KEBA

Automation by innovation.

ServoOne

Operation Manual

Drive controller

ServoOne single-axis system 4 A to 450 A

ServoOne high-performance drives

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

ServoOne Single-Axis System Operation Manual

ID no.: 1100.20B.9-01

Date: 09/2020

Applicable as from firmware version: V2.20-01

The German version is the original of this operation manual.

Subject to technical change without notice

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

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

Information and specifications may be subject to change at any time. For information on the latest version please visit www.keba.com.

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1 General

The product DVD from KEBA Industrial Automation Germany GmbH contains the complete documentation for the related product series. The documentation for a product series includes the operation manual (hardware description), device help (software description) as well as further user manuals (e.g. field bus description) and specifications. The documents are available in the format PDF.

1.1 Target group

Dear user,

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

1.2 Prerequisites

Prerequisites for the usage of devices from KEBA:

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

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

NOTE
This operation manual applies to all devices in the ServoOne single-axis system (referred to in the following as the drive controller or SO8 for short).

1.3 Reference documents

Document	Contents	ID no. Format
ServoOne Multi-Axis System Axis Controller - Operation Manual	Safety, mechanical installation, electrical installation, commissioning, diagnostics, STO, operation with drive controller as supply, project planning, application example, specifications, certification and applicable standards, technical data	1101.20B.x PDF
ServoOne Multi-Axis System Supply Unit - Operation Manual	Safety, mechanical installation, electrical installation, commissioning, diagnostics, specification, certification and applicable standards, technical data	1101.21B.x PDF
CANopen/EtherCAT - User Manual	Safety, commissioning, data transmission, operation modes, referencing, parameters, technical data	1100.28B.x PDF
PROFIBUS/ PROFINET	Safety, commissioning, data transmission, operation modes, referencing, parameters, technical data	1108.27B.x PDF
ServoOne Sercos II + III - User Manual	Safety, installation and connection, commissioning and configuration, setting parameters, data transmission, scaling and weighting, functionality, error message and diagnostics, parameter lists	1108.26B.x PDF
ServoOne System - System Catalogue	Information, notes on ordering, specifications and technical data on: ServoOne junior, ServoOne single-axis system, ServoOne multi-axis system, safety technology, communication, technology, function packages, accessories and motors	1100.24B.x PDF
ServoOne - Device Help	Description of the software functionality ServoOne, firmware versions: - SO junior from V1.30-xx - SO single-axis system from V3.25-xx - SO multi-axis system from V3.25-xx	0842.26B.x PDF
Program Help DriveManager 5 PC user software	Context-sensitive help for DriveManager version 5.x graphic PC user software for initial commissioning and serial commissioning, operation, diagnostics and project management	0842.25B.x HTML
UL-Certification	Contains measures for compliance with the UL certification for all product ranges.	0927.21B.x
Depending on the device configuration, there are additional operation manuals from the areas safety technology, communication, technology or function packages		

1.4 Order code

The ServoOne drive controller has the article designation SO8x.xxx.0xxx.xxxx.x. This provides information on the related variant of the SO8 supplied. The significance of the individual characters of the article designation is given in the following order code.

Article designation	SO8	4	.	006	.	0	0	3	2	.	0	0	0	0	.	X
ServoOne single-axis system																
Supply voltage: 3 x 400 V		4														
1/3 x 230 V		2														
Rated current	BG1	4.0 A		004												
		6.0 A		006												
	BG2	8.0 A		008												
		12.0 A		012												
	BG3	16 A		016												
		20 A		020												
	BG4	24 A		024												
		32 A		032												
	BG5	45 A		045												
		60 A		060												
		72 A		072												
	BG6	90 A		090												
		110 A		110												
	BG6a	143 A		143												
		170 A		170												
	BG7	250 A		250												
		325 A		325												
		450 A		450												
Mains supply	AC					0										

Article designation	SO8	4	.	006	.	0	0	3	2	.	0	0	0	0	.	X
Safety technology	STO					0										
	Integrated safety control (FS)*)					1										
Option 1 Communication	Not included						0									
	Sercos II						1									
	PROFIBUS						2									
	EtherCAT						3									
	CANopen						4									
	CANopen+2 AO						5									
	VARAN						6									
	PROFINET IRT						7									
	Sercos III						8									
	Powerlink						9									
Option 2 Technology	Not included							0								
	Second SinCos encoder							1								
	TTL encoder simulation / TTL master encoder							2								
	TwinSync communication							3								
	SSI encoder simulation							4								
	TTL encoder with commutation signals							5								
	Multi-IO (analogue and digital) expansion (M19)							6								
	Digital input/output (DIO)							8								
	Second safe SinCos encoder							A								
	Second safe SSI encoder							B								
	Second safe axis monitor (SinCos)							C								
Housing/cooling method	Air-cooled (standard)								0							
	Air-cooled with internal braking resistor								1							
	Liquid cooling with integr. braking resistor								7							
	Liquid-cooled (standard)								8							
Function package	Basic (without additional function package)										0					
	iPlc										1					
	HF										7					
	HF + iPlc										8					
Special design	None											0				
Protection	Standard												0			
	PCBs with protective varnish												1			
Hardware version	(May be multi-digit)															X

*) Only for BG1 ... 5

1.5 Data on manufacture

On rating plates for the drive controllers you will find the serial number, from which you can identify the date of manufacture based on the key (Figure 1.1). For the location of the rating plate on the SO8, refer to Figure 4.4 , for the related sizes BG1 to BG7.

Figure 1.1 ServoOne SO8 hardware rating plate

1.6 Scope of supply

The scope of supply includes:

- ServoOne single-axis system drive controller
- Terminal kit for control and power terminals (depending on device power and variant)
- Set of grommets (for devices with liquid cooling)
- Set with shield connecting terminals and fixing material
- Product DVD with booklet

1.7 Pictograms

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

NOTE

Useful information or reference to other documents.

1.*(digit)*

ACTION TO BE TAKEN

Action undertaken by the user or the system.

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

1.8 Disclaimer

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

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

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

1.9 Disposal

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

- Electrical waste
- Plastic
- Metal

Or engage a certified disposal organisation with scrapping

1.10 Support

Address: KEBA Industrial Automation Germany GmbH
Gewerbestrasse 5-9
35633 Lahnau

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

The Helpline is available by e-mail or telephone:

Service hours: Mo.-Fr.: 8 a.m. - 5 p.m. (CET)

E-mail: helpline@keba.de

Telephone: +49 6441 966-180

Internet: www.keba.com

NOTE

You will find detailed information about our services on our web site www.keba.com ➔ Service

2 Safety

2.1 Overview

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

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

2.2 Measures for your safety

NOTE

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

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

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

2. **Electric drives are dangerous:**

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

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

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

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

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

- Comply with connection conditions and technical data as per the documentation and the rating plate!
- Comply with standards and directives on electrical installation, such as cable cross-section, shielding, etc.!
- Do not touch electronic components and contacts!
  Electrostatic discharge can harm people and destroy components!
- Take protection measures and use protective devices as per the applicable regulations (e.g. EN 60204 or EN 61800-5-1)!
- Take protection measures against electric shock according to IEC 60364-4-41:2005/AMD1, section 411.3. As a protection measure, use additional protective equipotential bonding as described in appendix D of IEC 60364-4-41.
- Take "device earthing" protection measure!

5. **Ambient conditions**

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

2.3 General safety instructions and warnings

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

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

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

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

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

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

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

NOTE:

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

DANGER	WARNING	CAUTION
		

2.4 Intended use

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

CE The devices conform to the **Machinery Directive 2006/42/EC**
Tested and certified according to applicable standards (see declaration of conformity in chapter 1)

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

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

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

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

2.4.1 Repair

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

2.5 Misuse

Our devices are:

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

2.6 Responsibility

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

- For ensuring the drive is rendered safe if the device fails.
- For ensuring the safety of personnel and machinery.
- For ensuring the complete machine is in correct working order.
- For the risk assessment on the complete machine or system according to EN ISO 14121 (formerly DIN EN 1050) and EN ISO 13849-1 (formerly DIN EN 954-1).

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

- The safety requirements on electrical machines defined there are intended to protect personnel and machinery or systems.
- The emergency stop function (as per EN 60204) shuts down the supply of power to a machine, which results in the drives coasting down in an uncontrolled manner. To avert hazards, check whether it is appropriate:
  - To keep individual drives in operation.
  - To initiate specific safety procedures.
  - To incorporate a Safe Torque Off function (Safe Torque Off: movement stop by "switching off the electrical supply" - STO).

2.7 Relevant laws, standards and directives applied

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

NOTE:

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

NOTE:

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

2.8 Declaration of conformity

2.8.1 ServoOne BG1 to BG7

EU-Konformitätserklärung
EU Declaration of Conformity

KEBA
Automation by innovation.

Der Hersteller *The manufacturer*	KEBA Industrial Automation Germany GmbH Gewerbestraße 5-9 35633 Lahnau Deutschland

erklärt in alleiniger Verantwortung hiermit, dass die folgenden Produkte
declares under sole responsibility, that the following products

Produktbezeichnung: *Product designation:*	Servoregler *Servo Controller*
Produkttypen: *Product types:*	ServoOne Baugröße 1-7, *ServoOne Size 1-7*
ab Seriennummer: *from serial number:*	203600932 *203600932*
Produkttypen: *Product types:*	ServoOne Junior Baugröße 2-5 *ServoOne Junior Size 2-5*
ab Seriennummer: *from serial number*	203800250 *203800250*

den Sicherheitsbestimmungen der nachstehenden EG- und EU-Richtlinien entsprechen:
comply with the essential requirements of the following EC and EU Directives:

2006/42/EG *2006/42/EC*	[Maschinenrichtlinie] *[Machinery-Directive]*
2014/30/EU *2014/30/EU*	[EMV-Richtlinie] *[EMC-Directive]*

und dass folgende angeführte Normen angewandt wurden:
and that the following standards has been applied:

EN ISO 13849-1:2008 + AC:2009	EN 50178:1997	EN 62061:2005+AC:2010+A1:2013
EN 61800-3:2004 + A1:20012	EN 61800-5-1:2007	EN 61800-5-2:2007
EN 60204-1:2006 + A1:2009 + AC:2010 (in extracts)		IEC 61508 1-7:2010

Unterzeichnet für und im Namen von KEBA Industrial Automation Germany GmbH.
Signed for and on behalf of KEBA Industrial Automation Germany GmbH.

Unterschrift / *signature:*		
Name / *name:*	Alexander Lehmann	Dr. Josef Wiesinger
Stellung / *position:*	Leiter Qualitätsmanagement Head of Qualitymanagement	Geschäftsführer *Managing Director*
Datum / *date:*	16.09.2020	16.09.2020
Ort / *place:*	Lahnau	Lahnau
Land / *country:*	Deutschland	Deutschland

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The German-language version of this document is the original version, all other language versions have been translated from the original text.
Dokument: 1110.0DK.3-01

FB 0018 EU-Konformitätserklärung NSRL/EMV 2020/03 K

3 Mechanical installation

The device is designed only for installation in a stationary switch cabinet. The switch cabinet must as a minimum provide IP4x protection.

3.1 Notes for installation

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

Note the following points:

- Cooling air must be able to flow through the device without restriction.
- On installation in switch cabinets with convection (= heat loss is dissipated to the outside via the cabinet walls), always fit an internal fan.
- The backing plate must be well-earthed.
- The device is intended only for vertical installation in switch cabinets. The switch cabinet must as a minimum provide IP4X protection.
- To attain the best result for effective EMC installation you should use a chromated or galvanised backing plate. If backing plates are varnished, remove the coating from the contact area! The devices themselves have an aluminium back panel (BG1 to BG4) or a back panel made of galvanised sheet steel (BG5 to BG7).
- Maximum pollution degree 2 according to EN 60664-1.
- The drive controllers must not be installed in areas where they would be permanently exposed to vibration. You will find more information in the appendix, Table A.20.
- The device heats up during operation and the temperature on the heat sink may reach 100 °C. Pay attention to this aspect for neighbouring components.

NOTE

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

3.2 Mounting (air and liquid cooling)

Step	Action	Comment
1.	Mark out the position of the tapped holes and the pipe fittings, if necessary, on the backing plate. Drill holes and cut a thread for each fixing screw in the backing plate.	Pay attention to the mounting clearances! Pay attention to the bending radius of the connection cables! For dimensional drawings/hole spacing see Figure 3.2 to Figure 3.7
2.	Mount the drive controller vertically on the backing plate.	Observe the mounting clearances! The contact area must be bare metal.
3.	On devices with liquid cooling, while screwing the hose connections (not included in the scope of supply) into the pipe fittings, lock the pipe fittings using a 22 mm open-ended wrench to prevent damage due to the application of torque to the device.	Pay attention to a perfectly sealed connection without leaks (e.g. using Teflon sealing tape)!
4.	Mount the other components, such as the mains filter, mains choke etc., on the backing plate.	The cable between mains filter and drive controller may be max. 30 cm long.

Table 3.1 Mechanical installation

NOTE:

Connect the flow from the liquid cooling for BG7 to the connection correspondingly marked (Figure 3.8). For BG3 to BG6a the connection can be chosen as required.

3.3 Dimensions, devices with air cooling

3.3.1 Mounting clearances

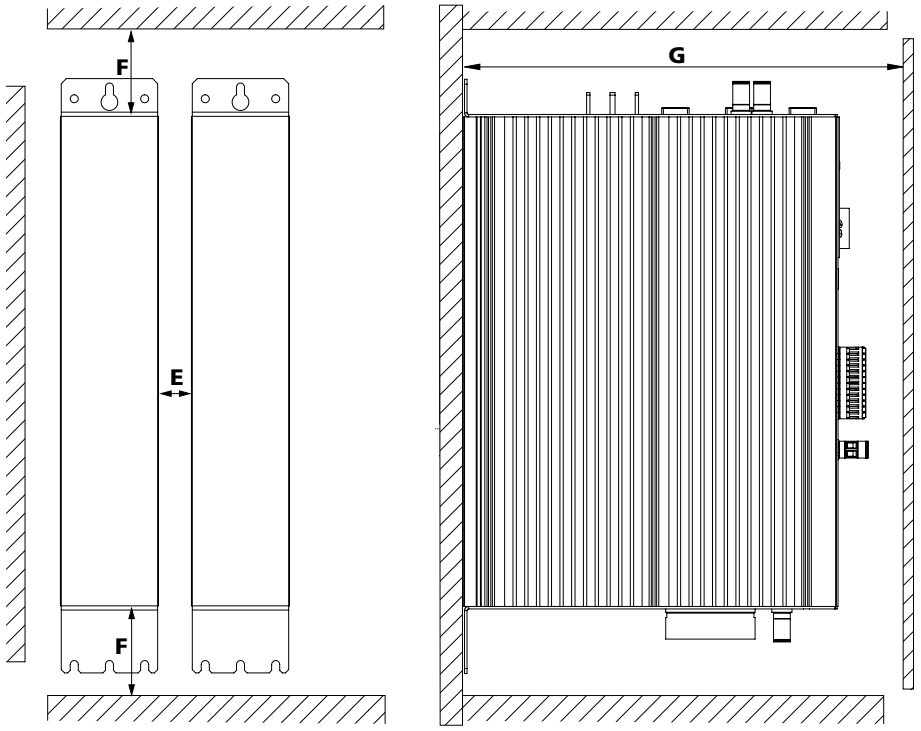


Figure 3.1 Mounting clearances for air cooling, schematic depiction for BG1 to BG6a

ServoOne	BG1	BG2	BG3	BG4	BG5	BG6	BG6a
	S082.004 S084.004 S084.006	S084.008 S084.012	S084.016 S084.020	S084.024 S084.032	S084.045 S084.060 S084.072	S084.090 S084.110	S084.143 S084.170
E	2				20	40	
F [1)]	≥100		≥150		≥180		
G [1)]	≥270				≥300		≥500

All dimensions in mm

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

Table 3.2 Mounting clearances for air cooling, see Figure 3.1

NOTE:

The minimum distance "E" specified in the table for sizes 1-4 applies for devices of the same power rating. On butt mounting devices with different drive powers, you should arrange the devices in order by power rating (e.g., viewed from the left, BG4-BG3-BG2-BG1). This arrangement will minimise the thermal interaction.

On butt mounting ServoOne controllers with other devices, you should ensure there is no thermal interaction between the devices.

3.3.2 Dimensions

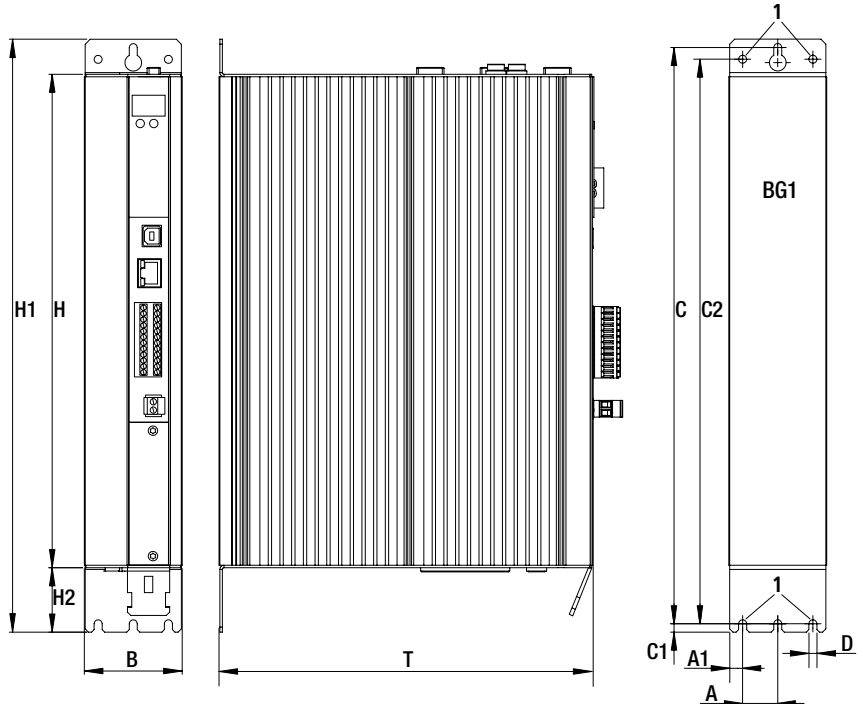


Figure 3.2 Dimensional drawing, housing with air cooling, schematic depiction for BG1

ServoOne	BG1
	S082.004 S084.004 S084.006
Weight [kg]	3,4
B (width)	58,5
H (height) [1]	295
T (depth) [1]	224
A	21
A1	8,25
C	344,5
C1	5
C2	337,5
D Ø	4,8
Screws	2 x M4 (Standard) 4 x M4 (Vibration)
H1	355
H2	38,5

All dimensions in mm

1) Without terminals, connectors and shield plates

Table 3.3 Dimensions, housing with air cooling BG1, see Figure 3.2

NOTE:

For applications with vibrations up to max. 3M3 according to DIN EN 60721-3-3, BG1 devices must be mounted with at least 4 screws in the corners of the mounting brackets (Figure 3.2, number 1).

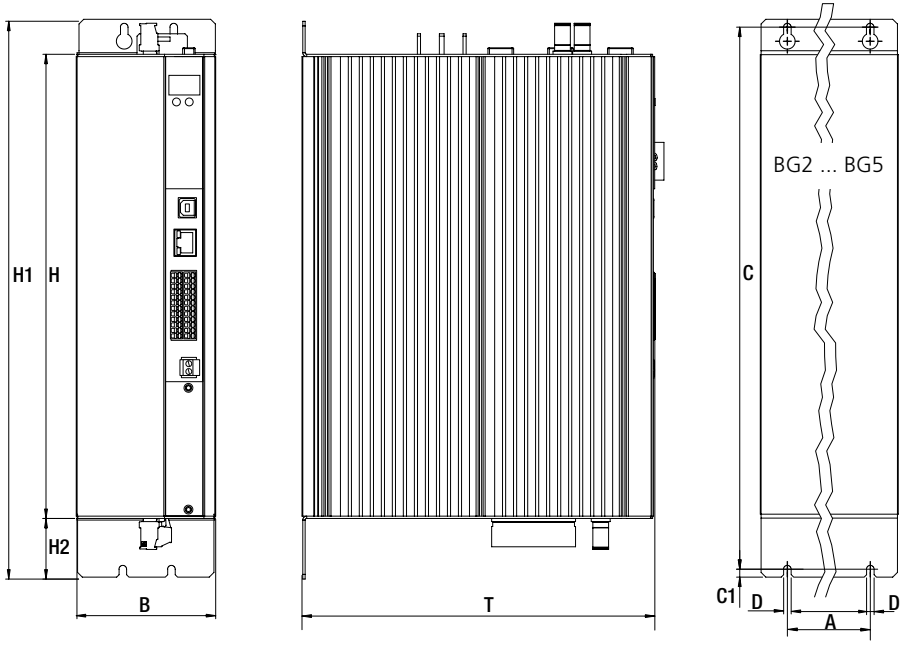


Figure 3.3 Dimensional drawing, housing with air cooling, schematic depiction for BG2 - BG5

ServoOne	BG2	BG3	BG4	BG5
	S084.008 S084.012	S084.016 S084.020	S084.024 S084.032	S084.045 S084.060 S084.072
Weight [kg]	4,9	6,5	7,5	13
B (width)	90	130	171	190
H (height) [1]	295			345
T (depth) [1]	224			238
A	50	80	120	150
C	344,5			365
C1	5			6
D Ø	4,8			5,6
Screws	4 x M4			4 x M5
H1	355			382,5
H2	38,5			15

All dimensions in mm

1) Without terminals, connectors and shield plates

Table 3.4 Dimensions, housing with air cooling, see Figure 3.3

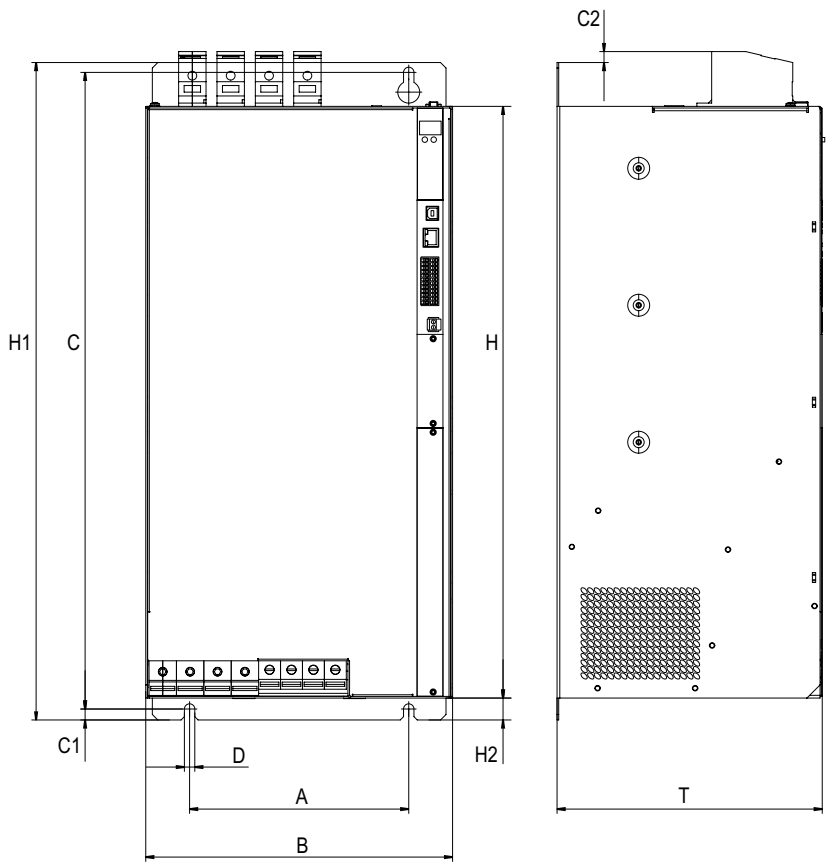


Figure 3.4 Dimensional drawing, housing with air cooling, schematic depiction for BG6/6a

ServoOne	BG6	BG6a
	S084.090 S084.110	S084.143 S084.170
Weight [kg]	28	32
B (width)	280	
H (height) [1]	540	
T (depth) [1]	242	322
A	200	
C	581	
C1	10	
D Ø	9,5	
Screws	4 x M8	
H1	600	
H2	20	

All dimensions in mm

1) Without terminals, connectors and shield plates

Table 3.5 imensions, housing with air cooling, see Figure 3.4

3.4 Dimensions, devices with liquid cooling

ServoOne	BG3		BG4		BG5	BG6		BG6a		BG7
	S084.016 S084.020		S084.024 S084.032		S084.045 S084.060 S084.072	S084.090 S084.110		S084.143 S084.170		S084.250 S084.325 S084.450
Weight [kg]	6.5		7.5		16.5	31.5		41.1		100
B (width)	130		171		190	280				380
H (height) [1]	295				345	540				855
T (depth) [1]	224				198	202		282		287
A	80		120		148	200				150
A1	10		25		39	65				29
A2	60				70					
C	382				378	581				952
C1	5				8	10				14
H1	392				394	600				979/995 [4]
H2	38.5				16.5	20				62
H3	75		70		53.5	56.5				124
T1	74				74					
D Ø	4.8				7	9.5				12
Screws	4 x M4				4 x M6	4 x M8				6 x M10
S	3/8 inch (female thread)									
D1 Ø	48 (bore for pipe fitting)									
E	2									
F [2]	≥150				≥180					
G [2]	≥270				≥300			≥500		

All dimensions in mm

1) Without terminals, connectors and shield plates

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

3) Without/with terminal covers and shield plates

4) Without/with busbars

Table 3.6 Dimensions, housing with liquid cooling, see Figure 3.5 to Figure 3.7

NOTE:

The minimum distance "E" specified in the table applies for devices of the same power rating. On butt mounting devices with different drive powers, you should arrange the devices in order by power rating (e.g., viewed from the left, BG4-BG3-BG2-BG1). This arrangement will minimise the thermal interaction.

On butt mounting ServoOne controllers with other devices, you should ensure there is no thermal interaction between the devices.

3.4.1 Mounting clearances

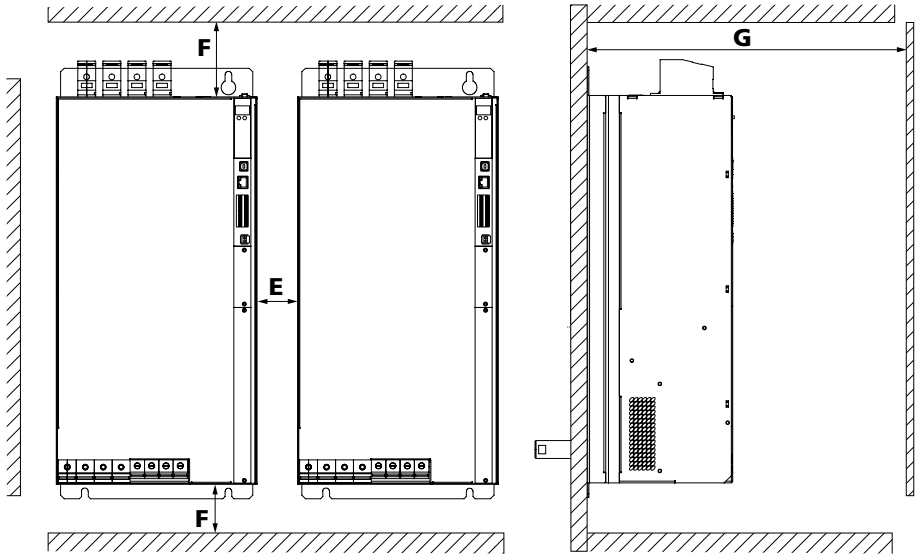


Figure 3.5 Mounting clearances for liquid cooling, schematic depiction for BG3 to BG7

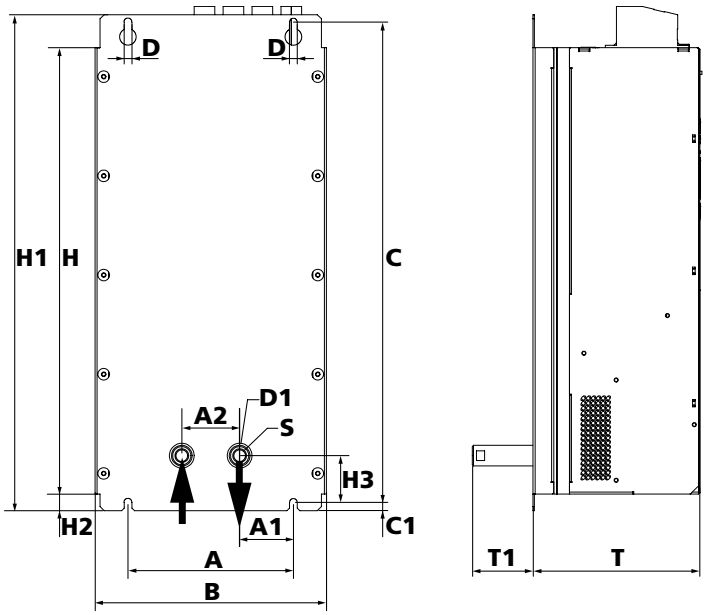


Figure 3.6 Dimensional drawing, housing with liquid cooling, schematic depiction for BG3 to BG6a

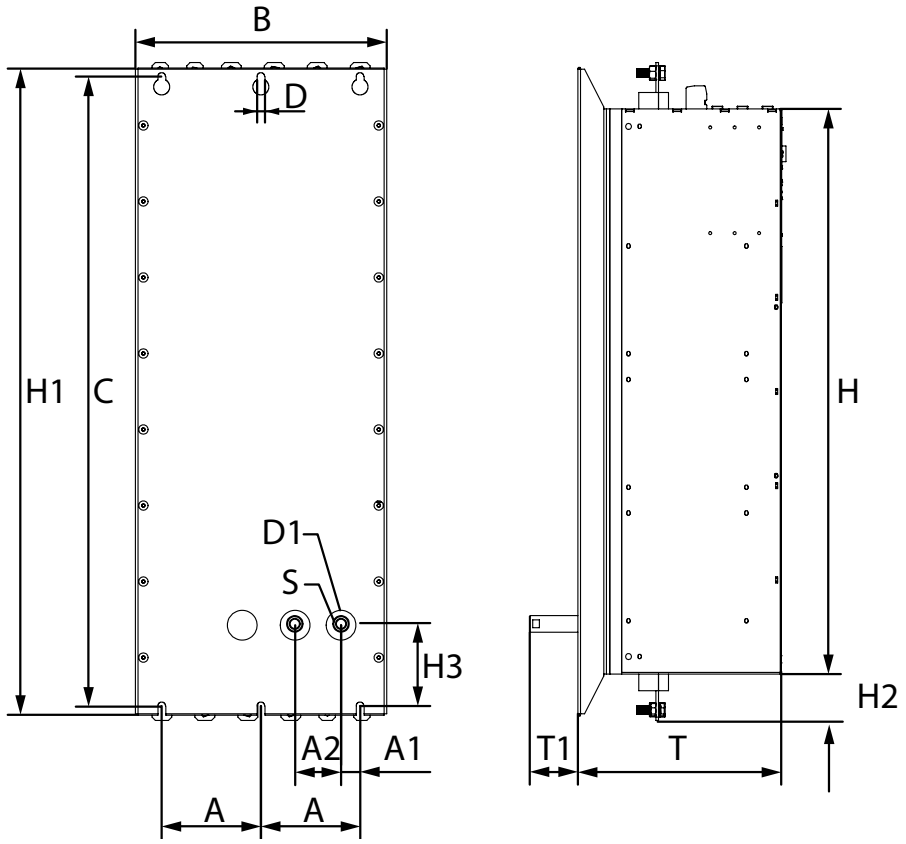


Figure 3.7 Dimensional drawing, housing with liquid cooling, schematic depiction for BG7

3.5 Cooling circuit connection

The ServoOne 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.

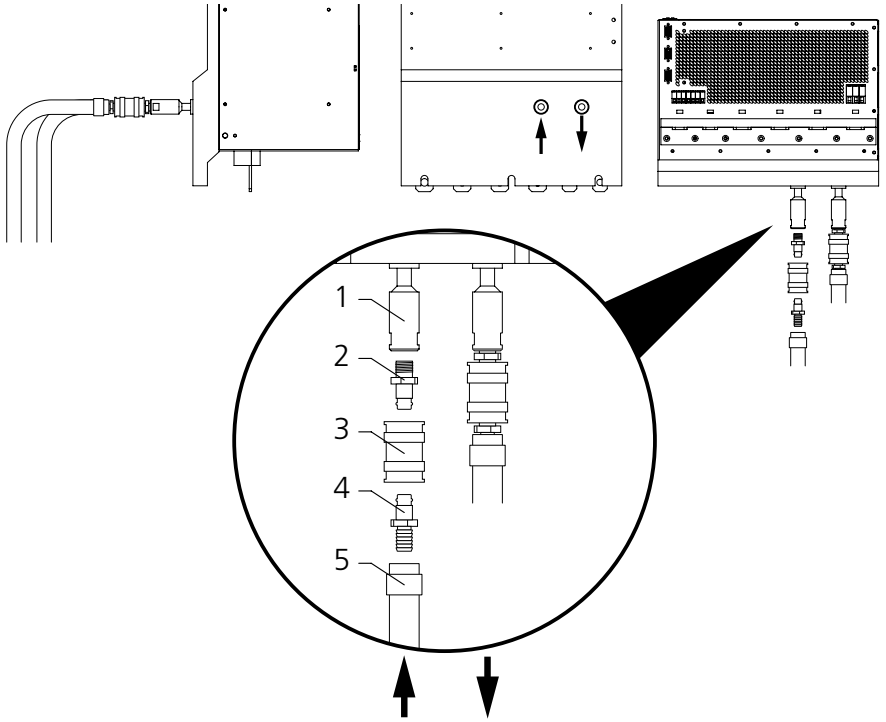


Figure 3.8 Cooling circuit connection (here: BG7)

Key

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

NOTE:
Items 2 to 5 are **not** included in the scope of supply. You will find these in the cooling circuit connection set (LCS01). Please order separately.

Figure 3.8 Cooling circuit connection (here: BG7)

NOTE:
It is imperative the flow from the liquid cooling is connected to the connection correspondingly marked in Figure 3.6, Figure 3.7 or Figure 3.8.

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

4 Electrical installation

4.1 Notes for installation

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

DANGER!	**Risk of injury due to electrical power!**
	• **Carelessness will result in serious injuries or death.** Never make or disconnect electrical connections while they are electrically live! Always disconnect the power before working on the device. Even 10 min. (BG1-4) / 30 min. (BG5-7) after switching off the mains supply, dangerously high voltages of ≥50 V may still be present (capacitor charge). **So check that electrical power is not present!** Work on the device must only be carried out after the DC link voltage has dropped below a residual voltage of 50 V (on BG1-BG6a to be measured on the terminals X11/L+ and L-, on BG7 on the terminals X11/ZK- and X11/ZK+). Any existing additional DC link connections as well as all motor connections are to be checked in relation to each other and in relation to earth to ensure they are not carrying any electrical power. If necessary, all cable connections are to be discharged using suitable means. A dangerous voltage may be present at the device, even if the device does not emit any visual or audible signals/indications (e.g. with mains voltage applied to terminal X11 and missing control supply +24 V on X9/X10 and X44)!

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

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

4.2 Effective EMC installation

4.2.1 Cable type

- Use only shielded mains, motor and signal cables. For all shielded connections, use cables with double copper braiding with 60 to 70 % coverage.
- If it is necessary to lay very large cable cross-sections, instead of shielded cables it is also possible to lay separate individually shielded wires (for currents > 60 A and output frequencies significantly higher than 400 Hz [HF function package], individually shielded wires are not allowed. Please contact our application specialists on the Helpline).

4.2.2 Routing of cables

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

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

4.2.3 Usage with mains choke

The usage of mains chokes is:

- Required on all devices from and including size BG5
- Required on the usage of the drive controller in harsh industrial systems
- Recommended to increase the life of the DC link capacitors

4.2.4 Usage with internal mains filters

The drive controllers BG1 to BG5 are equipped with integrated mains filters. With the measurement method specified by the standard, the servocontrollers meet the EMC protection goals according to EN 61800-3 for "First environment" (residential C2) and "Second environment" (industrial C3). For more detailed information see chapter A.6.

NOTE:

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

4.2.5 Usage with external mains filters

External RFI filters (EMC xxx) are available for the drive controllers BG6 and BG6a. With the measurement method specified and the external mains filter, these drive controllers also conform to the EMC product standard EN61800-3 for "First environment" (residential C2) and "Second environment" (industrial C3).

Whether an external mains filter is required for the devices of size BG7 depends on the type of connection and the local situation. For this reason the usage of a mains filter is to be considered in the specific case and decided during project planning.

To make it possible to use longer motor cables and achieve compliance with the EMC product standard EN 61800-3 for the "general availability" (residential C1), additional external mains filters are available for devices with an internal mains filter (BG1 to BG5).

4.2.6 Earthing measures

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

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

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

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

4.2.7 Shielding measures

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

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

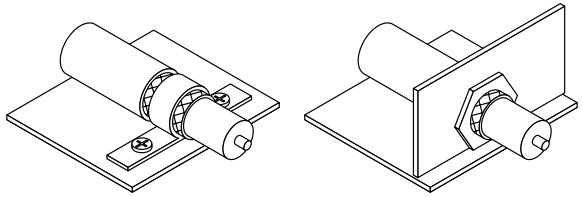


Figure 4.1 CORRECT shield connection

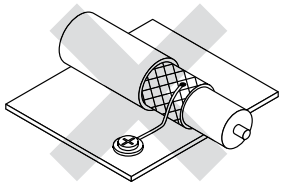


Figure 4.2 INCORRECT shield connection - do not extend to the earthing point (pigtail)

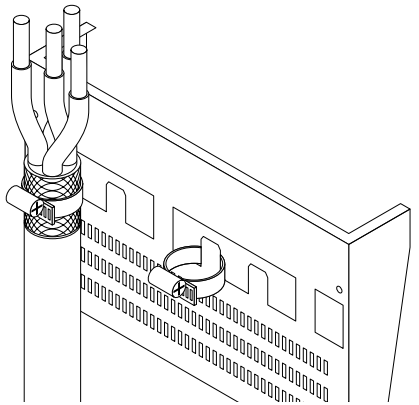


Figure 4.3 Shield connection

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

4.2.8 External components

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

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

4.3 Overview of the connections, BG1 to BG4

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

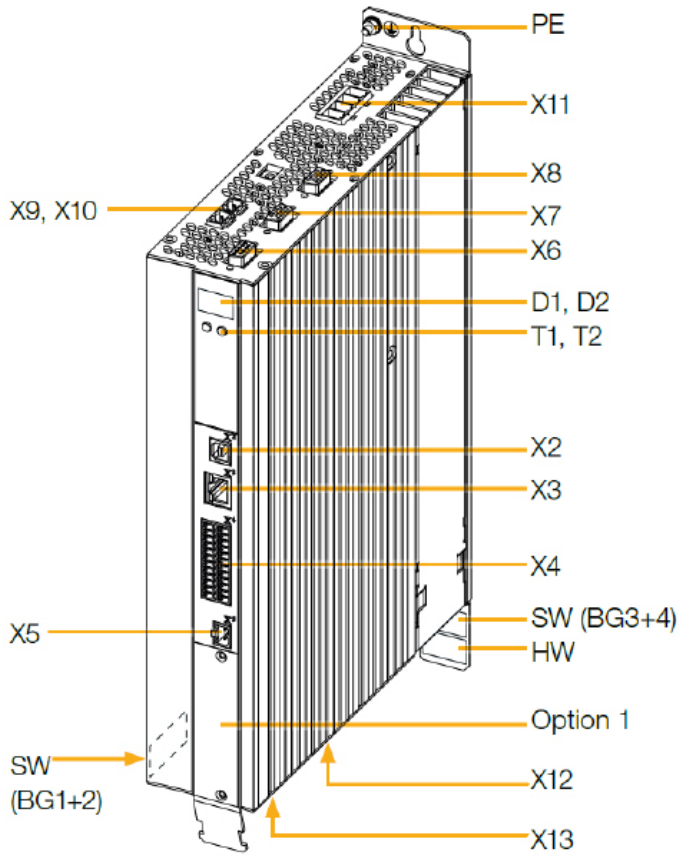


Figure 4.4 Layout, BG1 to BG4 (BG1 air cooling variant)

4.3.1 Connection diagram

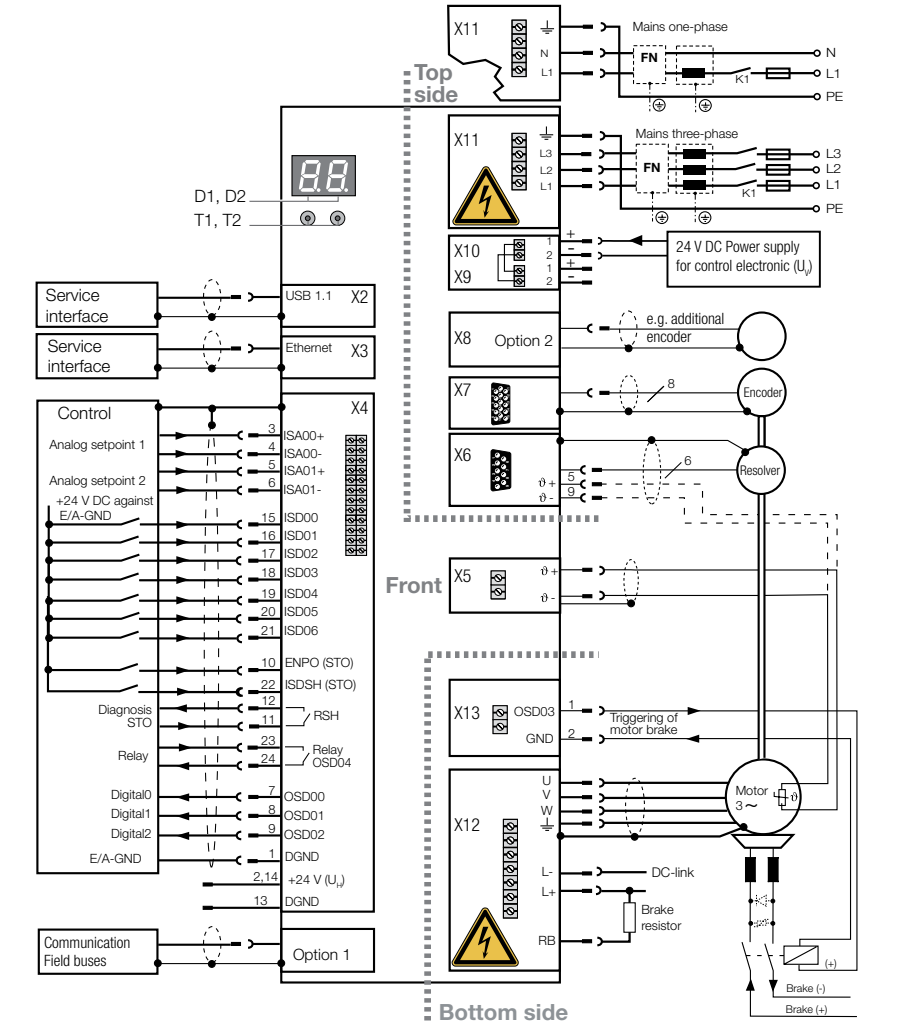


Figure 4.5 Connection diagram, BG1 to BG4

Key

Number	Designation
D1, D2	7-segment display
T1, T2	Button
X2	USB 1.1 interface
X3	Ethernet interface
X4	Control terminals
Option 1	Communication
X11	Connection for AC mains supply: 1 x 230 V = S082.004 (BG1) 3 x 400/460/480 V S084.004 to S084.032 (BG1-BG4)
PE	Connection for PE conductor
X9, X10	Connection for control supply
X8 (Option 2)	Technology
X7	Connection for high-resolution encoder
X6	Connection for resolver
X5	Connection for motor temperature monitoring
X13	Connection for motor brake
X12	Connection for motor, braking resistor and DC link
HW	Hardware rating plate
SW	Software rating plate

Table 4.1 Key to connection diagram, BG1 to BG4

4.4 Overview of the connections, BG5 to BG6a

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

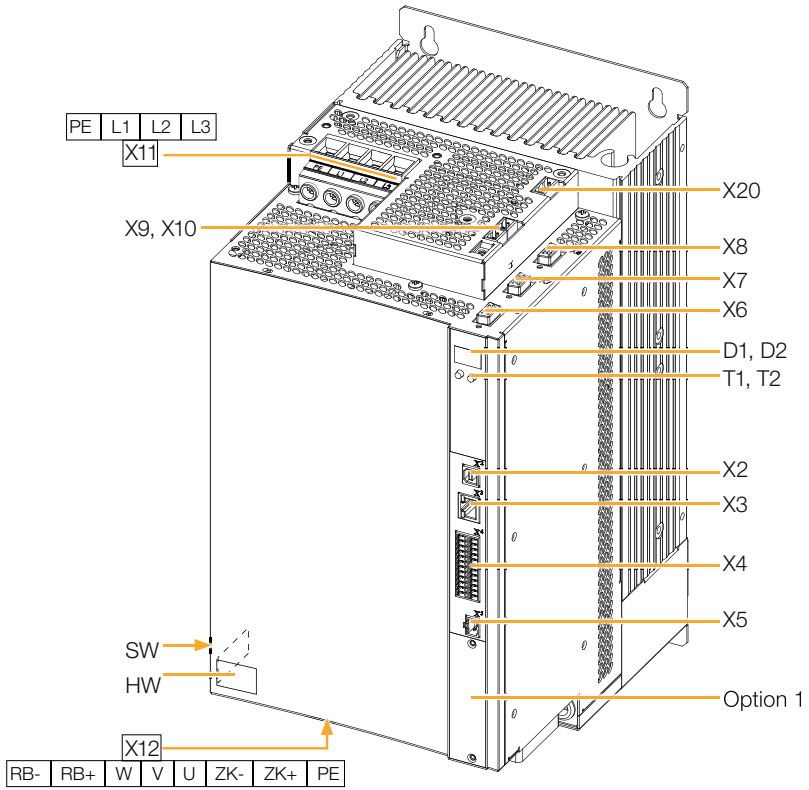


Figure 4.6 Layout, BG5 (air cooling housing variant)

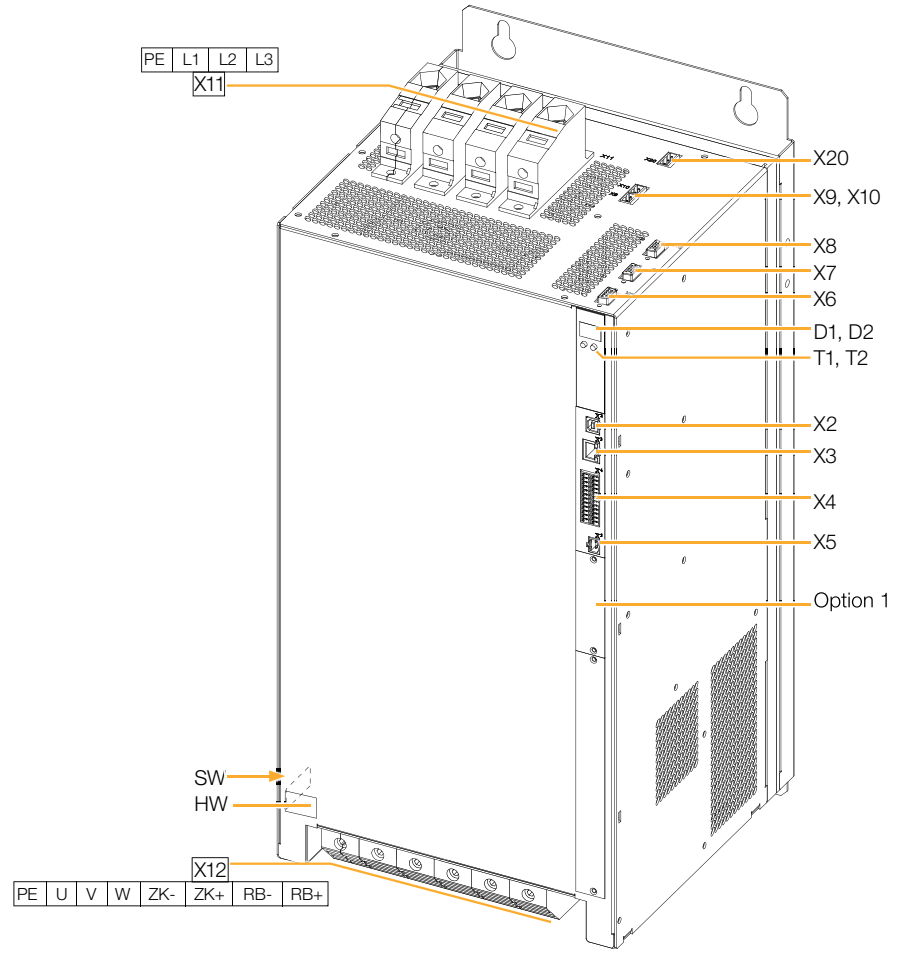


Figure 4.7 Layout, BG6 and BG6a (BG6a, liquid cooling housing variant)

4.4.1 Connection diagram

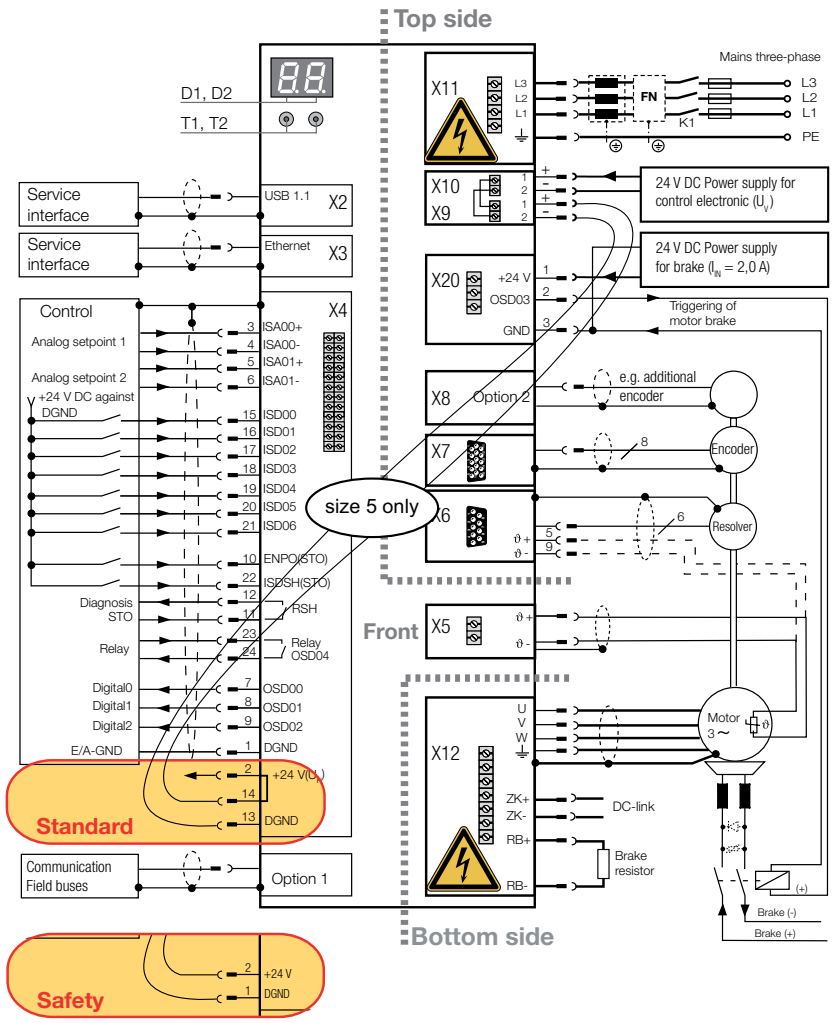


Figure 4.8 Connection diagram, BG5 to BG6a

NOTE:

There is a special aspect on the connection of the 24 V control supply for SO8 BG5. Please make sure that a connection (U_H) is made between X9/+ and X4/14 as well as between X9/- and X4/13. This is necessary to supply the digital control inputs/outputs with electrical power.

Key

Number	Designation
D1, D2	7-segment display
T1, T2	Button
X2	USB 1.1 interface
X3	Ethernet interface
X4	Control terminals
Option 1	Communication
X11	Connection for AC mains supply: 3 x 400/460/480 V SO84.045 to SO84.170 (BG5-BG6a)
PE	Connection for PE conductor
X9, X10	Connection for control supply
X20	Connection for motor brake
X8 (Option 2)	Technology
X7	Connection for high-resolution encoder
X6	Connection for resolver
X5	Connection for motor temperature monitoring
X12	Connection for motor, braking resistor and DC link
HW	Hardware rating plate
SW	Software rating plate

Table 4.2 Key to connection diagram BG5 to BG6a

4.5 Overview of the connections, BG7

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

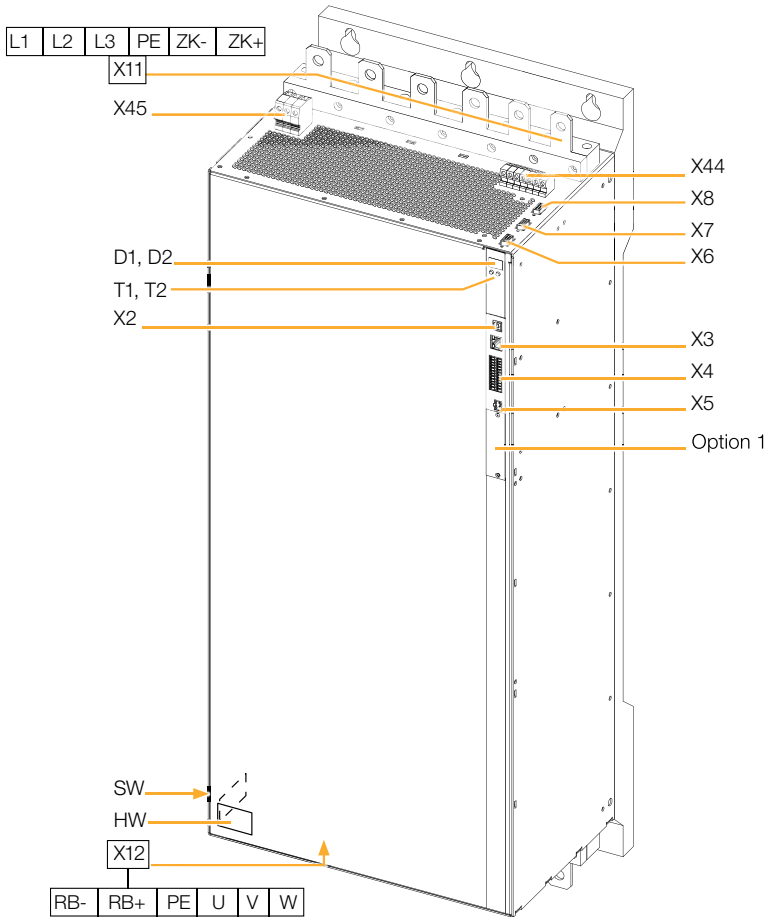


Figure 4.9 Layout, BG7 (without shield plates and terminal covers)

4.5.1 Connection diagram

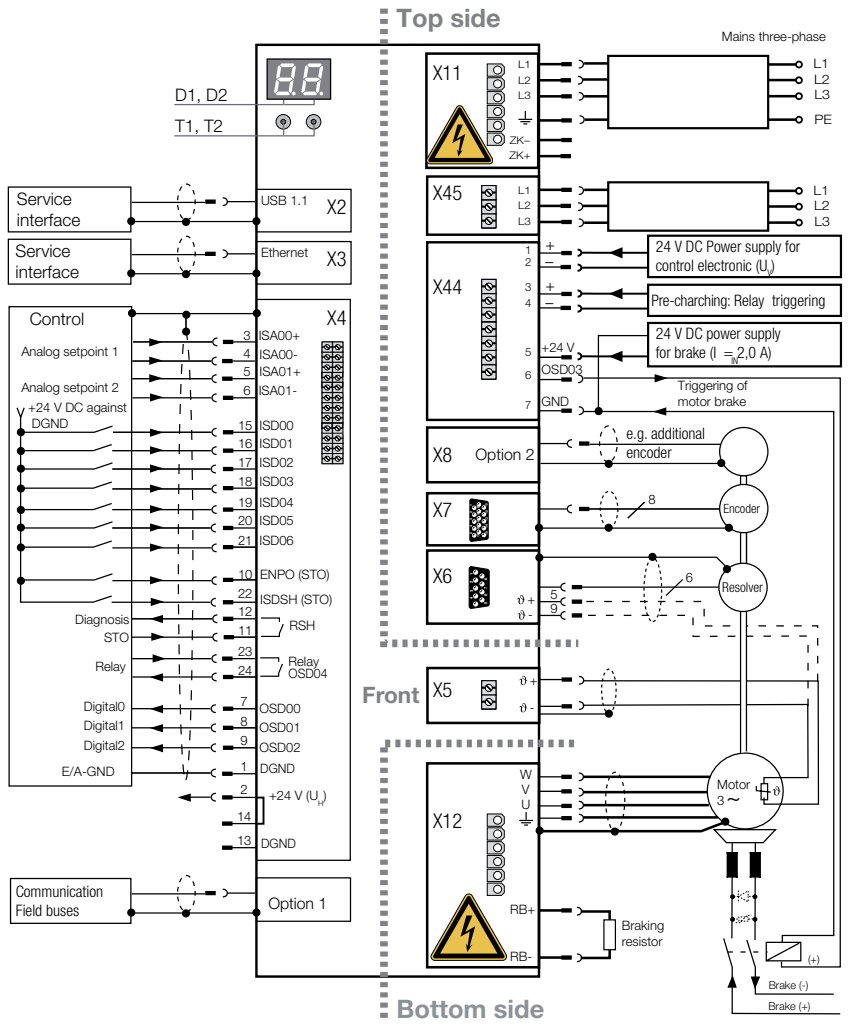


Figure 4.10 Connection diagram, BG7

Key

No.	Designation
D1, D2	7-segment display
T1, T2	Button
X2	USB 1.1 interface
X3	Ethernet interface
X4	Control terminals
Option 1	Communication
X11	Connection for AC mains supply: 3 x 400/460/480 V SO84.250 to SO84.450 (BG7) and DC link connection
PE	Connection for PE conductor
X45	Connection for DC link precharging, see chapter *4.8.6*
X44	Connection for control supply, precharging relay and motor brake
X8 (Option 2)	Technology option
X7	Connection for high-resolution encoder
X6	Connection for resolver
X5	Connection for motor temperature monitoring
X12	Connection for motor phases and braking resistor
HW	Hardware rating plate
SW	Software rating plate

Table 4.3 Key to connection diagram, BG7

4.6 Connection of PE conductor

Step	Action	PE mains connection according to DIN EN 61800-5-1
1.	Earth each of the drive controllers! Connect the terminal ⏚ in a **star configuration** and with a **large area connection** to the PE rail (main earth) in the switch cabinet.	As the leakage current >3.5 mA, the following applies to the PE connection: • Mains connection <10 mm² copper: protective earth conductor cross-section min. 10 mm² copper or two wires with the cross-section of the mains power cables (BG1-4). • Mains connection ≥10 mm² copper: protective earth conductor cross-section to suit the cross-section of the mains power cables (for BG5-7). Also comply with local and national regulations and conditions for equipment with high leakage current. The minimum cross-section of the protective earth conductor must comply with the local safety requirements for protective earth conductors for equipment with high leakage current.
2.	Also connect the PE conductor connections on all other components, such as mains choke, filter, etc. in a **star configuration** and with a **large area connection** to the PE rail (main earth) in the switch cabinet.	

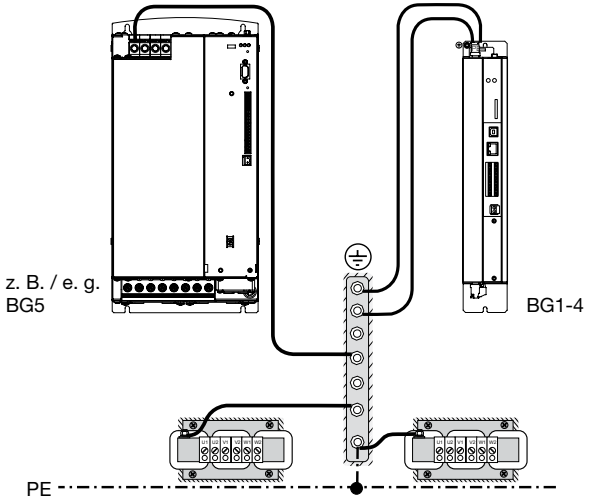


Figure 4.11 Star configuration layout for the PE conductor

4.7 Electrical isolation concept

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

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

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

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

NOTE:

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

SELV = Safety Extra Low Voltage

PELV = Protective Extra Low Voltage

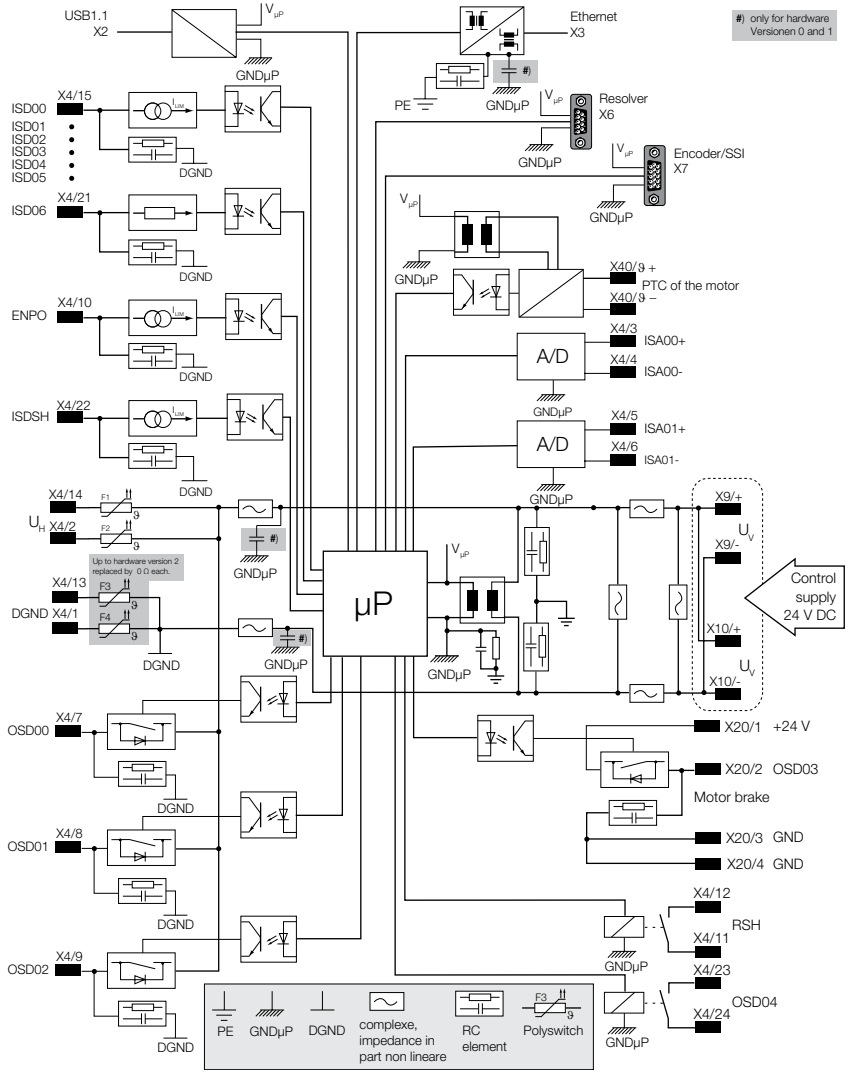


Figure 4.12 Electrical isolation concept for BG1 to BG4

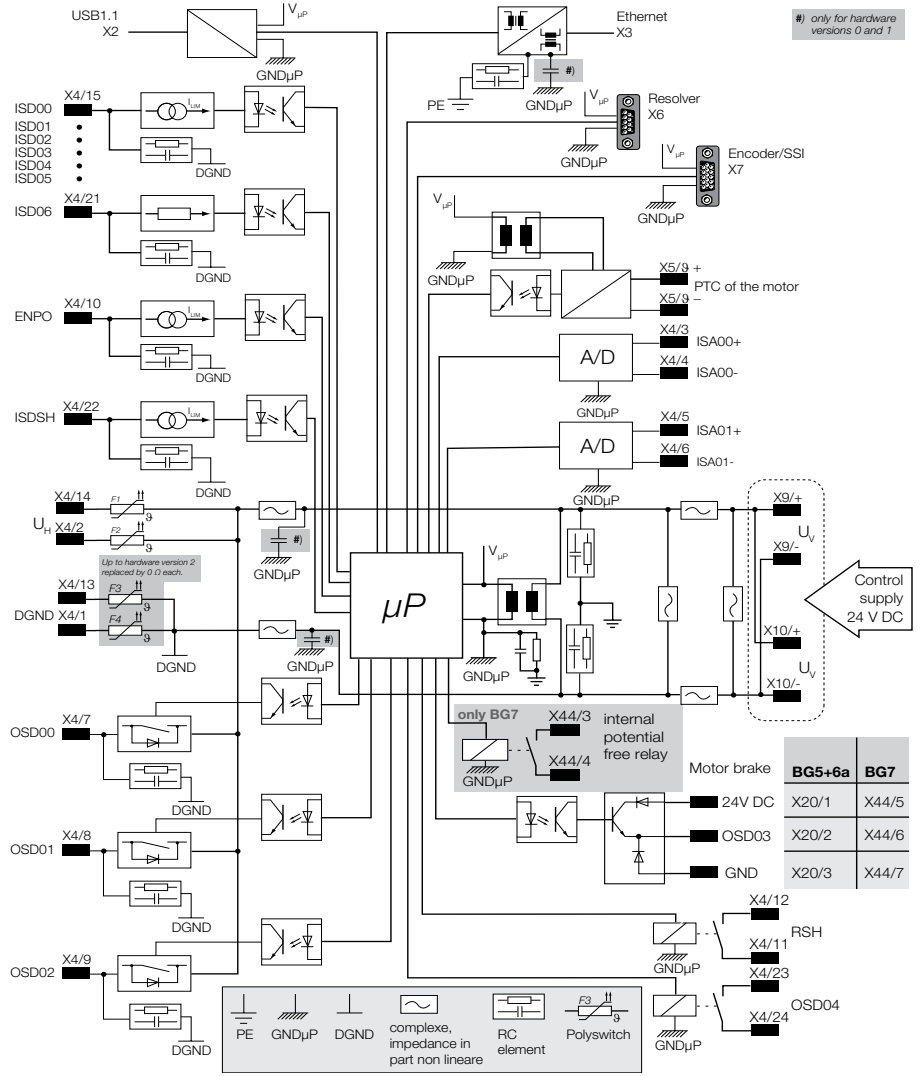


Figure 4.13 Electrical isolation concept for BG5 to BG7

4.8 Connection of the supply voltages

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

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

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

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

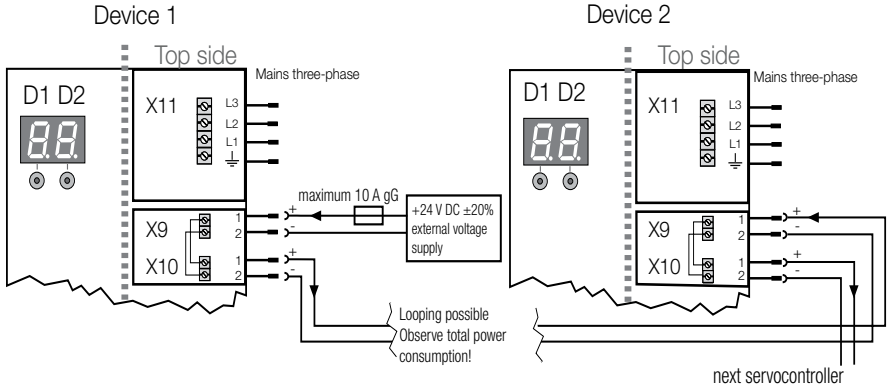


Figure 4.14 Connection of control supply, BG1 to BG6a

NOTE:

Suitable measures must generally be applied to provide adequate cable protection. You will find information on the connection of the control supply for BG7 in *Table 4.5*

Control supply, BG1 to BG6a	
Terminal/pin	**Specification**
X9/1 = + X9/2 = -	• U_V = 24 V DC ±20 % (BG5 to BG6a +20/-10 %), stabilised and smoothed • For information on the current required for the control supply see *Table A.17*. • Continuous current carrying capacity of the terminal max. 10 A (BG5 to BG6a max. 8 A), internal reverse polarity protection • The power supply unit used must have safe and reliable isolation in relation to the mains as per EN 50178 or EN 61800-5-1. • Connected internally to X10
X10/1 = + X10/2 = -	• Continuous current carrying capacity of the terminal max. 10 A (BG5 to BG6a max. 8 A) • Connected internally to X9

Table 4.4 Specification, control supply BG1 to BG6a

NOTE:

On the sizes BG1 to BG4, along with the control section the external 24 V also supply the output for the motor brake. If this output is active, the current for the control section plus the current for the motor holding brake, in addition to any current required for digital inputs and outputs, flows via terminal X9. Pay attention to this issue on dimensioning the power supply for the control section and on looping through to other devices.

NOTE:

For size BG5 the external 24 V control voltage must also be connected to the control terminals (see Figure 4.5).

Control supply, BG7	
Terminal/pin	**Specification**
X44/1 = + X44/2 = -	• U_V = 24 V DC ±10 % stabilised and smoothed • For information on the current required for the control supply see *Table A.17*. • Continuous current carrying capacity of the terminals max. 10 A, internal reverse polarity protection • The power supply unit used must have safe and reliable isolation in relation to the mains as per EN 50178 or EN 61800-5-1.

Table 4.5 Specification, control supply BG7

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

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

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

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

Note the following points:

Switching the mains power:

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

TN and TT system: operation is permitted if:

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

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

The star point of the supply system **is earthed** and

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

IT system: operation is not permitted!

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

– Connection of the drive controllers via a mains choke is imperative:

  – Where the drive controller is used in applications with disturbance variables corresponding to environment class 3, as per EN 61000-2-4 and above (harsh industrial environment).

  – For compliance with EN 61800-3 or IEC 61800-3, see Appendix.

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

NOTE:

Please be aware that the ServoOne drive controller is not designed for the mains quality inenvironment class 3 (EN 61000-2-4).

NOTE:

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

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

4.8.3 AC mains supply, BG1 to BG4

Drive controller	Device connected load [1] [kVA]		Specified mains fuse, utilisation class gG [A]
	With mains choke (4 % u_v)	Without mains choke	
S082.004	1.6	2.2	1 x max. 16
S084.004	2.9	4.1	3 x max. 10
S084.006	4.4	6.3	3 x max. 16
S084.008	6.0	8.5	3 x max. 20
S084.012	9.1	13.0	3 x max. 25
S084.016	12.0	16.2	3 x max. 32
S084.020	15.0	20.1	3 x max. 40
S084.024	18.2	24.7	3 x max. 50
S084.032	24.2	32.7	3 x max. 63

1) At 3 x 400 V mains voltage

Table 4.6 Connected load and mains fuse (BG1-4)

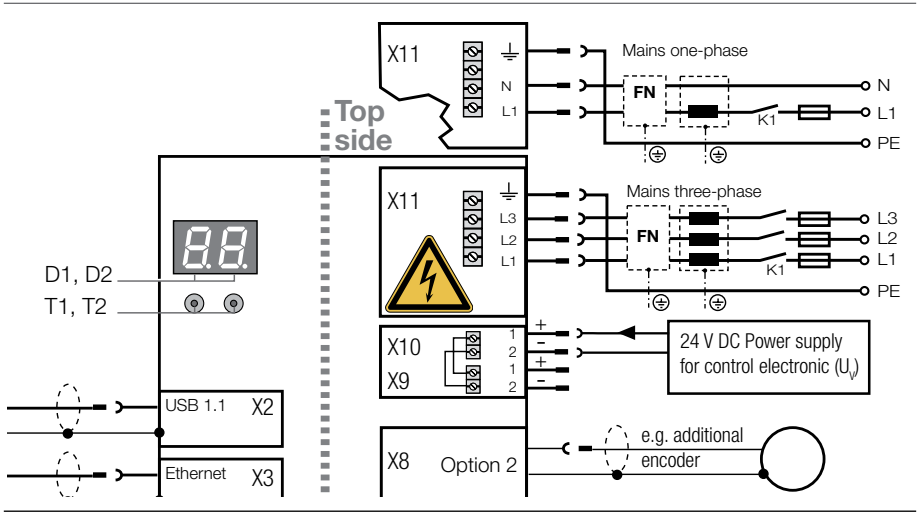


Figure 4.15 Connection example, control/mains supply for BG1 to BG4

4.8.4 AC mains supply, BG5 to BG6a

Drive controller	Device connected load [1] [kVA]		Specified mains fuse, utilisation class gG [A]
	With mains choke (2 % u_r)	Without mains choke	
S084.045	31.2/36.7 [2]	*For devices of sizes BG5 to BG7 a mains choke is imperative.*	3 x max. 63
S084.060	41.6/48.5 [2]		3 x max. 80
S084.072	50.0/52.6 [2]		3 x max. 100
S084.090	62/76 [2]		3 x max. 125
S084.110	76/99 [2]		3 x max. 160
S084.143	99/118 [2]		3 x max. 200
S084.170	118/128 [2]		3 x max. 224

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

Table 4.7 Connected load and mains fuse (BG5-6a)

CAUTION!	Damage to the device due to incorrect operation!
	• **Carelessness can cause damage to the device.** For devices of sizes BG5 to BG7 a mains choke is imperative. Due to a different precharging technology in these devices, it is also to be ensured that the mains choke is installed between the drive controller and mains filter (see chap. Figure 4.16).

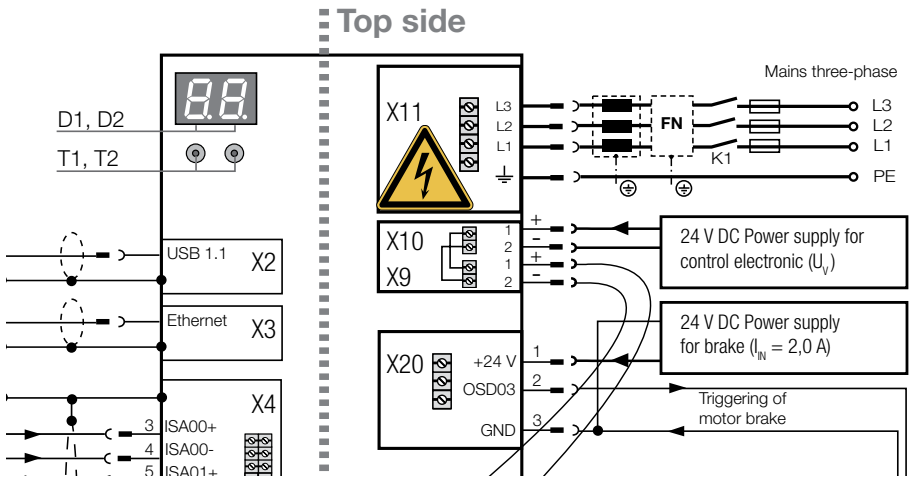


Figure 4.16 Connection example, control/mains supply for BG5 to BG6a

4.8.5 AC mains supply, BG7

Drive controller	Device connected load [1] [kVA]		Specified mains fuse, utilisation class gG [A]
	With mains choke (2 % u_K)	Without mains choke	
S084.250	173	*For devices of size BG7 a mains choke is imperative.*	3 x max. 300
S084.325	225		3 x max. 400
S084.450	310		3 x max. 500

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

Table 4.8 Connected load and mains fuse (BG7)

CAUTION!	Damage to the device due to incorrect operation!
	• **Carelessness can cause damage to the device.** For devices of sizes BG5 to BG7 a mains choke is imperative. Due to a different precharging technology in these devices, it is also to be ensured that the mains choke is installed between the drive controller and mains filter (see *Figure 4.17*).

4.8.6 Connection diagram, precharging (only BG7)

Designation	Specification		
	S084.250	S084.325	S084.450
Fuse 1	For values see Table 4.10		
Fuses 2, slow blow	6A		
Mains filter (optional)	300 A	400 A	500 A
Mains choke (U_k = 2 %)	250 A	325 A	450 A
K1	(e.g. Siemens 3RT10 65-6AP36)	(e.g. Siemens 3RT10 75-6AP36)	(e.g. Siemens 3RT10 76-6AP36)
K2	12 A / 5.5 kW / 24 V (e.g. Siemens 3RT10 17-1AB01)		
K3	7 A / 3 kW / 24 V (e.g. Siemens 3RT10 15-1AB01)		

Table 4.9 Specification of the peripherals connected (see Figure 4.17)

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

Control process

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

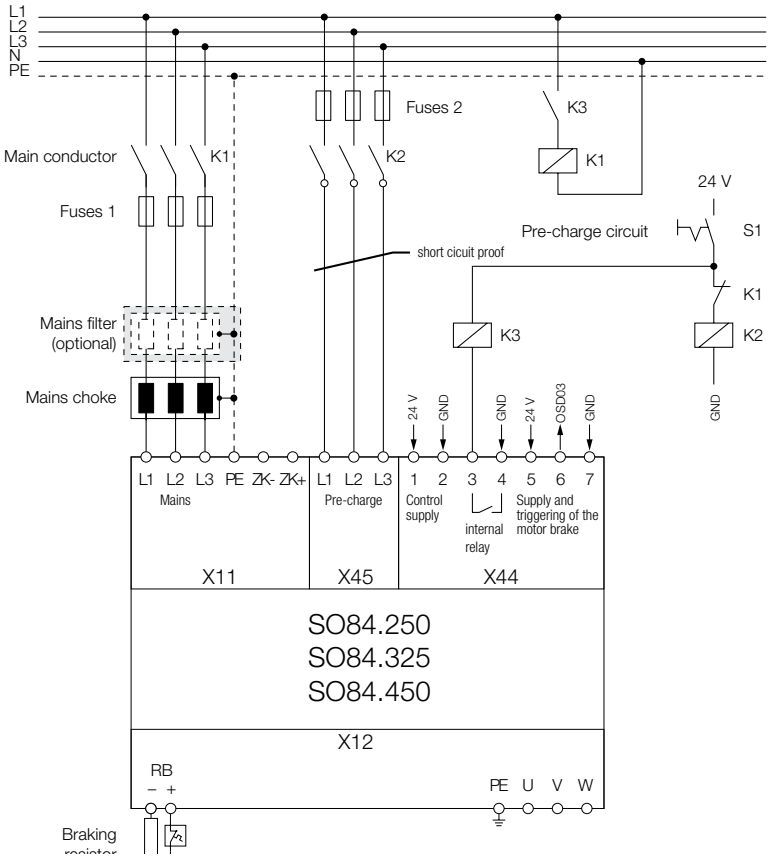


Figure 4.17 Connection example, precharging, control/mains supply for BG7 (from S.No. 1028xxxx)

NOTE:
It is imperative the stipulated percharging circuit is used. Deviations, e.g. continuous supply of power to the precharging can cause precharging resistors to overheat.

4.9 Control connections

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

4.9.1 Specification of the control connections

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

X4

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

Table 4.10 Specification of the control connections X4

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

(*) STO certification only applies for BG1 to BG6a

X4

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

Table 4.10 Specification of the control connections X4

NOTE:

If excessively high currents flow via the earth terminals, high-impedance isolation from the device ground is possible. In some circumstances this can result in the malfunction of the drive. To prevent this situation arising, avoid currents circulating in the wiring. Connect the grounds in a star topology and do not loop through.

4.9.2 Brake driver

On BG1 to BG4 the connector X13 is intended to be used to connect a motor brake.

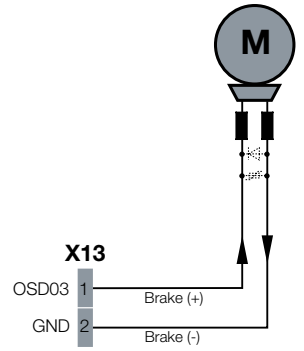
Des.	Term.	Specification	Connection
OSD03 GND	X13/1 X13/2	• Short circuit proof • Power is supplied via the control supply U_V on X9/X10. • $U_{BR} = U_V$-ΔU` (ΔU` typically approx. 1.4 V) • For operating a motor holding brake up to I_{BR} = 2.0 A max., for brakes with a higher current requirement a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

Table 4.11 Specification of the terminal connections X13 (BG1 to BG4)

On BG5 to BG6a the connector X20 is intended to be used to connect a motor brake.

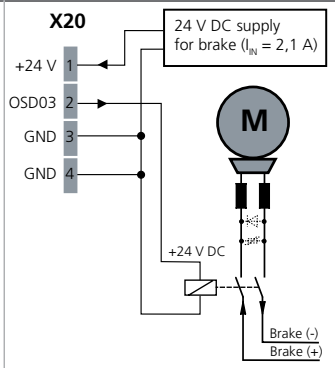
Des.	Term.	Specification	Connection
+24 V OSD03 GND	X20/1 X20/2 X20/3	• Short circuit proof • External power supply 24 V DC (I_{IN} = 2.1 A) required • For operating a motor holding brake up to I_{BR} = 2.0 A max., for brakes with a higher current requirement a relay must be connected in between. • Overcurrent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

Table 4.12 Specification of the terminal connections X20 (BG5 to BG6a)

On BG7 the connector X44 is intended to be used to connect a motor brake.

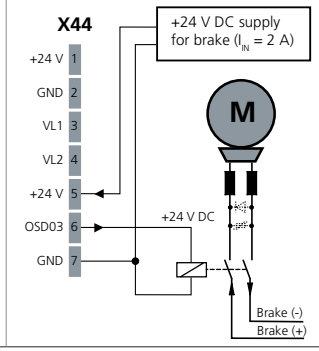
Des.	Term.	Specification	Connection
+24 V OSD03 GND	X44/5 X44/6 X44/7	• Short circuit proof • External power supply 24 V DC (I_{IN} = 2.1 A) required • For operating a motor holding brake up to I_{BR} = 2.0 A max., for brakes with a higher current requirement a relay must be connected in between • Overcurrent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

Table 4.13 Specification of the terminal connections X44 (BG7)

4.10 Specification, USB interface

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

Technical specification:

- USB 1.1 standard - full speed device interface
- Connection via commercially available USB interface cable type A to type B (see also ServoOne System Catalogue)

4.11 Specification, Ethernet interface

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

Technical specification:

- Transfer rate 10/100 Mbits/s BASE-T
- Transmission profile IEEE802.3 compliant
- Connection via commercially available crosslink cable (see also ServoOne System Catalogue System Catalogue)

4.12 Option 1 (Communication)

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

You will find all available options in the ServoOne System Catalogue. The user manuals for the respective options provide detailed information on commissioning.

4.13 Option 2 (Technology)

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

You will find all available options in the ServoOne System Catalogue. The user manuals for the respective options provide detailed information on commissioning.

4.14 Encoder connection

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

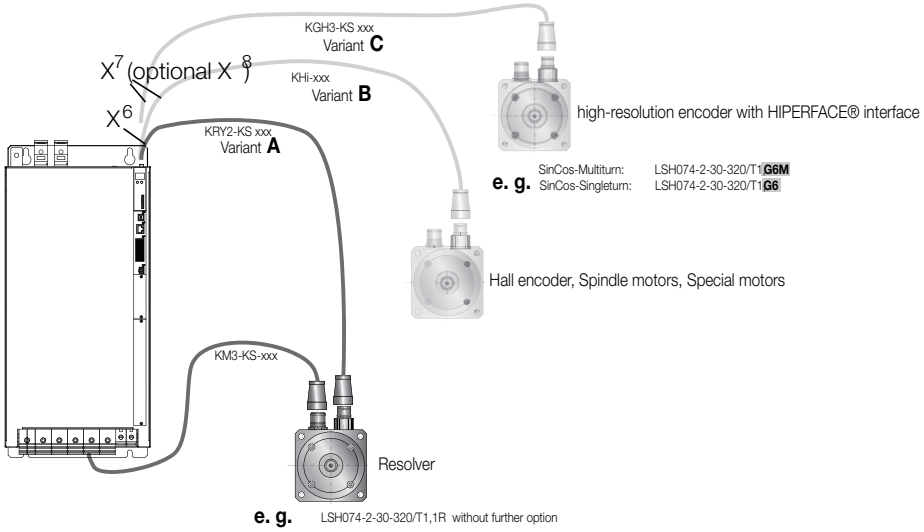


Figure 4.18 Motor/encoder cable assignment

4.14.1 Encoder connection for LSN/T motors

Please use the ready made motor and encoder cables from KEBA to connect the LSN/T synchronous motors.

4.14.2 Allocation of motor/encoder cable to the drive controller

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

	Motor (with encoder installed)	Encoder cable	Drive controller connection
Variant A	With resolver e.g. LSN/LST H074-2-30-320/T1, 1R without further options	KRY2-KSxxx	X6
Variant B	G13: = SinCos multiturn encoder with SSI/EnDat interface e.g. LSN/LST H074-2-30-320/T1,G13	KGS2-KSxxx	X7
	G12: = SinCos singleturn encoder with SSI/EnDat interface e.g. LSN/LST H074-2-30-320T1,G12	KGS2-KSxxx	X7
Variant C	G6: = SinCos singleturn encoder with HIPERFACE® interface e.g. LSN/LST H074-2-30-320/T1,G6	KGH3-KSxxx	X7
	G6M: = SinCos multiturn encoder with HIPERFACE® interface e.g. LSN/LST H074-2-30-320/T1,G6M	KGH3-KSxxx	X7

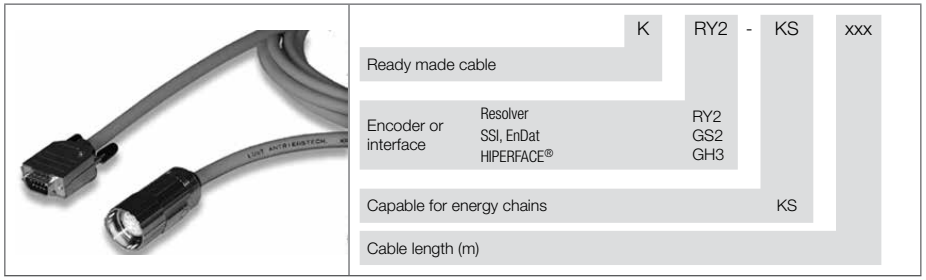
Table 4.14 Variants of motors, encoder type and encoder cable

NOTE:

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

4.14.3 Ready made encoder cables

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



Encoder cable KRY2-KS-xxx Order code

Technical data

	KRY2-KSxxx	KGS2-KSxxx	KGH3-KSxxx
Motors with encoder system	Resolver	G3, G5, G12.x (singleturn / multiturn encoder with SSI/EnDat interface)	G6, G6.x (singleturn / multiturn encoder with HIPERFACE® interface)
Controller-end assignment (Sub-D connector)	1 = 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 + RS485 5 = Data- RS485 6 = REFSIN 7 = Jumper to pin 12 8 = GND 11 = +SIN 12 = Jumper to pin 7 9, 10, 13, 14, 15 = n.c.
Capable for energy chains	Yes		
Minimum bending radius	90 mm	100 mm	90 mm
Temperature range	-40 ... +85 °C	-35 ... +80 °C	-40 ... +85 °C

Table 4.15 Technical data, encoder cables

	KRY2-KSxxx	KGS2-KSxxx	KGH3-KSxxx
Cable diameter approx.	8.8 mm		
Outer sheath material	PUR		
Resistance	Oil, hydrolysis and microbe resistant (VDE0472)		
Approvals	UL style 20233, 80 °C - 300 V, CSA-C22.2N.210-M90, 75 °C - 300 V FT1		

Table 4.15 Technical data, encoder cables

4.14.4 Resolver connection

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

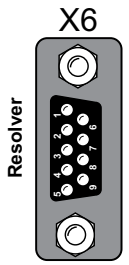
Fig.	X6/pin	Function
	1	Sin+ / (S2) analogue differential input track A
	2	REFSIN / (S4) analogue differential input track A
	3	Cos+ / (S1) analogue differential input track B
	4	Supply voltage 5..12 V, connected internally to X7/3
	5	ϑ+ (PTC, KTY, Klixon) 1)
	6	Ref+ analogue excitation
	7	Ref- analogue excitation (ground reference point to pin 6)
	8	REFCOS / (S3) analogue differential input track B
	9	ϑ- (PTC, KTY, Klixon) 1)

Table 4.16 Pin assignment X6

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

4.14.5 Connection for high-resolution encoders

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

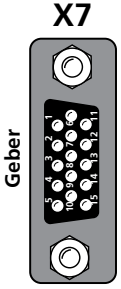
Fig.	Function
	**SinCos encoder with zero pulse** e.g. Heidenhain ERN1381, ROD486
	Heidenhain SinCos encoder with fully digital EnDat interface e.g. 13-bit singleturn encoder (ECN1313.EnDat01) and 25-bit multiturn encoder (EQN1325-EnDat01)
	Heidenhain encoder with digital EnDat interface Singleturn or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

Table 4.17 Suitable encoder types on X7

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

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

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

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

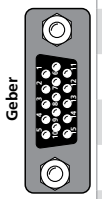
Fig.	X7 pin	SinCos and TTL	SinCos absolute value encoder SSI/EnDat	Absolute value encoder EnDat (digital)	Absolute value encoder HIPERFACE®	Comment
	1	A-	A-	-	REFCOS	
	2	A+	A+	-	+COS	
	3	+5 V DC ±5 %, IOUT max = 250 mA (150 mA for hardware versions 0..1), monitoring via sensor cable			7 to 12 V (typ.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

Table 4.18 Pin assignment for the connector X7

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

4.15 Motor connection

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

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

NOTE:

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

4.15.1 Motor connection for LSN/LST motors

NOTE:

To connect the servomotors in the product range LSN xxx and LST xxx we recommend our ready made motor cables (see Order Catalogue Servomotors).

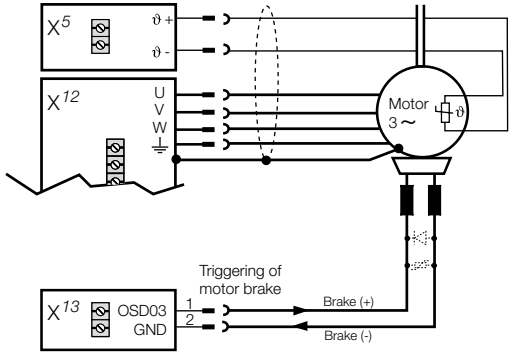


Figure 4.19 Connection of the motor for BG1 to BG4

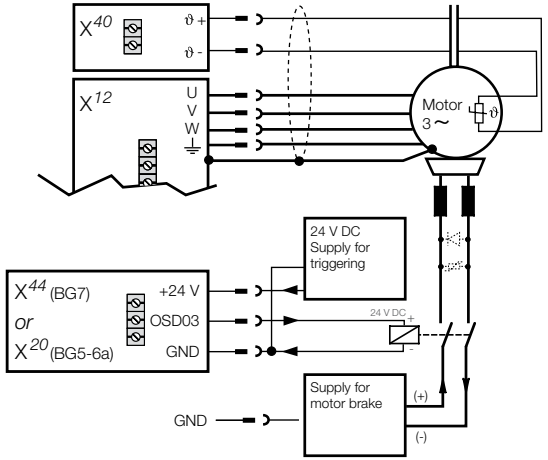


Figure 4.20 Connection of the motor for BG5 to BG7

4.15.2 Ready made motor cable

Motor cable KM3-KSxxx

		KMx	-	KS	xxx	-	xxx
Ready made motor cable	4 + 2 x 2 cores	3					
	4 cores	4					
Capable for energy chains				KS			
Cable length	In metres						
Motor cables	Up to I_O = 16 A						-
	Up to I_O = 24 A (only KM3)						24 A
	Up to I_O = 63 A (only KM3)						63 A

Order code

Technical data, motor cable

		KM2/3-KSxxx	KM2/3-KSxxx-24A	KM2/3-KSxxx-63A
For motors with plug-in power connection		Up to I_N = 16 A	Up to I_N = 24 A	Up to I_N = 63 A
Minimum bending radius	in fixed installation	60 mm	75 mm	110 mm
	in flexible use	120 mm	150 mm	220 mm
Temperature range		-50 ... +90 °C		
Cable diameter approx.		12 mm	15 mm	22 mm
Cable cross-section		4G1.5 + 2 x 2 x 0.75 mm²	4G2.5 + 2 x 2 x 1 mm²	4G10 + 2 x 1.5 mm² + 2 x 1 mm²
Outer sheath material		PUR		
Resistance		Oil, hydrolysis and microbe resistant (VDE0472), UL 20233, 80 °C - 300 V		
Allocation of the cores		U = 1 / V = 2 / W = 3 Earth = ge/gn PTC = 5 / PTC = 6 Brake + = 7 / Brake - = 8		
Approval		UL style 20234, 80 °C - 1000 V CSA-C22.2 N.210-M90, 80 °C - 1000 V FT1		

Table 4.19 Technical data, motor cable

NOTE:

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

4.15.3 Electronic overload protection for the motor

The motor protection function acquires the motor frequency, the motor current and other parameters. Depending on these parameters and the rated motor current, the motor protection triggers the overload protection function:

- As I^2T monitoring with programmable motor current, the permissible multiple of the rated motor current, the trigger time and the speed-dependency of the rated motor current.
- The I^2T integrator acts as a thermal memory for the system. The thermal memory is retained while the motor is shut down and if the device is switched on.
- The devices do not retain the thermal memory if switched off, i.e. the electronic motor overload protection is reset by switching off the power supply.

The electronic motor overload protection can be increased by using a motor temperature sensor.

NOTE:

You will find detailed information about the function and configuration of the parameters for the motor protection function in the device help (ID no.: 0842.26B.x).

4.15.4 Switching in the motor cable

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

To ensure unpowered switch-on, you must make sure that the contacts on the motor contactor are closed before the drive controller power stage is enabled. At the moment when the contactor is switched off it is necessary for the contact to remain closed until the drive controller's power stage is shut down and the motor current is 0. This is

achieved by using appropriate safety delays for the switching of the motor contactor in the control sequence for your machine.

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

4.16 Braking resistor (RB)

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

Device	Mains voltage				
	1 x 230 V	3 x 230 V	3 x 400 V	3 x 460 V	3 x 480 V
S082.004	390 V DC	-	-	-	-
S084.004 to S084.032	-	390 V DC	650 V DC	745 V DC	765 V DC
S084.045 to S084.450	-	820 V DC	820 V DC	820 V DC	820 V DC

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

4.16.1 Protection in case of brake chopper fault

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

4.16.2 Model with integrated braking resistor

For the drive controllers with an integrated braking resistor (model SO8x.xxx.xxxx.1xxx.x only the peak braking power is stated. The permissible average braking power must be calculated. It depends on the effective utilisation of the controller in the corresponding application.

CAUTION!	**Damage to the device with integrated braking resistor due to connection of an ext. braking resistor!**
	• **Carelessness can cause damage to the device** No additional external braking resistor may be connected to drive controllers S084.008 to S084.032 with integrated braking resistor.

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

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

Device	Technology	Rated resistance R_{BR}	Peak braking power P_{PBr} at Mains voltage / BR switch-on threshold		Pulse energy W_{IBr}	K1[1]
S082.004	PTC[2]	90 Ω[2]	1690 W	1 x 230 V / 390 V_{DC}	600 Ws	95 W
S084.004 S084.006	PTC[2]	90 Ω[2]	1690 W	3 x 230 V / 390 V_{DC}	600 Ws	95 W
S084.008 S084.012	Wire resistance	90 Ω	1690 W	3 x 230 V / 390 V_{DC}	3000 Ws	230 W
S084.016 S084.020			4700 W 6170 W	3 x 400 V / 650 V_{DC} 3 x 460 V / 745 V_{DC}	6000 Ws	360 W
S084.024 S084.032			6500 W	3 x 480 V / 765 V_{DC}	6000 Ws	480 W
S084.045 S084.060 S084.072	Wire resistance, only for liquid-cooled variants	20 Ω 10 Ω	33,6 kW 67,2 kW	3 x 400 V … 480 V / 820 V_{DC}	19,2 kWs 38,4 kWs	960 W
S084.090 S084.110 S084.143 S084.170		7,5 Ω	89,6 kW		80 kWs	2250 W
S084.250 S084.325 S084.450		3,3 Ω 2,4 Ω	203,7 kW 280 kW		144 kWs 198 kWs	5730 W

1) K1 corresponds approximately to the power dissipation that can be dissipated by the device cooling, reduced by the brake chopper losses..

2) The internal PTC BR is non-linear and has different resistance values depending on the operating voltage::
approx. 90 Ω at BR switch-on threshold 390 VDC
approx. 70 Ω at BR switch-on threshold 650 VDC
approx. 60 Ω at BR switch-on threshold 765 VDC

Table 4.21 Data on the integrated braking resistor (model SO8x.xxx.xxxx.1xxx)

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

NOTE:

The rest of the estimate assumes the usage of the drive controller at the rated ambient temperature (40 - 45 °C depending on the unit). This means that any additional energy input from the internal braking resistor caused by low ambient temperature will be neglected.

4.16.3 Method for estimating the mean braking power:

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

Boundary conditions

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

4.16.4 Connection of an external braking resistor

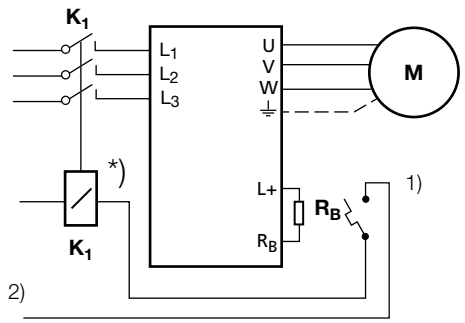
NOTE:

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

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

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

The braking resistor must be connected using a shielded cable. The cables are to be protected by suitable means.



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

1) Temperature switch, temperature sensor, bimetallic switch

2) Control voltage

Figure 4.21 Connection of braking resistor

DANGER!	**Risk of injury due to electrical power!**
	• **Carelessness will result in serious injuries or death.** Never make or disconnect electrical connections while they are electrically live! Always disconnect the power before working on the device. Even 10 min. after switching off the mains supply, dangerously high voltages of ≥50 V may still be present (capacitor charge). So check that electrical power is not present! Terminal L+ (BG1 to BG4) or BR+ (BG5 to BG7) is permanently connected to DC link potential (>300 V DC). The connection is not protected internally in the device.

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

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

Available braking resistors (excerpt)

Order designation	Continuous braking power	Resistance[1)]	Peak braking power [2)]	Protection	Figure
BR-200.01.540-UR	35 W	200 Ω	2800 W	IP54	 Example: BR-090.01,540-UR
BR-200.02.540-UR	150 W		2800 W	IP54	
BR-200.03.540-UR	300 W		2800 W	IP54	
BR-090.01.540-UR	35 W	90 Ω	6250 W	IP54	
BR-090.02.540-UR	150 W		6250 W	IP54	
BR-090.03.540-UR	300 W		6250 W	IP54	
BR-090.10.650-UR	1000 W		6250 W	IP65	
BR-026.01.540-UR	35 W	26 Ω	21600 W	IP54	
BR-026.02.540-UR	150 W		21600 W	IP54	
BR-026.03.540-UR	300 W		21600 W	IP54	
BR-026.10.650-UR	1000 W		21600 W	IP65	
BR-020.03.540-UR	300 W	20 Ω	27750 W	IP54	
BR-015.03.540-UR	300 W	15 Ω	37000 W	IP54	

1) Tolerance ±10 %

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

Table 4.22 Technical data - braking resistors

NOTE:

You will find the exact specifications of the braking resistors, in particular the surface temperature, the max. supply voltage and the dielectric strength at high voltages in the ServoOne System Catalogue.

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

5 Commissioning

5.1 Notes for operation

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

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

5.2 Initial commissioning

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

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

NOTE:

Details in relation to "STO" (Safe Torque Off) do not need to be taken into account for initial commissioning. You will find all information on the "STO" function in the 24-language document "Description of the STO Safety Function" (ID no. 1100.10B.x).

5.2.1 Switching on control supply

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

Display indication after switching on the control supply

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

Table 5.1 Switch-on status of the ServoOne (after connection of the 24 V DC control supply)

NOTE:

You will find details on the control supply in chapter *"4.8 Connection of the supply voltages" on page 34*

5.2.2 Establish connection between PC and drive controller

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

NOTE:

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

5.2.3 Configuring parameters

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

NOTE:

- **Online help**
  You will find a detailed description of DriveManager 5 and the commissioning wizard in the online help for DriveManager 5.
- **Motor data set**
  On using KEBA servomotors of type LSN or LST, the latest version of the motor data set required can be downloaded from www.keba.com, section "Downloads".

5.2.4 Controlling drive using DriveManager 5

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

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

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

Important information for the usage of motors!

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

Display indication after switching on the AC mains supply

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

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

NOTE:

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

Power-up sequence for starting the drive

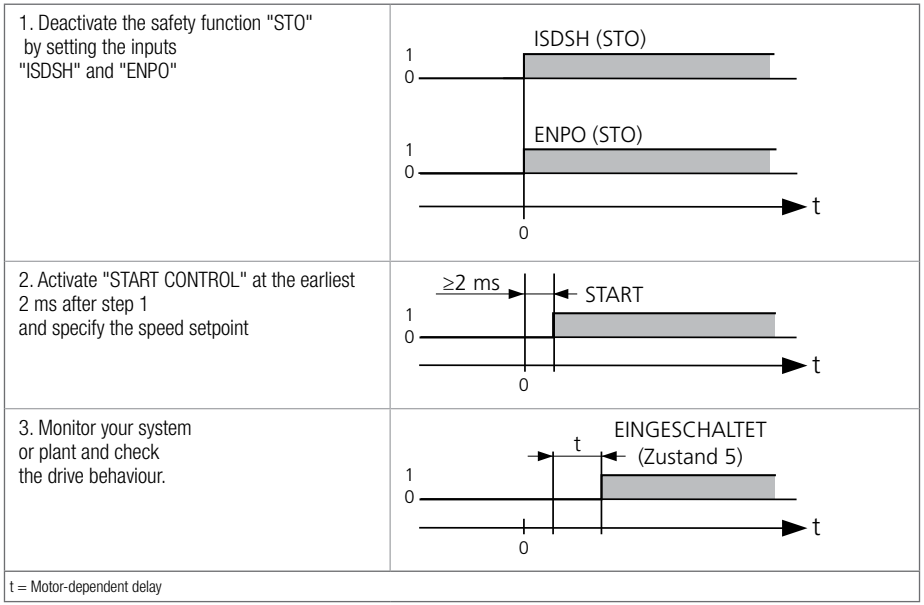


Figure 5.1 Switching on sequence

Display indication after starting the drive

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

Table 5.3 D1/D2 indication during activation of motor

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

Details for optimising the drive on your application can be found in the DriveManager 5 help system and in the ServoOne Application Manual.

5.3 Serial commissioning

An existing parameter data set can be transferred to other ServoOne drive controllers using DriveManager 5. You will find details in the help system in DriveManager 5

NOTE:

iPlc programs can only be loaded into a ServoOne drive controller using the programming system CoDeSys.

5.4 Integrated control unit

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

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

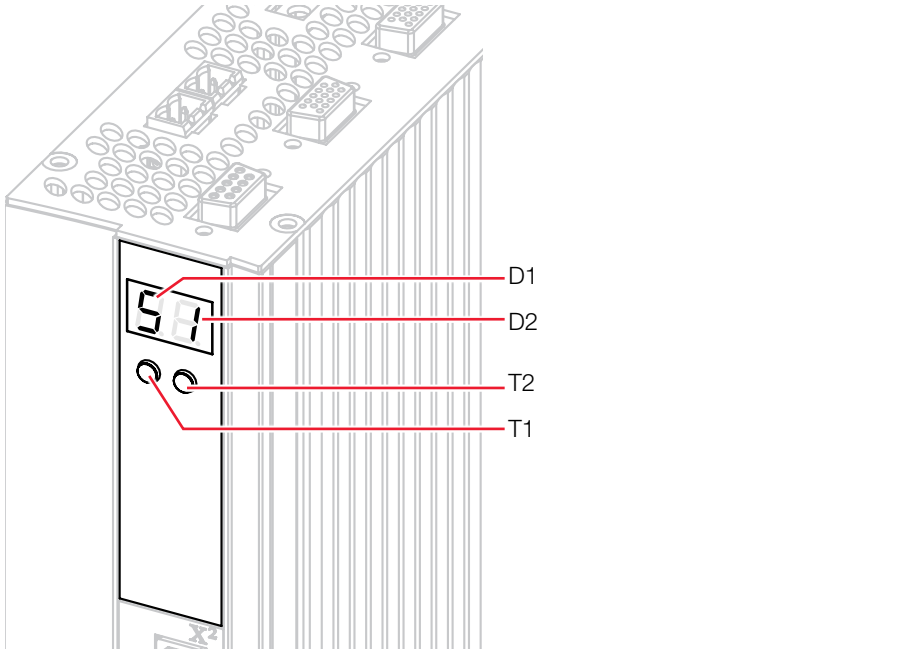


Figure 5.2 Integrated control unit

The following functions and displays are available:

- Indication of the device status
  The device status is indicated after switching on the control supply. If no input is made via the buttons for 60 seconds, the display switches back to the indication of the device status.
- Indication of the device errors, see chapter *“6.2 Status and error indication in DM5” on page 60 .*
  On the occurrence of an error in the device, the display is immediately switched to the indication of the error code.
- Parameter configuration (indication "PA")
- Ethernet IP address setting (indication "IP")
  Setting for the Ethernet IP address as well as the subnet mask
- Field bus settings (indication "Fb")
  Setting e.g. for the field bus address

5.4.1 Function of buttons T1 and T2

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

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

Table 5.4 Function of buttons T1 and T2

5.4.2 Display

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

Display	Meaning
	Menu entries ("PA" in this case serves as an example, for further possible entries see chapter 5.2.1 and 5.4.2)
	[Flashing decimal points] Selected function in progress
	[Two dashes] Entry/function not available
	[OK] Action executed successfully, no errors
	[Error] • Action via control unit **not** executed successfully, "Er" flashes alternately with the error number (see chapter 5.2.3) • Device error indication, "Er" flashes alternately with error number and error location (see "ServoOne Application Manual")
	Numerical values ("10" in this case serves as an example) • Data set and error numbers are shown in **decimal** on the parameter menu (PA). • All other values are displayed in **hexadecimal**. In these cases the 10 displayed would represent the decimal value 16.

Table 5.5 Meaning of display

NOTE:

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

5.4.3 Parameter menu (PA)

The following functions are available on the Parameter menu:

- Reset device to factory settings

Error numbers

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

NOTE:

The error messages displayed during user data entry should not be confused with drive error messages. You will find detailed information on the error codes and on error management in the "ServoOne 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
17	Parameter reset to factory settings failed
18	Parameter write access failed
19	Save parameter data set non volatile failed
20	Not all parameters written
21	Error while reset to factory settings

Table 5.6 Error numbers

5.4.4 Ethernet IP address menu (IP)

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

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

Table 5.7 IP address menu

Example configuration of the subnet mask

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

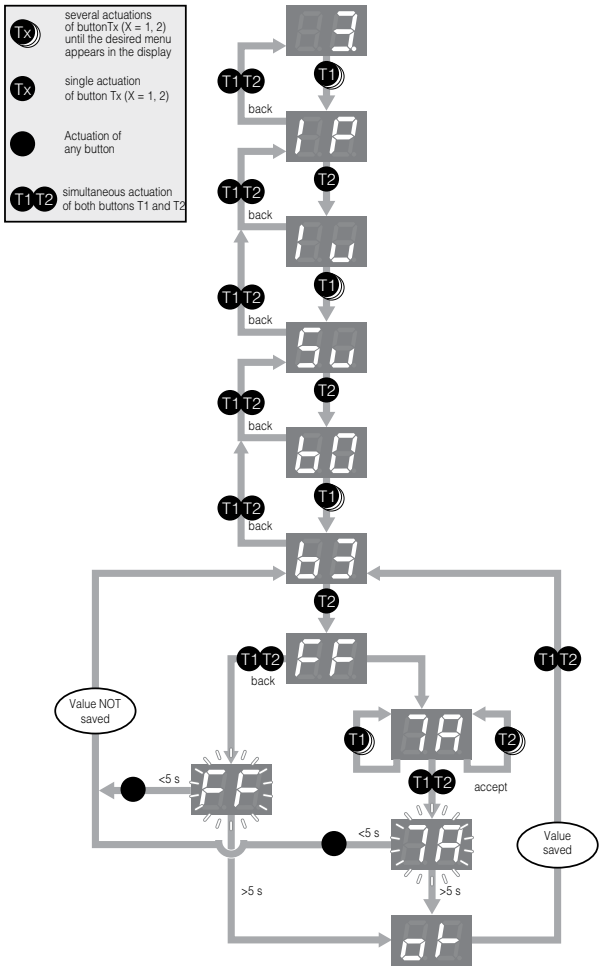


Figure 5.3 Example configuration of the subnet mask

NOTES:

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

5.4.5 Field bus address menu (Fb)

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

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

Table 5.8 Field bus address menu

Example configuration of the field bus address

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

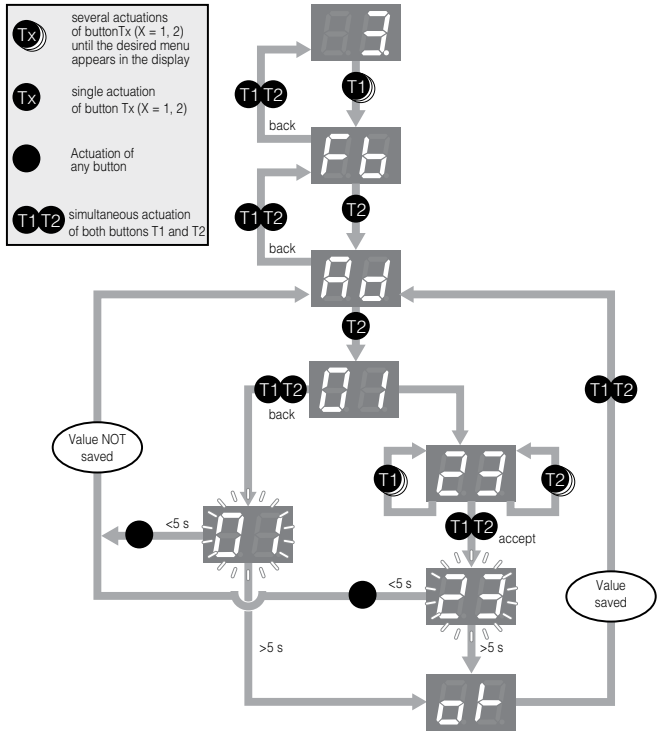


Figure 5.4 Example configuration of the field bus address

6 Diagnostics

6.1 Status indication on the device

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

6.1.1 Device states

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

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

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

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

Table 6.1 Device states

6.1.2 Error indication

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

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

Table 6.2 Display of the error code

NOTES:

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

6.2 Status and error indication in DM5

Click the "Device status" button in the header for the DM5 to open the "Device status" window.

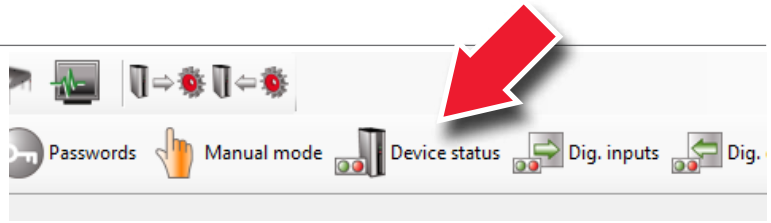


Figure 6.1 "Device status" button in the header

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

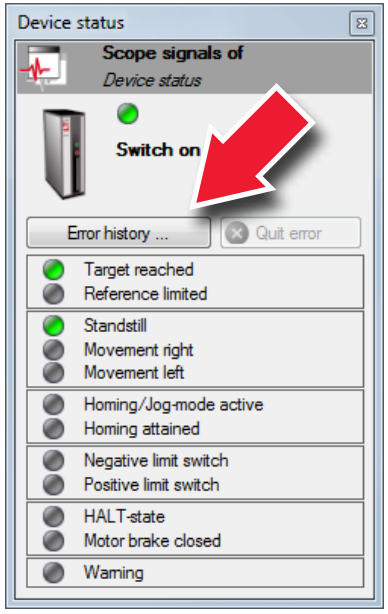


Figure 6.2 "Device status" window

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

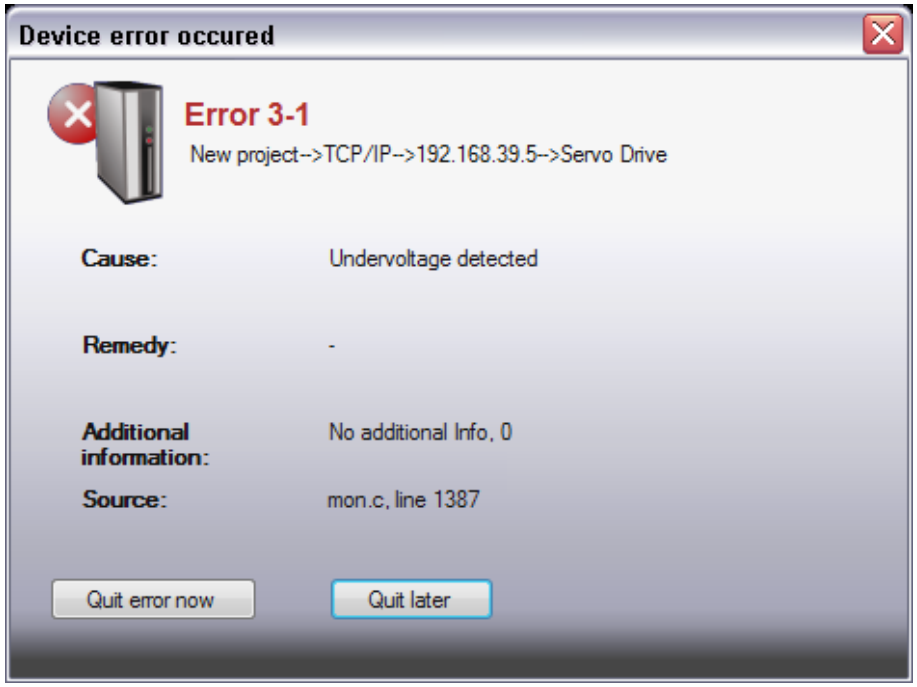


Figure 6.3 Error message

The **parameter 31** “Alarms & Warnings (Details)” contains detailed information on an error or warning that has occurred.

1. In the header of the “Project” window, select “Auto” or “Number search” and enter the figure “31” in the search field.
2. Double-click the lowest level in the project tree “Alarms & Warnings (Details)”.

NOTE:

You will find further information on parameter 31 in the program help for DriveManager 5.

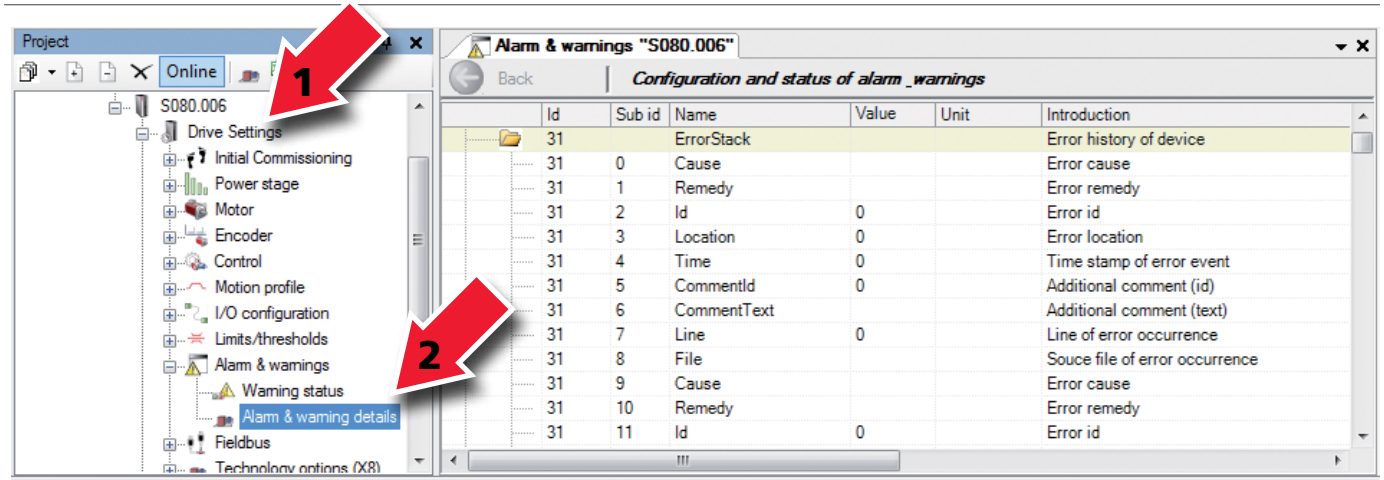


Figure 6.4 Parameter 31 "Alarms & Warnings (Details)"

7 Safe Torque Off (STO)

NOTE:
You will find all information on the "STO" function in the 24-language document "Description of the STO Safety Function" (ID no. 1100.10B.x).

Space for your own notes

A Appendix

A.1 Current carrying capacity of the drive controllers

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

A.1.1 Current carrying capacity, SO82.004 air cooling, single phase

Drive controller	Switching frequency of the power stage	Ambient temperature	Rated current	Peak current [A_{eff}]			
			At 230 V_{AC}	At rotating field frequency increasing linearly 0 to 5 Hz		For intermittent operation	For time [1]
	[kHz]	[°C]	[A_{eff}]	0 Hz	5 Hz	>5 Hz	[s]
S082.004 (BG1)	4	45	4.0	8.0	8.0	8.0	10
	8	40	4.0	8.0	8.0	8.0	
	12		3.7	7.4	7.4	7.4	
	16		2.7	5.4	5.4	5.4	

Data apply for a motor cable length ≤ 10 m

1) Shutdown as per I^2t characteristic

Table A.1 Rated and peak current, BG1 (air cooling, one-phase)

A.1.2 Current carrying capacity BG1-BG4, air cooling, three-phase

Drive controller	Switching frequency of the power stage	Ambient temperature	At mains voltage 400 V		At mains voltage 460 V		At mains voltage 480 V		Overload factor ≥ 5 Hz	For time 1)
			Rated current	Peak current [A_{eff}]	Rated current	Peak current [A_{eff}]	Rated current	Peak current [A_{eff}]		
	[kHz]	[°C]	[A_{eff}]	0 Hz to ≥5 Hz	[A_{eff}]	0 Hz to ≥5 Hz	[A_{eff}]	0 Hz to ≥5 Hz	[%]	[s]
S084.004 (BG1)	4	45 2)	4.0	8.0	4.0	8.0	4.0	8.0	200	10
	8	40	4.0	8.0	4.0	8.0	4.0	8.0		
	12		3.7	7.4	2.9	5.8	2.7	5.4		
	16		2.7	5.4	1.6	3.2	1.3	2.6		
S084.006 (BG1)	4	45 2)	6.0	12.0	6.0	12.0	6.0	12.0	200	10
	8	40	6.0	12.0	6.0	12.0	6.0	12.0		
	12		5.5	11.0	4.4	8.8	4.0	8.0		
	16		4.0	8.0	2.4	4.8	1.9	3.8		
S084.008 (BG2)	4	45	8.0	16.0	8.0	16.0	8.0	16.0	200	10
	8	40	8.0	16.0	7.2	14.4	6.9	13.8		
	12		6.7	13.4	5.3	10.6	4.9	9.8		
	16		5.0	10.0	3.7	7.4	3.3	6.6		
S084.012 (BG2)	4	45	12.0	24.0	12.0	24.0	12.0	24.0	200	10
	8	40	12.0	24.0	10.8	21.6	10.4	20.8		
	12		10.0	20.0	8.0	16.0	7.4	14.8		
	16		7.6	15.2	5.6	11.2	5.0	10		

All data apply for a motor cable length ≤ 10 m.

1) Shutdown as per I^2t characteristic

2) For S084 BG1-Safety only approved up to 40 °C.

Table A.2 Rated and peak current, BG1 to BG4 (air cooling, three-phase)

Drive controller	Switching frequency of the power stage	Ambient temperature	At mains voltage 400 V		At mains voltage 460 V		At mains voltage 480 V		Overload factor ≥ 5 Hz	For time [1]
			Rated current	Peak current [A_{eff}]	Rated current	Peak current [A_{eff}]	Rated current	Peak current [A_{eff}]		
	[kHz]	[°C]	[A_{eff}]	0 Hz to ≥5 Hz	[A_{eff}]	0 Hz to ≥5 Hz	[A_{eff}]	0 Hz to ≥5 Hz	[%]	[s]
S084.016 (BG3)	4	45	16.0	32.0	16.0	32.0	16.0	32.0	200	10
	8	40	16.0	32.0	13.9	27.8	13.3	26.6		
	12		11.0	22.0	8.8	17.6	8.0	16.0		
	16		8.0	16.0	5.9	11.8	5.2	10.4		
S084.020 (BG3)	4	45	20.0	40.0	20.0	40.0	20.0	40.0	200	10
	8	40	20.0	40.0	17.4	34.8	16.6	33.2		
	12		13.8	27.6	11.0	22.0	10.0	20.0		
	16		10.0	20.0	7.4	14.8	6.5	13.0		
S084.024 (BG4)	4	45	24.0	48.0	24.0	48.0	24.0	48.0	200	10
	8	40	24.0	48.0	21.0	42.0	20.0	40.0		
	12		15.8	31.6	12.4	24.8	11.3	22.6		
	16		11.3	22.6	9.2	18.4	8.4	16.8		
S084.032 (BG4)	4	45	32.0	64.0	32.0	64.0	32.0	64.0	200	10
	8	40	32.0	64.0	28.0	56.0	26.7	53.4		
	12		21.0	42.0	16.5	33.0	15.0	30.0		
	16		15.0	30.0	12.2	24.4	11.2	22.4		

All data apply for a motor cable length ≤ 10 m.

1) Shutdown as per I^2t characteristic

2) For SO84 BG1-Safety only approved up to 40 °C.

Table A.2 Rated and peak current, BG1 to BG4 (air cooling, three-phase)

A.1.3 Current carrying capacity, BG5 to BG6a, air cooling

Drive controller	Power stage switching frequency	Ambient temperature	At mains voltage 400 V				At mains voltage 460 V				At mains voltage 480 V				Overload factor ≥5 Hz	For time 1)
			Rated current	Peak current [Aeff] 2)			Rated current	Peak current [Aeff] 2)			Rated current	Peak current [Aeff] 2)				
				At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		
	[kHz]	[°C]	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[%]	[s]
S084.045 (BG5)	4	45	45	90	90		42	83	84		41	81	82		200	3/10 3)
	8	40	45	90	90		42	83	84		41	81	82			
	12	40	45	90	90		42	83	84		41	81	82			
	16	40	42	84	84		39	78	78		38	76	76			
S084.060 (BG5)	4	45	60	120	120		56	111	112		54	108	108		200	3/10 3)
	8	40	60	120	120		56	111	112		54	108	108			
	12	40	58	116	116		54	107	108		52	104	104			
	16	40	42	84	84		39	78	78		38	76	76			
S084.072 (BG5)	4	45	72	144	144		67	133	134		65	130	130		200	3/10 3)
	8	40	72	144	144		67	133	134		65	130	130			
	12 4)	40	58	116	116		54	107	108		52	104	104			
	16 4)	40	42	84	84		39	78	78		38	76	76			

All data apply for a motor cable length ≤ 10 m.

1) Shutdown as per I^2t characteristic

2) Permissible peak current at max. 70 % initial load

3) 10 s at heat sink temperature <45 °C

4) For S084 BG5-Safety only allowed up to 8 kHz

Table A.3 Rated and peak current, BG5 (air cooling)

Drive controller	Power stage switching frequency	Ambient temperature	At mains voltage 400 V				At mains voltage 460 V				At mains voltage 480 V				Overload factor ≥5 Hz	For time 1)
			Rated current	Peak current [Aeff] 2)			Rated current	Peak current [Aeff] 2)			Rated current	Peak current [Aeff] 2)				
				At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		
	[kHz]	[°C]	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[%]	[s]
S084.090 (BG6)	4	45	90	170	180		83	157	166		81	153	162		200	30
	8	40	90	134	180		83	124	166		81	121	162		200	
	12	40	90	107	144		83	99	133		81	95	130		160	
	16	40	72	86	115		67	80	107		65	77	104		160	
S084.110 (BG6)	4	45	110	170	220		102	157	204		99	153	198		200	30
	8	40	110	134	165		102	124	153		99	121	149		150	
	12	40	90	107	144		83	99	133		81	95	130		160	
	16	40	72	86	115		67	80	107		65	77	104		160	
S084.143 (BG6a)	4	45	143	191	286		132	176	264		129	170	258		200	30
	8	40	143	152	215		132	140	198		129	136	194		150	
	12	40	115	122	173		106	112	159		104	109	156		150	
	16	40	92	98	138		85	91	128		83	87	125		150	
S084.170 (BG6a)	4	45	170	191	323		157	176	298		153	170	291		190	10
	8	40	170	152	221		157	140	204		153	136	199		130	
	12	40	136	122	163		126	112	151		122	109	146		120	
	16	40	109	98	131		101	91	121		98	87	118		120	

All data apply for a motor cable length ≤ 10 m.

1) Shutdown as per I^2t characteristic

2) Permissible peak current at max. 70 % initial load

3) 10 s at heat sink temperature <45 °C

Table A.4 Rated and peak current, BG6 and BG6a (air cooling)

A.1.4 Current carrying capacity BG3-BG4, liquid cooling

NOTE:

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

Drive controller	Switching frequency of the power stage	Ambient temperature	At mains voltage 400 V		At mains voltage 460 V		At mains voltage 480 V		Overload factor ≥ 5 Hz	For time 1)
			Rated current	Peak current [A_{eff}]	Rated current	Peak current [A_{eff}]	Rated current	Peak current [A_{eff}]		
	[kHz]	[°C]	[A_{eff}]	0 Hz to ≥5 Hz	[A_{eff}]	0 Hz to ≥5 Hz	[A_{eff}]	0 Hz to ≥5 Hz	[%]	[s]
S084.016 (BG3)	4	45	16.0	32.0	16.0	32.0	16.0	32.0	200	10
	8	40	16.0	32.0	13.9	27.8	13.3	26.6		
	12		11.0	22.0	8.8	17.6	8.0	16.0		
	16		8.0	16.0	5.9	11.8	5.2	10.4		
S084.020 (BG3)	4	45	20.0	40.0	20.0	40.0	20.0	40.0	200	10
	8	40	20.0	40.0	17.4	34.8	16.6	33.2		
	12		13.8	27.6	11.0	22.0	10.0	20.0		
	16		10.0	20.0	7.4	14.8	6.5	13.0		
S084.024 (BG4)	4	45	24.0	48.0	24.0	48.0	24.0	48.0	200	10
	8	40	24.0	48.0	21.0	42.0	20.0	40.0		
	12		15.8	31.6	12.4	24.8	11.3	22.6		
	16		11.3	22.6	9.2	18.4	8.4	16.8		
S084.032 (BG4)	4	40	32.0	64.0	32.0	64.0	32.0	64.0	200	10
	8		32.0	64.0	28.0	56.0	26.7	53.4		
	12		21.0	42.0	16.5	33.0	15.0	30.0		
	16		15.0	30.0	12.2	24.4	11.2	22.4		

All data apply for a motor cable length ≤ 10 m.

1) Shutdown as per I^2t characteristic

2) Permissible peak current at max. 70 % initial load

Table A.5 Rated and peak current, BG3 and BG4 (liquid cooling)

A.1.5 Current carrying capacity BG5-BG6a, liquid cooling

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

Drive controller	Power stage switching frequency	Ambient temperature	At mains voltage 400 V				At mains voltage 460 V				At mains voltage 480 V				Overload factor ≥5 Hz	For time 1)
			Rated current	Peak current [Aeff] 2)			Rated current	Peak current [Aeff] 2)			Rated current	Peak current [Aeff] 2)				
				At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		
	[kHz]	[°C]	" [Aeff]"	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[%]	[s]
S084.045 (BG5)	4	45	53	90	90		49	83	83		48	82	82		170	30
	8		53	90	90		49	83	83		48	82	82			
	12		53	90	90		49	83	83		48	82	82			
	16		49	83	83		45	77	77		44	75	75			
S084.060 (BG5)	4	45	70	119	119		65	111	111		63	107	107		170	30
	8		70	119	119		65	111	111		63	107	107			
	12		68	116	116		63	107	107		61	104	104			
	16		49	83	83		45	77	77		44	75	75			
S084.072 (BG5)	4	45	84	143	143		78	133	133		76	129	129		170	30
	8		84	143	143		78	133	133		76	129	129			
	12 4)		68	116	116		63	107	107		61	104	104			
	16 4)		49	83	83		45	77	77		44	75	75			

All data apply for a motor cable length ≤ 10 m.

1) Shutdown as per I^2t characteristic

2) Permissible peak current at max. 70 % initial load

4) For S084 BG5-Safety only approved up to 8 kHz.

Table A.6 Rated and peak current, BG5 (liquid-cooled)

Drive controller	Power stage switching frequency	Ambient temperature	At mains voltage 400 V				At mains voltage 460 V				At mains voltage 480 V				Overload factor ≥5 Hz	For time 1)
			Rated current	Peak current [Aeff] 2)			Rated current	Peak current [Aeff] 2)			Rated current	Peak current [Aeff] 2)				
				At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		
	[kHz]	[°C]	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[%]	[s]
S084.090 (BG6)	4	45	110	206	220		102	191	204		99	186	198		200	30
	8		110	166	187		102	154	173		99	150	168		170	
	12		110	133	165		102	123	153		99	120	149		150	
	16		90	106	135		83	99	125		81	96	122		150	
S084.110 (BG6)	4	45	143	232	286		132	214	264		129	208	258		200	30
	8		143	192	215		132	177	198		129	172	194		150	
	12		114	153	171		105	142	158		103	138	155		150	
	16		91	123	137		84	114	126		82	111	123		150	
S084.143 (BG6A)	4	45	170	232	340		157	214	314		153	208	306		200	10
	8		170	192	255		157	177	236		153	172	230		150	
	12		136	153	204		126	142	189		122	138	183		150	
	16		109	123	164		101	114	152		98	111	147		150	
S084.170 (BG6A)	4	45	210	232	340		194	214	314		189	208	306		160	10
	8		210	192	255		194	177	236		189	172	230		120	
	12		168	153	204		155	142	189		151	138	183		120	
	16		134	123	164		124	114	152		121	111	147		120	

All data apply for a motor cable length ≤ 10 m.

1) Shutdown as per I^2t characteristic

2) Permissible peak current at 70 % initial load

Table A.7 Rated and peak current, BG6 and BG6a (liquid cooling)

A.1.6 Current carrying capacity BG7, liquid cooling

NOTE:
Axis controllers with power stage switching frequencies from 8 to 16 kHz are devices with the "HF function package" (incl. an HF parameter data set) with a rotating field frequency up to 1600 Hz.

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

Drive controller	Function package	Power stage switching frequency	Ambient temperature	At mains voltage 400 V				At mains voltage 460 V				At mains voltage 480 V				Overload factor ≥5 Hz	For time 1)
				Rated current	Peak current [Aeff] 2)			Rated current	Peak current [Aeff] 2)			Rated current	Peak current [Aeff] 2)				
					At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		At rotating field frequency increasing linearly		During intermittent operation		
		[kHz]	[°C]	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[Aeff]	0 Hz	Up to 5 Hz	>5 Hz	[%]	[s]
SO84.250 (BG7)	Standard	2	40	250	425			231	393			225	383			170	30
		4		250	375			231	346			225	338			150	
	HF*)	8	40	250	250	375		231	231	346		225	225	338			
		12		200	200	300		185	185	277		180	180	270			
		16		175	175	262		162	162	243		158	158	237			
SO84.325 (BG7)	Standard	2	40	325	552			300	511			293	498			170	30
		4		325	487			300	451			293	440			150	
	HF*)	8	40	325	325	487		300	300	451		293	293	440			
		12		300	300	450		277	277	417		270	270	405			
		16		270	270	405		250	250	375		243	243	365			
SO84.450 (BG7)	Standard	2	40	450	765			416	707			405	689			170	30
		4		450	675			416	624			405	608			150	
	HF*)	8	40	450	450	675		416	416	624		405	405	608			
		12		400	400	600		370	370	555		360	360	540			
		16		x	x			x	x			x	x			x	

All data apply for a motor cable length ≤ 10 m.

1) Shutdown as per I^2t characteristic

2) Permissible peak current at max. 70 % initial load

X) Not available

*) Model HF = SO84.xxx.xxxx.x7 or SO84.xxx.xxxx.x8 (For details see "1.4 Order code")

Table A.8 Rated and peak current, BG7 for standard and HF model (liquid-cooled)

A.2 Technical data, ServoOne

A.2.1 SO82.004 to SO84.016, air cooling

Designation / Technical data	SO82.004	SO84.004	SO84.006	SO84.008	SO84.012	SO84.016
Output, motor side [1]						
Voltage [4]	3-phase U_{Mains}					
Rated current, effective (I_N)	4 A	4 A	6 A	8 A	12 A	16 A
Peak current	See A.1.1	See A.1.2				
Rotating field frequency	0 ... 400 Hz / 1600 Hz optional					
Switching frequency of the power stage	4, 8, 12, 16 kHz					
Input, mains side						
Mains voltage	1 x 230 V ±10 %	(3 x 230 V/ 3 x 400 V/ 3 x 460 V/ 3 x 480 V) ±10 %				
Device connected load [1] (with mains choke)	2.2 kVA	2.9 kVA	4.4 kVA	6.0 kVA	9.1 kVA	12.0 kVA
Current [1] (with mains choke)	9.5 A [2]	4.2 A	6.4 A	8.7 A	13.1 A	17.3 A
Asymmetry of mains voltage	-	±3 % max.				
Frequency	50/60 Hz ±10 %					
Power dissipation at I_N [1]	85 W	96 W	122 W	175 W	240 W	330 W

1) Data referred to mains voltage 3 x 400 V_{eff} (for SO82.004: 1 x 230 Veff) and switching frequency of power stage 8 kHz
2) Without mains choke
3) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model SO8x.xxx.xxxx.1xxx)!
4) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.

Table A.9 Technical data, SO82.004 to SO84.016, air cooling

Designation / Technical data	SO82.004	SO84.004	SO84.006	SO84.008	SO84.012	SO84.016
DC link						
Capacitance	1740 µF	400 µF		725 µF		1230 µF
Brake chopper switch-on threshold [1]	390 V DC	650 V DC				
Minimum ohmic resistance of an externally installed braking resistor [3]	72 Ω			39 Ω		20 Ω
Brake chopper peak power with external braking resistor [1]	2.1 kW	5.9 kW		11 kW		21 kW
Optional: Internal braking resistor	PTC			90 Ω		
Brake chopper peak power with internal braking resistor	See Table 4.21					

1) Data referred to mains voltage 3 x 400 V_{eff} (for SO82.004: 1 x 230 Veff) and switching frequency of power stage 8 kHz
2) Without mains choke
3) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model SO8x.xxx.xxxx.1xxx)!
4) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.

Table A.9 Technical data, SO82.004 to SO84.016, air cooling

NOTE:
You will find more information on the brake chopper switch-on threshold in chapter “4.16 Braking resistor (RB)”

A.2.2 SO84.020 to SO84.072, air cooling

Designation / Technical data	SO84.020	SO84.024	SO84.032	SO84.045	SO84.060	SO84.072
Output, motor side [1]						
Voltage [2]	3-phase U_{Mains}					
Rated current, effective (I_N)	20 A	24 A	32 A	45 A	60 A	72 A
Peak current	See A.1.2			See A.1.3		
Rotating field frequency	0 ... 400 Hz / 1600 Hz optional					
Switching frequency of the power stage	4, 8, 12, 16 kHz					
Input, mains side						
Mains voltage	(3 x 230 V/ 3 x 400 V/ 3 x 460 V/ 3 x 480 V) ±10 %					
Device connected load [1] (with mains choke)	15.0 kVA	18.2 kVA	24.2 kVA	31.2 kVA	41.0 kVA	50 kVA
Current [1] (with mains choke)	21.6 A	26.2 A	34.9 A	45 A	60 A	72 A
Asymmetry of mains voltage	±3 % max.					
Frequency	50/60 Hz ±10 %					
Power dissipation at I_N [1]	400 W	475 W	515 W	610 W	830 W	1010 W
DC link						
Capacitance	1230 µF	2000 µF		430 µF	900 µF	
Brake chopper switch-on threshold	650 V DC [1]			820 V DC		
Minimum ohmic resistance of an externally installed braking resistor	20 Ω [3]	12 Ω [3]		18 Ω		13 Ω
Brake chopper peak power with external braking resistor	21 kW [1]	35 kW [1]		37 kW		52 kW
Optional: Internal braking resistor	90 Ω			-		
Brake chopper peak power with internal braking resistor	See Table 4.21			-		

1) Data referred to mains voltage 3 x 400 V_{eff} and switching frequency of the power stage 8 kHz
2) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.
3) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model SO8x.xxx.xxxx.1xxx)!

Table A.10 Technical data, SO84.020 to SO84.072, air cooling

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

A.2.3 SO84.090 to SO84.170, air cooling

Designation / Technical data	SO84.090	SO84.110	SO84.143	SO84.170
Output, motor side [1]				
Voltage [2]	3-phase U_{Mains}			
Rated current, effective (I_N)	90 A	110 A	143 A	170 A
Peak current	See A.1.3			
Rotating field frequency	0 ... 400 Hz / 1600 Hz optional			
Switching frequency of the power stage	4, 8, 12, 16 kHz			
Input, mains side				
Mains voltage	(3 x 230 V/ 3 x 400 V/ 3 x 460 V/ 3 x 480 V) ±10 %			
Device connected load [1] (with mains choke)	62 kVA	76 kVA	99 kVA	118 kVA
Current [1] (with mains choke)	90 A	110 A	143 A	170 A
Asymmetry of mains voltage	±3 % max.			
Frequency	50/60 Hz ±10 %			
Power dissipation at I_N [1]	1300 W	1600 W	2100 W	2500 W
DC link				
Capacitance	1060 µF	2120 µF	3180 µF	4240 µF
Brake chopper switch-on threshold	820 V DC			
Minimum ohmic resistance of an externally installed braking resistor	12 Ω	10 Ω	8.5 Ω	6.5 Ω

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

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

Table A.11 Technical data, SO84.090 to SO84.170, air cooling

Designation / Technical data	SO84.090	SO84.110	SO84.143	SO84.170
Brake chopper peak power with external braking resistor	56 kW	67 kW	79 kW	103 kW
Optional: Internal braking resistor	-	-	-	-
Brake chopper peak power with internal braking resistor	-	-	-	-

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

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

Table A.11 Technical data, SO84.090 to SO84.170, air cooling

NOTE:

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

A.2.4 SO84.016 to SO84.060, liquid cooling

Designation / Technical data	SO84.016	SO84.020	SO84.024	SO84.032	SO84.045	SO84.060
Output, motor side [1]						
Voltage [2]	3-phase U_{Mains}					
Rated current, effective (I_N)	16 A	20 A	24 A	32 A	53 A	70 A
Peak current	See A.1.4				See A.1.5	
Rotating field frequency	0 ... 400 Hz / 1600 Hz optional					
Switching frequency of the power stage	4, 8, 12, 16 kHz					
Input, mains side						
Mains voltage	(3 x 230 V/ 3 x 400 V/ 3 x 460 V/ 3 x 480 V) ±10 %					
Device connected load [1] (with mains choke)	12.0 kVA	15.0 kVA	18.2 kVA	24.2 kVA	36.7 kVA	48.5 kVA
Current [1] (with mains choke)	17.3 A	21.6 A	26.2 A	34.9 A	53 A	70 A
Asymmetry of mains voltage	±3 % max.					
Frequency	50/60 Hz ±10 %					
Power dissipation at I_N [1]	330 W	400 W	475 W	515 W	690 W	930 W
DC link						
Capacitance	1230 µF		2000 µF		430 µF	900 µF
Brake chopper switch-on threshold	650 V DC [1]				820 V DC	

1) Data referred to mains voltage 3 x 400 V_{eff} and switching frequency of the power stage 8 kHz
2) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.
4) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model SO8x.xxx.xxxx.7xxx)!
5) Cooling performance adequate also with optional internal braking resistor

Table A.12 Technical data, SO84.016 to SO84.060, liquid cooling

Designation / Technical data	SO84.016	SO84.020	SO84.024	SO84.032	SO84.045	SO84.060

Minimum ohmic resistance of an externally installed braking resistor	20 Ω		12 Ω		10 Ω [4]	
Brake chopper peak power with external braking resistor	21 kW		35 kW		67 kW	
Optional: Internal braking resistor	-				20 Ω	10 Ω
Brake chopper peak power with internal braking resistor	-				see Table 4.21	
Chiller data						
Coolant pressure (rated value / maximum value)	1 / 2 bar					
Coolant flow rate [5] (rated value / maximum value)	3 / 4 l per min				8 / 11 l per min	
Feed coolant temperature	The coolant temperature can be between 5 °C and 40 °C. However, the coolant temperature should not be more than 10 °K below the ambient temperature to prevent condensation on the heat sink.					

1) Data referred to mains voltage 3 x 400 V_{eff} and switching frequency of the power stage 8 kHz
2) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.
4) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model SO8x.xxx.xxxx.7xxx)!
5) Cooling performance adequate also with optional internal braking resistor

Table A.12 Technical data, SO84.016 to SO84.060, liquid cooling

A.2.5 SO84.072 to SO84.170, liquid cooling

Designation / Technical data	SO84.072	SO84.090	SO84.110	SO84.143	SO84.170
Output, motor side [1]					
Voltage [6]	3-phase U_{Mains}				
Rated current, effective (I_N)	84 A	110 A	143 A	170 A	210 A
Peak current	See A.1.5				
Rotating field frequency	0 ... 400 Hz / 1600 Hz optional				
Switching frequency of the power stage	4, 8, 12, 16 kHz				
Input, mains side					
Mains voltage	(3 x 230 V/ 3 x 400 V/ 3 x 460 V/ 3 x 480 V) ±10 %				
Device connected load (with mains choke)	52.6 kVA [2]	76 kVA	99 kVA	118 kVA	128 kVA [3]
Current [1] (with mains choke)	76 A [2]	110 A	143 A	170 A	185 A [3]
Asymmetry of mains voltage	±3 % max.				
Frequency	50/60 Hz ±10 %				
Power dissipation at I_N [1]	1130 W	1500 W	1940 W	2380 W	2650 W

1) Data referred to mains voltage 3 x 400 V_{eff} and switching frequency of the power stage 8 kHz
2) The input current must be limited to 76 A
3) The input current must be limited to 185 A
4) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model SO8x.xxx.xxxx.7xxx)!
5) Cooling performance adequate also with optional internal braking resistor
6) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.

Table A.13 Technical data, SO84.072 to SO84.210, liquid cooling

Designation / Technical data	SO84.072	SO84.090	SO84.110	SO84.143	SO84.170
DC link					
Capacitance	900 µF	2120 µF		4240 µF	
Brake chopper switch-on threshold	820 V DC				
Minimum ohmic resistance of an externally installed braking resistor [4]	10 Ω	12 Ω	10 Ω	8.5 Ω	6.5 Ω
Brake chopper peak power with external braking resistor	67 kW	56 kW	67 kW	79 kW	103 kW
Option: internal braking resistor	10 Ω	7.5 Ω			
Brake chopper peak power with internal braking resistor	see Table 4.21				
Chiller data					
Coolant pressure (rated value / maximum value)	1 / 2 bar				
Coolant flow rate [5] (rated value / maximum value)	8 / 11 l per min	11 / 13 l per min			
Feed coolant temperature	The coolant temperature can be between 5 °C and 40 °C. However, the coolant temperature should not be more than 10 °K below the ambient temperature to prevent condensation on the heat sink.				

1) Data referred to mains voltage 3 x 400 V_{eff} and switching frequency of the power stage 8 kHz
2) The input current must be limited to 76 A
3) The input current must be limited to 185 A
4) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model SO8x.xxx.xxxx.7xxx)!
5) Cooling performance adequate also with optional internal braking resistor
6) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.

Table A.13 Technical data, SO84.072 to SO84.210, liquid cooling

A.2.6 SO84.250 to SO84.450, liquid cooling

Designation / Technical data	S084.250	S084.325	S084.450
Output, motor side [1]			
Voltage [3]	3-phase U_{Mains}		
Rated current, effective (I_N)	250 A	325 A	450 A
Peak current	See A.1.6		
Rotating field frequency	0 ... 400 Hz / 1600 Hz optional		
Switching frequency of the power stage	2, 4 kHz (8, 12, 16) [2]		
Input, mains side			
Mains voltage	(3 x 230 V/ 3 x 400 V/ 3 x 460 V/ 3 x 480 V) ±10 %		
Device connected load (with mains choke)	173 kVA	225 kVA	310 kVA
Current [1] (with mains choke)	250 A	325 A	450 A
Asymmetry of mains voltage	±3 % max.		
Frequency	50/60 Hz ±10 %		
Power dissipation at I_N [1]	3960 W	4800 W	6750 W
DC link			
Capacitance	3600 µF	5400 µF	7200 µF
Brake chopper switch-on threshold	820 V DC		

1) Data referred to mains voltage 3 x 400 V_{eff} and switching frequency of the power stage 4 kHz
2) With HF function package
3) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.
4) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model SO8x.xxx.xxxx.7xxx)!
5) Cooling performance adequate also with optional internal braking resistor

Table A.14 Technical data SO84.250 to SO84.450, liquid cooling

Designation / Technical data	S084.250	S084.325	S084.450
Minimum ohmic resistance of an externally installed braking resistor	3.2 Ω [4]	2.5 Ω [4]	1.7 Ω [4]
Brake chopper peak power with external braking resistor	210 kW	269 kW	395 kW
Option: internal braking resistor	3.3 Ω		2.4 Ω
Brake chopper peak power with internal braking resistor	see Table 4.21		
Chiller data			
Coolant pressure (rated value / maximum value)	1 / 2 bar		
Coolant flow rate [5] (rated value / maximum value)	12 / 14 l per min		
Feed coolant temperature	The coolant temperature can be between 5 °C and 40 °C. However, the coolant temperature should not be more than 10 °K below the ambient temperature to prevent condensation on the heat sink.		

1) Data referred to mains voltage 3 x 400 V_{eff} and switching frequency of the power stage 4 kHz
2) With HF function package
3) When designing the drive, it is to be taken into account that the maximum output voltage reduces as a function of the active power.
4) Connection of an ext. braking resistor to devices with int. braking resistor not permitted (model SO8x.xxx.xxxx.7xxx)!
5) Cooling performance adequate also with optional internal braking resistor

Table A.14 Technical data SO84.250 to SO84.450, liquid cooling

A.3 Power connections

Feature	BG1 + BG2	BG3 + BG4	BG5	BG6 + BG6a	
				90 - 110 A	143 - 170 A
Cable cross-section (flexible with ferrule)	0.25 - 4 mm² (AWG 24 - AWG 10) *)	0.75 - 16 mm² (AWG 18 - AWG 6)	Max. 35 mm² (AWG 2)	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

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

Table A.15 Technical data, terminals for motor cable BG1 to BG6a

Feature	BG7
Screws for ring cable lug	ZK-, ZK+, RB-, RB+: M10 L1-3, U, V, W: M12
Tightening torque (Nm)	M10 screws: 20-25 M12 screws: 25-30

Table A.16 Technical data, busbars for motor cable BG7

A.4 Current required for the control supply

Housing variant	Size	Max. starting current	Continuous current
Air cooling	BG1 - BG4	6 A	2 A
	BG5	7 A	2.5 A
	BG6 - BG6a	10 A	0 A (10 A) [1]
Liquid cooling	BG3 - BG4	6 A	2 A
	BG5	7 A	2 A
	BG6 - BG6a	8 A	0 A (2 A) [1]
	BG7	4 A	2 A

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

Table A.17 Current required for the control supply

A.5 Ambient conditions

Ambient conditions	ServoOne
Protection	IP20 Exceptions: – IP10 for BG2 heat sink fan – IP00 in general for all connections terminals for all sizes
Accident prevention regulations	As per the local regulations (in Germany e.g. BGV V3)
Installation altitude	Up to 1000 m above MSL, over 1000 m above MSL with power reduction (1 % per 100 m, max. 2000 m above sea level)
Pollution degree	2 as per EN 60664-1
Type of mounting	Built-in unit, only for vertical mounting in a switch cabinet with min. IP4x protection, on using STO safety function min. IP54.

Table A.18 Ambient conditions, ServoOne

Climatic conditions			ServoOne
In transit	As per EN 61800-2, IEC 60721-3-2 class 2K3[1]		
	Temperature		-25 °C to +70 °C
	Relative atmospheric humidity		95 % at max. +40 °C
In storage	As per EN 61800-2, IEC 60721-3-1 classes 1K3 and 1K4[2]		
	Temperature		-25 °C to +55 °C
	Relative atmospheric humidity		5 to 95 %
In operation	As per EN 61800-2, IEC 60721-3-3 class 3K3[3]		
	Temperature	Air cooling	**BG1**[4] -10 °C to +45 °C (4 kHz) -10 °C to +40 °C (8, 12, 16 kHz) **BG2 to BG4** -10 °C to +45 °C (4 kHz), up to 55 °C with power reduction (5 % per °C) -10 °C to +40 °C (8, 12, 16 kHz), up to 55 °C with power reduction (4 % per °C) **BG5**[4] **to BG6a** -10 °C to +45 °C (4 kHz) -10 °C to +40 °C (8, 12, 16 kHz), above up to 55 °C with power reduction (2 % per °C)
		Liquid cooling	**BG3 to BG4** -10 °C to +45 °C (4 kHz), up to 55 °C with power reduction (5 % per °C) -10 °C to +40 °C (8, 12, 16 kHz), up to 55 °C with power reduction (4 % per °C) **BG5 to BG6a** -10 °C to +45 °C (4, 8, 12, 16 kHz), up to 55 °C with power reduction (2 % per °C) **BG7** -10 °C to +40 °C (2, 4, 8, 16 kHz), up to 55 °C with power reduction (2 % per °C)
	Relative atmospheric humidity		5 to 85 % without condensation

1) The absolute humidity is limited to max. 60 g/m³. This means, at 70 °C for example, that the relative atmospheric 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 atmospheric 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 atmospheric humidity stipulated in the table must not occur simultaneously.

4) Safety-Version only permitted up to 40 °C.

Table A.19 Climatic conditions, ServoOne

Mechanical conditions			ServoOne
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 60721-3-2 class 2M1		
	Drop height of packed device max. 0.25 m		
BG1 to BG6 Vibration limits for the system [1]	**Frequency [Hz]**	**Amplitude [mm]**	**Acceleration [m/s²]**
	As per EN 61800-2, IEC 60721-3-3 class 3M3		
	2 ≤ f < 9	1,5	Not applicable
	9 ≤ f < 200	Not applicable	5
BG6a to BG7 Vibration limits for the system[1]	As per EN 61800-2, IEC 60721-3-3 class 3M1		
	2 ≤ f < 9	0,3	Not applicable
	9 ≤ f < 200	Not applicable	1

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

Table A.20 Mechanical conditions, ServoOne

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

A.6 Permissible motor cable lengths

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

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

Switching frequency	4 kHz		8 kHz		12 kHz		16 kHz	
	Category							
Drive controller	C3	C2	C3	C2	C3	C2	C3	C2
S084.004[1]	40 m	20 m	40 m	15 m	40 m	10 m	40 m	8 m
S084.006[1]	40 m	20 m	40 m	15 m	40 m	10 m	40 m	8 m
S084.008[1]	40 m	20 m	40 m	15 m	40 m	10 m	40 m	10 m
S084.012[1]	40 m	20 m	40 m	15 m	40 m	10 m	40 m	10 m
S084.016[1]	40 m	10 m	40 m	10 m	40 m	10 m	40 m	10 m
S084.020[1]	40 m	10 m	40 m	10 m	40 m	10 m	40 m	10 m
S084.024[1]	40 m	10 m	40 m	10 m	40 m	10 m	40 m	10 m
S084.032[1]	40 m	10 m	40 m	10 m	40 m	10 m	40 m	10 m
S084.045[2]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m
S084.060[2]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m
S084.072[2]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m
S084.090[2] [3]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m
S084.110[2] [3]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m
S084.143[2] [3]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m

C3 = "Second environment" (industrial)

C2 = "First environment" (residential)

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

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

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

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

Table A.21 Permissible motor cable lengths

Switching frequency	4 kHz		8 kHz		12 kHz		16 kHz	
	Category							
Drive controller	C3	C2	C3	C2	C3	C2	C3	C2
S084.170[2] [3]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m
S084.250[2] [3] [4]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m
S084.375[2] [3] [4]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m
S084.450[2] [3] [4]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m

C3 = "Second environment" (industrial)

C2 = "First environment" (residential)

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

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

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

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

Table A.21 Permissible motor cable lengths

A.7 Hydrological data for the liquid cooling

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

NOTE:

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

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

Table A.22 Requirements, liquid cooling

NOTE:

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

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

Table A.23 Hydrological data for the liquid cooling

NOTE:

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

A.8 Monitoring of the heat sink temperature

If the max. permissible cooling temperature is exceeded, the drive controllers shut down with an overtemperature error.

Size	BG3	BG4	BG5	BG6a	BG7
Device	S084.016 S084.020	S084.024 S084.032	S084.045 S084.060 S084072	S084.090 S084.110 S084.143 S084.170	S084.250 S084.325 S084.450
Shutdown of the device at a heat sink temperature	65 °C				90 °C

Table A.24 Monitoring of the heat sink temperature

Should the coolant flow rate collapse or not become established, the power stage could overheat. For this reason the drive controllers BG3 to BG6a are equipped with monitoring of the heat sink temperature and drive controller BG7 is equipped with monitoring of the temperature of the power stage; this monitoring shuts down the drive controller in the event of overtemperature.

A.9 UL certification

You will find the description of all measures to maintain UL approval in the document "UL-Certification" (ID no.: 0927.21B.X-0)

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