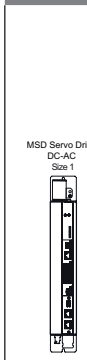
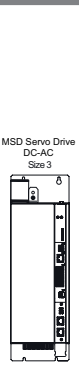
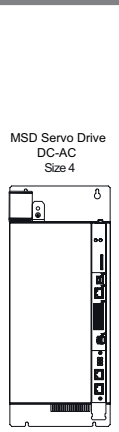
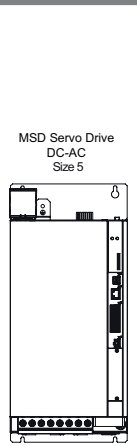
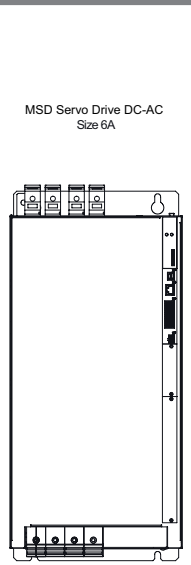
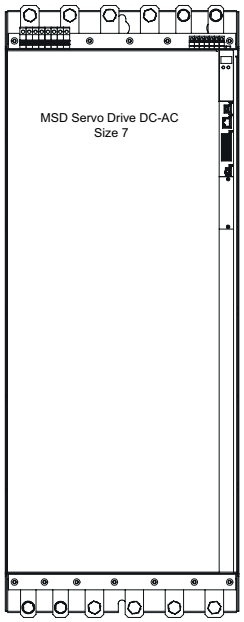
MSD Servo Drive
Multi-Axis System

Operation Manual

DC-AC Servo Drive

4 A to 450 A rated current

Size 1	Size 2	Size 3	Size 4	Size 5	Size 6A	Size 7
G393-004 G393-006	G393-008 G393-012	G393-016/ G397-020 G393-020/ G397-025	G393-024 / G397-026 G393-032 / G397-035	G393-045 / G397-053 G393-060/ G397-070 G393-072/ G397-084	G393-090 / G397-110 G393-110 / G397-143 G393-143 / G397-170 G393-170 / G397-210	G397-250 G397-325 G397-450
						

MSD Servo Drive Operation Manual

DC-AC Multi-Axis System

ID no.: CA97554-001, Rev. 3.5

Date: 09/2023

Applicable as from firmware version: V2.20-01

MSD Servo Drive energy-efficient Multi-Axis System

Consisting of DC-powered DC-AC Servo Ddrives and matching Power Supply Units, the MSD Servo Drive Multi-Axis System offers a high degree of solutions expertise and flexibility. Reduction of the wiring and shortening of the installation times are just as easy to achieve as resource-saving, cost-conscious operation.

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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10 Application example 87

Table of contents

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 formats PDF or HTML.

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 only applies to the DC-AC Servo Drive for the MSD Multi-Axis System (referred to in the following as the DC-AC Servo Drive or DC-AC for short).

1.3 Reference documents (extract)

Document	Contents	ID no. Format
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 PDF
MSD Power Supply Unit Multi-Axis System Operation Manual	Safety, mechanical installation, electrical installation, commissioning, diagnostics, specification certification and applicable standard , technical data	CA97556-001 PDF
MSD Servo Drive - Device Help	Description of the software functionality MSD Servo Drive, firm are versions: - MSD Single-Axis Servo Drive Compact from V1.30-xx - MSD Single-Axis System from V123-xx - MSD Multi-Axis System from V123-xx	CB40859-001 PDF and HTML
UL-Certificatio	Notes on UL-compliant mounting and usage	CC36842-001
Program Help Moog DriveAdministrator 5 PC uiser 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	CB50726-001 PDF
MSD Servo Drive AC-AC Servo Drive Single-Axis System- Operation Manual	Safety, mechanical installation, electrical installation, commissioning, diagnostics, specification , certification and applicable standards, technical data	CA65642-001 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/Profin User Manual	Description and configu ation of the parameters for the MSD Servo Drive on the PROFIBUS/PROFINET field bus syste	CA65645-001 PDF

NOTE:
Depending on the device model, further descriptions and manuals are available in the areas of safety technology, technology and function packages as well as communication.

Please visit our download page at www.moogsoftwaredownload.com/msd.html.

1.4 Order code

The MSD Servo Drive Multi-Axis System has the article designation *G393-xxx-xxx-xxx* and *G397-xxx-xxx-xxx*. This provides information on the related variant of the MSD Servo Drive DC-AC supplied. The significance of the individual characters of the article designation is given in the following order code.

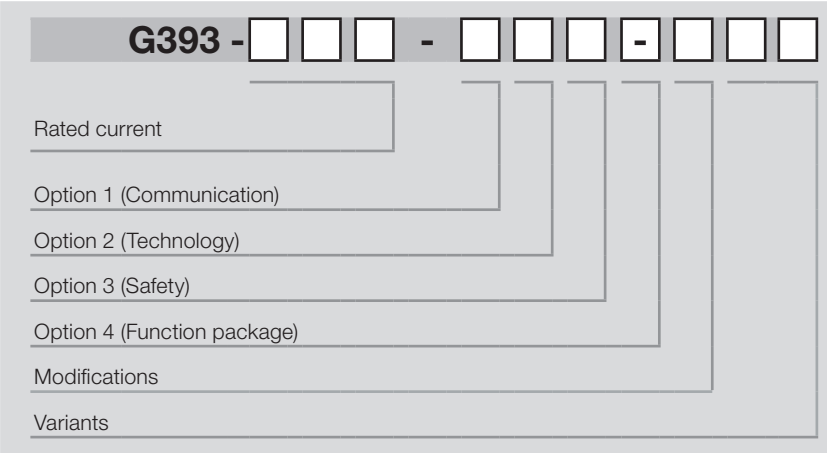

Figure 1.1 Order code MSD Servo Drive DC-AC (air-cooled)

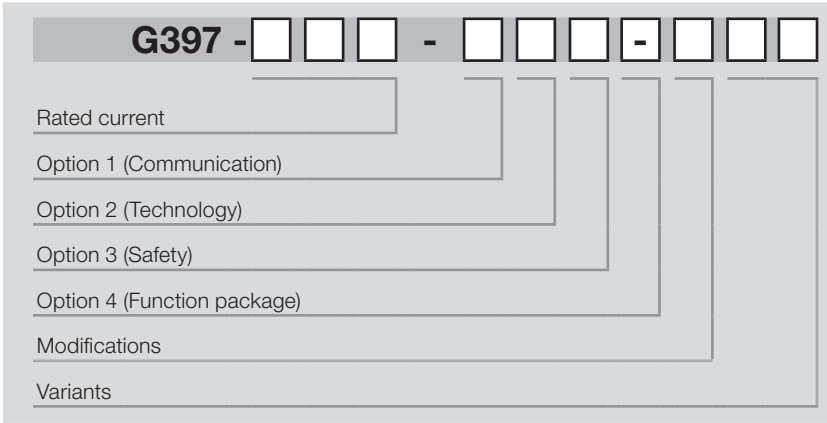

Figure 1.2 Order code MSD Servo Drive DC-AC (liquid-cooled)

1.5 Data on manufacture

On the rating plate for the DC-AC Servo Drive you will find the serial number, from which you can identify the date of manufacture based on the following key. For the location of the rating plate on the MSD ServoDrive refer to the layouts in chap. 4.3, p. 32 for the related Sizes 1 to 7.

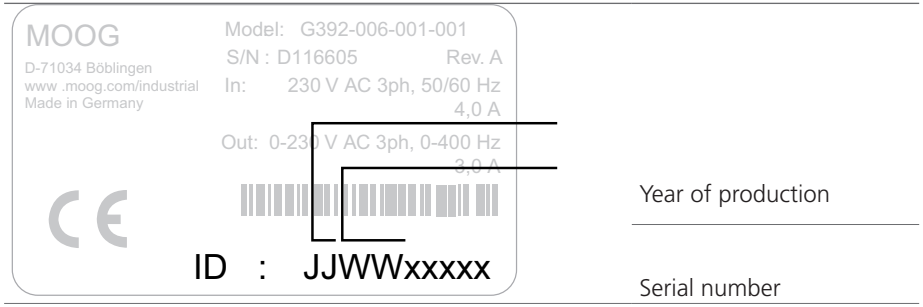

Figure 1.3 DC-AC Servo Drive hardware rating plate

1.6 Scope of supply

The scope of supply includes:

- MSD Servo Drive DC-AC
- Terminal kit for control and power terminals (depending on device power and variant)
- Set of grommets (on devices with liquid cooling)
- Set with shield connecting terminals and fixing material
- Pre-assembled DC link connections (up to and including Size 5)
- 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 Support

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.germany@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 minimum 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 pacema ers, 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 DC-AC 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 arn 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 DC-AC Servo Drives for the MSD Servo Drive Multi-Axis System conform to the **Machinery Directive 2006/42/EC**

Tested and certified according to applicable standards (see decla ation of conformity in chap. 2.8).

The DC-AC Servo Drives are only allowed to be combined with Power Supply Units from the MSD Servo Drive Multi-Axis System or drive units from the MSD Servo Drive Single-Axis System.

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.

2.4.1 Repair

Only have repairs undertaken by authorised repair shops. Unauthorised repairs could lead to death, injury or damage (see previous sections). 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 DIN EN 1050) 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 DC-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	G392/G393/G396/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 (Interfaces)
Quality Manager	Richard Konse

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

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 devices are 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 mechanical installation

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 ope ation and can reach temperatures of up to +100 °C (+212 °F). 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.

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 Servo Drives must not be installed in areas where they would be permanently exposed to vibration.

You will find further information in Table A.21 in the appendix.

NOTE:

It is imperative the Operation Manuals for the DC-AC Servo Drive and the Power Supply Unit or the supplying MSD Servo Drive are followed during installation of a MSD Servo Drive Multi-Axis System.

Note the following points:

- The backing plate must be well-earthed.
- 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 Size 1 to Size 4 and Size 7 have a rear wall made of aluminium. The devices Size 5 and Size 6A have a rear wall made of galvanised sheet steel.
- Maximum degree pollution degree 2 according to IEC/EN 60664-1. You will find further information on ambient conditions in Table A.19 in the appendix.
- Cooling air must be able to flow through the device without restriction.
- On installation in switch cabinets with convection, i.e. heat loss is dissipated to the outside via the switch cabinet walls, always fit an internal air circulation fan.

If you require further detailed information on installation, please contact the Helpline (see chapter "1.10 Support").

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.

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3.2 Mounting

Step	Action	Comment
1.	Mark out the position of the tapped holes and the pipe fitting , if necessary, on the backing plate. Drill holes and cut a thread for each fixing screw in the backing plat .	Pay attention to the mounting clearances! Pay attention to the bending radius of the connection cables! For dimensional drawings/ hole spacing see Figure 3.11, p. 22
2.	Mount the DC-AC Servo Drive vertically on the backing plate.	Observe the mounting clearances!
3.	On devices with liquid cooling, while screwing the hose connections (not included in the scope of supply) into the pipe fitting , 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, e.g. mains filte , mains choke etc., on the backing plate	

NOTE:

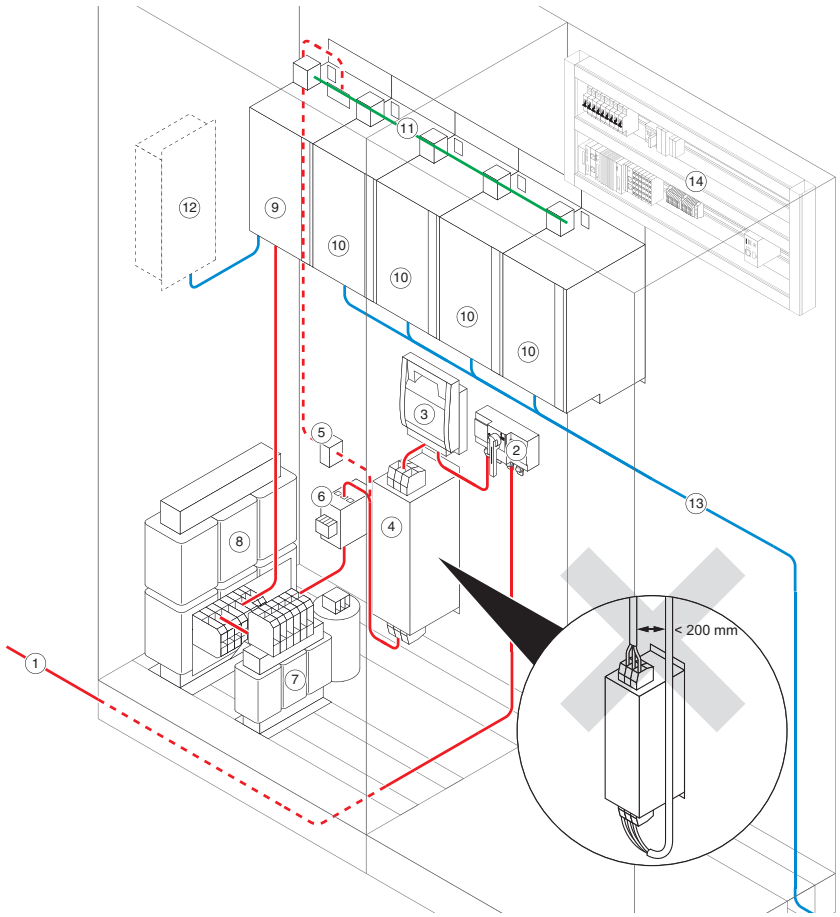
Connect the flow from the liquid cooling for the Size 6A and Size7 devices to the connection correspondingly marked (see Figure 3.19). For the devices Size 3 to Size , the connection can be chosen as required.

3.3 Switch cabinet layout

The positioning of the components in the switch cabinet has a significant effect on the trouble-free system and machine function. You should take into account the following points in your planning:

- Evaluate the assemblies used in relation to EMC.
- Divide the switch cabinet into zones with different power and interference levels.
- For devices susceptible to interference, maintain a distance of at least 200 mm (7.87 in)from the following components:
  - DC-AC Servo Drive
  - Input and output chokes, transformers
  - Mains, motor, DC power supply and braking resistor cables (even if shielded)
  - Relay and contactors (even if interference-suppressed)
- For small distances use separators for shielding; fasten the separators directly and conductively to the backing plate.
- If a motor contactor or motor choke is used, the component should be positioned directly at the DC-AC Servo Drive.
- Do not use fluorescent lamps in switch cabinets, as they emit high-frequency interference.
- Fit contactors, relays, solenoid valves, switched inductors and capacitors with suppressors.
- The mains filter must be mounted on the backing plate as close as possible to the feed point and with large surface area contact. The backing plate must be connected to the central earthing point with a low-impedance connection. No unfiltered cables are allowed to be laid on the mains input side of the filter so that no interference can be coupled into the cables.

3.3.1 Example:



1) *Mains cable*
2) *Main switch*
3) *Fuses*
4) *Mains filter 1)*
5) *Circuit breaker*
6) *Mains contactor*
7) *Input choke with capacitor connected*
8) *Step-up choke*
9) *MSD Power Supply Unit*
10) *MSD Servo Drive DC-AC*
11) *DC power supply via DC link cable*
12) *Braking resistor*
13) *Motor cables*
14) *Controller 2)*

1) *Cables without interference suppression must be laid at a distance of at least 200 mm (7.87 in) from the mains input side of the filter so that no interference can be coupled into the cables.*
2) Arrange the controller separated from the power area to prevent EMC coupling mechanisms. Control cables, signal cables and cable shields have been omitted for clarity

Figure 3.1 Example: arrangement in the switch cabinet

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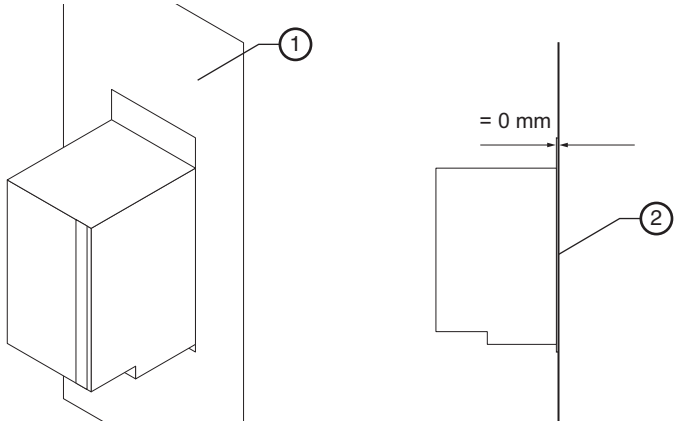
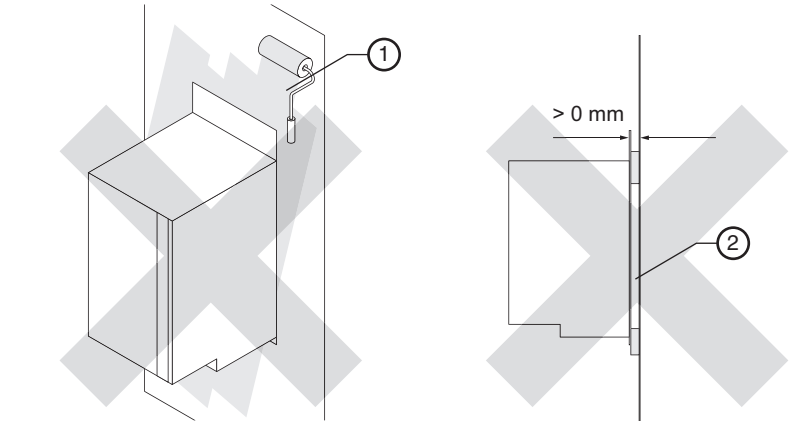
3.4 Wall mounting

- Use bare metal backing plates.
- The rear of the DC-AC Servo Drive must have good contact to the switch cabinet ground. The contact area must be bare metal to establish a good ground connection to the switch cabinet ground. There must not be an air gap between the rear wall of the DC-AC Servo Drive and the rear wall of the switch cabinet.
- The bases of the chokes must have good contact to the switch cabinet ground. The contact area must be bare metal to establish a good ground connection to the switch cabinet ground.



1) *Bare metal backing plate*
2) *Large area contact*

Figure 3.2 CORRECT mounting of DC-AC *Servo Drive*



1) *Paint*
2) *Air gap*

Figure 3.3 INCORRECT mounting of DC-AC *Servo Drive*

3.5 Arrangement in the group

- Devices with different housing variants, such as air cooling and liquid cooling, can be mounted side-by-side in any combination.
- Devices with the liquid cooling housing variant have a spacer on the rear in place of the heat sink. As a consequence it is possible to connect devices with the air cooling housing variant using pre-assembled DC link cables without additional compensation measures in relation to the device depth.
- The distance between the devices in a row is defined by the pre-assembled connection cables supplied and is 2 mm (0.08 in).

NOTE
Devices of Size 6A in the air cooling housing variant are an exception. The mounting distance between two Size 6A devices is 40 mm (1.57 in) (see Figure 3.9).

NOTE
Only use the DC link connections supplied for the electrical coupling of the devices Size1 to Size 5. If extending the DC link coupling is unavoidable, it is imperative you pay attention to the requirements in chap. A.5.2, p. 102.

- The DC-AC Servo Drives are allowed to be arranged to the left and/or right of a Power Supply Unit. On butt mounting devices with different drive powers you should arrange the devices in descending 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. The Power Supply Unit must always be fitted beside the Servo Drive with the highest power.
  On butt mounting other devices to the Multi-Axis System, attention is to be paid to ensuring there is no thermal interaction between the devices.

Permissible arrangements

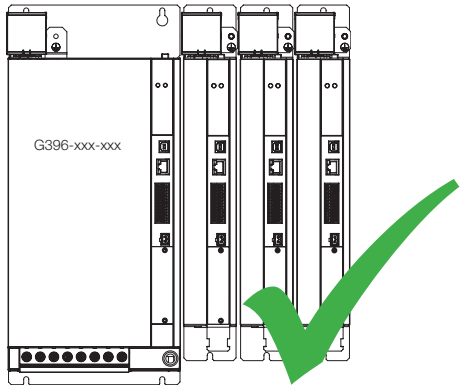


Figure 3.4 Example permissible arrangement: butt mounting DC-AC Servo Drives of the same size on one side of the Power Supply Unit

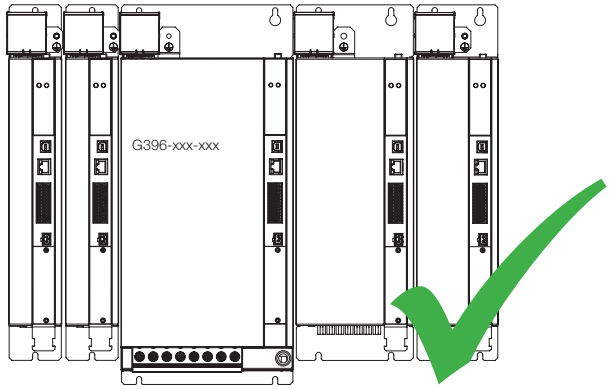


Figure 3.5 Example permissible arrangement: butt mounting DC-AC Servo Drives of the same size or reducing size on both sides of the Power Supply Unit

Impermissible arrangements

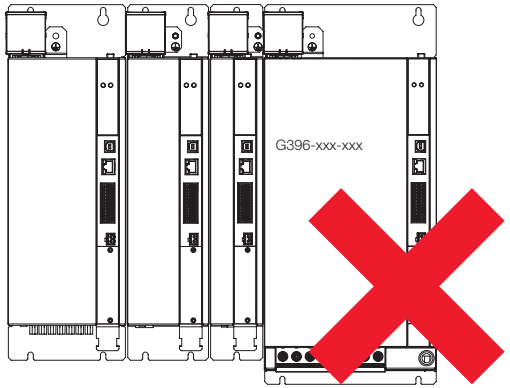


Figure 3.6 Example of an impermissible arrangement: butt mounting DC-AC Servo Drives of increasing size

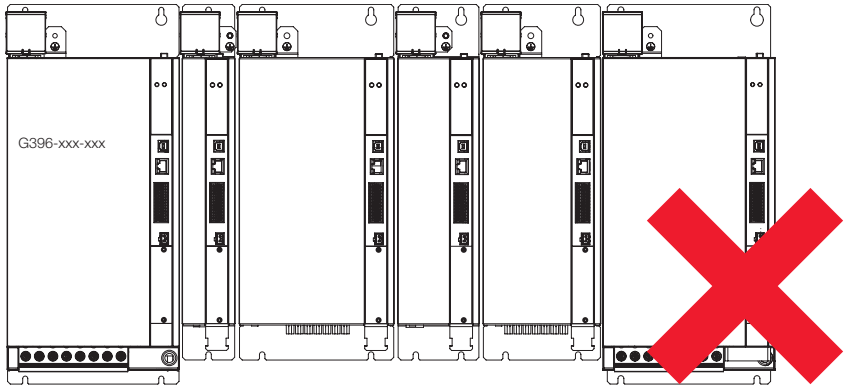


Figure 3.7 Example of an impermissible arrangement: butt mounting DC-AC Servo Drives of increasing and reducing sizes

3.6 Mounting DC-AC Servo Drive air cooling housing variant

Step	Action
1.	Arrange the devices starting from the Power Supply Unit to the right or/and left sorted in descending order by power rating to minimise the thermal effects. • Align all DC-AC Servo Drives and the Power Supply Unit Size 5 in a line along the top edge of the devices (see line A in Figure 3.8) to be able to make the DC link connections. • Align all DC-AC Servo Drives and the Power Supply Unit Size 6A in a line along the top edge of the devices (see line A in Figure 3.9). This action is necessary to be able to make the DC link connections. Move down the mounting bores for MSD Servo Drive DC-AC Size 6A and the Power Supply Unit Size 6A by approx. 20 mm (0.787 in) (see red line B in Figure 3.9).
2.	Mark out the position of the tapped holes on the backing plate. Drill holes in the backing plate and cut a thread for each fixing screw in the backing plat . Pay attention to the bending radius of the connection cables! For hole spacing and dimensional drawings see Table 3.1, Figure 3.10 and Figure 3.11.
3.	Mount the DC-AC Servo Drives vertically and butt mounted in a row on the backing plate. The contact area must be bare metal. Use the pre-assembled DC link cables supplied for the DC power supply. Continue with the electrical installation in chap. 4, p. 29.

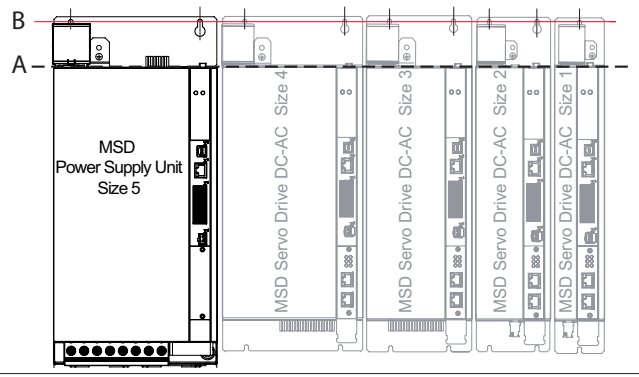


Figure 3.8 Alignment of DC-AC Servo Drives in relation to Power Supply Unit Size 5 (example)

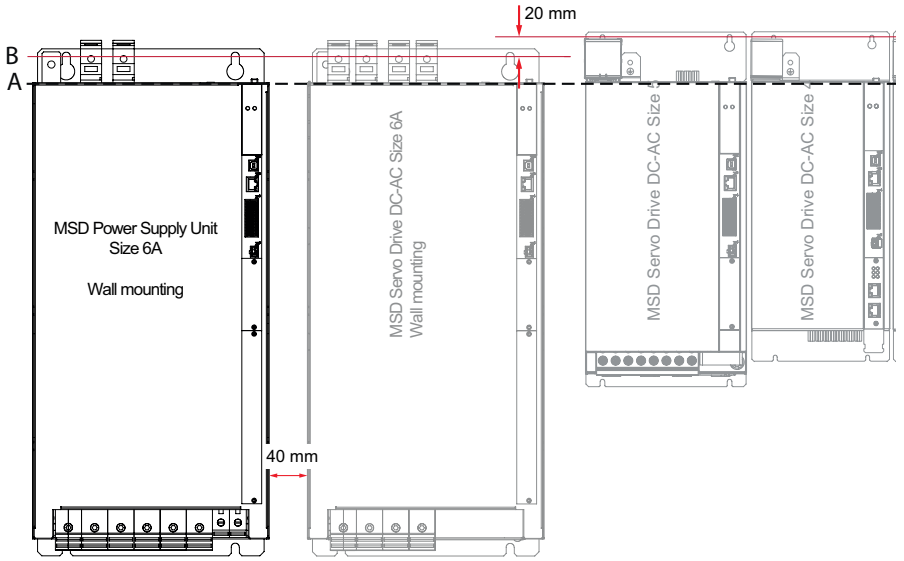


Figure 3.9 Alignment of DC-AC Servo Drives in relation to Power Supply Unit Size 6A (example)

3.6.1 Dimensions and mounting clearances

Size	Size 1	Size 2	Size 3	Size 4	Size 5	Size 6A
Device	G393-004 G393-006	G393-008 G393-012	G393-016 G393-020	G393-024 G393-032	G393-045 G393-060 G393-072	G393-090 G393-110 G393-143 G393-170
Weight kg (lb)	3.4 (7.5)	4.9 (10.8)	6.5 (14.3)	7.5 (16.5)	13 (28.7)	32 (70,6)
B (width)	58.5 (2.30)	90 (3.45)	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)	322 (12.68)
A	29.25 (1.15)	50 (1.97)	80 (3.15)	120 (4.72)	150 (5.91)	200 (7.87)
C	382 (15.04)				406.5 (16)	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)
E	Direct side by side mounting, maximum 2 (0.08)					40 (1.57) [2]
F [3]	≥100 (3.94)		≥150 (5.91)		≥180 (7.09)	
G [3]	≥270 (10.63)				≥300 (11.81)	≥500 (19.69)
H1	392 (15.43)				418.5 (16.48)	600 (23.62)
H2	38.5 (1.52)				15 (0.59)	20 (0.79)
Screws	2 x M4	4 x M4			4 x M5	4 x M8

1) Without terminals/connectors
3) The bending radius of the connection cables must be taken into account
2) Mounting distance Size 6A to other Size 6A

All dimensions in mm (in)

Table 3.1 Dimensions and mounting clearances, air cooling housing variant

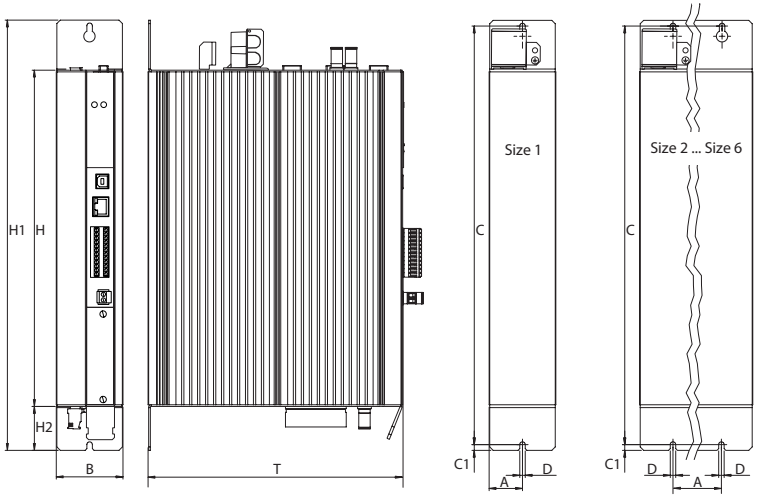


Figure 3.10 Dimensional drawing, air cooling housing variant

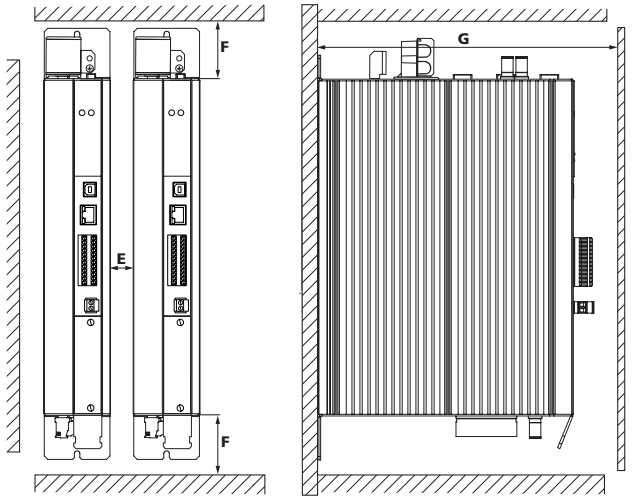


Figure 3.11 Mounting clearances, air cooling housing variant

3.7 Mounting DC-AC Servo Drive liquid cooling housing variant

Step	Action
1.	Arrange the devices starting from the Power Supply Unit to the right and/or left sorted in descending order by power rating to minimise the thermal effects. • Align all DC-AC Servo Drives and the Power Supply Unit Size 5 in a line along the top edge of the devices (see line A in Figure 3.12). This action is necessary to be able to supply the DC power using the pre-assembled cables. • Align all DC-AC Servo Drives and the Power Supply Unit Size 6A in a line along the top edge of the devices (see line A in Figure 3.13). Move down the mounting bores for DC-AC Servo Drive Size 6A and the Power Supply Unit BG6 by approx. 20 mm (0.787 in) (see red line B in Figure 3.13). This action is necessary to be able to make the DC link connections. • Align all DC-AC Servo Drives and the Power Supply Unit Size 7 in a line along the top edge of the devices (see line A in Figure 3.14). Move down the mounting bores for the Power Supply Unit Size 7 by approx. 28 mm (1.102 in) and for the DC-AC Servo Drive Size 6A by approx. 20 mm (0.787 in) (see red line B in Figure 3.14). In addition, a distance of ≥ 40 mm (1.574 in) must be maintained at the side (in the figure to the right of the ower Supply Unit Size 7. This action is necessary to be able to make the DC link connection. For information on the mounting clearances see Table 3.2.
2.	Mark out the position of the tapped holes and the pipe fittings on the backing plate. Drill holes and cut a thread for each fixing screw in the backing plate. Pay attention to the bending radius of the connection cables! For hole spacing and dimensional drawings see Table 3.2, Figure 3.15 and Figure 3.16.
3.	Mount the DC-AC Servo Drives vertically and butt mounted in a row on the backing plate. The contact area must be bare metal. Use the pre-assembled DC link cables supplied for the DC power supply.
4.	On screwing the hose connections (not included in the scope of supply) into the pipe fitting , lock the pipe fittings using a 22 mm (0.866 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) Continue with the electrical installation in chap. 4, p. 29.

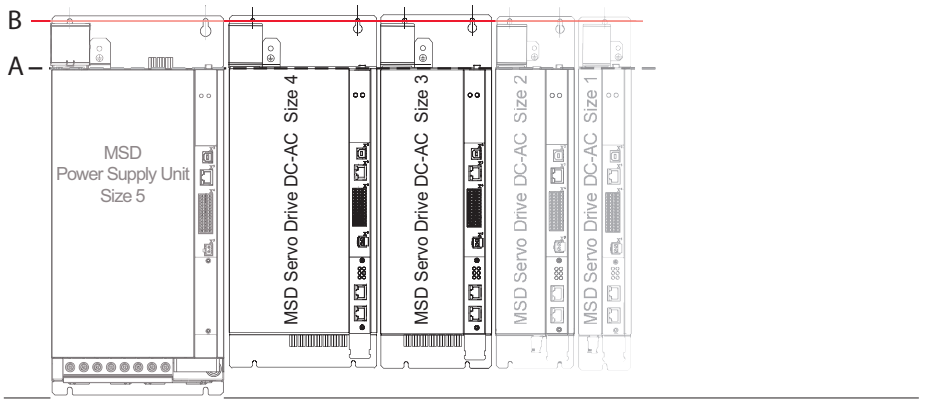


Figure 3.12 Alignment of DC-AC Servo Drives in relation to Power Supply Unit Size 5 (example)

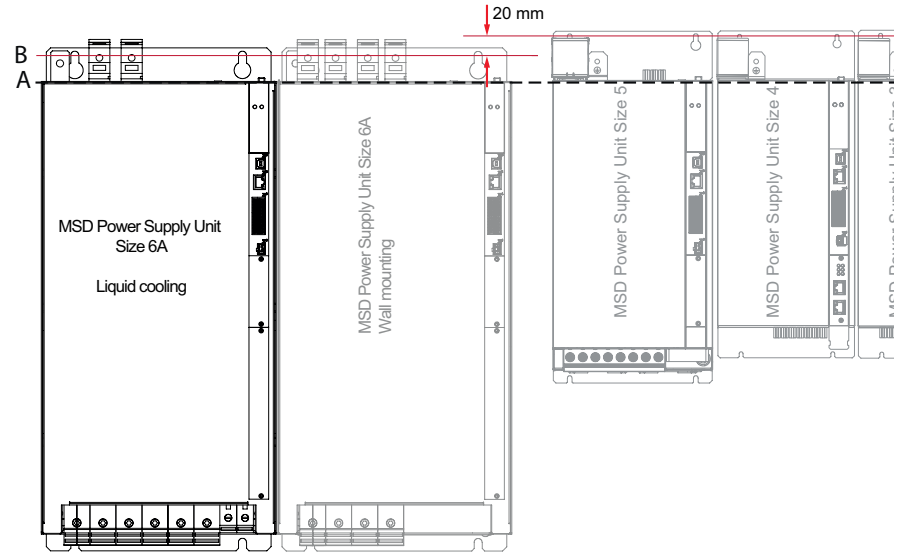


Figure 3.13 Alignment of DC-AC Servo Drives in relation to Power Supply Unit Size 6A (example)

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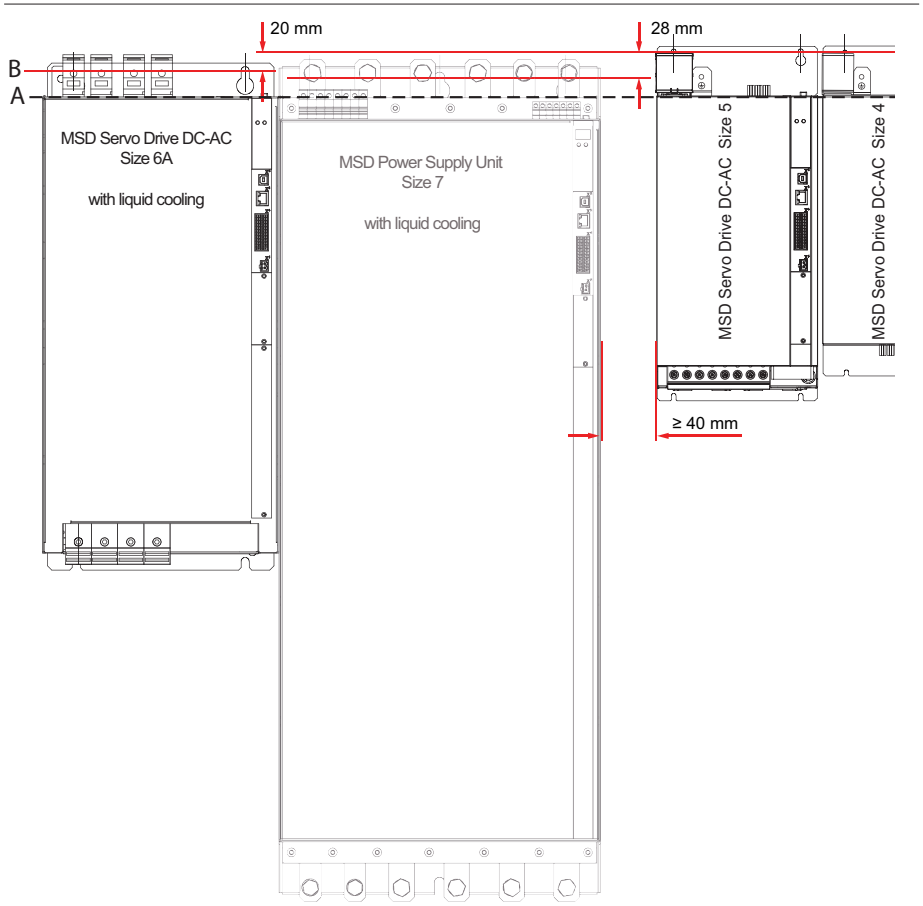


Figure 3.14 Alignment of DC-AC Servo Drives in relation to Power Supply Unit Size 7 (example)

3.7.1 Dimensions and mounting clearances

Size	Size 3		Size 4		Size 5	Size 6A	Size 7
Device	G397-020 G397-025		G397-026 G397-035		G397-053 G397-070 G397-084	G397-110 G397-143 G397-170 G397-210	G397-250 G397-325 G397-450
Weight kg (lb)	6.5 (14.3)		7.5 (16.5)		13 (28.7)	32 (70.6)	90 (198.4)
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)				238 (9.37)	285 (11.22)	287 (11.3)
A	80 (3,15)		120 (4.72)		150 (5.91)	200 (7.87)	150 (5.91)
A1	10 (0.39)		25 (0.98)		40 (1.57)	65 (2.56)	29 (1.14)
A2	60 (2.36)		70 (2.76)				
C	382 (15.04)				406.5 (16)	581 (22.87)	952 (37.48)
C1	5 (0.2)				6 (0.24)	10 (0.39)	14 (0.55)
D Ø	4.8 (0.19)				6.5 (0.26)	9.5 (0.37)	12 (0.47)
D1	48 (1.89) (Ø hole for pipe fitting						
E	Direct butt mounted, maximum 2 (0.08)						
F [2]	≥150 (5.91)				≥180 (7.09)		
G [2]	≥300 (11.81)					≥500 (19.69)	
H1	392 (15.43)				418.5 (16.48)	600 (23.62)	979/ 995 (38.54/39.17) [3]
H2	38.5 (1.52)				15 (0.59)	20 (0.79)	62 (2.44)

All dimensions in mm (in)

1) Without terminals/connectors
2) Also pay attention to the bending radius of the connection cables
3) Without/with busbars

Table 3.2 Dimensions and mounting clearances, liquid cooling housing variant

Size	Size 3	Size 4	Size 5	Size 6A	Size 7
Device	G397-020 G397-025	G397-026 G397-035	G397-053 G397-070 G397-084	G397-110 G397-143 G397-170 G397-210	G397-250 G397-325 G397-450
H3	75 (2.95)	70 (2.76)	54 (2.13)	56.5 (2.22)	124 (4.88)
S [inch]	3/8 (female thread)				
Screws	4 x M4		4 x M6	4 x M8	6 x M10
T1	74 (2.91)				

All dimensions in mm (in)

1) Without terminals/connectors
2) Also pay attention to the bending radius of the connection cables
3) Without/with busbars

Table 3.2 Dimensions and mounting clearances, liquid cooling housing variant

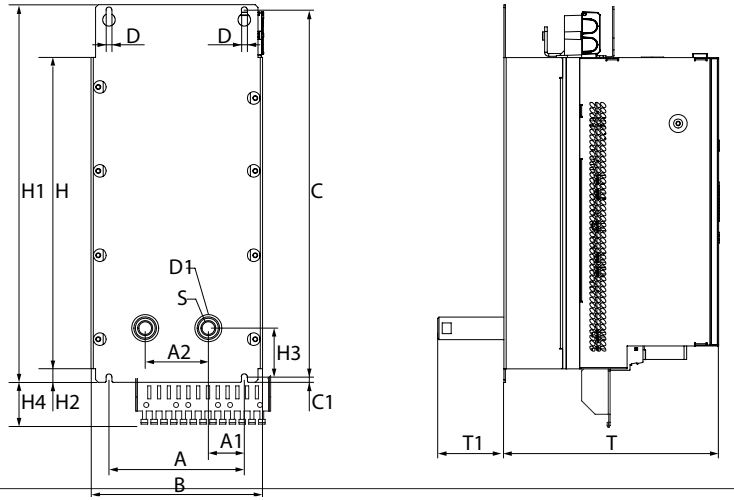


Figure 3.15 Dimensional drawing, liquid cooling housing variant, based on Size 5 as an example

NOTE:

The minimum distance specified in the table applies for devices of the same power. On butt mounting devices with different drive powers you should arrange the devices in descending 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. The Power Supply Unit must always be fitted beside the Servo Drive with the highest power.
On butt mounting other devices to the Multi-Axis System, attention is to be paid to ensuring there is no thermal interaction between the devices.

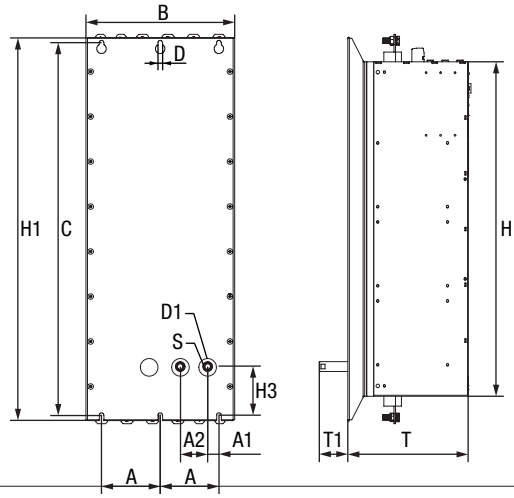


Figure 3.16 Dimensional drawing, liquid cooling housing variant, based on Size 7 as an example

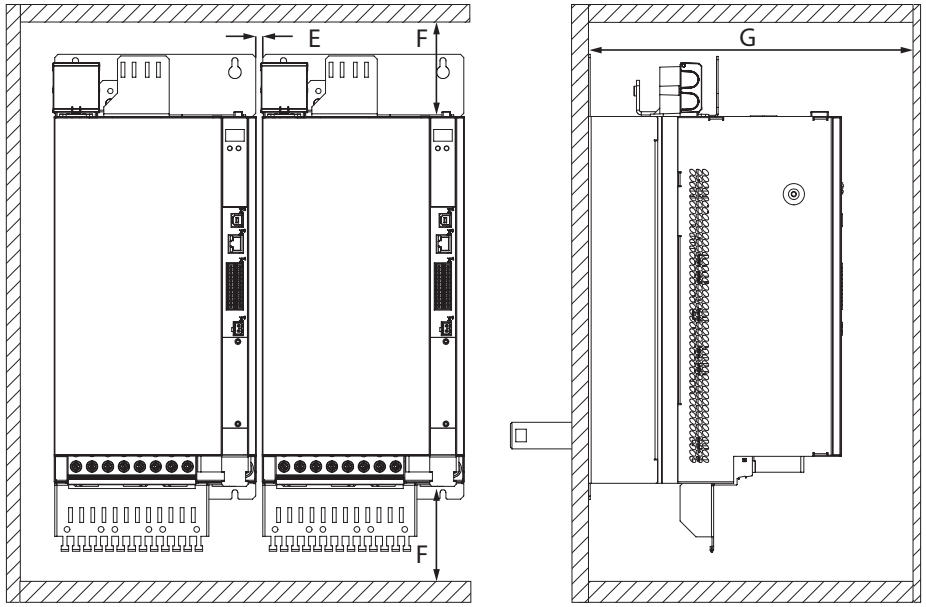


Figure 3.17 Mounting distance, liquid cooling housing variant, based on Size 5 as an example

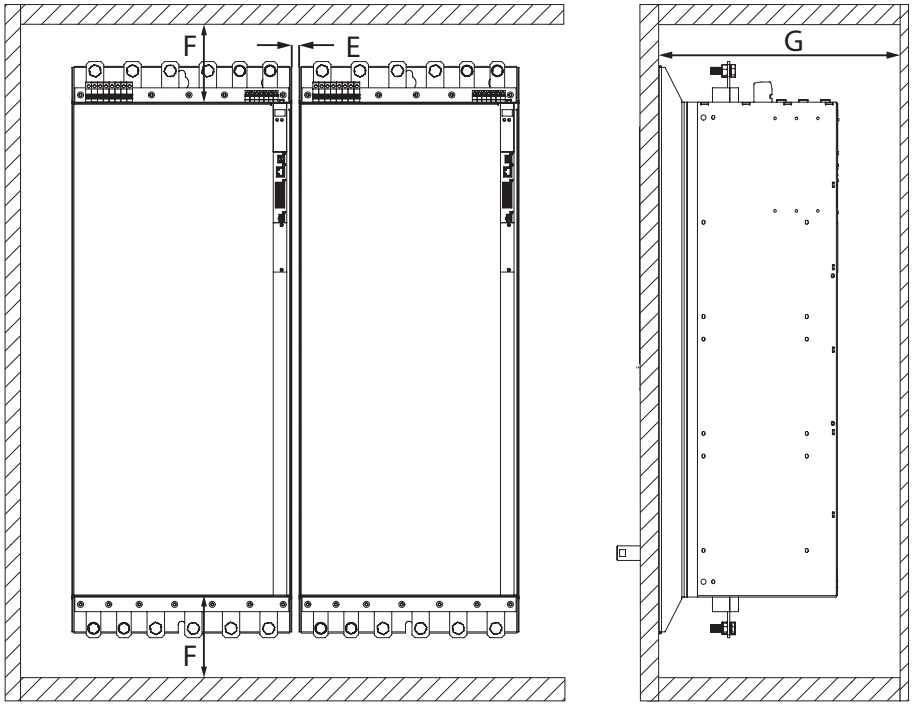
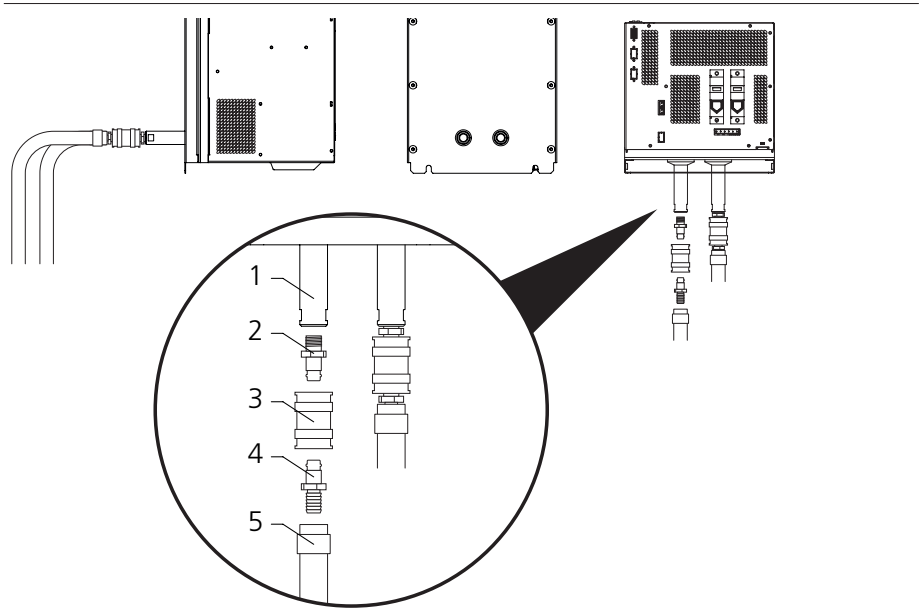


Figure 3.18 Mounting distance, liquid cooling housing variant, based on Size 7 as an example

3.8 Cooling circuit connection

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.

The devices with liquid cooling have 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.



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

Figure 3.19 Cooling circuit connection, based on Size 6A and Size 7 as an example

NOTE:

Items 2 to 5 are not included in the scope of supply and are to be ordered separately (connection set CB37132-001).

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! Before making any change the device is to be disconnected from the mains. Even 30 minimum after switching off the mains supply, dangerously high voltages of ≥50 V may still be present (capacitor charge). The discharging time depends on the DC-AC Servo Drives connected to the Multi-Axis System. **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 ZK 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. Dangerous voltage may be present at the device, even if the device is not emitting 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)!

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 ope ation and can reach temperatures of up to +100 °C (+212 °F). 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.

NOTE:

Along with this Operation Manual, it is imperative the manuals for the Power Supply Unit or the supplying AC-AC Servo Drive are read on installing the complete MSD Multi-Axis System.

4.2 Effective EMC installation

4.2.1 Cable type

- Use only shielded mains, motor and signal cables as shown in Figure 4.17. 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 use separate individually shielded wires.
- For currents > 60 A and output frequencies significantly higher than 400 Hz, individually shielded wires are not allowed. Please contact our application specialists via the Helpline about this topic.

NOTE

Only use the DC link connections supplied for the electrical coupling of the devices. If extending the DC link coupling is unavoidable, it is imperative you pay attention to the requirements in chap. A.5, p. 101. On the usage of connection cables that do not meet the requirements, Moog does not provide any guarantee for stable, safe operation.

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 DC-AC 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 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 the 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 definitive, but the surface over which high-frequency currents caused by the skin effect can flow away.
- 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.
- Larger openings in the switch cabinet (window, fan, display) degrade the shielding effect of the cabinet and must be protected with additional shielding measures for the HF range.
- Earth unused cores at one end so that there is no electrostatic charging.
- Free contact areas of paint and corrosion and make large area connections.
- The usage of metallised elements is to be preferred over painted components; it will then not be necessary to remove the paint.

For further information on the cross-section of the protective earth conductor see chap. 4.4, p. 38.

4.2.4 Shielding measures

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

- Use only shielded mains, motor and signal cables as shown in Figure 4.17, p. 43. 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 %.

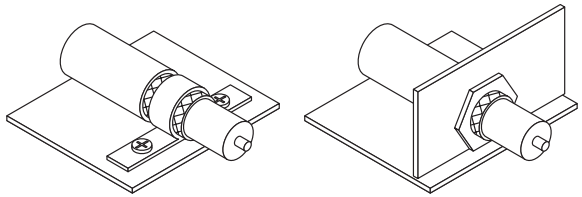


Figure 4.1 CORRECT shield connection

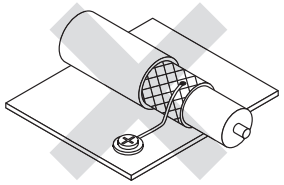


Figure 4.2 INCORRECT shield connection - do not extend to the earthing point (pigtail)

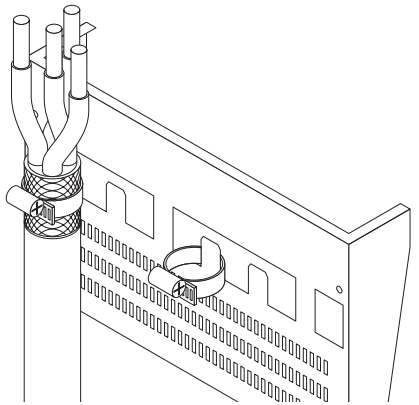


Figure 4.3 Shield connection

- 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 extensive installations.

4.2.5 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.

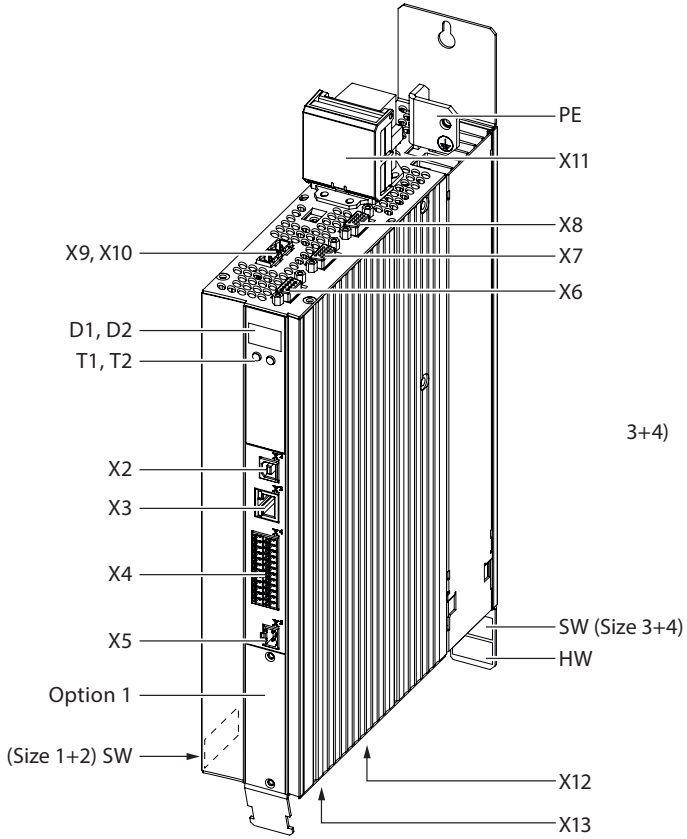
If you require further detailed information on installation, please contact the Moog Helpline.

4.3 Overview of the connections

Step	Action
1.	Determine the terminal assignment that applies to your device. For G393-004 (Size 1) to G393-032/G397-035 (Size 4) in chap. 4.3.1, p. 32 For G393-045/G397-053 (Size 5) to G393-170/G397-210 (Size 6A) in chap. 4.3.2, p. 34 For G397-250 to G397-450 (Size 7) in chap. 4.3.3, p. 36
2.	Connect all necessary input and output units to the control connections (chap. 4.6, p. 40), the optional interfaces (chap. 4.11, p. 47) and/or (chap. 4.12, p. 47) and the DC link if necessary.
3.	Connect encoder (chap. 4.13, p. 48) and motor (chap. 4.14, p. 51).
4.	With the aid of the pre-assembled connection cables (DC-L), connect the protective earth conductor (chap. 4.4, p. 38) and the supply voltages (chap. 4.7, p. 41).
5.	Continue with commissioning in chap. 5, p. 55.

4.3.1 Layout, G393-004 (Size 1) to G393-032/G397-035 (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.



HW: Hardware rating plate
SW: Software rating plate

Figure 4.4 Layout G393-004 (Size 1) to G393-032/G397-035 (Size 4) (G393-004 Size 1 as example)

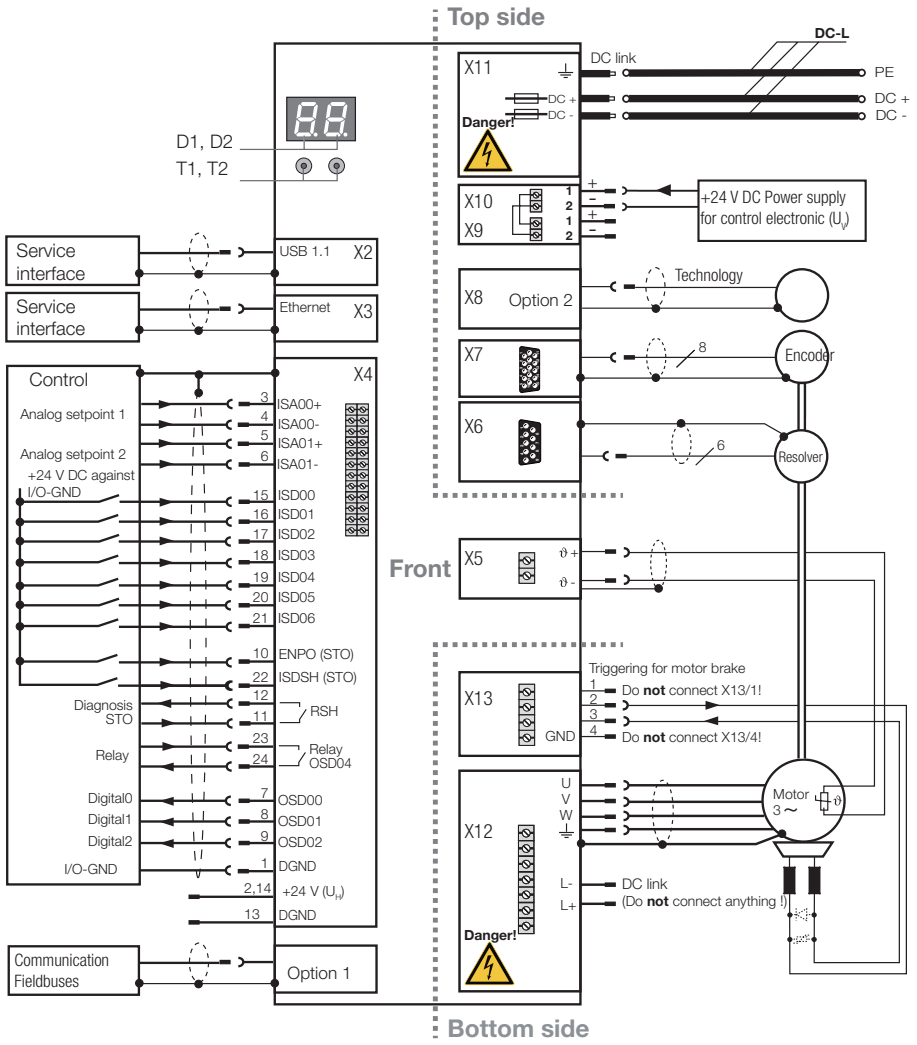


Figure 4.5 Connection diagram, G393-004 (Size 1) to G393-032/G397-035 (Size 4)

Abbreviation	Designation	Details
D1, D2	7-segment display	chap. 5.4.2
T1, T2	Button	chap. 5.4.1
X2	USB 1.1 interface	chap. 4.9
X3	Ethernet interface	chap. 4.10
X4	Control connections	chap. 4.8
Option 1	Communication	chap. 4.11
X11	Connection for DC supply	chap. 4.7
DC-L	DC link cables	chap. A.5
PE	Connection for PE conductor	chap. 4.4
X9, X10	Connection for control supply	chap. 4.6
X8 (Option 2)	Technology	chap. 4.12
X7	Connection for high-resolution encoder	chap. 4.13
X6	Connection for resolver	chap. 4.13.4
X5	Connection for motor temperature sensor	chap. 4.14
X13	Connection for motor brake	chap. 4.8.2
X12	Connection for motor	chap. 4.14

Table 4.1 Key to layout and connection diagram, G393-004 (Size 1) to G393-032/G397-035 (Size 4)

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4.3.2 Layout, G393-045/G397-053 (Size 5) to G393-170/G397-210 (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.

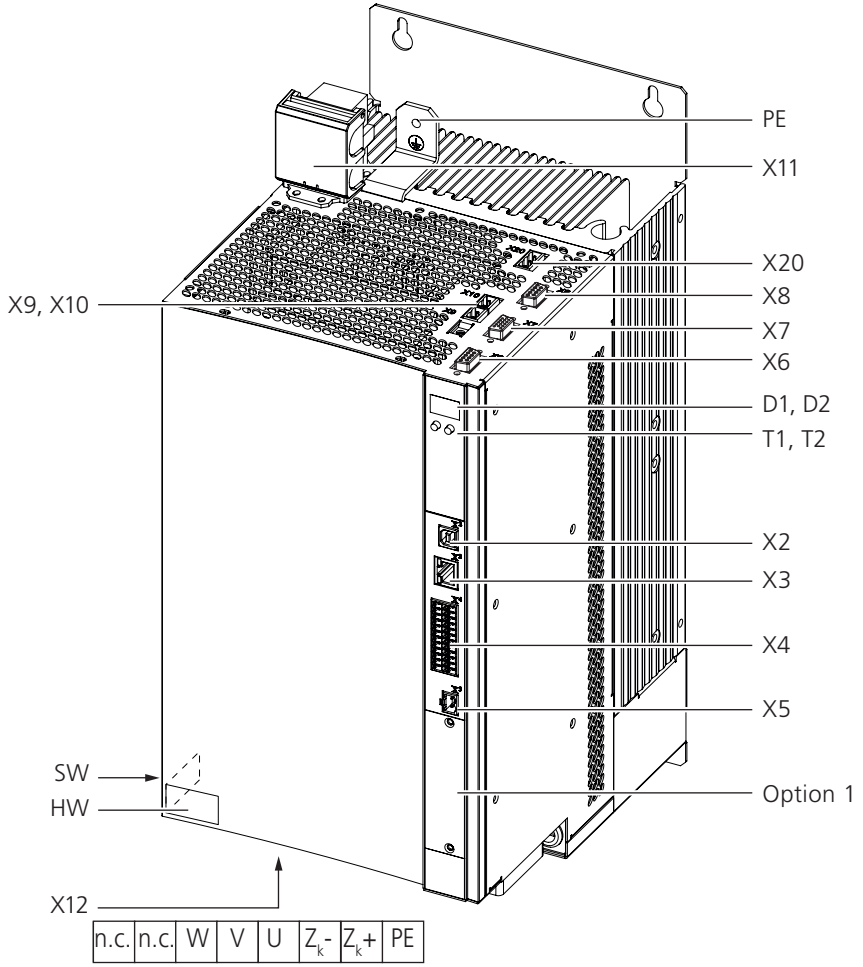


Figure 4.6 Layout, G393-045/G397-053 to G393-072/G397-084 (Size 5, without shield plates)

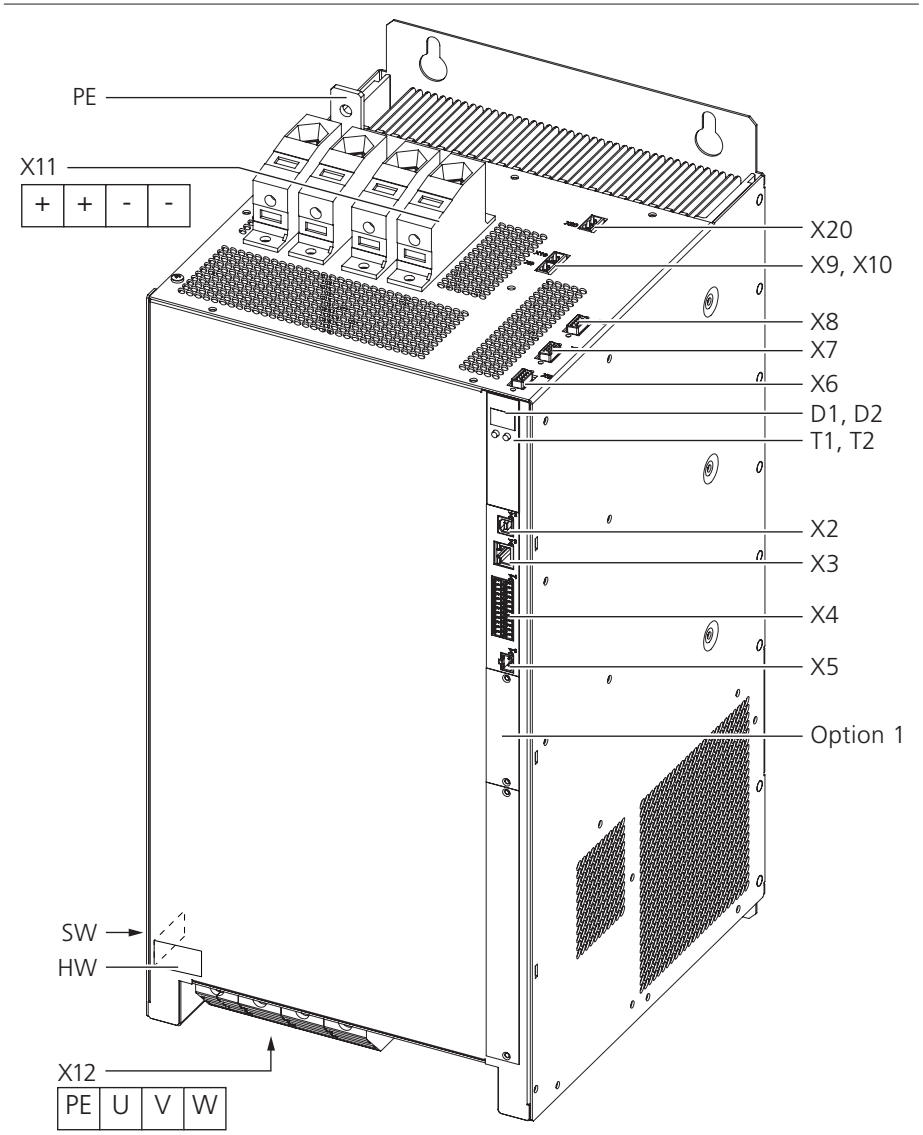
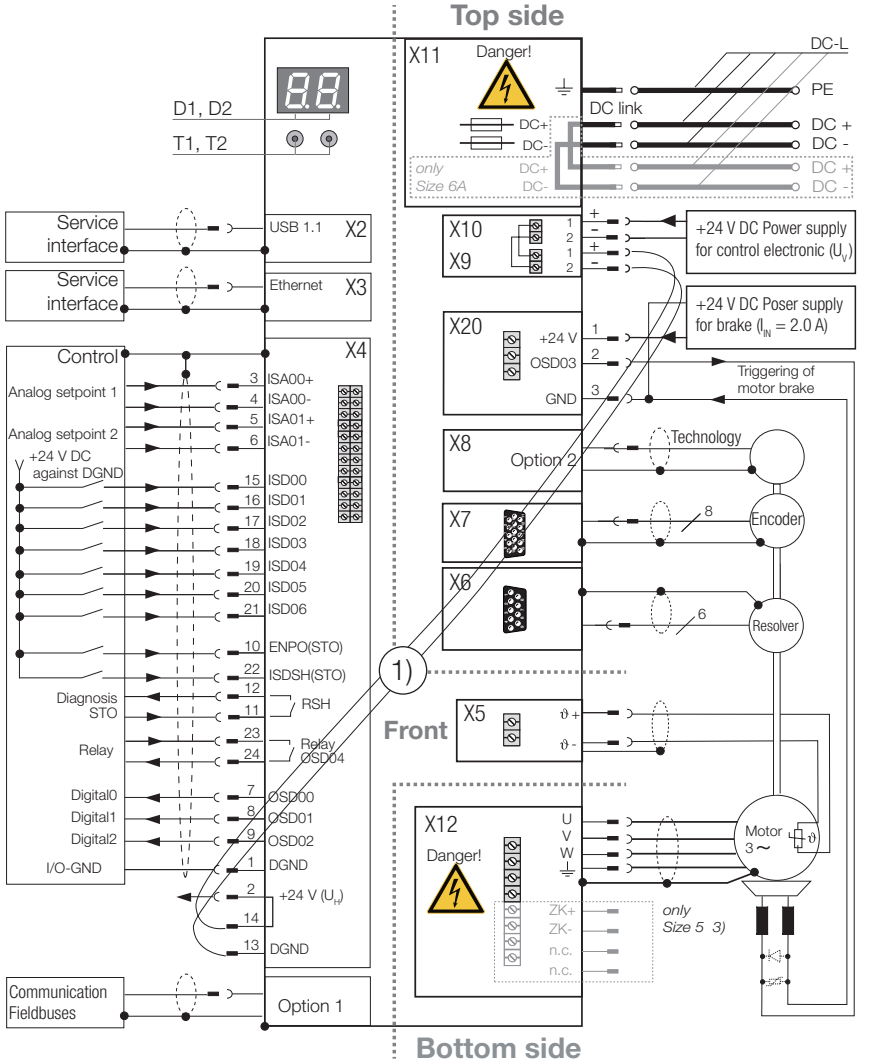


Figure 4.7 Layout, G393-090/G397-110 to G393-170/G397-210 (Size 6A, without shield plates)



1) Applies only for Size 5, see also related note.

Figure 4.8 Connection diagram, G393-045/G397-053 (Size 5) to G393-170/G397-210 (Size 6A)

Abbreviation	Designation	Details
D1, D2	7-segment display	Chap. 5.4.2
T1, T2	Button	Chap. 5.4.1
X2	USB 1.1 interface	chap. 4.9
X3	Ethernet interface	chap. 4.10
X4	Control connections	chap. 4.8
Option 1	Communication	chap. 4.11
X11	Connection for DC supply	chap. 4.7
DC-L	DC link cables	chap. A.5
PE	Connection for PE conductor	chap. 4.4
X9, X10	Connection for control supply	chap. 4.6
X8 (Option 2)	Technology	chap. 4.12
X7	Connection for high-resolution encoder	chap. 4.13
X6	Connection for resolver	chap. 4.13.4
X5	Connection for motor temperature sensor	chap. 4.14
X20	Connection for motor brake	chap. 4.8.2
X12	Connection for motor	chap. 4.14
HW	Hardware rating plate	Figure 4.6
SW	Software rating plate	Figure 4.7

Table 4.2 Key to connection diagram, G393-045/G397-053 (Size 5) to G393-170/G397-210 (Size 6A)

NOTE:

There is a special aspect on the connection of the control supply for Size 5. Please make sure that a connection 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 (U_H).

4.3.3 Layout, G397-250 to G397-450 (Size 7)

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.

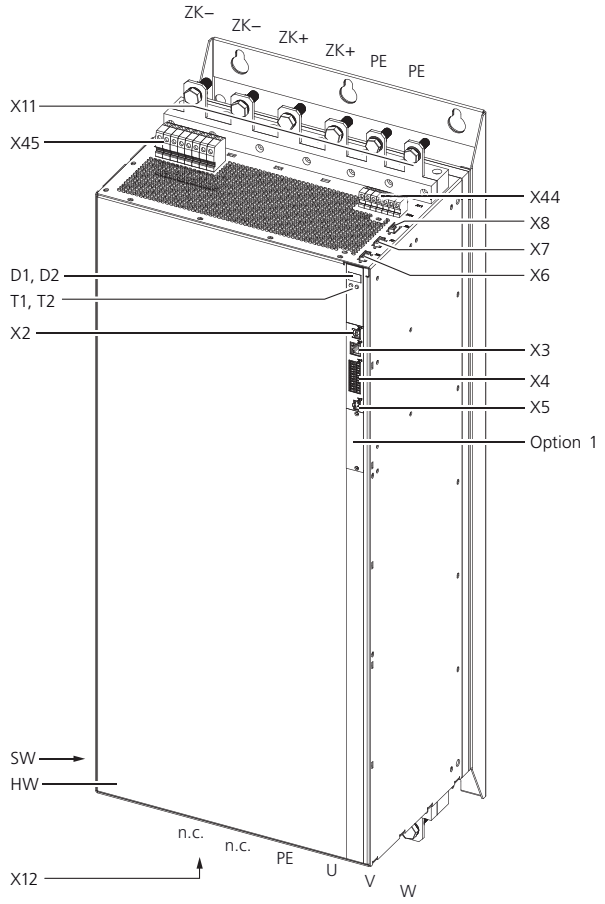


Figure 4.9 Layout, G393-250 to G393-450 (Size 7, without shield plates)

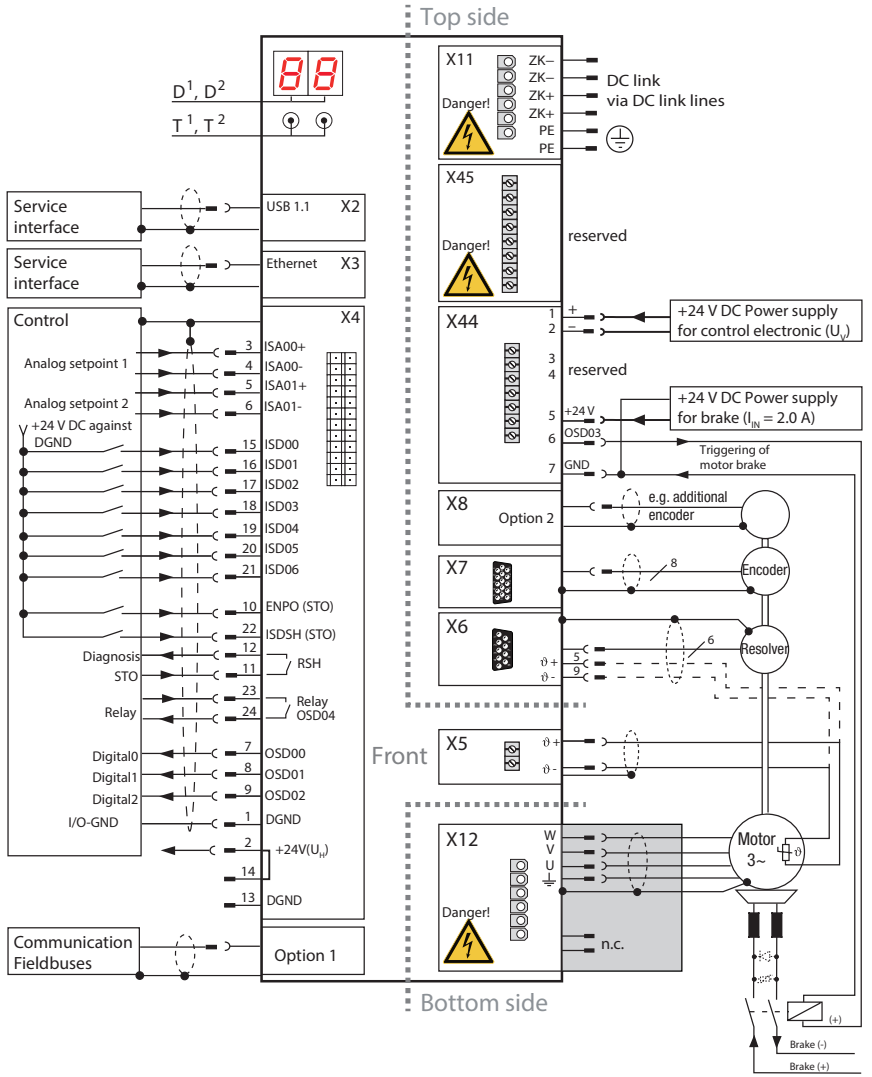


Figure 4.10 Connection diagram, G393-250 to G393-450 (Size 7)

Abbreviation	Designation	Details
D1, D2	7-segment display	Chap. 5.4.2
T1, T2	Button	Chap. 5.4.1
X2	USB 1.1 interface	chap. 4.9
X3	Ethernet interface	chap. 4.10
X4	Control connections	chap. 4.8
Option 1	Communication	chap. 4.11
X11	Connection for DC supply	chap. 4.7
DC-L	DC link cables	chap. A.5
PE	Connection for PE conductor	chap. 4.4
X44	Connection for control supply	chap. 4.6
	Connection for motor brake	chap. 4.8.2
X8 (Option 2)	Technology	chap. 4.12
X7	Connection for high-resolution encoder	chap. 4.13
X6	Connection for resolver	chap. 4.13.4
X5	Connection for motor temperature sensor	chap. 4.14
X12	Connection for motor	chap. 4.14
HW	Hardware rating plate	Figure 4.9
SW	Software rating plate	Figure 4.9

Table 4.3 Key to connection diagram (Size 7)

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4.4 Protective earth conductor connection

Step	Action
1.	Earth each of the DC-AC Servo Drives! The following applies for the PE connection according to IEC/EN 61800-5-1 (as leakage current >3.5 mA): • Use a protective earth conductor with the same cross-section as the mains cables, however at least 10 mm² (0.015 in²) copper. Also take into account the local and national regulations and conditions. On operation with a Power Supply Unit: • G393-004 (Size 1) to G393-072/G397-084 (Size 5) – Connect the PE connections on the DC-AC Servo Drives and the Power Supply Unit together using the pre-assembled cables. – Connect the Power Supply Unit to the PE rail (main earth) in the switch cabinet. • G393-090/G397-110 (BG6) to G397-450 (Size 7) – Connect each DC-AC Servo Drive directly to the PE rail (main earth) in the switch cabinet. – Connect the Power Supply Unit directly to the PE rail (main earth) in the switch cabinet. On operation with a AC-AC Servo Drive as the supply: • G393-004 (Size 1) to G393-072/G397-084 (Size 5) – Connect the PE connections on the DC-AC Servo Drives together using the pre-assembled cables. Do NOT connect the PE connection on a DC-AC Servo Drive to the PE connection on the supplying AC-AC Servo Drive, instead connect directly to the PE rail (main earth) in the switch cabinet. – Connect the AC-AC Servo Drive directly to the PE rail (main earth) in the switch cabinet. • G393-090/G397-110 (BG6) to G397-450 (Size 7) – Connect each DC-AC Servo Drive directly to the PE rail (main earth) in the switch cabinet. – Connect the AC-AC Servo Drive directly to the PE rail (main earth) in the switch cabinet.
2.	Also connect the protective earth conductor connections on all other components, such as mains filter [1] etc. in a star topology to the PE rail (main earth) in the switch cabinet. *1) The components are only required for the Power Supply Unit.*

You will find an example for the protective earth conductor connections in Figure 4.17, p. 43.

4.5 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.

The control electronics therefore require a separate control supply that corresponds to the requirements of a SELV/PELV.

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

This concept also delivers higher operational safety and reliability of the DC-AC Servo Drive.

NOTE

The terminal X5 (terminal assignment) represents a special case in relation to insulation and isolation. On this topic follow the instructions in 4.14, p. 51 chap. 4.14.

SELV = Safety Extra Low Voltage

PELV = Protective Extra Low Voltage

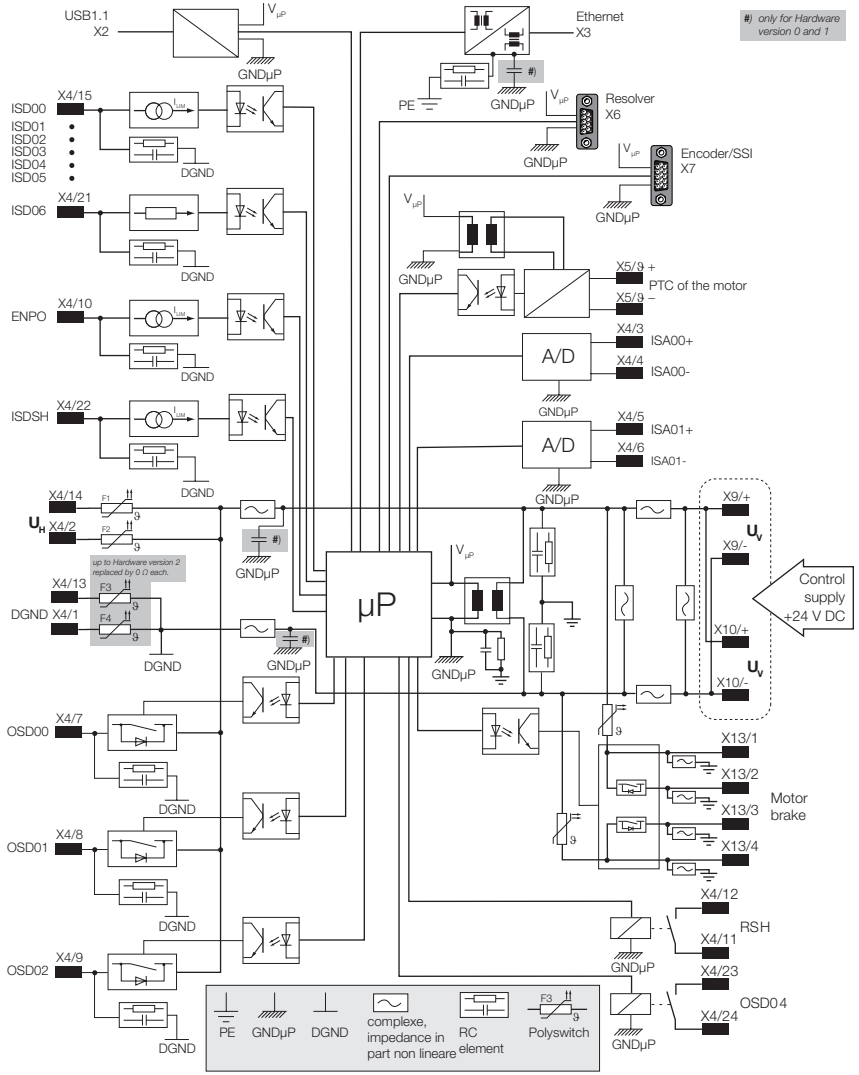
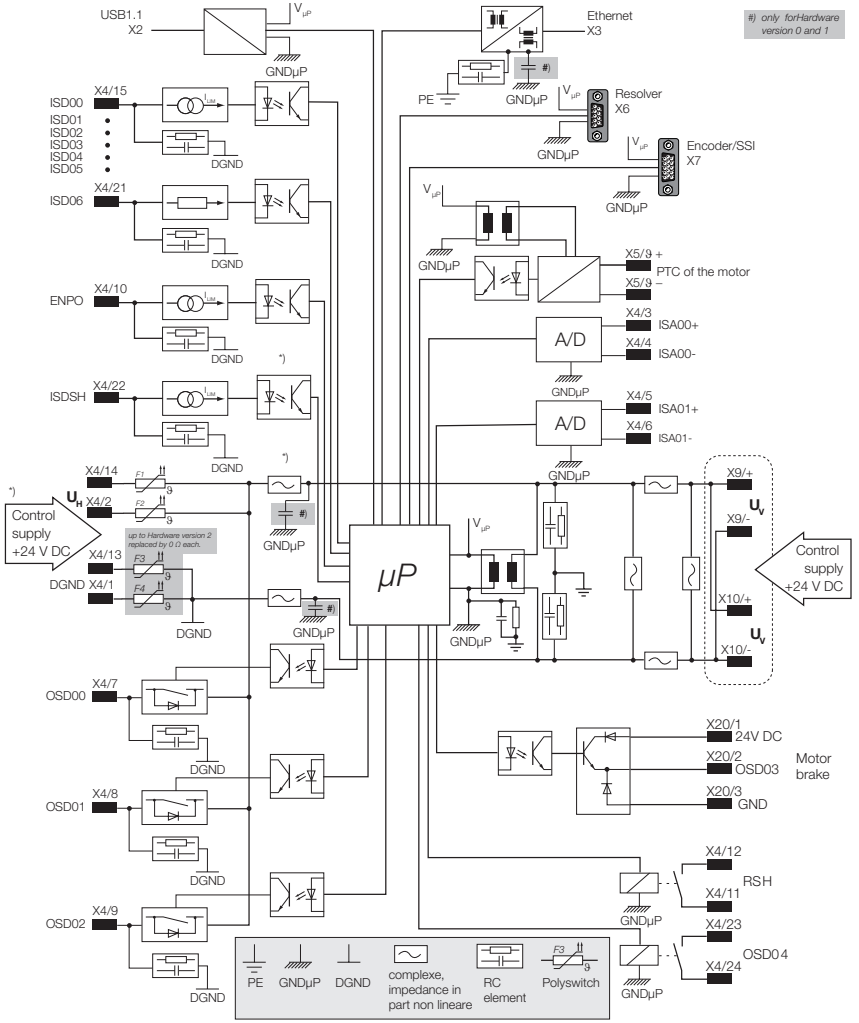


Figure 4.11 Electrical isolation concept, Size 1 to Size 4



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

Figure 4.12 Electrical isolation concept, Size 5 and Size 6A

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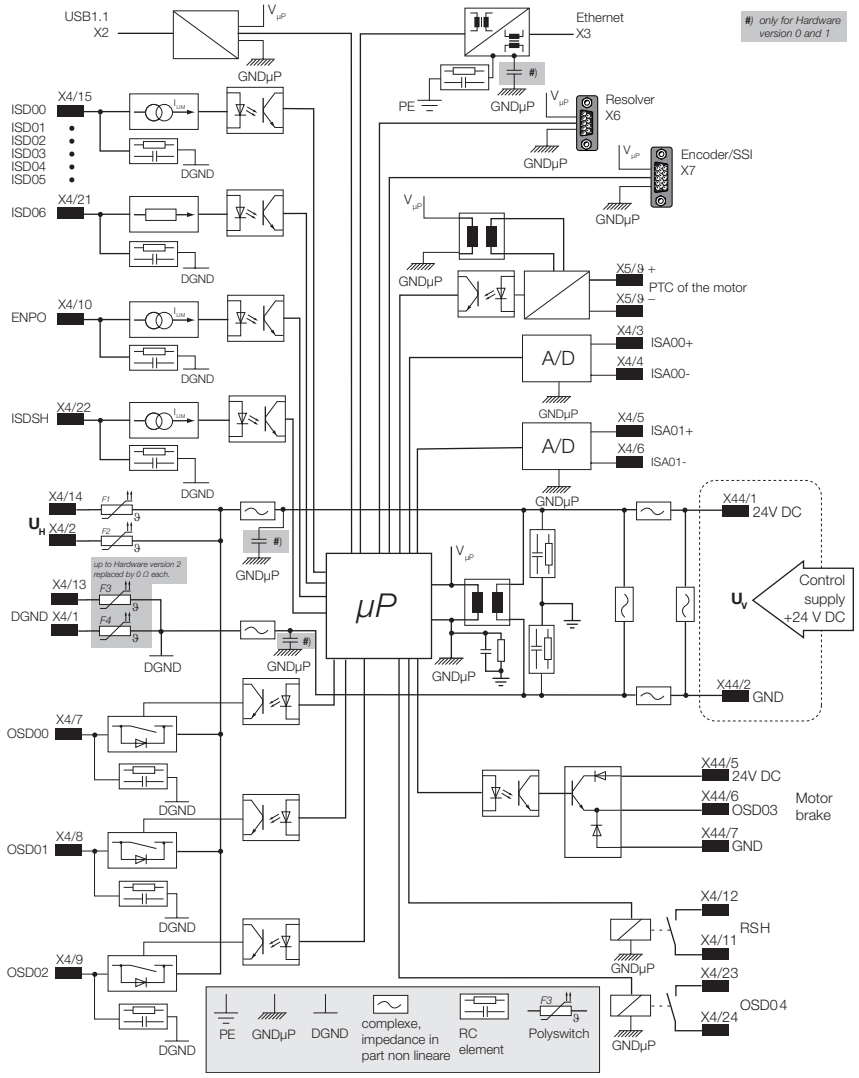


Figure 4.13 Electrical isolation concept, Size 7

4.6 Connection of control supply (+24 V DC)

The supply of power to the DC-AC 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 DC-AC Servo Drive can be checked first and the device parameters configured for the planned application.

NOTE:

Dimension the control supply to suit the maximum current required. Pay attention to the general wiring rules on the topic of cable protection.

NOTE:

On the sizes Size 1 to Size 4, along with the control section the external power supply also supplies the output for the motor holding 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. You will find the current required by the individual devices in chap. A.4.

Do not use the connector as a "switch" for a reset.

G393-004 (Size 1) to G393-170/G397-210 (Size 6A)

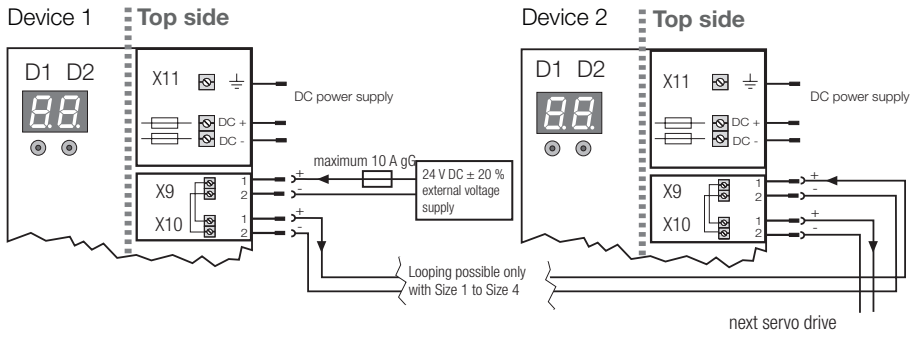


Figure 4.14 Connection for control supply

Terminal/pin	Specification
X9/1 = + X9/2 = -	• U_V = +24 V DC ±20% (Size 5 and Size 6A +20/-10%), stabilised and smoothed • For maximum starting and continuous currents see chap. A.4 • Fuse protection for the terminal maximum 10 A • Internal polarity reversal protection • The Power Supply Unit used must have safe and reliable isolation in relation to the mains as per IEC/EN 50178 or IEC/EN 61800-5-1. • Connected internally to X10
X10/1 = + X10/2 = -	• Connected internally to X9

Table 4.4 Specification, control supply Size 1 to Size 6A

NOTE:

On wiring the 24 V supply, please pay attention to the special aspect for the Size 5, see connection diagram Figure 4.8

G397-250 to G397-450 (Size 7)

Terminal/pin	Specification
X44/1 = + X44/2 = -	• U_V = 2+4 V DC ±10 %, stabilised and smoothed • For maximum starting and continuous currents see chap. A.4 • Fuse protection for the terminal maximum 10 A • Internal polarity reversal protection • The Power Supply Unit used must have safe and reliable isolation in relation to the mains as per IEC/EN 50178 or IEC/EN 61800-5-1.

Table 4.5 Specification, control supply Size 7

4.7 Connection of DC power supply

4.7.1 Connection, Size 1 to Size 6A

1. Make sure all DC-AC Servo Drives are arranged in a row and butt mounted.
See installation instructions in chap. 3

2. Use the pre-assembled connection cables supplied for the DC power supply to the DC-AC Servo Drives Size 1 to Size 5. Via the terminals X11 connect together all (+) connections and all (–) connections.
The pre-assembled connection cables supplied are as long as the related device is wide.
You must make up your own suitable DC connection cables for the Size 6A DC-AC Servo Drives.

3. You will find more detailed information on the mains connection for the ower Supply Unit in the Operation Manual MSD Power Supply Unit.

NOTE:

The DC-AC Servo Drives Size 1 to Size 6A are equipped internally with DC link fuses for device protection (for details see A.2).

NOTE:

Set the value for the supply voltage connected in the firmware for the DC-AC Servo Drive before commissioning.

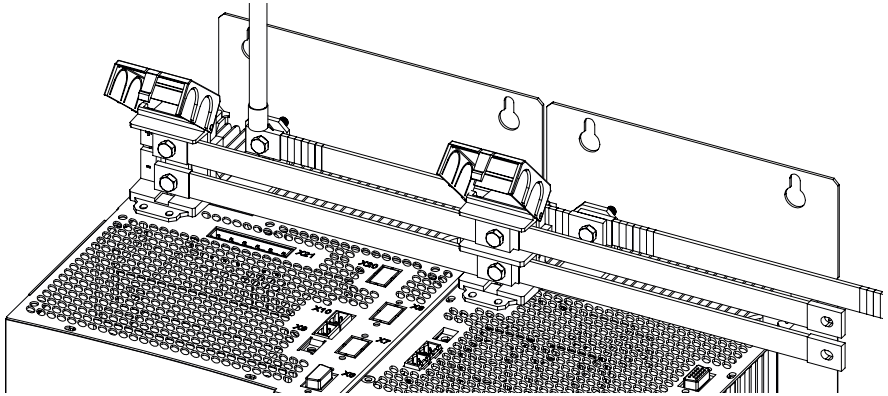


Figure 4.15 Detail: connection, DC power supply Size 5

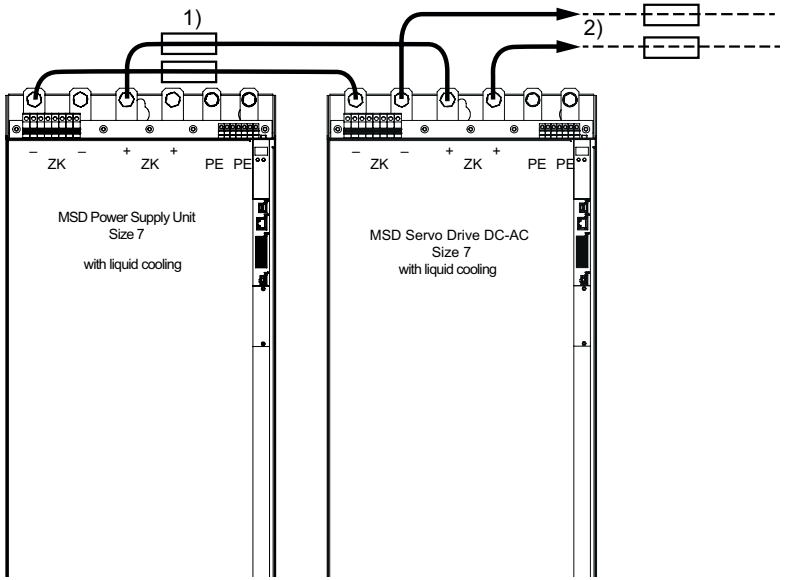
4.7.2 Connection Size 7

NOTE:

The DC-AC Servo Drives Size 7 require separate protection of the DC supply for safe operation. This protection is a prerequisite for CE conformity and the UL certification.

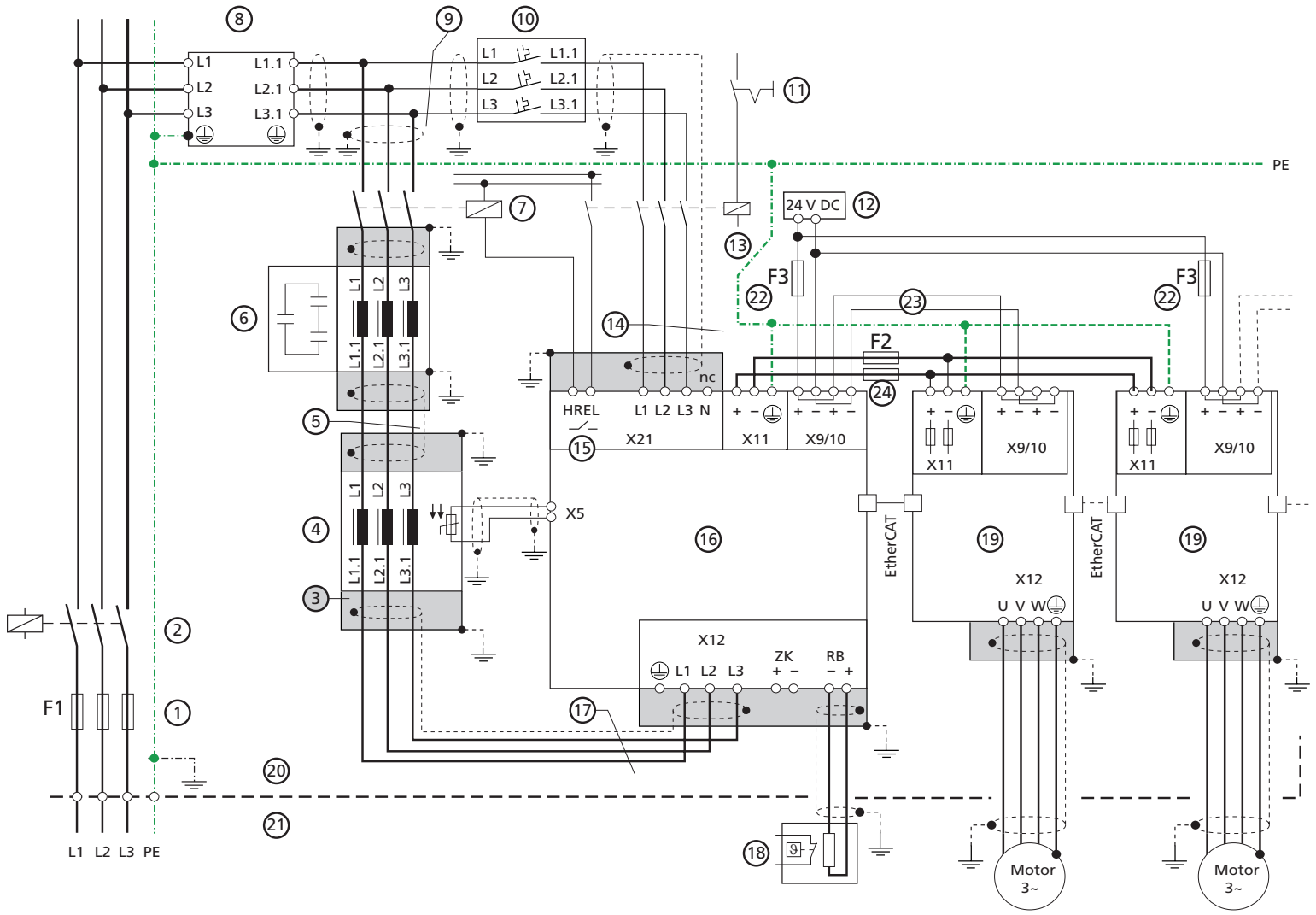
Type	Voltage	Fuses		
		Current	Voltage	Type (Mersen)
G397-250	700 V DC	2 x 400 A	700 V DC	A70QS400-4 or -4k
G397-325	700 V DC	2 x 400 A		A70QS400-4 or -4k
G397-450	700 V DC	2 x 600 A		A70QS600-4 or -4k

Table 4.6 Protection of DC supply for Servo Drives Size 7



1) For necessary DC fuse see Table 4.6
2) Connection of further DC-AC Servo Drives; provide fuses for further Size 7 devices or if the cable cross-section is reduced for smaller devices

Figure 4.16 Schematic, connection of DC power supply Size 7



Key

1) *Mains fuses (F1)*
2) *Mains supply/emergency stop*
3) *Shield plates (grey)*
4) *Step-up choke with KTY temperature sensor*
5) *Shielded cables should be used from >500 mm (19.685 in) cable length*
6) *Input choke with film capacitor*
7) *Mains contactor (after precharging via HREL)*
8) *Mains filter*
9) *Short circuit proof cables*
10) *Circuit breaker*
11) *Multi-axis system on/off*
12) *External +24 V DC control supply*
13) *Auxiliary contactor (precharging/ synchronisation)*
14) *Connection, DC link precharging and mains synchronisation*
15) *Floating contact: 250 V AC/5 A or 30 V DC/6 A (active, once precharging complete)*
16) *MSD Power Supply Unit Size 6A*
17) *AC mains connection*
18) *Braking resistor*
19) *MSD Servo Drive DC-AC*
20) *Switch cabinet*
21) *Field*
22) *F3 maximum 10 A*
23) *For available supply current, see Operation Manual MSD Power Supply Unit chap. 4.6.1+ A.2*
24) *F2 DC fuses, see Operation Manual MSD Power Supply Unit, chap. 4.7.2*

Figure 4.17 Connection of power supply and control supply as well as protective earth conductor in the axis group (example)

4.8 Control connections

Step	Action
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: request STO X4/22, ENPO X4/10 and a start signal (with control via terminal). Ground the cable shields over a wide 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!

4.8.1 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 • Frequency range <500 Hz • Sampling cycle: 1 ms • Switching level low/high: ≤4.8 V / ≥18 V • I_{MAX} at +24 V = 3 mA typ.	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 • 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

Hardware version 0..1		Minimum	Maximum	Typ.
ISD05	↑	3 µs	16 µs	8 µs
ISD05	↓	4 µs	27 µs	15 µs
ISD06	↑↓		2 µs	

From hardware version 2		Minimum	Maximum	Typ.
ISD05 + ISD06	↑↓		2 µs	

– Activation via ISD05/ISD06 = 15 (PROBE)

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 4.7 Specification of the control connections X4

Des.	Term.	Specification		Electrical isolation
ENPO	X4/10	• Disable the restart inhibit (STO) and enable the 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
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 dow • 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

*) STO certification only applies for DC-AC Servo Drives of Size 1 to Size 6A.

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 4.7 Specification of the control connections X4

Des.	Term.	Specification		Electrical isolation	
Relay outputs					
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	Yes	
Auxiliary voltage					
+24 V	X4/2 X4/14	• Auxiliary voltage for supplying the digital control inputs • $U_{II} = U_V$-ΔU (ΔU typically approx. 1.2 V), no irreparable damage in event of 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	

Table 4.7 Specification of the control connections X4

NOTE

High-impedance isolation in the relation to device ground

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.

NOTE:

Take into account that in the event of a fault, the Power Supply Unit may no longer be able to feed regenerative energy from the DC-AC Servo Drive to the mains. To prevent irreparable damage to the Power Supply Unit's braking resistor on extended regenerative operation, the DC-AC Servo Drives and the Power Supply Unit can be mutually interlocked via terminal X4. You will find further information and an example circuit in chap. 10.1, p. 87.

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4.8.2 Brake driver

G393-004 (Size 1) to G393-032/G397-035 (Size 4)

The connector X13 is intended to be used to connect a motor brake.

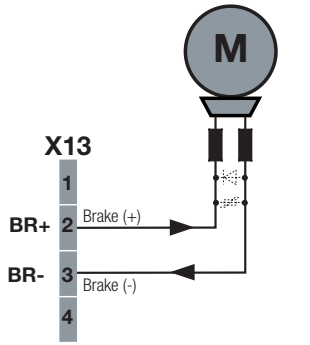
Des.	Term.	Specification	Connection
+24 V BR+ BR– GND	X13/1 X13/2 X13/3 X13/4	• Short circuit proof • Power is supplied via the control supply U_V on X9 or X10 • $U_{BR} = U_V - \Delta U`$ ($\Delta U`$ typically approx. 1.4 V) • For operating a motor holding brake up to I_{BR} = 2.0 A maximum, for brakes with a higher current requirement a relay must be connected in between. • Overcurrent causes shutdown • Can also be used as configu able digital output. • Configu able cable break monitoring <500 mA in state "1" (up to the relay)	

Table 4.8 Specification of the terminal connections X13

G393-045/G397-053 (Size 5) to G393-170/G397-210 (Size 6A)

The connector X20 is intended to be used to connect a motor brake.

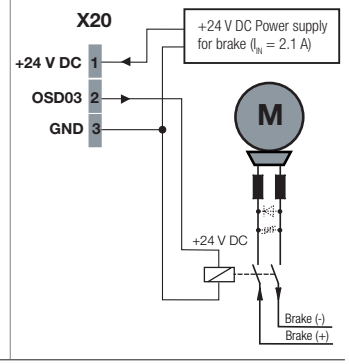
Des.	Term.	Specification	Connection
+24 V OSD03 GND	X20/1 X20/2 X20/3	• Short circuit proof • External power supply +24 V DC (I_{IN} = 2.1 A) required • For operating a motor holding brake up to I_{BR} = 2.0 A maximum, for brakes with a higher current requirement a relay must be connected in between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

Table 4.9 Specification of the terminal connections X20

G397-250 to G397-450 (Size 7)

The connector X44 is intended to be used to connect a motor brake.

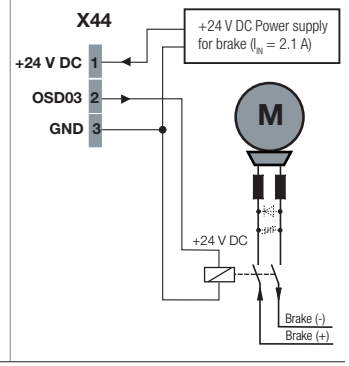
Des.	Term.	Specification	Connection
+24 V OSD03 GND	X44/5 X44/6 X44/7	• Short circuit proof • External power supply +24 V DC (I_{IN} = 2.1 A) required • For operating a motor holding brake up to I_{BR} = 2.0 A maximum, for brakes with a higher current requirement a relay must be connected in between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

Table 4.10 Specification of the terminal connections X44

4.9 Specification, USB interface

The service and diagnostics 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)

4.10 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 compliant
- Connection via commercially available crosslink cable (see also MSD Servo Drive Ordering Catalog)

4.11 Option 1

Depending on the DC-AC Servo Drive variant, Option 1 is factory-configured with various options. Field bus options such as EtherCAT 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.

4.12 Option 2

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.

4.13 Encoder connection

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

4.13.1 Encoder connection for synchronous motors

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

4.13.2 Allocation of motor/encoder cable to the DC-AC 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!

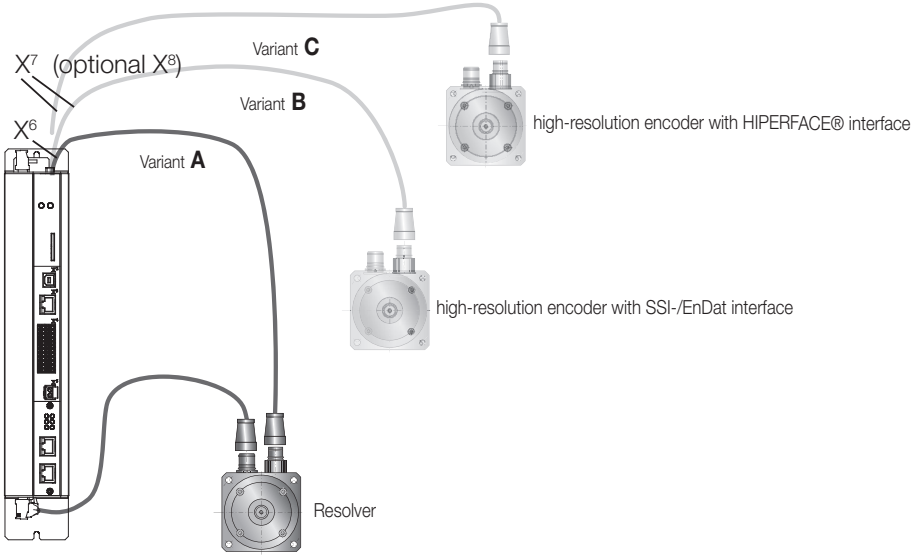


Figure 4.18 Motor/encoder cable assignment

	Motor (with encoder installed)	Encoder cable	Connection on the Servo Drive
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 singleturn encoder with HIPERFACE® interface	CA58877-002-yyy	X7

Table 4.11 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!

4.13.3 Ready made encoder cables

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

	C08335	-	013	-	yyy
Ready made cable *Resolver cable* *Encoder cable SSI, EnDat* *Encoder cable Hiperface®*	 CA58876 CA58877		 002 002		
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

Technical data

	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)
Controller-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)
Cable diameter approx.	8.8 mm		
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 4.12 Technical data, encoder cables

4.13.4 Resolver connection

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

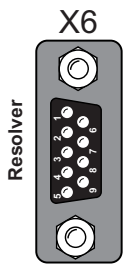
Figure	X6/pin	Function
	1	Resolver S3 differential input (reference to Pin X6-2)
	2	Resolver S1 differential input (reference to Pin X6-1)
	3	Resolver S2 differnetial input (reference to Pin X6-8)
	4	Supply voltage 5..12 V, connected internally to X7/3
	5	ϑ+ (PTC, NTC, KTY Klixon) [1]
	6	Ref+ analog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

Table 4.13 Pin assignment X6

1) It is imperative attention is paid to the warning

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 (PTC, also NTC, KTY and Klixon) must be provided with basic insulation in relation to the motor winding on connection to X5, on connection to X6 with reinforced insulation as per IEC/EN 61800-5-1. The operation of a motor temperature sensor on X6 is only allowed if the DC-AC Servo Drive is supplied from an AC-AC Servo Drive (MSD Servo Drive AC-AC Single-Axis System) (see chap. "8 Project planning with AC-AC Servo Drive as supply").

4.13.5 Connection for high-resolution encoders

The interface X7 makes possible the evaluation of the following encoder types.

Fig.	Function
X7  Encoder/ SSI	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)
	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 4.14 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 pair cable cores.
- Do not cut the encoder cable, for example to route the signals via terminals in the switch cabinet.

Fig.	X7 pin	Sin/Cos and TTL	Sin/Cos absolute value encoder SSI/EnDat	Absolute value encoder EnDat (digital)	Absolute value encoder HIPERFACE®	
X7  Encoder/ SSI	1	A-	A-	-	REFCOS	
	2	A+	A+	-	+COS	
	3	+5 V DC ±5 %, $I_{OUT,max}$ = 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 drawn at X7/3 and X6/4 must not exceed the value given!
	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 4.15 Pin assignment for the connector X7

NOTE:

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

4.14 Motor connection

Step	Action
1.	Define the cable cross-section according to local and national regulations and conditions. It is dependent on the rated current, the type of cable laying and the ambient temperature.
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 prevent interference emissions. Fasten shield connection plate for the motor connection X12 using both screws.
3.	Wire the temperature sensor, 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 prevent 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 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 output.

4.14.1 Motor connection for servo motors

NOTE:
To connect the servomotors please use a ready made motor cable from Moog.

G393-004 (Size 1) to G393-032/G397-035 (Size 4)

NOTE
Recommended connection option for a motor brake with a motor brake current of maximum 2 A see Figure 4.19.

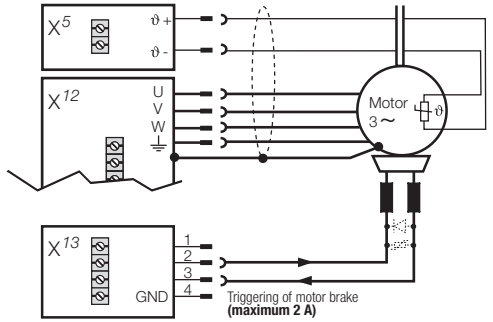


Figure 4.19 Connection of the motor for Size 1 to Size 4 (motor brake to 2 A)

NOTE:

Connection option for a motor brake with a motor brake current from 2 A see Figure 4.20. Cable break detection is not possible.

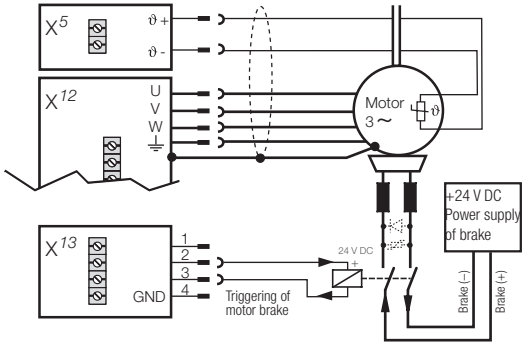


Figure 4.20 Connection of the motor for Size 1 to Size 4 (motor brake from 2 A)

G393-045/G397-053 (Size 5) to G393-170/G397-210 (Size 6A)

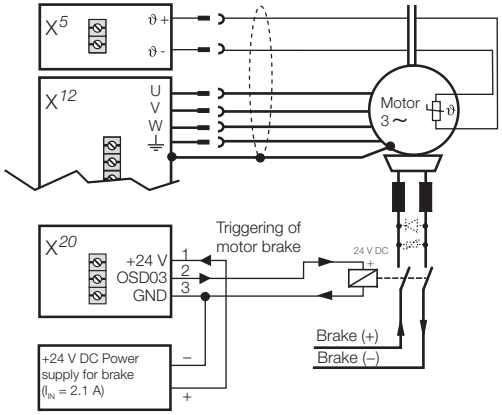


Figure 4.21 Connection of the motor for G393-045/G397-053 (Size 5) to G393-170/G397-210 (Size 6A)

G397-250 bis G397-450 (Size 7)

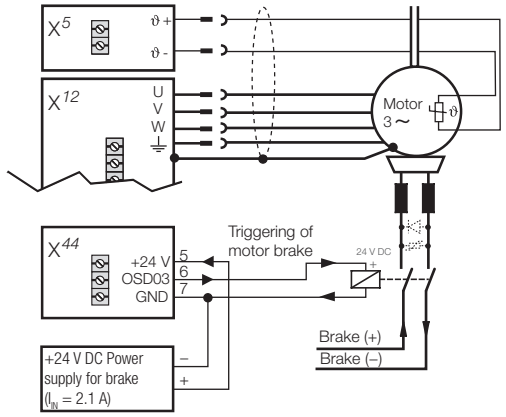


Figure 4.22 Connection of the motor for G397-250 bis G397-450 (Size 7)

4.14.2 Ready made motor cable

C08336	-	xxx	yyy[1)]
Ready made motor caböe			
Capable fpr energy chains			
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

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 to +125 °C (-40 to +275 °F)		TBD		-50 to +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 4.16 Technical data motor cable

NOTE:

Cores 5 and 6 (PTC) are required only for motors in which the motor PTC cannot be connected via the encoder cable. In the case of servomotors with resolver, the PTC is connected via the resolver cable.

4.14.3 Switching in the motor cable

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

To ensure unpowered switch-on, you must make sure that the contacts on the motor contactor are closed before the DC-AC 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 DC-AC 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.

5 Commissioning

5.1 Notes for commissioning

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

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 ope ation and can reach temperatures of up to +100 °C (+212 °F). 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.

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

5.2 Initial commissioning

Once the DC-AC Servo Drive has been installed as described in chap. 3 and wired with all required power supplies and external components as described in chap. 4, initial commissioning can performed in the following sequence:

Step	Action
1.	Install and start the PC software Moog DriveAdministrator 5. You will find more detailed information in the Installation Manual Moog DriveAdministrator 5.
2.	Switch on the control supply (chap. 5.2.1).
3.	Connect the DC-AC Servo Drive to the PC (chap. 5.2.2).
4.	Configure the pa ameters (chap. 5.2.3).
5.	Test the drive using Moog DriveAdministrator 5 (chap. 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).

MOOG ID no.: CA97554-001 09/2023

5.2.1 Switching on control supply

Step	Action
2.	To initialise and configure parameters, initially only switch on the +24 V control supply. Do **not** yet switch on the power supply.

Display indication after switching on the control supply

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

Table 5.1 Switch-on status of the DC-AC Servo Drive on connection of the +24 V DC control supply

NOTE:

You will find details on the control supply in chap. 4.6.
You will find details on the display indication in chap. 5.4.

5.2.2 Connection between PC and DC-AC Servo Drive

Step	Action
3.	The PC can be connected to the DC-AC Servo Drive via USB or Ethernet (TCP/IP). Connect PC and DC-AC Servo Drive using the related connection cable.

NOTE:

- Initialisation
  The communication link between PC and DC-AC Servo Drive can only be set up after the DC-AC Servo Drive has completed its initialisation.
- USB driver and TCP/IP configuration
  If the PC does not recognise the DC-AC 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

Step	Action
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
  On using Moog servo motors, the latest version of the motor data set required.

5.2.4 Controlling drive using Moog DriveAdministrator 5

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

DANGER!	**Risk of injury due to rotating parts on the motor!**
	• **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 the motor due to incorrect operation during motor test run!**
	• **Carelessness can result in significant damage to the motor or machine.** • It is imperative the safety instructions and warnings from chapter 2 are followed during commissioning. Please note that you yourself are responsible for safe operation. • Before you start commissioning it must be ensured that the machine will not be damaged by the test! Pay particular attention to the limitations of the positioning range. • Certain motors are **only** intended for operation on the DC-AC 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 temperature sensor installed must be connected to the terminals of the temperature monitoring system for the DC-AC Servo Drive also during the test run. • The motor holding 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 power supply

D1	D2	Action	Reaction	Explanation
		Switching on the power supply	Controller ready, power stage ready, control deactivated	Device is ready to switch on

Table 5.2 Display D1, D2 after switching on the power supply

NOTE:

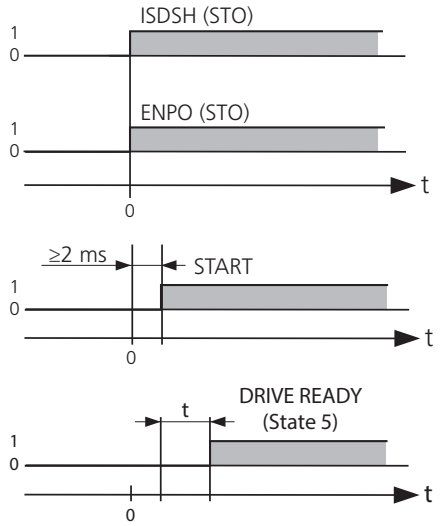
- Inputs "ISDSH" and "ENPO"
  For step 1 in Table 5.3 at least the two inputs"ISDSH" and "ENPO" on terminal X4 must be connected.
- Ready to operate
  On operation with a AC-AC Servo Drive as the supply, all DC-AC Servo Drives in the system must be in state 2 (ready to operate) before the first axis starts.
- Manual mode window
  Step 2 in Table 5.3 is best undertaken via the "Manual mode" window in Moog DriveAdministrator 5. You will find details in the online help.
- 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

1. Deactivate the safety function "STO" by setting the inputs "ISDSH" and "ENPO"

2. Activate "START CONTROL" at the earliest2 ms after step 1 and specify the speed setpoint

3. Monitor your system or plant and check the drive behaviour.



t = Motor-dependent delay

Table 5.3 Power-up sequence

Display reading 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	Drive ready	Motor energised, control active

Table 5.4 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 next step, "Enable start", it is imperative you specify a plausible setpoint via the analog input! The setpoint set is transferred to the drive immediately after the motor control has started.

For details on adjusting the drive to your application, please refer to the online help for Moog DriveAdministrator 5 and the device help.

5.3 Serial commissioning

An existing parameter data set can be transferred to other DC-AC Servo Drives using Moog DriveAdministrator 5. You will find details on this topic in the online help for Moog DriveAdministrator 5 and in chap. 5.4.

NOTE:

MDS PLC programs can only be loaded into a DC-AC Servo Drive using the programming system CODESYS.

5.4 Integrated control unit

The integrated control unit permits diagnostics on the DC-AC 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)

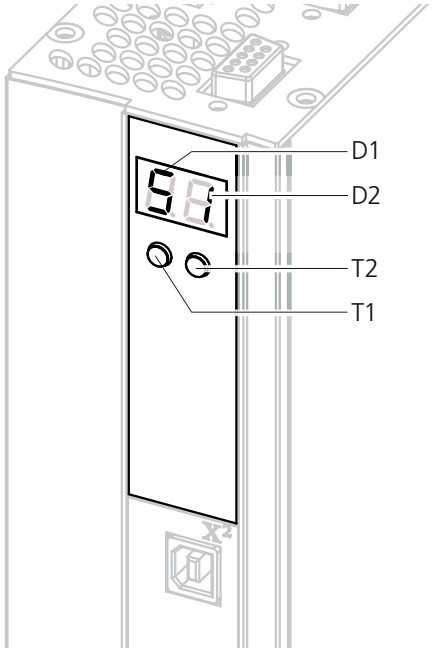


Figure 5.1 Integrated control unit

The following functions and displays are available:

- Indication of the device status (see chap. 6.1.1)
  The device status is indicated after switching on the control supply. If no input is made via the keypad for 60 seconds, the display switches back to the indication of the device status.
- Indication of the device error status (see chap. 6.1.2)
  On the occurrence of an error in the device, the display is immediately switched to the indication of the error code.
- Parameter setting (indication "PA") (see chap. 5.4.3)
  Resetting device parameters to their factory setting
- Ethernet IP address setting (indication "IP") (see chap. 5.4.4)
  Ethernet IP address and subnet mask setting
- Field bus settings (indication "Fb") (see chap. 5.4.5)
  E.g. field bus address setting

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 secon . 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 second .
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 5.5 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 chap. 5.4.4 and chap. 5.4.5)
	[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 chap. chap. 5.4.3) • Device error indication, "Er" flashes alternately with error number and error location
	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 5.6 Meaning of display

NOTE:

If no input is made via the keyboard for a period of 60 s, the display returns 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

Menu level 1	Menu level 2	Parameter	Value range	Meaning	Explanation
PA	Pr	-	-	Parameter reset	Reset device settings to factory settings.

Table 5.7 Parameter menu

Error messages displayed during user data entry

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 device help.

Error number	Meaning
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 5.8 Error messages displayed during user data entry

5.4.4 Ethernet IP address menu (IP)

An Ethernet TCP/IP interface 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 5.9 IP address menu

MOOG ID no.: CA97554-001 09/2023

Example configuration of the subnet mask

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

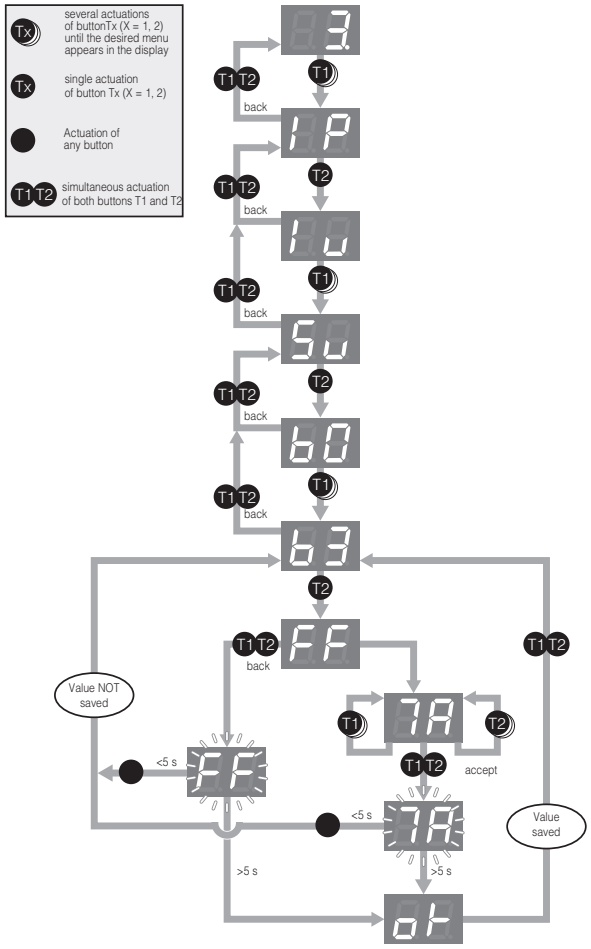


Figure 5.2 Example configuration of the subnet mask

NOTE:

- During the flashing phase after step 7 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.
- The modified IP address is only effective after restarting the control electronics (24 V reset).

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 5.10 Field bus address menu

Example configuration of the field bus address

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

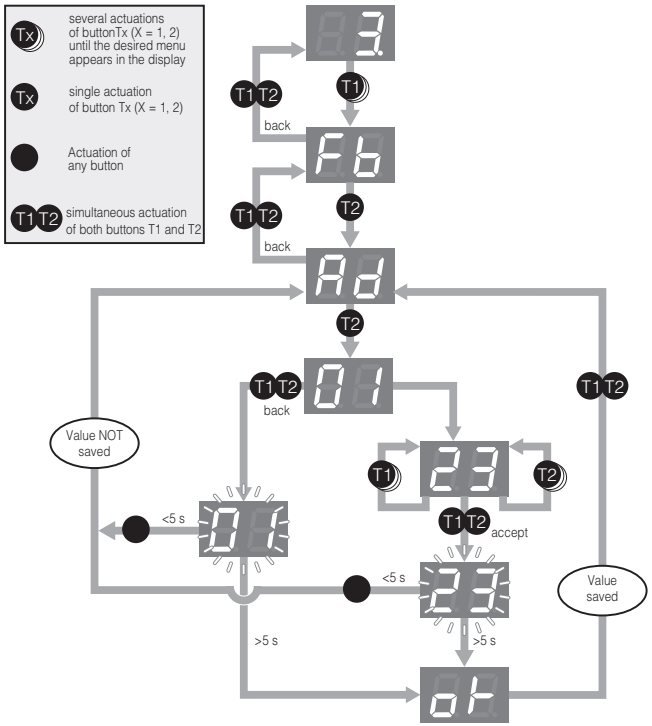


Figure 5.3 Example configuration of the field bus address

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
 [1]	Not ready to switch on (no DC link voltage) [2]
 [1]	Start inhibit (DC link OK, power stage not ready [2]
	Ready to switch on (power stage ready)
	Switched on (power applied to drive) [3]
	Drive ready (power applied to drive and drive ready for setpoint input) [3]
	Quick stop [3]
	Fault reaction active [3]

1) This not a "safe indication" in the context of IEC/EN 61800-5-2.

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

3) 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

NOTE:

- Acknowledge error
  The errors can be acknowledged according to their programmed reaction (ER) or only by means of a 24 V reset (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 Device Help.

6.2 Status and error indication in Moog DriveAdministrator 5

Click the "Device status" button in the header in the Moog DriveAdministrator 5 to open the "Device status" window.

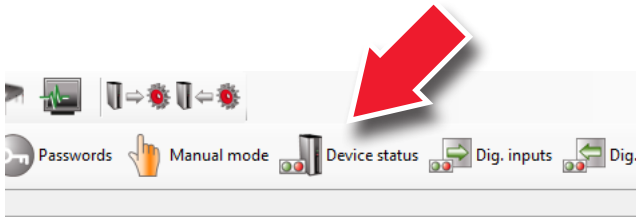


Figure 6.1 "Device status" button in the header

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

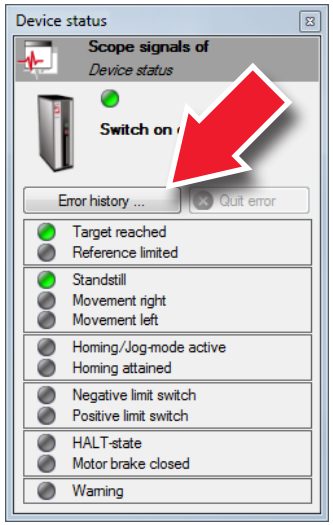


Figure 6.2 "Device status" window

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

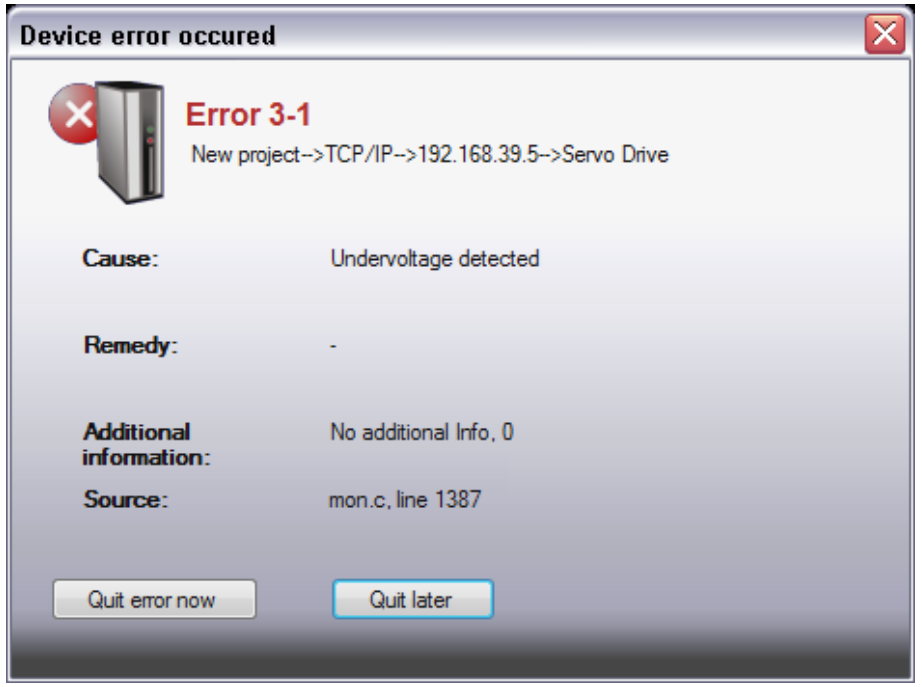


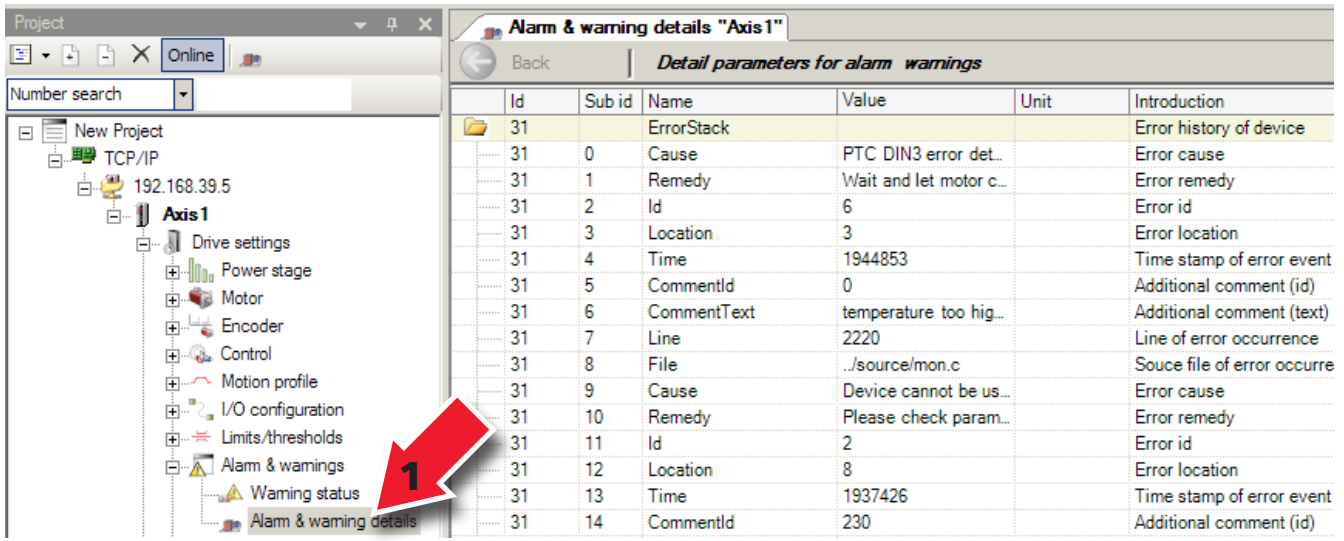
Figure 6.3 Error message

Alarms & Warnings (Details)" contains detailed information on an error or warning that has occurred.

1. Double-click the lowest level in the project tree "Alarms & Warnings (Details)".

NOTE:

You will find further information in the program help for Moog DriveAdministrator 5.



Id	Sub id	Name	Value	Unit	Introduction
31		ErrorStack			Error history of device
31	0	Cause	PTC DIN3 error det...		Error cause
31	1	Remedy	Wait and let motor c...		Error remedy
31	2	Id	6		Error id
31	3	Location	3		Error location
31	4	Time	1944853		Time stamp of error event
31	5	CommentId	0		Additional comment (id)
31	6	CommentText	temperature too hig...		Additional comment (text)
31	7	Line	2220		Line of error occurrence
31	8	File	../source/mon.c		Souce file of error occurre
31	9	Cause	Device cannot be us...		Error cause
31	10	Remedy	Please check param...		Error remedy
31	11	Id	2		Error id
31	12	Location	8		Error location
31	13	Time	1937426		Time stamp of error event
31	14	CommentId	230		Additional comment (id)

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

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).

7 Safe Torque Off (STO)

8 Project planning with AC-AC Servo Drive as supply

NOTE

You will find help with the selection of the optimal operation mode (with Power Supply Unit or with AC-AC Servo Drive) in chap. 9.

On setting up a Multi-Axis System with AC-AC Servo Drives as the supply, it is imperative the "Operation Manual MSD Servo Drive AC-AC" (ID no. CA65642-001) is also followed.

On continuous regenerative operation of one or more axes, additional measures may be necessary. Please contact our support.

8.1 Arrangement of the devices and components

The positioning of the components in the switch cabinet has a significant effect on the trouble-free system and machine function using the Multi-Axis System. It is therefore imperative you pay attention to the points in chap. 3 on mounting and in chap. 4.2 on the installation of a Multi-Axis System.

8.1.1 Device protection

During the installation of a Multi-Axis System with AC-AC Servo Drive as the supply, pay attention to the following information on device protection:

Mains fuses

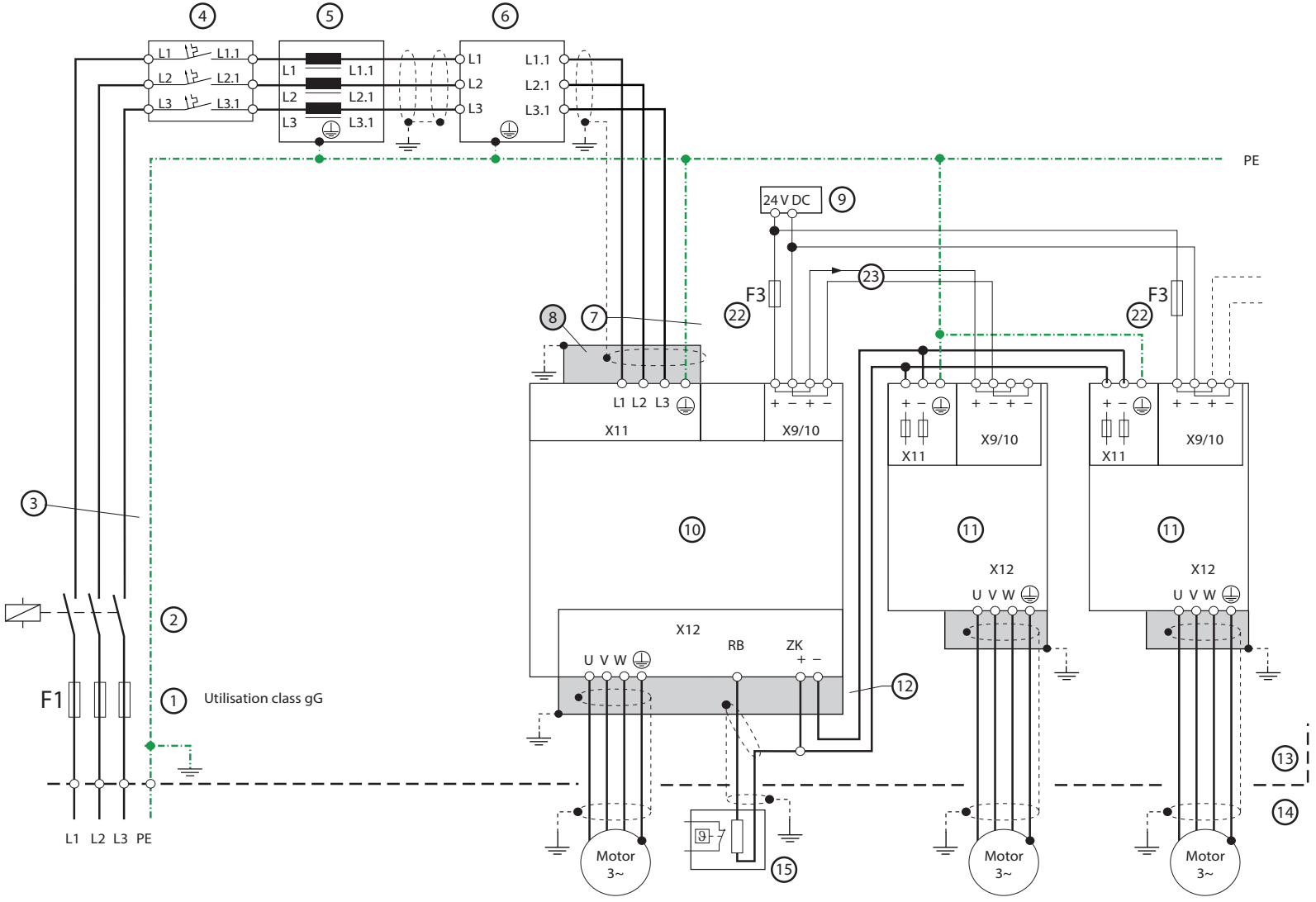
- G392-004 (Size 1) to G392-072/G395-084 (Size 5)
  In all circumstances the mains fuses are to be installed in addition to the motor protection switch and will prevent irreparable damage to the device (e.g. if there is a component fault or overload). Use mains fuses (utilisation class gG) to isolate all poles of the Servo Drive from the mains. You will find more detailed information in the Operation Manual MSD Servo Drive AC-AC (ID no. CA65642-001) in the chapter "Electrical installation".
- G392-090/G395-110 (BG6) to G395-450 (Size 7)
  Instead of mains fuses of utilisation class gG, semiconductor fuses of utilisation class gRL (gS) are to be used. As this type of fuse is a full-range fuse it offers protection for the devices and the cabling. As a result the motor protection switch is not required.

AC-AC Servo Drive	SIBA article number	Rated current	Height
G392-090/ G395-110	2020934.125	125 A	NH 00
G392-110/ G395-143	2021134.160	160 A	NH 1
G392-143/ G395-170	2021134.200	200 A	NH 1
G392-170/ G395-210	2021134.250	250 A	NH 1
G395-250	2021234.315	315 A	NH 2
G395-325	2021234.400	400 A	NH 2
G395-450	2021234.500	500 A	NH 2

Table 8.3 Recommended mains fuses from the manufacturer SIBA (www.siba-fuses.com)

Motor protection switch

- G392-004 (Size 1) to G392-072/G395-084 (Size 5)
  In all circumstances the motor protection switch is to be installed in addition to the mains fuses. It provides overload protection for the device, mains choke and mains filter in the range up to the permissible overload range. The rated current of the motor protection switch ("circuit breaker for system and motor protection" of CLASS 10, SIEMENS product range SIRIUS 3RV10 or SIRIUS 3RV20) is to be selected to suit the lowest rated current $I_{Rated\ (f\_sw\ and\ U\_Mains)}$ of the components used (mains choke, mains filter, AC-AC Servo Drive).
- G392-090/G395-110 (Size 6A) to G395-450 (Size 7)
  The motor protection switch is not required if semiconductor fuses of utilisation class gRL (gS) are used instead of mains fuses of utilisation class gG (see chap. Table 8.3).
- Braking resistor
  The AC-AC Servo Drive's braking resistor is to be dimensioned such that the total regenerative power from the Multi-Axis System can be dissipated. On dimensioning the connection cables for the braking resistor, it is to be noted that if there is a fault the mains side protection devices will trigger safely. It is to be taken into account that the ratio of currents $I_{DC\ bus\ eff}$ / $I_{Mains\ side\ eff}$ is up to 1.4-times.

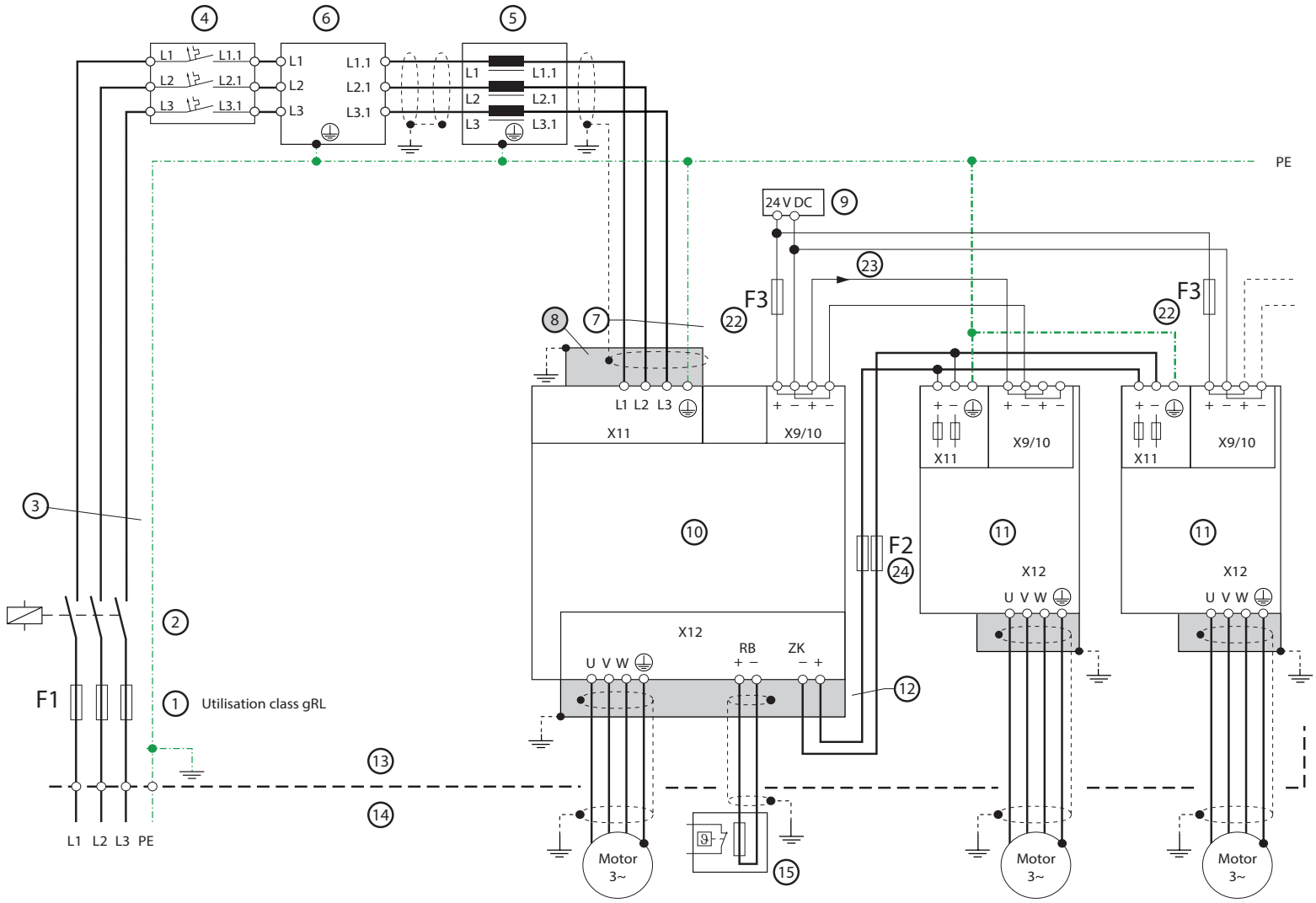


Key

1. F1 Mains fuses [1], type gG
2. Mains supply/emergency stop
3. Short circuit proof cables
4. Motor protection switch [1]
5. Mains choke
6. Mains filte
7. AC mains connection
8. Shield plates (grey)
9. External +24 V DC control supply (protected)
10. MSD Servo Drive AC-AC (Size 1 to Size 5)
11. MSD Servo Drive DC-AC
12. DC link coupling
13. Switch cabinet
14. Field
15. Braking resistor [1]
22. F3 10 A maximum
23. For avail. supply current, see Appendix A.4

1) Pay attention to the requirements on device protection in chap. 8.1.1!

Figure 8.1 Overview, connection diagram for operation with supply by a AC-AC Servo Drive (Size 1 to Size 5)

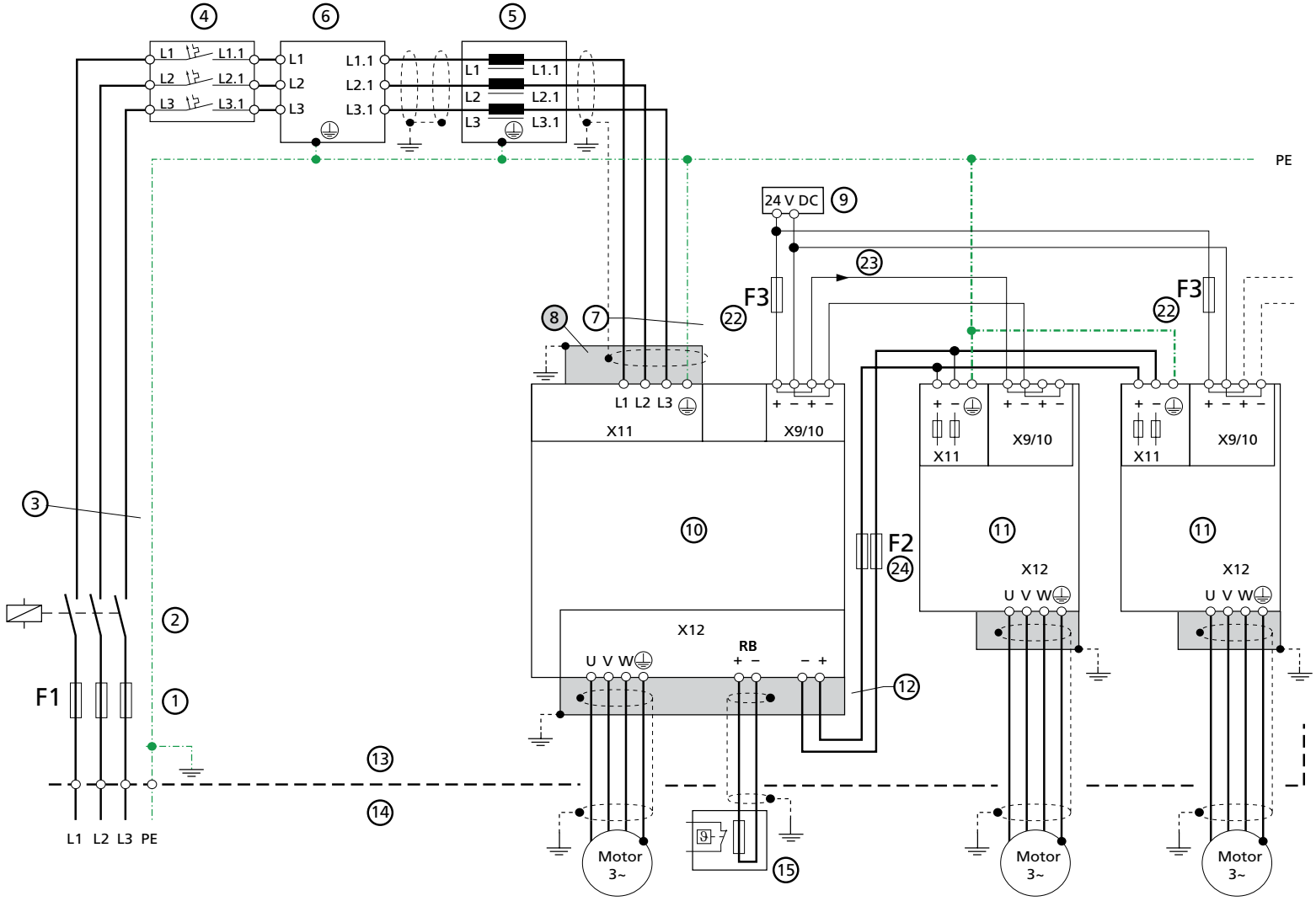


Key

1. F1 Mains fuses [1], type gRL
2. Mains supply/emergency stop
3. Short circuit proof cables
4. Motor protection switch [1]
5. Mains choke
6. Mains filte
7. AC mains connection
8. Shield plates (grey)
9. External 24 V DC control supply (protected)
10. MSD Servo Drive AC-AC (Size 6/ Size 6A)
11. MSD Servo Drive DC-AC
12. DC link coupling
13. Switch cabinet
14. Field
15. Braking resistor [1]
22. F3 10 A maximum
23. For avail. supply current, see Appendix A.4
24. F2 DC fuses, see Operation Manual MSD Power Supply Unit, chap. 4.8.2

1) Pay attention to the requirements on device protection, chap. 8.1.1!

Figure 8.2 Overview, connection diagram for operation with supply by a AC-AC Servo Drive (Size 6 to Size 6A)



Key

1. F1 Mains fuses [1], type gRL
2. Mains supply/emergency stop
3. Short circuit proof cables
4. Motor protection switch [1]
5. Mains choke
6. Mains filte
7. AC mains connection
8. Shield plates (grey)
9. External 24 V DC control supply (protected)
10. MSD Servo Drive AC-AC (Size 7)
11. MSD Servo Drive DC-AC
12. DC link coupling
13. Switch cabinet
14. Field
15. Braking resistor [1]
22. F3 10 A maximum
23. For avail. supply current, see Appendix A.4
24. F2 DC fuses, see Operation Manual MSD Power Supply Unit, chap. 4.8.2

1) Pay attention to the requirements on device protection, chap. 8.1.1!

Figure 8.3 Overview, connection diagram for operation with supply by a AC-AC Servo Drive (Size 7)

8.2 Switch cabinet arrangement with AC-AC Servo Drive as supply

The switch cabinet arrangement shown here is for illustration. It does not guarantee general suitability for a specific application or compliance with the applicable regulations. In each case check and evaluate the layout planned in relation to the specific application as well as the regulations applicable in the installation location for the system. Moog does not accept any liability for the applicability of the switch cabinet arrangement shown in the following.

Item	Meaning
1	Mains cable
2	Main switch
3	Fuse
4	Mains filte
5	Does not exist
6	Mains contactor
7	Does not exist
8	Does not exist
9	AC-AC Servo Drive for supplying the DC-AC Servo Drives
10	DC-AC Servo Drive
11	DC link power supply for the Servo Drives
12	Ext. braking resistor for the AC-AC Servo Drive
13	Motor cables
14	Controller (higher level)

Table 8.4 Key to switch cabinet arrangement

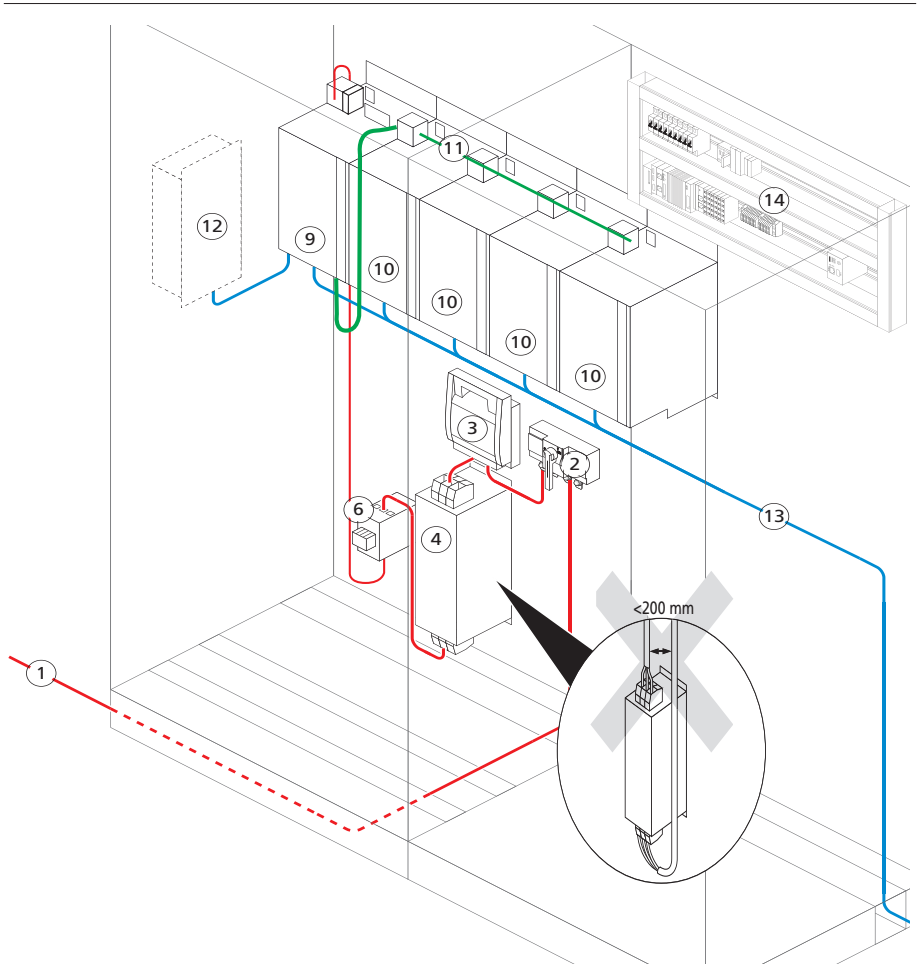


Figure 8.4 Switch cabinet arrangement, Multi-Axis System with supply by AC-AC Servo Drive (from Size 5)

9 Project planning

9.1 Overview and comparison of the Multi-Axis Systems

This overview presents two possible system variants for MSD Multi-Axis Systems: "operation with a Power Supply Unit" and "operation with a AC-AC Servo Drive as the supply". It will help you to identify the optimal variant for your application. Aspects such as installation space, installation effort, procurement and operating costs are considered.

- The information in this chapter relates only to the devices and components in the product family MSD Servo Drive (not including MSD Servo Drive Compact) from Moog. Operation with devices or components from other manufacturers or product families is not allowed!
- For each application several factors, e.g. total power and simultaneity factor, are to be taken into account to ensure safe operation of the system.
- In any case, during the planning of your application consult Moog planning support who will take into account all parameters using a powerful software application for planning.
- It is only allowed to commission a MSD Multi-Axis System after the dimensioning has been checked by Moog planning support!

9.2 Application examples

The MSD Multi-Axis System can demonstrate its advantages over a classic system comprising several AC-AC Servo Drives in applications that often operate regeneratively. Depending on the length of the regenerative phases and whether other axes of the system are operating as motors during these phases, operation with a Power Supply Unit or with a AC-AC Servo Drive can be more appropriate.

9.3 Operation with a Power Supply Unit

In this system variant the DC-supplied DC-AC Servo Drives are connected to a central Power Supply Unit.

Advantages

- Regenerative power from one axis is available to the other axes via the central DC link
- Surplus energy in the DC link is fed back to the supply system centrally via the Power Supply Unit
- Sinusoidal mains current with very low harmonics during motor and regenerative operation
- The power factor can be controlled at cos φ = 1 (reactive power compensation)
- Same power ratings for motor operation and regenerative operation
- The system can have more axes than on supply using one AC-AC Servo Drive
- Depending on the planning for the Power Supply Unit, all axes can be operated simultaneously at rated power
- The installation of the supply cables between the Power Supply Unit and the DC-AC Servo Drives is convenient and space saving via a continuous busbar system (Size 1 to Size 5)
- The operating costs are lower than for a system comprising AC-AC Servo Drives or with a AC-AC Servo Drive as the supply
- Higher DC link voltage than on corresponding AC supply, as a consequence it is possible to use smaller motors
- Regulated DC link voltage, therefore it is no longer necessary to take in account mains voltage fluctuations as a reserve in the system
- Due to higher DC link voltage, poor supply networks can be compensated and maximum motor torques achieved in the field-weakening range
- Complete compensation of mains voltage dips due to the ability to increase the voltage
- High dynamic performance due to fast changes in the energy flow on the load side
- If there is a power failure, it is possible to brake via integrated brake choppers

Disadvantages

- The space required due to the Power Supply Unit and its external circuit can, in some circumstance, be greater than on operation with a AC-AC Servo Drive as the supply or a system comprising AC-AC Servo Drives.
- The investment costs are higher than for a system comprising AC-AC Servo Drives or with a AC-AC Servo Drive as the supply.

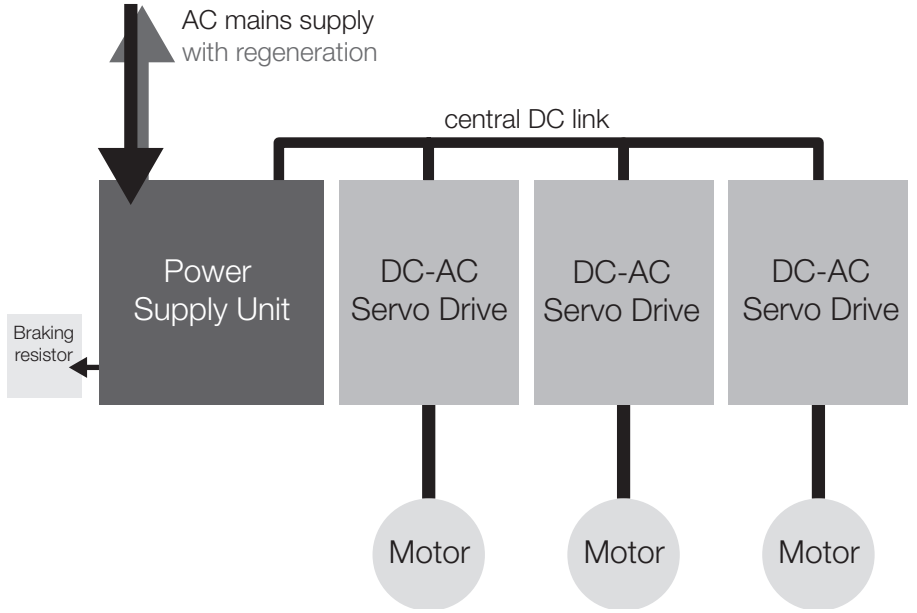


Figure 9.1 Block diagram of a Multi-Axis System with Power Supply Unit and regeneration

9.4 Operation with AC-AC Servo Drive as supply

Advantages

- The investment costs are lower than on operation with a Power Supply Unit
- As an additional Power Supply Unit is not required, in general the space required is less than on operation with a Power Supply Unit
- Regenerative power is available to the other axes via the central DC link
- Surplus energy is dissipated centrally via the AC-AC Servo Drive's braking resistor

Disadvantages

- In this system variant, in general it is not possible to operate all axes at full rated power, as otherwise the DC link on the AC-supplied AC-AC Servo Drive may be overloaded
- It may be necessary to oversize the supplying AC-AC Servo Drive
- Regenerative power cannot be fed back to the supply system, instead it can only be converted into heat via a braking resistor
- Similar to the AC-AC Servo Drive, it may be necessary to oversize the braking resistor, as a consequence the heat produced causes additional effort for installation and temperature control
- The operating costs are higher than for a system comprising AC-AC Servo Drives or with a Power Supply Unit
- Lower DC link voltage than on operation with a Power Supply Unit
- Due to the total DC link capacitance, fewer DC-AC Servo Drives can be connected than to the Power Supply Unit

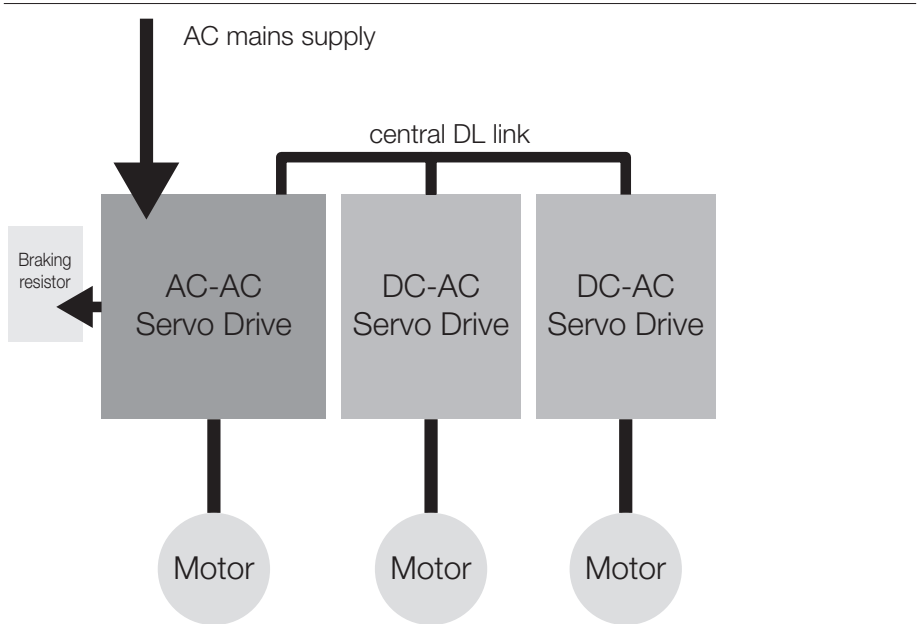


Figure 9.2 Block diagram of a Multi-Axis System with AC-AC Servo Drive as supply

9.5 Functional comparison

As a selection aid, the technical and functional differences between operation with a AC-AC Servo Drive as the supply and operation with a Power Supply Unit are compared.

Feature	AC-AC Servo Drive as supply	Power Supply Unit
Operation on different mains voltages around the world possible	○ 1)	●
Regeneration possible (sinusoidal)		●
Operation with any simultaneity factor possible	○	●
DC link coupling via busbar system (Size 1 - Size 5)	○	●
Energy equalisation by central DC link	●	●
Controlled stop on power failure	●	●
Requires external step-up choke and input choke		●
Requires external braking resistor	●	○ 2)
Air cooling	●	●
Liquid cooling	●	●
Higher DC link voltage (650 V/770 V)		●
Reactive power compensation		○
EtherCAT, SERCOS II & III, PROFINET IRT, VARAN, CANopen, PROFIBUS-DPV1	●	●
Sin/Cos encoder, TTL encoder simulation/encoder	●	●

● = *applicable*, ○ = *partially applicable*

1) With autotransformer

2) Possibly for emergency operation on power failure

Table 9.1 Functional comparison

9.6 Cost-effectiveness calculation

Along with the functional advantages, a Multi-Axis System also offers ecological and financial advantages due to the energy saving. Depending on the application, higher investment costs are quickly compensated by the reduced power consumption.

Example with three axes

	Individual AC axes	AC-AC Servo Drive as supply	Power Supply Unit
Components	3x G392-024/G395-024 3x mains choke 3x braking resistor	2x G393-024/G397-026 1x G392-060/G395-070 with - Mains choke - Braking resistor	3x G393-024/ G397-026 1x G396-050 1x MCS set
Investment costs	100 %	108%	163%
Energy saving 1)	-	5 %	10 %
Electricity price	0.1264 €/kWh 2)		
Operating time	16 hours/day, 20 days/month		
Amortisation of the additional costs after	**-**	**6 months**	**23 months**

1) Compared to individual AC axes, this value is to be determined individually for each application

2) Bundesverband der Energie-Abnehmer e.V., German electricity price comparison II/2011 for medium-sized industrial customers, average electricity price in former West German states

Table 9.2 Cost-effectiveness calculation for three axes

Example with six axes

	Individual AC axes	AC-AC Servo Drive as supply	Power Supply Unit
Components	6x G392-024/G395-024 6x mains choke 6x braking resistor	5x SG393-024/G397-026 1x G392-143/G395-170 with - Mains choke - Mains filte - Braking resistor	6x G393-024/G397-026 1x G396-110 1x MCS set
Investment costs	100 %	115%	142 %
Energy saving [1]	-	5 %	10 %
Electricity price	0.1264 €/kWh [2]		
Operating time	16 hours/day, 20 days/month		
Amortisation of the additional costs after	**-**	**11 months**	**16 months**

1) *Compared to individual AC axes, this value is to be determined individually for each application*

2) *Bundesverband der Energie-Abnehmer e.V., German electricity price comparison II/2011 for medium-sized industrial customers, average electricity price in former West German states*

Table 9.3 Cost-effectiveness calculation for six axes

9.7 Dimensioning

This section provides you with an overview on how you can design the MSD Servo Drive Multi-Axis System to suit your application. A large number of parameters need to be taken into account during the design of a Multi-Axis System. You can compile all relevant data for dimensioning your application using the instructions in this chapter.

NOTE

If you have any questions about the project planning for your machine or the commissioning of your device, our Helpline will provide you with quick, specific assistance (see chapter 1.10.).

9.7.1 Determining the drive power required per axis

To determine the drive power per rotary axis the following information is required:

- Maximum torque
- Effective torque
- Maximum speed
- Gear ratio
  - Formula for effective torque (for torque curves with constant sections):

$$M_{eff} = \sqrt{\frac{\sum M_i^2 \cdot t_i}{T}}$$

  - Formula for maximum torque:

$$M_{max} = M_{accel} + \frac{1}{i} \frac{1}{n_{gear}} M_{load}$$

$$M_{accel} = 2 \cdot \circ \frac{\tilde{n}}{\tilde{t}} (J_{Motor} + \frac{1}{i^2} J_{load})$$

To determine the drive power for linear motors, the following information is required per axis:

- Maximum thrust
- Effective thrust
- Maximum feed velocity

9.7.2 Selection of suitable gearboxes and motors

The gearbox is selected depending on the application, either to obtain the maximum dynamic performance, of the most efficient continuous operation possible.

– Formula for gear ratio (for optimal dynamic performance):

$$i = \sqrt{\frac{J_{Load}}{J_{Motor}}}$$

– Formula for gear ratio (for good utilisation during continuous operation):

$$i = \frac{n_N}{n_{Load}}$$

Motors are selected based on the following criteria:

- M_{max}
- n_{max}
- $M_{Rated} > M_{eff}$

Define the encoder system depending on the requirement in your application in relation to absolute accuracy, reproducible accuracy, robustness and determination of the machine zero point:

- Resolver
- Sin/Cos encoder, singleturn
- Sin/Cos encoder, multiturn

9.7.3 Selection of suitable DC-AC Servo Drives

After the motors have been selected, matching DC-AC Servo Drives are selected based on the following criteria:

- Maximum current
- Rated current

9.7.4 Selection of suitable Power Supply Unit

NOTE

During all the following dimensioning calculations, always pay attention to the Operation Manual MSD Power Supply Unit (ID no. CA97556-001).

To identify a suitable Power Supply Unit, a power/time diagram for a complete machine cycle must be available for all axes. Figure 9.3, p. 83 contains an example.

The power required by each individual axis at each point in time is added together to produce the power/time diagram for the Power Supply Unit. The following characteristic data for the Power Supply Unit can be derived from this diagram:

- Nominal supply power
- Maximum supply power
- Nominal regenerative power
- Maximum regenerative power

With a low simultaneity factor in the axis group, it may be possible to select the largest axis as a AC-AC Servo Drive that can take over the supply for the entire axis group. However, it is then not possible to feed power back to the supply system. Regenerative power produced must be dissipated via a braking resistor and converted into heat.

NOTE

If the supply system fails, due to the principle of operation the Power Supply Unit can no longer feed back power. For this special situation, we therefore recommend you to use a braking resistor with a power rating that should be designed for this braking process.

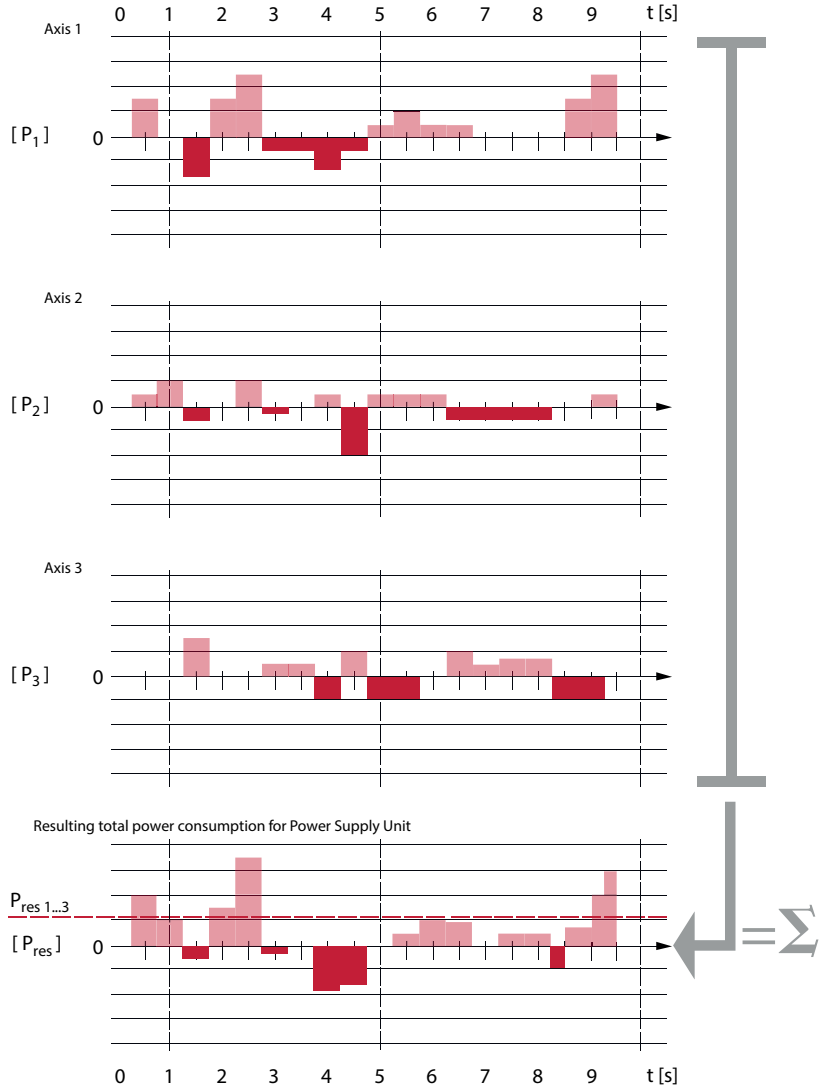


Figure 9.3 Time/power diagram with Power Supply Unit

The precharging circuit and DC link on the Power Supply Unit must not be overloaded. For this reason the total power consumption and total DC link capacitance for all Servo Drives must not exceed the limits for the Power Supply Unit. On this topic pay attention to Table 9.4 and Table 9.5:

Power Supply Unit	Power output [kW]		DC link capacitance [µF]	Maximum total DC link capacitance [µF]
	Continuous	Peak [1]		
G396-026	26	52	900	10000
G396-050	50	94		
G396-075	75	127	4240	20000
G396-110	110	160		

1) *For 10 s*

Table 9.4 Power output and capacitances for the Power Supply Units

DC-AC Servo Drive	DC link capacitance [µF]	
	Air cooling	Liquid cooling
G393-004	60	-
G393-006	60	-
G393-008	105	-
G393-012	105	-
G393-016 / G397-020	288	288
G393-020 / G397-025	288	288
G393-024 / G397-026	504	504
G393-032 / G397-035	504	504
G393-045 / G397-053	430	900
G393-060 / G397-070	900	900
G393-072 / G397-084	900	900
G393-090 / G397-110	1060	2120
G393-110 / G397-143	2120	2120
G393-143 / G397-170	3180	4240
G393-170 / G397-210	4240	4240

Table 9.5 DC link capacitances for the DC-AC Servo Drives

Example calculation: supply with Power Supply Unit

Two DC-AC Servo Drives G393-024/G397-026 , two DC-AC Servo Drives G393-060/ G397-070 and one DC-AC Servo Drive G393-090 (air cooling) are to be connected to one Power Supply Unit G396-075.

Calculation: 1 x 4240 µF + 2 x 504 µF + 2 x 900 µF + 1 x 1060 µF = 8108 µF

Result: The Power Supply Unit is adequately dimensioned with a maximum total DC link capacitance of 9200 µF.

NOTE:

Note that it is necessary to take into account not only the DC link capacitance of the DC-AC Servo Drives, but also the capacitance of the Power Supply Unit.

9.7.5 External components

On the usage of a Power Supply Unit you need additional components:

- Mains connection set (consisting of mains filter, input choke incl. capacitor, step-up choke, EMC fastening material)

On this topic see MSD Ordering Catalog (ID no.: CDL29950-en).

9.7.6 Selection of a suitable AC-AC Servo Drive as supply

With a low simultaneity factor in the axis group, it may be possible to select the largest axis as a AC-AC Servo Drive that can take over the supply for the entire axis group. To identify a suitable AC-AC Servo Drive, a power/time diagram over a complete load cycle must be available for all axes. Figure 9.4, p. 85 contains an example.

The power required by each individual axis (incl. the AC-AC Servo Drive axis) at each point in time is added together to produce the overall power/time diagram. The following characteristic data can be derived from this diagram:

- Nominal power consumption of the AC-AC Servo Drive axis
- Maximum power consumption of the AC-AC Servo Drive axis
- Nominal regenerative power
- Maximum regenerative power

However, it is then not possible to feed power back to the supply system. Regenerative power produced must be dissipated via a braking resistor and converted into heat.

NOTE:

You will find details on dimensioning the braking resistor in chap. 8.1.1, p. 71.

DC link power and total DC link capacitance of the AC-AC Servo Drive

For an initial estimation as to whether a AC-AC Servo Drive is adequate for supplying other Servo Drives, the power available from the AC-AC Servo Drive DC link can be calculated approximately using the following formulas:

$$P_{rated} = \sqrt{3} \cdot U_{Mains} \cdot I_{rated\ (f_{sw}\ and\ U_{mains})} \cdot 0.8$$

$$P_{Max} = \sqrt{3} \cdot U_{Mains} \cdot I_{Max\ (f_{sw}\ and\ U_{mains})} \cdot 0.8$$

Here $I_{Rated\ (fsw\ and\ U\_Mains)}$ is the rated current and $I_{MAX\ (fsw\ and\ U\_Mains)}$ the maximum current from the AC-AC Servo Drive corresponding to the switching frequency of the power stage and the mains voltage.

CAUTION!	**Damage to the device due to exceeding the maximum power.**
	• **The device may suffer irreparable damage.** The power figures are a root-mean-square alue over one load cycle. The maximum power is not allowed to be exceeded at any time and is only allowed to be drawn for the stated time, as otherwise the AC-AC Servo Drive will be irreparably damaged.

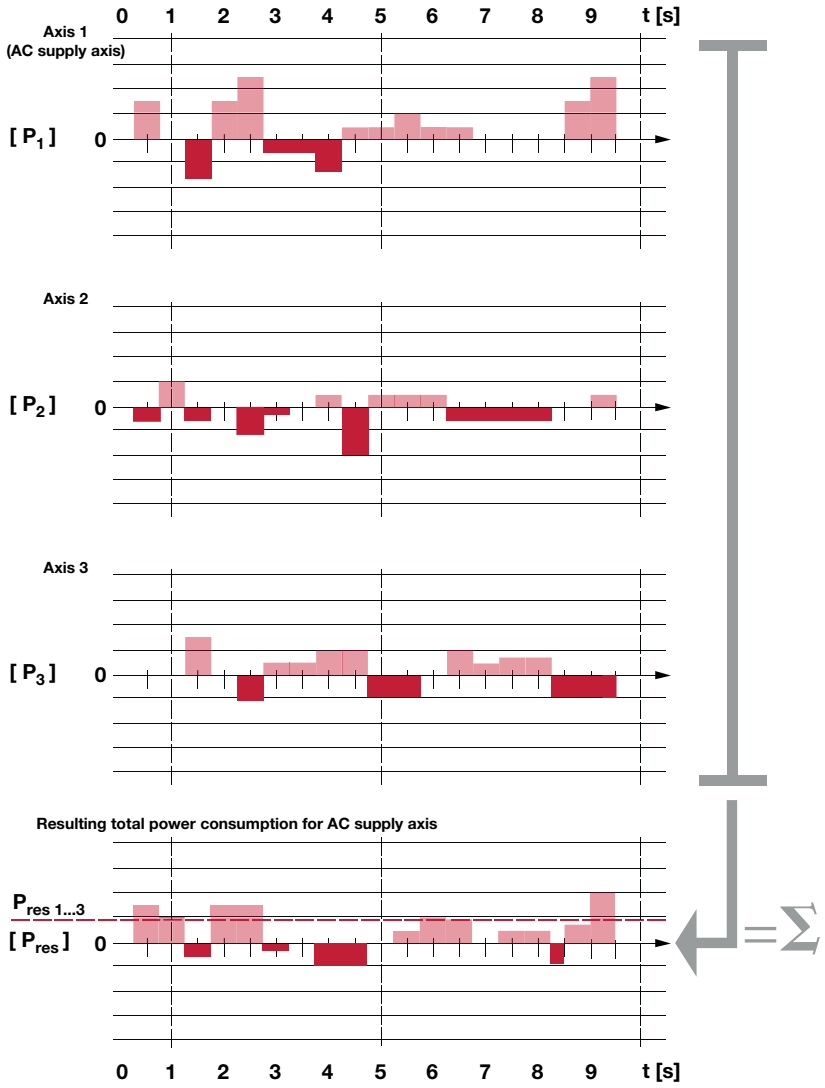


Figure 9.4 Time/power diagram with AC-AC Servo Drive as supply

Along with the total power consumption, the total DC link capacitance for the axis group must be considered. The maximum total DC link capacitance of the AC-AC Servo Drive is not allowed to be exceeded. On this topic pay attention to Table 9.6 as well as Table 9.5.

AC-AC Servo Drive	Internal DC link capacitance [µF]		Maximum total DC link capacitance [µF]	
	Air cooling	Liquid cooling	Mains voltage 400 V AC	Mains voltage 460 V AC or 480 V AC
G392-004	400	-	800	800
G392-006	400	-	800	800
G392-008	725	-	1355	1355
G392-012	725	-	1355	1355
G392-016 / G395-020	1230	1230	2460	1734
G392-020 / G395-025	1230	1230	2460	1734
G392-024 / G395-026	2000	2000	2504	2000
G392-032 / G395-035	2000	2000	2504	2000
G392-045 / G395-053	430	430	5100	5100
G392-060 / G395-070	900	900	5100	5100
G392-072 / G395-084	900	900	5100	5100
G392-090 / G395-110	1060	2120	9200	9200
G392-110 / G395-143	2120	2120	9200	9200
G392-143 / G395-170	3180	4240	9200	9200
G392-170 / G395-210	4240	4240	9200	9200
G395-250	-	3600	60000	60000
G395-325	-	5400	60000	60000
G395-450	-	7200	60000	60000

Table 9.6 DC link capacitance and maximum total DC link capacitance for the AC-AC Servo Drive

CAUTION!	**Damage to your system/machine due to uncontrolled or inappropriate commissioning.**
	**The device may suffer irreparable damage.** • Pay attention to switch-on sequence The mains voltage is only allowed to be switched on after switching on the +24 V DC supply voltage for the control electronics and conclusion of the initialisation phase. • Pay attention to power classes It is only allowed to connect DC-AC Servo Drives of lower or the same power class to a AC-AC Servo Drive. • Pay attention to maximum number of axes It is allowed to operate a maximum of six DC-AC Servo Drives on one supplying AC-AC Servo Drive. If your requirements are higher, please consult your project engineer.

Example calculation: supply from a AC-AC Servo Drive

Two DC-AC Servo Drives G393-024/G307-026, two DC-AC Servo Drives G393-060/G397-060 and one DC-AC Servo Drive G393-090 (air cooling) are to be connected to one AC-AC Servo Drive G392-170/G395-210.

Calculation: 1 x 4240 µF + 2 x 504 µF + 2 x 900 µF + 1 x 1060 µF = 8108 µF

Result: The AC-AC Servo Drive is adequately dimensioned with a maximum total DC link capacitance of 9200 µF.

NOTE:

Note that it is necessary to take into account not only the DC link capacitance of the DC-AC Servo Drives, but also the capacitance of the supplying AC-AC Servo Drive.

9.7.7 External components

On the usage of a AC-AC Servo Drive as the supply you need additional components:

- Mains filter
- Mains choke
- Braking resistor
- EMC fastening material
- Possibly ferrite toroidal cores over the motor cable

On this topic see MSD Ordering Catalog (ID no.: CDL29950-en).

10 Application example

10.1 Interlocking Power Supply Unit and DC-AC Servo Drives

The following example shows how the Power Supply Unit can be connected to the DC-AC Servo Drives used in the Multi-Axis System such that the entire Multi-Axis System is shut down in the event of a fault.

In the normal case the DC-AC Servo Drives feed power back to the mains via the Power Supply Unit in regenerative operation. On the failure of the Power Supply Unit or the mains, the energy is fed to the braking resistor. To protect against overloading the Power Supply Unit's brake chopper, the Power Supply Unit can be connected to the DC-AC Servo Drives and configured as follows. As soon as the Power Supply Unit is no longer actively regulated, the enable for the power stage (ENPO) is withdrawn from the DC-AC Servo Drives.

Step	Action	Comment
1.	Connect the Power Supply Unit to the DC-AC Servo Drives connected as shown in Figure 10.1.	
2.	Assign the output REL (X4/23,24) on the Power Supply Unit the function "Regulation in operation" (value 2, OUTPUT_FS_ACTIV).	You will find further functions in the Operation Manual MSD Power Supply Unit.

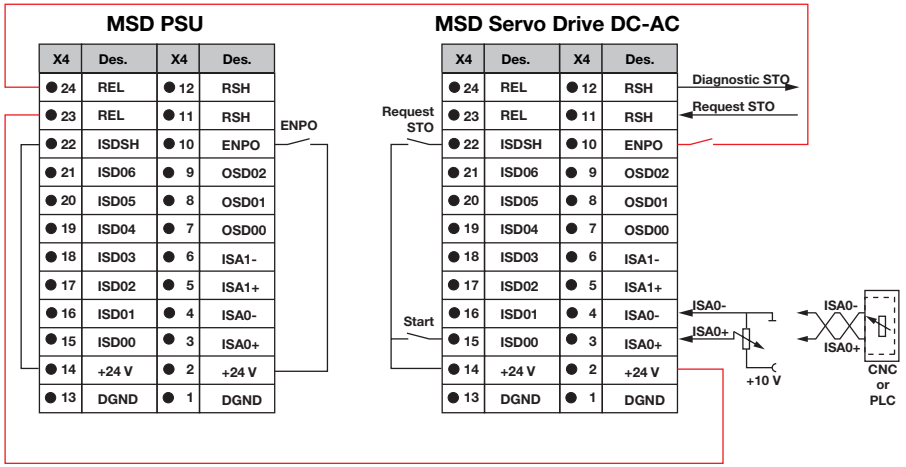


Figure 10.1 Interlocking MSD Servo Drive Multi-Axis System (example)

A.1 Current carrying capacity

The maximum permissible DC-AC Servo Drive output current and the peak current are dependent on the DC supply 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 Current carrying capacity, Size 1 to Size 4, air cooling

DC-AC Servo Drive	Switching frequency power stage [kHz]	Ambient temperature [°C (°F)]	At 565 V DC *)				At 650 V DC*) **)				At 678 V DC*)				At 770 V DC **)				For time [s]
			Rated current [A_{eff}]	Peak current [1] [A_{eff}]			Rated current [A_{eff}]	Peak current [1] [A_{eff}]			Rated current [A_{eff}]	Peak current [1] [A_{eff}]			Rated current [A_{eff}]	Peak current [1] [A_{eff}]			
				At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation	
				0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz	
G393-004 (Size 1)	4	+40 (+104)	5.3	8.4	8.4		5.3	8.4	8.4		5.3	8.4	8.4		5.1	8.1	8.1		10
	8		4.0	8.4	8.4		3.4	7.2	7.2		3.3	7.0	7.0		3.2	6.8	6.8		
	12		3.7	6.6	6.6		2.8	5.0	5.0		2.7	4.8	4.8		2.1	3.8	3.8		
	16		2.7	5.2	5.2		1.9	3.6	3.6		1.8	3.4	3.4		1.1	2.1	2.1		
G393-006 (Size 1)	4	+40 (+104)	8.0	12.7	12.7		8.0	12.7	12.7		8.0	12.7	12.7		7.6	12.1	12.1		10
	8		6.0	12.7	12.7		5.1	10.8	10.8		5.0	10.6	10.6		4.8	10.2	10.2		
	12		5.5	9.9	9.9		4.2	7.5	7.5		4.0	7.2	7.2		3.2	5.7	5.7		
	16		4.0	7.7	7.7		2.9	5.6	5.6		2.7	5.2	5.2		1.6	3.1	3.1		
G393-008 (Size 2)	4	+40 (+104)	9.3	15.9	15.9		8.5	14.6	14.6		8.5	14.6	14.6		8.0	13.7	13.7		10
	8		9.3	15.9	15.9		6.7	11.5	11.5		6.1	10.4	10.4		5.9	10.1	10.1		
	12		6.7	9.4	9.4		5.6	7.9	7.9		5.4	7.6	7.6		5.3	7.4	7.4		
	16		5.5	7.7	7.7		4.1	5.8	5.8		3.9	5.5	5.5		3.7	5.2	5.2		

1) At maximum 70% initial load

2) Shutdown as per I^2t characteristic

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

**) On supply by AC-AC Servo Drive, Single-Axis System*

***) On supply by an active Power Supply Unit*

Table A.1 Rated and peak current, G393-004 to G393-032 (air cooling)

DC-AC Servo Drive	Switching frequency power stage [kHz]	Ambient temperature [°C (°F)]	At 565 V DC *)				At 650 V DC*) **)				At 678 V DC*)				At 770 V DC **)				For time [s]
			Rated current [A_{eff}]	Peak current [1] [A_{eff}]			Rated current [A_{eff}]	Peak current [1] [A_{eff}]			Rated current [A_{eff}]	Peak current [1] [A_{eff}]			Rated current [A_{eff}]	Peak current [1] [A_{eff}]			
				At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation	
				0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz	
G393-012 (Size 2)	4	+40 (+104)	14.0	24.0	24.0		11.8	20.2	20.2		11.4	19.5	19.5		11.2	19.2	19.2		10
	8		14.0	24.0	24.0		10.0	17.1	17.1		9.2	15.8	15.8		8.8	15.1	15.1		
	12		10.0	14.1	14.1		8.4	11.8	11.8		8.1	11.4	11.4		7.9	11.1	11.1		
	16		8.2	11.5	11.5		6.2	8.7	8.7		5.8	8.2	8.2		5.5	7.7	7.7		
G393-016 (Size 3)	4	+40 (+104)	20.0	33.6	33.6		20.0	33.6	33.6		20.0	33.6	33.6		20.0	33.6	33.6		10
	8		16.0	33.6	33.6		13.9	29.1	29.1		13.3	27.9	27.9		11.2	23.5	23.5		
	12		11.0	23.6	23.6		8.8	18.9	18.9		8.5	18.3	18.3		7.0	15.0	15.0		
	16		8.5	19.4	19.4		6.5	14.8	14.8		6.0	13.7	13.7		4.5	10.2	10.2		
G393-020 (Size 3)	4	+40 (+104)	25.0	42.0	42.0		25.0	42.0	42.0		25.0	42.0	42.0		25.0	42.0	42.0		10
	8		20.0	42.0	42.0		17.4	36.5	36.5		16.6	34.8	34.8		14.0	29.4	29.4		
	12		13.8	29.6	29.6		11.0	23.6	23.6		10.0	21.5	21.5		7.5	16.1	16.1		
	16		10.0	22.8	22.8		7.4	16.8	16.8		6.5	14.8	14.8		5.0	11.4	11.4		
G393-024 (Size 4)	4	+40 (+104)	30.0	48.0	48.0		26.0	41.6	41.6		26.0	41.6	41.6		26.0	41.6	41.6		10
	8		24.0	48.0	48.0		21.0	42.0	42.0		20.0	40.0	40.0		18.9	37.8	37.8		
	12		15.8	31.6	31.6		12.4	24.8	24.8		11.3	22.6	22.6		10.5	21.0	21.0		
	16		11.3	22.6	22.6		8.9	17.8	17.8		8.4	16.8	16.8		7.9	15.8	15.8		
G393-032 (Size 4)	4	+40 (+104)	40.0	64.0	64.0		33.7	53.9	53.9		32.5	52.0	52.0		32.0	51.2	51.2		10
	8		32.0	64.0	64.0		28.0	56.0	56.0		26.7	53.4	53.4		25.2	50.4	50.4		
	12		21.0	42.0	42.0		16.5	33.0	33.0		15.0	30.0	30.0		14.0	28.0	28.0		
	16		15.0	30.0	30.0		11.9	23.8	23.8		11.2	22.4	22.4		10.5	21.0	21.0		

1) At maximum 70% initial load

2) Shutdown as per I^2t characteristic

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

**) On supply by AC-AC Servo Drive, Single-Axis System*

***) On supply by an active Power Supply Unit*

Table A.1 Rated and peak current, G393-004 to G393-032 (air cooling)

A.1.2 Current carrying capacity, Size 5 to Size 6A, air cooling

DC-AC Servo Drive	Switching frequency power stage [kHz]	Ambient temperature [°C (°F)]	At 565 V DC *)				At 650 V DC *) **)				At 678 V DC *)				At 770 V DC **)				Overload factor [%]	For time 2) [s]
			Rated current [A_{eff}]	Peak current [A_{eff}] 1)			Rated current [A_{eff}]	Peak current [A_{eff}] 1)			Rated current [A_{eff}]	Peak current [A_{eff}] 1)			Rated current [A_{eff}]	Peak current [A_{eff}] 1)				
				At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation		
				0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz		
G393-045 (Size 5)	4	+40 (+104)	45	90	90		42	84	84		41	82	82		41	82	82		200	10
	8		45	90	90		42	84	84		41	82	82		41	82	82			
	12		45	90	90		42	84	84		41	82	82		37	74	74			
	16		42	84	84		39	78	78		38	76	76		34	64	68			
G393-060 (Size 5)	4	+40 (+104)	60	120	120		56	111	111		54	108	108		54	108	108		200	10
	8		60	120	120		56	111	111		54	108	108		54	108	108			
	12		58	116	116		54	108	108		52	104	104		48	96	96			
	16		42	84	84		39	78	78		38	76	76		34	68	68			
G393-072 (Size 5)	4	+40 (+104)	72	144	144		67	133	133		65	130	130		65	130	130		200	10
	8		72	144	144		67	133	133		65	130	130		65	130	130			
	12		58	116	116		54	108	108		52	104	104		48	96	96			
	16		42	84	84		39	78	78		38	76	76		34	68	68			

1) At maximum 70% initial load

2) Shutdown as per I^2t characteristic

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

**) On supply by AC-AC Servo Drive, Single-Axis System*

***) On supply by an active Power Supply Unit*

Table A.2 Rated and peak current, G393-045 to G393-170 (air cooling)

DC-AC Servo Drive	Switching frequency power stage [kHz]	Ambient temperature [°C (°F)]	At 565 V DC *)				At 650 V DC *) **)				At 678 V DC *)				At 770 V DC **)				Overload factor [%]	For time 2) [s]
			Rated current [A_{eff}]	Peak current [A_{eff}] 1)			Rated current [A_{eff}]	Peak current [A_{eff}] 1)			Rated current [A_{eff}]	Peak current [A_{eff}] 1)			Rated current [A_{eff}]	Peak current [A_{eff}] 1)				
				At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation		
				0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz		
G393-090 (Size 6A)	4	+40 (+104)	90	170	180		83	157	166		81	153	162		73	138	146		200	30
	8		90	134	180		83	124	166		81	121	162		73	109	146			
	12		90	107	144		83	99	133		81	96	130		73	86	117		160	
	16		72	86	115		67	80	107		65	77	104		59	70	94			
G393-110 (Size 6A)	4	+40 (+104)	110	170	220		102	157	204		99	153	198		90	134	180		200	30
	8		110	134	165		102	125	153		99	121	149		90	109	135		150	
	12		90	107	144		83	99	133		81	96	130		73	86	117		160	
	16		72	86	115		67	80	107		65	77	104		59	70	94		160	
G393-143 (Size 6A)	4	+40 (+104)	143	191	286		132	176	264		129	171	258		116	154	232		200	30
	8		143	152	215		132	140	198		129	137	194		116	122	174		150	
	12		115	122	172		106	112	159		104	109	156		94	98	141		150	
	16		92	98	138		85	91	128		83	87	125		75	78	138		150	
G393-170 (Size 6A)	4	+40 (+104)	170	191	315		157	176	291		153	171	283		138	154	255		185	10
	8		170	152	221		157	140	204		153	137	199		138	122	179		130	
	12		136	122	163		126	112	151		122	109	146		110	98	132		120	
	16		109	98	131		101	91	121		98	87	118		88	78	106		120	

1) At maximum 70% initial load

2) Shutdown as per I^2t characteristic

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

**) On supply by AC-AC Servo Drive, Single-Axis System*

***) On supply by an active Power Supply Unit*

Table A.2 Rated and peak current, G393-045 to G393-170 (air cooling)

A.1.3 Current carrying capacity, Size 3 to Size 4, liquid cooling

DC-AC Servo Drive	Switching frequency power stage [kHz]	Ambient temperature [°C (°F)]	At 565 V DC *)				At 650 V DC *) **)				At 678 V DC *)				At 770 V DC **)				For time[2] [s]
			Rated current [A_{eff}]	Peak current [A_{eff}] [1]			Rated current [A_{eff}]	Peak current [A_{eff}] [1]			Rated current [A_{eff}]	Peak current [A_{eff}] [1]			Rated current [A_{eff}]	Peak current [A_{eff}] [1]			
				At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation	
				0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz	
G397-020 (Size 3)	4	+40 (+104)	20.0	33.6	33.6		20.0	33.6	33.6		20.0	33.6	33.6		20.0	33.6	33.6		10
	8		20.0	33.6	33.6		17.4	29.2	29.2		16.6	27.9	27.9		15.8	26.5	26.5		
	12		17.4	26.4	26.4		12.5	19.0	19.0		11.4	17.3	17.3		10.7	16.2	16.2		
	16		12.0	18.2	18.2		9.1	13.8	13.8		8.5	12.9	12.9		8.1	12.3	12.3		
G397-025 (Size 3)	4	+40 (+104)	25.0	42.0	42.0		25.0	42.0	42.0		25.0	42.0	42.0		25.0	42.0	42.0		10
	8		25.0	42.0	42.0		21.8	36.6	36.6		20.8	34.9	34.9		19.8	33.2	33.2		
	12		21.8	33.1	33.1		15.6	23.7	23.7		14.3	21.7	21.7		13.4	20.3	20.3		
	16		15.0	22.8	22.8		11.4	17.3	17.3		10.6	16.1	16.1		10.1	15.3	15.3		
G397-026 (Size 4)	4	+40 (+104)	30.0	48.1	48.1		26.0	41.6	41.6		26.0	41.6	41.6		26.0	41.6	41.6		10
	8		26.3	48.1	48.1		23.0	42.0	42.0		21.9	40.0	40.0		20.7	37.8	37.8		
	12		22.5	31.5	311.5		17.7	24.8	24.8		16.1	22.5	22.5		15.4	21.5	21.5		
	16		16.1	22.5	22.5		12.8	17.9	17.9		12.0	16.8	16.8		11.3	15.8	15.8		
G397-035 (Size 4)	4	+40 (+104)	40.0	64.0	64.0		33.7	53.9	53.9		32.5	52.0	52.0		32.0	51.2	51.2		10
	8		35.0	64.0	64.0		30.6	55.9	55.9		29.2	53.4	53.4		27.6	50.5	50.5		
	12		30.0	42.0	42.0		23.6	33.0	33.0		21.4	30.0	30.0		20.5	28.7	28.7		
	16		21.4	29.9	30.0		17.0	23.8	23.8		16.0	22.4	22.4		15.0	21.0	21.0		

1) At maximum 70% initial load

2) Shutdown as per I^2t characteristic

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

**) On supply by AC-AC serco drive, Single-Axis System*

***) On supply by an active Power Supply Unit*

Table A.3 Rated and peak current, G397-020 to G397-035 (liquid cooling)

A.1.4 Current carrying capacity, Size 5 to Size 6A, Size 7, liquid cooling

DC-AC Servo Drive	Switching frequency power stage [kHz]	Ambient temperature [°C (°F)]	At 565 V DC *)				At 650 V DC *) **)				At 678 V DC *)				At 770 V DC **)				Overload factor [%]	For time[2] [s]
			Rated current [A_{eff}]	Peak current [A_{eff}] [1]			Rated current [A_{eff}]	Peak current [A_{eff}] [1]			Rated current [A_{eff}]	Peak current [A_{eff}] [1]			Rated current [A_{eff}]	Peak current [A_{eff}] [1]				
				At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation		
				0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz		
G397-053 (Size 5)	4	+40 (+104)	53	90	90		49	83	83		48	82	82		48	82	82		170	30
	8		53	90	90		49	83	83		48	82	82		48	82	82			
	12		53	90	90		49	83	83		48	82	82		42	80	72			
	16		49	84	84		45	77	77		44	75	75		39	64	66			
G397-070 (Size 5)	4	+40 (+104)	70	120	120		65	111	111		63	107	107		63	107	107		170	30
	8		70	120	120		65	111	111		63	107	107		63	107	107			
	12		68	116	116		63	107	107		61	104	104		55	94	94			
	16		49	84	84		45	77	77		44	75	75		39	66	66			
G397-084 (Size 5)	4	+40 (+104)	84	144	144		78	133	133		76	130	130		76	130	130		170	30
	8		84	144	144		78	133	133		76	130	130		76	130	130			
	12		68	116	116		63	107	107		61	104	104		55	94	94			
	16		49	84	84		45	77	77		44	75	75		39	66	66			

1) At maximum 70% initial load

2) Shutdown as per I^2t characteristic

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

**) On supply by AC-AC Servo Drive, Single-Axis System*

***) On supply by an active Power Supply Unit*

Table A.4 Rated and peak current, G397-053 to G397-450 (liquid cooling)

DC-AC Servo Drive	Switching frequency power stage [kHz]	Ambient temperature [°C (°F)]	At 565 V DC *)			At 650 V DC *) **)			At 678 V DC *)			At 770 V DC **)			Overload factor [%]	For time[2] [s]
			Rated current [A_{eff}]	Peak current [A_{eff}] [1]		Rated current [A_{eff}]	Peak current [A_{eff}] [1]		Rated current [A_{eff}]	Peak current [A_{eff}] [1]		Rated current [A_{eff}]	Peak current [A_{eff}] [1]			
				At rotating field frequency increasing linearly	Intermittent operation		At rotating field frequency increasing linearly	Intermittent operation		At rotating field frequency increasing linearly	Intermittent operation		At rotating field frequency increasing linearly	Intermittent operation		
				0 Hz	Up to 5 Hz > 5 Hz		0 Hz	Up to 5 Hz > 5 Hz		0 Hz	Up to 5 Hz > 5 Hz		0 Hz	Up to 5 Hz > 5 Hz		
G397-110 (Size 6A)	4	+40 (+104)	110	205	220	102	190	204	99	185	198	90	167	180	200	30
	8		110	166	187	102	153	173	99	149	168	90	134	153	170	
	12		110	132	165	102	122	153	99	119	149	90	107	135	150	
	16		90	106	135	83	98	125	81	95	122	73	86	110	150	
G397-143 (Size 6A)	4	+40 (+104)	143	231	286	132	214	264	129	207	258	116	186	232	200	30
	8		143	191	215	132	176	198	129	171	194	116	154	174	150	
	12		114	153	171	105	141	158	103	137	155	93	123	140	150	
	16		91	122	137	84	113	126	82	110	123	74	99	111	150	
G397-170 (Size 6A)	4	+40 (+104)	170	231	340	157	214	314	153	207	306	138	186	276	200	10
	8		170	191	255	157	176	236	153	171	230	138	154	207	150	
	12		136	153	204	126	141	189	122	137	183	110	123	165	150	
	16		109	122	164	101	113	152	98	110	147	88	99	132	150	
G397-210 (Size 6A)	4	+40 (+104)	210	231	336	194	214	310	189	207	302	170	185	272	160	10
	8		210	191	252	194	176	233	189	171	227	170	154	204	120	
	12		168	153	202	155	141	186	151	137	181	136	123	163	120	
	16		134	122	161	124	113	149	121	110	145	109	99	131	120	

1) At maximum 70% initial load

2) Shutdown as per I^2t characteristic

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

**) On supply by AC-AC Servo Drive, Single-Axis System*

***) On supply by an active Power Supply Unit*

Table A.4 Rated and peak current, G397-053 to G397-450 (liquid cooling)

DC-AC Servo Drive	Switching frequency power stage [kHz]	Ambient temperature [°C (°F)]	At 565 V DC *)				At 650 V DC *) **)				At 678 V DC *)				At 770 V DC **)				Overload factor [%]	For time[2] [s]
			Rated current [A_{eff}]	Peak current [A_{eff}] [1]			Rated current [A_{eff}]	Peak current [A_{eff}] [1]			Rated current [A_{eff}]	Peak current [A_{eff}] [1]			Rated current [A_{eff}]	Peak current [A_{eff}] [1]				
				At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation		At rotating field frequency increasing linearly		Intermittent operation		
				0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz		0 Hz	Up to 5 Hz	> 5 Hz		
G397-250 (Size 7)	2	+45 (+113)	250	425			231	393			225	383			210	357			170	30
	4			375				347				337				315			150	
G393-325 (Size 7)	2	+45 (+113)	325	552			301	511			293	497			273	464			170	30
	4			487				451				439				410			150	
G397-450 (Size 7)	2	+45 (+113)	450	765			416	707			405	689			378	643			170	30
	4			675				624				607				567			150	

1) At maximum 70% initial load

2) Shutdown as per I^2t characteristic

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

**) On supply by AC-AC Servo Drive, Single-Axis System*

***) On supply by an active Power Supply Unit*

Table A.4 Rated and peak current, G397-053 to G397-450 (liquid cooling)

NOTE:

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

A.2 Technical data

A.2.1 G393-004 to G393-020 / G397-020 to G397-025

Size		Size 1		Size 2		Size 3	
Device		G393-004	G393-006	G393-008	G393-012	G393-016/ G397-020	G393-020/ G397-025
Output, motor side [1]							
Voltage		3-phase $U_{ZK}/\sqrt{2}$					
Rated current, effective (I_N)	Air cooling	4 A	6 A	9.3 A	14 A	16 A	20 A
	Liquid cooling	-	-	-	-	20 A	25 A
Peak current	Air cooling	See Table A.1					
	Liquid cooling	-	-	-	-	See Table A.3	
Rotating field frequenc		0 to 400 Hz					
Switching frequency of the power stage		4, 8, 12, 16 kHz					
DC input							
DC voltage (U_{ZK}) nominal [2]		565 V_{DC} / 650 V_{DC} / 678 V_{DC} / 770 V_{DC}					
Current [3] [1]		$1.1 \cdot I_{Motor}$					
Internal DC fuse		25 A		50 A		63 A	
Device connected load [1] [3]		$U_{ZK} \cdot 1.1 \cdot I_{Motor}$					
Power dissipation at I_N and 8 kHz/ 565 V DC [3]	Air cooling	110 W	140 W	185 W	255 W	320 W	390 W
	Liquid cooling	-	-	-	-	390 W	480 W
DC link							
Capacitance		60 µF		105 µF		288 µF	

1) *Data referred to DC input voltage of 565 V DC and switching frequency 8 kHz*

2) *Generated from rectified TN system with earthed star point and phase conductor voltages 3 x 400 V AC, 3 x 460 V AC or 3 x 480 V AC using the approved devices from Moog (MSD Servo Drive AC-AC or MSD Power Supply Unit). Insulation voltage as per IEC/EN 61800-5-1, system voltage 277 V, overvoltage category III.*

3) *Approximate values*

Table A.5 Technical data, G393-004 to G393-020 / G397-020 to G397-025

A.2.2 G393-024 to G393-072 / G397-026 to G397-084

Size		Size 4		Size 5		
Device		G393-024/ G397-026	G393-032/ G397-035	G393-045/ G397-053	G393-060/ G397-070	G393-072/ G397-084
Output motor side [1]						
Voltage		3-phase $U_{ZK}/\sqrt{2}$				
Rated current, effective (I_N)	Air cooling	24 A	32 A	45 A	60 A	72 A
	Liquid cooling	26.3 A	35 A	53 A	70 A	84 A
Peak current	Air cooling	See Table A.1		See Table A.2		
	Liquid cooling	See Table A.3		See Table A.4		
Rotating field frequenc		0 to 400 Hz				
Switching frequency of the power stage		4, 8, 12, 16 kHz				
DC input						
DC voltage (U_{ZK}) nominal [2]		565 V_{DC} / 650 V_{DC} / 678 V_{DC} / 770 V_{DC}				
Current [1] [3]		$1.1 \cdot I_{Motor}$				
DC fuse (internal)		100 A		200 A		
Device connected load [3]		$U_{ZK} \cdot 1.1 \cdot I_{Motor}$				
Power dissipation at I_N and 8 kHz [1] [3]	Air cooling	420 W	545 W	610 W	830 W	1010 W
	Liquid cooling	455 W	595 W	690 W	930 W	1130 W
DC link						
Capacitance	Air cooling	504 µF		430 µF	900 µF	
	Liquid cooling			900 µF		

1) *Data referred to DC input voltage of 565 V DC and switching frequency 8 kHz*

2) *Generated from rectified TN system with earthed star point and phase conductor voltages 3 x 400 V AC, 3 x 460 V AC or 3 x 480 V AC using the approved devices from Moog (MSD Servo Drive AC-AC or MSD Power Supply Unit). Insulation voltage as per IEC/EN 61800-5-1, system voltage 277 V, overvoltage category III.*

3) *Approximate values*

Table A.6 Technical data, G393-024 to G393-072 / G397-026 to G397-084

A.2.3 G393-090 to G393-170 / G397-110 to G397-210

Size		Size 6A			
Device		G393-090/ G397-110	G393-110/ G397-143	G393-143/ G397-170	G393-170/ G397-210
Output motor side [1]					
Voltage		3-phase $U_{ZK}/\sqrt{2}$			
Rated current, effective (I_N)	Air cooling	90 A	110 A	143 A	170 A
	Liquid cooling	110 A	143 A	170 A	210 A
Peak current	Air cooling	See A.2			
	Liquid cooling	See A.4			
Rotating field frequenc		0 to 400 Hz			
Switching frequency of the power stage		4, 8, 12, 16 kHz			
DC input					
DC voltage (U_{ZK}) nominal [2]		565 V_{DC} / 650 V_{DC} / 678 V_{DC} / 770 V_{DC}			
Current [1] [3]		$1.1 \cdot I_{Motor}$			185 A [4]
DC fuse (internal)		300 A		400 A	
Device connected load [3]		$U_{ZK} \cdot 1.1 \cdot I_{Motor}$			104 kW [4]
Power dissipation at I_N and 8 kHz [1] [3]	Air cooling	1300 W	1600 W	2100 W	2500 W
	Liquid cooling	1500 W	1940 W	2380 W	2650 W
DC link					
Capacitance	Air cooling	1060 µF	2120 µF	3180 µF	4240 µF
	Liquid cooling	2120 µF	3180 µF	4240 µF	

1) *Data referred to DC input voltage of 565 V DC and switching frequency 8 kHz*

2) *Generated from rectified TN system with earthed star point and phase conductor voltages 3 x 400 V AC, 3 x 460 V AC or 3 x 480 V AC using the approved devices from Moog (MSD Servo Drive AC-AC or MSD Power Supply Unit). Insulation voltage as per IEC/EN 61800-5-1, system voltage 277 V, overvoltage category III.*

3) *Approximate values*

4) *Permissible maximum input power (with liquid cooling)*

Table A.7 Technical data, G393-090 to G393-170 / G397-0110 to G397-210

A.2.4 G397-250 to G397-450

Size	Size 7		
Device	G397-250	G397-325	G397-450
Output, motor side			
Voltage	3-phase $U_{ZK}/\sqrt{2}$		
Rated current, effective (I_{Motor}) [1]	250 A	325 A	450 A
Peak current	See Table A.4		
Rotating field frequenc	0 to 400 Hz		
Switching frequency of the power stage	2 kHz, 4 kHz		
DC input			
DC voltage (U_{ZK}) nominal [2]	565 V_{DC} / 650 V_{DC} / 678 V_{DC} / 770 V_{DC}		
Current [3] [1]	$1.1 \cdot I_{Motor}$		
Device connected load [3] [1]	$U_{ZK} \cdot 1.1 \cdot I_{Motor}$		
Power dissipation at I_N and 4 kHz/ 565 V_{DC}	3200 W	3800 W	5400 W
DC link			
Capacitance	3600 µF	5400 µF	7200 µF

1) *Data referred to DC input voltage of 565 V DC and switching frequency 8 kHz*

2) *Generated from rectified TN system with earthed star point and phase conductor voltages 3 x 400 V AC, 3 x 460 V AC or 3 x 480 V AC using the approved devices from Moog (MSD Servo Drive AC-AC or MSD Power Supply Unit). Insulation voltage as per IEC/EN 61800-5-1, system voltage 277 V, overvoltage category III.*

3) *Approximate values*

Table A.8 Technical data, G397-250 to G397-450 (liquid cooling)

A.3 Power connections

Size / Device		Size 1 G393-004 G393-006	Size 2 G393-008 G393-012	Size 3 G393-016/G397-020 G303-020/G397-025	Size 4 G393-024/G397-026 G393-032/G397-035	Size 5 G393-045/G397-053 G393-060/G397-070 G303-072/G307-084
X11/ L+, L-	Screw size	M5 Use the connection cables supplied.				
	Tightening torque	2.5 to 4.5 Nm (22 to 39.8 lb-in)				
X11/PE	Screw size	M5 Only use the connection cables supplied.				
	Tightening torque	2.5 to 4.5 Nm (22 to 39.8 lb-in)				
X12/ U, V, W, PE	Cable cross-section [1]	0.25 to 4 mm² (0.0004 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)
	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)

1) Flexible cable with ferrule

The protective earth conductor cross-section depends on the cross-section of the phase conductor. See chap. 4.4, p. 38.

The minimum cross-section of the connection cables depends on the local regulations, conditions as well as on the rated current of the Power Supply Unit.

Table A.9 Terminals, Size 1 to Size 5

Size / Device		Size 6A G393-090/G397-110 G393-110/G397-143	Size 6A G393-143/G397-170 G393-170/G397-210
X11/ ZK+,ZK-	Cable cross-section [1]	Make up your own suitable DC link connection cables 35 to 95 mm² (0.054 to 0.15 in²) (AWG 2 to AWG 3/0) [1]	
	Tightening torque	25 to 30 Nm (221 to 265 lb-in)	
X11/PE	Screw size for ring cable lug	M8	
	Tightening torque	2.5 to 4.5 Nm (22 to 39.8 lb-in)	
X12/ U, V, W, PE	Cable cross-section [2]	35 to 95 mm² (0.054 to 0.15 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	15 to 20 Nm (132.7 to 177 lb-in)	25 to 30 Nm (221 to 265 lb-in)

1) Flexible cable with/without ferrule

2) Flexible cable with ferrule

The protective earth conductor cross-section depends on the cross-section of the phase conductor. See chap. 4.4, p. 38.

The minimum cross-section of the connection cables depends on the local regulations, conditions as well as on the rated current of the Power Supply Unit.

Table A.10 Terminals, Size 6A

Size / Device		Size 7 G397-250 G397-325 G397-450
X11/ ZK+, ZK-	Screw size for ring cable lug	M12
	Tightening torque	25 to 30 Nm (221 to 265 lb-in)
X11/PE [1]	Screw size for ring cable lug	M10
	Tightening torque	20 to 25 Nm (177 to 221 lb-in)
X12/ L1, L2, L3	Screw size for ring cable lug	M12
	Tightening torque	25 to 30 Nm (221 to 265 lb-in)
X12/PE [1]	Screw size for ring cable lug	M12
	Tightening torque	25 to 30 Nm (221 to 265 lb-in)
X12/ RB+, RB-	Screw size for ring cable lug	M10
	Tightening torque	20 to 25 Nm (177 to 221 lb-in)

1) *The protective earth conductor cross-section depends on the cross-section of the phase conductor. See chap. 4.4, p. 38.*
The minimum cross-section of the connection cables depends on the local regulations, conditions as well as on the rated current of the Power Supply Unit.

Table A.11 Busbar connections, Size 7

A.4 Current required for the control supply

Size / Device	Size 1 G393-004 G393-006	Size 2 G393-008 G393-012	Size 3 G393-016 G393-020	Size 4 G393-024 G393-032	Size 5 G393-045 G393-060 G393-072	Size 6A G393-090 G393-110 G393-143 G393-170	Size 7 G397-250 G397-325 G397-450
Wall mounting							
Maximum starting current	6 A				7 A	10 A	-
Rated current	2 A				2.5 A	8 A	-
Liquid cooling							
Maximum starting current	-		6 A		7 A	8 A	4 A
Rated current	-		2 A		2 A	2 A	2 A

Table A.12 Current required for the control supply

A.5 Pre-assembled DC link connections

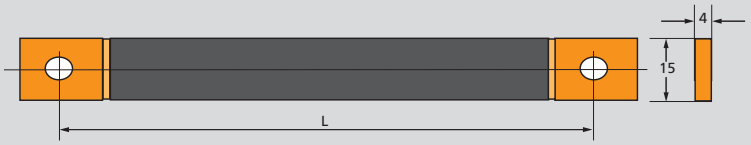
Type	L	Cross-section	Model	Connection
DC link Size 1	61.5 mm (2.42 in)	20 mm² (0.31 in²)	Flat copper braid covered with double heatshrink sleeve	Flat lug with hole Ø 5.5 mm (0.22 in) on both ends
DC link Size 2	93 mm (3.66 in)			
DC link Size 3	133 mm (5.24 in)			
DC link Size 4	174 mm (6.85 in)			
DC link Size 5	193 mm (7.6 in)			
Sketch				

Table A.13 Technical data, pre-assembled connection cables

NOTE

Requirements for longer cables

- Only the pre-assembled cables supplied are to be used for the electrical DC coupling of the devices Size 1 to Size 5.
- If extension of the cables is unavoidable (e.g. to bridge a switch cabinet panel or for a second group of DC-AC Servo Drives), the DC link must be connected as follows:
  - Cable cross-section >30 mm² (0.047 in²) (copper)
  - A PE conductor of the same cross-section is to be laid alongside and connected to the PE terminals on the two devices connected.
  - The three conductors (DC+, DC-, PE) are to be bundled and shielded.
  - A length of 2 m (6.56 ft) is not allowed to be exceeded.
  - Per Multi-Axis System there is only allowed to be one extension.
  - If the cross-section is reduced or the type of laying changes, further protection in addition to the cable protection is necessary.

A.5.1 DC coupling, Power Supply Unit and DC-AC Servo Drive

Power Supply Unit \ DC-AC Servo Drive			Size 1 G393-004 G393-006	Size 2 G393-008 G393-012	Size 3 G393-016/G397-020 G393-020/G397-025	Size 4 G393-024/G397-026 G393-032/G397-035	Size 5 G393-045/G397-053 G393-060/G397-070 G393-072/G397-084	Size 6A G393-090/G397-110 G393-110/G397-143 G393-143/G397-170 G393-170/G397-210	Size 7 G397-250 G397-325 G397-450
Size 5	G396-026 G396-050	Cable	Use the pre-assembled connection cables supplied.					-	-
		Tightening torque	2.5 to 4.5 Nm (22 to 39.8 lb-in)					-	-
Size 6A	G396-075 G396-110	Cable	Make up your own suitable DC link connection cables.					95 mm² (0.15 in²) (AWG 4/0)	-
		Tightening torque	2.5 to 4.5 Nm (22 to 39.8 lb-in)					See Table A.12	-
Size 7	G396-250 G396-360	Minimum cable cross-section	6 mm² (0.009 in²) (AWG 9), maximum 1 m (3.28 ft)		16 mm² (0.025 in²) (AWG 5), maximum 1 m (3.28 ft)		35 mm² (0.054 in²) (AWG 2)	95 mm² (0.15 in²) (AWG 4/0)	2x95 mm² (0.15 in²) 3) (AWG 4/0)
			Ring cable lug 1, 2) with hole Ø 5.3 mm (0.21 in).						
		Tightening torque	2.5 to 4.5 Nm (22 to 39.8 lb-in) 1)					See Table A.12	See Table A.13

1) *On the DC-AC Servo Drive*

2) *On ring cable lugs with insulation, the crimped area and minimum 20 mm (0.79 in) of the cable insulation are to be insulated continuously using heatshrink sleeve.*

3) *Referred to DC voltage (U_{ZK}) 565 V_{DC}*

Table A.14 DC coupling, Power Supply Unit and DC-AC Servo Drive: cables, cable cross-section and tightening torques

A.5.2 DC coupling, DC-AC Servo Drive and DC-AC Servo Drive

DC-AC Servo Drive			Size 1	Size 2	Size 3	Size 4	Size 5	Size 6A	Size 7
			G393-004 G393-006	G393-008 G393-012	G393-016/G397-020 G393-020/G397-025	G393-024/G397-026 G393-032/G397-035	G393-045/G397-053 G393-060/G397-070 G393-072/G397-084	G393-090/G397-110 G393-110/G397-143 G393-143/G397-170 G393-170/G397-210	G397-250 G397-325 G397-450
Size 1	G393-004 G393-006	Cable	Use the pre-assembled connection cables supplied.					-	-
		Tightening torque	2.5 to 4.5 Nm (22 to 39.8 lb-in)					-	-
Size 2	G393-008 G393-012	Cable	Use the pre-assembled connection cables supplied.					-	-
		Tightening torque	2.5 to 4.5 Nm (22 to 39.8 lb-in)					-	-
Size 3	G393-016/ G397-020 G393-020/ G397-025	Cable	Use the pre-assembled connection cables supplied.					-	-
		Tightening torque	2.5 to 4.5 Nm (22 to 39.8 lb-in)					-	-
Size 4	G393-024/ G397-026 G393-032/ G397-035	Cable	Use the pre-assembled connection cables supplied.					-	-
		Tightening torque	2.5 to 4.5 Nm (22 to 39.8 lb-in)					-	-
Size 5	G393-045.1 G393-060.1 G393-072.1	Cable	Only use the pre-assembled connection cables supplied.					-	-
		Tightening torque	2.5 to 4.5 Nm (22 to 39.8 lb-in)					-	-
Size 6A	G393-090.1 G393-110.1 G393-143.1 G393-170.1	Cable	Ring cable lug [1, 2] with hole Ø 5.3 mm. (0.21 in)					95 mm² (0.15 in²) (AWG 4/0)	-
		Tightening torque	2.5 to 4.5 Nm (22 to 39.8 lb-in)					See Table A.12	-
Size 7	G397-250 G393-325.1 G397-450	Minimum cable cross-section	6 mm² (0.009 in²) (AWG 9), maximum 1 m (3.28 ft)		16 mm² (0.025 in²) (AWG 5), maximum 1 m (3.28 ft)		35 mm² (0.054 in²) (AWG 2)	95 mm² (0.15 in²) (AWG 4/0)	2x95 mm² (0.15 in²) [3] (AWG 4/0)
			Ring cable lug [1, 2] with hole Ø 5.3 mm. (0.21 in)						
		Tightening torque	2.5 to 4.5 Nm (22 to 39.8 lb-in) [1]					See Table A.12	See Table A.13

1) *On the DC-AC Servo Drive*

2) *On ring cable lugs with insulation, the crimped area and minimum 20 mm (0.79 in) of the cable insulation are to be insulated continuously using heatshrink sleeve.*

3) *Referred to DC voltage (U_{ZK}) 565 V_{DC}*

Table A.15 DC coupling, DC-AC Servo Drive and DC-AC Servo Drive: cables, cable cross-section and tightening torques

A.5.3 DC coupling, AC-AC Servo Drive and DC-AC Servo Drive

AC-AC servo drive \ DC-AC Servo Drive			Size 1 G393-004 G393-006	Size 2 G393-008 G393-012	Size 3 G393-016/G397-020 G393-020/G397-025	Size 4 G393-024/G397-026 G393-032/G397-035	Size 5 G393-045/G397-053 G393-060/G397-070 G393-072/G397-084	Size 6A G393-090/G397-110 G393-110/G397-143 G393-143/G397-170 G393-170/G397-210	Size 7 G397-250 G397-325 G397-450
Size 1	G392-004 G392-006	Cable	-		-		-	-	-
		Tightening torque	-		-		-	-	-
Size 2	G392-008 G392-012	Cable	-		-		-	-	-
		Tightening torque	-		-		-	-	-
Size 3	G392-016/ G395-016 G392-020/ G395-020	Cable	-		-		-	-	-
		Tightening torque	-		-		-	-	-
Size 4	G392-024/ G395-024 G392-032/ G395-032	Cable	6 mm² (0.009 in²) (AWG 9), maximum 1 m (3.28 ft)	16 mm² (0.025 in²) (AWG 5), maximum 1 m (3.28 ft)			-	-	-
			Ring cable lug [1, 2] with hole Ø 5.3 mm (0.21 in)						
		Tightening torque	2.5 to 4.5 Nm (22 to 39.8 lb-in) [1]				-	-	-

1) *On the DC-AC Servo Drive*

2) *On ring cable lugs with insulation, the crimped area and minimum 20 mm (0.79 in) of the cable insulation are to be insulated continuously using heatshrink sleeve.*

3) *Referred to DC voltage (U_{ZK}) 565 V_{DC}*

Table A.16 DC coupling, AC-AC Servo Drive and DC-AC Servo Drive: cables, cable cross-section and tightening torques

AC-AC servo drive \ DC-AC Servo Drive			Size 1 G393-004 G393-006	Size 2 G393-008 G393-012	Size 3 G393-016/G397-020 G393-020/G397-025	Size 4 G393-024/G397-026 G393-032/G397-035	Size 5 G393-045/G397-053 G393-060/G397-070 G393-072/G397-084	Size 6A G393-090/G397-110 G393-110/G397-143 G393-143/G397-170 G393-170/G397-210	Size 7 G397-250 G397-325 G397-450
Size 5	G393-045.0 G393-060.0 G393-072.0	Cable	6 mm² (0.009 in²) (AWG 9), maximum 1 m (3.28 ft)	16 mm² (0.025 in²) (AWG 5), maximum 1 m (3.28 ft)			35 mm² (0.054 in²) (AWG 2)	-	-
			Ring cable lug [1, 2] with hole Ø 5.3 mm (0.21 in)						
		Tightening torque	2.5 to 4.5 Nm (22 to 39.8 lb-in) [1]					-	-
Size 6A	G393-090.0 G393-110.0 G393-143.0 G393-170.0	Cable	6 mm² (0.009 in²) (AWG 9), maximum 1 m (3.28 ft)	16 mm² (0.025 in²) (AWG 5), maximum 1 m (3.28 ft			35 mm² (0.054 in²) (AWG 2)	95 mm² (0.15 in²) (AWG 4/0)	-
			Ring cable lug [1, 2] with hole Ø 5.3 mm (0.21 in)						
		Tightening torque	2.5 to 4.5 Nm (22 to 39.8 lb-in) [1]					See Table A.12	-

1) *On the DC-AC Servo Drive*

2) *On ring cable lugs with insulation, the crimped area and minimum 20 mm (0.79 in) of the cable insulation are to be insulated continuously using heatshrink sleeve.*

3) *Referred to DC voltage (U_{ZK}) 565 V_{DC}*

Table A.16 DC coupling, AC-AC Servo Drive and DC-AC Servo Drive: cables, cable cross-section and tightening torques

DC-AC Servo Drive / AC-AC servo drive		Size 1 G393-004 G393-006	Size 2 G393-008 G393-012	Size 3 G393-016/G397-020 G393-020/G397-025	Size 4 G393-024/G397-026 G393-032/G397-035	Size 5 G393-045/G397-053 G393-060/G397-070 G393-072/G397-084	Size 6A G393-090/G397-110 G393-110/G397-143 G393-143/G397-170 G393-170/G397-210	Size 7 G397-250 G397-325 G397-450
Size 7 G393-250.0 G393-325.0 G393-450.0	Minimum cable cross-section	6 mm² (0.009 in²) (AWG 9), maximum 1 m (3.28 ft)		16 mm² (0.025 in²) (AWG 5), maximum 1 m (3.28 ft)		35 mm² (0.054 in²) (AWG 2)	95 mm² (0.15 in²) (AWG 4/0)	2x95 mm² (0.15 in²) [3] (AWG 4/0)
		Ring cable lug [1, 2] with hole Ø 5.3 mm (0.21 in)						
	Tightening torque	2.5 to 4.5 Nm (22 to 39.8 lb-in) [1]					See Table A.12	See Table A.13

1) *On the DC-AC Servo Drive*

2) *On ring cable lugs with insulation, the crimped area and minimum 20 mm (0.79 in) of the cable insulation are to be insulated continuously using heatshrink sleeve.*

3) *Referred to DC voltage (U_{ZK}) 565 V_{DC}*

Table A.16 DC coupling, AC-AC Servo Drive and DC-AC Servo Drive: cables, cable cross-section and tightening torques

A.6 Ambient conditions

Ambient conditions	
Protection	Built-in unit IP20 Exceptions: IP00 for all terminals on all sizes IP10 for BG2 heat sink fan
Accident prevention regulations	As per the local regulations (in Germany e.g. DGUV V3)
Installation altitude	Up to 1000 m (3280 ft) above MSL, higher with power reduction (1 % per 100 m (328 ft), maximum 2000 m (6561 ft) above MSL)
Pollution degree according to IEC/EN 60664-1	2
Type of mounting	Built-in unit, only for vertical mounting in a switch cabinet with minimum IP4x protection, when using STO safety function minimum IP54

Table A.17 Ambient conditions

Climatic conditions			
In transit	As per IEC/EN 61800-2, IEC/EN 60721-3-2 class 2K3[1]		
	Temperature		-25 °C to +70 °C (-13 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 +40 °C (+14 °F to +104 °F) (4, 8, 12, 16 kHz) **Size 2 to Size 4** -10 °C to +40 °C (+14 °F to +104 °F) (4, 8, 12, 16 kHz), to +55 °C (+131 °F) with power reduction (4 % per °C) **Size 5 and Size 6A** -10 °C to +40 °C (+14 °F to +104 °F) (4, 8, 12, 16 kHz), to +55 °C (+131 °F) with power reduction (2 % per °C)
		Liquid cooling	**Size 3 and Size 4** -10 °C to +40 °C (+14 °F to +104 °F) (4, 8, 12, 16 kHz), to +55 °C (+131 °F) with power reduction (4 % per °C) **Size 5 and 6A** -10 °C to +40 °C (+14 °F to +104 °F) (4, 8, 12, 16 kHz), 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), 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.18 Climatic conditions

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.19 Mechanical conditions

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 minimum IP54 for STO! As per EN ISO 13849-2 the switch cabinet must have IP54 protection or higher on using the STO (Safe Torque OFF) safety function.

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 cooling medium 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 material	Aluminium	

Table A.20 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	Size 3	Size 4	Size 5	Size 6A	Size 7
Device	G397-020 G397-025	G397-026 G397-035	G397-053 G397-070 G397-084	G397-110 G397-143 G397-170 G397-210	G397-250 G397-325 G397-450
Coolant pressure (rated value / maximum value)	1 bar / 2 bar				
Coolant flow ate rated value approx.	3 l per min /		8 l per min /	11 l per min /	12 l per min /
maximum value approx.	4 l per min		11 l per min	13 l per min	14 l per min

Table A.21 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	G397-020 G397-025	G397-026 G397-035	G397-053 G397-070 G397-084	G397-110 G397-143 G397-170 G397-210	G397-250 G397-325 G397-450
Shutdown of the device at a heat sink temperature	+65 °C (+149 °F)				+90 °C (+194 °F)

Table A.22 Dynamic monitoring of the heat sink temperature

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.

UL certification (Size 1 to Size 7)

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

Glossary

Symbole

A

B

C

D

E

F

H

I

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M

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