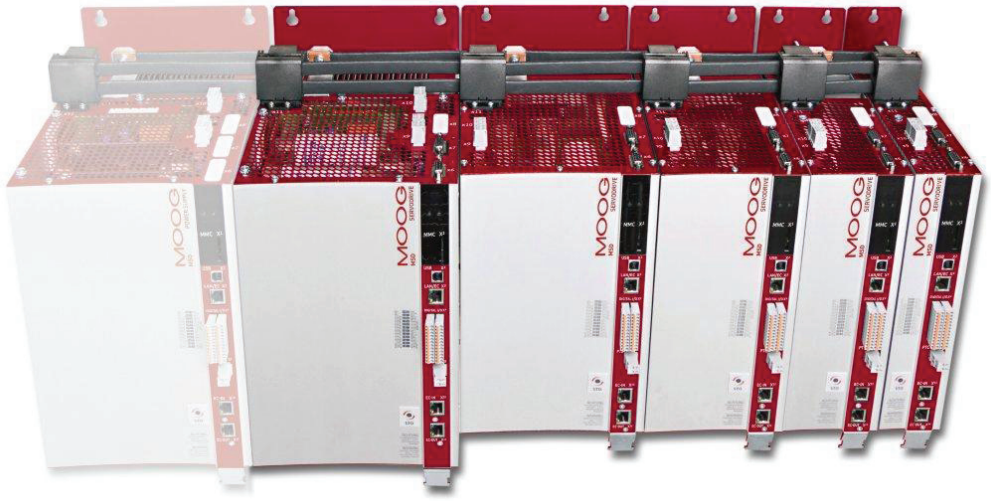
MSD Servo Drive DC-AC

Operation Manual



Multi-Axis System

DC-AC 565 to 770 V DC

MSD Servo Drive DC-AC Operation Manual Multi-Axis System

Id. no.: CA97554-001, Rev. 1.1

Date: 06/2012

Applicable as from firmware version: V2.20-01

The German version is the original version of the operation manual.

MSD Servo Drive _ Energy-efficient multi-axis system

Comprising DC-powered DC-AC servo drives and coordinated supply units, the MSD Servo Drive multi-axis system offers a high degree of solutions expertise and flexibility. Reduced wiring and shorter installation times are demands which can be easily met, as can the need to conserve resources and minimize cost in operation.

Technical alterations reserved

The contents of our documentation have been compiled with greatest care and in compliance with our present status of information.

Nevertheless we would like to point out that this document cannot always be updated parallel to the technical further development of our products.

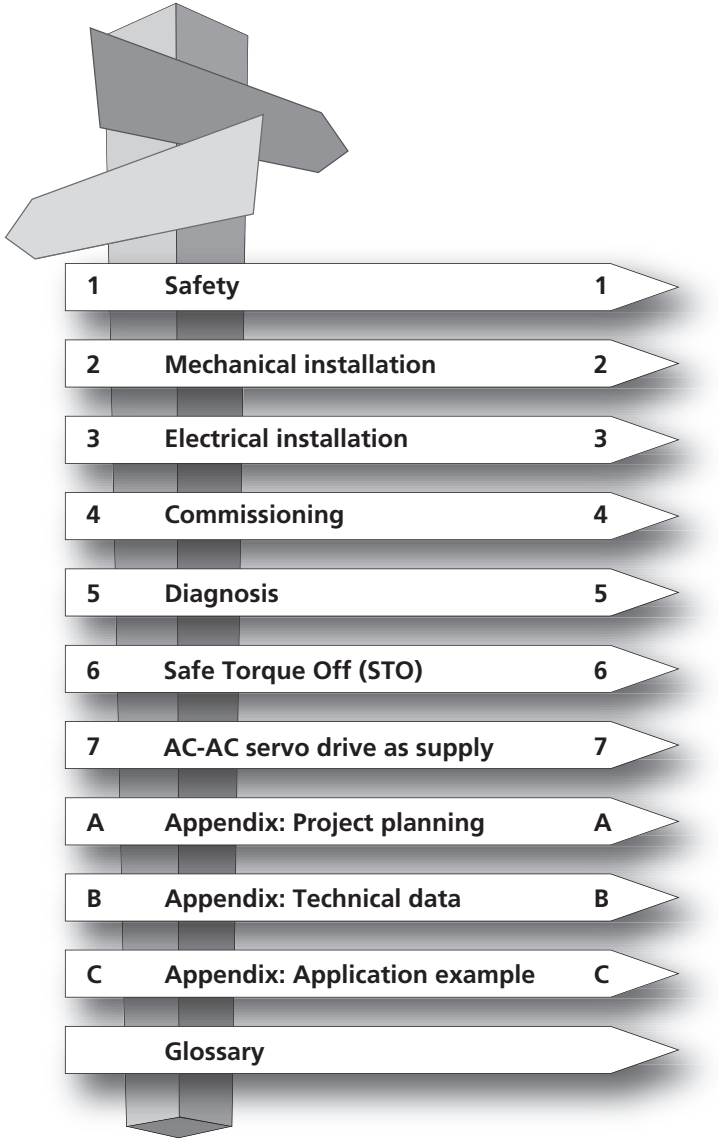
Information and specifications may be changed at any time. For information on the latest version please refer to drives-support@moog.com.

How to use this document

Dear user,

We are happy that you have made a decision in favour of a product from Moog GmbH. In order to be able to start using your new device quickly and without problems, we ask you kindly to read this Operation Manual thoroughly beforehand.

Step	Action	Comment
1.	This Operation Manual will enable you to install and commission DC-AC servo drive very quickly and easily.	Quick-start guide
2.	Simply follow the step-by-step tables in the chapters.	And away you go!



Id.-No.: CA97554-001 Date: 06/2012

Documentation on the MSD Servo Drive multi-axis system

Documents directly required to construct and operate the multi-axis system

Document	Contents	Id. no.
MSD Power Supply Unit Operation Manual	Mechanical installation, Electrical installation, Safety, Specification	CA97556-001
MSD Servo Drive DC-AC Multi-Axis System Operation Manual	Mechanical installation, Electrical installation, Safety, Specification	CA97554-001
MSD Servo Drive AC-AC Single-Axis System Operation Manual	Mechanical installation, Electrical installation, Safety, Specification	CA65642-001

Information on the complete MSD Servo Drive family

Document	Contents	Id. no
MSD Servo Drive Ordering Catalog	Overview and ordering instructions for: MSD Motion Controller, MSD Servo Drive Compact, MSD Servo Drive single-axis system, MSD Servo Drive multi-axis system, variants and accessories	CDL 29950-en

Further documentation relating to the MSD Servo Drive family

Document	Contents	Id. no
MSD Servo Drive Application Manual	Description of the base software for the single- and multi-axis systems and the MSD Servo Drive Compact	CA65643-001
MSD Servo Drive CANopen/EtherCAT User Manual	Description and parameter setting of the MSD Servo Drive on the CANopen or EtherCAT fieldbus system	CA65647-001
MSD Servo Drive SERCOS II	Description and parameter setting of the MSD Servo Drive on the SERCOS II fieldbus system	CA65648-001
MSD Servo Drive SERCOS III	Description and parameter setting of the MSD Servo Drive on the SERCOS III fieldbus system	CA97557-001
MSD Servo Drive Profibus User Manual	Description and parameter setting of the MSD Servo Drive on the Profibus-DPV fieldbus system	CA65645-001

Order code

The order designation G393-xxx-xxx-xxx and G397-xxx-xxx-xxx informs you about the corresponding variant of the servo drive delivered to you. The significance of the individual characters of the servo drives are given in the following order code. You will find a complete order code with all values in the MSD Servo Drive Ordering Catalog.

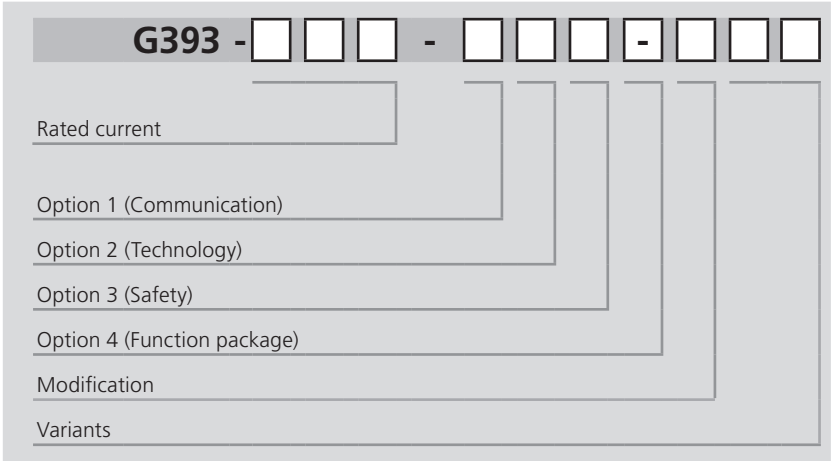


Fig. 0.1 Order code MSD Servo Drive DC-AC (air-cooled)

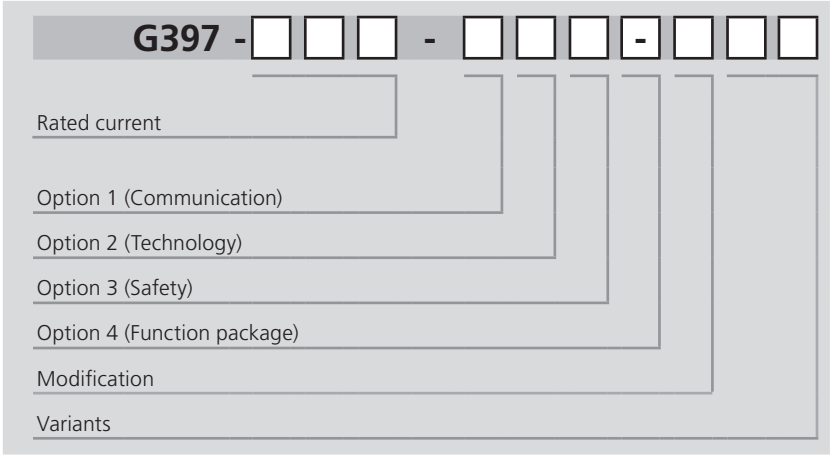


Fig. 0.2 Order code MSD Servo Drive DC-AC (liquid-cooled)

Rating plate

On rating plates of the MSD Servo Drives you will find the serial number, from which you can identify the date of manufacture based on the following key. You will find details of the rating plate's location on the MSD Servo Drive starting on page 20.

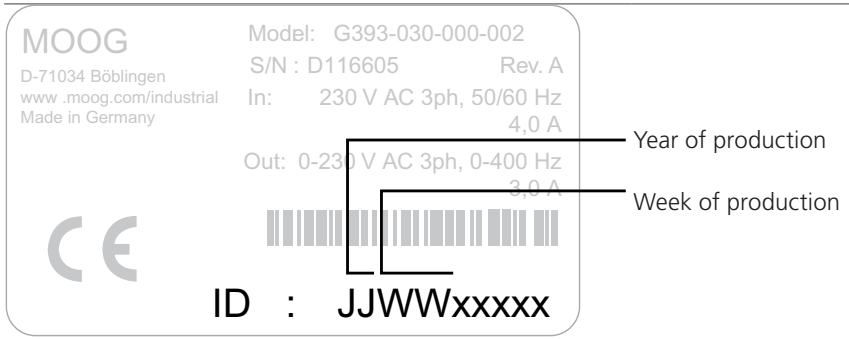


Fig. 0.3 Hardware rating plate MSD Servo Drive DC-AC

Supply package

The supply package 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)
- Ready made-up connection cables
- Product DVD

Pictograms

To provide clear guidance, this Operation Manual uses pictograms. Their meanings are set out in the following table. The pictograms always have the same meanings, even where they are placed without text, such as next to a connection diagram.

Warning symbols (see also section1.1)	
	ATTENTION! Misoperation may result in damage to the drive or malfunctions.
	DANGER FROM ELECTRICAL TENSION! Improper behaviour may endanger human life.
	DANGER FROM ROTATING PARTS! Drive may start up automatically.
Hints & Tips	
	NOTE: Useful information or reference to other documents
	STEP: Action in a sequence of multiple actions.

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Space for your personal notes

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1 Safety

1.1 For your safety

The instructions set out below should be read through prior to initial commissioning in order to prevent injury and/or damage to property. The safety instructions must be followed at all times.

1.1.1 Read the Operation Manual first!

	Read the Operation Manual first! • Follow the safety instructions! • Refer to the user information!
	Electric drives are dangerous: • Electrical voltages 230 V AC / 320 V DC to 480 V AC / 770 V DC **Dangerously high voltages ≥50 V may still be present 10 minutes after the power is cut (capacitor charge). So check that the power has been cut!** • Rotating parts • Hot surfaces
	Protection against magnetic and/or electromagnetic fields during installation and operation. • Persons fitted with heart pacemakers, metallic implants and hearing aids etc. must not be allowed access to the following areas: – Areas where drive systems are installed, repaired and operated. – Areas where motors are installed, repaired and operated. Motors with permanent magnets pose a particular hazard. NOTE: If it is necessary to access such areas, suitability to do so must be determined beforehand by a doctor.
	Your qualification: • In order to prevent personal injury and damage to property, only personnel with electrical engineering qualifications may work on the device. • The said qualified personnel must be familiar with the contents of the Operation Manual (cf. IEC 364, DIN VDE 0100). • Awareness of national accident prevention regulations (e.g. BGV A3 in Germany).
	During intsallation observe the following instructions: • Always comply with the connection conditions and technical specifications. • Comply with the standards for electrical installations, such as regarding wire cross-section, protective conductor and ground connections. • Do not touch electronic components and contacts (electrostatic discharge may destroy components).

Table 1.1 Safety instructions

1.1.2 Warning symbols used

The safety instructions detail the following hazard classes.
The hazard class defines the risk posed by failing to comply with the safety notice.

Warning symbols	General explanation	Hazard class to ANSI Z 535
	ATTENTION! Misoperation may result in damage to the drive or malfunctions.	Serious injury or damage to property may occur.
	DANGER FROM ELECTRICAL TENSION! Improper behaviour may endanger human life.	Death or serious injury will occur.
	DANGER FROM ROTATING PARTS! Drive may start up automatically.	Death or serious injury will occur.

Table 1.2 Explanations of warning symbols

1.2 Intended use

MSD Servo Drives are components for installation into stationary electric systems or machines.

When installed in machines the commissioning of the servo drive (i.e. start-up of intended operation) is prohibited, unless it has been ascertained that the machine fully complies with the provisions of the Machinery Directive 2006/42/EC; compliance with EN 60204 is mandatory.

Commissioning (i.e. start-up of intended operation) is only permitted when strictly complying with the EMC Directive (2004/108/EC).

CE The MSD Servo Drive DC-AC conforms to the Low Voltage Directive 2006/95/EC.

The DC-AC servo drives comply with the requirements of the harmonized product standard EN 61800-5-1.

If the DC-AC servo drive is used for special applications, such as in areas subject to explosion hazard, the required standards and regulations (e.g. in the Ex zone EN 50014, “General provisions” and EN 50018 “Flameproof housing”) must always be observed.

Repairs may only be carried out by authorized repair workshops. Unauthorized opening and incorrect intervention could lead to death, physical injury or material damage. The warranty provided by Moog GmbH would thereby be rendered void.

NOTE: Deployment of the DC-AC servo drives in non-stationary equipment is classed as non-standard ambient conditions, and is permissible only by special agreement.

1.3 Responsibility

Electronic devices are fundamentally not fail-safe. The company setting up and/or operating the machine or system is itself responsible for ensuring that the drive is rendered safe if the device fails.

In the section on “Electrical equipment of machines” the standard EN 60204-1/ DIN VDE 113 “Safety of machines” stipulates safety requirements for electrical controls. They are intended to protect personnel and machinery, and to maintain the function capability of the machine or system concerned, and must be observed.

The function of an emergency off system does not necessarily have to cut the power supply to the drive. To protect against danger, it may be more beneficial to maintain individual drives in operation or to initiate specific safety sequences. Execution of the emergency stop measure is assessed by means of a risk analysis of the machine or plant, including the electrical equipment in accordance with EN ISO 14121 (previously DIN EN 1050), and is determined in accordance with EN ISO 13849-1 (previously EN 954-1), “Safety of machines - Safety-related parts of controls” by selecting the circuit category.

2 Mechanical installation

2.1 Notes for installation

ATTENTION!

- **During installation**
  please be sure to avoid ...
  – drill chippings, screws or other foreign bodies dropping into the device;
  – penetration of damp into the device
- **Switch cabinet**
  The device is solely intended for installation in a stationary switch cabinet. The switch cabinet must as a minimum provide IP4x protection. When using the STO (Safe Torque OFF) safety function, according to EN ISO 13849-2 the switch cabinet must have IP54 protection or higher.
- **Immediate vicinity**
  – The servo drives must not be installed in areas where they would be permanently exposed to vibrations. For more information refer to tabe B.20 in the appendix.
  – The device heats up in operation and at the heat sink may reach temperatures of up to +100 °C (+212 °F). Pay attention to this in relation to adjacent components.

NOTE: For installation of the servo drive within a MSD Servo Drive multi-axis system, be sure also to refer to the Operation Manual for the power supply unit or the supplying single-axis servo drives.

The layout and installation of the DC-AC servo drives and the power supply unit is subject to the following basic rules:

- **Pollution**
  Maximum pollution severity 2 to EN 60664-1. Further information on environmental conditions can be found in table B.18 in the appendix.
- **Effective EMC installation**
  To attain the best result for effective EMC installation you should use a well grounded chromated or galvanized backing plate. If backing plates are varnished, remove the coating from the contact area. The devices themselves have an aluminium rear panel (Size 1 to Size 4) or a rear panel made of aluminized/ galvanized sheet steel (Size 5, Size 6A).
- **Cooling**
  Cooling air must be able to flow through the device without restriction. For mounting in switch cabinets with convection (= heat loss is discharged to the outside via the cabinet walls), always fit an internal air circulation fan.
- **End-to-end mounting and alignment**
  – Devices with different housing variants (air-cooled and liquid-cooled) can be installed next to each other in any combination, as devices with liquid-cooled housings have a spacer on the rear in place of the heat sink. Consequently, it is possible to connect to devices with air-cooled housings using the ready made-up DC link cables without additional measures to compensate for differing unit depth.
  – No – minimum clearance between the devices is required. Exceptions to this rule are the following air-cooled devices of size Size 6A (see Table 2.1). The maximum distance between the devices is dictated by the supplied ready made-up cables, and is 1.5 mm (except Size 6A).
  – In the case of end-to-end mounting, the DC-AC servo drive must be sorted in ascending **or** descending order of power.
  – A vertical offset of 18.5 mm must be allowed between the top fixing screws for devices of sizes Size 1 to Size 5 and devices of size B (see Fig. 2.6).

If you need more details on installation please contact the Moog Helpline (see page 50).

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2.2 DC-AC servo drive installation Air-cooled housing

Step	Action	Comment
1.	Arrange the devices starting from the power supply unit to the right and/or left sorted in descending order of power output, in order to minimize thermal influences. In the case of the power supply unit Size 5, align all MSD Servo Drive DC-AC devices in a line along the top edge of the unit (see Fig. 2.5). In the case of the power supply unit Size 6A, align all MSD Servo Drive DC-AC devices 18.5 mm lower (see Fig. 2.6).	This is necessary in order to execute the DC link using the ready made-up cables. For specified mounting clearances- see Table 2.1.
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.	Take account of the bend radius of the connecting cables! For hole pitch and dimensional drawings see Table 2.1, Fig. 2.1 and Fig. 2.2.
3.	Mount the DC-AC servo drives vertically in a row on the back plane.	The contact area must be metallically bright. For the DC power supply use the supplied ready made-up DC link cables.
	Continue with the electrical installation in section 3.	

Dimensions and mounting distances for air-cooled housing

MSD Servo Drive	Size 1	Size 2	Size 3	Size 4	Size 5	Size 6A
	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]	3.4	4.9	6.5	7.5	13	32
B (width)	58.5	90	130	171	190	280
H (height) [1]	295				345	540
T (depth) [1]	224				240	322
A	29.25	50	80	120	150	200
C	382				406.5	581
C1	5				6	10
D	4.8				5.6	9.5
E	Direct side by side mounting, maximum 2					40 [2]
F [3]	≥100		≥150		≥180	
G [3]	≥270				≥300	≥500
H1	392				418.5	600
H2	38.5				15	20
Screws	2 x M4	4 x M4			4 x M5	4 x M8

1) without terminals/connectors
2) Mounting clearance of Size 6A to other Size 6A units
3) The bend radius of the connecting cables must be taken into account
All dimensions in mm

Table 2.1 Dimensions and mounting distances for air-cooled housing

NOTE: The minimum clearance specified in the table applies to devices of the same power output. Arrange devices with different drive power in descending order of power output (e.g. viewed from the left Size 4-Size 3-Size 2-Size 1). This minimizes the mutual thermal influence. The supply unit must always be arranged on the side of the most powerful DC-AC servo drive.

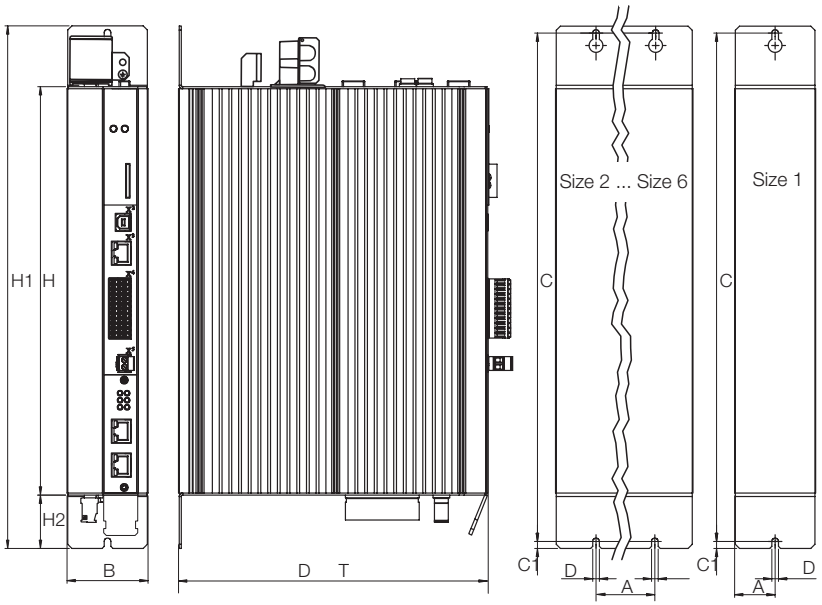

Fig. 2.1 Dimensional drawing, air-cooled housing

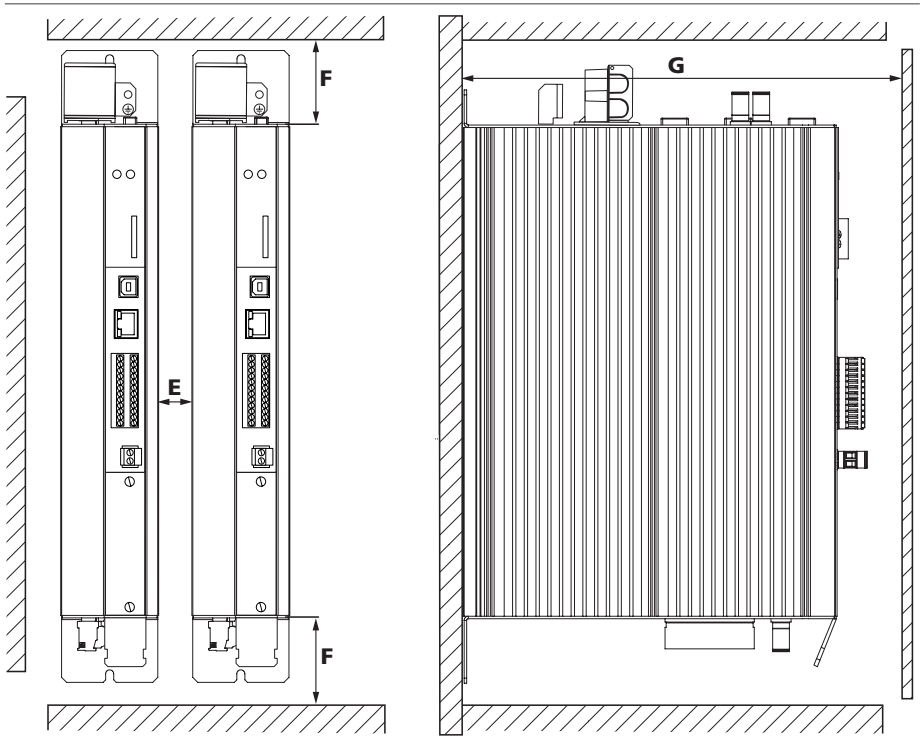

Fig. 2.2 Mounting clearance, air-cooled housing

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2.3 DC-AC servo drive installation Liquid-cooled housing

Step	Action	Comments
1.	Arrange the devices starting from the supply unit to the right and/or left sorted in descending order of power output, in order to minimize thermal influences. In the case of the power supply unit Size 5, align all DC-AC servo drives in a line along the top edge of the unit (Fig. 2.5). In the case of the power supply unit Size 6A, align all DC-AC servo drives 18.5 mm lower (Fig. 2.6).	This is necessary in order to execute the DC link using the ready made-up cables. For specified mounting clearances see Table 2.1.
2.	Mark out the positions of the tapped holes and the pipe socket on the backing plate. Drill holes and cut a thread for each fixing screw in the backing plate.	Take account of the bend radius of the connecting cables! For hole pitch and dimensional drawings see Table 2.2, Fig. 2.3 and Fig. 2.4.
3.	Mount the DC-AC servo drives vertically in a row on the back plane.	The contact area must be metallically bright. For the DC power supply use the supplied ready made-up DC link cables.
4.	When fitting the hose connections (not supplied) in the pipe sockets, brace with a 22 mm open-ended wrench in order to prevent damage to the device by torsion.	Ensure a perfect liquid-tight connection (e.g. using a Teflon sealing strip)!
	Continue with the electrical installation in section 3	

Dimensions and mounting distances for liquid-cooled housing

MSD Servo Drive	Size 3		Size 5	Size 6A
	G397-020 G397-025	G397-026 G397-035	G397-053 G397-070 G397-084	G397-110 G397-143 G397-170 G397-210
Weight [kg]	6.5	7.5	13	32
B (width)	130	171	190	280
H (height) [1]	295		346.5	540
T (depth) [1]	224		238.5	285
A	80	120	150	200
A1	10	25	40	65
A2	60	70		
C	382		406.5	581
C1	5		6	10
D	4.8		6.5	9.5
D1	48 (hole for pipe-socket)			
E	Direct side by side mounting, maximum 2			
F [2]	≥150		≥180	
G [2]	≥300			≥500
H1	392		418.5	600
H2	38.5		15	20
H3	75	70	54	56.5
S [inches]	3/8 (inside thread)			
Screws	4 x M4		4 x M6	4 x M8
T1	74		73.5	

1) Without terminals/connectors *All dimensions in mm*

2) The bend radius of the connecting cables must be taken into account

Table 2.2 Dimensions and mounting distances for liquid-cooled housing

NOTE: Arrange devices with different drive power in descending order of power output (e.g. viewed from the left Size 4 - Size 3 - Size 2 - Size 1). This minimizes the mutual thermal influence. The supply unit must always be arranged on the side of the most powerful DC-AC servo drive.

When side by side mounting MSD Servo Drives together with other devices, you must make sure that the device do not affect one another thermally.

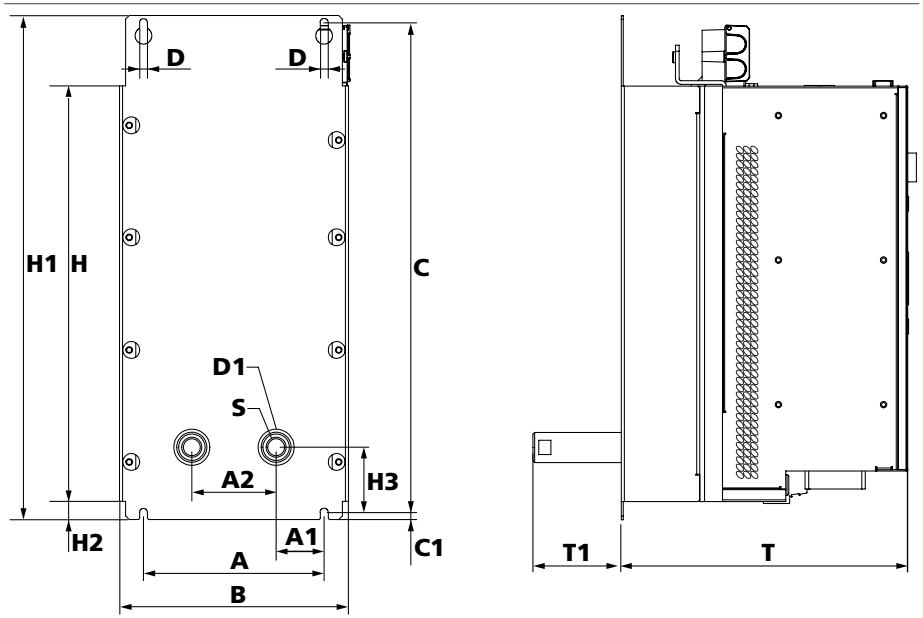

Fig. 2.3 Dimensional drawing, liquid-cooled housing

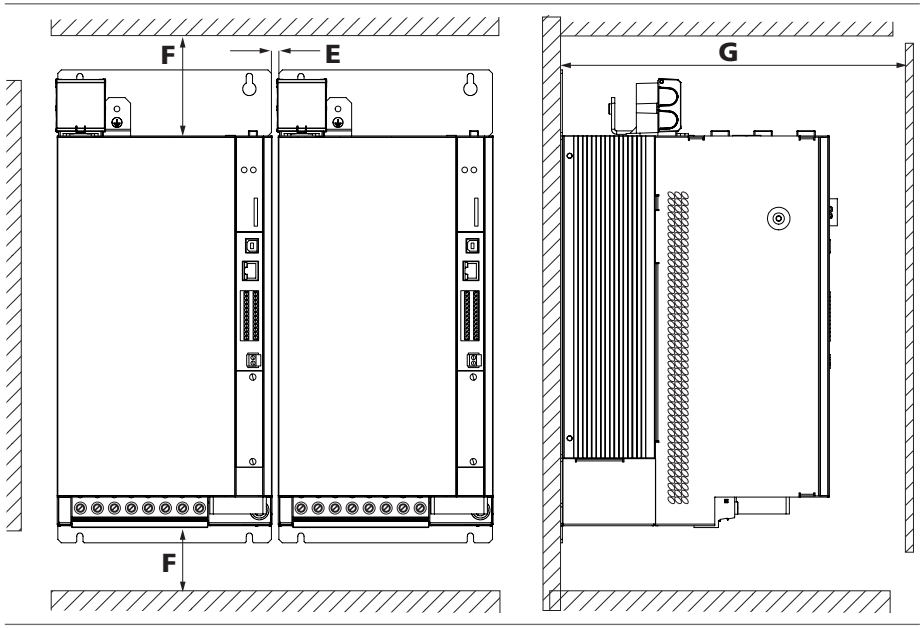

Fig. 2.4 Mounting clearance, liquid-cooled housing

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2.4 Alignment and arrangement in a group

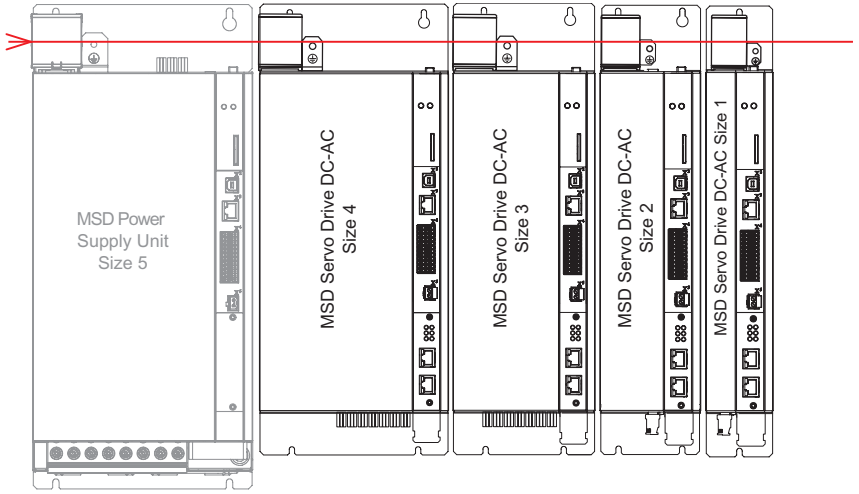


Fig. 2.5 Alignment DC-AC servo drive on power supply unit Size 5 (example)

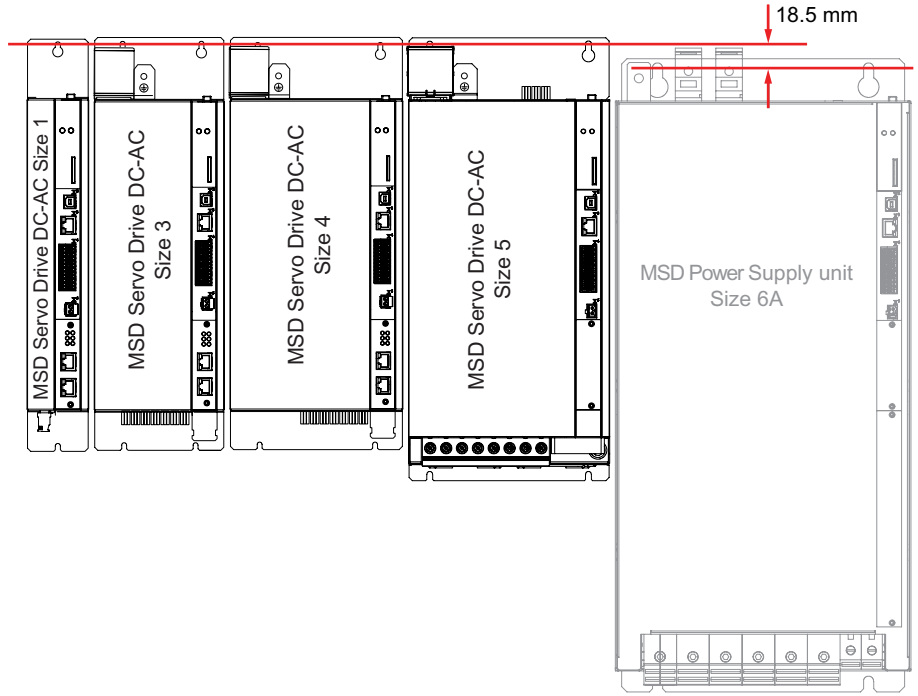


Fig. 2.6 Alignment DC-AC servo drive on power supply unit Size 6A (example)

Permissible multi-axis layouts

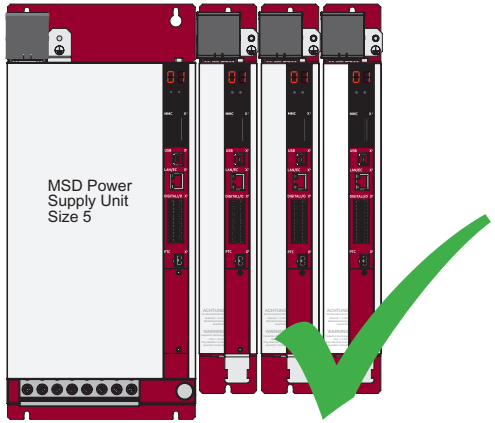


Fig. 2.7 Example of a permissible layout: Arrangement of MSD Servo Drives DC-AC of same size on one side of the power supply unit

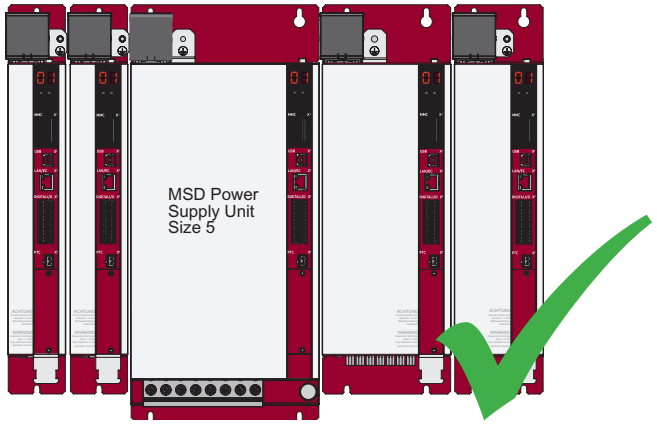


Fig. 2.8 Example of a permissible layout: Arrangement of MSD Servo Drives DC-AC of same size and in descending order of size on both sides of the power supply unit respectively

Impermissible multi-axis layouts

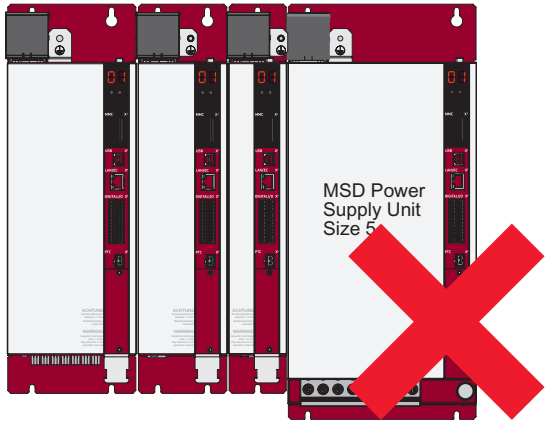


Fig. 2.9 Example of an impermissible layout: Arrangement of MSD Servo Drives DC-AC in ascending order of size

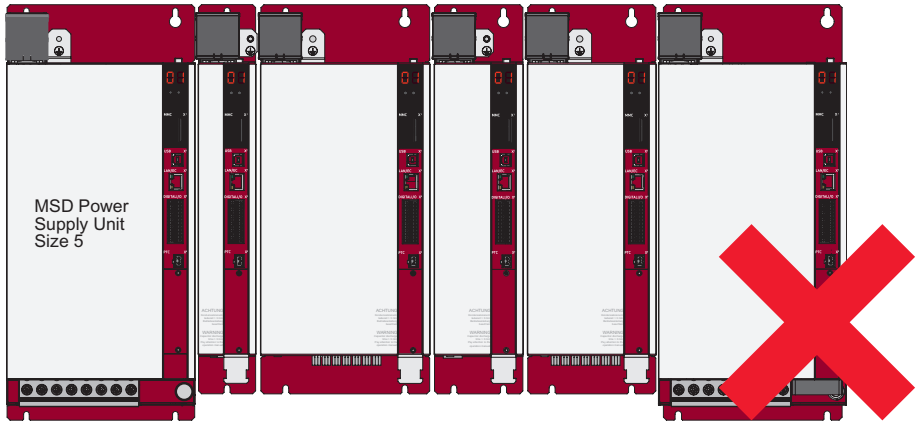
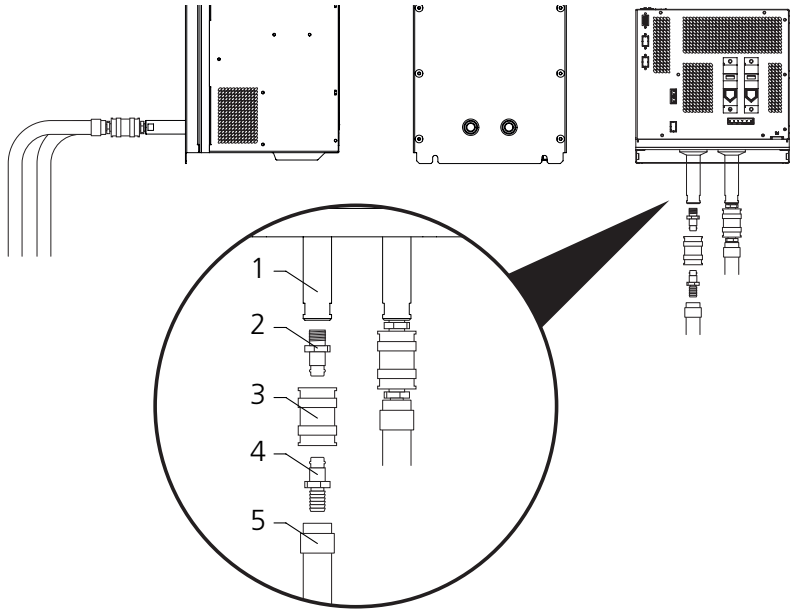


Fig. 2.10 Example of an impermissible layout: Arrangement of MSD Servo Drives DC-AC in ascending and descending order of size

2.5 Cooling circuit connection

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



Key

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

Fig. 2.11 Cooling circuit connection (here: Size 6A)

NOTE: Items 2 to 5 are **not** included in the scope of supply and are to be ordered separately.

3 Electrical installation

3.1 Notes for installation

ATTENTION!

- **Qualified personnel**
  Installation must only be carried out by qualified electricians who have undergone instruction in the necessary accident prevention measures.
- **During installation**
  please be sure to avoid ...
  – screws, cable residues or other foreign bodies dropping into the device;
  – penetration of damp into the device

DANGER FROM ELECTRICAL TENSION!

- **Danger of life!**
  – Never wire or disconnect electrical connections while they are live! Disconnect the device from the mains supply (230/400/460/480 V AC or 565/650/678/770 V DC) before working on it. Dangerously high voltages of ≥ 50 V may still be present 10 minutes after the power is cut (capacitor charge). Work on the device must only be carried out when the DC link voltage has dropped below a residual voltage of 50V (measured on Size 1 - Size 4 at terminals X11 and X12/L- / L+, on Size 5 and Size 6A on terminals X11 and X12/ZK- / ZK+).
  – Even if the device does not emit any visual or audible signals or show other indications, dangerous voltage may be connected to the device (such as with mains voltage to terminal X11 switched on) and no control supply (+24 V DC on X9, X10)!

NOTE: For installation of the servo drive within a MSD Servo Drive multi-axis system, be sure also to refer to the Operation Manual for the MSD Power Supply Unit or the supplying MSD Servo Drive AC-AC.

- **Compliance with EMC product standard**
  Commissioning (i.e. starting intended operation) is only permitted when strictly complying with EMC product standard EN 61800-3:2004. The installer/operator of a machine and/or item of plant must provide proof of compliance with the protection targets stipulated in the standard.
- **Cable type**
  – Use shielded mains, motor and signal cables with double copper braiding, providing 60 to 70 % coverage.
  – Always route the motor cable without interruptions and by the shortest route out of the switch cabinet. If a motor contactor or motor choke is used, the component should be directly mounted to the DC-AC servo drive and the shield of the motor cable should not be stripped too soon.
  – If very large cable cross-sections have to be installed, shielded single wires may also be used instead of shielded cables.

ATTENTION! Use the supplied ready made-up cables for the electrical connections between the devices. If extending the DC link is unavoidable, be sure to comply with the rules set out in section B.5 (page 79). If cables not conforming to the stipulated rules are used, Moog GmbH can provide no guarantee of stable and safe operation.

- **Cable laying**
  – Lay mains, motor and signal cables isolated from each other. Maintain a minimum clearance of 0.2 metres wherever possible. Use separators as necessary.
  – Always route the motor cable without interruptions and by the shortest route out of the switch cabinet. If a motor contactor or motor choke is used, the component should be directly mounted to the servo drive and the shield of the motor cable should not be stripped too soon.
  – As far as possible route signal cables into the switch cabinet from one side only.
  – Cables of the same circuit must be twisted.
  – Avoid unnecessary cable lengths and loops.
- **Shielding**
  Do not strip the cable shields too soon, and lay them across wide areas both on the component and on the backing plate and PE rail (main ground) of the backing plate.

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- **Grounding**
  The grounding measures of relevance to the servo drive are detailed in section 3.4 on page 24.
- **External components**
  - Place larger consumers near the supply.
  - Contactors, relays, solenoid valves (switched inductors) must be wired with fuses. The wiring must be directly connected to the respective coil.
  - Switched inductors should be at least 0.2 m away from process controlled assemblies.

If you need more details on installation please contact the Moog Helpline (see page 50).

Step	Action	Comment
1.	Identify the terminal assignment applicable to your device.	Section 3.2 for Size 1 to Size 4 Section 3.3 for Size 5 and Size 6A
2.	Connecct all required input and output units to the control terminals and option interfaces where appropriate.	Section 3.7 Section 3.10 and/or 3.11
3.	Connect the encoder and motor.	Sections 3.12 and 3.13
4.	Connect the protective conductor and the supply voltages using the ready made-up cables (DC Link).	Sections 3.4 and 3.6
5.	Continue with commissioning ind section 4.	

3.2 Overview of connections Size 1 to Size 4

The following shows the layout, with the corresponding positions of plugs and terminals. To aid orientation, the connectors and terminals are labelled by abbreviations.

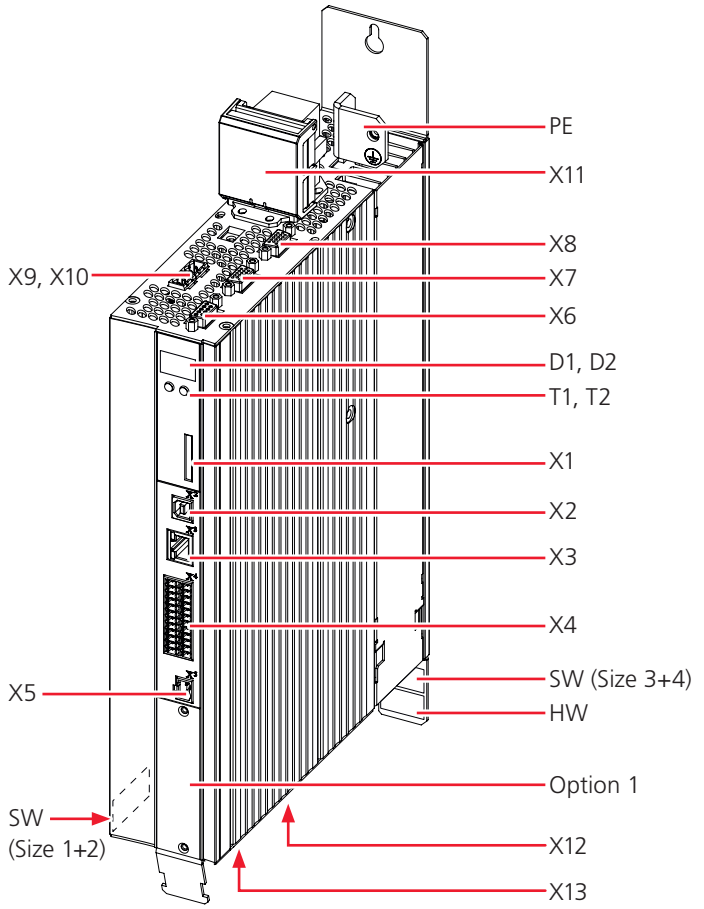


Fig. 3.1 Layout Size 1 to Size 4 (here: Size 1)

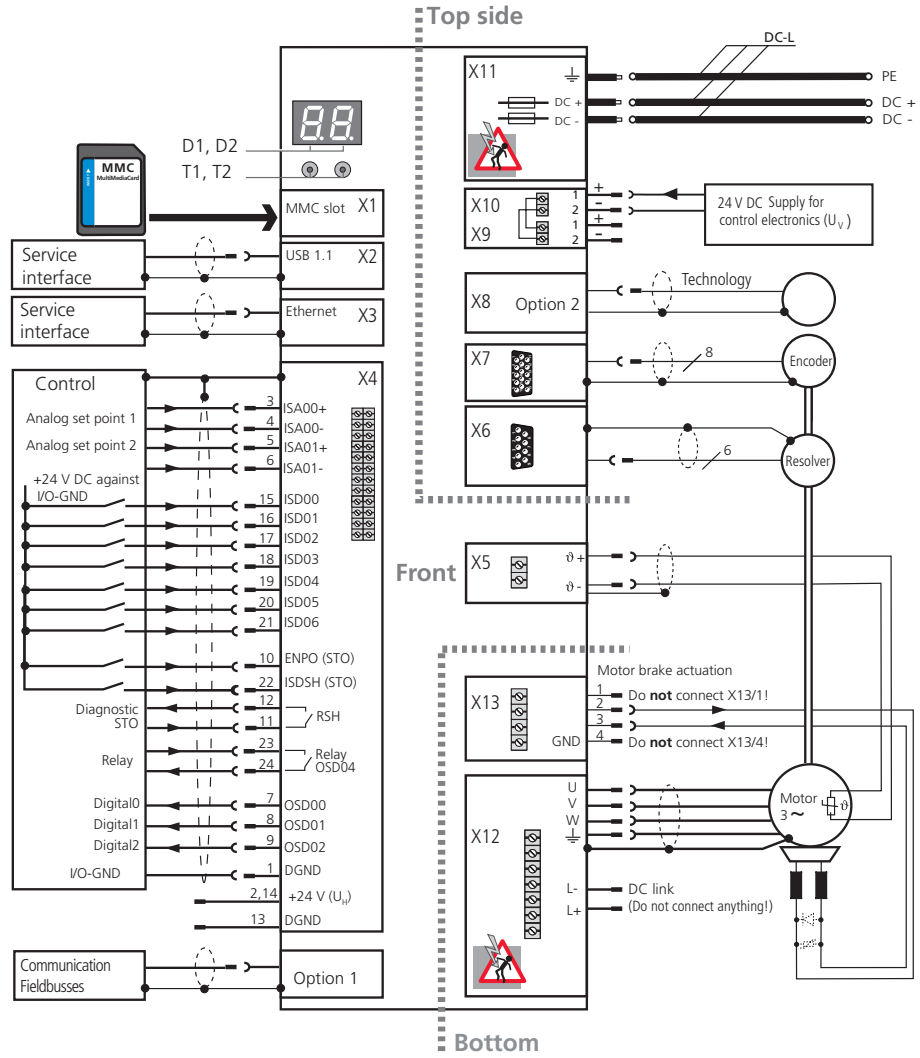


Fig. 3.2 Connection diagram Size 1 to Size 4

Abbr.	Designation	Details
D1, D2	7-segment display	page 42
T1, T2	Pushbuttons	page 42
X1	Slot for MMC card	page 41
X2	USB 1.1 interface	page 31
X3	Ethernet interface	page 31
X4	Terminals	page 29
Option 1	Communication	page 31
X11	Connection DC supply	page 27
DC-L	DC link cables	page 79
PE	Connection protective conductor	page 24
X9, X10	Connection control supply	page 26
X8 (Option 2)	Technology	page 31
X7	Connection high-resolution encoder	page 34
X6	Connection resolver	page 33
X5	Connection motor temperature sensor	page 35
X13	Connection motor brake	page 30
X12	Connection motor	page 35
HW	Hardware name plate	page 5
SW	Software name plate	-

Table 3.1 Key to connection diagram Size 1 to Size 4

3.3 Overview of connections Size 5 and Size 6A

The following shows the layout, with the corresponding positions of plugs and terminals. To aid orientation, the connectors and terminals are labelled by abbreviations.

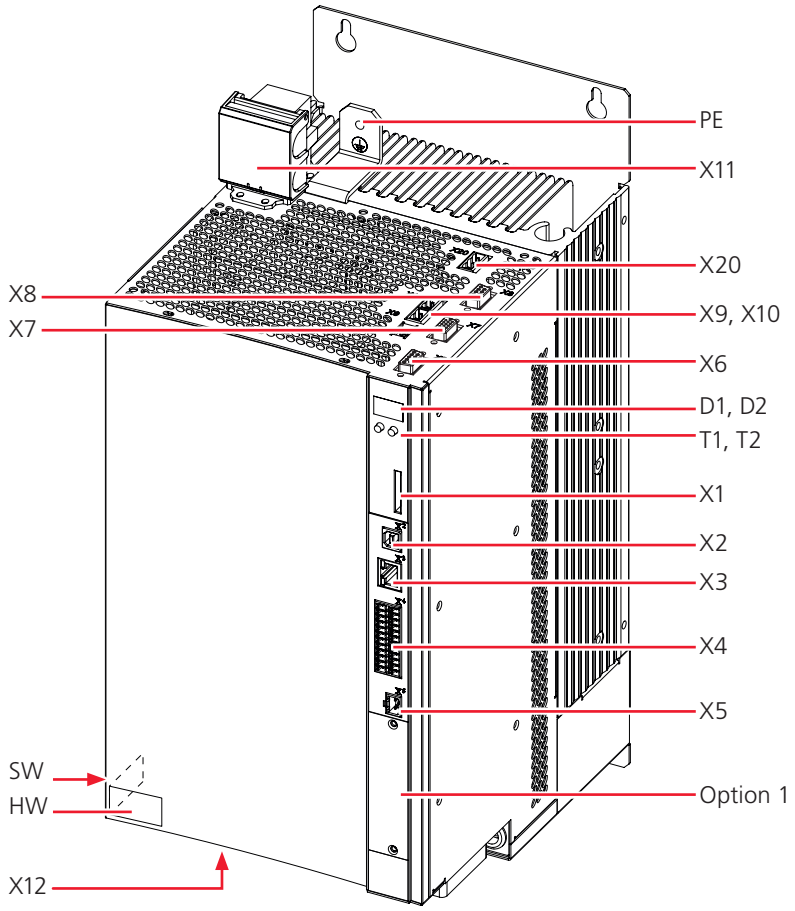


Fig. 3.3 Layout Size 5 (without shields)

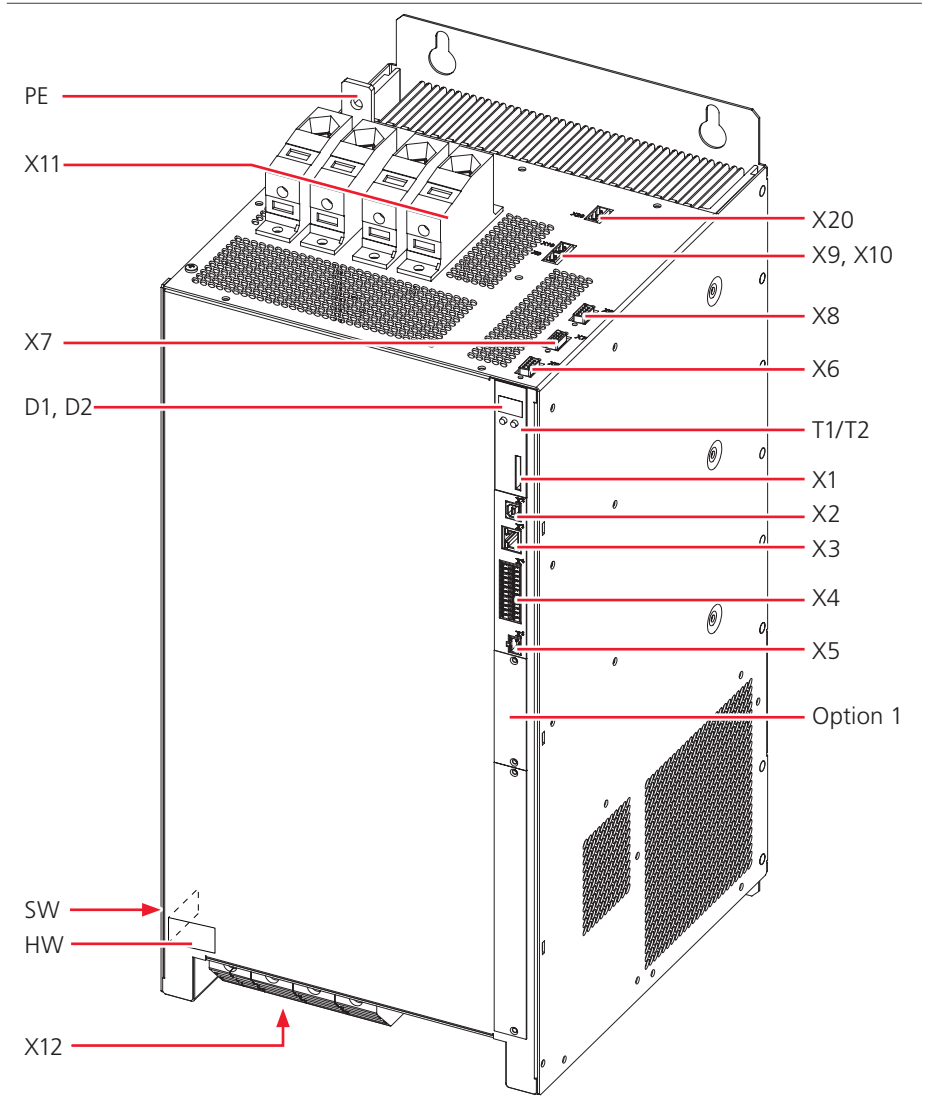


Fig. 3.4 Layout Size 6A (without shield)

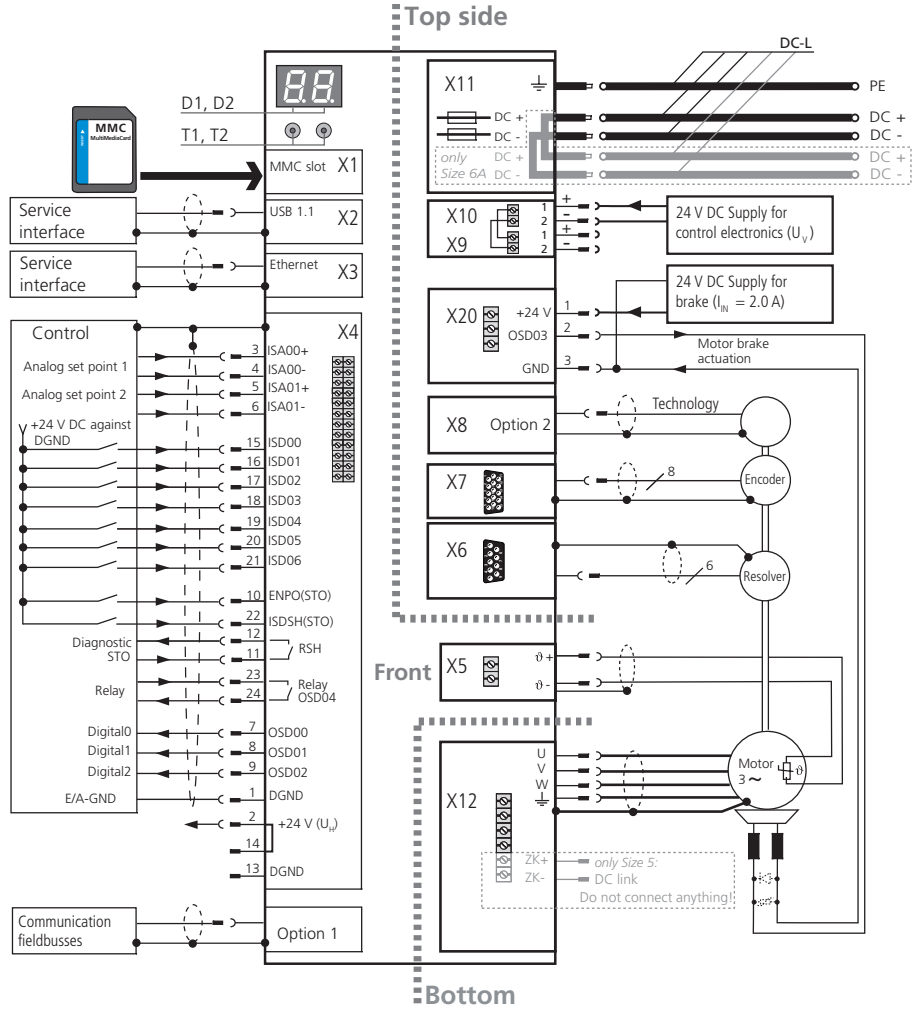


Fig. 3.5 Connection diagram Size 5 and Size 6A

Abbr.	Designation	Details
D1, D2	7-segment display	page 42
T1, T2	Pushbuttons	page 42
X1	Slot for MMC card	page 41
X2	USB 1.1 interface	page 31
X3	Ethernet interface	page 31
X4	Terminals	page 29
Option 1	Communication	page 31
X11	Connection DC supply	page 27
DC-L	DC link cables	page 79
PE	Connection protective conductor	page 24
X9, X10	Connection control supply	page 26
X8 (Option 2)	Technology	page 31
X7	Connection high-resolution encoder	page 34
X6	Connection resolver	page 33
X5	Connection motor temperature sensor	page 35
X20	Connection motor brake	page 30
X12	Connection motor	page 35
HW	Hardware name plate	page 5
SW	Software name plate	-

Table 3.2 Key to connection diagram Size 5 and Size 6A

3.4 Protective conductor connection

Step	Action	PE mains connection to DIN EN 61800-5-1
1.	Ground every servo drive! **When operating with power supply unit:** • Interconnect the PE terminals of the DC-AC servo drives (up to and including Size 5) and the power supply unit by the ready made-up cables. • Connect the PE terminal of the power supply unit and DC-AC servo drive Size 6A directly to the PE rail (main ground) in the switch cabinet. **When operating with AC-AC servo drive as supply:** • Interconnect the PE terminals of the DC-AC servo drives by the ready made-up cables. • Do NOT connect the PE terminal of the DC-AC servo drive to a PE terminal of the supplying single-axis drive, but directly to the PE rail (main ground) in the switch cabinet. • Connect the supplying single-axis drive likewise directly to the PE rail (main ground) in the switch cabinet.	Rules for the PE terminal (as leakage current >3.5 mA): Use protective conductors with the same cross-section as the mains power cables, though at least 10 mm² copper. Also comply with local and national regulations and conditions.
2.	Connect the protective conductor terminals of all other components, such as mains filter* etc., in a **star configuration** to the PE rail (main ground) in the switch cabinet.	*) Components are only required for the MSD Power Ssupply Unit.

You will find a wiring diagram, also showing the protective conductor terminals, on page 28.

3.5 Electrical isolation method

The control electronics, with its 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.

You therefore need a separate control supply, compliant with the requirements of a SELV/PELV.

The opposite overview shows the potential supplies for the individual terminals in detail.

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

ATTENTION! A special case with regard to insulation and isolation is terminal X5 (motor PTC). In this regard refer to the notes in section 3.13 "Motor connection“ startting on page 35.

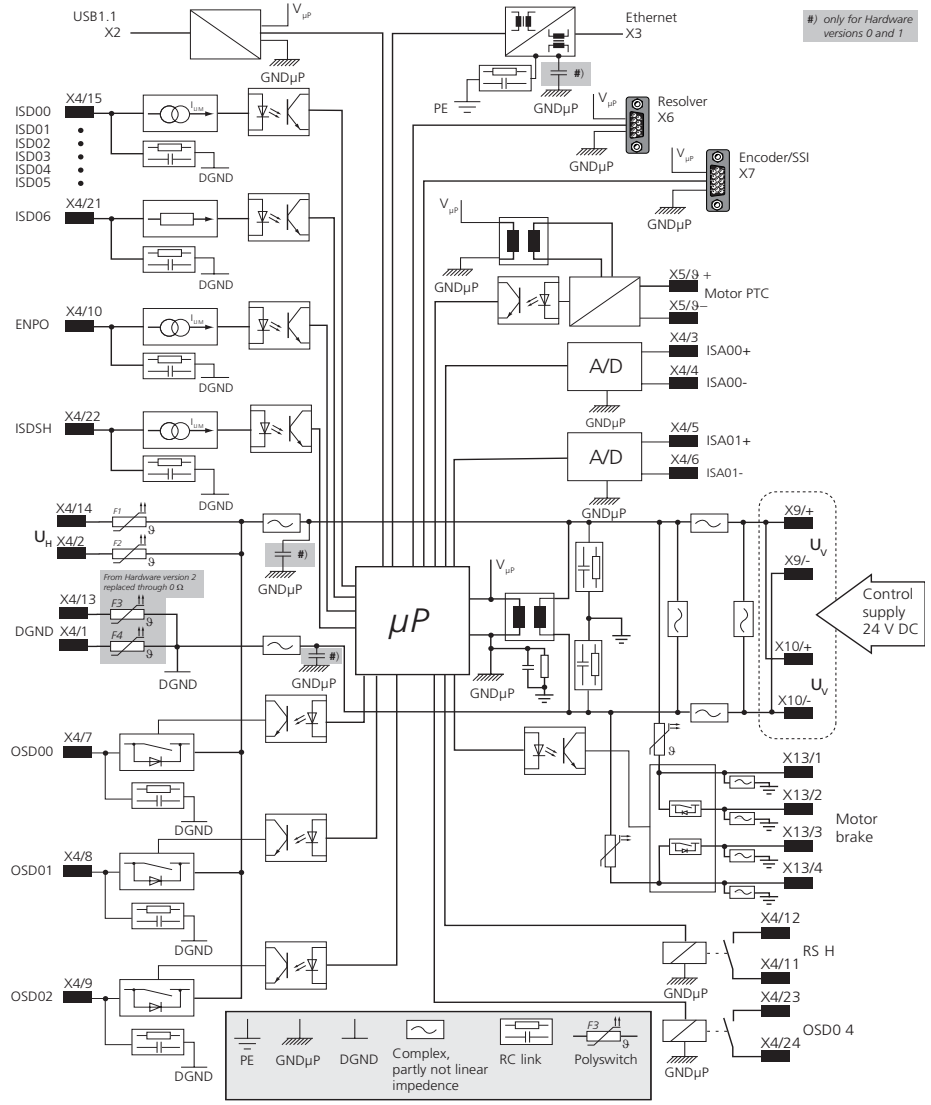


Fig. 3.6 Electrical isolation method Size 1 to Size 4

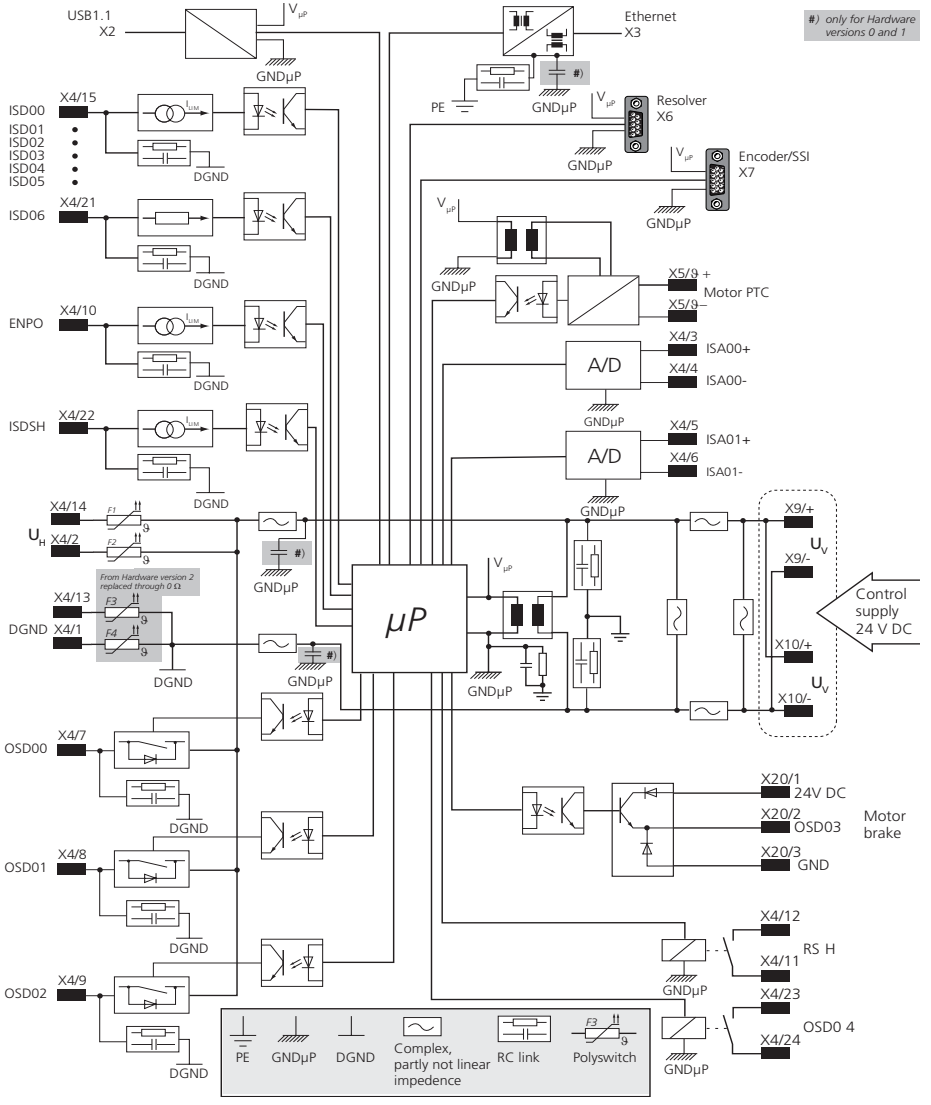


Fig. 3.7 Electrical isolation method Size 5 and Size 6A

3.6 Connection of supply voltage

The power supply for the MSD Servo Drive is separated into the supplies for control and power sections. The control supply must always be connected supply for the control must always be connected **first**, so that actuation of the MSD Servo Drive can first be checked or the device can be parameterized for the intended application.

3.6.1 Connection of control supply (+24 V DC)

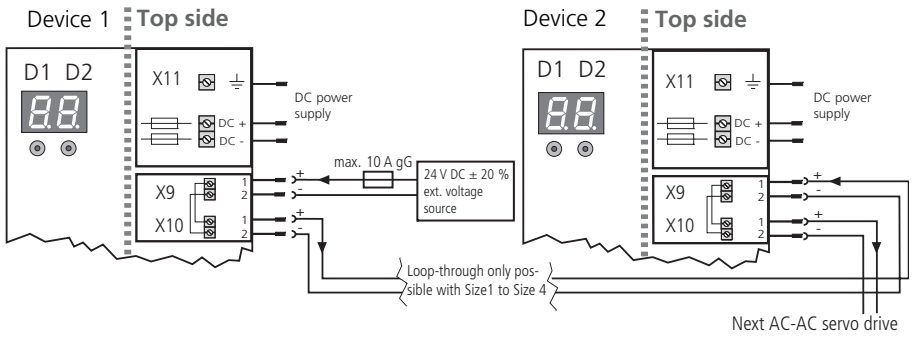


Fig. 3.8 Connection control supply

Terminal/Pin	Specification
X9/1 = + X9/2 = -	• U_V = +24 V DC ±20% (Size 5 and Size 6A +20/-10%), stabilized and filtered • For max. startup and continuous currents see table B.15 on page 78 • Continuous current capacity of terminals max. 10 A (Size 5 and Size 6A max. 8 A), internal polarity reversal protection • The power supply unit used must have a safe and reliable isolation against the mains system according to EN 50178 or EN 61800-5-1. • Internally wired with X10
X10/1 = + X10/2 = -	• Continuous current capacity of terminals max. 10 A (Size 5 and Size 6A max. 8 A) • Internally wired with X9

Table 3.3 Specification control supply

ATTENTION! The control supply (+24 V DC) should be dimensioned according to the maximum current demand. Suitable measures must also be applied to provide adequate cable protection.

NOTE: In the case of sizes Size 1 to Size 4, in addition to the control section the external voltage source also supplies the output for the motor holding brake. When this output is active, the current for the control section plus the current for the motor holding brake plus additional required current for digital inputs and outputs flows through terminal X9. Note this when dimensioning the voltage source for the control section and when looping-through to other devices. For the current demand of the individual device refer appendix B in table B.15 on page 78.

3.6.2 DC power supply connection

Step	Action	Comment
1.	Make sure all MSD Servo Drives DC-AC are arranged in a row and abutting each other.	See mounting instructions in section 2 „Mechanical installation“
2.	For the DC power supply to the DC-AC servo drives use the supplied ready made-up cables. Interconnect all (+) connections and all (-) connections via terminals X11.	The supplied ready made-up cables are as long as the corresponding device is wide.
3.	For more details on the mains power connection of the power supply unit refer to the MSD Power Supply Unit Operation Manual.	

ATTENTION!

- **Connecting cable**
  Use the supplied ready made-up cables for the electrical connections between the devices. If extending the DC link is unavoidable, be sure to comply with the rules set out in section B.5 (page 79). If cables not conforming to the stipulated rules are used, Moog GmbH can provide no guarantee of stable and safe operation.
- **Terminal cover**
  The cover over terminal X11 (DC connection) on sizes Size 1 to Size 5 must be closed after installing the ready made-up cables. Operation without the cover is not permitted.

NOTE: Prior to commissioning, the value of the connected supply voltage must be set in the servo drive. For more details see section 4 "Commissioning“.

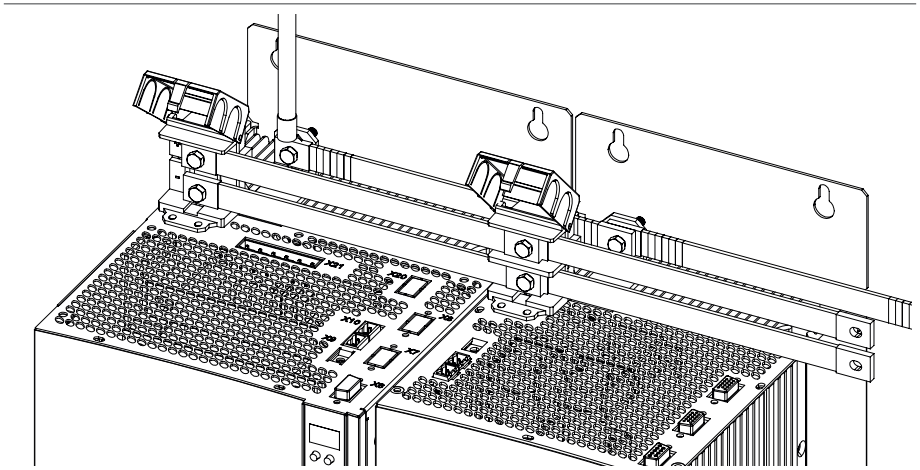


Fig. 3.9 Detail: DC power supply connection, Size 5

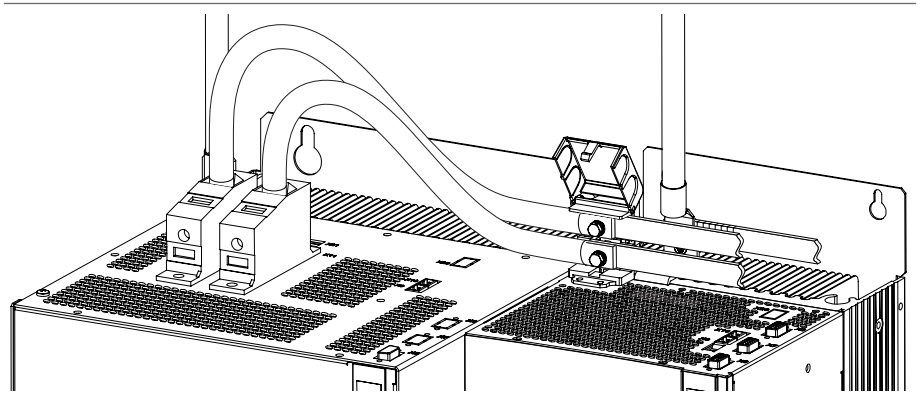
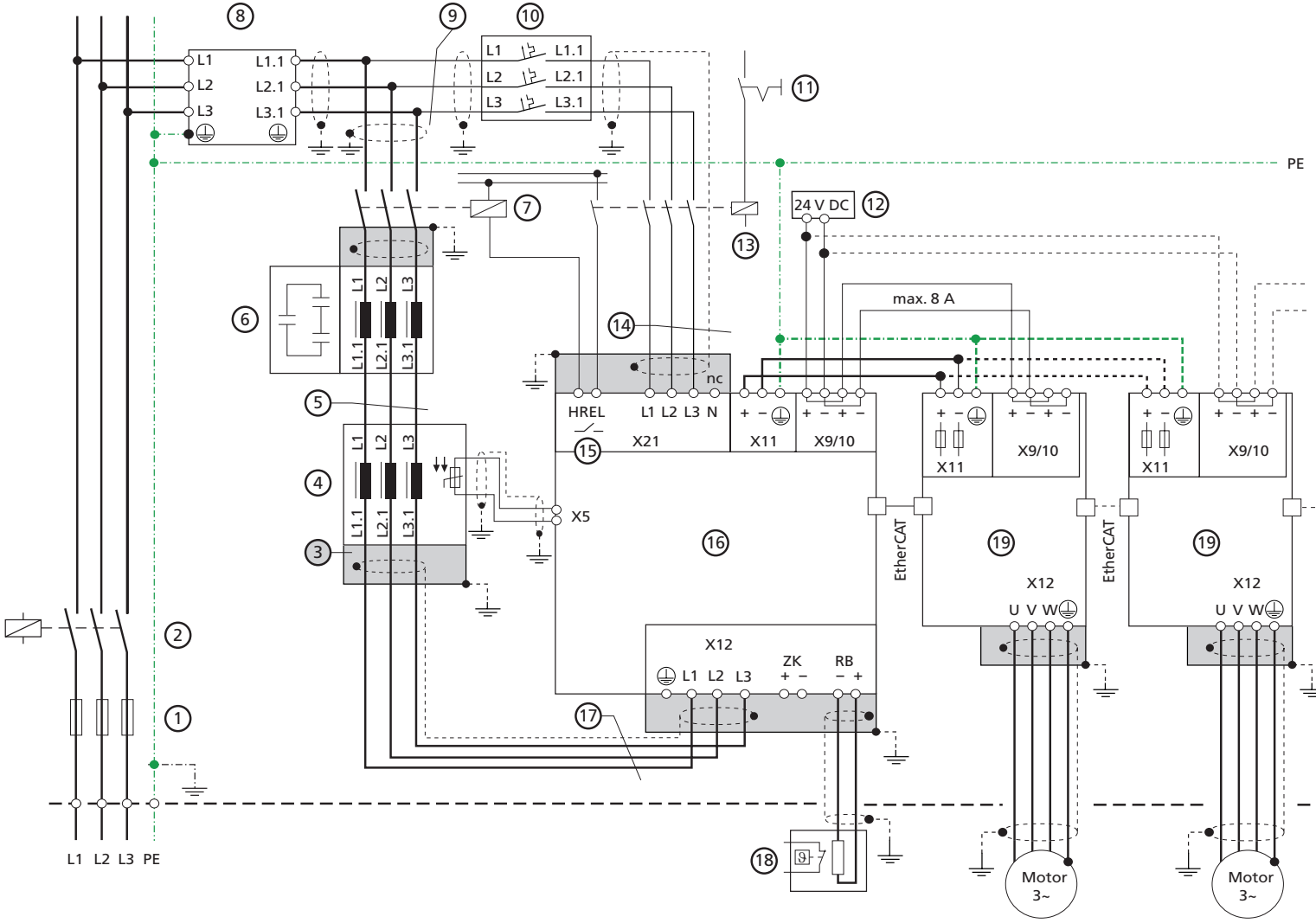


Fig. 3.10 Detail: Size 6A DC power supply connection to smaller DC-AC servo drives



Key

1. Mains fuses
2. Mains supply/Emergency-Off
3. Shields (grey)
4. Step-up reactor with KTY temperature sensor
5. Above an cable length of >500 mm shielded cables should be used
6. Input reactor with membrane capacitor
7. Mains contactor (after precharge by 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 (precharge/ synchronization)
14. Connection of DC link precharge and mains synchronization
15. Floating contact: 250 V AC/5 A or 30 V DC/6 A (active, when precharge complete)
16. MSD Power Supply Unit Size 6A
17. AC power connection
18. Braking resistor
19. MSD Servo Drive DC-AC
20. Switch cabinet
21. Field

Fig. 3.11 Connection for power and control supply and protective conductor in mult-axis system (example)

3.7 Control connections

Step	Action	Comment
1.	Check whether a complete device setup is already available, i.e. whether the drive has already been configured.	
2.	If this is the case, a special control terminal assignment applies. Please contact your project engineer to obtain the terminal assignment!	
3.	Choose a connection assignment.	
4.	Wire the control terminals with shielded cables. The following is strictly required: STO request X4/22, ENPO X4/10 and a start signal (with control via terminal).	Ground the cable shields over a wide area on both sides. Cable corss-sections: 0.2 to 1.5 mm²,with ferrules with plastic sheath max. 0.75 mm²
5.	Keep all contacts open (inputs inactive).	
6.	Check all connections again!	

3.7.1 Specification of control connections

Des.	Term.	Specification	Isolation
Analog inputs			
ISA0+ ISA0- ISA1+ ISA1-	X4/3 X4/4 X4/5 X4/6	• U_{IN} = ±10 V DC • Resolution 12 Bit; R_{IN} approx. 101 kΩ • Terminal scan cycle "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	Default input • Frequency range <500 Hz • Scan 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 default input • Input Touchprobe for fast storage of process data (e.g. actual position) – Internal signal delay Hardware-Version 0..1: ISD05 ↑ Min. 3 µs Max. 16 µs Typ. 8 µs; ISD05 ↓ Min. 4 µs Max. 27 µs Typ. 15 µs; ISD06 ↑↓ Max. 2 µs from Hardware-Version 2: ISD05 + ISD06 ↑↓ Max. 2 µs – Activation via ISD05/ISD06 = 15 (PROBE) • Default input – Frequency range ≤500 Hz – Scan cycle: 1 ms • $U_{IN\ max}$ = +24 V DC +20% • $I_{IN\ max}$ at +24 V DC = 10 mA, R_{IN} = ca. 3 kΩ • Switching level Low/High: ≤4.8 V / ≥18 V	yes
ENPO	X4/10	• Disable restart inhibit (STO) and enable power-stage = High-level • OSSD-capable (from hardware version 2) • Reaction time approx. 10 ms • Switching level Low/High: ≤4.8 V / ≥18 V • $U_{IN\ max}$ = +24 V DC +20% • I_{IN} at +24 V DC = typ. 3 mA	yes

X4

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

Table 3.4 Specification of control connections X4

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Des.	Term.	Specification		Isolation
Digital outputs				
OSD00 OSD01 OSD02	X4/7 X4/8 X4/9	• No destruction in case of short-circuit (+24 V -> GND), but device may briefly shut down • I_{MAX} = 50 mA, PLC-compatible • Terminal scan cycle = 1ms • High-side driver		yes
STO (Safe Torque Off)				
ISDSH (STO)	X4/22	• "Request input" = Low-level • OSSD-capable (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	Diagnosis STO, both tripping channels active, one NO contact with automatically resetting circuit-breaker (polyswitch) • 25 V / 200 mA AC, cos φ = 1 • 30 V / 200 mA DC, cos φ = 1	X4/12 X4/11	yes
Relay 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	
Auxiliary voltage				
+24 V	X4/2 X4/14	• Auxiliary voltage to feed the digital control inputs • $U_H = U_V$-ΔU (ΔU typically approx. 1.2 V), no destruction in case of shot-circuit (+24 V -> GND), but device may briefly shut down. • I_{MAX} = 80 mA (per pin) with self-resetting circuit-breaker (polyswitch)		yes
Digital ground				
DGND	X4/1 X4/13	Reference ground for +24 V, I_{MAX} = 80 mA (per pin), Hardware versions 0..1 with self-resetting circuit-breaker (polyswitch)		yes

X4

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

Table 3.4 Specification of control connections X4

ATTENTION! With high currents flowing through the ground terminals a high resistance isolation from the device ground is required. This may cause incorrect response of the drive (avoid ring currents in the wiring).

NOTE: Note that in the event of a fault the supply unit may no longer be able to feed regenerative power from the DC-AC servo drives back into the grid. In order to prevent destruction of the supply unit braking resistor in sustained regenerative mode, the DC-AC servo drives and power supply unit can be mutually locked via X4. For more information and an example of circuit configuration refer to appendix on page 83.

3.7.2 Brake driver

Connector X13 (Size 1 to Size 4) is intended for connection of a motor brake.

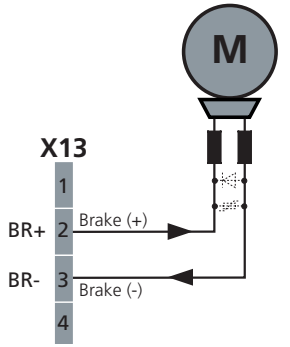
Des.	Term.	Specification	Connection
+24 V BR+ BR- GND	X13/1 X13/2 X13/3 X13/4	• Short-circuit-proof • Voltage supply is via the control supply U_V on X9 or X10 • $U_{BR} = U_V$-ΔU` (ΔU` typically approx. 1.4 V) • To actuate a motor holding brake up to I_{BR} = 2.0 A max., for brakes with higher current requirements a relay must be interposed. • Overcurrent causes shutdown • Also usable as configurable digital output. • Interruptible cable break monitoring <500 mA in condition "1" (up to relay)	

Table 3.5 Specification of terminal connections X13

Connector X20 (Size 5 and Size 6A) is intended for connection of a motor brake.

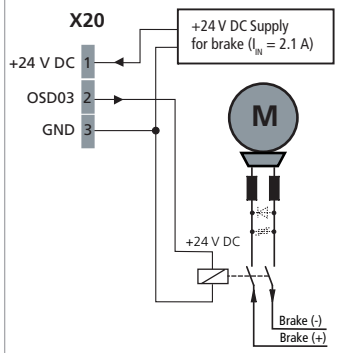
Des.	Term.	Beake driver X20	Connection
+24 V OSD03 GND	X20/1 X20/2 X20/3	• Short-cicuit-proof • External voltage supply 24 V DC (I_{IN} = 2.1 A) required • To actuate a motor holding brake of up to I_{BR} = 2.0 A max., for brakes with higher current requirements a relay must be interposed. • Overcurrent causes shutdown • Interruptible cable break monitoring <200 mA typically in condition "1" (up to relay)	

Table 3.6 Specification of terminal connections X20

3.8 Specification of USB port

The service and diagnostic interface X2 is executed as a USB V1.1 port. It is suitable only for connection of a PC for commissioning, service and diagnosis purposes using the Moog DriveAdministrator 5 software.

Technical specification:

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

3.9 Specification of Ethernet port

The service and diagnostic interface X3 is executed as an Ethernet port. It is suitable only for connection of a PC for commissioning, service and diagnosis purposes using the Moog DriveAdministrator 5 software.

Technical specification:

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

3.10 Option 1

Depending on the MSD Servo Drive variant, option 1 is factory-configured with various options. Fieldbus 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.

3.11 Option 2

Option 2 can be fault-configured with various technology options. Additional or special encoders can be evaluated with it 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.

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3.12 Encoder connection

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

3.12.1 Encoder connection of servo motors

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

3.12.2 Matching motor/encoder cable to servo drive

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

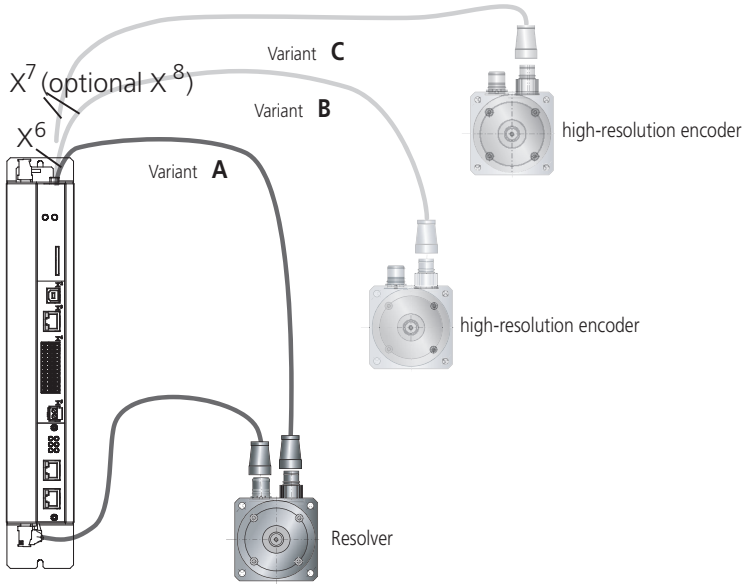


Fig. 3.12 Matching motor/encoder cable

	Motor (with installed encoder)	Encoder cable	Connection of the servo drive
Variant A	with resolver without further option	C08335-011-yyy	X6
Variant B	Sin/Cos multi-turn encoder with SSI/EnDat interface	CA58876-002-yyy	X7
Variant C	Sin/Cos multi-turn encoder with HIPERFACE® interface	CA58877-002-yyy	X7

Table 3.7 Variants of motors, encoder type and encoder cable

NOTE: Do not split 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!

3.12.3 Ready made-up encoder cables

The specifications can only be assured when using the Moog system cables.

Encoder cable	CO8335	-	011	-	yyy
Ready made-up cable					
Resolver cable					
Encoder cable SSI, EnDat	CA58876		002		
Encoder cable Hiperface®	CA58877		002		
Encoder system					
Version					
Cable length (m)					

1) yyy stands for length in meters; standard length: 1 m, 5 m, 10 m, 15 m, 20 m, 50 m. Further length on request

Encoder cable CO8335-011-yyy[1)] Order code

Technical data encoder cable

Technical data	CO8335-011-yyy [1)]	CA58876-002-yyy [1)]	CA58877-002-yyy [1)]
Motors with encoder system	Resolver	G3, G5, G12.x (single-turn / multi-turn encoder with SSI/EnDat interface)	G6, G6.x (single-turn / multi-turn encoder with HIPERFACE® interface)
Controller-end assignment (sub-D connector)	1 = S2 2 = S4 3 = S1 4 = n.c. 5 = PTC+ 6 = R1 7 = R2 8 = S3 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+ EIA485 5 = Data- EIA485 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 bend radius	90 mm	100 mm	90 mm
Temperature range	-40 ... +85 °C (-40 ... +185 °F)	-35 ... +80 °C (-31 ... +176 °F)	-40 ... +85 °C (-40 ... +185 °F)

Table 3.8 Technical data encoder cable

Technical data	CO8335-011-yyy [1)]	CA58876-002-yyy [1)]	CA58877-002-yyy [1)]
Cable diameter approx.	8.8 mm		
Material of outer sheath	PUR		
Resistance	Resistant to oil, hydrolysis and microbic attack (VDE0472)		
Approvals	UL-Style 20233, +80 °C (+176 °F) - 300 V, CSA-C22.2N.210-M90, +75 °C (+167 °F) - 300 V FT1		

Table 3.8 Technical data encoder cable

3.12.4 Resolver connection

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

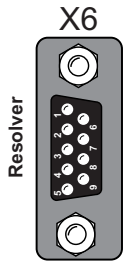
Fig.	X6/Pin	Function
	1	Sin+ / (S2) analog differential input track A
	2	Refsin / (S4) analog differential input track A
	3	Cos+ / (S1) analog differential input track B
	4	Supply voltage 5..12 V, internally connected to X7/3
	5	Do not connect anything!
	6	Ref+ analog excitation
	7	Ref- analog excitation (ground reference point to pin 6)
	8	Refcos / (S3) analog differential input track B
	9	Do not connect anything!

Table 3.9 Pin assignment X6

3.12.5 Connection for high-resolution encoders

Interface X7 enables evaluation of the following encoder types.

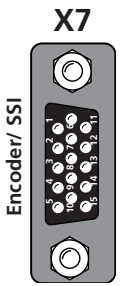
Fig.	Function
	**Sin/Cos encoder with zero pulse** e.g. Heidenhain ERN1381, ROD486
	Heidenhain Sin/Cos encoder with EnDat interface e.g. 13 bit single-turn encoder (ECN1313.EnDat01) and 25 bit multi-turn encoder (EQN1325-EnDat01)
	Sin/Cos encoder with SSI interface e.g. 13 bit single-turn and 25 bit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

Table 3.10 Suitable encoder types on X7

NOTES:

- The usage of encoders not included in the range supplied by Moog GmbH requires special approval by Moog GmbH.
- 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 encoder cable detects the actual supply voltage at the encoder, thereby compensating for the voltage drop on the cable. Only use of the sensor cable ensures 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, bearing in mind the following:

- Always use shielded cables. The shield is to be connected at both ends.
- Connect the differential track signals A, B, R or CLK, DATA to each other via twisted wires.
- Do not separate 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®
	1	A-	A-	-	REFCOS
	2	A+	A+	-	+COS
	3	+5 V DC ±5%, IOUT max = 250 mA (150 mA for Hardware versions 0..1), monitoring via sensor cable			7 to 12 V (typ. 11 V) max. 100 mA
	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 -	-
	14	-	CLK+	CLK+	-
	15	-	CLK -	CLK -	-

The sum of the currents drawn at X7/3 and X6/4 must not exceed the value given!

After connecting pin 7 to pin 12 a voltage of 11.8 V is applied to X7, pin 3!

Table 3.11 Pin assignment of connector X7

NOTE: The encoder supply on X7/3 is short-circuit proof in 5 V and 11 V operation. The drive remains in operation such that on the evaluation of encoder signals a corresponding error message can be generated.

3.13 Motor connection

Step	Action	Comment
1.	Specify the cable cross-section dependent on the maximum current and ambient temperature.	Cable cross-section according to local and country-specific regulations and conditions.
2.	Connect the shielded motor cable to terminals X12/ U, V, W and ground the motor to ⏚.	Mount shield at both ends to reduce interference emission. Secure shield connection plate of motor terminal X12 by **both** screws.
3.	Wire the temperature sensor (if present) to X5 using separately shielded cables and activate the temperature evaluation via DriveAdministrator 5.	Mount shield at both ends to reduce interference emission.

ATTENTION! For terminal X5 it must be ensured that the temperature monitor used is equipped with a basic isolation in accordance with 61800-5-1 against the motor winding.

NOTE: In the event of a short-circuit or ground fault in the motor cable, the power stage is disabled and an error message is generated.

3.13.1 Connection of synchronous motors

ATTENTION! Use only motors permitting connection of the motor temperature monitor solely to X5 of the DC-AC servo drive. This must be expressly specified when ordering the motor.

NOTE: Please use a ready made-up motor cable from Moog GmbH to connect the servo motor series.

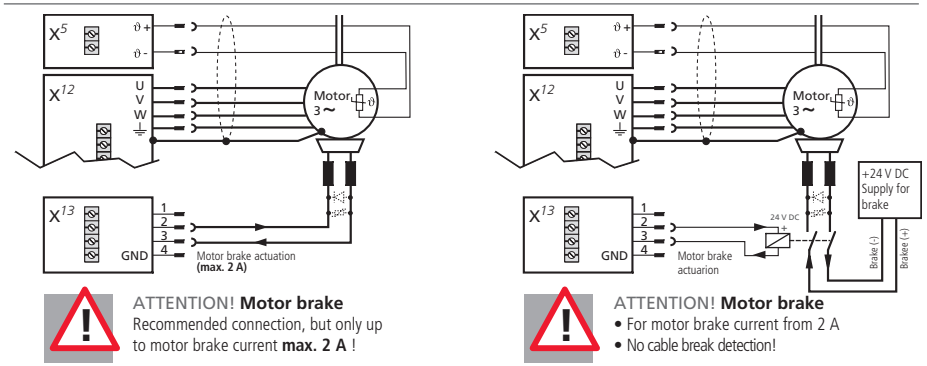


Fig. 3.13 Connection options of motors Size 1 to Size 4

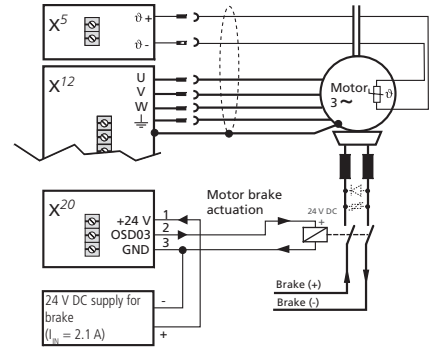


Fig. 3.14 Connection of motors Size 5 and Size 6A

3.13.2 Ready made-up motor cable

CO8336 - xxx yyy[1)]

Ready made-up motor cable

Configuration option

Cable length (m)

1) yyy stands for length in meters; standard length: 1 m, 5 m, 10 m, 15 m, 20 m, 50 m. Further length on request

Motor cable CO8336-xxx-yyy Order code

Technical data motor cable

Technical data	C08336-xxx-yyy[1),2)]	CB05708-xxx-yyy[1),2)]
Continous rated current	10 A	TBD
Surge current	30 A (90s at +72.7 °C) (+162.9 °F)	TBD
Minimum bend radius	In fixed installation: 60 mm In flexible use: 120 mm	TBD
Cable diameter range	9 to 14.4 mm	TBD
Cable cross-section	4 x 1.5 mm² + 2 x 1 mm²	4 x 4 mm² + 2 x 1.5 mm²
Temperature range	-50 °C to +90 °C (-58 °F to +194 °F)	TBD
	Connector pin / Wiring	
Wiring	2 / U 4 / VV 1 / WWW PE / yellow; green 5 / Brake +; white 6 / Brake -; black Connector housing / Screen	
Connector type	Size 1	

2) xxx-001 for standard configuration option, others on request

Table 3.12 Technical data motor cable (Connector type Size 1)

Technical data	C08733-xxx-yyy[1),2)]	B47916-xxx-yyy[1),2)]	CA98676-yyy[1),2)]
Continous rated current	44 A	61 A	82 A
Surge current	TBD		
Minimum bend radius	In fixed installation: 60 mm In flexible use: 120 mm	TBD	
Cable diameter range	16.2 ±3 mm	TBD	
Cable cross-section	4 x 6 mm² + 2 x 1 mm²	4 x 10 mm² + 2 x 1.5 mm²	4 x 16 mm² + 2 x 1.5 mm²
Temperature range	-50 °C to +90 °C (-58 °F to +194 °F)	TBD	
	Connector pin / Wiring		
Wiring	U / U V / VV W / WWW PE / yellow; green + / Brake +; white - / Brake -; black Connector housing / Screen		
Connector type	Size 1.5		

2) xxx-001 for standard configuration option, others on request

Table 3.13 Technical data motor cable (Connector type Size 1.5)

3.13.3 Switching in the motor cable

ATTENTION! Switching in the motor cable must take place with the power cut and the power stage disabled, as otherwise problems such as burned-off contactor contacts may occur. In order to ensure unpowered switch-on, you must make sure that the contacts of the motor contactor are closed before the servo drive power stage is enabled. At the moment the contactor is switched off it is necessary for the contact to remain closed until the servo drive power stage is shut down and the motor current is 0. This is done by inserting appropriate safety times for switching of the motor contactor in the control sequence of your machine.

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

4 Commissioning

4.1 Notes for operation

ATTENTION!

- **Safety instructions**
  Observe the safety instructions set out in chapter 1 during operation.
- **During operation**
  be sure to avoid ...
  – penetration of the device by foreign bodies or damp;
  – aggressive or conductive substances in the immediate vicinity;
  – covering over vent openings.
- **Cooling**
  – The device heats up in operation and at the heat sink may reach temperatures of up to +100 °C (+212 °F). It poses a risk of skin burns if touched.
  – Cooling air must be able to flow through the device without restriction.

NOTE: For commissioning and operation of the DC-AC servo drive within a MSD Servo Drive multi-axis system, be sure also to refer to the Operation Manual for the MSD Power Supply Unit or the supplying MSD Servo Drive AC-AC.

4.2 Initial commissioning

When the MSD Servo Drive DC-AC has been installed as per section 2 and wired with all required voltage supplies and external components as per section 3, initial commissioning is carried out in the following steps:

Step	Action	Comment
1.	Installing and starting the PC software	see Moog DriveAdministrator 5 Installation Manual
2.	Switching on control voltage	see section 4.2.1
3.	Connecting PC and servo drive	see section 4.2.2
4.	Parameter setting	see section 4.2.3
5.	Controlling the servo drive with DriveAdministrator 5	see section 4.2.4

NOTE: Details relating to "STO" (Safe Torque Off) are not taken onto consideration 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).

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4.2.1 Switching on control voltage

2. For initialization and parameter setting, first switch on only the 24 V control voltage. Do **not yet** switch on the power supply.

Display readout after switching on the control supply

D1	D2	Action	Explanation
		Switch-on of ext. 24 V control voltage	Initialization in progress
		Initialization complete	Not ready for start

Table 4.1 Switch-on status of MSD Servo Drive (after connection of the 24 V DC control voltage)

NOTE: For details on the control supply refer to section 3.6 “Connection of supply voltage” starting on page 26.

4.2.2 Connecting the PC and servo drive

3. The PC can be connected to the servo drive via USB or Ethernet (TCP/ IP). Connect the PC and servo drive to the corresponding cables.

NOTES:

- **Initialization**
  Communication between the PC and the servo drive can only be stablished once the servo drive has completed its initialization.
- **USB driver and TCP/IP configuration**
  If the PC does not detect the connected servo drive, check the driver and the settings of the relevant interface (see Moog DriveAdministrator 5 Installation Manual).

4.2.3 Parameter setting

4. For drive system setup Moog DriveAdministrator 5 includes a Commissioning Wizard.Start the Wizard.

NOTES:

- **Online help**
  For a detailed description of Moog DriveAdministrator 5 and of the Commissioning Wizard, refer to the Moog DriveAdministrator 5 Online Help.
- **Motordata set**
  When using Moog servo motors, the latest version of the necessary motor data set can be obtained from the “Downloads” section at http://drives-support.com.

4.2.4 Controlling the drive with Moog DriveAdministrator 5

5. Switch on the power supply. Then enable the power stage and activate the control. The drive should be tested with no coupled mechanism.

DANGER FROM ROTATING PARTS! Danger to life from uncontrolled rotation! Before motors with a feather key at the shaft end are commissioned, the feather key should be secured against being ejected, if this cannot be prevented by drive elements such as pulleys, couplings, or the like.

ATTENTION!

- **Avoid damage by motor test run!**
  In this case it must be ensured that the test will not cause any damage to the system! Pay particular attention to the limitations of the travel range. Please note that you yourself are responsible for safe operation.
  Moog GmbH cannot accept liability for any damage incurred.

- **Destruction of the motor**
  - The motors are intended for operation on the servo drive. Direct connection to the mains supply may destroy the motor.
  - The motor surfaces may become extremely hot. Temperature-sensitive items should therefore not be placed on top of or attached to the motors. Protective measures may be needed to prevent touching.
  - In order to avoid overheating of the motor, the temperature sensor installed in the winding must be connected to the terminal of the servo drive temperature monitor (X5).
  - The motor brake (if installed) should be checked for fault-free functioning before commissioning of the motor. The optionally installed standstill holding brake is only designed for a limited number of emergency braking operations. Use as a working brake is prohibited.

Display readout after switching on the power supply

D1	D2	Action	Reaction	Explanation
5	2	Switching on the power supply	Open-loop control ready, power stage ready, closed-loop control disabled	Device is ready to switch on

Table 4.2 Display D1/D2 after switching on the mains supply

NOTES:

- **Inputs "ISDSH" and "ENPO"**
  For step 1 from table 4.3 the two inputs "ISDSH" and "ENPO" of terminal X4 must be configured as a minimum.
- **Readiness**
  When operating with an AC-AC servo drive as the supply, all DC-AC servo drives in the system must be in state 2 (ready for operation) before the first axis starts up.
- **Manual mode dialog**
  The best way to execute step 2 from table 4.3 is via the "Manual mode" dialog of Moog DriveAdministrator 5. For details refer to the Online Help.
- **Configuration of inputs/outputs**
  If step 2 is to be executed via the inputs of terminal X4, the sources for "START CONTROL" and speed reference setpoint should be configured accordingly in the "Inputs/outputs" subject area of Moog DriveAdministrator 5.

Power-up sequence to start the drive

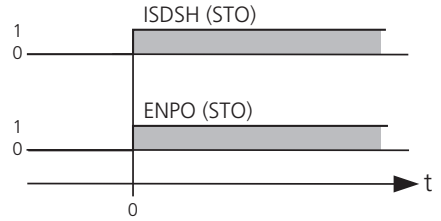
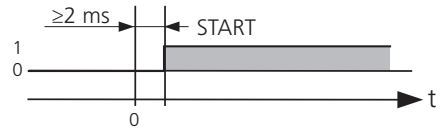
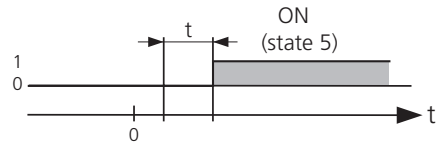
1. Disable "STO" safety function by setting inputs "ISDSH" and "ENPO"	
2. Activate "START CONTROL" at the earliest 2 ms after step 1 and set the reference speed	
3. Observe your system/ plant and check the drive response.	
t = Motor-dependent delay time	

Table 4.3 Power-up sequence

Display readout after drive start-up

D1	D2	Action	Reaction	Explanation
3		"STO" and power stage "ENPO" enabled	Ready for start	Power stage ready
ATTENTION! Make sure before the next step, "Start enable", to preset a plausible setpoint value by way of the analog input! The presetting is transferred directly to the drive when motor control starts.				
5		"Start" enabled	On	Drive powered, control active

Table 4.4 Display D1, D2 during motor activation

For details on adapting the drive in your application refer to the Moog DriveAdministrator 5 Online Help and the MSD Servo Drive Application Manual.

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4.3 Serial commissioning

An existing parameter data set can be transferred to other MSD Servo Drives using Moog DriveAdministrator 5 or a MMC card. For details refer to the Moog DriveAdministrator 5 Online Help or section 4.4.

NOTE: iPlc programs can only be installed on a MSD Servo Drive using the CoDeSys programming system.

4.4 Integrated operator control unit and MMC card

The built-in operator control unit permits diagnosis of the MSD Servo Drive. In addition, use of the MMC card aids serial commissioning without a PC. The operator control unit comprises the following elements, all located on the front of the device:

- 2-digit 7-segment display (D1, D2)
- two pushbuttons (T1, T2)
- MMC slot (X1)
  Moog MMCplus cards of type SC-MMC128 can be used (128 MB memory and 3.3 V supply voltage, for further details see MSD Servo Drive Ordering Catalog).

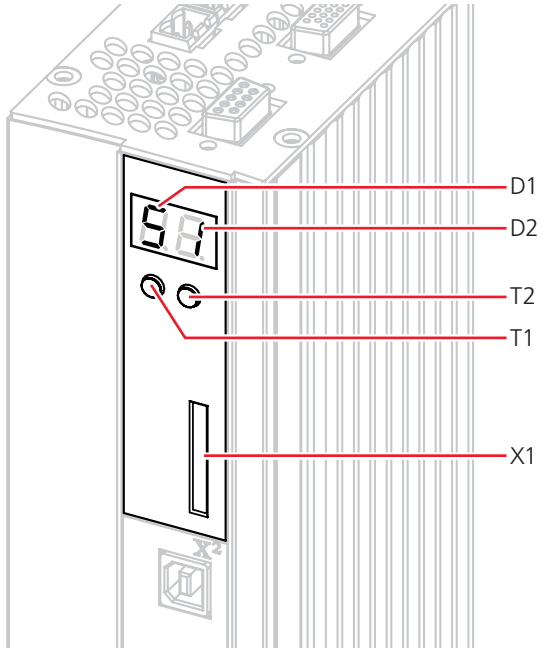

Fig. 4.1 Integrated operator control unit

The following functions and displays are available:

- Display of device state (see section 5.1.1 starting on page 47)
  The device state is displayed after switching on the control voltage. If no input is made via the keypad for 60 seconds, the display switches back to the device state.
- Display of device error state (see section 5.1.2 starting on page 47)
  If a device error occurs the display immediately switches to show the error code.
- Parameter setting (display "PA") (see section 4.4.3 starting on page 43)
  Reset device parameters to factory defaults and data set handling by way of the MMC card
- Ethernet IP address setting (display "IP") (see section 4.4.4 starting on page 44)
  Setting of the Ethernet IP address and the subnet mask
- Fieldbus settings (display "Fb") (see section 4.4.5 starting on page 45)
  Setting of fieldbus address for example
- Firmware update with MMC card (see section 4.4.6 starting on page 46)

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4.4.1 Functions of buttons T1 and T2

By way of the keypad the different menus are activated and the relevant functions controlled.

Button	Function	Comment
T1 (left	• Activate menu (quit device state display) • Scroll through menus/submenus • Set values - left-hand segment display (D1)	Button T1 can be held down for any length of time, as the display merely scrolls through the available menu items at the respective level. No settings are changed.
T2 (right)	• Select the highlighted menu • Set values - right-hand segment display (D2)	Button T2 must **not** be held down for any length of time, as the display would then immediately move up in the menu structure from one level to the next and alter the parameter ultimately reached. So be sure to release button T2 every time the display changes.
T1 and T2 simultaneous	• Menu level up • Apply selection • Acknowledgement	After simultaneously pressing T1 and T2 the applied value flashes for five seconds. During this time the save operation can be aborted by pressing any button without the setting being applied. Otherwise the new value is saved after five seconds.
General		• The button press time until anaction is executed is around 1 second. • If no user action occurs for 60 seconds, the display switches back to the device status.

Table 4.5 Functions of buttons T1 and T2

4.4.2 Display

The following table defines various readouts and items of status information shown on the display.

Display	Meaning
	Menu entries ("PA" is given as an example here; for other possible entries see sections 4.4.4 and 4.4.5)
	[flashing decimal points] Selected function in action (e.g write to/read from MMC card)
	[two lines] Entry/function not available
	[OK] Action completed successfully, no errors
	[Error] • Action via operator control unit **not** completed successfully, "Er" flashes alternately with error number (see section 4.4.3) • Device error display, "Er" flashes alternately with error number and error location (see "MSD Servo Drive Application Manual")
	Numerical values ("10" is by way of example in this case) • On the Parameters menu (PA) data set and error numbers are displayed in **decimal** format. • All other values are displayed in **hexadecimal** format. In those cases the displayed "10" would represent the decimal value 16.

Table 4.6 Meaning of display

NOTE: If no input is made via the keypad for 60 seconds, the display switches back to the device state.

4.4.3 Parameter menu (PA)

On the Parameters menu the following functions are available::

- Reset device settings to factory defaults
- Data set handling with MMC card

NOTES:

- It is only possible to operate the MMC if the power stage is **not** active.
- Accessing the MMC may as long as 2 minutes. During this time both decimal points flash.

Menu level 1	Menu level 2	Parameter	Value range	Meaning	Explanation
PA	Pd	-	00..99	Parameter download *)	100 data sets (0..99) can be read from the path: \PARA\TRANSFER\PDSxx.dmd (xx = 00.99) by the MMC.
	Pu	-	00..99	Parameter upload *)	100 data sets (0..99) can be stored on the MMC in the directory \PARA\ TRANSFER\PDSxx.dmd . The directory is generated automatically. Existing data sets may be overwritten.
	Pr	-	-	Parameter reset	Reset device settings to factory defaults.
	Pc	-	-	Parameter clear	Clear all data sets on the MMC card.

*) *It is only possible to operate the MMC if the power stage is **not** active. Accessing the MMC may as long as 2 minutes.*

Table 4.7 Parameter menu

Error numbers

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

NOTE: The error messages displayed during user input should not be confused with drive error messages. For detailed information on the error codes and on error management refer to the "MSD Servo Drive Application Manual".

Error number	Meaning
00	File System No Error
01	File System Any file system error
02	File System command rejected
03	File System function parameter invalid
04	File System create file error
05	File System open file error
06	MMC create directory failed
07	MMC mounting error
08	MMC unmounting error
09	MMC using not allowed with current technology option card
10	MMC error uninstall X12 card
11	MMC not inserted
12	MMC mounting, create node
13	MMC not supported by hardware (not NSP 257)
14	MMC device in control enabled
15	MMC load parameter dataset to device failed
16	MMC save parameter dataset failed
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 4.8 Error numbers

4.4.4 Ethernet IP address menu (IP)

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

Menu level 1	Menu level 2	Parameter	Value range	Meaning	Explanation
IP	Iu	b0	00..FF	IP address udate Byte 0	Setting of byte 0 of the IP address in hexadecimal format (e.g. "5" at 192.168.39.**5**)
		b1	00..FF	IP address udate Byte 1	Setting of byte 1 of the IP address in hexadecimal format (e.g. "7" at 192.168.**39**.5)
		b2	00..FF	IP address udate Byte 2	Setting of byte 2 of the IP address in hexadecimal format (e.g. "A8" at 192.**168**.39.5)
		b3	00..FF	IP address udate Byte 3	Setting of 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 default (192.168.39.5)
	Su	b0	00..FF	Subnet mask udate Byte 0	Setting of byte 0 of the subnet mask in hexadecimal format (e.g. "00" at 255.255.255.**0**)
		b1	00..FF	Subnet mask udate Byte 1	Setting of byte 1 of the subnet mask in hexadecimal format (e.g. "FF" at 255.255.**255**.0)
		b2	00..FF	Subnet mask udate Byte 2	Setting of byte 2 of the subnet mask in hexadecimal format (e.g. "FF" at 255.**255**.255.0)
		b3	00..FF	Subnet mask udate Byte 3	Setting of byte 3 of the subnet mask in hexadecimal format (e.g. "FF" at **255**.255.255.0)
	Sr	-	-	Subnet mask reset to factory setting	Reset subnet mask to factory default setting (255.255.255.0)

Table 4.9 IP address menu

Example configuration of subnet mask

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

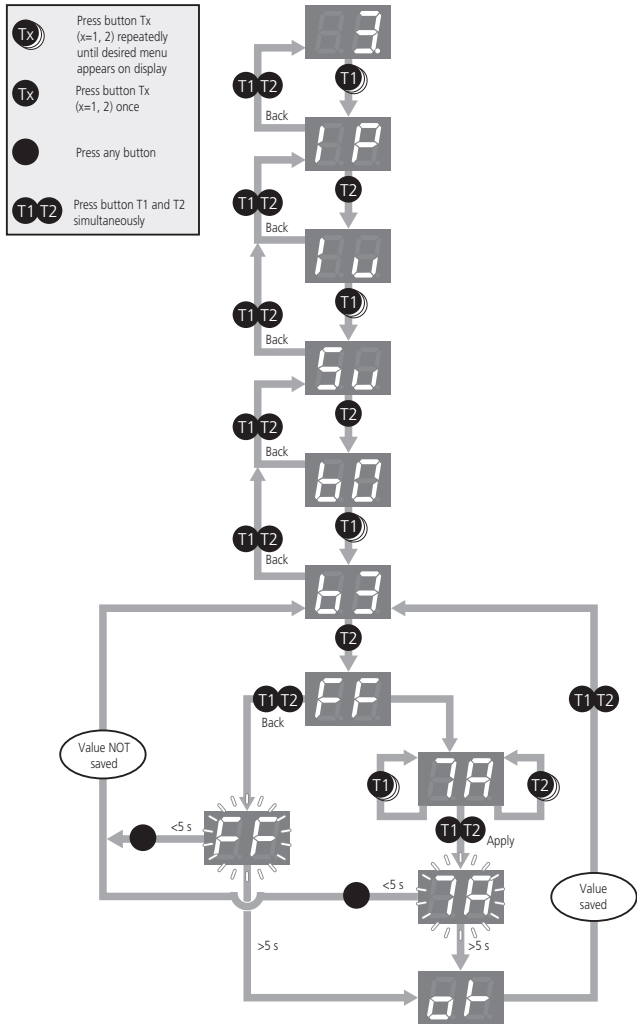

Fig. 4.2 Example configuration of subnet mask

NOTES:

- During the flash phase after step 7 the save operation can be aborted by pressing any button without the setting being applied. Otherwise the new value is saved after five seconds.
- Without a restart of the control electronics a changed IP address is not applied.

4.4.5 Fieldbus address menu (Fb)

The functions available under this menu item depend on the device expansion option. For detailed information refer to the relevant specification.

Menu level 1	Menu level 2	Param-eter	Value range	Meaning	Explanation
Fb	Ad	-	00..xx *or* - -	Fieldbus address	Setting of fieldbus address (only when fieldbus option used), otherwise display "- -" *(The maximum programmable value depends on the option)*
	Po	-	0..3 *or* - -	Transmit power	Setting of fibre-optic power output (only with SERCOS II option), otherwise display "- -"

Table 4.10 Fieldbus address menu

Example configuration of fieldbus address

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

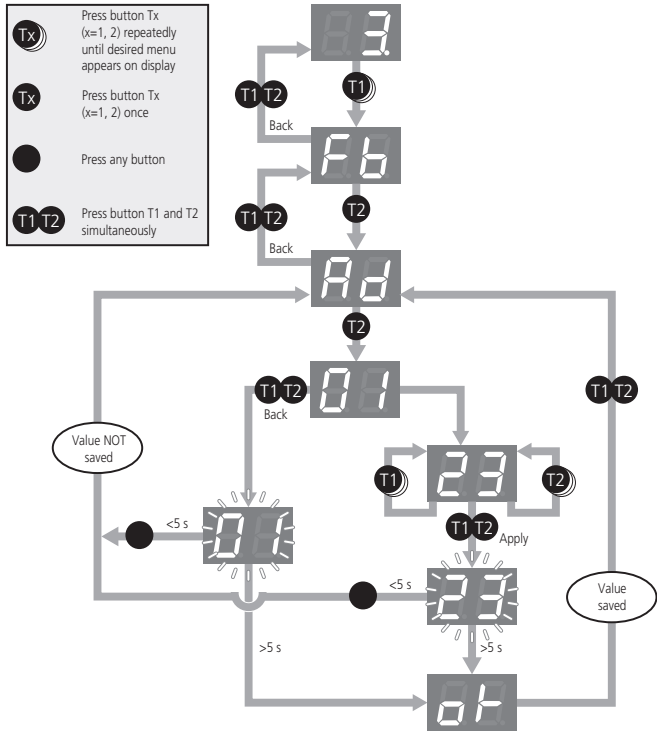

Fig. 4.3 Example configuration of fieldbus address

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4.4.6 Firmware update with MMC card

The MMC card can be used to perform a firmware update for the MSD Servo Drive. For this, the HEX file of the update firmware must be copied under the name “main.hex” to the “\Firmware\” folder in the root directory of the MMC card.

Connect the preconfigured MMC card to the MSD Servo Drive. Then perform a reset of the 24 V DC control supply by pressing both buttons (T1 and T2) simultaneously. When the display shows the code “c1” you can release the buttons.

The progress of the firmware update is indicated on the display by a flashing dot after D2 and consecutively by “c1” ... “c4”. When the update has been completed successfully the new firmware starts up as normal. In the event of an error the code “cE” is displayed. In this case a reset of the 24 V DC control supply must be performed and the download repeated.

5 Diagnostics

5.1 Status display on device

The device states are displayed on the device by way of the 7-segment display.

5.1.1 Device states

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

**) Not a "safe indication" as specified in EN 61800-5-2.*
*1) **S.** flashes when the STO (Safe Torque Off) function is active, display goes out when function is inactive.*
2) The dot flashes when the power stage is active.

Table 5.1 Device states

5.1.2 Error display

The 7-segment display shows the specificerror codes. 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 jumps to ER	

Table 5.2 Display of error codes

NOTE:

- **Error reset**
  Errors can be reset according to their programmed reaction (ER) or only by a 24 V reset (X9/10) (ER.). Errors marked with a dot can only be reset when the cause of the error has been eliminated.
- **Error code**
  For detailed information on the error codes and on error management refer to the "MSD Servo Drive Application Manual".

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5.2 Status and error display in MDA 5

Click the "Drive status" button on the MDA 5 header to open the drive status window.

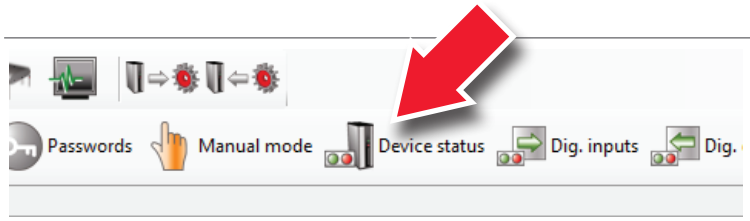


Fig. 5.1 "Drive status" button on header

Click the "Error history..." button to call up information on the last 20 occurring errors.

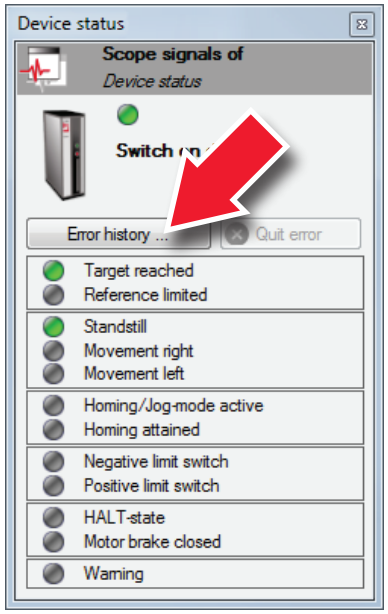


Fig. 5.2 "Drive status" window

When an error occurs a pop-up window immediately appears showing more details about the current error.

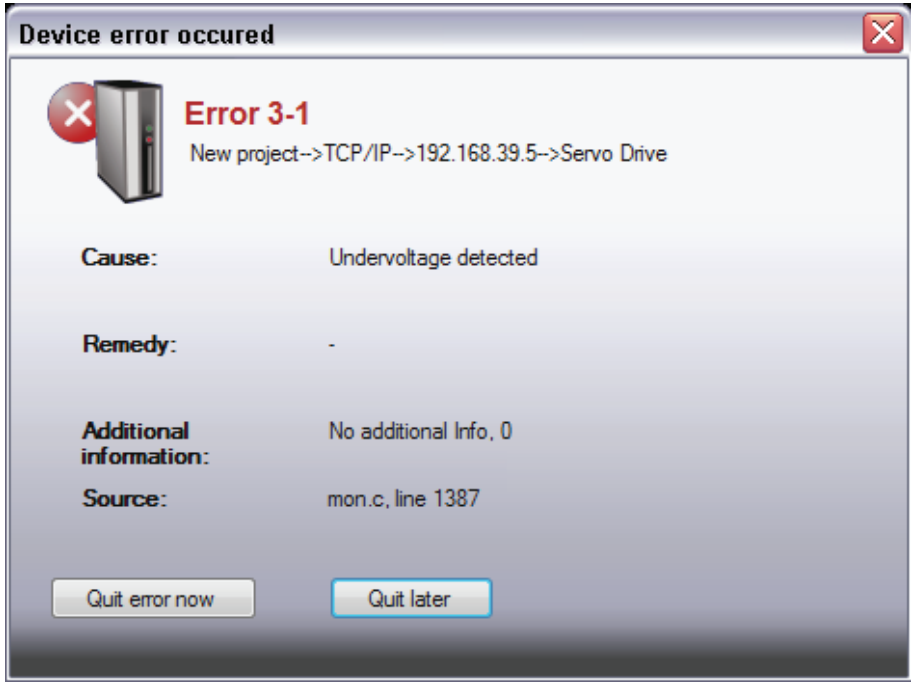
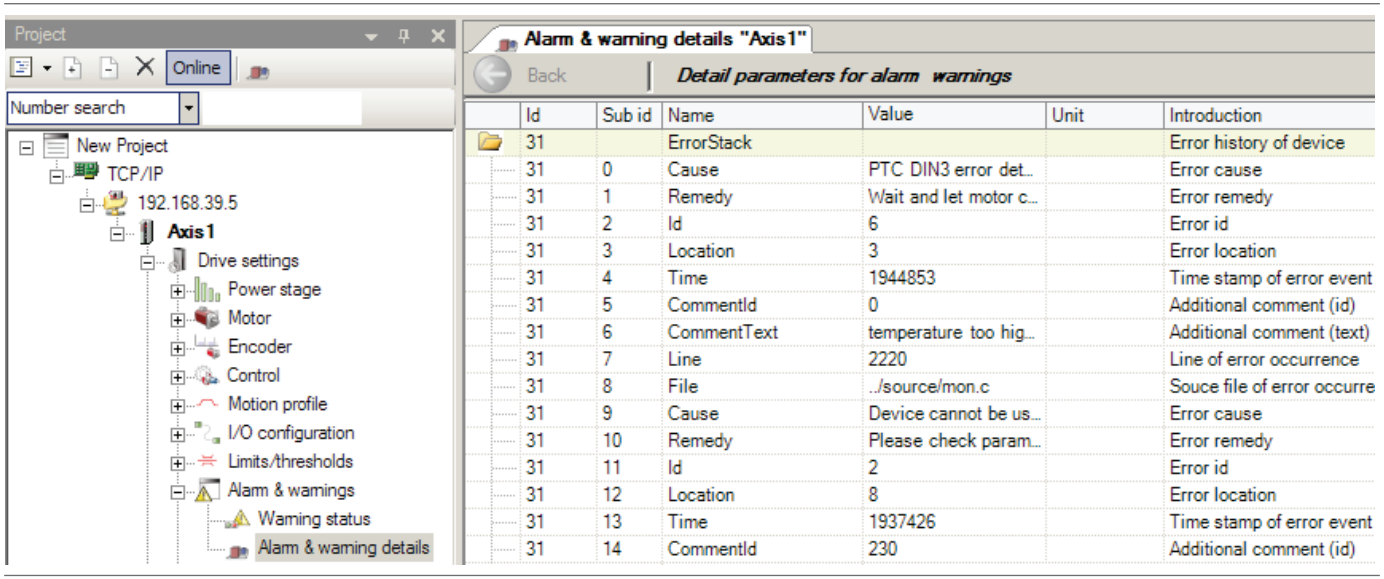


Fig. 5.3 Error message

Parameter 31 "Alarms & Warnings (Details)" gives detailed information about occurring errors and warnings.

1. In the "Project" window at the top in the header area select "Number search" and in the search box enter the number "31".
2. Then, in the project tree which opens up, double-click on the lowest level, "Alarms & warnings (Details)".

NOTE: More detailed information on parameter 31 can be found in the MSD Servo Drive Application Manual.



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)

Fig. 5.4 Parameter 31 "Alarms & Warnings (details)"

5.3 Helpline/Support & Service

Our Helpline can provide you with fast, targeted assistance if you have any technical queries relating to project planning or commissioning of the drive unit. To that end, please collect the following information prior to making contact:

1. Type designation, serial number and software version of the devices (see software rating plate)
2. Moog DriveAdministrator version in use (Menu: ►Help ►Information... ►Version)
3. Displayed error code (on 7-segment display or Moog DriveAdministrator)
4. Description of the error symptoms, how it occurred and relevant circumstances
5. Save device settings to file in Moog DriveAdministrator
6. Name of company and contact, telephone number and e-mail address

If you have any technical questions concerning project planning or commissioning of the drive unit, please feel free to contact our helpline.

- Helpline - Please contact us:
  Moog GmbH
  Hanns-Klemm-Straße 28
  D-71034 Böblingen
  Phone: +49 7031 622 0
  Telefax: +49 7031 622 100
  E-Mail: drives-support@moog.com

If you need further assistance, our specialists at the Moog Service Center will be happy to help.

- Service - Please contact us:
  Phone: +49 7031 622 0
  E-Mail: info.germany@moog.com

6 Safe Torque Off (STO)

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

Space for your personal notes

7 Operation with AC-AC servo drive as supply

NOTE: **Project planning**
For assistance in choosing the optimum operation mode (with power supply unit or AC-AC servo drive) refer to appendix starting on page 59.

ATTENTION! **Refer to the AC-AC servo drive operation manual!**
When constructing a multi-axis system with AC-AC servo drives as the supply source, be sure to refer to the „MSD Servo Drive AC-AC Operation Manual" (Id. no. CA65642-001).

7.1 Layout of devices and components

The placement of components in the switch cabinet is a key factor in operating the plant and machinery of the multi-axis system without disturbance. So be sure to observe the following points when planning:

- The "Notes for installation" on page 11 and the "Notes for installation" on page 19 ff. apply without restriction.

Also note the following points:

- Assess the assemblies used in terms of their electromagnetic compatibility.
- Then divide the switch cabinet into zones of differing power and interference levels and group the modules accordingly.
- Keep units susceptible to interference at a minimum clearance of 0.2 metres from the following components:
  - Servo drive
  - Input and output reactors
  - Transformers
  - Mains, motor, DC power supply and braking resistor cables (even if shielded)
  - Relays and contactors (even if interference-suppressed)
- The mains filter must be sealed tight as far as possible at the AC-AC servo drive (Size 1 to Size 4) or be mounted on the backing plate across a wide area at the feed-in point (Size 5 to Size 7).
- The backing plate must have a low-resistance connection to the central grounding point.
- No unshielded cables may be routed on the mains input side of the filter, to prevent interference.
- Do not use fluorescent lamps in switch cabinets, as they emit high-frequency interference.

ATTENTION! **Device protection**
When installing a multi-axis system with an AC-AC servo drive as the supply, note the following points relating to device protection:

- **Mains fuses**
  - **Size 1 to Size 5**
    The mains fuses should always be installed additional to the motor protection switch and prevent destruction of the device (e.g. in the case of a component defect or overload). Use mains fuses (duty class gG) to isolate all poles of the servo drive from the mains supply. For more details refer to MSD Servo Drive AC-AC Operation Manual (Id. no. CA65642-001) in the "Electrical installation" section.
  - **Size 6 to 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.

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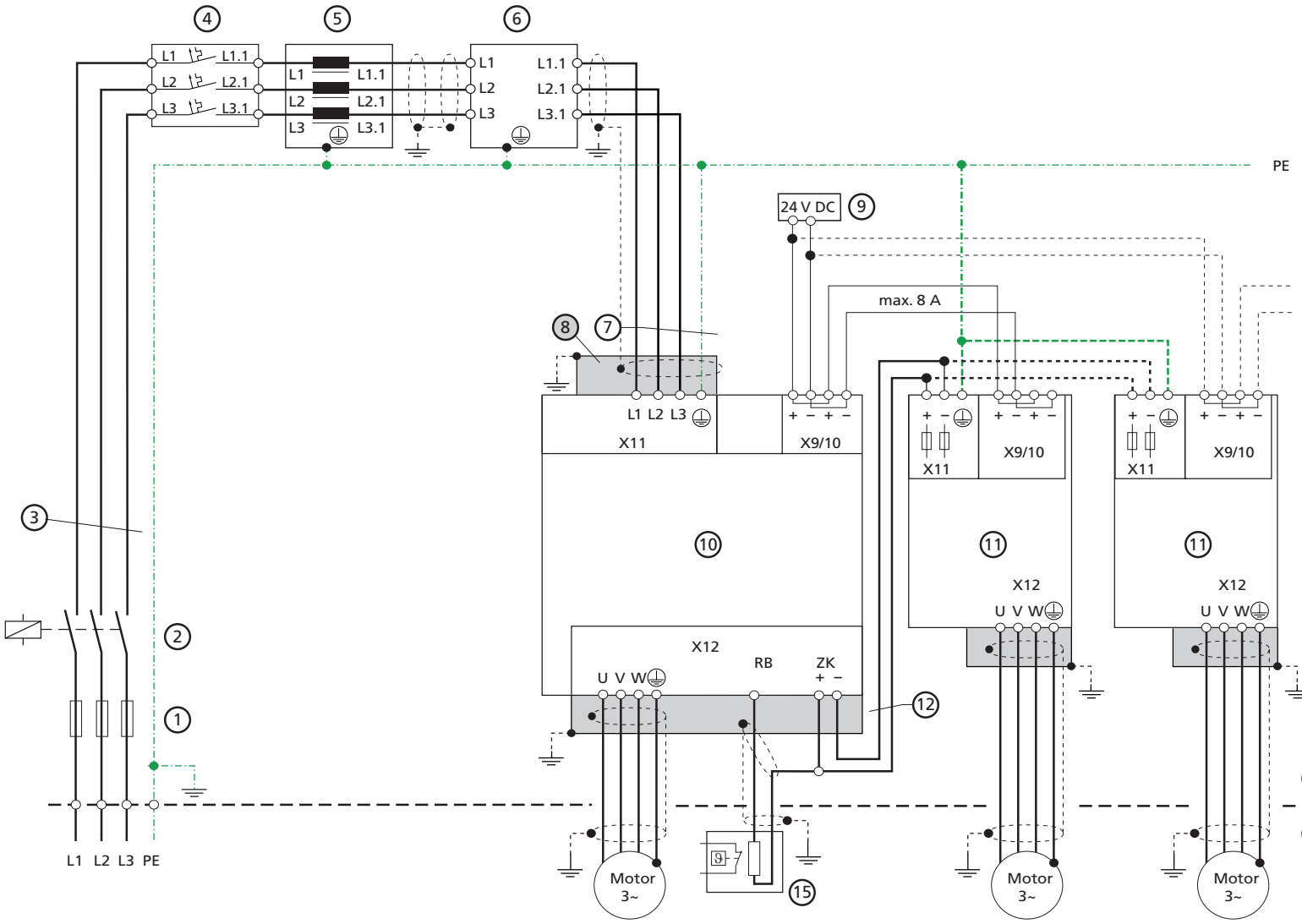
AC-AC servo drive	SIBA articel number	Rated current	Size
G392-090 G395-110	2020934.125	125 A	NH 00
G392-110 G395-143	2021134.160	160 A	NH 1
G392-143 G395-170	2021134.200	200 A	NH 1
G392-170 G395-210	2021134.250	250 A	NH 1
G395-250	2021234.315	315 A	NH 2
G395-325	2021234.400	400 A	NH 2
G395-450	2021234.500	500 A	NH 2

Table 7.1 Recommended mains fuses from the manufacturer SIBA (www.siba-fuses.com

- **Motor protection switch**
  - **Size 1 to Size 5**
    The motor protection switch should always be installed additional to the mains fuses. It serves as an overload protector for the device, mains choke and mains filter in the range up to the permissible overload. The rated current of the motor protection switch ("Power switch for system and motor protection", trip class 10, SIEMENS series SIRIUS 3RV10 or SIRIUS 3RV20) should be selected according to the lowest rated current $I_{rated\ (f\_sw\ and\ U\_mains)}$ of the components used (mains choke, mains filter, AC-AC servo drive).
  - **Size 6 to Size 7**
    The motor protection switch is not required if, instead of mains fuses of utilisation class gG, semiconductor fuses of utilisation class gRL (gS) are used (see table 7.1).
- **Braking resistor**
  The braking resistor of the AC-AC servo drive should be dimensioned such that the total regenerative power of the multi-axis system can be dissipated. When dimensioning the connecting cables of the braking resistor, ensure that the mains-side protective devices are safely tripped in the event of a fault. Note that the ratio of the currents $I_{DC\ bus\ \ eff}$ / $I_{mains\ side\ \ eff}$ = √(3/2) .



Key

1. Mains fuses [1)]
2. Mains supply/Emergency-stop
3. Short-circuit-proof cables
4. Motor protection switch [1)]
5. Mains choke
6. Mains filter
7. AC power connection
8. Shields (grey)
9. External 24 V DC control supply (fuse-protected)
10. MSD Servo Drive AC-AC (Size 1 to Size 4)
11. MSD Servo Drive DC-AC
12. DC link
13. Switch cabinet
14. Field
15. Braking resistor [1)]

[1)] ATTENTION:
Observe the requirements for device protection on page 53!

Fig. 7.1 Overview - Connection diagram for operation with supply by AC-AC servo drive (Size 1 to Size 4)

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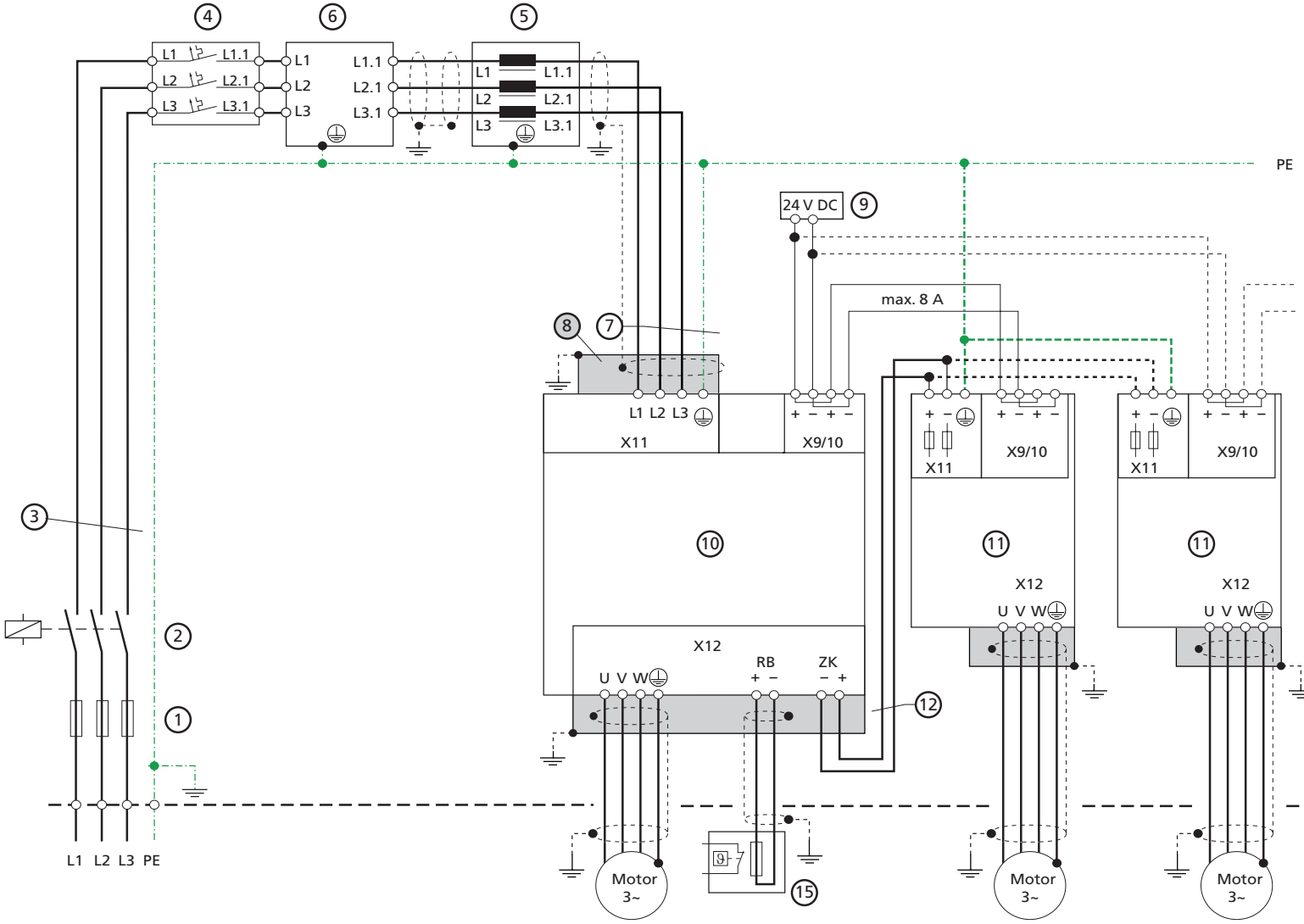
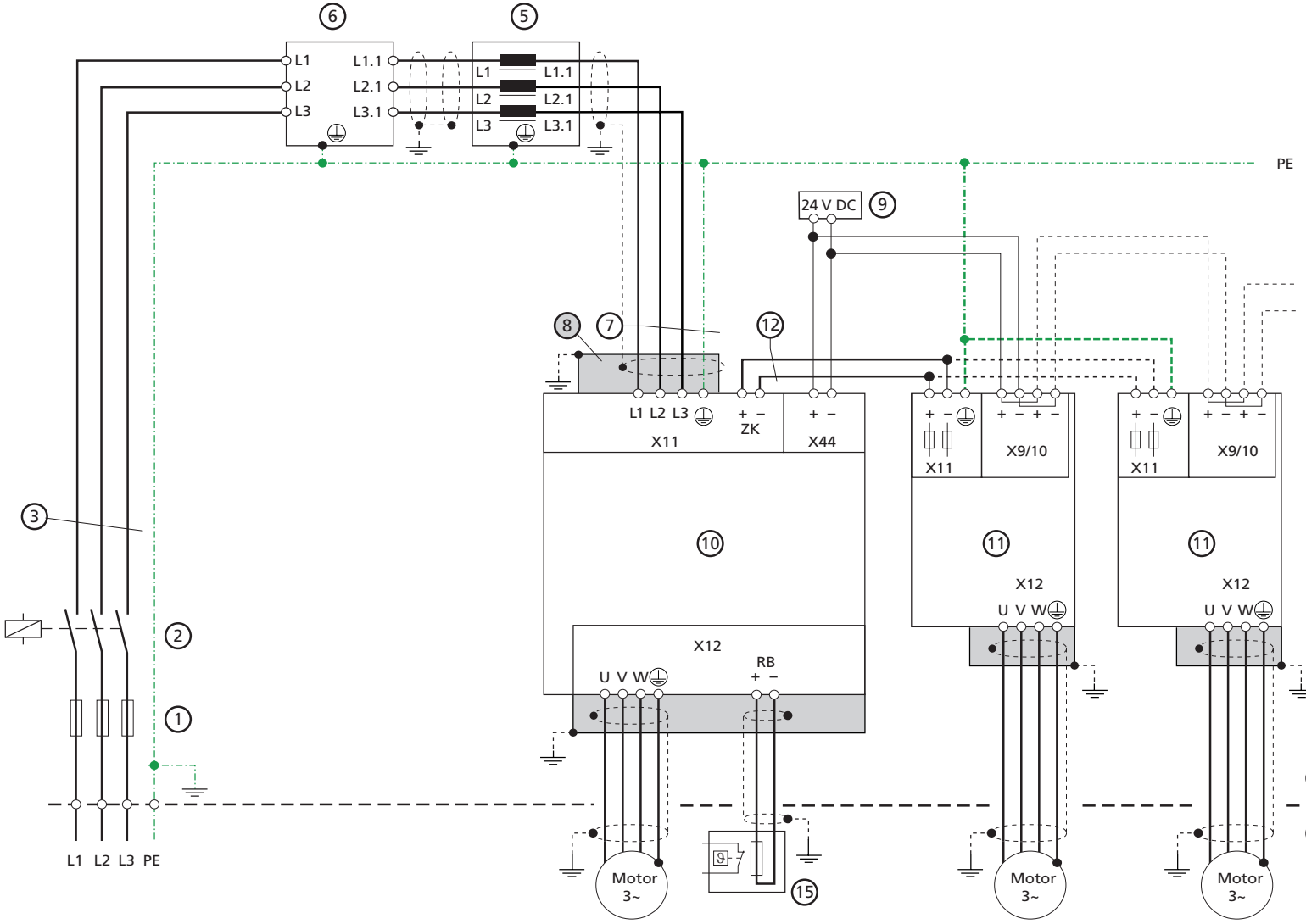


Key

1. Mains fuses [1)]
2. Mains supply/Emergency stop
3. Short-circuit-proof cables
4. for Size 5: Motor protection switch [1)]
5. Mains choke
6. Mains filter
7. AC power connection
8. Shield (grey)
9. External 24 V DC control supply (fuse-protected)
10. MSD Servo Drive AC-AC (Size 5 to Size 6A)
11. MSD Servo Drive DC-AC
12. DC link
13. Switch cabinet
14. Field
15. Braking resistor [1)]

[1)] ATTENTION:
Observe the requirements for device protection on page 53!

Fig. 7.2 Overview - Connection diagram for operation with supply by AC-AC servo drive (Size 5 to Size 6A)



Key

1. Mains fuses [1)]
2. Mains supply/emergency stop
3. Short-circuit-proof cables
4. *not present*
5. Mains chokel
6. Mains filter
7. AC power connection
8. Shields (grey)
9. External 24 V DC control supply (fuse-protected)
10. MSD Servo Drive AC-AC (Size 7)
11. MSD Servo Drive DC-AC
12. DC link
13. Switch cabinet
14. Field
15. Braking resistor [1)]

[1)] ATTENTION:
Observe the requirements for device protection on page 53!

Fig. 7.3 Overview - Connection diagram for operation with supply by AC-AC servo drive (Size 7)

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7.2 Operation with AC-AC servo drive as supply

NOTE: The switch cabinet layout shown here is intended as an illustration only. It does not guarantee general suitability for a specific application or compliance with relevant directives. You should check and assess the layout you are planning in each individual case with regard to the specific application and compliance with locally applicable directives. Moog GmbH can provide no guarantee as to the applicability of the following switch cabinet layout.

ID number	Meaning
1	Mains cable
2	Main switch
3	Fuse
4	Mains filter
5	*not present*
6	Mains contactor
7	*not present*
8	*not present*
9	AC-AC servo drive for co-supply of the DC-AC servo drive
10	DC-AC servo drive
11	DC link power supply to DC-AC servo drives
12	Braking resistor external to AC-AC servo drive
13	Motor cables
14	Control (higher-level)

Table 7.2 Key to switch cabinet layout

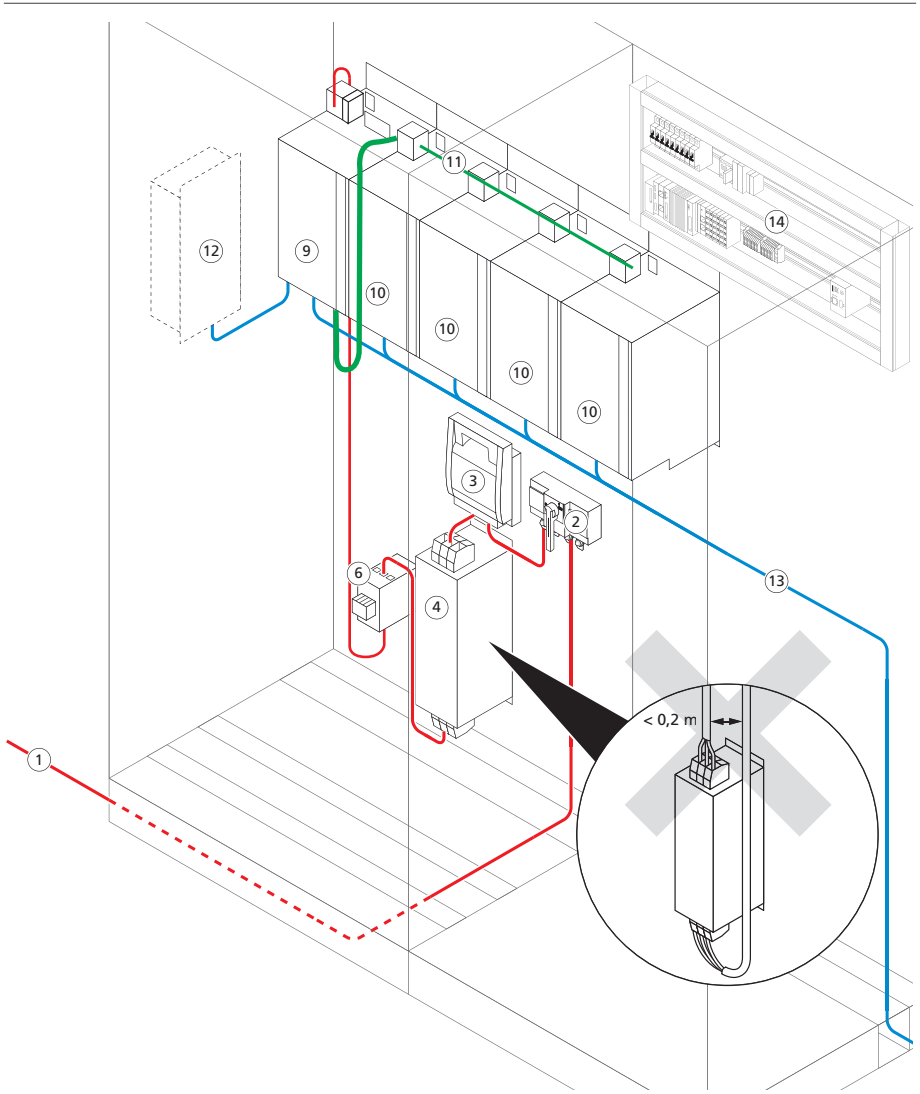

Fig. 7.4 Switch cabinet layout, multi-axis system with supply by AC-AC servo drive (as from Size 5)

A Project planning

A.1 Overview and comparision of multi-axis systems

This overview presents the two possible system variants for Moog multi-axis systems: "Operation with power supply unit" and "Operation with AC-AC servo drive as supply". It will help you to judge the optimum variant for your application. Aspects such as available installation space, complexity of installation, acquisition and operating cost are considered.

ATTENTION!

- The variants set out in this section relate solely to devices and components of the MSD Servo Drive product family (excluding MSD Servo Drive Compact). Operation with devices or components from other manufacturers or product families is not permitted!
- For each application, a number of specific factors, such as total power output and simultaneity, must be individually considered in order to ensure safe system operation.
- You should always consult Moog's Project Support advisors when planning your application. They will be able to balance all the parameters using a powerful project planning software program.
- Commissioning of a MSD Servo Drive multi-axis system should only be undertaken following dimensioning by Moog's Project Support department!

A.2 Application examples

The MSD Servo Drive multi-axis systems are able to demonstrate their advantages over a conventional system comprising multiple AC-AC servo drives particularly in applications which often feature regenerative operation. Depending on the length of the regenerative phases, and whether other system axes are in motorized mode during those phases, operation either with a power supply unit or a AC-AC servo drive as the supply source may be preferable.

A.3 Operation with MSD Power Supply Unit

In this system variant the DC-fed DC-AC servo drives are connected to a central power supply unit.

Advantages

- Regenerative power from an axis is available to the other axes via the central DC link
- Surplus power in the DC DC link is fed back into the supply grid centrally via the power supply unit
- Sinusoidal mains current with very low harmonics in motorized and regenerative mode
- Controlability of power factor to cos $\varphi = 1$ (reactive current compensation)
- Identical power values in motorized and regenerative mode
- The system can have more axes than in the case of supply with an AC-AC servo drive
- Depending on the configuration of the power supply unit, all axes can be operated simul- taneously at rated power
- Installation of the supply cables between the power supply unit and DC-AC servo drive is convenient and space-saving, using a through-going rail system (Size 1 to Size 5)
- The operating cost is below that of a system comprising an AC-AC servo drive or AC-AC servo drives as the supply source
- Higher DC link voltage than with a corresponding AC feed, meaning smaller-sized motors can be used
- Loop-controlled DC link voltage, so mains voltage fluctuations no longer have to be allowed for in the system by way of a reserve
- Higher DC link voltage enables compensation for weak supply systems and maxi- mum motor torques in the field-weakening range
- Full compensation for mains voltage drops based on the ability to increase voltage
- High dynamism based on rapid changes in power flux on the load side
- In case of power failure, braking is possible by way of built-in braking choppers

Disadvantages

- Due to the power supply unit and its external circuitry, more space may be required than in operation with an AC-AC servo drive as the supply source or a system comprising AC-AC servo drives.
- The investment cost is higher than that for a system comprising an AC-AC servo drive or AC-AC servo drives as the supply source.

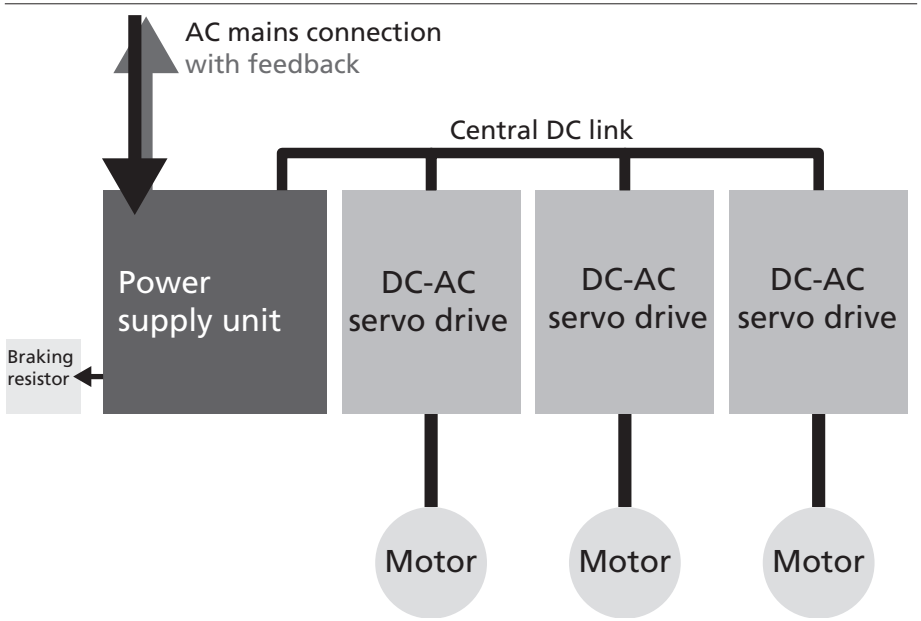

Fig. A.1 Block diagram of a multi-axis system with power supply unit and mains feedback

A.4 Operation with MSD Servo Drive AC-AC as supply

Advantages

- The investment cost is lower than in operation with a power supply unit
- As no additional power supply unit is required, the space needed is usually less than in operation with a power supply unit
- Regenerative power is available to the other axes via the central DC link
- Surplus power is dissipated centrally via the braking resistor of the AC-AC servo drive

Disadvantages

- In this system variant the full rated power can usually not be requested simultaneously on all axes, as otherwise the DC link of the AC-fed AC-AC servo drive may be overloaded
- The supplying AC-AC servo drive may need to be overdimensioned
- Regenerative power cannot be fed back into the supply grid, but can only be converted into heat by way of a braking resistor
- Similarly to the AC-AC servo drive, the braking resistor may need to be overdimensioned, as a result of which the heat it generates might necessitate additional effort and expense for installation and air-conditioning
- The operating cost is higher than that of a system comprising an AC-AC servo drive or AC-AC servo drives as the supply source
- Lower DC link voltage than in operation with a power supply unit
- Owing to the complete DC link capacitance, fewer DC-AC servo drives can be connected than in the case of the power supply unit

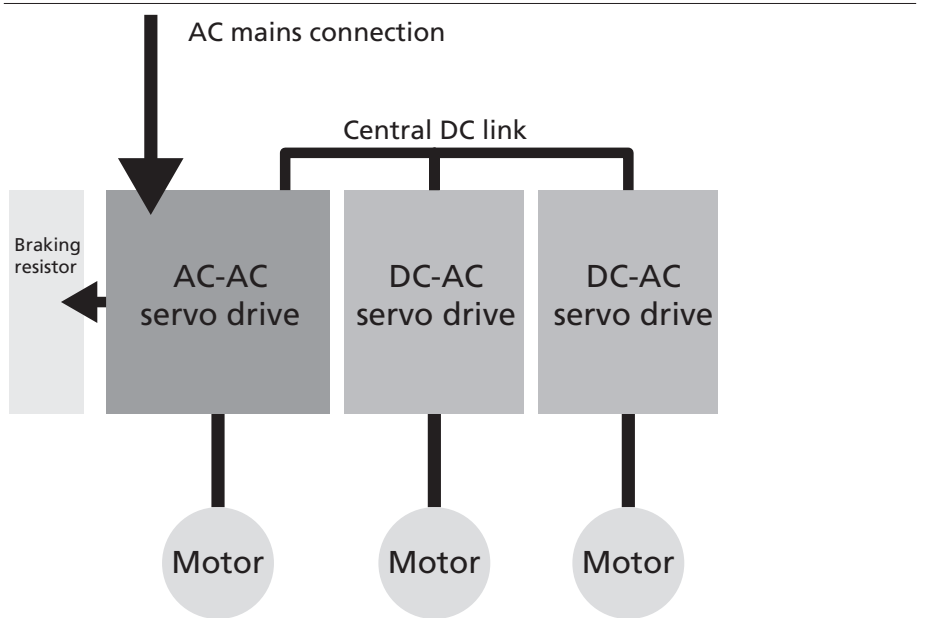

Fig. A.2 Block diagram of a multi-axis system with AC-AC servo drive as supply

A.5 Functional comparison

The technical and functional differences between operation with an AC-AC servo drive as the supply source and operation with a power supply unit are compared here as an aid to selection.

Feature	AC-AC servo drive as supply	Power supply unit
Operation on a wide variety of mains voltages worldwide possible	○ 1)	●
Regenerative (sinusoidal)		●
Operation possible with any simultaneity factor	○	●
DC link via rail system (Size 1 - Size 5)	○	●
Power equalization by central DC link	●	●
Controlled shutdown in case of power failure	●	●
Requires external step-up and input reactors		●
Requires external braking resistor	●	○ 2)
Air cooling	●	●
Liquid cooling	●	●
Higher DC link voltage (650 V/770 V)		●
Reactive current compensation		○
EtherCAT, SERCOS II & III, PROFINET IRT, VARAN, CANopen, Profibus-DPV1	●	●
Sin/Cos encoder, TTL encoder simulation/TTL master encoder	●	●

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

1) With autotransformer

2) For emergency running in case of power failure

Table A.1 Functional comparison

A.6 Financial calculation

Alongside the functional advantages, a multi-axis system also offers ecological and financial benefits based on the energy saving. Depending on the application, higher investment cost can be amortized quickly thanks to the reduced power consumption.

Example with three axes

	AC-AC axes	AC-AC servo drive as supply	Power supply unit
Components	3x G392-024 3x mains choke 3x braking resistor	2x G393-024 1x G392-060 with - mains choke - braking resistor	3x G393-024 1x G396-050 1x LCL-Set
Investment costs	100%	108%	163%
Energy saving 1)	-	5%	10%
Electric price	0.1264 €/kWh 2)		
Operating time	16 hours per day, 20 days per month		
Amortization of additional cost after	**-**	**6 months**	**23 months**

1) Compared to AC-AC axes; this value need to be determined individually for each application

2) German Federal Association of Energy Consumers; electricity price comparison II2011 for small and medium-sized industrial customers; average electricity price, federal states in former West Germany

Table A.2 Financial calculation for three axes

Example with six axes

	AC-AC axes	AC-AC servo drive as supply	Power supply unit
Components	6x G392-024 6x mains choke 6x braking resistor	5x G393-024 1x G392-143 with - mains choke - mains filter - braking resistor	6x G393-024 1x G396-110 1x LCL-Set
Investment costs	100%	115%	142%
Energy saving 1)	-	5%	10%
Electric price	0.1264 €/kWh 2)		
Operating time	16 hours per day, 20 days per month		
Amortization of additional cost after	**-**	**11 months**	**16 months**

1) Compared to AC-AC axes; this value need to be determined individually for each application

2) German Federal Association of Energy Consumers; electricity price comparison II2011 for small and medium-sized industrial customers; average electricity price, federal states in former West Germany

Table A.3 Financial calculation for six axes

A.7 Dimensioning

This section summarizes how you can configure the MSD Servo Drive multi-axis system appropriately for your application. The configuration of a multi-axis system depends on a large number of parameters. The guidance provided in this section enables you to compile all the relevant data for the dimensioning of your specific application.

NOTE: Based on this data, the system engineering for the MSD Servo Drive family will be able to provide you with detailed dimensional calculations for your system requirements. You can reach the system engineering via drives-support@moog.com.

A.7.1 Calculating the required drive power per axis

Calculation of the drive power requires the following data for each rotary axis:

- Maximum torque
- Effective torque
- Maximum speed
- Gear ratio
  - Effective torque formula
    (with torque curves constant in each segment):

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

  - Maximum torque formula:

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

$$M_{accel} = 2 \cdot \pi \frac{\Delta n}{\Delta t} (J_{motor} + \frac{1}{i^2} J_{load})$$

Calculation of the drive power for linear motors requires the following data for each rotary axis:

- Maximum thrust
- Effective thrust
- Maximum feed rate

A.7.2 Selection of suitable gearing and motors

The gearing is selected depending on the application either to attain the maximum dynamism or for the most efficient possible continuous operation.

- Gear ratio formula (for optimum dynamism):

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

- Gear ratio formula (for effective utilization in continuous operation):

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

Motors are selected according to the following criteria:

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

Specify the encoder system according to the requirements of your application in terms of absolute accuracy, repeatable accuracy, robustness and calculation of the machine zero:

- Resolver
- Sin/Cos encoder, single-turn
- Sin/Cos encoder, multi-turn

A.7.3 Selection of suitable DC-AC servo drives

When the motors have been selected, the matching DC-AC servo drives are selected according to the following criteria:

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- Maximum current
- Rated current

A.7.4 Selection of suitable power supply unit

ATTENTION! In all the following dimension calculations always also refer to the operation manual for the MSD Power Supply Unit (ID. no.: CA97556-001).

To determine the suitable power supply unit, a power/time graph over a complete machine cycle must be available for all axes. Figure A.3 presents an example of one.

The power demand of each individual axis at every point in time is added together to produce the power/time graph for the power supply unit. The following characteristic values for the power supply unit can be derived from it:

- Nominal feed power
- Maximum feed power
- Nominal feedback power
- Maximum feedback power

If the simultaneity factor in the axis network is low, it may be possible to select the largest axis as the AC-AC servo drive and handle the feed for the entire axis network. Feedback into the supply grid is then not possible however. Regenerative power must be discharged by way of a braking resistor and converted into heat.

NOTE: If the supplying voltage grid fails, the power supply unit's design means it is no longer capable of feedback. For this special emergency case we therefore recommend you use a braking resistor, with a power rated for this one braking action.

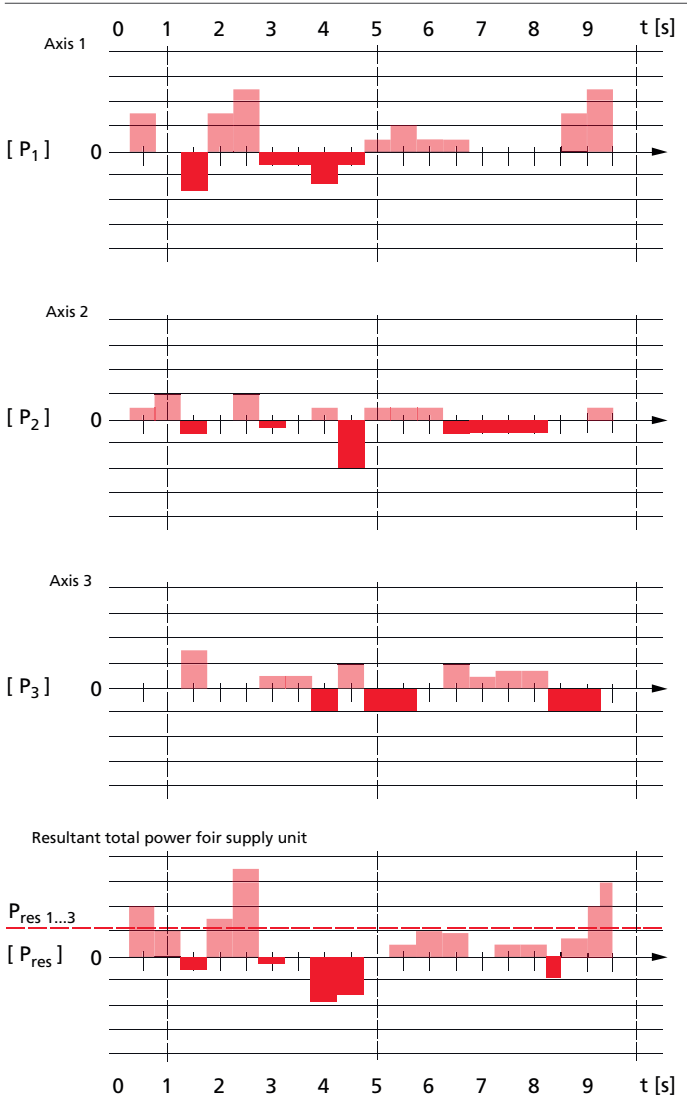

Fig. A.3 Time/power graph with power supply unit

The precharge circuit and DC link of the power supply unit must not be overloaded. Consequently, the total power tap and total DC link capacitance of all DC-AC servo drives must not exceed the limit values of the power supply unit. In this regard refer to tables A.4 and A.5:

Power supply unit	Power output [kW]		DC link capacitance [µF]	max. DC link capacitance [µF]
	Continu-ous	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 A.4 Power output and capacitances of 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 A.5 DC link capacitances of the DC-AC servo drives

Calculation example: Feed with power supply unit

Two DC-AC servo drives G393-024, two DC-AC servo drives G393-060 and one DC-AC servo drive G393-090 (air-cooled) are to be connected to a 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 precharge capacitance of 9200 µF.

NOTE: Note that not only the DC link capacitances of the DC-AC servo drives, but also of the power supply unit, need to be considered.

A.7.5 External components

When using a power supply unit you will need additional components:

- Mains connection set (comprising mains filter, input reactor including capacitor, step-up reactor, EMC fixings)

See MSD Servo Drive Ordering Catalog (Id. No.: CDL 29950-en).

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A.7.6 Selection of suitable AC-AC servo drive as supply

If the simultaneity factor in the axis network is low, it may be possible to select the largest axis as the AC-AC servo drive and handle the feed for the entire axis network. To determine the suitable AC-AC servo drive, a power/time graph over a complete load cycle must be available for all axes. Figure A.4 presents an example of one.

The power demand of each individual axis (including the AC-AC servo drive axis) at every point in time is added together to produce the total power/time graph. The following characteristic values can be derived from it:

- Nominal input power of the AC-AC servo drive axis
- Maximum input power of the AC-AC servo drive axis
- Nominal regenerative power
- Maximum regenerative power

Feedback into the supply grid is then not possible however. Regenerative power must be discharged by way of a braking resistor and converted into heat.

ATTENTION! **Dimensioning of braking resistor**
The braking resistor of the AC-AC servo drive should be dimensioned such that the total regenerative power of the multi-axis system can be dissipated.

DC link power and total DC link capacitance of AC-AC servo drive

To gain an initial estimate as to whether a AC-AC servo drive is adequate to supply additional DC-AC servo drives, the power made available by the DC link of the AC-AC servo drive can be approximated using the following formulas:

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

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

In this, $I_{rated\ (fsw\ and\ U\_mains)}$ is the rated current and $I_{MAX\ (fsw\ and\ U\_mains)}$ the maximum current of the servo drive according to the switching frequency of the power stage and the mains voltage.

ATTENTION! **Do not exceed the maximum power**
The power values are quadratic means over a load cycle. The maximum power must not be exceeded at any time, and may only be tapped for the specified time, otherwise the AC-AC servo drive will be destroyed.

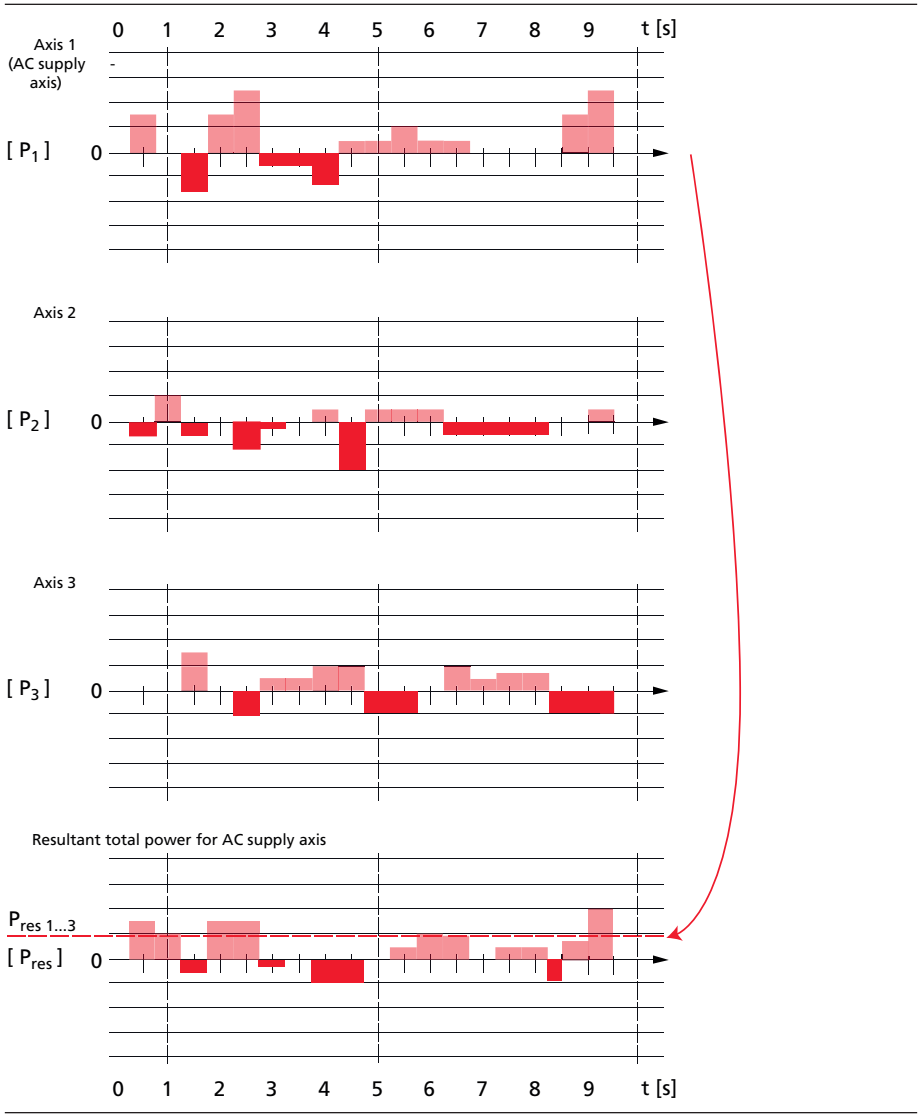

Fig. A.4 Time/power graph with AC-AC servo drive as supply

In addition to the total power tap, the total DC link capacitance of the axis network also needs to be considered. The maximum total DC link capacitance of the AC-AC servo drive must not be exceeded. In this regard refer to table A.6 and to table A.5 on page 65:

AC-AC servo drive	internal DC link capacitance [µF]		max. 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 / G395-016	1230	1230	2460	1734
G392-020 / G395-020	1230	1230	2460	1734
G392-024 / G395-024	2000	2000	2504	2000
G392-032 / G395-032	2000	2000	2504	2000
G392-045 / G395-053	430	430	5100	5100
G392-060 / G395-070	900	900	5100	5100
G392-072 / G395-085	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 A.6 DC link capacitance and Maximum total DC link capacitance of the AC-AC servo drives

ATTENTION!

- **Observe switching 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.
- **Observe power classes**
  It is only allowed to connect DC-AC servo drives of lower or the same power class to an AC-AC servo drive.
- **Observe maximum number of axes**
  It is allowed to operate a maximum of six DC-AC servo drives on one supplying AC-AC servo drive.

Calculation example: Feed from a AC-AC servo drive

Two DC-AC servo drives G393-024, two DC-AC servo drives G393-060 and one DC-AC servo drive G393-090 (air-cooled) are to be connected to an AC-AC servo drive G392-170.

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 not only the DC link capacitances of the DC-AC servo drives, but also of the supplying AC-AC servo drive, need to be considered.

A.7.7 External components

When using a AC-AC servo drive as the supply source you will need additional components:

- Mains filter
- Mains choke
- Braking resistor
- EMC fixings

See MSD Servo Drive Ordering Catalog (Id.-No.: CDL 29950-en).

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Space for your personal notes

B Technical data

B.1 Current capacity of MSD Servo Drive DC-AC

The maximum permissible 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 system and the ambient temperature. If the conditions change, the maximum permissible current capacity of the servo drives also changes.

B.1.1 Size 1 to Size 4 (air-cooled, 400 V AC)

Type	Power stage switching frequency	Ambient temperature	Rated current	Peak current [1]				
				I_{MAX} 0 Hz	I_{1MAX} ≥5 Hz	t_1 [2]	I_{2MAX} ≥5 Hz	t_2 [2]
	[kHz]	[°C]/[°F]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[s]	[A_{eff}]	[s]
G393-004 (Size 1)	4	+40/+104	5.3	8.4	8.4	10	11.9	0.5
	8		4.0	8.4	8.4		-	-
	12		3.7	6.6	6.6		-	-
	16		2.7	5.2	5.2		-	-
G393-006 (Size 1)	4	+40/+104	8.0	12.7	12.7	10	18.0	0.5
	8		6.0	12.7	12.7		-	-
	12		5.5	9.9	9.9		-	-
	16		4.0	7.7	7.7		-	-
G393-008 (Size 2)	4	+40/+104	9.3	15.9	15.9	10	23.9	0.5
	8		9.3	15.9	15.9		-	-
	12		6.7	9.4	9.4		-	-
	16		5.5	7.7	7.7		-	-
G393-012 (Size 2)	4	+40/+104	14.0	24.0	24.0	10	36.0	0.5
	8		14.0	24.0	24.0		-	-
	12		10.0	14.1	14.1		-	-
	16		8.2	11.5	11.5		-	-
G393-016 (Size 3)	4	+40/+104	20.0	33.6	33.6	10	48.0	0.5
	8		16.0	33.6	33.6		-	-
	12		11.0	23.6	23.6		-	-
	16		8.5	19.4	19.4		-	-
G393-020 (Size 3)	4	+40/+104	25.0	42.0	42.0	10	60.0	0.5
	8		20.0	42.0	42.0		-	-
	12		13.8	29.6	29.6		-	-
	16		10.0	22.8	22.8		-	-
G393-024 (Size 4)	4	+40/+104	30.0	48.0	48.0	10	72.0	0.5
	8		24.0	48.0	48.0		-	-
	12		15.8	31.6	31.6		-	-
	16		11.3	22.6	22.6		-	-
G393-032 (Size 4)	4	+40/+104	40.0	64.0	64.0	10	96.0	0.5
	8		32.0	64.0	64.0		-	-
	12		21.0	42.0	42.0		-	-
	16		15.0	30.0	30.0		-	-

1) At max. 70 % preload
2) Shutdown as per I²t characteristic
All data apply for motor cable length ≤10 m

Table B.1 Rated and peak current, Size 1 to Size 4 (air-cooled, 400 V AC)

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B.1.2 Size 1 to Size 4 (air-cooled, 460 V AC)

Type	Power stage switching frequency	Ambient temperature	Rated current	Peak current [1]				
				I_{MAX} 0 Hz	I_{1MAX} ≥5 Hz	t_1 [2]	I_{2MAX} ≥5 Hz	t_2 [2]
	[kHz]	[°C]/[°F]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[s]	[A_{eff}]	[s]
G393-004 (Size 1)	4	+40/+104	5.3	8.4	8.4	10	11.9	0.5
	8		3.4	7.2	7.2		-	-
	12		2.8	5.0	5.0		-	-
	16		1.9	3.6	3.6		-	-
G393-006 (Size 1)	4	+40/+104	8.0	12.7	12.7	10	18.0	0.5
	8		5.1	10.8	10.8		-	-
	12		4.2	7.5	7.5		-	-
	16		2.9	5.6	5.6		-	-
G393-008 (Size 2)	4	+40/+104	8.5	14.6	14.6	10	21.8	0.5
	8		6.7	11.5	11.5		-	-
	12		5.6	7.9	7.9		-	-
	16		4.1	5.8	5.8		-	-
G393-012 (Size 2)	4	+40/+104	11.8	20.2	20.2	10	30.3	0.5
	8		10.0	17.1	17.1		-	-
	12		8.4	11.8	11.8		-	-
	16		6.2	8.7	8.7		-	-
G393-016 (Size 3)	4	+40/+104	20.0	33.6	33.6	10	48.0	0.5
	8		13.9	29.1	29.1		-	-
	12		8.8	18.9	18.9		-	-
	16		6.5	14.8	14.8		-	-
G393-020 (Size 3)	4	+40/+104	25.0	42.0	42.0	10	60.0	0.5
	8		17.4	36.5	36.5		-	-
	12		11.0	23.6	23.6		-	-
	16		7.4	16.8	16.8		-	-
G393-024 (Size 4)	4	+40/+104	26.0	41.6	41.6	10	62.4	0.5
	8		21.0	42.0	42.0		-	-
	12		12.4	24.8	24.8		-	-
	16		8.9	17.8	17.8		-	-
G393-032 (Size 4)	4	+40/+104	33.7	53.9	53.9	10	80.9	0.5
	8		28.0	56.0	56.0		-	-
	12		16.5	33.0	33.0		-	-
	16		11.9	23.8	23.8		-	-

1) At max. 70 % preload
2) Shutdown as per I²t characteristic
All data apply for motor cable length ≤10 m

Table B.2 Rated and peak current, Size 1 to Size 4 (air-cooled, 460 V AC)

B.1.3 Size 1 to Size 4 (air-cooled, 480 V AC)

Type	Power stage switching frequency	Ambient temperature	Rated current	Peak current [1]				
				I_{MAX} 0 Hz	I_{1MAX} ≥5 Hz	t_1 [2]	I_{2MAX} ≥5 Hz	t_2 [2]
	[kHz]	[°C]/[°F]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[s]	[A_{eff}]	[s]
G393-004 (Size 1)	4	+40/+104	5.3	8.4	8.4	10	11.9	0.5
	8		3.3	7.0	7.0		-	-
	12		2.7	4.8	4.8		-	-
	16		1.8	3.4	3.4		-	-
G393-006 (Size 1)	4	+40/+104	8.0	12.7	12.7	10	18.0	0.5
	8		5.0	10.6	10.6		-	-
	12		4.0	7.2	7.2		-	-
	16		2.7	5.2	5.2		-	-
G393-008 (Size 2)	4	+40/+104	8.5	14.6	14.6	10	21.8	0.5
	8		6.1	10.4	10.4		-	-
	12		5.4	7.6	7.6		-	-
	16		3.9	5.5	5.5		-	-
G393-012 (Size 2)	4	+40/+104	11.4	19.5	19.5	10	29.3	0.5
	8		9.2	15.8	15.8		-	-
	12		8.1	11.4	11.4		-	-
	16		5.8	8.2	8.2		-	-
G393-016 (Size 3)	4	+40/+104	20.0	33.6	33.6	10	48.0	0.5
	8		13.3	27.9	27.9		-	-
	12		8.5	18.3	18.3		-	-
	16		6.0	13.7	13.7		-	-

1) At max. 70 % preload
2) Shutdown as per I²t characteristic
All data apply for motor cable length ≤10 m

Table B.3 Rated and peak current, Size 1 to Size 4 (air-cooled, 480 V AC)

Type	Power stage switching frequency	Ambient temperature	Rated current	Peak current [1]				
				I_{MAX} 0 Hz	I_{1MAX} ≥5 Hz	t_1 [2]	I_{2MAX} ≥5 Hz	t_2 [2]
	[kHz]	[°C]/[°F]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[s]	[A_{eff}]	[s]
G393-020 (Size 3)	4	+40/+104	25.0	42.0	42.0	10	60.0	0.5
	8		16.6	34.8	34.8		-	-
	12		10.0	21.5	21.5		-	-
	16		6.5	14.8	14.8		-	-
G393-024 (Size 4)	4	+40/+104	26.0	41.6	41.6	10	62.4	0.5
	8		20.0	40.0	40.0		-	-
	12		11.3	22.6	22.6		-	-
	16		8.4	16.8	16.8		-	-
G393-032 (Size 4)	4	+40/+104	32.5	52.0	52.0	10	78.0	0.5
	8		26.7	53.4	53.4		-	-
	12		15.0	30.0	30.0		-	-
	16		11.2	22.4	22.4		-	-

1) At max. 70 % preload
2) Shutdown as per I²t characteristic
All data apply for motor cable length ≤10 m

Table B.3 Rated and peak current, Size 1 to Size 4 (air-cooled, 480 V AC)

B.1.4 Size 1 to Size 4 (air-cooled, 770 V DC)

Type	Power stage switching frequency	Ambient temperature	Rated current	Peak current [1]				
				I_{MAX} 0 Hz	I_{1MAX} ≥5 Hz	t_1 [2]	I_{2MAX} ≥5 Hz	t_2 [2]
	[kHz]	[°C]/[°F]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[s]	[A_{eff}]	[s]
G393-004 (Size 1)	4	+40/+104	5.1	8.1	8.1	10	11.5	0.5
	8		3.2	6.8	6.8		-	-
	12		2.1	3.8	3.8		-	-
	16		1.1	2.1	2.1		-	-
G393-006 (Size 1)	4	+40/+104	7.6	12.1	12.1	10	17.1	0.5
	8		4.8	10.2	10.2		-	-
	12		3.2	5.7	5.7		-	-
	16		1.6	3.1	3.1		-	-
G393-008 (Size 2)	4	+40/+104	8.0	13.7	13.7	10	20.6	0.5
	8		5.9	10.1	10.1		-	-
	12		5.3	7.4	7.4		-	-
	16		3.7	5.2	5.2		-	-
G393-012 (Size 2)	4	+40/+104	11.2	19.2	19.2	10	28.8	0.5
	8		8.8	15.1	15.1		-	-
	12		7.9	11.1	11.1		-	-
	16		5.5	7.7	7.7		-	-
G393-016 (Size 3)	4	+40/+104	20.0	33.6	33.6	10	48.0	0.5
	8		11.2	23.5	23.5		-	-
	12		7.0	15.0	15.0		-	-
	16		4.5	10.2	10.2		-	-

1) At max. 70 % preload
2) Shutdown as per I²t characteristic
All data apply for motor cable length ≤10 m

Table B.4 Rated and peak current, Size 1 to Size 4 (air-cooled, 770 V DC)

Type	Power stage switching frequency	Ambient temperature	Rated current	Peak current [1]				
				I_{MAX} 0 Hz	I_{1MAX} ≥5 Hz	t_1 [2]	I_{2MAX} ≥5 Hz	t_2 [2]
	[kHz]	[°C]/[°F]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[s]	[A_{eff}]	[s]
G393-020 (Size 3)	4	+40/+104	25.0	42.0	42.0	10	60.0	0.5
	8		14.0	29.4	29.4		-	-
	12		7.5	16.1	16.1		-	-
	16		5.0	11.4	11.4		-	-
G393-024 (Size 4)	4	+40/+104	26.0	41.6	41.6	10	62.4	0.5
	8		18.9	37.8	37.8		-	-
	12		10.5	21.0	21.0		-	-
	16		7.9	15.8	15.8		-	-
G393-032 (Size 4)	4	+40/+104	32.0	51.2	51.2	10	76.8	0.5
	8		25.2	50.4	50.4		-	-
	12		14.0	28.0	28.0		-	-
	16		10.5	21.0	21.0		-	-

1) At max. 70 % preload
2) Shutdown as per I²t characteristic
All data apply for motor cable length ≤10 m

Table B.4 Rated and peak current, Size 1 to Size 4 (air-cooled, 770 V DC)

B.1.5 Size 5 and Size 6A (air-cooled)

Type	Power stage switching frequency	Ambient temperature	Rated current				Peak current [A_{eff}] [1]			
			at 565 V_{DC} (400 V_{AC})[3]	at 650 V_{DC} (460 V_{AC})[3]	at 678 V_{DC} (480 V_{AC})[3]	at 770 V_{DC}	at linear rising rotating field frequency 0 to 5 Hz		for intermittent operation	for time [2]
	[kHz]	[°C]/[°F]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[A_{eff}]	0 Hz	5 Hz	>5 Hz	[s]
G393-045 (Size 5)	4	+40/+104	45	42	41	41	90	90	90	3
	8		45	42	41	41	90	90	90	
	12		45	42	41	37	90	90	90	
	16		42	39	38	34	84	84	84	
G393-060 (Size 5)	4	+40/+104	60	56	54	54	120	120	120	3
	8		60	56	54	54	120	120	120	
	12		58	54	52	48	116	116	116	
	16		42	39	38	34	84	84	84	
G393-072 (Size 5)	4	+40/+104	72	67	65	65	144	144	144	3
	8		72	67	65	65	144	144	144	
	12		58	54	52	48	116	116	116	
	16		42	39	38	34	84	84	84	
G393-090 (Size 6A)	4	+40/+104	90	83	81	73	170	180	180	10
	8		90	83	81	73	134	180	180	
	12		90	83	81	73	107	144	144	
	16		72	67	65	59	86	115	115	

1) When supplied with 565 VDC (corresponding to 400 V AC) at max. 70 % preload
2) Shutdown as per I²t characteristic
3) When supplied with AC-AC servo drive
All data apply for motor cable length ≤10 m

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

Type	Power stage switching frequency	Ambient temperature	Rated current				Peak current [A_{eff}] [1]			
			at 565 V_{DC} (400 V_{AC})[3]	at 650 V_{DC} (460 V_{AC})[3]	at 678 V_{DC} (480 V_{AC})[3]	at 770 V_{DC}	at linear rising rotating field frequency 0 to 5 Hz		for intermittent operation	for time [2]
	[kHz]	[°C]/[°F]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[A_{eff}]	0 Hz	5 Hz	>5 Hz	[s]
G393-110 (Size 6A)	4	+40/+104	110	102	99	90	170	220	220	10
	8		110	102	99	90	134	165	165	
	12		90	83	81	73	107	144	144	
	16		72	67	65	59	86	115	115	
G393-143 (Size 6A)	4	+40/+104	143	132	129	116	190	286	286	10
	8		143	132	129	116	151	215	215	
	12		115	106	104	94	121	172	172	
	16		92	85	83	75	97	138	138	
G393-170 (Size 6A)	4	+40/+104	170	157	153	138	190	315	315	10
	8		170	157	153	138	151	220	220	
	12		136	126	122	110	121	164	164	
	16		109	101	98	88	97	131	131	

1) When supplied with 565 VDC (corresponding to 400 V AC) at max. 70 % preload
2) Shutdown as per I²t characteristic
3) When supplied with AC-AC servo drive
All data apply for motor cable length ≤10 m

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

B.1.6 Size 3 and Size 4 (liquid-cooled, 400 V AC)

Type	Power stage switching frequency	Ambient temperature	Rated current	Peak current [1]				
				I_{MAX} 0 Hz	I_{1MAX} ≥5 Hz	t_1 [2]	I_{2MAX} ≥5 Hz	t_2 [2]
	[kHz]	[°C]/[°F]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[s]	[A_{eff}]	[s]
G397-020 (Size 3)	4	+40/+104	20.0	33.6	33.6	10	48.0	0.5
	8		20.0	33.6	33.6		-	-
	12		17.4	26.4	26.4		-	-
	16		12.0	18.2	18.2		-	-
G397-025 (Size 3)	4	+40/+104	25.0	42.0	42.0	10	60.0	0.5
	8		25.0	42.0	42.0		-	-
	12		21.8	33.1	33.1		-	-
	16		15.0	22.8	22.8		-	-
G397-026 (Size 4)	4	+40/+104	30.0	48.0	48.0	10	72.0	0.5
	8		26.3	48.1	48.1		-	-
	12		22.5	31.5	31.5		-	-
	16		16.1	22.5	22.5		-	-
G397-035 (Size 4)	4	+40/+104	40.0	64.0	64.0	10	96.0	0.5
	8		35.0	64.0	64.0		-	-
	12		30.0	42.0	42.0		-	-
	16		21.4	29.9	29.9		-	-

1) At max. 70 % preload
2) Shutdown as per I²t characteristic
All data apply for motor cable length ≤10 m

Table B.6 Rated and peak current, Size 3 and Size 4 (liquid-cooled, 400 V AC)

B.1.7 Size 3 and Size 4 (liquid-cooled, 460 V AC)

Type	Power stage switching frequency	Ambient temperature	Rated current	Peak current [1]				
				I_{MAX} 0 Hz	I_{1MAX} ≥5 Hz	t_1 [2]	I_{2MAX} ≥5 Hz	t_2 [2]
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[s]	[A_{eff}]	[s]
G397-020 (Size 3)	4	+40/+104	20.0	33.6	33.6	10	48.0	0.5
	8		17.4	29.2	29.2		-	-
	12		12.5	19.0	19.0		-	-
	16		9.1	13.8	13.8		-	-
G397-025 (Size 3)	4	+40/+104	25.0	42.0	42.0	10	60.0	0.5
	8		21.8	36.6	36.6		-	-
	12		15.6	23.7	23.7		-	-
	16		11.4	17.3	17.3		-	-
G397-026 (Size 4)	4	+40/+104	26.0	41.6	41.6	10	62.4	0.5
	8		23.0	42.0	42.0		-	-
	12		17.7	24.8	24.8		-	-
	16		12.8	17.9	17.9		-	-
G397-035 (Size 4)	4	+40/+104	33.7	53.9	53.9	10	80.9	0.5
	8		30.6	55.9	55.9		-	-
	12		23.6	33.0	33.0		-	-
	16		17.0	23.8	23.8		-	-

1) At max. 70 % preload
2) Shutdown as per I²t characteristic
All data apply for motor cable length ≤10 m

Table B.7 Rated and peak current, Size 3 and Size 4 (liquid-cooled, 460 V AC)

B.1.8 Size 3 and Size 4 (liquid-cooled, 480 V AC)

Type	Power stage switching frequency	Ambient temperature	Rated current	Peak current [1]				
				I_{MAX} 0 Hz	I_{1MAX} ≥5 Hz	t_1 [2]	I_{2MAX} ≥5 Hz	t_2 [2]
	[kHz]	[°C]/[°F]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[s]	[A_{eff}]	[s]
G397-020 (Size 3)	4	+40/+104	20.0	33.6	33.6	10	48.0	0.5
	8		16.6	27.9	27.9		-	-
	12		11.4	17.3	17.3		-	-
	16		8.5	12.9	12.9		-	-
G397-025 (Size 3)	4	+40/+104	25.0	42.0	42.0	10	60.0	0.5
	8		20.8	34.9	34.9		-	-
	12		14.3	21.7	21.7		-	-
	16		10.6	16.1	16.1		-	-
G397-026 (Size 4)	4	+40/+104	26.0	41.6	41.6	10	62.4	0.5
	8		21.9	40.0	40.0		-	-
	12		16.1	22.5	22.5		-	-
	16		12.0	16.8	16.8		-	-
G397-035 (Size 4)	4	+40/+104	32.5	52.0	52.0	10	78.0	0.5
	8		29.2	53.4	53.4		-	-
	12		21.4	30.0	30.0		-	-
	16		16.0	22.4	22.4		-	-

1) At max. 70 % preload
2) Shutdown as per I²t characteristic
All data apply for motor cable length ≤10 m

Table B.8 Rated and peak current, Size 3 and Size 4 (liquid-cooled, 480 V AC)

B.1.9 Size 3 and Size 4 (liquid-cooled, 770 V DC)

Type	Power stage switching frequency	Ambient temperature	Rated current	Peak current [1]				
				I_{MAX} 0 Hz	I_{1MAX} ≥5 Hz	t_1 [2]	I_{2MAX} ≥5 Hz	t_2 [2]
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[s]	[A_{eff}]	[s]
G397-020 (Size 3)	4	+40/+104	20.0	33.6	33.6	10	48.0	0.5
	8		15.8	26.5	26.5		-	-
	12		10.7	16.2	16.2		-	-
	16		8.1	12.3	12.3		-	-
G397-025 (Size 3)	4	+40/+104	25.0	42.0	42.0	10	60.0	0.5
	8		19.8	33.2	33.2		-	-
	12		13.4	20.3	20.3		-	-
	16		10.1	15.3	15.3		-	-
G397-026 (Size 4)	4	+40/+104	26.0	41.6	41.6	10	62.4	0.5
	8		20.7	37.8	37.8		-	-
	12		15.4	21.5	21.5		-	-
	16		11.3	15.8	15.8		-	-
G397-035 (Size 4)	4	+40/+104	32.0	51.2	51.2	10	76.8	0.5
	8		27.6	50.5	50.5		-	-
	12		20.5	28.7	28.7		-	-
	16		15.0	21.0	21.0		-	-

1) At max. 70 % preload
2) Shutdown as per I²t characteristic
All data apply for motor cable length ≤10 m

Table B.9 Rated and peak current, Size 3 and Size 4 (liquid-cooled, 770 V DC)

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B.1.10 Size 5 and Size 6A (liquid-cooled)

Type	Power stage switching frequency	Ambient temperature	Rated current				Peak current [A_{eff}] 1)			
			at 565 V_{DC} (400 V_{AC} 3))	at 650 V_{DC} (460 V_{AC} 3))	at 678 V_{DC} (480 V_{AC} 3))	at 770 V_{DC}	at linear rising rotating field frequency 0 to 5 Hz		for intermittent operation	for time 2)
	[kHz]	[°C]/[°F]	[A_{eff}]	[A_{eff}]	[A_{eff}]	[A_{eff}]	0 Hz	5 Hz	>5 Hz	[s]
G397-053 (Size 5)	4	+40/+104	53	49	48	48	90	90	90	3
	8		53	49	48	48	90	90	90	
	12		53	49	48	42	90	90	90	
	16		49	45	44	39	84	84	84	
G397-070 (Size 5)	4	+40/+104	70	65	63	63	120	120	120	3
	8		70	65	63	63	120	120	120	
	12		68	63	61	55	116	116	116	
	16		49	45	44	39	84	84	84	
G397-084 (Size 5)	4	+40/+104	84	78	76	76	144	144	144	3
	8		84	78	76	76	144	144	144	
	12		68	63	61	55	116	116	116	
	16		49	45	44	39	84	84	84	
G397-110 (Size 6A)	4	+40/+104	110	102	99	90	205	220	220	10
	8		110	102	99	90	165	187	187	
	12		110	102	99	90	132	165	165	
	16		90	83	81	73	106	135	135	
G397-143 (Size 6A)	4	+40/+104	143	132	129	116	230	286	286	10
	8		143	132	129	116	190	215	215	
	12		114	105	103	93	152	172	172	
	16		91	84	82	74	122	138	138	
G397-170 (Size 6A)	4	+40/+104	170	157	153	138	230	340	340	10
	8		170	157	153	138	190	255	255	
	12		136	126	122	110	152	204	204	
	16		109	101	98	88	122	163	163	
G397-210 (Size 6A)	4	+40/+104	210	194	189	170	230	340	340	10
	8		210	194	189	170	190	255	255	
	12		168	155	151	136	152	204	204	
	16		134	124	121	109	122	163	163	

1) When supplied with 565 VDC (corresponding to 400 V AC) at max. 70 % preload
2) Shutdown as per I²t characteristic
3) When supplied with AC-AC servo drive
All data apply for motor cable length ≤10 m

Table B.10 Rated and peak current, Size 5 and Size 6A (liquid-cooled)

B.2 Technical data MSD Servo Drive DC-AC

B.2.1 G392-004 to G393-020 / G397-020 to G397-025

Technical data \ Designation		G393-004	G393-006	G393-008	G393-012	G393-016/ G397-020	G393-020/ G397-025
Output motor-side [1]							
Voltage		3-phase $U_{DC}/\sqrt{2}$					
Rated current effective (I_N)	Air cooling	4 A	6 A	8 A	12 A	16 A	20 A
	Liquid cooling	-	-	-	-	20 A	25 A
Peak current	Air cooling	see tables B.1 to B.4					
	Liquid cooling	-	-	-	-	tables B.6 to B.9	
Rotating field frequency		0 ... 400 Hz					
Power stage switching frequency		4, 8, 12, 16 kHz					
DC input							
DC voltage (U_{DC}) nominal [2]		565 V_{DC} / 650 V_{DC} / 678 V_{DC} / 770 V_{DC}					
Current (RMS approximation value)		1.7 · I_{Motor}					
Device connected load [3]		U_{ZK} · 1.7 · I_{Motor}					
Power loss 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							
Capacity		60 µF		105 µF		288 µF	

1) *All data referred to output voltage 400 V_{eff} and switching frequency 8 kHz*
2) *Generated from rectified TN system with grounded neutral point and external conductor voltages 3 x 400 V AC, 3 x 460 V AC or 3 x 480 V AC with the approved Moog Servo Drive devices (MSD Servo Drive AC-AC or MSD Power Supply Unit). Insulation voltage as per EN 61800-5-1, system voltage 277 V, overvoltage category III.*
3) *Approximate values*

Table B.11 Technical data G393-004 to G393-020

B.2.2 G393-024 to G393-060 / G397-026 to G397-070

Technical data \ Designation		G393-024/ G397-026	G393-032/ G397-035	G393-045/ G397-053	G393-060/ G397-070
Output motor-side[1]					
Voltage		3-phase $U_{DC}/\sqrt{2}$			
Rated current effective (I_N)	Air cooling	24 A	32 A	45 A	60 A
	Liquid cooling	26 A	35 A	53 A	70 A
Peak current	Air cooling	see tables B.1 to B.4		see table B.5	
	Liquid cooling	see tables B.6 to B.9		see table B.10	
Rotating field frequency		0 ... 400 Hz			
Power stage switching frequency		4, 8, 12, 16 kHz			
DC input					
DC voltage (U_{DC}) nominal [2]		565 V_{DC} / 650 V_{DC} / 678 V_{DC} / 770 V_{DC}			
Current (RMS approximation value)		1.7 · I_{Motor}			
Device connected load		U_{ZK} · 1.7 · I_{Motor}			
Power loss at I_N and 8 kHz/ 565 V DC [3]	Air cooling	420 W	545 W	610 W	830 W
	Liquid cooling	455 W	595 W	690 W	930 W
DC link					
Capacity	Air cooling	504 µF		430 µF	900 µF
	Liquid cooling			900 µF	

1) *All data referred to output voltage 400 V_{eff} and switching frequency 8 kHz*
2) *Generated from rectified TN system with grounded neutral point and external conductor voltages 3 x 400 V AC, 3 x 460 V AC or 3 x 480 V AC with the approved Moog Servo Drive devices (MSD Servo Drive AC-AC or MSD Power Supply Unit). Insulation voltage as per EN 61800-5-1, system voltage 277 V, overvoltage category III.*
3) *Approximate values*

Table B.12 Technical data G393-024 to G396-060

B.2.3 G393-072 to G393-170 / G397-084 to G397-210

Technical data \ Designation		G393-072/ G397-084	G393-090/ G397-110	G393-110/ G397-130	G393-143/ G397-170	G393-170/ G397-210
Output motor-side[1]						
Voltage		3-phase $U_{DC}/\sqrt{2}$				
Rated current effective (I_N)	Air cooling	72 A	90 A	110 A	143 A	170 A
	Liquid cooling	84 A	110 A	143 A	170 A	210 A
Peak current	Air cooling	see table B.5				
	Liquid cooling	see table B.10				
Rotating field frequency		0 ... 400 Hz				
Power stage switching frequency		4, 8, 12, 16 kHz				
DC input						
DC voltage (U_{DC}) nominal [2]		565 V_{DC} / 650 V_{DC} / 678 V_{DC} / 770 V_{DC}				
Current (RMS approximation value)		$1.2 \cdot I_{Motor}$				
Device connected load [3]		$U_{ZK} \cdot 1.2 \cdot I_{Motor}$				
Power loss at I_N and 8 kHz/ 565 V DC	Air cooling	1010 W	1300 W	1600 W	2100 W	2500 W
	Liquid cooling	1130 W	1500 W	1940 W	2380 W	2650 W
DC link						
Capacity	Air cooling	900 µF	1060 µF	2120 µF	3180 µF	4240 µF
	Liquid cooling		2120 µF	3180 µF	4240 µF	

1) *All data referred to output voltage 400 V_{eff} and switching frequency 8 kHz*

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

3) *Approximate values*

Table B.13 Technical data G393-090 to G396-170

B.3 Motor cable terminals

Feature	Size 1 + Size 2	Size 3 + Size 4	Size 5	Size 6A	
				90 - 110 A	143 - 170 A
Cable connection capability (flexible, with ferrule)	0.25 - 4 mm² (AWG 24 - AWG 10) *)	0.75 - 16 mm² (AWG 18 - AWG 6)	max. 25 mm² (AWG 4)	35 - 95 mm² (AWG 2 - AWG 4/0)	50 - 150 mm² (AWG 3 - AWG 5/0)
Tightening torque (Nm)	0.7 - 0.8	1.7 - 1.8	2.5 - 4.5	15 - 20	25 - 30
Recommended crimping tool	Phoenix CRIMPFOX 6	Phoenix CRIMPFOX 6 or. 16 S	Phoenix CRIMPFOX or similar	-	-

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

Table B.14 Technical data – motor terminals Size 1 to Size 6A

B.4 Current consumption of control supply

Housing variant	Size	max. startup current	Continuous current
Air cooling	Size 1 - Size 4	6 A	2 A
	Size 5	7 A	2.5 A
	Size 6A	10 A	8 A
Liquid cooling	Size 3 - Size 4	6 A	2 A
	Size 5	7 A	2 A
	Size 6A	8 A	2 A

Table B.15 Current consumption of control supply

B.5 Ready made-up cables

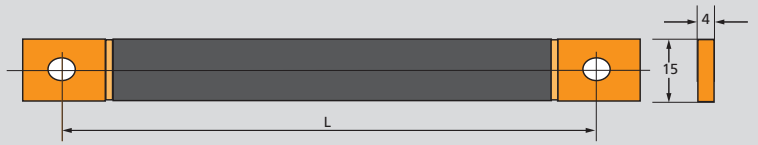
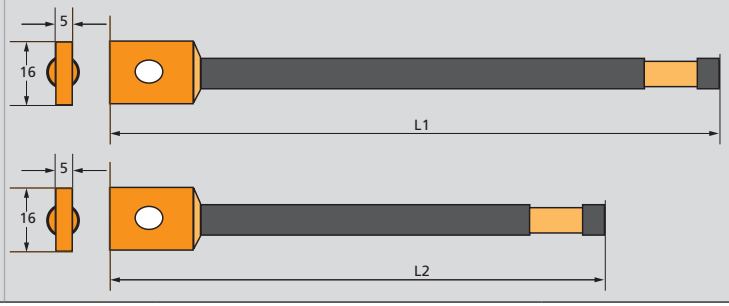
Type	L	Cross-section	Variant	Connection
DC link Size 1	61.5 mm	42 mm²	Flat copper braiding with double shrink-fit tube covering	Flat sheath on both sides with hole Ø 5.5 mm
DC link Size 2	93 mm	42 mm²		
DC link Size 3	133 mm	42 mm²		
DC link Size 4	174 mm	42 mm²		
DC link Size 5	193 mm	42 mm²		
Sketch				
DC link Size 6A	L1 = 385 mm L2 = 345 mm	30 mm²	Round stranded copper with double shrink-fit tube covering	One side flat sheath with hole Ø 5.5 mm, second side stripped strand
Sketch				

Table B.16 Technical data – ready made-up encoder cables

Cable connections

Supply		DC-AC servo drive to connect: Size 1 Size 2	Size 3 Size 4	Size 5	Size 6A
Power supply unit Size 5	Cable	Use only the ready made-up cables supplied.			-
or DC-AC servo drive Size 1 to Size 5	Tightening torque (Nm)	2.5			-
Power supply unit Size 6A	Cable	Use only the ready made-up cables supplied.			95 mm² (AWG 4/0)
	Tightening torque (Nm)	2.5			20
AC-AC servo drive	Cable	6 mm² (AWG 9), max. 1 m	16 mm² (AWG 5), max. 1 m	35 mm² (AWG 2)	95 mm² (AWG 4/0)
		On one side ring cable lug [1] with hole Ø 5.3 mm.			
	Tightening torque (Nm)	2.5			20

1) In the case of ring cable lugs without insulation, the crush zone and min. 20 mm of the cable insulation should be insulated fully with heat-shrink tubing.

Table B.17 Cables, cross-sections and tightening torques

ATTEMTION! **Requirements for longer cables**

- Use only the ready made-up cables supplied for the DC electrical connections between the devices.
- If extending the cable is unavoidable (such as to bypass a switch cabinet panel or for a second DC-AC servo drive array), the DC link connection must be made as follows:
  - Cable cross-section >30 mm² (copperr)
  - A PE conductor of the same cross-section should run alongside and be connected to the PE terminals of the two interconnected devices.
  - The three conductors (DC+, DC-, PE) should be bundled and shielded.
  - A length of 2 metres must not be exceeded.
  - Only **one** extension may be executed in each multi-axis system.

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B.6 Ambient conditions

Ambient conditions	MSD Servo Drive DC-AC
Protection	IP20 except terminals (IP00)
Accident prevention regulations	according to local regulations (in Germany e.g. BGV A3)
Mounting height	up to 1000 m above MSL, above with power reduction (1% per 100 m, max. 2000 m above MSL)
Pollution severity	2
Type of installation	Built-in unit, only for vertical installation in a switch cabinet with min. IP4xprotection; when using the STO safety function min. IP54

Table B.18 MSD Servo Drive ambient conditions

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

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

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

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

Table B.19 MSD Servo Drive climatic conditions

Mechanical conditions		MSD Servo Drive DC-AC	
Vibration limit in transit	as per EN 61800-2, IEC 60721-3-2 class 2M1		
	Frequency [Hz]	Amplitude [mm]	Acceleration [m/s²]
	2 ≤ f < 9	3.5	Not applicable
	9 ≤ f < 200	Not applicable	10
	200 ≤ f < 500	Not applicable	15
Shock limit in transit	as per EN 61800-2, IEC 60721-2-2 class 2M1		
	Drop height of packed device max. 0.25 m		
Vibration limits of the system [1]	as per EN 61800-2, IEC 60721-3-3 class 3M1		
	Frequency [Hz]	Amplitude [mm]	Acceleration [m/s²]
	2 ≤ f < 9	0.3	Not applicable
	9 ≤ f < 200	Not applicable	1

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

Table B.20 MSD Servo Drive mechanical conditions

ATTENTION!

- **Switch cabinet**
  According to EN ISO 13849-2, when using the STO (Safe Torque OFF) safety function the switch cabinet STO must have IP54 protection or higher.
- **Vibration**
  The servo drives must not be installed in areas where they would be permanently exposed to vibrations.

B.7 Hydrological data of liquid cooling

ATTENTION! The temperature of the cooling plate must not be more than +10 °C (+50 °F) below the ambient temperature. Condensation will result in destruction of the device.

NOTE: Customers must provide adequate heat dissipation for the water cooler. The coolant should be approved by Moog GmbH if it deviates from the following requirements::

Requirements		Limits
Coolant quality		Recommended: Drinking water + corrosion inhibitor (e.g. ethylene glycol) Not permitted: Chlorid ions (Cl- >100 ppm), Calcium carbonate (CaCO3 >160 ppm)
Pollution		The coolant must be as pure as possible so as not to clog the ducts. At a suspension concentration above 15 mg/dm³ continuous cleaning is recommended.
Cooler temperature		The coolant temperature may 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, so as to prevent condensation on the heat sink.
Cooler material		Aluminium
Coolant pressure (nominal/maximum value)		1 bar / 2 bar
Coolant flow rate (nominal/maximum value)	Size 3 to Size 4	3 l per min / 4 l per min
	Size 5	8 l per min / 11 l per min
	Size 6A	11 l per min / 13 l per min

Table B.21 Liquid cooling requirements

B.8 Dynamic heat sink temperature monitoring

If the coolant flow breaks down or is not generated, the power stage may overheat. For this reason the servo drive is fitted with a dynamichet sink temperature monitor which shuts off the servo drive in the event of overheating. The servo drive shuts down at a heat sink temperature of +65 °C (+149 °F) regardless of the temperature gradient.

B.9 UL approbation Size 5 and Size 6A

1. Control board input ratings 24 V DC.
2. Maximum surrounding air temperature +40 °C (+104 °F).
3. Internal overload protection operates within max. 3 seconds for Size 5 or max. 10 seconds for Size 6A when reaching 200% of the motor full load current.
4. Suitable for use on a circuit capable of delivering not more than
   Size 5: 5.000 Amperes DC, 700 Volts DC maximum.
   Size 6A: 10.000 Amperes DC, 700 Volts DC maximum.
5. All wiring terminals shall be marked to indicate proper connections for the power supply, load and control circuitry.
6. Tightening torque:

	DC supply input	Motor terminals
Size 5 (air / liquid)	22-39.8 lb-in	MKDSP25-15: 40 lb-in
Size 6A (air / liquid)	HDFK95-F-VP: 175 lb-in WGK95VPF: 133 lb-in	UKH95: 175 lb-in UKH150: 270 lb-in

Table B.22 Tightening torque

7. Use in a pollution degree 2 environment only.
8. Use +75 °C (+ 167 °F) copper conductors only.
9. Wiring terminal intended for connection of a field-installed equipment grounding conductor shall be marked with "G", "GR", "GRD", "GROUND", "GROUNDING" or with a grounding symbol 5019 defined in IEC Publication 417.
10. Inverters are to be supplied by a suitable DC source providing voltage transients limitation to 4 kV maximum.

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C Application example

C.1 Power supply unit/DC-AC servo drive lock

The following example presents a means of configuring the MSD Power Supply Unit with the MSD Servo Drive DC-AC used in the multi-axis system such that in the event of a fault the complete multi-axis system is shut down.

Normally in regenerative mode the DC-AC servo drives feed power back via the power supply unit into the public grid. In the event of failure of the power supply unit or of the public grid, the power is routed into the braking resistor. To protect against overloading of the braking chopper of the power supply unit, the power supply unit can be configured in conjunction with the DC-AC servo drives as follows. As soon as the power supply unit is no longer actively controlling, the DC-AC servo drives' power stage enable (ENPO) is cancelled.

Step	Action	Comment
1.	Wire the supply unit with the connected DC-AC servo drives as shown in fig. C.1.	
2.	Assign power supply unit output REL (X4/23.24) the "Control in function" function (value 2, OUTPUT_FS_ACTIV).	For more functions refer to the MSD Power Supply Unit Operation Manual.

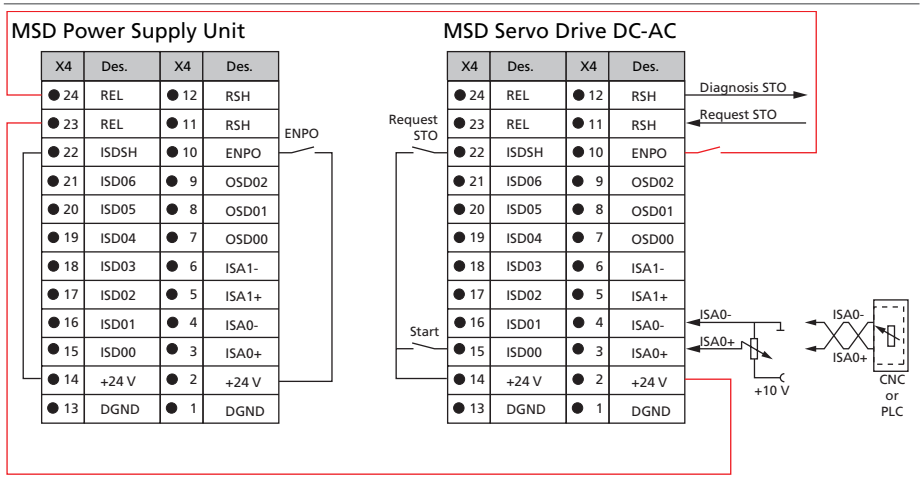

Fig. C.1 MSD Servo Drive multi-axis system lock

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The contents of our documentation have been compiled with greatest care and in compliance with our present status of information.

Nevertheless we would like to point that this document cannot always be updated parallel to the technical further development of our products.

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

Id. no.: CA97554-001, Rev. 1.1

Date: 06/2012

Applicable as from firmware version: V2.20-01