmware and the device has been restarted (if the mains voltage or switching frequency has been changed) may the mains power supply for the supply for the power section be activated.

4.8.1 Connection of the control section supply (+24 V DC)

DANGER	**Risk of injury due to electrical power!**
	• **Carelessness will result in serious injuries or death.** A dangerous voltage may be present at the device, even if the device does not emit any visual or audible signals/indications (e.g. with mains voltage applied to terminal X11 and missing control supply +24 V DC on X9/X10 or X44)! Prior to working on the device, it is therefore necessary to check there is no supply of electrical power on X11.

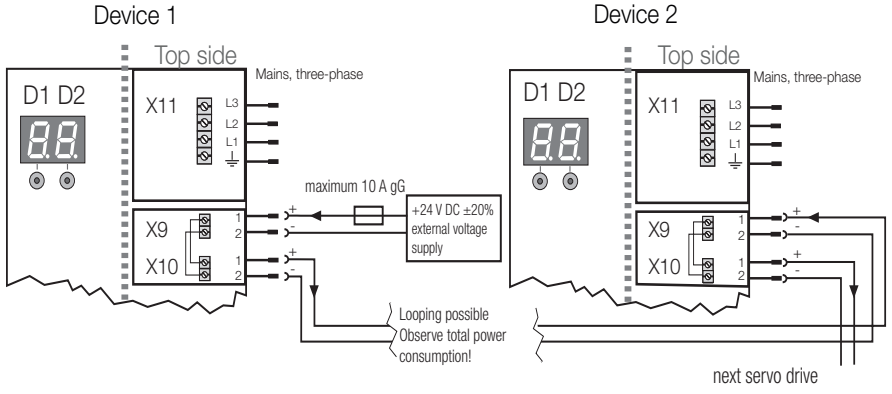


Figure 4.14 Connection of control supply, Size 1 to Size 6A

NOTE:

Suitable measures must generally be applied to provide adequate cable protection. You will find information on the connection of the control supply for Size 7 in Table 4.5

Control supply, Size 1 to Size 6A	
Terminal/pin	**Specification**
X9/1 = + X9/2 = -	• U_V = +24 V DC ±20 % (Size 5 to Size 6A +20/-10 %), stabilised and smoothed • For information on the current required for the control supply see Table A.17. • Continuous current carrying capacity of the terminal maximum 10 A (Size 5 to Size 6A maximum 8 A), internal reverse polarity protection • The power supply unit used must have safe and reliable isolation in relation to the mains as per EN 50178 or IEC/EN 61800-5-1. • Connected internally to X10
X10/1 = + X10/2 = -	• Continuous current carrying capacity of the terminal maximum 10 A (Size 5 to Size 6A maximum 8 A) • Connected internally to X9

Table 4.4 Specification control supply Size 1 to Size 6A

NOTE:

On the sizes Size 1 to Size 4, along with the control section the external 24 V also supply the output for the motor brake. If this output is active, the current for the control section plus the current for the motor holding brake, in addition to any current required for digital inputs and outputs, flows via terminal X9. Pay attention to this issue on dimensioning the power supply for the control section and on looping through to other devices.

NOTE:

For size Size 5 the external 24 V control voltage must also be connected to the control terminals (see Figure 4.5).

Control supply, Size 7	
Terminal/pin	**Specification**
X44/1 = + X44/2 = -	• U_V = 24 V DC ±10 % stabilised and smoothed • For information on the current required for the control supply see Table A.17. • Continuous current carrying capacity of the terminals maximum 10 A, internal reverse polarity protection • The power supply unit used must have safe and reliable isolation in relation to the mains as per EN 50178 or IEC/EN 61800-5-1.

Table 4.5 Specification control supply Size 7

4.8.2 Connection of power section supply (400/460/480 V AC)

Step	Action	Comment
1.	Specify the cable cross-section dependent on the rated current and ambient temperature.	Cable cross-section according to local and country-specific regulations and conditions
2.	Wire the servo drive to suit its size and type of connection. From 0.3 m (0.98 ft) cable length use shielded cable!	See Figure 4.15, Figure 4.16, Figure 4.17
3.	Wire the mains choke	Reduces the distortion (THD) in the system and prolongs the life of the servo drive.
4.	Install a mains isolating device K1 (power circuit breaker, contactor, etc.).	Do **not switch on** AC mains supply yet!
5.	Use mains fuses (utilisation class gG) to isolate all poles of the servo drive from the mains supply.	For compliance with equipment safety requirements laid down in IEC/EN 61800-5-1

DANGER!	**Risk of injury due to electrical power!**
	• **Carelessness will result in serious injuries or death.** Never make or disconnect electrical connections while they are electrically live! Always disconnect the power before working on the device. Even 10 min. after switching off the mains supply, dangerously high voltages of ≥50 V may still be present (capacitor charge). So check that electrical power is not present!

CAUTION!	**Risk of injury or damage to the device due to incorrect residual current device!**
	• **Carelessness may result in injuries or damage.** If local regulations require the installation of an residual current device, the following applies: In the event of a fault the servo drive is able to generate DC leakage currents without zero crossing. Servo drives therefore must only be operated with (RCDs) [1] type B for AC fault currents, pulsating or smooth DC fault currents, which are suitable for servo drive operation, see IEC 60755. RCMs [2] can also be used for monitoring purposes.
1) Residual Current Device 2) Residual Current Monitor	

Note the following points:

Switching the mains power:

– In the event of excessively frequent switching the device protects itself by means of high-resistance decoupling from the mains. After a rest phase of a few minutes the device is ready to start once again.

TN and TT system: operation is permitted if:

– In the case of single-phase devices for 1 x 230 V AC the supply system conforms to the maximum overvoltage category III as per IEC/EN 61800-5-1.

– In the case of three-phase devices with phase conductor voltages 3 x 230 V AC, 3 x 400 V AC, 3 x 460 V AC and 3 x 480 V AC

  The **star point** of the supply system is **earthed** and
  The supply system conforms to the maximum overvoltage category III as per IEC/EN 61800-5-1 at a system voltage (phase conductor → star point) of maximum 277 V.

IT system: operation is not permitted!

– If there is an earth fault the voltage is approx. twice as high. Clearances and creepages to IEC/EN 61800-5-1 are no longer maintained.

– Connection of the servo drives via a mains choke is imperative:
  – Where the servo drive is used in applications with disturbance variables corresponding to environment class 3, as per IEC/EN 61000-2-4 and above (harsh industrial environment).
  – For compliance with IEC/EN 61800-3, see Appendix.

– You will find further information on current carrying capacity, technical data and ambient conditions in the appendix.

NOTE:

Please be aware that the MSD Servo Drive is not designed for the mains quality inenvironment class 3 (IEC/EN 61000-2-4). Further measures are essential to achieve this environment class! For further information please consult your project engineer.

NOTE:

The minimum cross-section of the mains power cable depends on the local regulations and conditions, as well as on the rated current of the servo drive.

CAUTION!	**Damage to the device due to incorrect operation!**
	• **Carelessness can cause damage to the device.** Only when the mains voltage has been pre-set in the device firmware and the device has been restarted (if the mains voltage or switching frequency has been changed) may the mains power supply for the supply for the power section be activated.

4.8.3 AC mains supply, Size 1 to Size 4

Servo drive	Device connected load [1] [kVA]		Specified mains fuse, utilisation class gG [A]
	With mains choke (4 % u_K)	Without mains choke	
G392-004A	1.6	2.2	1 x maximum 16
G392-004	2.9	4.1	3 x maximum 10
G392-006	4.4	6.3	3 x maximum 16
G392-008	6.0	8.5	3 x maximum 20
G392-012	9.1	13.0	3 x maximum 25
G392-016 G395-016	12.0	16.2	3 x maximum 32
G392-020 G395-020	15.0	20.1	3 x maximum 40
G392-024 G395-024	18.2	24.7	3 x maximum 50
G392-032 G395-032	24.2	32.7	3 x maximum 63

1) At 3 x 400 V mains voltage

Table 4.6 Connected load and mains fuse (Size 1to Size 4)

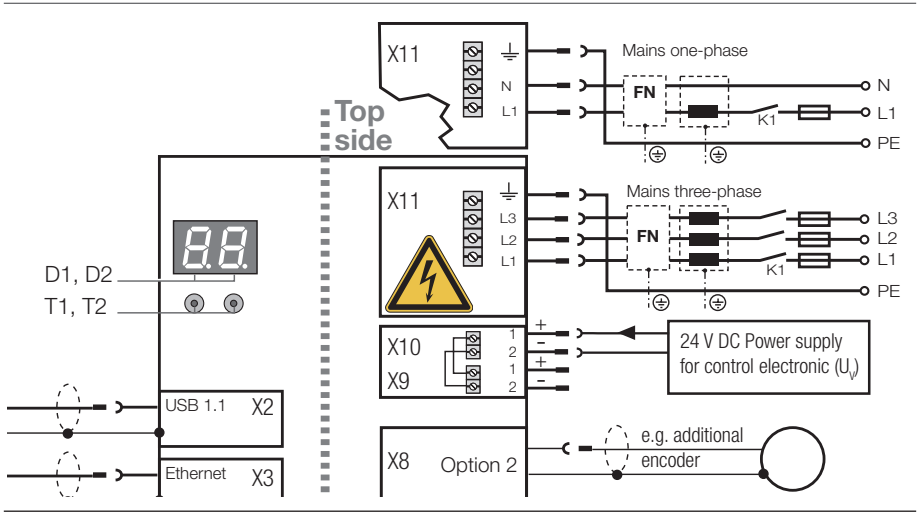


Figure 4.15 Connection example, control/mains supply for Size 1 to Size 4

4.8.4 AC mains supply, Size 5 to Size 6A

Servo drive	Device connected load [1] [kVA]		Specified mains fuse, utilisation class gG [A]
	With mains choke (2 % u_K)	Without mains choke	
G392-045 G395-053	31.2/36.7 [2]	*For devices of sizes Size 5 to Size 7 a mains choke is imperative.*	3 x maximum 63
G392-060 G395-070	41.6/48.5 [2]		3 x maximum 80
G392-072 G395-084	50.0/52.6 [2]		3 x maximum 100
G392-090 G395-110	62/76 [2]		3 x maximum 125
G392-110 G395-143	76/99 [2]		3 x maximum 160
G392-143 G395-170	99/118 [2]		3 x maximum 200
G392-170 G395-210	118/128 [2]		3 x maximum 224
G395-250	173		3 x maximum 300
G395-325	225		3 x maximum 400
G395-450	310		3 x maximum 500

1) At 3 x 400 V mains voltage
2) Second value applies for devices with water cooling

Table 4.7 Connected load and mains fuse (Size 5 to Size 6A)

CAUTION!	Damage to the device due to incorrect operation!
	• **Carelessness can cause damage to the device.** For devices of sizes Size 5 to Size 7 a mains choke is imperative. Due to a different precharging technology in these devices, it is also to be ensured that the mains choke is installed between the servo drive and mains filter (see Figure 4.16).

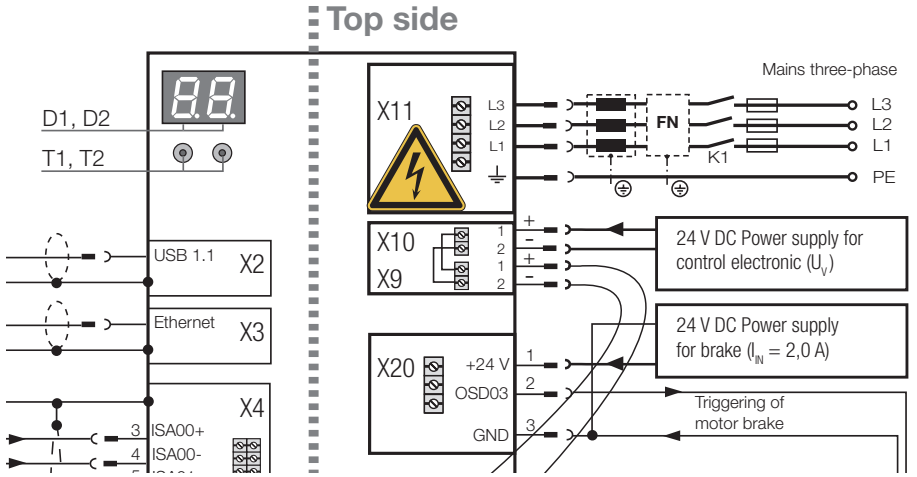


Figure 4.16 Connection example, control/mains supply for Size 5 to Size 6A

4.8.5 AC mains supply, Size 7

Servo drive	Device connected load [1] [kVA]		Specified mains fuse, utilisation class gG [A]
	With mains choke (2 % u_K)	Without mains choke	
G395-250	173	*For devices of Size 7 mains choke is imperative.*	3 x maximum 300
G395-325	225		3 x maximum 400
G395-450	310		3 x maximum 500

1) At 3 x 400 V mains voltage
2) Second value applies for devices with water cooling

Table 4.8 Connected load and mains fuse (Size 7)

CAUTION!	Damage to the device due to incorrect operation!
	• **Carelessness can cause damage to the device.** For devices of sizes Size 5 to Size 7 a mains choke is imperative. Due to a different precharging technology in these devices, it is also to be ensured that the mains choke is installed between the servo drive and mains filter (see Figure 4.17).

4.8.6 Connection diagram, precharging (only Size 7)

Designation	Specification		
	G395-250	G395-325	G395-450
Fuses 2, slow blow	For values see Table 4.10		
Mains filter (optional	300 A	400 A	500 A
Mains choke (U_k = 2 %)	250 A	325 A	450 A
K1	(e.g. Siemens 3RT10 65-6AP36)	(e.g. Siemens 3RT10 75-6AP36)	(e.g. Siemens 3RT10 76-6AP36)
K2	12 A / 5.5 kW / 24 V (e.g. Siemens 3RT10 17-1AB01)		
K3	7 A / 3 kW / 24 V (e.g. Siemens 3RT10 15-1AB01)		

Table 4.9 Example data for Figure 4.17

Wire the precharging circuit according to the standards using short circuit proof cables. The connection ratings for the internal relay for the terminals X44/3, 4 are U_{max} = 30 V DC, I_{max} = 6 A. Use an auxiliary contactor K3.

Control process

- **Precharging the DC link**
  Switch S1 "Mains supply On" is switched on. The precharging contactor K2 closes and the DC link is precharged via internal precharging resistors on terminal X45. The main contactor K1 remains open initially.
- **Precharging completed**
  At a defined DC link voltage the contact on the internal relay on terminal X44/3,4 is closed. The auxiliary contactor K3 closes and switches on the main contactor K1. The precharging contactor K2 is opened via an auxiliary contact (normally closed contact) on K1. The MSD Servo Drive changes to ready to operate.
- **Switching off**
  Via switch S1 "Mains supply Off" the servo drive is completely disconnected from the mains.

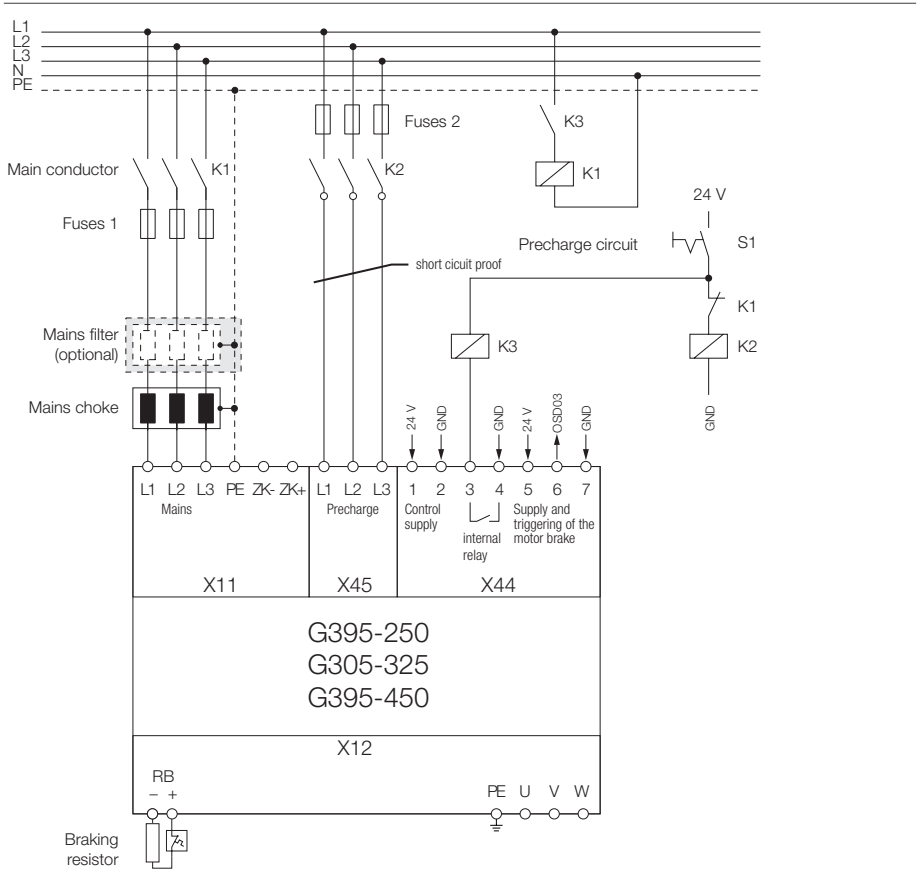


Figure 4.17 Connection example, precharging, control/mains supply 3 x 230/400/460/480 V for Size 7

CAUTION!	Shutdown of the precharging!
	In order to protect the servo drive against thermal overload, it must be ensured that the precharging of the DC link is not set for more than **2 minutes** without the main contactor being active. The precharging of the DC link is not designed for high power consumption during operation. **Failure to do so may destroy the device!**

4.9 Control connections

Step	Action	Comment
1.	Check whether a complete device setup is already available, i.e. whether the drive has already been configured	
2.	If so, a special control terminal assignment applies. Please contact your project engineer to obtain the terminal assignment!	
3.	Choose a terminal assignment.	
4.	Wire the control terminals using shielded cables. The following are imperative: ISDSH (X4/22) and ENPO (X4/10)	Ground the cable shields over a large area at both ends. Cable cross-sections: 0.2 to 1.5 mm² (0.0003 to 0.002 in²), with ferrules with plastic sleeve maximum 0.75 mm² (0.001 in²)
5.	Keep all contacts open (inputs inactive).	
6.	Check all connections again!	

4.9.1 Specification of the control connections

Des.	Term.	Specification	Electrical isolation
Analog inputs			
ISA0+ ISA0- ISA1+ ISA1-	X4/3 X4/4 X4/5 X4/6	• U_{IN} = ±10 V DC • Resolution 12 bits; R_{IN} approx. 101 kΩ • Terminal scan cycle in the "IP mode" 125 µs, otherwise 1 ms • Tolerance: U ±1 % of the measuring range end value	No
Digital inputs			
ISD00 ISD01 ISD02 ISD03 ISD04	X4/15 X4/16 X4/17 X4/18 X4/19	Standard input • $U_{IN\ max}$ = +24 V DC +20 % • I_{max} at 24 V = 3 mA typ. • Switching level low/high: ≤4.8 V / ≥18 V • Frequency range <500 Hz • Sampling cycle: 1 ms	Yes
ISD05 ISD06	X4/20 X4/21	Touchprobe or standard input • Input for touchprobe for quickly saving process data (e.g. actual position) – Internal signal delay Hardware version 0..1: ISD05 ↑ Min. 3 µs, Max. 16 µs, Typ. 8 µs; ISD05 ↓ Min. 4 µs, Max. 27 µs, Typ. 15 µs; ISD06 ↑↓ Max. 2 µs From hardware version 2: ISD05 + ISD06 ↑↓ Max. 2 µs – Activation via ISD05/ISD06 = 15 (PROBE) • Standard input – Frequency range ≤500 Hz – Sampling cycle: 1 ms • $U_{IN\ max}$ = +24 V DC +20 % • $I_{IN\ max}$ at +24 V DC = 10 mA, R_{IN} = approx. 3 kΩ • Switching level low/high: ≤4.8 V / ≥18 V	Yes
ENPO	X4/10	• Disable restart inhibit (STO) and enable power stage = High level • OSSD support (from hardware version 2) • Response time approx. 10 ms • Switching level low/high: ≤4.8 V / ≥18 V • $U_{IN\ max}$ = +24 V DC +20 % • I_{IN} at +24 V DC = typ. 3 mA	Yes

X4

REL	24	12	RSH
REL	23	11	RSH
ISDSH	22	10	ENPO
ISD06	21	9	OSD02
ISD05	20	8	OSD01
ISD04	19	7	OSD00
ISD03	18	6	ISA1-
ISD02	17	5	ISA1+
ISD01	16	4	ISA0-
ISD00	15	3	ISA0+
+24V	14	2	+24V
DGND	13	1	DGND

Table 4.10 Specification of the control connections X4

Des.	Term.	Specification		Electrical isolation
Digital outputs				
OSD00 OSD01 OSD02	X4/7 X4/8 X4/9	• No irreparable damage in the event of a short circuit (+24 V -> GND), however, device may briefly shut down • I_{max} = 50 mA, PLC-compatible • Terminal scan cycle in = 1 ms • High-side driver		Yes
STO "Safe Torque Off" (*)				
ISDSH (STO)	X4/22	• Input "Request STO" = low level • OSSD support (from hardware version 2) • Switching level low/high: ≤4.8 V / ≥18 V • $U_{IN\ max}$ = +24 V DC +20 % • I_{IN} at +24 V DC = typ. 3 mA		Yes
RSH RSH	X4/11 X4/12	Diagnostics STO, both shut-off channels active, one NO contact with automatically resetting circuit breaker (polyswitch) • 25 V / 200 mA AC, cos φ = 1 • 30 V / 200 mA DC, cos φ = 1	X4/12 X4/11	Yes
Relay output				
REL	X4/23 X4/24	Relay, 1 NO contact • 25 V / 1.0 A AC, cos φ = 1 • 30 V / 1.0 A DC, cos φ = 1 • Switching delay approx. 10 ms • Cycle time 1 ms	X4/23 X4/24	
Auxiliary voltage				
+24 V	X4/2 X4/14	• Auxiliary voltage for supplying the digital inputs • $U_H = U_V$-ΔU (ΔU typically approx. 1.2 V), no irreparable damage in the event of a short circuit (+24 V -> GND), but device may briefly shut down • I_{max} = 80 mA (per pin) with self-resetting circuit breaker (polyswitch)		Yes
Digital ground				
DGND	X4/1 X4/13	Reference ground for 24 V, I_{max} = 80 mA (per pin), hardware versions 0..1 with self-resetting circuit breaker (polyswitch)		Yes

X4

REL →	24	12	→ RSH
REL →	23	11	← RSH
ISDSH →	22	10	← ENPO
ISD06 →	21	9	→ OSD02
ISD05 →	20	8	→ OSD01
ISD04 →	19	7	→ OSD00
ISD03 →	18	6	← ISA1-
ISD02 →	17	5	← ISA1+
ISD01 →	16	4	← ISA0-
ISD00 →	15	3	← ISA0+
+24V ↔	14	2	↔ +24V
DGND ↔	13	1	↔ DGND

(*) STO certification only applies for Size 1 to Size 6

Table 4.10 Specification of the control connections X4

NOTE:

If excessively high currents flow via the earth terminals, high-impedance isolation from the device ground is possible. In some circumstances this can result in the malfunction of the drive. To prevent this situation arising, avoid currents circulating in the wiring.

4.9.2 Brake driver

On Size 1 to Size 4 the connector X13 is intended to be used to connect a motor brake.

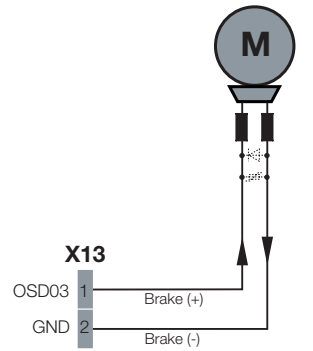
Des.	Term.	Specification	Connection
OSD03 GND	X13/1 X13/2	• Short circuit proof • Power is supplied via the control supply U_V on X9/X10. • $U_{BR} = U_V$-ΔU` (ΔU` typically approx. 1.4 V) • For operating a motor holding brake up to I_{BR} = 2.0 A maximum, for brakes with a higher current requirement a relay must be connected in between. • Overcurrent causes shutdown • Can also be used as configurable digital output • Configurabl cable break monitoring <500 mA in state "1" (up to the relay)	

Table 4.11 Specification of the terminal connections X13 (Size 1 to Size 4)

On Size 5 to Size 6A the connector X20 is intended to be used to connect a motor brake.

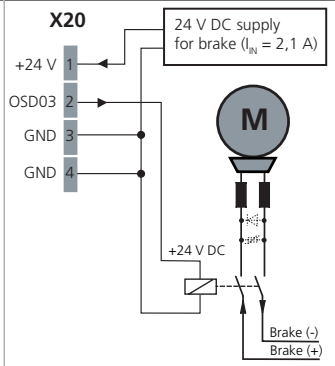
Des.	Term.	Specification	Connection
+24 V OSD03 GND	X20/1 X20/2 X20/3	• Short circuit proof • External power supply 24 V DC (I_{IN} = 2.1 A) required • For operating a motor holding brake up to I_{BR} = 2.0 A maximum, for brakes with a higher current requirement a relay must be connected in between. • Overcurrent causes shutdown • Configurabl cable break monitoring <200 mA in state "1" (up to the relay)	

Table 4.12 Specification of the terminal connections X20 (Size 5 to Size 6A)

On Size 7 the connector X44 is intended to be used to connect a motor brake.

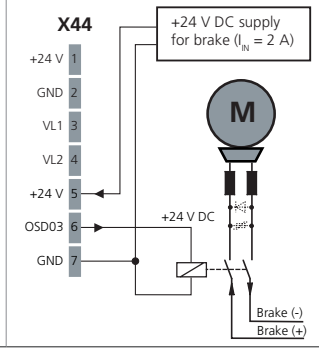
Des.	Term.	Specification	Connection
+24 V OSD03 GND	X44/5 X44/6 X44/7	• Short circuit proof • External power supply 24 V DC (I_{IN} = 2.1 A) required • For operating a motor holding brake up to I_{BR} = 2.0 A maximum, for brakes with a higher current requirement a relay must be connected in between • Overcurrent causes shutdown • Configurabl cable break monitoring <200 mA in state "1" (up to the relay).	

Table 4.13 Specification of the terminal connections X44 (Size 7)

4.10 Specification, USB interface

The service and diagnostic interface X2 is designed as a USB V1.1 interface. It is only suitable for connecting a PC for commissioning, service and diagnostics using the software Moog DriveAdministrator 5.

Technical specification:

- USB 1.1 standard - full speed device interface
- Connection via commercially available USB interface cable type A to type B (see also MSD Servo Drive Ordering Catalog)

4.11 Specification, Ethernet interface

The service and diagnostic interface X3 is designed as an Ethernet interface. It is only suitable for connecting a PC for commissioning, service and diagnostics using the software Moog DriveAdministrator 5.

Technical specification:

- Transfer rate 10/100 Mbits/s BASE-T
- Transmission profile IEEE802.3 complian
- Connection via commercially available crosslink cable (see also MSD Servo Drive Ordering Catalog)

4.12 Option 1 (Communication)

Depending on the MSD Servo Drive variant, Option 1 is factory-configured with various options. Field bus options such as EtherCAT, PROFIBUS or SERCOS are available.

You will find all available options in the MSD Servo Drive Ordering Catalog. The user manuals for the respective options provide detailed information on commissioning.

4.13 Option 2 (Technology)

Option 2 can be factory-configured with various technology options. Additional or special encoders can be evaluated here for example.

You will find all available options in the MSD Servo Drive Ordering Catalog. The user manuals for the respective options provide detailed information on commissioning.

4.14 Encoder connection

All encoder connections are located on the top of the unit.

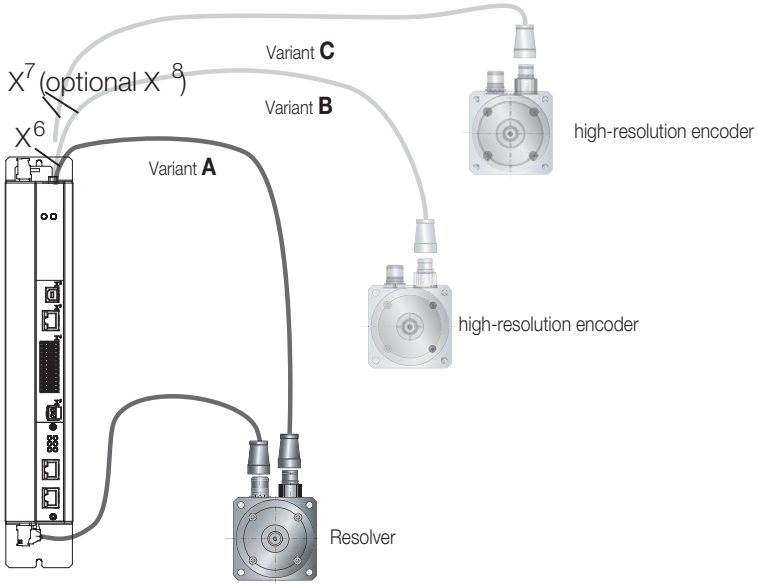


Figure 4.18 Motor/encoder cable assignment

4.14.1 Encoder connection for servo motors

Please use the ready made motor and encoder cables from Moog to connect the servo motors.

4.14.2 Allocation of motor/encoder cable to the servo drive

Compare the rating plates of the components. Make absolutely sure you are using the correct components according to variant A, B or C!

	Motor (with encoder installed)	Encoder cable	Servo drive connection
Variant A	With resolver without further options	C08335-013-yyy	X6
Variant B	Sin/Cos multiturn encoder with SSI/EnDat interface	CA58876-002-yyy	X7
Variant C	Sin/Cos multiturn encoder mit HIPERFACE®-Schnittstelle	CA58877-002-yyy	X7

Table 4.14 Variants of motors, encoder type and encoder cable

NOTE:

Do not cut the encoder cable, for example to route the signals via terminals in the switch cabinet. The knurled screws on the D-Sub connector housing must be tightly locked!

4.14.3 Ready made encoder cables

The specifications can only be assured on the usage of Moog system cables.

Encoder cable	C08335	-	013	-	yyy
Ready made cable					
Resolver cable					
Encoder cable SSI, EnDat	CA58876		002		
Encoder cable Hiperface®	CA58877		002		
Encoder system					
Version					
Cable length (m)					

1) yyy stands for length in meters; standard length: 1 m (3.28 ft), 5 m (16.40 ft), 10 m (32.80 ft), 15 m (49 ft), 20 m (65 ft), 50 m (164 ft). Further length on request

Encoder cable C08335-013-yyy[1)] Order code

	C08335-013-yyy[1)]	CA58876-002-yyy[1)]	CA58877-002-yyy[1)]
Motors with encoder system	Resolver	G3, G5, G12.x (singleturn / multiturn encoder with SSI/EnDat interface)	G6, G6.x (singleturn / multiturn encoder with HIPERFACE® interface)
Drive-end assignment (Sub-D connector)	1 = S3 2 = S1 3 = S2 4 = n.c. 5 = PTC+ 6 = R1 7 = R2 8 = S4 9 = PTC-	1 = A- 2 = A+ 3 = VCC (+5 V) 4 = DATA+ 5 = DATA- 6 = B- 8 = GND 11 = B+ 12 = VCC (Sense) 13 = GND (Sense) 14 = CLK+ 15 = CLK- 7, 9, 10 = n.c.	1 = REFCOS 2 = +COS 3 = U_S 7 – 12 V 4 = Data + RS485 5 = Data- RS485 6 = REFSIN 7 = Jumper to pin 12 8 = GND 11 = +SIN 12 = Jumper to pin 7 9, 10, 13, 14, 15 = n.c.
Capable for energy chains	Yes		
Minimum bending radius	90 mm (3.54 in)	100 mm (3.93 in)	90 mm (3.54 in)
Temperature range	-40 to +85 °C (-40 to +185 °F)	-35 to +80 °C (-31 to +176 °F)	-40 to +85 °C (-40 to +185 °F)

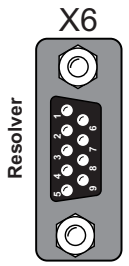
Table 4.15 Technical data, encoder cables

	C08335-013-yyy[1)]	CA58876-002-yyy[1)]	CA58877-002-yyy[1)]
Cable diameter approx.	8.8 mm (0.34 in)		
Outer sheath material	PUR		
Resistance	Oil, hydrolysis and microbe resistant (VDE0472)		
Approvals	UL style 20233, +80 °C (+176 °F) - 300 V, CSA-C22.2N.210-M90, +75 °C (+167 °F) - 300 V FT1		

Table 4.15 Technical data, encoder cables

4.14.4 Resolver connection

A resolver is connected to slot X6 (9-pin D-Sub socket).

Fig.	X6/pin	Function
	1	Resolver S3 differential input (reference to Pin X6-2)
	2	Resolver S1 differential input (reference to Pin X6-1)
	3	Resolver S2 differnetial input (reference to Pin X6-8)
	4	Supply voltage 5..12 V, connected internally to X7/3
	5	9+ (PTC, NTC, KTY, Klixon) 1)
	6	Ref+ analog excitation
	7	Ref- analog excitation (ground reference point to pin 6)
	8	Resolver S4 differntial input (reference to Pin X6-3)
	9	9- (PTC, NTC, KTY, Klixon) [1)]

1) It is imperative attention is paid to the warning

Table 4.16 Pin assignment X6

CAUTION	**Damage to the device due to incorrect insulation of the motor winding!**
	• **Carelessness can cause damage to the motor/device** The motor temperature sensor must, in relation to the motor winding, on connection to X5 be provided with **basic insulation**, on connection to X6 or X7 with **reinforced insulation** as per IEC/EN 61800-5-1.

4.14.5 Connection for high-resolution encoders

The interface X7 makes it possible to evaluate the following encoder types.

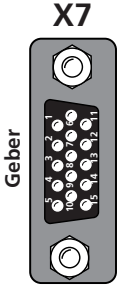
Fig.	Function
	**Sin/Cos encoder with zero pulse** e.g. Heidenhain ERN1381, ROD486
	Heidenhain Sin/Cos encoder with fully digital EnDat interface e.g. 13-bit singleturn encoder (ECN1313.EnDat01) and 25-bit multiturn encoder (EQN1325-EnDat01)
	Heidenhain encoder with digital EnDat interface Single or multiturn encoder
	Sin/Cos encoder with SSI interface e.g. 13-bit singleturn and 25-bit multiturn encoder (ECN413-SSI, EQN425-SSI)
	Sick-Stegmann Sin/Cos encoder with HIPERFACE® interface Single and multiturn encoder, e.g. SRS50, SRM50

Table 4.17 Suitable encoder types on X7

NOTE:
The usage of encoders not included in the range supplied by Moog requires special approval by Moog.

- The maximum signal input frequency is 500 kHz.
- Encoders with a power supply of 5 V ±5 % must have a separate sensor cable connection. The sensor cable detects the actual supply voltage at the encoder; it is then possible to compensate for the voltage drop on the cable. Only by using the sensor cable is it ensured that the encoder is supplied with the correct voltage. The sensor cable must always be connected.

Select the cable type specified by the motor or encoder manufacturer. During this process bear in mind the following boundary conditions:

- Always used shielded cables. Connect the shield at both ends.
- Connect the differential track signals A/B, R or CLK, DATA using twisted pairs.
- Do not cut the encoder cable, for example to route the signals via terminals in the switch cabinet.

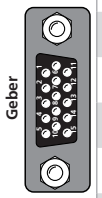
Fig.	X7 pin	SinCos and TTL	SinCos absolute value encoder SSI/EnDat	Absolute value encoder EnDat (digital)	Absolute value encoder HIPERFACE®	Comment
	1	A-	A-	-	REFCOS	
	2	A+	A+	-	+COS	
	3	+5 V DC ±5 %, IOUT maximum = 250 mA (150 mA for hardware versions 0..1), monitoring via sensor cable			7 to 12 V (typ. 11 V) maximum 100 mA	The sum of the currents tapped at X7/3 and X6/4 must not exceed the specified value
	4	-	Data +	Data +	Data +	
	5	-	Data -	Data -	Data -	
	6	B-	B-	-	REFSIN	
	7	-	-	-	U_S - switch	
	8	GND	GND	GND	GND	
	9	R-	-	-	-	
	10	R+	-	-	-	
	11	B+	B+	-	+SIN	
	12	Sense +	Sense +	Sense +	U_S - switch	
	13	Sense -	Sense -	Sense -	-	After connecting pin 7 to pin 12, a voltage of 11.8 V is set on X7, pin 3!
	14	-	CLK+	CLK+	-	
	15	-	CLK -	CLK -	-	

Table 4.18 Pin assignment for the connector X7

NOTE:
The encoder supply at X7/3 is short circuit proof on both 5 V and 11 V operation. The drive remains in operation enabling the generation of a corresponding error message on evaluating the encoder signals.

4.15 Motor connection

Step	Action	Comment
1.	Specify the cable cross-section dependent on the rated current and ambient temperature.	Cable cross-section according to local and country-specific regulations and conditions.
2.	Connect the shielded motor cable to terminals X12/ U, V, W and connect the motor to earth at ⏚.	Connect the shield at both ends to reduce interference emissions. Fasten shield connection plate for the motor connection X12 using **both** screws.
3.	Wire the temperature sensor PTC (if fitted) to terminal X5 using separate shielded cables and activate the temperature evaluation using Moog DriveAdministrator 5.	Connect the shield at both ends to reduce interference emissions.

CAUTION	**Damage to the device due to incorrect insulation of the motor winding!**
⚠	• **Carelessness can cause damage to the motor/device** The motor temperature sensor must, in relation to the motor winding, on connection to X5 be provided with **basic insulation**, on connection to X6 or X7 with **reinforced insulation** as per IEC/EN 61800-5-1.

NOTE:

In the event of a short circuit or earth fault in the motor cable, the power stage is disabled and an error message is issued.

4.15.1 Motor connection for servo motors

NOTE:

To connect the servomotors we recommend our ready made motor cables (see Servo Motors Ordering Catalog).

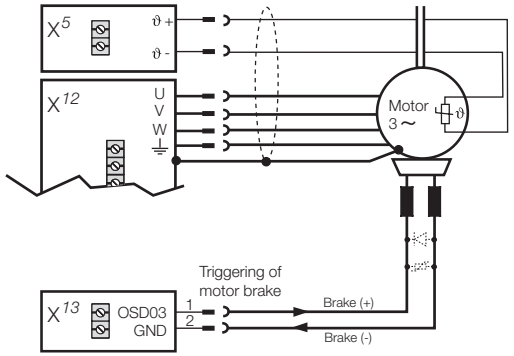


Figure 4.19 Connection of the motor for Size 1 to Size 4

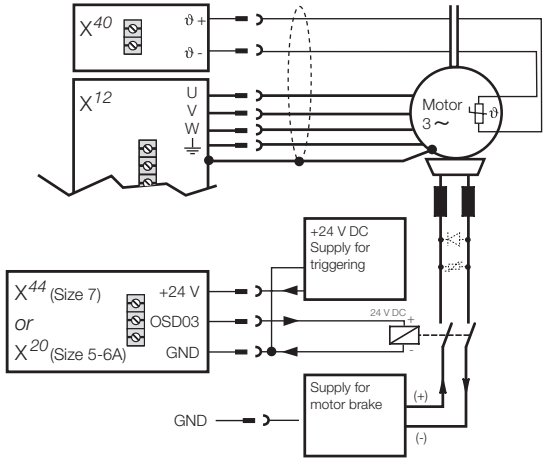


Figure 4.20 Connection of the motor for Size 5 to Size 7

4.15.2 Ready made motor cable

C08336 - xxx yyy[1)]

Ready made-up motor cable

Configuration option

Cable length (m)

1) yyy stands for length in meters; standard length: 1 m (3.28 ft), 5 m (16.40 ft), 10 m (32.80 ft), 15 m (49 ft), 20 m (65 ft), 50 m (164 ft). Further length on request

Motor cable C08336-xxx-yyy Order code

NOTE:

Cores 5 and 6 (PTC) are required only for motors with optical encoders (G12, G13, G6, G6M). For servo motors with resolver, the PTC is connected via the resolver cable.

Technical data motor cable

Technical data	C08336-xxx-yyy[1),2)]		CB05708-xxx-yyy[1),2)]		CA44958-xxx-yyy[1),2)]		CB00076-xxx-yyy[1),2)]		CA98676-xxx-yyy[1),2)]	
Continuous rated current	10 A		TBD		44 A		61 A		82 A	
Cable cross-section	4 x 1,5 mm² + 2 x 1 mm² (4 x 0.0024 in² + 2 x 0.0016 in²)		4 x 4 mm² + 2 x 1,5 mm² (4 x 0.0062 in² + 2 x 0.0023 in²)		4 x 6 mm² + 2 x 1,5 mm² (4 x 0.0093 in² + 2 x 0.0023 in²)		4 x 10 mm² + 2 x 1,5 mm² (4 x 0.00155 in² + 2 x 0.0023 in²)		4 x 16 mm² + 2 x 1,5 mm² (4 x 0.0248 in² + 2 x 0.0023 in²)	
Temperature range	-40 bis +125 °C (-40 to +275 °F)		TBD		-50 bis +90 °C (-58 to +194 °F)		TBD		TBD	
Wiring	Connector pin	Wiring	Connector pin	Wiring	Connector pin	Wiring	Connector pin	Wiring	Connector pin	Wiring
	2	U	2	U	U	U	U	U	U	U
	4	VV	4	VV	V	VV	V	VV	V	VV
	1	WWW	1	WWW	W	WWW	W	WWW	W	WWW
	PE	yellow / green	PE	yellow / green	PE	yellow / green	PE	yellow / green	PE	yellow / green
	5	Brake + / white	5	Brake + / white	+	Brake - / white	+	Brake + / white	+	Brake + / white
	6	Brake - / black	6	Brake - / black	-	Brake - / black	-	Brake - / black	-	Brake - / black
	Connector housing	Monitor	Connector housing	Monitor	Connector housing	Monitor	Connector housing	Monitor	Connector housing	Monitor
Connector type	Size 1		Size 1		Size 1,5		Size 1,5		Size 1,5	

1) yyy stands for length in meters; standard length: 1 m (3.28 ft), 5 m (16.40 ft), 10 m (32.80 ft), 15 m (49 ft), 20 m (65 ft), 50 m (164 ft). Further length on request
2) xxx-001 for standard configuration option, further options on request

Table 4.19 Technical data motor cable

4.15.3 Switching in the motor cable

CAUTION!	Damage to the device due to switching in the motor cable!
	• **Carelessness can cause damage to the device** Switching in the motor cable must take place with the power switched off and the power stage disabled, as otherwise problems such as burned contactor contacts or power stage damage may occur.

To ensure unpowered switch-on, you must make sure that the contacts on the motor contactor are closed before the servo drive power stage is enabled. At the moment when the contactor is switched off it is necessary for the contact to remain closed until the servo drive's power stage is shut down and the motor current is 0. This is achieved by using appropriate safety delays for the switching of the motor contactor in the control sequence for your machine.

Despite these measures, the possibility cannot be ruled out that the servo drive may malfunction during switching in the motor cable.

4.16 Braking resistor (RB)

In regenerative operation, e.g. when braking the drive, the motor feeds energy back to the servo drive. This increases the voltage in the DC link. If the voltage exceeds the switch-on threshold, the internal brake chopper transistor is activated and the regenerated power is converted into heat by means of a braking resistor.

Device	Mains voltage				
	1 x 230 V	3 x 230 V	3 x 400 V	3 x 460 V	3 x 480 V
G392-004A	390 V DC	-	-	-	-
G392-004/G395-016 to G392-032/G395-032	-	390 V DC	650 V DC	745 V DC	765 V DC
G392-045/G395-053 to G392-170/G395-450	-	820 V DC	820 V DC	820 V DC	820 V DC

Table 4.20 Brake chopper switch-on thresholds (DC link voltage)

4.16.1 Protection in case of brake chopper fault

WARNING!	Risk of injury due to hot surfaces caused by a faulty brake chopper!
	• **Carelessness may result in serious burns or damage.** If the brake chopper is overloaded the internal brake chopper transistor may be switched on continuously, which will result in the overheating of the device and the braking resistor. Temperatures of up to +250 °C (+482 °F) may be reached. To prevent more serious damage we recommend the activation of the following software function: You can activate this function by assigning BC_FAIL(56) to any digital output (Moog DriveAdministrator 5 ▶ "I/O configuration" ▶ Digital outputs ▶ OSD00 to OSD02). In the event of a fault the selected output then switches from 24 V to 0 V. With this signal it is to be ensured that the servo drive is safely disconnected from the mains supply and the power stage is disconnected. For a multi-axis group, deactivate all power stages.

4.16.2 Model with integrated braking resistor Size 1 to Size 4

For the servo drives with an integrated braking resistor (model G392-xxx-xxx-xx2/xx4 and G395-xxx-xxx-xx2/xx4, only available up to and including Size 4) only the peak braking power is stated in the catalog. The permissible continuous braking power must be calculated. It depends on the effective utilisation of the drive in the corresponding application.

CAUTION!	**Damage to the device with integrated braking resistor due to connection of an external braking resistor!**
	• **Carelessness can cause damage to the device** No additional external braking resistor may be connected to servo drives G392-008 to G392-032/G395-032 with integrated braking resistor.

The servo drive is thermally designed in such a way that no energy input by the internal braking resistor is permitted during continuous operation at rated current and at maximum ambient temperature.

Consequently, a drive design featuring an integrated braking resistor only makes sense when the effective servo drive load is ≤80 % or the braking resistor is designed for one-off emergency stop. In the event of an emergency stop, only the thermal capacity of the braking resistor can be used for a one-off braking action. The permissible energy WIBr can be taken from the following table.

Device	Technology	Rated resistance R_{BR}	Peak braking power P_{PBr}	Pulse energy W_{IBr}	K1
G392-004A	PTC	90 Ω	1690 W [1]	600 Ws	95 W
G392-004 G392-006			1690 W [2]		95 W
G392-008 G392-012	Wire resistance		4700 W [3]	6000 Ws	230 W
G392-016/G395-016 G392-020/G395-020			6170 W [4]		360 W
G392-024/G395-024 G392-032/G395-032			6500 W [5]		480 W

1) Data referred to 1 x 230 V mains voltage (BR switch-on threshold 390 V_{DC})
2) Data referred to 3 x 230 V mains voltage (BR switch-on threshold 390 V_{DC})
3) Data referred to 3 x 400 V mains voltage (BR switch-on threshold 650 V_{DC})
4) Data referred to 3 x 460 V mains voltage (BR switch-on threshold 745 V_{DC})
5) Data referred to 3 x 480 V mains voltage (BR switch-on threshold 765 V_{DC})

Table 4.21 Data on the integrated braking resistor (model G392-xxx-xxx-xx2/xx4 and G395-xxx-xxx-xx2/xx4)

If the drive is not permanently operated at its power limit, the reduced power dissipation of the drive can be used as braking power.

NOTE:

The rest of the calculation assumes that the servo drive is used at maximum permissible ambient temperature. This means that any additional energy input from the internal braking resistor caused by low ambient temperature will be neglected.

4.16.3 Model with integrated braking resistor Size 5 to Size 7

Servo drives of sizes 5 to 7 with liquid cooling can be equipped with an integrated braking resistor as an option. You will find the technical data in chapter A.2

4.16.4 Method to calculate the continuous braking power:

• Calculation of effective servo drive utilisation in a cycle T:	$I_{eff} = \sqrt{\frac{1}{T}\int_0^T i^2\,dt}$
• Determination of permissible continuous braking power based on unused drive power:	$P_{DBr} = \left(1 - \frac{I_{eff}}{I_N}\right) \times K1$

Boundary conditions

• A single braking action must not exceed the maximum pulse energy of the braking resistor.	$W_{IBr} \geq P_{PBr} \times T_{Br}$
• The continuous braking power calculated for the device must be greater than the effective braking power for a device cycle.	$P_{DBr} \geq \frac{1}{T} \times \int_0^T P_{PBr}\,dt_{Br}$
This results in the minimum permissible cycle time T with calculated continuous braking power:	$T = \frac{P_{PBr}}{P_{DBr}} \times \int_0^T dt_{Br}$
The maximum total on-time of the braking resistor over a specified cycle time T with calculated continuous braking power is:	$T_{BrSum} = \frac{P_{DBr}}{P_{PBr}} \times T$

4.16.5 Connection of an external braking resistor

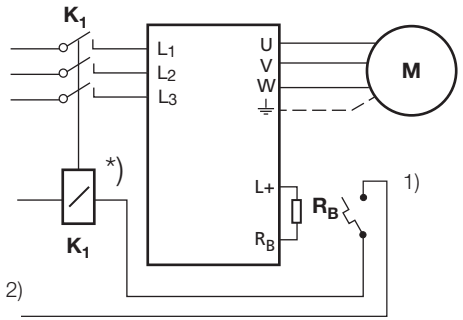
NOTE:

Be sure to follow the installation instructions for the external braking resistor.

The temperature sensor (bimetallic switch) on the braking resistor must be wired in such a way that the power stage is deactivated and the connected servo drive is disconnected from the mains supply if the braking resistor overheats.

The minimum permissible connection resistance for the servo drive must not be infringed, for technical data see chapter A.2.

The braking resistor must be connected using a shielded cable.



*) Depending on how the temperature sensor is connected, the nature and magnitude of the control voltage, the power required by the mains contactor, it may be necessary to provide an auxiliary contactor.

1) Temperature switch, temperature sensor, bimetallic switch

2) Control voltage

Figure 4.21 Connection of braking resistor

DANGER!	Risk of injury due to electrical power!
	• **Carelessness will result in serious injuries or death.** Never make or disconnect electrical connections while they are electrically live! Always disconnect the power before working on the device. Even 10 min. after switching off the mains supply, dangerously high voltages of ≥50 V may still be present (capacitor charge). So check that electrical power is not present! Terminal L+ (Size 1 to Size 4) or BR+ (Size 5 to Size 7) is permanently connected to DC link potential (>300 V DC). The connection is not protected internally in the device.

WARNING!	Risk of injury due to hot surfaces on the ext. braking resistor!
	• **Carelessness may result in serious burns.** The braking resistor heats up very significantly during operation and can reach temperatures of up to +250 °C (+482 °F). On touching there is a risk of serious burns to the skin.

CAUTION!	Damage to the external braking resistor due to lack of temperature monitoring!
	• **Carelessness can result in overheating of the ext. braking resistor!** The external braking resistor must be monitored by the controller. The temperature of the braking resistor is monitored by a temperature sensor (Klixon). In the event of overheating the servo drive must be disconnected from the mains supply.

Available braking resistors (excerpt)

Order designation	Coninuous braking power	Resistance [1]	Peak breaking power [2]	Protection	Thermal capacity	Figure
CB09047-001	35 W	200 Ω	2800 W	IP54	0,21 kJ/K	 Example: CB09047-001
CB09048-001	150 W		2800 W	IP54	0,86 kJ/K	
CB09049-001	300 W		2800 W	IP54	1,026 kJ/K	
CA59737-001	35 W	90 Ω	6250 W	IP54	0,21 kJ/K	
CA59738-001	150 W		6250 W	IP54	0,86 kJ/K	
CA59739-001	300 W		6250 W	IP54	1,026 kJ/K	
CA59740-001	1000 W		6250 W	IP65	3,225 kJ/K	
CA59741-001	35 W	26 Ω	21600 W	IP54	0,21 kJ/K	
CA59742-001	150 W		21600 W	IP54	0,86 kJ/K	
CA59743-001	300 W		21600 W	IP54	1,026 kJ/K	
CA59744-001	1000 W		21600 W	IP65	3,225 kJ/K	
CB36901-001	300 W	20 Ω	27750 W	IP54	1,026 kJ/K	
CB36902-001	300 W	15 Ω	37000 W	IP54	1,026 kJ/K	

1) Tolerance ±10 %

2) Is the maximum possible braking power depending on the ON-time and cycle time

Table 4.22 Technical data - braking resistors

NOTE:

You will find the exact specifications of the braking resistors, in particular the surface temperature, the maximum supply voltage and the dielectric strength at high voltages in the MSD Servo Drive Ordering Catalog.

Please consult your project engineer for more detailed information on the design of braking resistors.

5 Commissioning

5.1 Notes for operation

CAUTION	Damage to the device due to incorrect installation conditions!
	**The device may suffer irreparable damage.** Therefore during operation • Moisture must not be allowed to enter the device • There must not be any aggressive or conductive substances in the ambient air • Foreign bodies such as drilling chips, screws, washers etc. must not be allowed to fall into the device • The ventilation openings must not covered

WARNING!	Risk of injury due to hot surfaces on the device (heat sink)!
	• **Carelessness may result in serious burns.** The device heats up very significantly during operation and can reach temperatures of up to +100 °C (+212 °F). On touching there is a risk of burns to the skin. For this reason provide protection against touching.

5.2 Initial commissioning

Once the MSD Servo Drive has been installed as described in chapter 3 and wired with all required voltage supplies and external components as described in chapter 4, initial commissioning can performed in the following sequence:

Step	Action	Comment
1.	Install and start PC software	See Installation Manual Moog DriveAdministrator 5
2.	Switching on control supply	See 5.2.1
3.	Establish connection between PC and servo drive	See 5.2.2
4.	Parameter configuratio	See 5.2.3
5.	Control drive using DriveAdministrator 5	See 5.2.4

NOTE:

Details in relation to "STO" (Safe Torque Off) do not need to be taken into account for initial commissioning. You will find all information on the “STO” function in the 24-language document "Description of the STO Safety Function" (ID no. CB19388).

5.2.1 Switching on control supply

2. To initialise and set parameters, initially only switch on the +24 V control supply. Do **not** yet switch on the AC mains supply.

Display indication after switching on the control supply

D1	D2	Action	Explanation
		Switch on the ext. +24 V control supply	Initialisation in progress
		Initialisation completed	Not ready to switch on

Table 5.1 Switch-on status of the MSD Servo Drive (after connection of the +24 V DC control supply)

NOTE:

You will find details on the control supply in chapter *"4.8 Connection of the supply voltages" on page 32*

5.2.2 Establish connection between PC and servo drive

3. The PC can be connected to the servo drive via USB or Ethernet (TCP/IP). Connect PC and servo drive using the related connection cable.

NOTE:

- **Initialisation**
  The communication link between PC and servo drive can only be set up after the servo drive has completed its initialisation.
- **USB driver and TCP/IP configuration**
  If the PC does not recognise the servo drive connected, please check the driver and the settings for the related interface (see Installation Manual Moog DriveAdministrator 5).

5.2.3 Configuring parameters

4. The commissioning wizard in Moog DriveAdministrator 5 is provided for making the settings for the drive system. Start the wizard.

NOTE:

- **Online help**
  You will find a detailed description of Moog DriveAdministrator 5 and the commissioning wizard in the online help for Moog DriveAdministrator 5.
- **Motor data set**
  If you intend to use a Moog Servo Motor, motor datasets are available.

5.2.4 Controlling drive using Moog DriveAdministrator 5

5. Switch on the AC mains supply. Then enable the power stage and activate the control. The drive should be tested without the coupled mechanism.

WARNING!	**Risk of injury due to uncontrolled rotation!**
	• **Carelessness may result in serious injuries or death.** Before commissioning motors with feather keys in the shaft end, these keys must be reliably secured against throwing out, if this is not already prevented by drive elements such as belt pulleys, couplings or similar.

CAUTION!	**Damage to your system/machine due to uncontrolled or inappropriate commissioning.**
	• **Carelessness may result in damage to your system/machine.** It is imperative attention is paid to the limitations of the movement range. You are responsible for a safe process. Moog will not assume liability for any damage that occurs.

Important information for the usage of motors!

- Certain motors are intended for operation on the servo drive. Direct connection to the mains supply can cause irreparable damage to the motor.
- The motor surfaces may become extremely hot. No temperature sensitive parts may touch or be fastened to these areas, appropriate measures to prevent physical contact must be taken wherever necessary.
- To avoid overheating of the motor, the motor holding brake installed in the winding must be connected to the terminals of the temperature monitoring system for the servo drive (X5 or X6).
- The motor brake (if installed) should be checked for correct function before commissioning the motor. Motor holding brakes are only designed for a limited number of emergency braking operations. Use as a service brake is not allowed.

Display indication after switching on the AC mains supply

D1	D2	Action	Reaction	Explanation
5.	2.	Switch on the AC mains supply	Controller ready, power stage ready, control deactivated	Device is ready to switch on

Table 5.2 Display D1/D2 after switching on the AC mains supply

NOTE:

- **Inputs "ISDSH" and "ENPO"**
  For step 1 at least the two inputs "ISDSH" and "ENPO" on terminal X4 must be connected.
- **Manual mode window**
  Step 2 is best undertaken via the "Manual mode" window in Moog DriveAdministrator 5, you will find details in the help system.
- **Configuration of the inputs/outputs**
  If step 2 is to be implemented via the inputs on terminal X4, the sources for "START CONTROL" and speed setpoint must be configured accordingly in "Inputs/Outputs" in Moog DriveAdministrator 5.

Power-up sequence for starting the drive

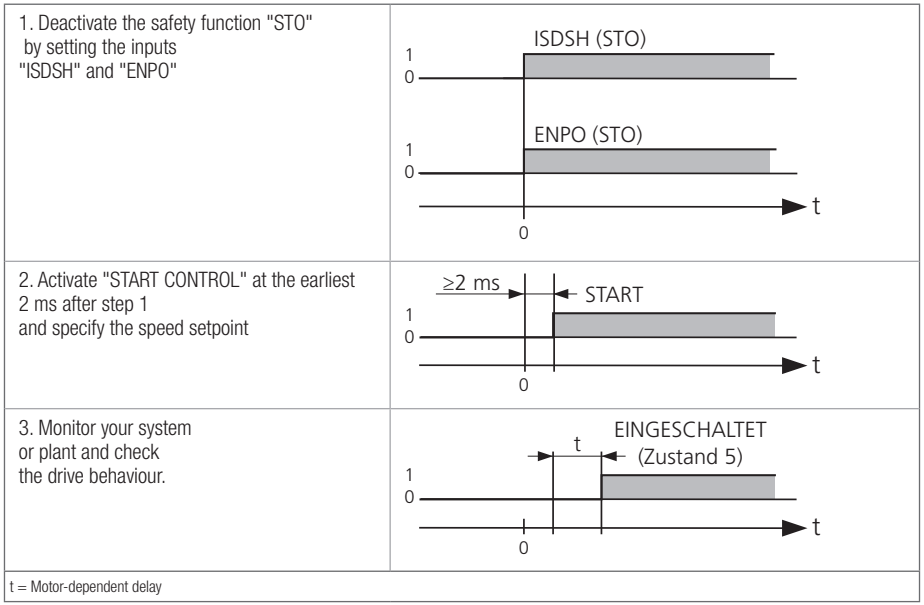


Figure 5.1 Switching on sequence

Display indication after starting the drive

D1	D2	Action	Reaction	Explanation
3		"STO" and power stage "ENPO" enabled	Ready to switch on	Power stage ready
Pay attention to warning prior to the "Start" step!				
5		"Start" enabled	Switched on	Motor energised, control active

Table 5.3 D1/D2 indication during activation of motor

CAUTION!	**Damage to your system/machine due to uncontrolled or inappropriate commissioning.**
	• **Carelessness may result in damage to your system/machine.** Before the "Start" step it is imperative you ensure a plausible setpoint is specified because the setpoint set is transferred to the drive immediately after the motor control has started and can result in the unexpected acceleration of the drive.

Details for optimising the drive on your application can be found in the Moog DriveAdministrator 5 help system and in the MSD Servo Drive Device Help.

5.3 Serial commissioning

An existing parameter data set can be transferred to other MSD Servo Drives AC-AC using Moog DriveAdministrator 5. You will find details in the help system in Moog DriveAdministrator 5

NOTE:
MSD PLC programs can only be loaded into a MSD Servo Drive AC-AC using the programming system CoDeSys.

5.4 Integrated control unit

The integrated control unit permits diagnostics on the MSD Servo Drive. The control unit comprises the following elements, all located on the front of the device:

- 2-digit 7-segment display (D1, D2)
- Two buttons (T1, T2)

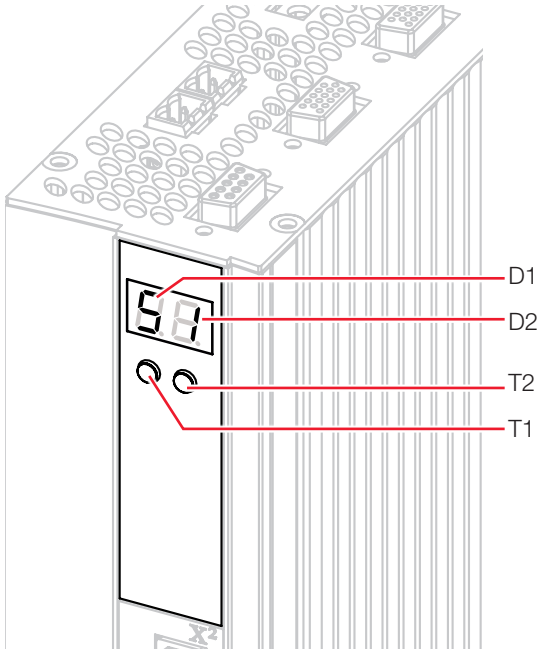


Figure 5.2 Integrated control unit

The following functions and displays are available:

- Indication of the device status
  The device status is indicated after switching on the control supply. If no input is made via the buttons for 60 seconds, the display switches back to the indication of the device status.
- Indication of the device errors, see chapter *“6.2 Status and error indication in MDA5” on page 58 .*
  On the occurrence of an error in the device, the display is immediately switched to the indication of the error code.
- Parameter configuration (indication " A")
- Ethernet IP address setting (indication "IP")
  Setting for the Ethernet IP address as well as the subnet mask
- Field bus settings (indication "Fb")
  Setting e.g. for the field bus addres

5.4.1 Function of buttons T1 and T2

These buttons are used to activate the different menus and to control the corresponding functions.

Button	Function	Comment
T1 (left)	• Activate the menu (exit the device status display) • Scroll through the menus/sub-menus • Set values - left segment display (D1)	The button T1 can be held pressed for any length of time because the display will only scroll through the menu commands available at the corresponding level. No settings will be changed.
T2 (right)	• Selection of chosen menu • Set values - right segment display (D2)	The button T2 must **not** be held pressed for any length of time because the display will change from one menu level to the next within the menu structure and then change the parameter that is reached at the end. You should therefore always release the button T2 after each change in display.
T1 and T2 together	• Menu level up • Accept selection • Acknowledge	After pressing T1 and T2 at the same time, the value applied flashes for five second During this time the save procedure can still be aborted by pressing any button, without applying the value set. Otherwise the new value will be saved after five seconds
General		• The time the button needs to be held depressed until an action is executed is approx. 1 second. • If there is no action by the user for a period of 60 seconds, the display returns to the indication of the device status.

Table 5.4 Function of buttons T1 and T2

5.4.2 Display

The following table defines various indications and items of status information provided via the display.

Display	Meaning
	Menu entries ("PA" in this case serves as an example, for further possible entries see chapter 5.2.1 and 5.4.2)
	[Flashing decimal points] Selected function in progress
	[Two dashes] Entry/function not available
	[OK] Action executed successfully, no errors
	[Error] • Action via control unit **not** executed successfully, "Er" flashes alternately with the error number (see chapter 5.4.3) • Device error indication, "Er" flashes alternately with error number and error location (see "MSD Servo Drive Device Help")
	Numerical values ("10" in this case serves as an example) • Data set and error numbers are shown in **decimal** on the parameter menu (PA). • All other values are displayed in **hexadecimal**. In these cases the 10 displayed would represent the decimal value 16.

Table 5.5 Meaning of display

NOTE:

If no input is made via the buttons for 60 s, the display switches back to the indication of the device status.

5.4.3 Parameter menu (PA)

The following functions are available on the Parameter menu:

- Reset device to factory settings

Error numbers

A failed user action is indicated by an error message. The message consists of the alternating display of "Er" and the error number.

NOTE:

The error messages displayed during user data entry should not be confused with drive error messages. You will find detailed information on the error codes and on error management in the "MSD Servo Drive Device Help".

Error number	Meaning
00	File system no error
01	File system any file system error
02	File system command rejected
03	File system function parameter invalid
04	File system create file error
05	File system open file error
17	Parameter reset to factory settings failed
18	Parameter write access failed
19	Save parameter data set non volatile failed
20	Not all parameters written
21	Error while reset to factory settings

Table 5.6 Error numbers

5.4.4 Ethernet IP address menu (IP)

An Ethernet TCP/IP port is available as a service and diagnostics interface. The IP address is set in the factory to 192.168.39.5. It can be changed using the PC software Moog DriveAdministrator 5 or via the display.

Menu level 1	Menu level 2	Parameter	Value range	Meaning	Explanation
IP	Iu	b0	00..FF	IP address update byte 0	Setting for byte 0 of the IP address in hexadecimal format (e.g. "05" in 192.168.39.**5**)
		b1	00..FF	IP address update byte 1	Setting for byte 1 of the IP address in hexadecimal format (e.g. "27" for 192.168.**39**.5)
		b2	00..FF	IP address update byte 2	Setting for byte 2 of the IP address in hexadecimal format (e.g. "A8" for 192.**168**.39.5)
		b3	00..FF	IP address update byte 3	Setting for byte 3 of the IP address in hexadecimal format (e.g. "C0" at **192**.168.39.5)
	Ir	-	-	IP reset to factory setting	Reset IP address to factory setting (192.168.39.5)
	Su	b0	00..FF	Subnet mask update byte 0	Setting for byte 0 of the subnet mask in hexadecimal format (e.g. "00" in 255.255.255.**0**)
		b1	00..FF	Subnet mask update byte 1	Setting for byte 1 of the subnet mask in hexadecimal format (e.g. "FF" in 255.255.**255**.0)
		b2	00..FF	Subnet mask update byte 2	Setting for byte 2 of the subnet mask in hexadecimal format (e.g. "FF" in 255.**255**.255.0)
		b3	00..FF	Subnet mask update byte 3	Setting for byte 3 of the subnet mask in hexadecimal format (e.g. "FF" in **255**.255.255.0)
	Sr	-	-	Subnet mask reset to factory setting	Reset subnet mask to factory setting (255.255.255.0)

Table 5.7 IP address menu

Example configuration of the subnet mask

In this example the subnet mask is changed from 255.255.255.0 to 122.255.255.0.

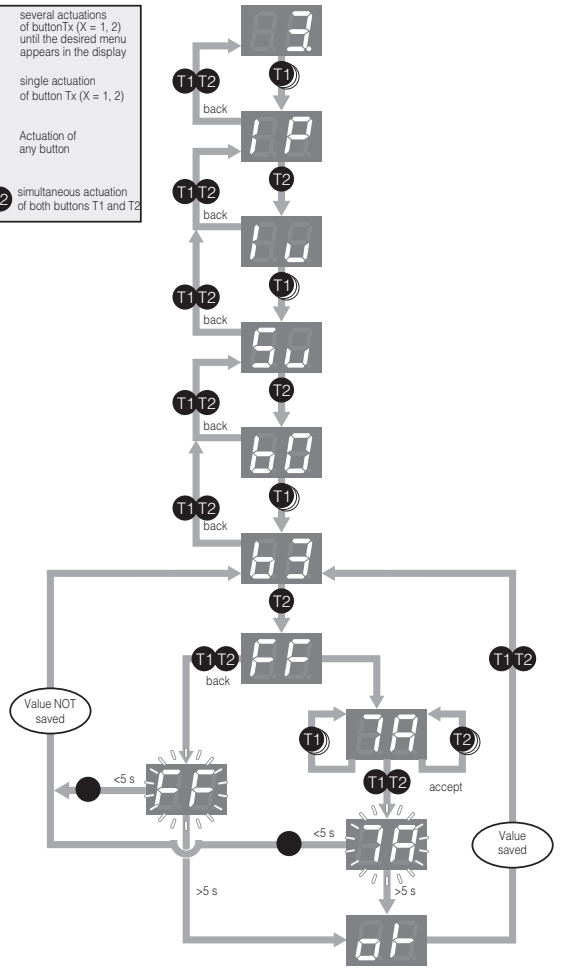


Figure 5.3 Example configuration of the subnet mask

NOTES:

- During the flashing phase the save procedure can still be aborted by pressing any button, without applying the value set. Otherwise the new value will be saved after five seconds.
- A modified IP address will not be applied without restarting the control electronics.

5.4.5 Field bus address menu (Fb)

The functions available on this menu item depend on the device's communication option. For detailed information refer to the relevant specification.

Menu level 1	Menu level 2	Parameter	Value range	Meaning	Explanation
Fb	Ad	-	00..xx or - -	Field bus address	Setting for field bus addres (only if field bus option used) otherwise indication "- -" (The maximum value that can be programmed depends on the option)
	Po	-	0..3 or - -	Transmit power	Setting for fibre-optic power output (only with SERCOS II option), otherwise indication "- -"

Table 5.8 Field bus address menu

Example configuration of the field bus address

In this example the field bus address is changed from 1 to 23.

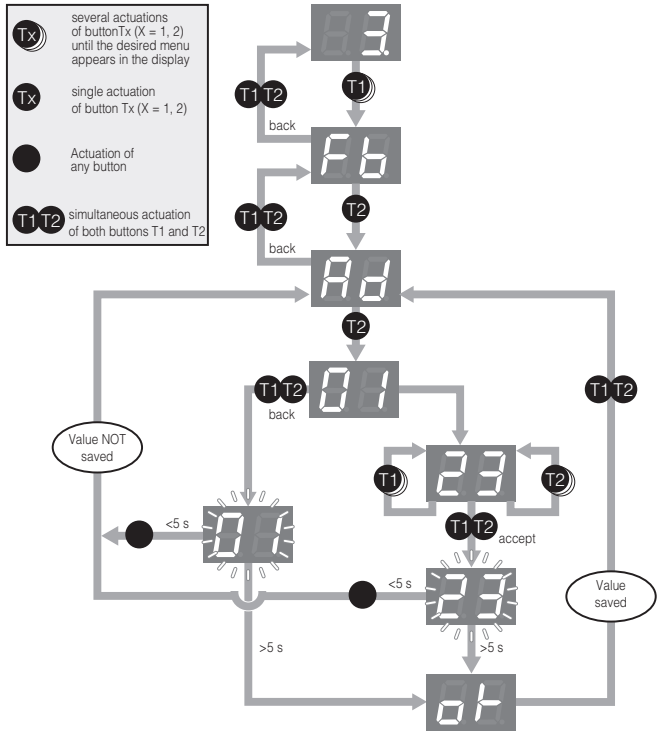


Figure 5.4 Example configuration of the field bus address

6 Diagnostics

6.1 Status indication on the device

The device states are shown on the device using the 7-segment display.

6.1.1 Device states

Display	System state
	Device in reset state
	Self-initialisation on device startup
 *)	Not ready to switch on (no DC link voltage) [1]
 *)	Start inhibit (DC link OK, power stage not ready) [1]
	Ready to switch on (power stage ready)
	Switched on (power applied to drive) [2]
	Drive ready (power applied to drive and drive ready for reference value input) [2]
	Quick stop [2]
	Error response active [2]

*) Not a "safe indication" as specified in IEC/EN 61800-5-2.

1) **S.** flashes if the function STO (Safe Torque Off) is active, indication extinguishes if function is inactive.

2) The point flashes if the power stage is active.

Table 6.1 Device states

6.1.2 Error indication

The specific error codes are indicated via the 7-segment display. Each error code comprises the alternating sequence ►"Er" ►error number ►error location.

Display	Meaning
	Device error
↓ Display changes after approx. 1 s	
	Error number (decimal) Example: 05 = Overcurrent
↓ Display changes after approx. 1 s	
	Error location (decimal) Example: 01 = Hardware monitoring
↑ After approx. 1 s the display changes back to ER	

Table 6.2 Display of the error code

NOTES:

- **Acknowledging error**
  The errors can be acknowledged according to their programmed reaction (ER) or only by means of a +24 V reset (X9/X10) (ER**.**). Errors marked with a point can only be reset once the cause of the error has been rectified.
- Error code
  You will find detailed information on the error codes and on error management in the "MSD Servo Drive Device Help".

6.2 Status and error indication in MDA5

Click the "Device status" button in the header for the MDA5 to open the "Device status" window.

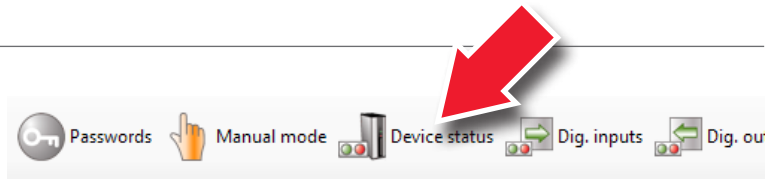


Figure 6.1 "Device status" button in the header

Use the "Error history..." button to retrieve information on the last 20 errors that have occurred.

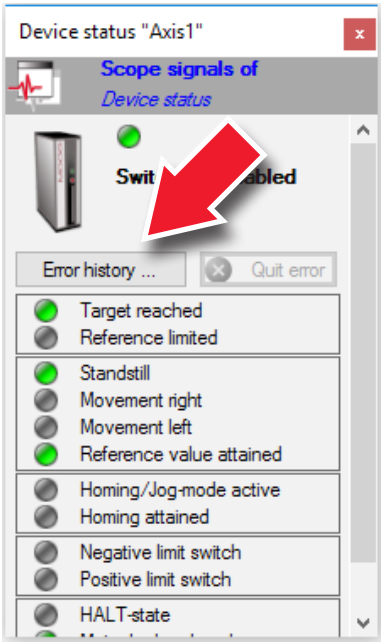


Figure 6.2 "Device status" window

On the occurrence of an error, a "pop-up" window appears immediately with more detailed information on the actual error.

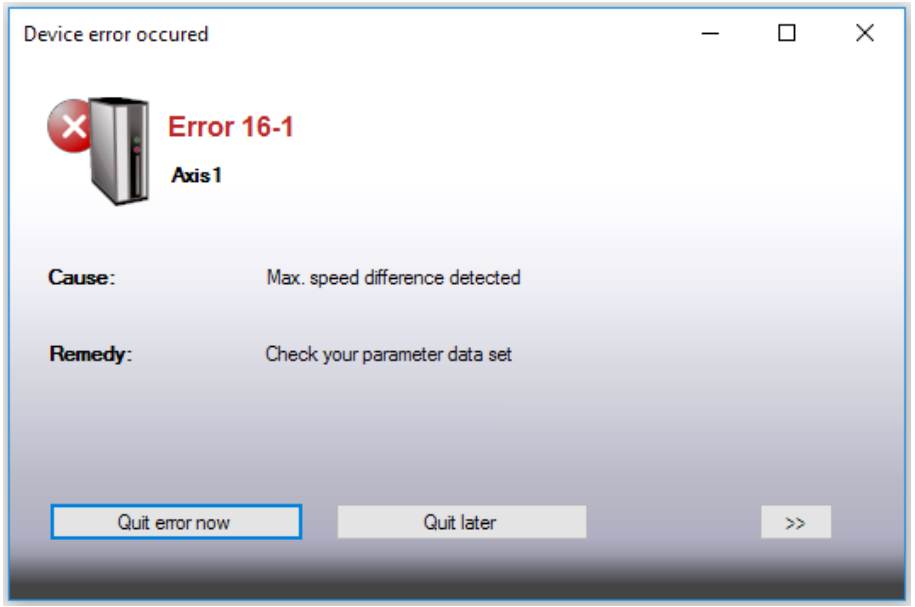


Figure 6.3 Error message

“Alarms & Warnings details” contains detailed information on an error or a warning that has occured.

1. Double-click in the project tree “Alarms & Warnings (Details)”.

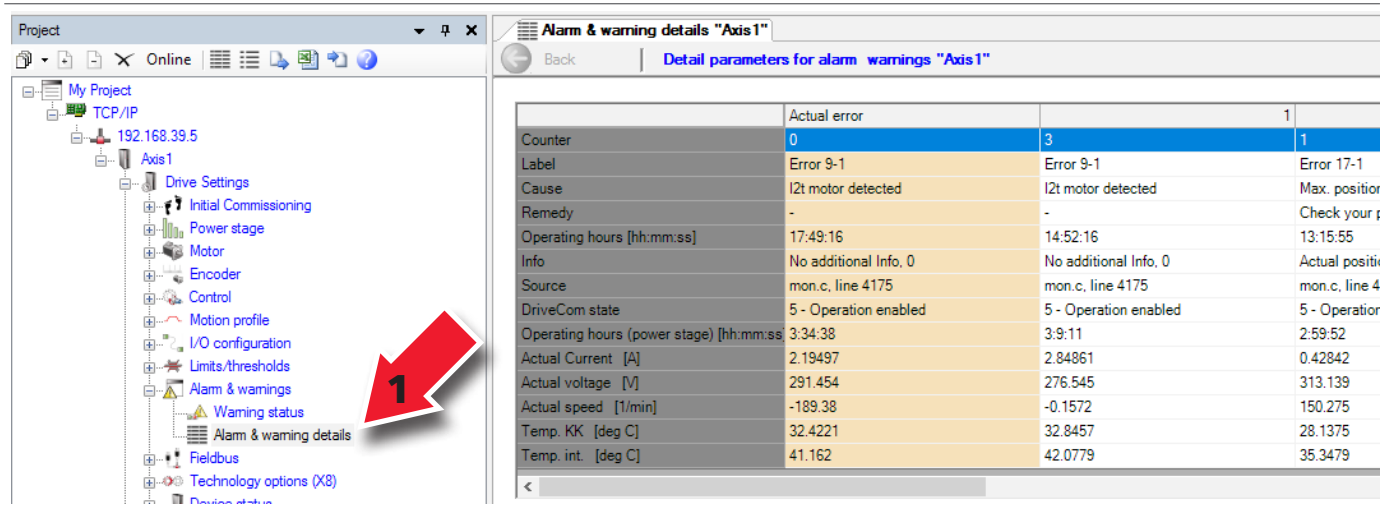


Figure 6.4 Parameter 31 "Alarms & Warnings (Details)"

NOTE:

You will find further information in the Program Help for “Moog DriveAdministrator 5”.

7 Safe Torque Off (STO)

NOTE:
You will find all information on the "STO" function in the 24-language document "Description of the STO Safety Function" (ID no. CB19388).

Space for your own notes

A Appendix

A.1 Current carrying capacity of the servo drives

The maximum permissible servo drive output current and the peak current are dependent on the mains voltage, the motor cable length, the power stage switching frequency, the design of the cooling and the ambient temperature. If the conditions change, the maximum permissible current carrying capacity of the servo drives also changes.

A.1.1 G392-004A (air cooling, 1 x 230 V AC)

Servo drive	Switching frequency of the power stage	Ambient temperature	Rated current	Peak current [A_{eff}]			
			At 230 V_{AC}	At rotating field frequency increasing linearly 0 to 5 Hz		For intermittent operation	For time [1]
	[kHz]	[°C]/[°F]	[A_{eff}]	0 Hz	5 Hz	>5 Hz	[s]
G392-004A (Size 1)	4	+45 (+113)	4	8	8	8	10
	8	+40 (+104)	4	8	8	8	
	12		3.7	7.4	7.4	7.4	
	16		2.7	5.4	5.4	5.4	

Data apply for a motor cable length ≤10 m (32.80 ft).

1) Shutdown as per I^2t characteristic

Table A.1 Rated and peak current, Size 1 (air cooling, one-phase)

A.1.2 Current carrying capacity Size 1 to Size 4, air cooling, three-phase

Servo drive	Switching frequency of the power stage	Ambient temperature	At mains voltage 400 V		At mains voltage 460 V		At mains voltage 480 V		Overload factor ≥ 5 Hz	For time 1)
			Rated current	Peak current [A_{eff}]	Rated current	Peak current [A_{eff}]	Rated current	Peak current [A_{eff}]		
	[kHz]	[°C]/[°F]	[A_{eff}]	0 Hz to ≥5 Hz	[A_{eff}]	0 Hz to ≥5 Hz	[A_{eff}]	0 Hz to ≥5 Hz	[%]	[s]
G392-004 (Size 1)	4	+45 2) (+113)	4	8	4	8	4	8	200	10
	8	+40 (+104)	4	8	4	8	4	8		
	12		3.7	7.4	2.9	5.8	2.7	5.4		
	16		2.7	5.4	1.6	3.2	1.3	2.6		
G392-006 (Size 1)	4	+45 2) (+113)	6	12	6	12	6	12	200	10
	8	+40 (+104)	6	12	6	12	6	12		
	12		5.5	11	4.4	8.8	4	8		
	16		4	8	2.4	4.8	1.9	3.8		
G392-008 (Size 2)	4	+45 (+113)	8	16	8	16	8	16	200	10
	8	+40 (+104)	8	16	7.2	14.4	6.9	13.8		
	12		6.7	13.4	5.3	10.6	4.9	9.8		
	16		5	10	3.7	7.4	3.3	6.6		
G392-012 (Size 2)	4	+45 (+113)	12	24	12	24	12	24	200	10
	8	+40 (+104)	12	24	10.8	21.6	10.4	20.8		
	12		10	20	8	16	7.4	14.8		
	16		7.6	15.2	5.6	11.2	5	10		

All data apply for a motor cable length ≤10 m (32.80 ft).

1) Shutdown as per I^2t characteristic

2) For G392 Size 1-Safety only approved up to +40 °C (+104 °F).

Table A.2 Rated and peak current, Size 1 to Size 4 (air cooling, three-phase)

Servo drive	Switching frequency of the power stage	Ambient temperature	At mains voltage 400 V		At mains voltage 460 V		At mains voltage 480 V		Overload factor ≥ 5 Hz	For time [1]
			Rated current	Peak current [A_{eff}]	Rated current	Peak current [A_{eff}]	Rated current	Peak current [A_{eff}]		
	[kHz]	[°C]/[°F]	[A_{eff}]	0 Hz to ≥5 Hz	[A_{eff}]	0 Hz to ≥5 Hz	[A_{eff}]	0 Hz to ≥5 Hz	[%]	[s]
G392-016 (Size 3)	4	+45 (+113)	16	32	16	32	16	32	200	10
	8	+40 (+104)	16	32	13.9	27.8	13.3	26.6		
	12		11	22	8.8	17.6	8	16		
	16		8	16	5.9	11.8	5.2	10.4		
G392-020 (Size 3)	4	+45 (+113)	20	40	20	40	20	40	200	10
	8	+40 (+104)	20	40	17.4	34.8	16.6	33.2		
	12		13.8	27.6	11	22	10	20		
	16		10	20	7.4	14.8	6.5	13		
G392-024 (Size 4)	4	+45 (+113)	24	48	24	48	24	48	200	10
	8	+40 (+104)	24	48	21	42	20	40		
	12		15.8	31.6	12.4	24.8	11.3	22.6		
	16		11.3	22.6	9.2	18.4	8.4	16.8		
G392-032 (Size 4)	4	+45 (+113)	32	64	32	64	32	64	200	10
	8	+40 (+104)	32	64	28	56	26.7	53.4		
	12		21	42	16.5	33	15	30		
	16		15	30	12.2	24.4	11.2	22.4		

All data apply for a motor cable length ≤10 m (32.80 ft).

1) Shutdown as per I^2t characteristic

2) For G392 Size 1-Safety only approved up to +40 °C (+104 °F).

Table A.2 Rated and peak current, Size 1 to Size 4 (air cooling, three-phase)

A.1.3 Current carrying capacity, Size 5 to Size 6A, air cooling

Servo drive	Power stage switching frequency	Ambient temperature	At mains voltage 400 V				At mains voltage 460 V				At mains voltage 480 V				Overload factor ≥5 Hz	For time [1]
			Rated current	Peak current [Aeff] [2]			Rated current	Peak current [Aeff] [2]			Rated current	Peak current [Aeff] [2]				
				At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		
	[kHz]	[°C]/[°F]	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[%]	[s]
G392-045 (Size 5)	4	+45 (+113)	45	90	90		42	83	84		41	81	82		200	3/10 [3]
	8	+40 (+104)	45	90	90		42	83	84		41	81	82			
	12		45	90	90		42	83	84		41	81	82			
	16		42	84	84		39	78	78		38	76	76			
G392-060 (Size 5)	4	+45 (+113)	60	120	120		56	111	112		54	108	108		200	3/10 [3]
	8	+40 (+104)	60	120	120		56	111	112		54	108	108			
	12		58	116	116		54	107	108		52	104	104			
	16		42	84	84		39	78	78		38	76	76			
G392-072 (Size 5)	4	+45 (+113)	72	144	144		67	133	134		65	130	130		200	3/10 [3]
	8	+40 (+104)	72	144	144		67	133	134		65	130	130			
	12 [4]		58	116	116		54	107	108		52	104	104			
	16 [4]		42	84	84		39	78	78		38	76	76			

All data apply for a motor cable length ≤10 m (32.80 ft).

1) Shutdown as per I^2t characteristic

2) Permissible peak current at maximum 70 % initial load

3) 10 s at heat sink temperature <+45 °C (+113 °F)

4) For G392 Size 5-Safety only allowed up to 8 kHz

Table A.3 Rated and peak current, Size 5 (air cooling)

Servo drive	Power stage switching frequency	Ambient temperature	At mains voltage 400 V				At mains voltage 460 V				At mains voltage 480 V				Overload factor ≥5 Hz	For time [1]
			Rated current	Peak current [Aeff] [2]			Rated current	Peak current [Aeff] [2]			Rated current	Peak current [Aeff] [2]				
				At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		
	[kHz]	[°C]/[°F]	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[%]	[s]
G392-090 (Size 6)	4	+45 (+113)	90	170	180		83	157	166		81	153	162		200	30
	8	+40 (+104)	90	134	180		83	124	166		81	121	162		200	
	12		90	107	144		83	99	133		81	95	130		160	
	16		72	86	115		67	80	107		65	77	104		160	
G392-110 (Size 6)	4	+45 (+113)	110	170	220		102	157	204		99	153	198		200	30
	8	+40 (+104)	110	134	165		102	124	153		99	121	149		150	
	12		90	107	144		83	99	133		81	95	130		160	
	16		72	86	115		67	80	107		65	77	104		160	
G392-143 (Size 6A)	4	+45 (+113)	143	191	286		132	176	264		129	170	258		200	30
	8	+40 (+104)	143	152	215		132	140	198		129	136	194		150	
	12		115	122	173		106	112	159		104	109	156		150	
	16		92	98	138		85	91	128		83	87	125		150	
G392-170 (Size 6A)	4	+45 (+113)	170	191	323		157	176	298		153	170	291		190	10
	8	+40 (+104)	170	152	221		157	140	204		153	136	199		130	
	12		136	122	163		126	112	151		122	109	146		120	
	16		109	98	131		101	91	121		98	87	118		120	

All data apply for a motor cable length ≤10 m (32.80 ft).

1) Shutdown as per I^2t characteristic

2) Permissible peak current at maximum 70 % initial load

Table A.4 Rated and peak current, Size 6 and Size 6A (air cooling)

A.1.4 Current carrying capacity Size 3 to Size 4, liquid cooling

NOTE:

The shutdown temperature for liquid-cooled devices is +65 °C (+149 °F) (internally at the heat sink). The servo drive is shut down and is only ready for operation again after a short cooling phase.

Servo drive	Switching frequency of the power stage	Ambient temperature	At mains voltage 400 V		At mains voltage 460 V		At mains voltage 480 V		Overload factor ≥ 5 Hz	For time 1)
			Rated current	Peak current [A_{eff}]	Rated current	Peak current [A_{eff}]	Rated current	Peak current [A_{eff}]		
	[kHz]	[°C]/[°F]	[A_{eff}]	0 Hz to ≥5 Hz	[A_{eff}]	0 Hz to ≥5 Hz	[A_{eff}]	0 Hz to ≥5 Hz	[%]	[s]
G395-016 (Size 3)	4	+45 (+113)	16	32	16	32	16	32	200	10
	8	+40 (+104)	16	32	13.9	27.8	13.3	26.6		
	12		11	22	8.8	17.6	8	16		
	16		8	16	5.9	11.8	5.2	10.4		
G395-020 (Size 3)	4	+45 (+113)	20	40	20	40	20	40	200	10
	8	+40 (+104)	20	40	17.4	34.8	16.6	33.2		
	12		13.8	27.6	11	22	10	20		
	16		10	20	7.4	14.8	6.5	13		
G395-024 (Size 4)	4	+45 (+113)	24	48	24	48	24	48	200	10
	8	+40 (+104)	24	48	21	42	20	40		
	12		15.8	31.6	12.4	24.8	11.3	22.6		
	16		11.3	22.6	9.2	18.4	8.4	16.8		
G395-032 (Size 4)	4	+40 (+104)	32	64	32	64	32	64	200	10
	8		32	64	28	56.0	26.7	53.4		
	12		21	42	16.5	33	15	30		
	16		15	30	12.2	24.4	11.2	22.4		

All data apply for a motor cable length ≤10 m (32.80 ft).

1) Shutdown as per I^2t characteristic

2) Permissible peak current at maximum 70 % initial load

Table A.5 Rated and peak current, Size 3 and Size 4 (liquid cooling)

A.1.5 Current carrying capacity Size 5 to Size 6A, liquid cooling

NOTE:
The shutdown temperature for liquid-cooled devices is +65 °C (+149 °F) (internally at the heat sink). The servo drive is shut down and is only ready for operation again after a short cooling phase.

Servo drive	Power stage switching frequency	Ambient temperature	At mains voltage 400 V				At mains voltage 460 V				At mains voltage 480 V				Overload factor ≥5 Hz	For time [1]
			Rated current	Peak current [Aeff] [2]			Rated current	Peak current [Aeff] [2]			Rated current	Peak current [Aeff] [2]				
				At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		
	[kHz]	[°C]/[°F]	" [Aeff]"	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[%]	[s]
G395-053 (Size 5)	4	+45 (+113)	53	90	90		49	83	83		48	82	82		170	30
	8		53	90	90		49	83	83		48	82	82			
	12		53	90	90		49	83	83		48	82	82			
	16		49	83	83		45	77	77		44	75	75			
G395-070 (Size 5)	4	+45 (+113)	70	119	119		65	111	111		63	107	107		170	30
	8		70	119	119		65	111	111		63	107	107			
	12		68	116	116		63	107	107		61	104	104			
	16		49	83	83		45	77	77		44	75	75			
G395-084 (Size 5)	4	+45 (+113)	84	143	143		78	133	133		76	129	129		170	30
	8		84	143	143		78	133	133		76	129	129			
	12 [3]		68	116	116		63	107	107		61	104	104			
	16 [3]		49	83	83		45	77	77		44	75	75			

All data apply for a motor cable length ≤10 m (32.80 ft).

1) Shutdown as per I^2t characteristic

2) Permissible peak current at maximum 70 % initial load

3) For G395 Size 5-Safety only approved up to 8 kHz.

Table A.6 Rated and peak current, Size 5 (liquid-cooled)

Servo drive	Power stage switching frequency	Ambient temperature	At mains voltage 400 V				At mains voltage 460 V				At mains voltage 480 V				Overload factor ≥5 Hz	For time [1]
			Rated current	Peak current [Aeff] [2]			Rated current	Peak current [Aeff] [2]			Rated current	Peak current [Aeff] [2]				
				At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		
	[kHz]	[°C]/°F[	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[%]	[s]
G395-110 (Size 6)	4	+45 (+113)	110	206	220		102	191	204		99	186	198		200	30
	8		110	166	187		102	154	173		99	150	168		170	
	12		110	133	165		102	123	153		99	120	149		150	
	16		90	106	135		83	99	125		81	96	122		150	
G395-143 (Size 6)	4	+45 (+113)	143	232	286		132	214	264		129	208	258		200	30
	8		143	192	215		132	177	198		129	172	194		150	
	12		114	153	171		105	142	158		103	138	155		150	
	16		91	123	137		84	114	126		82	111	123		150	
G395-170 (Size 6A)	4	+45 (+113)	170	232	340		157	214	314		153	208	306		200	10
	8		170	192	255		157	177	236		153	172	230		150	
	12		136	153	204		126	142	189		122	138	183		150	
	16		109	123	164		101	114	152		98	111	147		150	
G395-210 (Size 6A)	4	+45 (+113)	210	232	340		194	214	314		189	208	306		160	10
	8		210	192	255		194	177	236		189	172	230		120	
	12		168	153	204		155	142	189		151	138	183		120	
	16		134	123	164		124	114	152		121	111	147		120	

All data apply for a motor cable length ≤10 m (32.80 ft).

1) Shutdown as per I^2t characteristic

2) Permissible peak current at 70 % initial load

Table A.7 Rated and peak current, Size 6 and Size 6A (liquid cooling)

A.1.6 Current carrying capacity Size 7, liquid cooling

NOTE:

The shutdown temperature for liquid-cooled devices is +90 °C (+194 °F) (internally at the heat sink). The servo drive is shut down and is only ready for operation again after a short cooling phase.

Servo drive	Power stage switching frequency	Ambient temperature	At mains voltage 400 V				At mains voltage 460 V				At mains voltage 480 V				Overload factor ≥5 Hz	For time [1]
			Rated current	Peak current [Aeff] [2]			Rated current	Peak current [Aeff] [2]			Rated current	Peak current [Aeff] [2]				
				At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		
	[kHz]	[°C]/[°F]	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[%]	[s]
G395-250 (Size 7)	2	+40 (+104)	250	425			231	393			225	383			170	30
	4		250	375			231	346			225	338			150	
G395-325 (Size 7)	2	+40 (+104)	325	552			300	511			293	498			170	30
	4		325	487			300	451			293	440			150	
G395-450 (Size 7)	2	+40 (+104)	450	765			416	707			405	689			170	30
	4		450	675			416	624			405	608			150	

All data apply for a motor cable length ≤10 m (32.80 ft).

1) Shutdown as per I^2t characteristic

2) Permissible peak current at maximum 70 % initial load

Table A.8 Rated and peak current, Size 7 (liquid-cooled)

A.2 Technical data, MSD Servo Drive

A.2.1 G392-004A to G392-016, air cooling

Designation / Technical data	G392-004A	G392-004	G392-006	G392-008	G392-012	G392-016
Output, motor side [1]						
Voltage [4]	3-phase U_{Mains}					
Rated current, effective (I_N)	4 A	4 A	6 A	8 A	12 A	16 A
Peak current	See A.1.1	See A.1.2				
Rotating field frequenc	0 ... 400 Hz					
Switching frequency of the power stage	4, 8, 12, 16 kHz					
Input, mains side						
Mains voltage	1 x 230 V ±10 %	(3 x 230 V/ 3 x 400 V/ 3 x 460 V/ 3 x 480 V) ±10 %				
Device connected load [1] (with mains choke)	2.2 kVA	2.9 kVA	4.4 kVA	6 kVA	9.1 kVA	12 kVA
Current [1] (with mains choke)	9.5 A [2]	4.2 A	6.4 A	8.7 A	13.1 A	17.3 A
Asymmetry of mains voltage	-	±3 % maximum				
Frequency	50/60 Hz ±10 %					
Power dissipation at I_N [1]	85 W	96 W	122 W	175 W	240 W	330 W

1) Data referred to mains voltage 3 x 400 V_{eff} (for G392-004A: 1 x 230 Veff) and switching frequency of power stage 8 kHz
2) Without mains choke
3) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model G392-xxx-xxx-xx2/xx4)!
4) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.

Table A.9 Technical data, G392-004A to G392-016, air cooling

Designation / Technical data	G392-004A	G392-004	G392-006	G392-008	G392-012	G392-016
DC link						
Capacitance	1740 µF	400 µF		725 µF		1230 µF
Brake chopper switch-on threshold [1]	390 V DC	650 V DC				
Minimum ohmic resistance of an externally installed braking resistor [3]	72 Ω			39 Ω		20 Ω
Brake chopper peak power with external braking resistor [1]	2.1 kW	5.9 kW		11 kW		21 kW
Optional: Internal braking resistor	PTC (175 Ω)			90 Ω		
Brake chopper peak power with internal braking resistor	See “Table 4.21 Data on the integrated braking resistor (model G392-xxx-xxx-xx2/xx4 and G395-xxx-xxx-xx2/xx4)”					

1) Data referred to mains voltage 3 x 400 V_{eff} (for G392-004A: 1 x 230 Veff) and switching frequency of power stage 8 kHz
2) Without mains choke
3) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model G392-xxx-xxx-xx2/xx4)!
4) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.

Table A.9 Technical data, G392-004A to G392-016, air cooling

NOTE:
You will find more information on the brake chopper switch-on threshold in chapter “4.6 Connection of PE conductor”

A.2.2 G392-020 to G392-072, air cooling

Designation / Technical data	G392-020	G392-024	G392-032	G392-045	G392-060	G392-072
Output, motor side [1]						
Voltage [2]	3-phase U_{Mains}					
Rated current, effective (I_N)	20 A	24 A	32 A	45 A	60 A	72 A
Peak current	See A.1.2			See A.1.3		
Rotating field frequenc	0 ... 400 Hz					
Switching frequency of the power stage	4, 8, 12, 16 kHz					
Input, mains side						
Mains voltage	(3 x 230 V/ 3 x 400 V/ 3 x 460 V/ 3 x 480 V) ±10 %					
Device connected load [1] (with mains choke)	15 kVA	18.2 kVA	24.2 kVA	31.2 kVA	41.0 kVA	50 kVA
Current [1] (with mains choke)	21.6 A	26.2 A	34.9 A	45 A	60 A	72 A
Asymmetry of mains voltage	±3 % maximum					
Frequency	50/60 Hz ±10 %					
Power dissipation at I_N [1]	400 W	475 W	515 W	610 W	830 W	1010 W
DC link						
Capacitance	1230 µF	2000 µF		430 µF	900 µF	
Brake chopper switch-on threshold	650 V DC [1]			820 V DC		

1) Data referred to mains voltage 3 x 400 V_{eff} and switching frequency of the power stage 8 kHz
2) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.
3) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model G392-xxx-xxx-xx2/xx4)!

Table A.10 Technical data, G392-020 to G392-072, air cooling

Designation / Technical data	G392-020	G392-024	G392-032	G392-045	G392-060	G392-072
Minimum ohmic resistance of an externally installed braking resistor	20 Ω [3]	12 Ω [3]		18 Ω		13 Ω
Brake chopper peak power with external braking resistor	21 kW [1]	35 kW [1]		37 kW		52 kW
Optional: Internal braking resistor	90 Ω			-		
Brake chopper peak power with internal braking resistor	See “Table 4.21 Data on the integrated braking resistor (model G392-xxx-xxx-xx2/xx4 and G395-xxx-xxx-xx2/xx4)”			-		

1) Data referred to mains voltage 3 x 400 V_{eff} and switching frequency of the power stage 8 kHz
2) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.
3) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model G392-xxx-xxx-xx2/xx4)!

Table A.10 Technical data, G392-020 to G392-072, air cooling

NOTE:

For more information on the brake chopper also refer to chapter “4.16 Braking resistor (RB)”

A.2.3 G392-090 to G392-170, air cooling

Designation / Technical data	G392-090	G392-110	G392-143	G392-170
Output, motor side [1]				
Voltage [2]	3-phase U_{Mains}			
Rated current, effective (I_N)	90 A	110 A	143 A	170 A
Peak current	See A.1.3			
Rotating field frequenc	0 ... 400 Hz			
Switching frequency of the power stage	4, 8, 12, 16 kHz			
Input, mains side				
Mains voltage	(3 x 230 V/ 3 x 400 V/ 3 x 460 V/ 3 x 480 V) ±10 %			
Device connected load [1] (with mains choke)	62 kVA	76 kVA	99 kVA	118 kVA
Current [1] (with mains choke)	90 A	110 A	143 A	170 A
Asymmetry of mains voltage	±3 % maximum			
Frequency	50/60 Hz ±10 %			
Power dissipation at I_N [1]	1300 W	1600 W	2100 W	2500 W
DC link				
Capacitance	1060 µF	2120 µF	3180 µF	4240 µF
Brake chopper switch-on threshold	820 V DC			
Minimum ohmic resistance of an externally installed braking resistor	12 Ω	10 Ω	8.5 Ω	6.5 Ω
Brake chopper peak power with external braking resistor	56 kW	67 kW	79 kW	103 kW
Optional: Internal braking resistor	-	-	-	-
Brake chopper peak power with internal braking resistor	-	-	-	-

1) Data referred to mains voltage 3 x 400 V_{eff} and switching frequency of the power stage 8 kHz

2) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.

Table A.11 Technical data, G392-090 to G392-170, air cooling

Table A.11 Technical data, G392-090 to G392-170, air cooling

NOTE:

For more information on the brake chopper and braking resistors also refer to chapter “4.16 Braking resistor (RB)”

A.2.4 G395-016 to G395-070, liquid cooling

Designation / Technical data	G395-016	G395-020	G395-024	G395-032	G395-053	G395-070
Output, motor side [1]						
Voltage [2]	3-phase U_{Mains}					
Rated current, effective (I_N)	16 A	20 A	24 A	32 A	53 A	70 A
Peak current	See A.1.4				See A.1.5	
Rotating field frequenc	0 ... 400 Hz					
Switching frequency of the power stage	4, 8, 12, 16 kHz					
Input, mains side						
Mains voltage	(3 x 230 V/ 3 x 400 V/ 3 x 460 V/ 3 x 480 V) ±10 %					
Device connected load [1] (with mains choke)	12 kVA	15 kVA	18.2 kVA	24.2 kVA	36.7 kVA	48.5 kVA
Current [1] (with mains choke)	17.3 A	21.6 A	26.2 A	34.9 A	53 A	70 A
Asymmetry of mains voltage	±3 % maximum					
Frequency	50/60 Hz ±10 %					
Power dissipation at I_N [1]	330 W	400 W	475 W	515 W	690 W	930 W
DC link						
Capacitance	1230 µF		2000 µF		430 µF	900 µF
Brake chopper switch-on threshold	650 V DC [1]				820 V DC	

1) Data referred to mains voltage 3 x 400 V_{eff} and switching frequency of the power stage 8 kHz
2) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.
3) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model G395-xxx-xxx-xx2/xx4)!
4) Cooling performance adequate also with optional internal braking resistor

Table A.12 Technical data, G395-016 to G395-070, liquid cooling

Designation / Technical data	G395-016	G395-020	G395-024	G395-032	G395-053	G395-070
Minimum ohmic resistance of an externally installed braking resistor	20 Ω		12 Ω		10 Ω [3]	
Brake chopper peak power with external braking resistor	21 kW		35 kW		67 kW	
Optional: Internal braking resistor	-				20 Ω	10 Ω
Brake chopper continuous power with internal braking resistor	-				675 W	1350 W
Brake chopper peak power with internal braking resistor	-				34 kW	67 kW
Chiller data						
Coolant pressure (rated value / maximum value)	1 / 2 bar					
Coolant flow rate [4] (rated value / maximum value)	3 / 4 l per min				8 / 11 l per min	
Feed coolant temperature	The coolant temperature can be between +5 °C (+41 °F) and +40 °C (+104 °F). However, the coolant temperature should not be more than 10 °K below the ambient temperature to prevent condensation on the heat sink.					

1) Data referred to mains voltage 3 x 400 V_{eff} and switching frequency of the power stage 8 kHz
2) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.
3) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model G395-xxx-xxx-xx2/xx4)!
4) Cooling performance adequate also with optional internal braking resistor

Table A.12 Technical data, G395-016 to G395-070, liquid cooling

A.2.5 G395-084 to G395-210, liquid cooling

Designation / Technical data	G395-084	G395-110	G395-143	G395-170	G395-210
Output, motor side [1]					
Voltage [6]	3-phase U_{Mains}				
Rated current, effective (I_N)	84 A	110 A	143 A	170 A	210 A
Peak current	See A.1.5				
Rotating field frequenc	0 ... 400 Hz				
Switching frequency of the power stage	4, 8, 12, 16 kHz				
Input, mains side					
Mains voltage	(3 x 230 V/ 3 x 400 V/ 3 x 460 V/ 3 x 480 V) ±10 %				
Device connected load (with mains choke)	52.6 kVA [2]	76 kVA	99 kVA	118 kVA	128 kVA [3]
Current [1] (with mains choke)	76 A [2]	110 A	143 A	170 A	185 A [3]
Asymmetry of mains voltage	±3 % maximum				
Frequency	50/60 Hz ±10 %				
Power dissipation at I_N [1]	1130 W	1500 W	1940 W	2380 W	2650 W

1) Data referred to mains voltage 3 x 400 V_{eff} and switching frequency of the power stage 8 kHz
2) The input current must be limited to 76 A
3) The input current must be limited to 185 A
4) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model G395-xxx-xxx-xx2)!
5) Cooling performance adequate also with optional internal braking resistor
6) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.

Table A.13 Technical data, G395-084 to G395-210, liquid cooling

Designation / Technical data	G395-084	G395-110	G395-143	G395-170	G395-210
DC link					
Capacitance	900 µF	2120 µF		4240 µF	
Brake chopper switch-on threshold	820 V DC				
Minimum ohmic resistance of an externally installed braking resistor [4]	10 Ω	12 Ω	10 Ω	8.5 Ω	6.5 Ω
Brake chopper peak power with external braking resistor	67 kW	56 kW	67 kW	79 kW	103 kW
Option: internal braking resistor	10 Ω	7.5 Ω		7.5 Ω	
Brake chopper continuous power with internal braking resistor	1350 W	2650 W		2650 W	
Brake chopper peak power with internal braking resistor	67 kW	90 kW		90 kW	
Chiller data					
Coolant pressure (rated value / maximum value)	1 / 2 bar				
Coolant flow rate [5] (rated value / maximum value)	8 / 11 l per min	11 / 13 l per min			
Feed coolant temperature	The coolant temperature can be between +5 °C (+41 °F) and +40 °C (+104 °F). However, the coolant temperature should not be more than 10 °K below the ambient temperature to prevent condensation on the heat sink.				

1) Data referred to mains voltage 3 x 400 V_{eff} and switching frequency of the power stage 8 kHz
2) The input current must be limited to 76 A
3) The input current must be limited to 185 A
4) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model G395-xxx-xxx-xx2)!
5) Cooling performance adequate also with optional internal braking resistor
6) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.

Table A.13 Technical data, G395-084 to G395-210, liquid cooling

A.2.6 G395-250 to G395-450, liquid cooling

Designation / Technical data	G395-250	G395-325	G395-450
Output, motor side [1]			
Voltage [3]	3-phase U_{Mains}		
Rated current, effective (I_N)	250 A	325 A	450 A
Peak current	See A.1.6		
Rotating field frequenc	0 ... 400 Hz		
Switching frequency of the power stage	2, 4 kHz (8, 12, 16) [2]		
Input, mains side			
Mains voltage	(3 x 230 V/ 3 x 400 V/ 3 x 460 V/ 3 x 480 V) ±10 %		
Device connected load (with mains choke)	173 kVA	225 kVA	310 kVA
Current [1] (with mains choke)	250 A	325 A	450 A
Asymmetry of mains voltage	±3 % maximum		
Frequency	50/60 Hz ±10 %		
Power dissipation at I_N [1]	3960 W	4800 W	6750 W
DC link			
Capacitance	3600 µF	5400 µF	7200 µF
Brake chopper switch-on threshold	820 V DC		

1) Data referred to mains voltage 3 x 400 V_{eff} and switching frequency of the power stage 4 kHz
2) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.
3) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model G395-xxx-xxx-xx2)!
4) Cooling performance adequate also with optional internal braking resistor

Table A.14 Technical data G395-250 to G395-450 liquid cooling

Designation / Technical data	G395-250	G395-325	G395-450
Minimum ohmic resistance of an externally installed braking resistor	3.2 Ω [3]	2.5 Ω [3]	1.7 Ω [3]
Brake chopper peak power with external braking resistor	210 kW	269 kW	395 kW
Option: internal braking resistor	3.3 Ω		2.4 Ω
Brake chopper continuous power with internal braking resistor	5000 W		6800 W
Brake chopper peak power with internal braking resistor	204 kW		280 kW
Chiller data			
Coolant pressure (rated value / maximum value)	1 / 2 bar		
Coolant flow rate [4] (rated value / maximum value)	12 / 14 l per min		
Feed coolant temperature	The coolant temperature can be between +5 °C (+41 °F) and +40 °C (+104 °F). However, the coolant temperature should not be more than 10 °K below the ambient temperature to prevent condensation on the heat sink.		

1) Data referred to mains voltage 3 x 400 V_{eff} and switching frequency of the power stage 4 kHz
2) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.
3) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model G395-xxx-xxx-xx2)!
4) Cooling performance adequate also with optional internal braking resistor

Table A.14 Technical data G395-250 to G395-450 liquid cooling

A.3 Power connections

Feature	Size 1 and Size 2	Size 3 and Size 4	Size 5	Size 6 and Size 6A	
				90 - 110 A	143 - 170 A
Cable cross-section (flexible with ferrule	0.25 to 4 mm² (0.004 to 0.006 in²) (AWG 24 to AWG 10) *)	0.75 to 16 mm² (0.001 to 0.025 in²) (AWG 18 to AWG 6)	maximum 35 mm² (0.054 in²) (AWG 2)	35 to 95 mm² (0.054 to 0.147 in²) (AWG 2 to AWG 4/0)	50 to 150 mm² (0.078 to 0.23 in²) (AWG 3 to AWG 5/0)
Tightening torque	0.7 to 0.8 Nm (6.2 to 7 lb-in)	1.7 to 1.8 Nm (15 to 15.9 lb-in)	2.5 to 4.5 Nm (22 to 39.8 lb-in)	15 to 20 Nm (132.7 to 177 lb-in)	25 to 30 Nm (221 to 265 lb-in)

*) For ferrule without plastic sleeve up to 6 mm² possible

Table A.15 Technical data, terminals for motor cable Size 1 to Size 6A

Feature	Size 7
Screws for ring cable lug	ZK-, ZK+, RB-, RB+: M10 L1-3, U, V, W: M12
Tightening torque (Nm)	M10 screws: 20-25 M12 screws: 25-30

Table A.16 Technical data, busbars for motor cable Size 7

A.4 Current required for the control supply

Housing variant	Size	Maximum starting current	Continuous current
Air cooling	Size 1 to Size 4	6 A	2 A
	Size 5	7 A	2.5 A
	Size 6 to Size 6A	10 A	0 A (10 A) [1]
Liquid cooling	Size 3 to Size 4	6 A	2 A
	Size 5	7 A	2 A
	Size 6 to Size 6A	8 A	0 A (2 A) [1]
	Size 7	4 A	2 A

1) The value in brackets applies as long as the voltage supply for the power section is switched off. When the power section is supplied with power, an internal high-voltage switched-mode power supply takes over the supply of the control section.

Table A.17 Current required for the control supply

A.5 Ambient conditions

Ambient conditions	MSD Servo Drive
Protection	IP20 Exceptions: IP10 for BG2 heat sink fan IP00 in general for all connections terminals for all sizes
Accident prevention regulations	As per the local regulations (in Germany e.g. DGUV V3)
Installation altitude	Up to 1,000 m (3,280 ft) above MSL, over 1,000 m (3,280 ft) above MSL with power reduction (1 % per 100 m (328 ft), maximum 2,000 m (6,561 ft) above MSL)
Pollution degree	2 as per IEC/EN 60664-1
Type of mounting	Built-in unit, only for vertical mounting in a switch cabinet with minimum IP4x protection, on using STO safety function min. IP54.

Table A.18 Ambient conditions, MSD Servo Drive

Climatic conditions			MSD Servo Drive
In transit	As per IEC/EN 61800-2, IEC/EN 60721-3-2 class 2K3[1]		
	Temperature		-25 °C to +70 °C (-13 °F to +158 °F)
	Relative atmospheric humidity		95 % at maximum +40 °C (+104 °F)
In storage	As per IEC/EN 61800-2, IEC/EN 60721-3-1 classes 1K3 and 1K4[2]		
	Temperature		-25 °C to +55 °C (-13 °F to +131 °F)
	Relative atmospheric humidity		5 to 95 %
In operation	As per IEC/EN 61800-2, IEC/EN 60721-3-3 class 3K3[3]		
	Temperature	Air cooling	**Size 1** -10 °C to +45 °C (+14 °F to +113 °F) (4 kHz) -10 °C to +40 °C (+14 °F to +113 °F) (8, 12, 16 kHz) **Size 2 to Size 4** -10 °C to +45 °C (+14 °F to +113 °F) (4 kHz), up to +55 °C (+131 °F) with power reduction (5 % per °C) -10 °C to +40 °C (+14 °F to +104 °F) (8, 12, 16 kHz), up to +55 °C (+131 °F) with power reduction (4 % per °C) **Size 5 to Size 6A** -10 °C to +45 °C (+14 °F to +113 °F) (4 kHz) -10 °C to +40 °C (+14 °F to +104 °F) (8, 12, 16 kHz), above up to +55 °C (+131 °F) with power reduction (2 % per °C)
		Liquid cooling	**Size 3 to Size 4** -10 °C to +45 °C (+14 °F to +113 °F) (4 kHz), up to +55 °C (+131 °F) with power reduction (5 % per °C) -10 °C to +40 °C (+14 °F to +104 °F) (8, 12, 16 kHz), up to +55 °C (+131 °F) with power reduction (4 % per °C) **Size 5 to Size 6A** -10 °C to +45 °C (+14 °F to +113 °F) (4, 8, 12, 16 kHz), up to +55 °C (+131 °F) with power reduction (2 % per °C) **Size 7** -10 °C to +40 °C (+14 °F to +104 °F) (2, 4 kHz), up to +55 °C (+131 °F) with power reduction (2 % per °C)
	Relative atmospheric humidity		5 to 85 % without condensation

1) The absolute humidity is limited to maximum 60 g/m³. This means, at +70 °C (+158 °F) for example, that the relative atmospheric humidity may only be maximum 40 %.

2) The absolute humidity is limited to maximum 29 g/m³. So the maximum values for temperature and relative atmospheric humidity stipulated in the table must not occur simultaneously.

3) The absolute humidity is limited to maximum 25 g/m³. That means that the maximum values for temperature and relative atmospheric humidity stipulated in the table must not occur simultaneously.

Table A.19 Climatic conditions, MSD Servo Drive

Mechanical conditions			
Vibration limit in transit	As per EN 61800-2, IEC/EN 60721-3-2 class 2M1		
	Frequency [Hz]	Amplitude [mm (in)]	Acceleration [m/s² (in/s²)]
	2 ≤ f < 9	3.5 (0.14)	Not applicable
	9 ≤ f < 200	Not applicable	10 (393.70)
	200 ≤ f < 500	Not applicable	15 (590.55)
Shock limit in transit	As per EN 61800-2, IEC/EN 60721-3-2 class 2M1		
	Drop height of packed device maximum 0.25 m (9.84 in)		
Vibration limits for the system 1)	As per EN 61800-2, IEC/EN 60721-3-3 class 3M1		
	Frequency [Hz]	Amplitude [mm (in)]	Acceleration [m/s² (in/s²)]
	2 ≤ f < 9	0.3 (0.01)	Not applicable
	9 ≤ f < 200	Not applicable	1 (39.37)

1) Note: The devices are only designed for stationary use.

Table A.20 Mechanical conditions, MSD Servo Drive

CAUTION!	Damage to the device due to incorrect operation!
	• **Failure to observe the ambient conditions may result in damage.** • No continuous vibration! The servo drives must not be installed in areas where they would be permanently exposed to vibration. • Switch cabinet min. IP54 for STO! According to EN ISO 13849-2 the switch cabinet must have IP54 protection or higher on using the STO (Safe Torque OFF) safety function. • Observe cooling conditions! Forced cooling by external air flow necessa y. Air must be able to flow unhindered through the device (air flow at least 1.2 m/s) If a temperature cut-out occurs, the cooling conditions must be improved

A.6 Permissible motor cable lengths

You will also find details on the topic of "electromagnetic compatibility" in the chapter “4.2 Effective EMC installation”.

The table below shows the permissible motor cable lengths while complying with the standard IEC/EN 61800-3.

Switching frequency	4 kHz		8 kHz		12 kHz		16 kHz	
	Category							
Servo drive	C3	C2	C3	C2	C3	C2	C3	C2
G392-004A[1] G392-004[1]	40 m (131.23 ft)	20 m (65.62 ft)	40 m (131.23 ft)	15 m (49.21 ft)	40 m (131.23 ft)	10 m (32.80 ft)	40 m (131.23 ft)	8 m (26.25 ft)
G392-006[1]	40 m (131.23 ft)	20 m (65.62 ft)	40 m (131.23 ft)	15 m (49.21 ft)	40 m (131.23 ft)	10 m (32.80 ft)	40 m (131.23 ft)	8 m (26.25 ft)
G392-008[1]	40 m (131.23 ft)	20 m (65.62 ft)	40 m (131.23 ft)	15 m (49.21 ft)	40 m (131.23 ft)	10 m (32.80 ft)	40 m (131.23 ft)	10 m (32.80 ft)
G392-012[1]	40 m (131.23 ft)	20 m (65.62 ft)	40 m (131.23 ft)	15 m (49.21 ft)	40 m (131.23 ft)	10 m (32.80 ft)	40 m (131.23 ft)	10 m (32.80 ft)
G392-016[1] G395-016[1]	40 m (131.23 ft)	10 m (32.80 ft)	40 m (131.23 ft)	10 m (32.80 ft)	40 m (131.23 ft)	10 m (32.80 ft)	40 m (131.23 ft)	10 m (32.80 ft)
G395-020[1] G395-020[1]	40 m (131.23 ft)	10 m (32.80 ft)	40 m (131.23 ft)	10 m (32.80 ft)	40 m (131.23 ft)	10 m (32.80 ft)	40 m (131.23 ft)	10 m (32.80 ft)
G392-024[1] G395-024[1]	40 m (131.23 ft)	10 m (32.80 ft)	40 m (131.23 ft)	10 m (32.80 ft)	40 m (131.23 ft)	10 m (32.80 ft)	40 m (131.23 ft)	10 m (32.80 ft)
G392-032[1] G395-032[1]	40 m (131.23 ft)	10 m (32.80 ft)	40 m (131.23 ft)	10 m (32.80 ft)	40 m (131.23 ft)	10 m (32.80 ft)	40 m (131.23 ft)	10 m (32.80 ft)

C3 = "Second environment" (industrial)

C2 = "First environment" (residential)

1) The motor shield connection is not on the shield plate, but instead directly at the device terminals.

2) To comply with the standard, mains chokes (uK = 4 % up to 32 A / uK = 2 % for 45 to 450 A) must be used

3) Standard can only be met with an external filter (no internal filter fitt

4) Also applies at a switching frequency F_S = 2 kHz

Table A.21 Permissible motor cable lengths

Switching frequency	4 kHz		8 kHz		12 kHz		16 kHz	
	Category							
Servo drive	C3	C2	C3	C2	C3	C2	C3	C2
G392-045[2] G395-053[2]	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)
G392-060[2] G395-070[2]	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)
G392-072[2] G395-084[2]	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)
G392-090[2] [3] G395-110[2] [3]	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)
G392-110[2] [3] G395-143[2] [3]	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)
G392-143[2] [3] G395-170[2] [3]	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)
G392-170[2] [3] G395-210[2] [3]	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)	25 m (82.02 ft)	10 m (32.80 ft)
G395-250[2] [3] [4]	25 m (82.02 ft)	10 m (32.80 ft)	-	-	-	-	-	-
G395-325[2] [3] [4]	25 m (82.02 ft)	10 m (32.80 ft)	-	-	-	-	-	-
G395-450[2] [3] [4]	25 m (82.02 ft)	10 m (32.80 ft)	-	-	-	-	-	-

C3 = "Second environment" (industrial)

C2 = "First environment" (residential)

1) The motor shield connection is not on the shield plate, but instead directly at the device terminals.

2) To comply with the standard, mains chokes (uK = 4 % up to 32 A / uK = 2 % for 45 to 450 A) must be used

3) Standard can only be met with an external filter (no internal filter fitt

4) Also applies at a switching frequency F_S = 2 kHz

Table A.21 Permissible motor cable lengths

A.7 Hydrological data for the liquid cooling

CAUTION!	Damage to the device due to condensation on the cooling plate
	• **Carelessness can cause condensation on the cooling plate and as a consequence irreparable damage to the device!** The temperature of the cooling plate is not allowed to be more than +10 °C (+18 °F) below the ambient temperature.

NOTE:
Adequate heating of the water chiller is to be provided by the customer.

Requirements	Limits	
Coolant quality	Recommended: tap water + corrosion inhibitor Corrosion protection through: 10-20 % vol Ethylene glycol	
	Limit concentrations:	
	Calcium	< 50 ppm
	Magnesium	< 50 ppm
	Total alkaline earth ions	< 100 ppm
	Chlorides	< 25 ppm
	Sulphates	< 25 ppm
Soiling	The coolant must be as pure as possible to ensure the channels are not clogged. With a suspended matter concentration of more than 15 mg/dm³, continuous purification is recommended.	
Coolant temperature	The coolant temperature can be between +5 °C (+41 °F) and +40 °C (+104 °F). However, the coolant temperature must not be more than 10 °K below the ambient temperature to prevent condensation on the heat sink.	
Cooler and cooler connection material	Aluminium	

Table A.22 Requirements, liquid cooling

NOTE:
Do not use material combinations with contact corrosion in the cooling circuit, such as aluminium and copper. This can lead to leaks and blockages of the cooling lines.

Size	BG3	BG4	BG5	BG6a	BG7
Coolant pressure (rated value / maximum value)	1 bar / 2 bar				
Coolant flow rate (rated value approx. / maximum value approx.)	3 l per min / 4 l per min		8 l per min / 11 l per min	11 l per min / 13 l per min	12 l per min / 14 l per min

Table A.23 Hydrological data for the liquid cooling

NOTE:
The requirements on liquid-cooled devices as per IEC/EN 61800-5-1 are to be ensured by the user.

A.8 Monitoring of the heat sink temperature

If the maximum permissible cooling temperature is exceeded, the servo drives shut down with an overtemperature error.

Size	Size 3	Size 4	Size 5	Size 6A	Size 7
Device	G395-016 G395-020	G395-024 G395-032	G395-045 G395-060 G395-072	G395-090 G395-110 G395-143 G395-170	G395-250 G395-325 G395-450
Shutdown of the device at a cooling temperature of	+65 °C (+149 °F)				+90 °C (+194 °F)

Should, for devices with liquid cooling, the coolant flow rate collapse or not become established, the power stage may overheat. For this reason the servo drive is equipped with dynamic monitoring of the heat sink temperature that shuts down the servo drive if there is an excessively high temperature gradient.

A.9 UL certification

The description of all measures to maintain UL certification is to be found in the document "UL-Certification" (ID No: CC36842-001).

Glossary

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