LTi DRiVES

ServoOne

Operation Manual

Single-Axis System

4 A to 450 A

ServoOne Drives with Ambition

The modular design of ServoOne ensures optimal integration into the machine process. Whether through a high speed field bus communication with the central multi-axis machine control, or through decentralized programmable Motion Control Intelligence in the drive controller, ServoOne will master both tasks brilliantly.

ServoOne Operation Manual Single-Axis System

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Status: 01/2011

Valid from firmware status: V2.20-01

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

Technical alterations reserved.

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

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

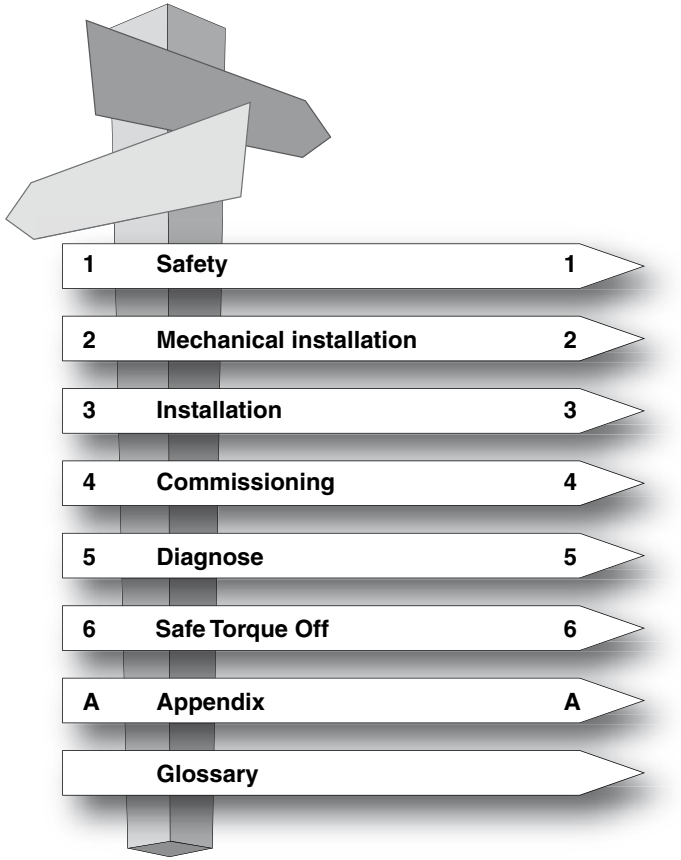
Information and specifications may be changed at any time. For information on the latest version please refer to http://drives.lt-i.com.

Guide through this document

Dear user!

We are happy that you have made a decision in favour of a product from LTi DRiVES. In order to be able to start operation of your new ServoOne quickly and without problems, we ask you kindly to read this operation manual thoroughly beforehand.

Step	Action	Comment
1.	This Operation Manual will enable you to install and commission ServoOne drive system very quickly and easily.	Guide to quick-starting
2.	Simply follow the step-by-step tables in the chapters.	And away you go!



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Order code

The order designation informs about the corresponding design variant of the drive controller delivered to you. You find details about the order code in the ServoOne system catalogue.

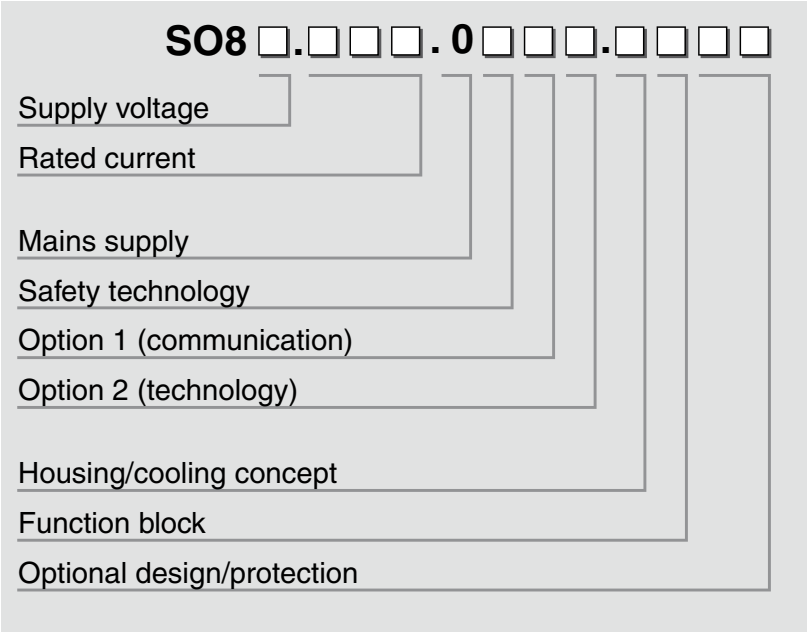

Fig. 0.1 Order code ServoOne

Rating plate

The rating plate on ServoOne drive units informs about the serial number, from which you can read the manufacturing date by using the following key. The location of the rating plate on your ServoOne can be found from page 18 onwards.

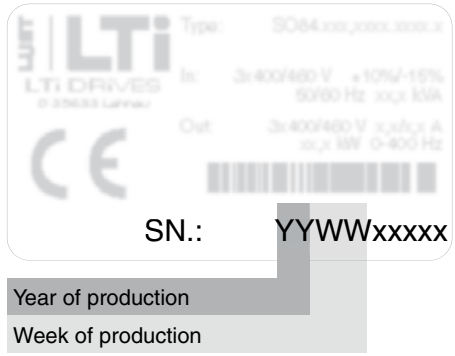

Fig. 0.2 Rating plate hardware ServoOne

Scope of supply

The scope of supply includes:

- ServoOne drive unit
- Terminal accessory pack for control and power terminals (depending on device rated power and variant)
- Product DVD

Pictograms

Pictograms as described in the following table are used in this operation manual for better orientation. The meaning of the corresponding pictogram is always correct, even if it is placed e.g. next to a terminal diagram without any accompanying text.

Warning symbols (see also section 1.1)	
	ATTENTION! Misoperation may cause damage to or malfunction of the drive.
	DANGER CAUSED BY HIGH VOLTAGE! Improper behaviour may cause danger to human life.
	DANGER FROM ROTATING PARTS! The drive may automatically start to run.
Notes & supportive action	
	NOTE: Useful information or reference to other documents
	STEP: Processing step within a multi-action sequence

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Space for personal notes

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1. Safety

1.1 Measures for your safety

The following information must be read before initial commissioning to avoid physical injury and/or material damage. The safety regulations must be strictly observed at any time.

	Read the Operation Manual first! • Follow the safety instructions! • Please observe the user information!
	Electric drives are generally potential danger sources: • Electrical voltages 230 V AC to 680 V DC **Even 30 minutes after switching off the mains supply dangerously high voltages of ≥ 50 V may still be present (capacitor charge). Therefore check for isolation from supply!** • Rotating parts • Hot surfaces
	Protection against magnetic and/or electromagnetic fields during installation and operation. • For persons with pacemakers, metal containing implants and hearing aids etc. access to the following areas is prohibited: – Areas in which drive systems are installed, repaired and operated. – Areas in which motors are assembled, repaired and operated. Motors with permanent magnets are sources of special dangers. NOTE: If there is a necessity to access such areas a decision from a physician is required.
	Your qualification: • In order to prevent personal injury or material damage, only personnel with electrical engineering qualifications may work on the device. • The qualified person must become familiar with the operation manual (see IEC 364, DIN VDE 0100). • Knowledge of national accident prevention regulations (e.g. BGV A3 in Germany).
	During installation follow these instructions: • Always comply with the connection conditions and technical specifications. • Comply with the standards for electrical installation, such as wire cross-section, PE-conductor and ground connection. • Do not touch electronic components and contacts (electrostatic discharge may destroy components).

Table 1.1 Notes on safety

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Warning symbols used

The notes on safety describe the following danger classes.
The danger class describes the risk which may arise when not complying with the corresponding safety note.

Warning symbols	General explanation	Danger class acc. to ANSI Z 535
	ATTENTION! Misoperation may cause damage to or malfunction of the drive.	This may result in physical injury or damage to material.
	DANGER CAUSED BY HIGH VOLTAGE! Improper behaviour may cause danger to human life.	Danger to life or severe physical injury.
	DANGER FROM ROTATING PARTS! The drive may automatically start to run.	Danger to life or severe physical injury.

Table 1.2 Explanation of warning symbols

1.2 Intended use

ServoOne drive controllers are components for installation into stationary electric, industrial and commercial systems or machines.

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

Commissioning, i.e. starting intended operation, is only permitted when strictly complying with the EMC-directive (2004/108/EC).

CE The ServoOne drive controller is in conformity with the low voltage directive 2006/95/EC

The drive controller fulfils the demands of the harmonized product standard EN 61800-5-1:2003.

If the drive controller is used in special applications, e.g. in potentially explosive areas, the applicable regulations and standards (e.g. in potentially explosive areas EN 50014 “General provisions” and EN 50018 “Flameproof enclosure”) must strictly be followed.

Repairs must only be carried out by authorised repair workshops. Unauthorised opening and incorrect intervention could lead to physical injury or material damage. The warranty granted by LTi DRiVES will become null and void.

NOTE: The use of drive controllers in mobile equipment is assumed an exceptional environmental condition and is only permitted after a special agreement.

1.3 Responsibility

Electronic devices are never fail-safe. The company setting up and/or operating the machine or plant is itself responsible for ensuring that the drive is rendered safe if the device fails.

The standard EN 60204-1/DIN VDE 0113 “Safety of machines”, under the subject “Electrical equipment of machines”, stipulates safety requirements for electrical controls. They are intended for the safety of personnel and machinery as well as for maintaining the functional capability of the machine or plant concerned, and must be observed.

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

2. Mechanical installation

2.1 Notes on installation

ATTENTION!

- **During installation work**
  Strictly avoid that ...
  – drill chips, screws or other foreign objects drop into the device
  – moisture enters into the device
- **Control cabinet**
  The device is solely intended for installation in a stationary control cabinet. The control cabinet must at least meet the requirements of degree of protection IP4x. When using the safety function STO (Safe Torque OFF), the control cabinet must, in accordance with EN ISO 13849-2, have a degree of protection of IP54 or higher.
- **Environment**
  – The drive controllers must not be installed in areas where they would be permanently exposed to vibrations. Further information can be found in table A.18 in the appendix.
  – The device heats up during operation and the temperature on the heat sink may reach 100 °C. Please bear this in mind for adjacent components.

The following general guidelines apply for the installation of single axis controllers.

- **Cooling**
  Cooling air must be able to flow through the device without restriction.
  For installation in control cabinets with convection (= heat loss is discharged to the outside via the cabinet walls), always fit an internal air circulation fan.
- **EMC compatible installation**
  The best result for an EMC compatible installation is achieved by using a well grounded, chromated or galvanised mounting plate. If mounting plates are paint coated, remove the coating from the contact area! The devices themselves have an aluminium back panel (BG1 to BG2) or a back panel made of aluminized/ galvanized sheet steel (BG5 to BG7).
- **Pollution severity**
  Maximum pollution severity 2 in accordance with EN 60664-1. Further information on environmental conditions can be found in table A.16 in the appendix.

If you require further detailed information on installation you should consult the LTi Helpline (see page 54).

2.2 Installation

Step	Action	Comment
1.	Mark out the positions of the tapped holes and, if applicable, the pipe socket on the mounting plate. Drill the holes and cut a thread for each fastening screw into the mounting plate.	Observe the mounting clearances! Consider the bending radius of the connecting leads! Dimensioned drawings/hole distances see Fig. 2.2 to Fig. 2.5
2.	Mount the drive controller vertically on the mounting plate.	Observe the mounting clearances! The contact area must be metallic bright.
3.	For devices with liquid cooling the pipe sockets must be supported with a 22 mm open end spanner when screwing in the hose connections (not included in the scope of supply), to prevent the device from being damaged by torsional torque.	Ensure perfect liquid tight connection (e.g. use Teflon sealing tape)!
4.	Install further components, such as e.g. mains filter, power choke, etc. on the mounting plate.	The lead between mains filter and drive controller must not be longer than max. 30 cm.
5.	Now continue with the electrical installation in chapter 3.	

Table 2.1 Mechanical installation

NOTE: Connect the liquid cooling supply at BG7 to the marked connection (Fig. 2.5). For BG3 to BG6a this connection is freely selectable.

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2.2.1 Dimensions on devices with air cooling

ServoOne	BG1	BG2	BG3	BG4	BG5	BG6	BG6a
	SO82.004 SO84.004 SO84.006	SO84.008 SO84.012	SO84.016 SO84.020	SO84.024 SO84.032	SO84.045 SO84.060 SO84.072	SO84.090 SO84.110	SO84.143 SO84.170
Weight [kg]	3.4	4.9	6.5	7.5	13	28	32
B (Width)	58.5	90	130	171	190	280	
H (Height)[1)]	295				345	540	
T (Depth)[1)]	224				240	242	322
A	29.25	50	80	120	150	200	
C	344.5				365	581	
C1	5				6	10	
D Ø	4.8				5.6	9.5	
Screws	2 x M4	4 x M4			4 x M5	4 x M8	
E	2				20	40	
F [2)]	≥ 100		≥ 150		≥ 180		
G [2)]	≥ 270				≥ 300		≥ 500
H1	355				382.5	600	
H2	38.5				15	20	

all measurements in mm
1) without terminals, plugs and plate screens
2) Possibly bigger bending radii of connecting leads must be accounted for.

Table 2.2 Dimensions of housing with air cooling, see Fig. 2.1 and Fig. 2.2

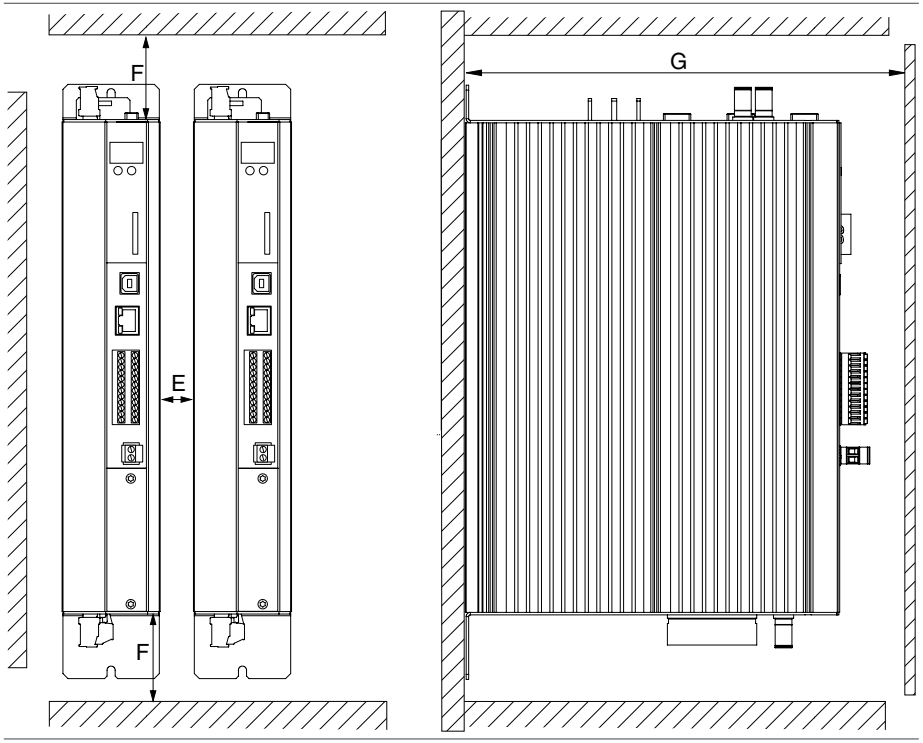


Fig. 2.1 Installation distances in case of air cooling, schematic representation for BG1 to BG6a

NOTE: The minimum distance "E" specified in the table for sizes 1-4 applies for devices with the same power. When butt mounting devices with different drive power you should arrange the devices according to their power (e.g. viewed from the left BG4-BG3-BG2-BG1). This minimizes the thermal influence among each other.

When butt mounting ServoOne controllers together with other devices, you must make sure that these device do not affect one another thermally.

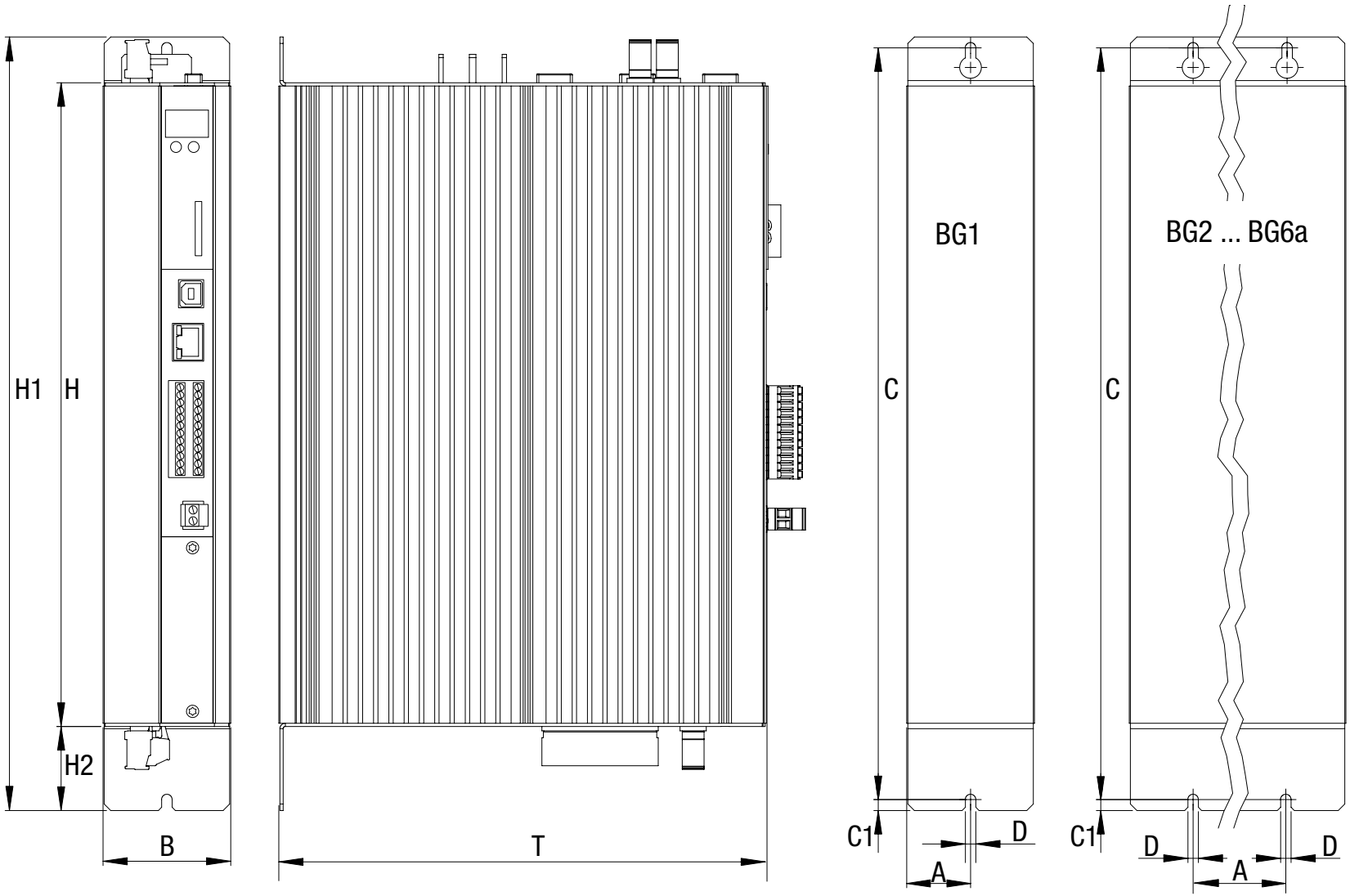


Fig. 2.2 Dimensional drawing of housing with air cooling, schematic representation for BG1 to BG6a.

2.2.2 Dimensions on devices with liquid cooling

ServoOne	BG3		BG4		BG5	BG6		BG6a	BG7
	SO84.016 SO84.020		SO84.024 SO84.032		SO84.045 SO84.060 SO84.072	SO84.090 SO84.110		SO84.143 SO84.170	SO84.250 SO84.325 SO84.450
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			952
T (Depth)[1]	224				198.3	202		282	286.5
A	80		120		148	200			150
A1	10		25		39	65			29
A2	60				70				
C	382				377.25	581			952
C1	5				8	10			12
H1	392				394.25	600			971/1305 [3]
H2	38.5				16.75	20			60
H3	75	70			53.75	56.5			136
T1	74				73.5				
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 socket)								
E	2								
F [2]	≥ 150				≥ 180				
G [2]	≥ 270				≥ 300			≥ 500	

all measurements in mm

1) without terminals, plugs and plate screens

2) Possibly bigger bending radii of connecting leads must be accounted for.

3) without/with terminal covers and plate screens

Table 2.3 Dimensions of housing with liquid cooling, see Fig. 2.3 and Fig. 2.5

NOTE: The minimum distance "E" specified in the table applies for devices with the same power. When butt mounting devices with different drive power you should arrange the devices according to their power (e.g. viewed from the left BG4-BG3-BG2-BG1). This minimizes the thermal influence among each other.

When butt mounting ServoOne controllers together with other devices, you must make sure that these device do not affect one another thermally.

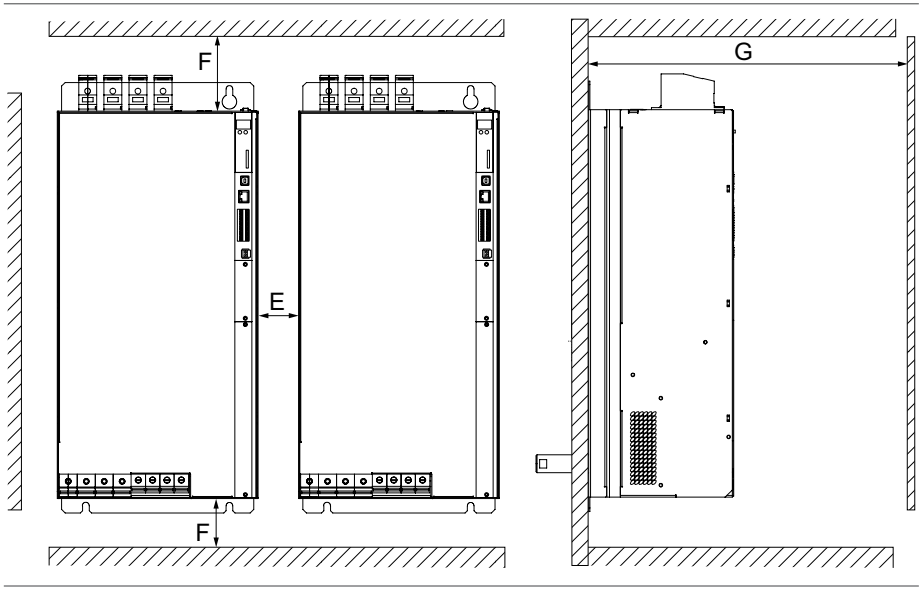


Fig. 2.3 Installation distances in case of liquid cooling, schematic representation for BG3 to BG7

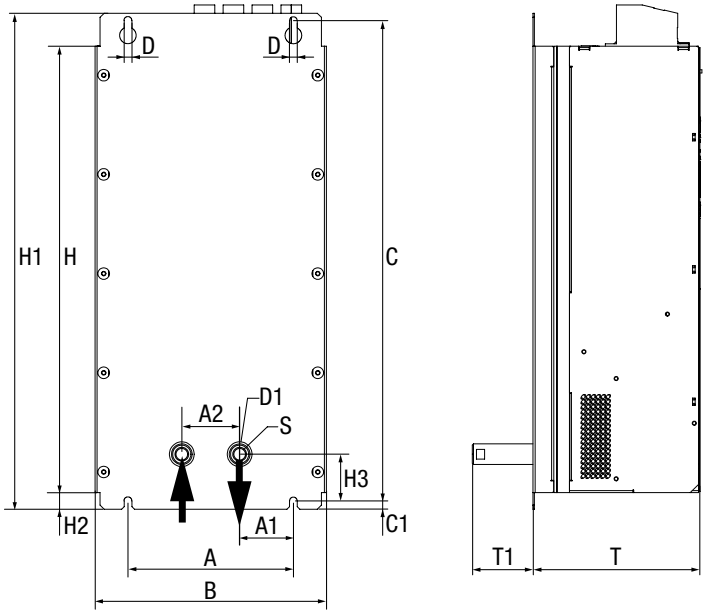


Fig. 2.4 Dimensional drawing of housing with liquid cooling, schematic representation for BG3 to BG6a

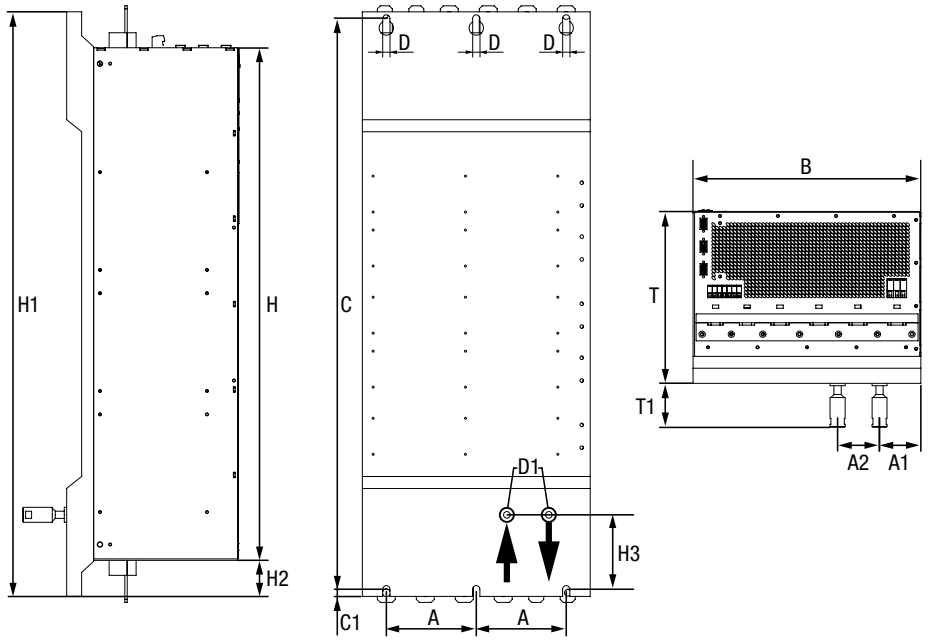
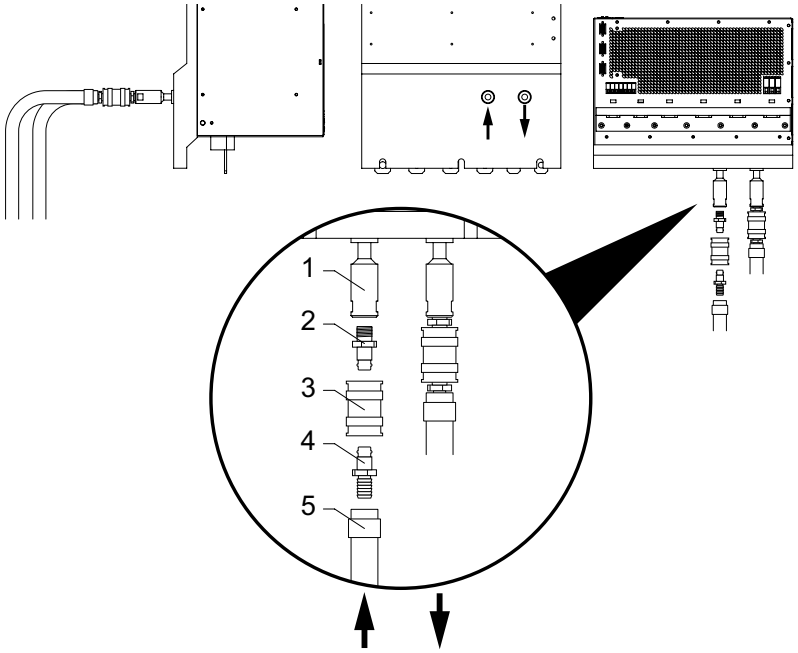


Fig. 2.5 Dimensional drawing of housing with liquid cooling, schematic representation for BG7

2.2.3 Connection of cooling circuit

Depending on size the ServoOne has a liquid coolant capacity of up to 0.5 l. After disconnecting the connections residual liquid may remain in the device and run out when tipped over. We recommend to use a drip free liquid coupling (not included in the scope of supply), to prevent liquid coolant from running out and to enable disconnecting and connecting in filled condition.



Legend

1) Liquid connection with 3/8 inch female thread
2) Drip free quick-release nipple with 3/8 inch male thread
3) Drip free liquid coupling
4) Adapter for hose connection
5) PUR (polyurethane) hose with hose clamp

Fig. 2.6 Connection of cooling circuit (here: BG7)

NOTES:

- **Scope of supply**
  Positions 2 to 5 are **not** contained in the scope of supply and must be provided by the customer.
- **Supply connection**
  Connect the supply of the liquid cooling strictly to the connections marked in Fig 2.4, Fig. 2.5 or Fig. 2.6 accordingly.

3. Installation

3.1 Notes for installation

ATTENTION!

- **Qualified personnel**
  Installation must only be carried out by electrical engineering experts who have been specially instructed in the necessary accident prevention measures.
- **During installation work**
  Strictly avoid that ...
  – screws, cable rests or foreign bodies drop into the device
  – moisture enters into the device,

DANGER CAUSED BY HIGH VOLTAGE!

- **Danger to life!**
  – Never wire or disconnect electrical connections while they are live. Isolate the device from the mains supply (230/400/460/480 V AC) before working on it. Even 30 minutes after switching off the mains supply dangerously high voltages of ≥ 50 V may still be present (capacitor charge). 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-BG4 to be measured on terminals X12/L- and L+ or on BG5 to BG6a on terminals X12/ZK- and X12/ZK+, on BG/ on terminals X11/ZK- and X11/ZK+).
  – Dangerous voltage may be applied to 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 or X44)!

The following general guidelines apply for the installation of single axis controllers:

- **Compliance with the EMC product standard**
  Commissioning (i.e. starting intended operation) is only permitted when strictly complying with EMC product standard EN 61800/-3:2004. The installer/operator of a machine and/or equipment must provide evidence of the compliance with the protection targets stipulated in the EMC-standard.
- **Cable type**
  – Use only shielded mains, motor and signal lines with double copper braiding that is overlapping by 60 to 70 %.
  – If very large cable cross-sections need to be routed, shielded individual cores may be used instead of shielded cables.
- **Routing of cables**
  – Route mains, motor and signal cables separated from one another. If possible, keep a distance of at least 0.2 m, otherwise use separators.
  – Always route the motor cable without interruptions and the shortest way out of the control cabinet. When using a motor contactor or a motor choke, the respective component should be directly mounted to the drive controller and the shielding of the motor cable should not be stripped off too soon.
  – If possible enter signal lines only from one side into the control cabinet.
  – Lines of the same electric circuit must be twisted.
  – Avoid unnecessary cable lengths and loops.
- **Grounding**
  grounding measures of relevance for the drive controller are described in section 3.5 “PE-terminal“ on page 24.
- **Shielding measures**
  Do not strip the cable shields too early and attach them amply to both the component and the PE bar (main ground) of the mounting plate.
- **External components**
  – Place larger consumers near the supply.
  – Contactors, relays, solenoid valves (switched inductivities) must be wired with fuses. The wiring must be directly connected to the respective coil.
  – Any switched inductance should be at least 0.2 m away from the process controlled assemblies.

Additional information can be found in the corresponding connection description. If you require further detailed information on installation you should consult the LTi Helpline (see page 54).

Step	Action	Comment
1.	Determine the pin assignment for your device.	Section 3.2 for BG1 to BG4 Section 3.3 for BG5 to BG6a Section 3.4 for BG7
2.	Connect all required input and output units to the control terminals and, if necessary, to the optional interfaces.	Section 3.8 Section 3.11 and/or 3.12
3.	Connect encoder, motor and, if necessary, the external braking resistor.	Sections 3.13, 3.14 and 3.15
4.	Connect the PE-conductor and the supply voltages.	Sections 3.5 and 3.7
5.	Continue with the commissioning in chapter 4.	

Table 3.1 Electrical installation

3.2 Overview of connections BG1 to BG4

The following shows the position plan with the corresponding positions of plugs and terminals. For better orientation we have identified the designations of plugs and terminals with an abbreviation.

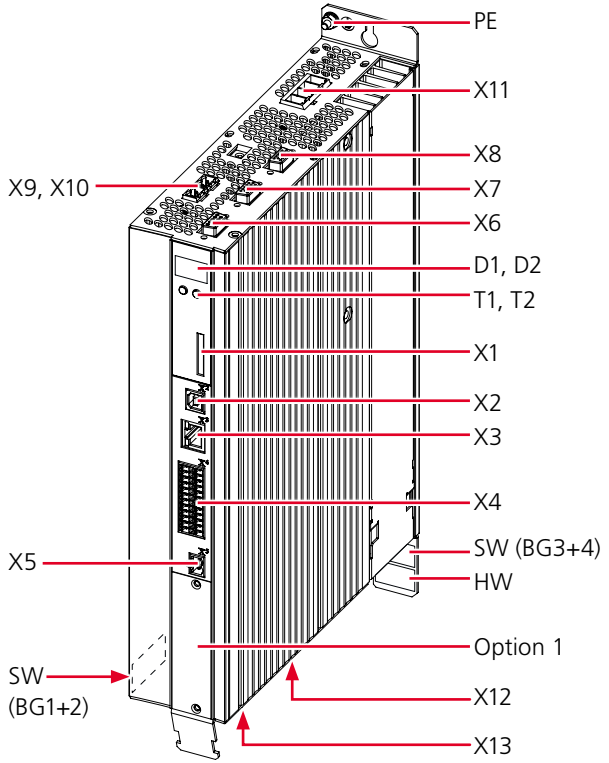


Fig. 3.1 Position plan BG1 to BG4 (here: BG1)

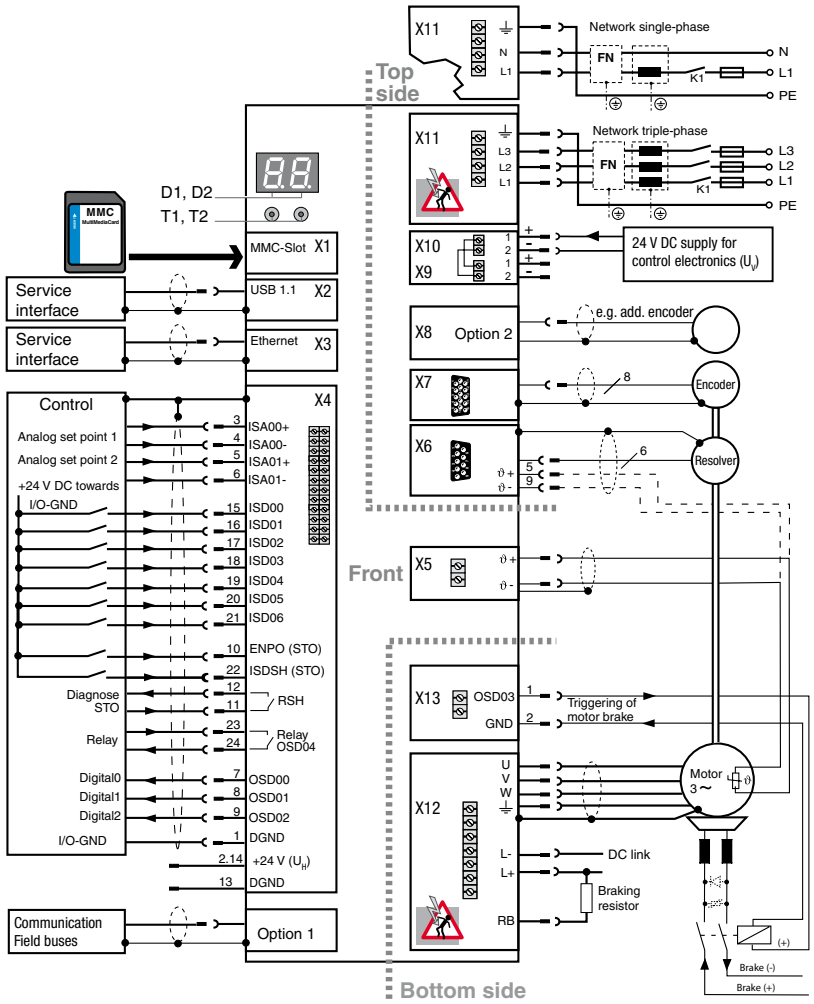


Fig. 3.2 Connection overview BG1 to BG4

No.	Designation	Function	Page
D1, D2	7-segment display	Equipment status display	see page 46
T1, T2	Button	Service functions	see page 46
X1	Slot for MMC exchangeable data carrier	Enables e. g. firmware download without PC	see page 45
X2	USB 1.1 interface	Service interface, Plug & Play connection to PC	see page 33
X3	Ethernet interface	Service interface, fast TCP/IP port (RJ45)	see page 33
X4	Control terminals	Relay output diagnose STO, 7 digital inputs, ENPO, ISDSH, 2 analog inputs, 3 digital outputs, 1 additional relay output	see page 30
Option 1	Communication	Factory installed module for field buses, e.g. SERCOS, PROFIBUS-DP, EtherCAT or CANopen	see page 33
X11	AC mains connection	Mains supply	see page 27
PE	PE-terminal	Terminal diagram see section 3.5	see page 24
X9, X10	Connection control supply U_V	24 V supply voltage for control electronics of drive controller	see page 26
X8 Option 2	Technology	see X7	see page 33
X7	high resolution encoder interface	Sin/Cos-encoder, EnDat 2.1-encoder, HIPERFACE®-encoder	see page 35
X6	Resolver connection	Motor temperature monitoring can be routed through the resolver lead (X6/5 and 9)	see page 35
X5	Connection motor temperature monitoring	PTC, following DIN 44082 Linear temperature sensor KTY84-130 Automatic cutout Klixon	see page 35
X13	Connection of motor brake	Power output with open-circuit/overload detection to the relay. Attention: Observe the freewheeling suppressor circuit	see page 32
X12	Power terminal	Motor, braking resistor and connection of the DC link	see page 36
HW	Hardware rating plate	contains serial number and electrical performance data	see page 4
SW	Software rating plate	contains serial number, software version, MAC address	see page 4

Table 3.2 Legend to terminal diagram BG1 to BG4

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3.3 Overview of connections BG5 to BG6a

The following shows the position plan with the corresponding positions of plugs and terminals. For better orientation we have identified the designations of plugs and terminals with an abbreviation.

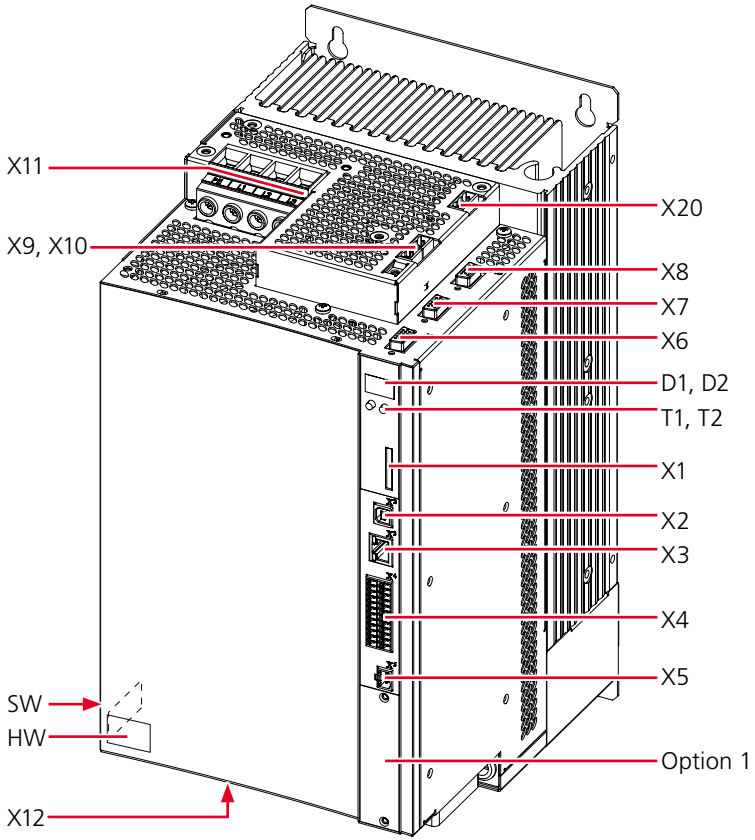

Fig. 3.3 Position plan BG5 (here: Housing variant for wall mounting)

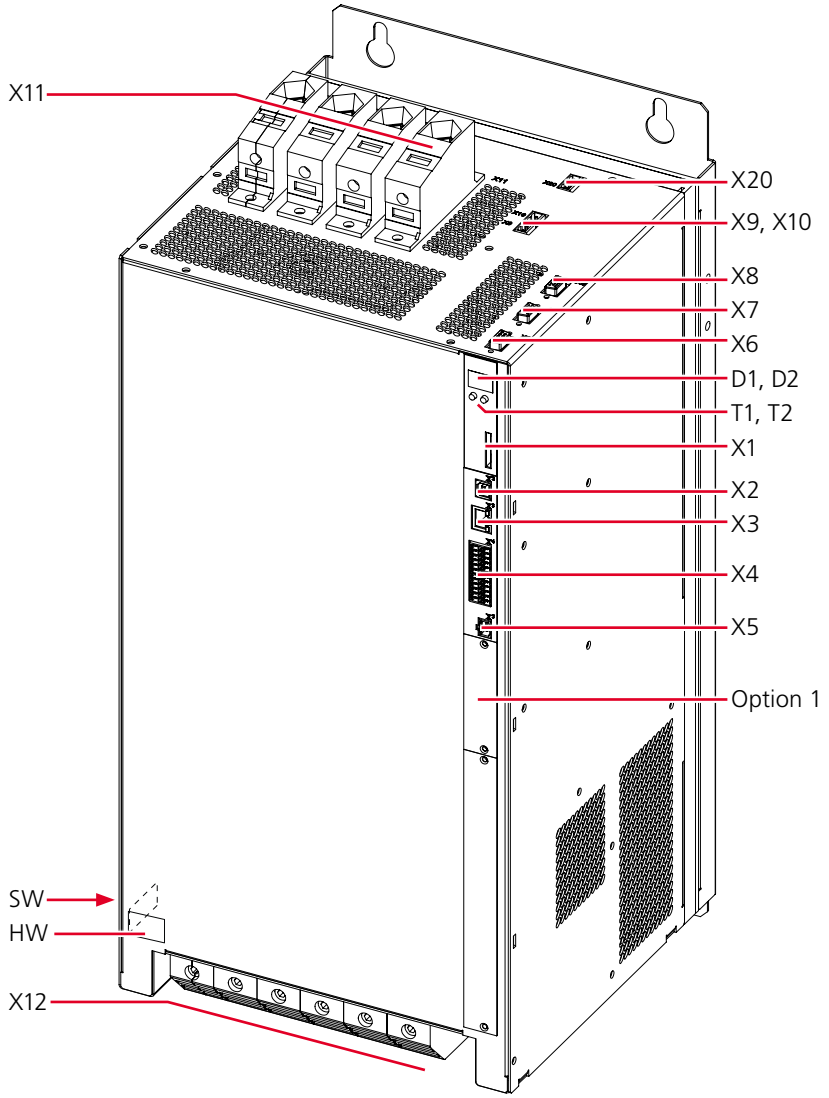

Fig. 3.4 Position plan BG6 and BG6a (here: BG6a, housing variant liquid cooling)

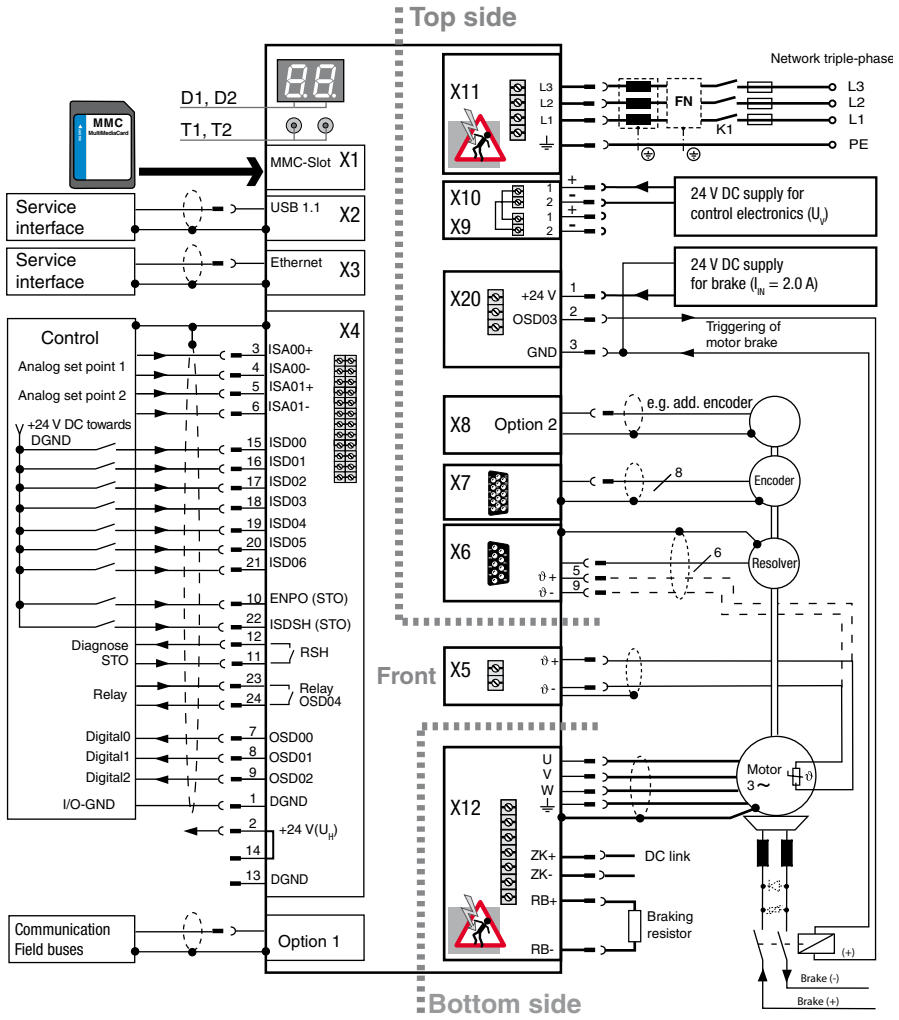

Fig. 3.5 Terminal diagram BG5 to BG6a

No.	Designation	Function	Page
D1, D2	7-segment display	Equipment status display	see page 46
T1, T2	Button	Service functions	see page 46
X1	Slot for MMC exchangeable data carrier	Enables e. g. firmware download without PC	see page 45
X2	USB 1.1 interface	Service interface, Plug & Play connection to PC	see page 33
X3	Ethernet interface	Service interface, fast TCP/IP port (RJ45)	see page 33
X4	Control terminals	Relay output diagnose STO, 8 digital inputs, 2 analog inputs, 3 digital outputs, 1 additional relay output	see page 30
Option 1	Communication	Factory installed module for field buses, e.g. SERCOS, PROFIBUS-DP, EtherCAT or CANopen	see page 33
X11	AC mains connection	Mains supply	see page 27
PE	PE-terminal	Terminal diagram see section 3.5	see page 24
X9, X10	Connection control supply U_V	Supply voltage for control electronics of drive controller	see page 26
X8 Option 2	Technology	see X7	see page 33
X7	high resolution encoder interface	Sin/Cos-encoder, EnDat 2.1-encoder, HIPERFACE®-encoder	see page 35
X6	Resolver connection	Motor temperature monitoring can be routed through the resolver lead (X6/5 and 9)	see page 35
X5	Connection motor temperature monitoring	PTC, following DIN 44082 Linear temperature sensor KTY84-130 Automatic cutout Klixon	see page 35
X20	Connection of motor brake	Power output with open-circuit/overload detection to the relay. Attention: Observe the freewheeling suppressor circuit	see page 32
X12	Power terminal	Motor, brake resistance and connection of the DC link	see page 36
HW	Hardware rating plate	contains serial number and electrical performance data	see page 4
SW	Software rating plate	contains serial number, software version, MAC address	see page 4

Table 3.3 Legend to terminal diagram BG5 to BG6a

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3.4 Overview of connections BG7

The following shows the position plan with the corresponding positions of plugs and terminals. For better orientation we have identified the designations of plugs and terminals with an abbreviation.

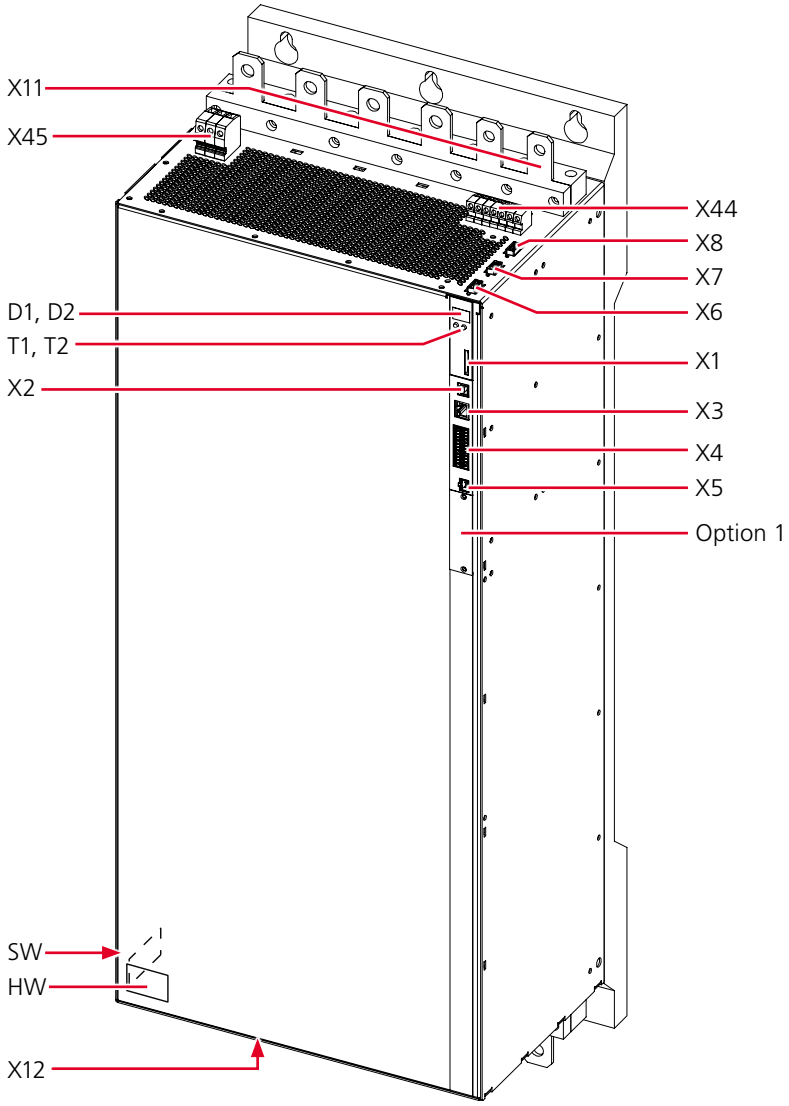

Fig. 3.6 Position plan BG7 (here without plate screens and terminal covers on X11 and X12)

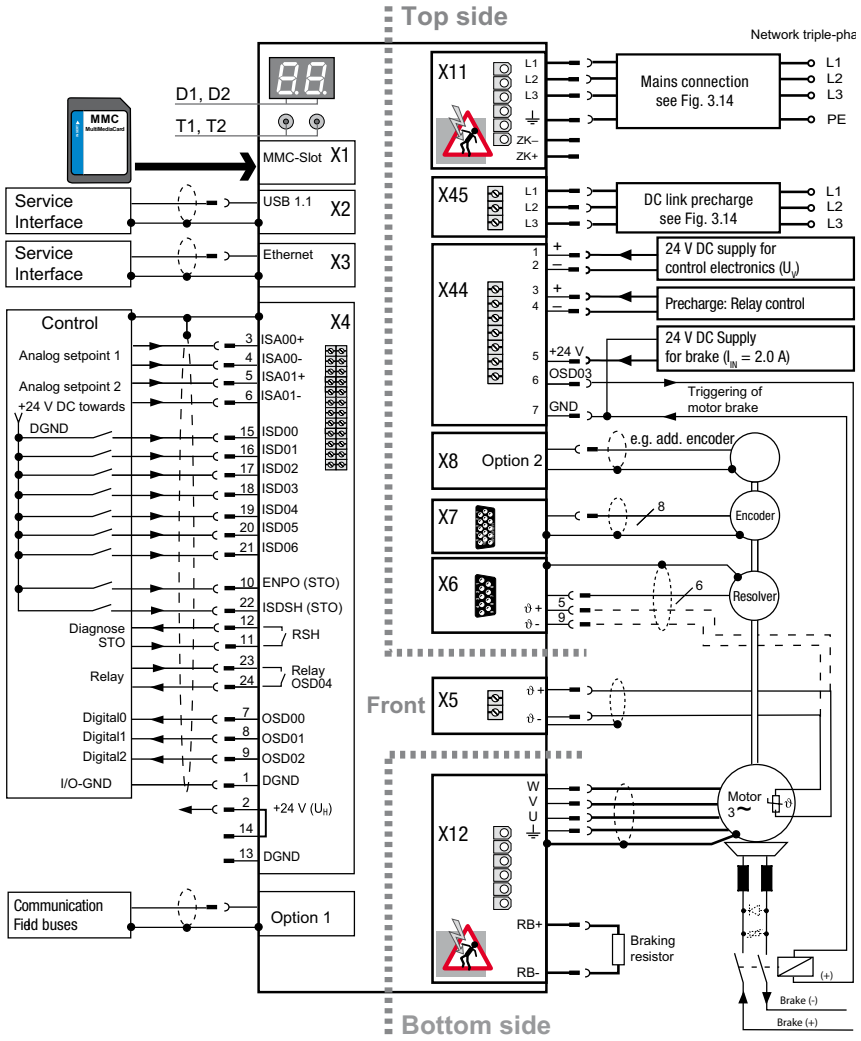

Fig. 3.7 Terminal diagram BG7

No.	Designation	Function	Page
D1, D2	7-segment display	Equipment status display	see page 46
T1, T2	Button	Service functions	see page 46
X1	Slot for MMC exchangeable data carrier	Enables e. g. firmware download without PC	see page 45
X2	USB 1.1 interface	Service interface, Plug & Play connection to PC	see page 33
X3	Ethernet interface	Service interface, fast TCP/IP port (RJ45)	see page 33
X4	Control terminals	Relay output diagnose STO, 8 digital inputs, 2 analog inputs, 3 digital outputs, 1 additional relay output	see page 30
Option 1	Communication	Factory installed module for field buses, e.g. SERCOS, PROFIBUS-DP, EtherCAT or CANopen	see page 33
X11	Mains connection	Mains supply and connection of DC link	see page 27
PE	conductor connection	Terminal diagram see section *3.5*	see page 24
X45	Precharge connection	DC link precharge	see page 30
X44	Connections control supply U_V, precharge and motor brake	Supply voltage for control electronics and motor brake of drive controller, triggering for precharge, power output for motor brake with open circuit/ overload detection to the relay. Attention: Observe the freewheeling suppressor circuit	see page 29
X8 Option 2	Technology	see X7	see page 33
X7	high resolution encoder interface	Sin/Cos-encoder, EnDat 2.1-encoder, HIPERFACE®-encoder	see page 35
X6	Resolver connection	Motor temperature monitoring can be routed through the resolver lead (X6/5 and 9)	see page 35
X5	Connection motor temperature monitoring	PTC, following DIN 44082 Linear temperature sensor KTY84-130 Automatic cutout Klixon	see page 35
X12	Power terminal	Motor and braking resistor	see page 36
HW	Hardware rating plate	contains serial number and electrical performance data	see page 4
SW	Hardware rating plate	contains serial number and electrical performance data	see page 4

Table 3.4 Legend to terminal plan BG7

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3.5 PE-terminal

Step	Action	PE mains connection acc. to DIN EN 61800-5-1
1.	Ground each of the drive controllers! Connect terminal ⏚ **in star configuration** and **amply dimensioned** with the PE-bar (main ground) in the control cabinet.	The following applies for the PE connection (because leakage current > 3.5 mA): • Mains connection <10 mm² copper. Use PE-conductor cross-section min. 10 mm² copper or two cables with the cross-section of the mains cables.
2.	Also connect the PE-conductor terminals of all other components, such as mains choke, filter, etc. in a **star configuration** and **amply dimensioned** to the PE-bar (main ground) in the control cabinet.	• Mains connection ≥10 mm² copper. Use a PE-conductor cross section complying with the cross-section of the mains cables. Apart from this, you must also consider local and country specific regulations and conditions.

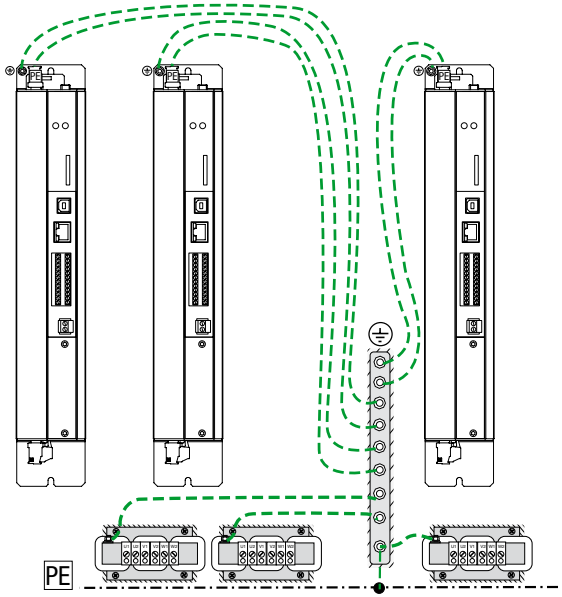

Fig. 3.8 Star configuration layout of PE-conductor

3.6 Electrical isolation concept

The control electronics with its logics (µP), the encoder terminals and the inputs and outputs is galvanically isolated from the power section (mains supply/DC link). All control terminals are designed as safety extra-low voltage (SELV/PELV) circuit and must only be operated with SELV or PELV voltages complying with the corresponding specification. This provides reliable protection against electric shock on the control side.

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

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

This concept additionally enhances the operational safety and reliability of the drive controller.

ATTENTION! Terminal X5 (motor PTC) represents a special feature with respect to insulation and isolation. In this respect follow the notes in section 3.14 “Motor connection” starting from page 36.

SELV = Safety Extra Low Voltage

PELV = Protective Extra Low Voltage

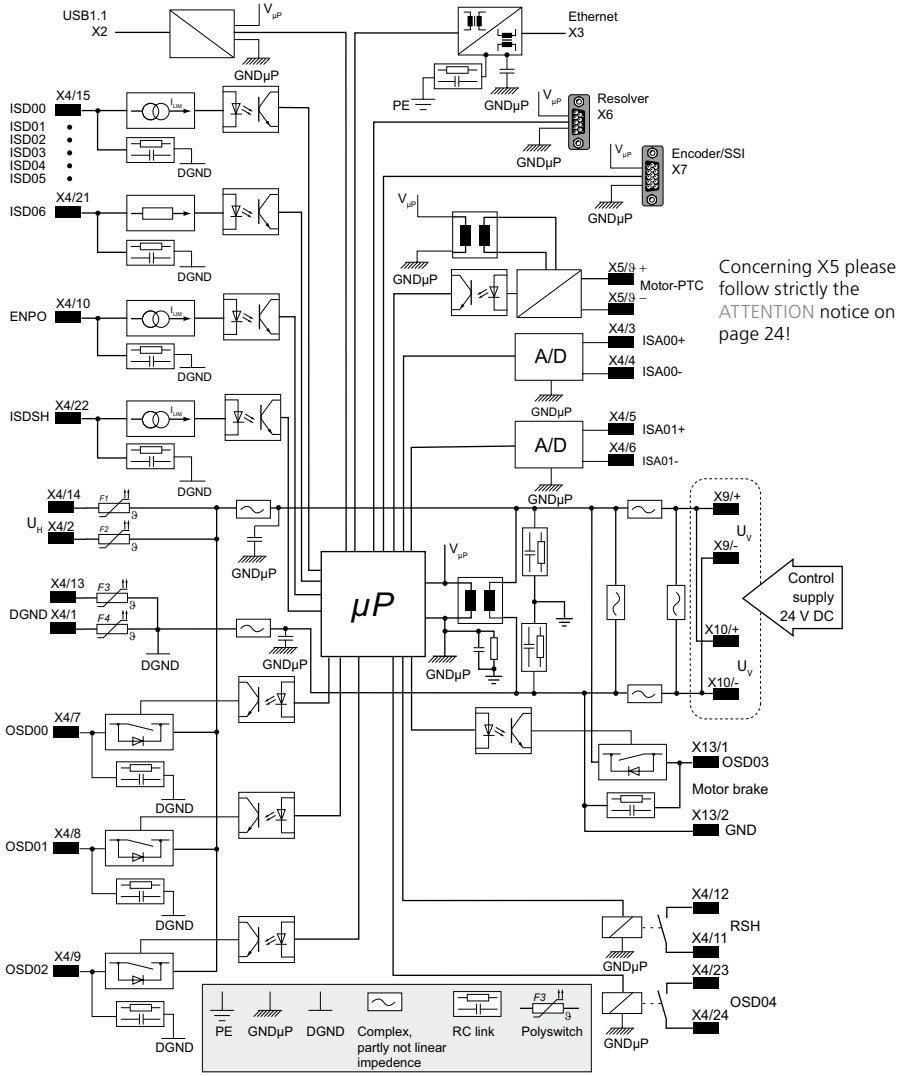

Fig. 3.9 Electrical isolation concept for BG1 to BG4

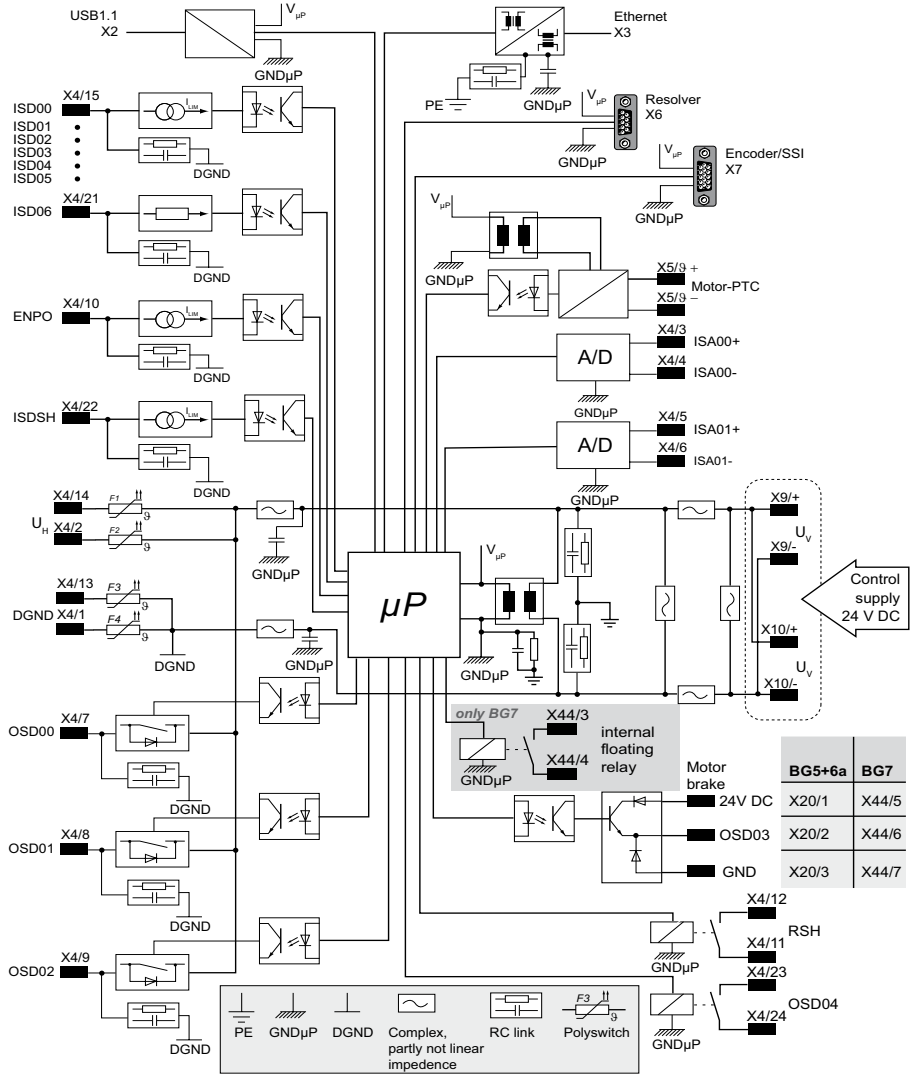

Fig. 3.10 Electrical isolation concept BG5 to BG7

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3.7 Connection of supply voltages

The power supply for the ServoOne is separated into the supplies for control and power sections. In the connecting sequence the control supply must always be connected **first**, so that triggering of the ServoOne can first be checked or the device can be parameterized for the intended application.

DANGER CAUSED BY HIGH VOLTAGE: Dangerous voltage may be applied to 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)!

3.7.1 Connection control supply (24 V DC)

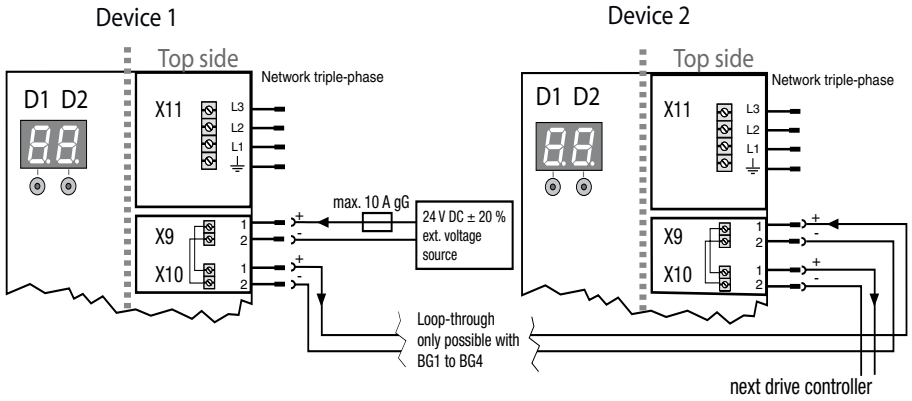

Fig. 3.11 Connection control supply BG1 to BG6a

NOTE: The connection of control supply for BG7 can be found in Fig. 3.14 on page 29.

ATTENTION! Generally apply suitable measures to provide adequate line protection.

Control supply BG1 to BG6a	
Terminal/Pin	**Specification**
X9/1 = + X9/2 = -	• U_V = 24 V DC ±20 % (BG5 to BG6a +20/-10 %), stabilized and filtered • max. starting and continuous currents see table A.4 on page 72 • Current carrying capacity of terminal continuously max. 10 A (BG5 to BG6a max. 8 A), internal polarity reversal protection • The power supply unit used must have a safe and reliable isolation towards the mains network, as per EN 50178 or EN 61800-5-1. • Internally interconnected with X10
X10/1 = + X10/2 = -	• Current carrying capacity of terminal continuously max. 10 A (BG5 to BG6a max. 8 A) • Internally interconnected with X9

Table 3.5 Specification control supply BG1 to BG6a

NOTE: With sizes BG1 to BG4 the external voltage source not only supplies the control unit, but also the output for the motor holding brake. If this output is active, the current for the control unit plus the current for the motor holding brake and additional current requirements for digital inputs and outputs flows through terminal X9. Please take this into consideration when rating the voltage source for the control unit and when looping through to other equipment. The current demand for the individual devices can be found in the appendix on page 72 in table A.15.

Control supply BG7	
Terminal/Pin	**Specification**
X44/1 = + X44/2 = -	• U_V = 24 V DC ±10 %, stabilized and filtered • max. starting and continuous currents see table A.4 on page 72 • Current carrying capacity of terminal continuously max. 10 A, internal polarity reversal protection • The power supply unit used must have a safe and reliable isolation towards the mains network, as per EN 50178 or EN 61800-5-1.

Table 3.6 Specification of control supply BG7

3.7.2 Connection of AC mains supply

Step	Action	Comment
1.	Determine the cable cross-section, depending on maximum current and ambient temperature.	Cable cross-section acc. to local and country specific regulations and conditions.
2.	Wire the drive controller according to its size and type of connection. For cable lengths in excess of 0.3 m use shielded cables!	see Fig. 3.12, Fig. 3.13 or Fig. 3.14
3.	If necessary wire the mains choke, see section 3.7.2	Reduces the voltage distortions (THD) in the net and prolongs the lifetime of the drive controller.
4.	Install a K1 circuit breaker (power circuit breaker, contactor, etc.).	Do **not yet switch on** the AC mains supply!
5.	Use mains fuses (duty class gG, see table 3.7), which will isolate all poles of the drive controller from the mains supply.	For compliance with the equipment safety act acc. to EN 61800-5-1

DANGER CAUSED BY HIGH VOLTAGE! Danger to life! Never wire or disconnect electrical connections while these are live. Always isolate the device from the mains supply before working on it. Even 30 minutes after switching off the mains supply dangerously high voltages ≥ 50 V may still be present (capacitor charge). Therefore check for isolation from supply!

ATTENTION! Should local regulations require the installation of a residual current protective device (RCD), the following applies:
In case of a fault the drive controller is able to generate DC leak currents without zero crossing. Drive controllers therefore must only be operated with residual current protective device (RCDs) type B for AC fault currents, pulsating or smooth DC fault currents, which are suitable for drive controller operation, see IEC 60755. Residual current monitoring devices (RCMs) can additionally be used for monitoring purposes.

Please note:

- Switching the mains power:
  - In case of too frequent switching the unit protects itself by high-resistance isolation from the system. After a rest phase of a few minutes the device is again ready for operation.
- TN network and TT network: Operation is permitted if:
  - with single-phase devices for 1 x 230 V AC the supply network corresponds with the maximum overvoltage category III in accordance with EN 61800-5-1.
  - with triple-phase devices with phase-to-phase voltages 3 x 230 V AC, 2 x 400 V AC, 3 x 460 V AC and 3 x 480 V AC
    1. **the neutral point** of the supply net **is grounded** and
    2. the supply net meets the requirements of the maximum overvoltage category III in accordance with EN 61800-5-1 under a system voltage (external conductor ➜ neutral point) of maximum 277 V.
- IT-network: not permitted!
  - In case of an ground fault the electrical stress is approx. twice as high. Clearances and creepages acc. to EN 61800-5-1 are no longer maintained.
- Connection of the drive controller via a mains choke is mandatory:
  - where the drive controller is used in applications with disturbance variables corresponding with environment class 3, as per EN 61000-2-4 and higher (hostile industrial environment).
  - for compliance with EN 61800-3 or IEC 61800-3, see appendix.
- For further information on current carrying capacity, technical data and environmental conditions please refer to the appendix.

NOTE: Please note that the ServoOne has not been designed for environment class 3. Further measures are mandatory in order to achieve this environment class! For further information please consult your project engineer.

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Drive controller	Device connected load[1] [kVA]		Max. cable cross-section[2] of terminal [mm²]	Specified mains fuse, duty class gG [A]
	With mains choke (4 % u_K)	Without mains choke		
SO82.004	1.6	2.2	4	1 x max. 10
SO84.004	2.8	4.0	4	3 x max. 10
SO84.006	4.2	6.0	4	3 x max. 16
SO84.008	5.9	8.3	4	3 x max. 20
SO84.012	8.8	12.5	4	3 x max. 25
SO84.016	11.1	15.0	16	3 x max. 32
SO84.020	13.9	18.7	16	3 x max. 40
SO84.024	16.6	22.5	16	3 x max. 50
SO84.032	22.2	30.0	16	3 x max. 63
	With mains choke (2 % u_K)			
SO84.045	31	*For devices of sizes BG5 to BG7 a mains choke is mandatory.*	25	3 x max. 63
SO84.060	42		25	3 x max. 80
SO84.072	50		25	3 x max. 100
SO84.090	62		50	3 x max. 125
SO84.110	76		50	3 x max. 160
SO84.143	99		95	3 x max. 200
SO84.170	118		95	3 x max. 224
SO84.250	173		*Connection via screwed on ring terminal ends.*	3 x max. 300
SO84.325	225			3 x max. 400
SO84.450	310			3 x max. 500

1) With 3 x 400 V mains voltage

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

Table 3.7 Connected load and mains fuse

NOTE: Before commissioning the value of the connected mains voltage must be set in the drive controller (factory setting = 3 x 400 V AC).

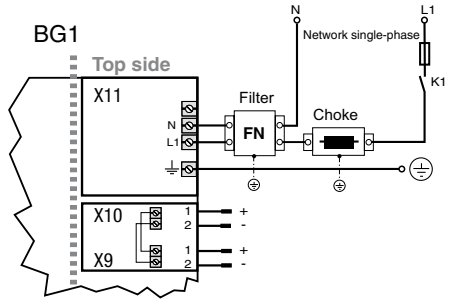

Fig. 3.12 Connection of mains supply 1 x 230 V

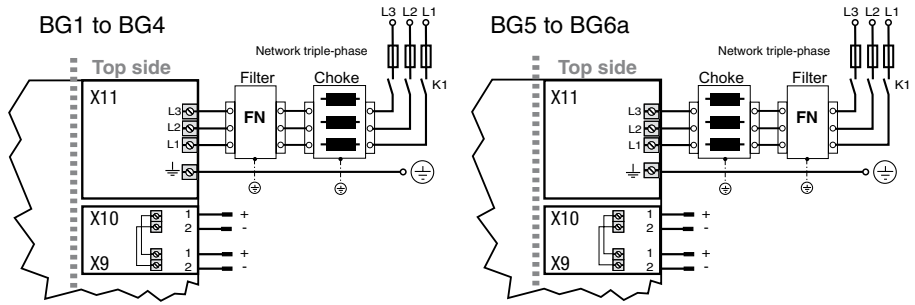

Fig. 3.13 Connection of mains supply 3 x 230/400/460/480 V for BG1 to BG6a

ATTENTION! For devices of sizes BG5 to BG7 a mains choke is mandatory. Due to the different precharging technology in these devices you must make sure that the mains choke is installed between drive controller and mains filter (see Fig. 3.13 and Fig. 3.14).

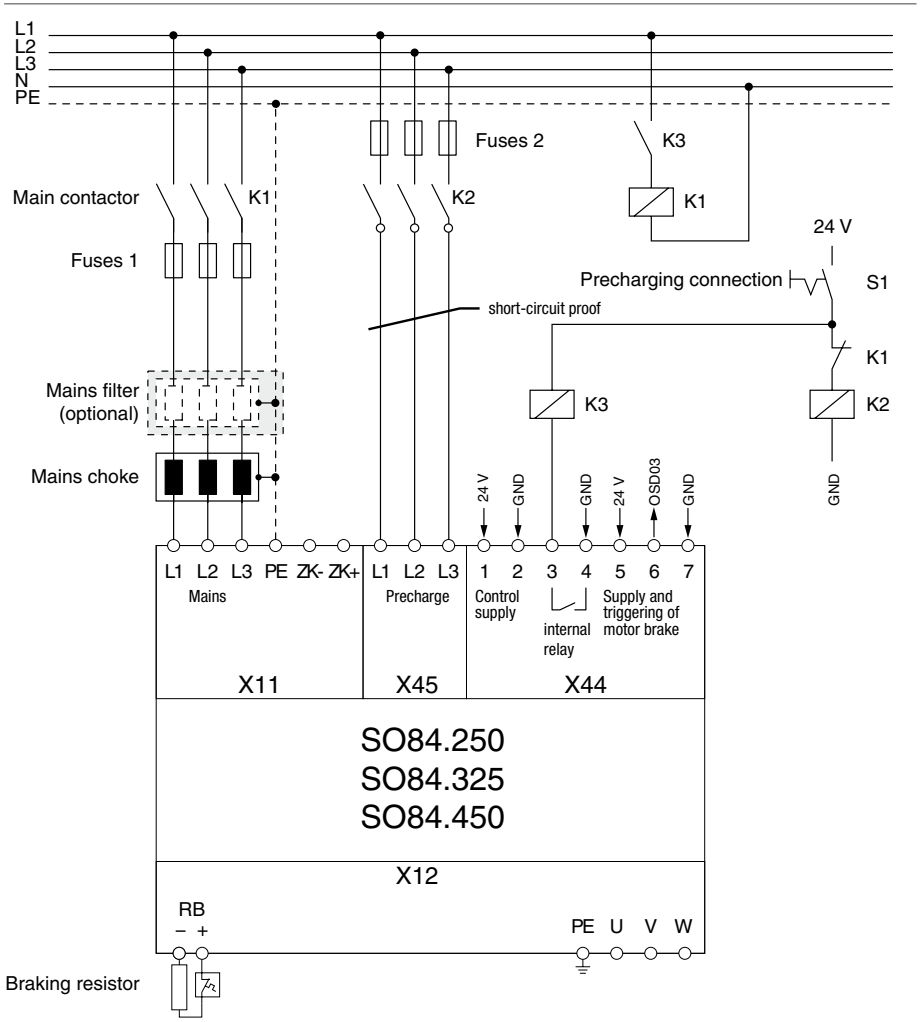

Fig. 3.14 Connection of precharge, control and mains supply 3 x 230/400/460/480 V for BG7

3.7.3 Use with mains choke

The use of mains chokes is:

- necessary with all device from and including size BG5
- necessary when using drive controllers in hostile industrial networks
- recommended to prolong the lifetime of DC link capacitors

3.7.4 Use with internal mains filter

Drive controllers BG1 to BG5 are equipped with integrated mains filters. With the measuring methods specified in the standard these drive controllers comply with the EMC safety-related requirements specified in IEC 61800-3 for "Environment 1" (residential area C2) and "Environment 2" (industrial area C3). More detailed information see section A.6 "Mains filter", page 74.

ATTENTION! This is a restricted availability product in accordance with IEC 61800-3. In living areas this product may cause radio interference; in this case the operator may be forced to apply appropriate measures.

3.7.5 Use with external mains filter

External radio interference suppression filters (EMCxxx) are available for the drive controllers for BG6 and BG6a. With the specified measuring method and the external mains filter these drive controllers also ensure compliance with the EMC product standard EN 61800-3 für "Environment 1" (residential areas C2) and "Environment 2" (industrial area C3).

The question of whether size BG7 requires an external mains filter depends on the type of connection and the local conditions. For this reason the use of a mains filter must always considered individually and within the scope of a project.

In order to reach the use of longer motor cables and compliance with the EMC product standard IEC 61800-3 for the "general availability" (residential area C1), additional external mains filters are available for the devices with internal mains filters (BG1 to BG5).

3.7.6 Terminal diagram precharge (only BG7)

Designation	Specification		
	SO84.250	SO84.325	SO84.450
Fuses 1	250 A	315 A	400 A
Fuses 2, slow-blowing	6 A		
Mains filter (optional)	220 A	300 A	400 A
Mains choke (U_K = 2 %)	250 A	325 A	450 A
K1	225 A/ 110 kW / 230 V (e.g. Siemens 3RT10 64-6AP36)	300 A/ 160 kW / 230 V (e.g. Siemens 3RT10 66-6AP36)	400 A/ 200 kW / 230 V (e.g. Siemens 3RT10 75-6AP36)
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)		

Recommended data for operation with asynchronous machine

Table 3.8 Specification of connection periphery

Wire the precharge circuitry as shown in Fig. 3.14 as per standard with short-circuit proof cables. The connected loads of the internal relay for terminals X44/3, 4 are U_{max} = 30 V DC, I_{max} = 6 A. You should therefore use a contactor relay K3.

Control sequence

- **Precharge of DC link**
  Switch S1 "Mains supply On" is switched on. The precharging contactor K2 closes and the DC link is precharged via internal precharging resistor on terminal X45. The main contactor K1 remains open for the time being.
- **Precharging completed**
  At a defined DC link voltage the contact of the internal relay on terminal X44/3,4 is closed. The contactor relay K3 closes and connects the main contactor K1. The precharging contactor K2 is opened via an auxiliary contact (normally closed contact) on K1. The ServoOne changes to standby.
- **Switching off**
  The switch S1 "Mains supply Off" completely disconnects the drive controller from the mains supply.

3.8 Control connections

Step	Action	Comment
1.	Check whether a complete device setting is already available, i.e. whether the drive has already been projected.	
2.	If this is the case, a special control terminal assignment applies. Please contact your project engineer to obtain the terminal assignment.	
3.	Choose a terminal assignment.	
4.	Wire the control terminals with shielded cables. The following is strictly required: ISDSH (X4/22) and ENPO (X4/10)	Ground the cable shields over a wide area at both ends. Conductor sizes: 0.2 to 1.5 mm², in case of ferrules with plastic sleeves max. 0.75 mm²
5.	Keep all contacts still open (inputs inactive)!	
6.	Check all connections once again!	

3.8.1 Specification of control connections

Des.	Terminal	Specification	Electrical isolation
Analog inputs			
ISA0+ ISA0- ISA1+ ISA1-	X4/3 X4/4 X4/5 X4/6	• U_{IN} = ±10 V DC • Resolution 12 bit; R_{IN} approx.101 kΩ • Terminal sampling cycle in "IP mode" = 125 µs, otherwise = 1 ms • Tolerance: U ±1 % of the measuring range end value	no
Digital inputs			
ISD00 ISD01 ISD02 ISD03 ISD04	X4/15 X4/16 X4/17 X4/18 X4/19	Standard input • Frequency range < 500 Hz • Sampling cycle: 1 ms • Switching level low/high: ≤ 4.8 V / ≥ 18 V • I_{max} at 24 V = 3 mA typ.	yes
ISD05 ISD06	X4/20 X4/21	Touch probe or standard input • Touch probe for quick saving of process data (e.g. actual position) – Internal signal delay ISD05 ↑: Min. 3 µs, Max. 16 µs, Type 8 µs ISD05 ↓: Min. 4 µs, Max. 27 µs, Type 15 µs ISD06 ↑↓: Type < 2 µs – Activation via ISD05/ISD06 = 15 (PROBE) • Standard input – Frequency range ≤ 500 kHz – Sampling cycle: 1 ms • Switching level low/high: ≤ 4.8 V / ≥ 18 V • ISD05: I_{max} at 24 V = 3 mA • ISD06: Imax at 24 V = 10 mA typ., RIN = 3 kΩ typ.	yes
ENPO (STO)	X4/10	• Request input STO • Deactivation of the restarting lock (STO) and release of the power stage = High-Level • Frequency range < 500 Hz • Reaction time approx. 10ms • Switching level low/high: ≤ 4.8 V / ≥ 18 V • for 24 V typ. 3 mA	yes

X4

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

Table 3.9 Specification of control connections X4

Des.	Terminal	Specification		Electrical isolation
Digital outputs				
OSD00 OSD01 OSD02	X4/7 X4/8 X4/9	• no destruction in short-circuit incidents (+24 V -> GND), however, the device may switch off for a moment. • I_{max} = 50 mA, PLC-compatible • Terminal sampling cycle = 1 ms • High-side driver		yes
STO ("Safe Torque OFF")				
ISDSH (STO)	X4/22	• Request input STO • Frequency range < 500 Hz • Switching level low/high: <4.8 V / >18 V • for 24 V typ. 3 mA		yes
RSH RSH	X4/11 X4/12	Diagnose STO, both tripping channels active, one normally open contact with automatically resetting circuit breaker (polyswitch) • 25 V / 200 mA AC, cos φ= 1 • 30 V / 200 mA DC, cos φ= 1	X4/12 X4/11	yes
Relay outputs				
REL	X4/23 X4/24	Relay, 1 normally open • 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 supply				
+24 V	X4/2 X4/14	• Auxiliary supply to feed the digital control inputs • $U_H = U_V$-ΔU (ΔU typically approx. 1.2 V), no destruction in short-circuit incidents (+24 V -> GND), however, device may switch off for a short time. • 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) with self-resetting circuit breaker (polyswitch)		yes

X4

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

Table 3.9 Specification of control connections X4

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NOTE: **High-resistance isolation to device ground**
With too high currents flowing through the ground terminals a high resistance isolation from the device ground is possible. This can lead to malfunction of the drive. To prevent this, you must avoid circulating currents in the wiring.

3.8.2 Brake driver

On BG1 to BG4 plug X13 serves the purpose of connecting a motor brake.

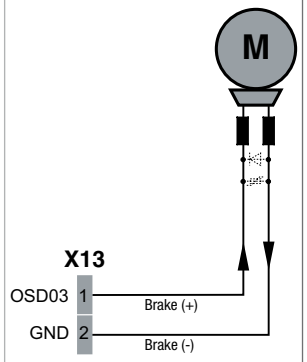
Des.	Terminal	Specification	Connection
OSD03 GND	X13/1 X13/2	• Short-circuit proof • Voltage supply through control supply U_V to X9/X10. • $U_{BR} = U_V - \Delta U`$ ($\Delta U`$ typically approx. 1.4 V) • To trigger a motor holding brake of up to I_{BR} = 2.0 A max., for brakes with higher current requirements a relay must be connected in series. • Overcurrent causes shut down • Can also be used as configurable digital output. • Interruptible cable breakage monitoring < 500 mA typically in condition "1" (up to relay).	

Table 3.10 Specification of terminal connections X13 (BG1 to BG4)

On BG5 to BG6a plug X20 serves the purpose of connecting a motor brake.

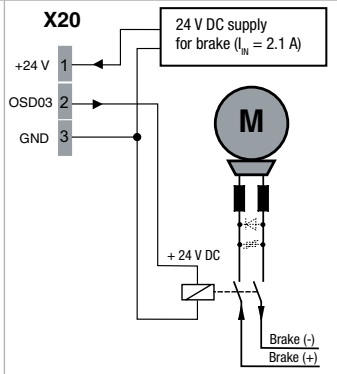
Des.	Terminal	Specification	Connection
+24 V OSD03 GND	X20/1 X20/2 X20/3	• Short-circuit proof • External voltage supply 24 V (I_{IN}= 2.1 A) required • To trigger a motor holding brake of up to I_{BR} = 2.0 A max., for brakes with higher current requirements a relay must be connected in series. • Overcurrent causes shut down • interruptible cable breakage monitoring < 200 mA typically in condition "1" (up to relay)	

Table 3.11 Specification of terminal connections X20 (BG5 to BG6a)

On BG7 plug X44 serves the purpose of connecting a motor brake.

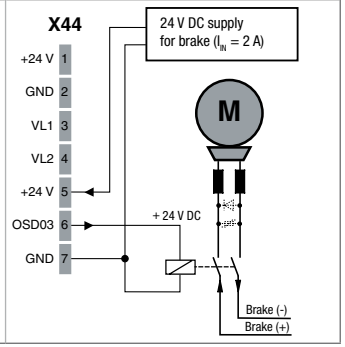
Des.	Terminal	Specification	Connection
+24 V OSD03 GND	X44/5 X44/6 X44/7	• Short-circuit proof • External voltage supply 24 V (I_{IN}= 2.1 A) required • To trigger a motor holding brake of up to I_{BR} = 2.0 A max., for brakes with higher current requirements a relay must be connected in series. • Overcurrent causes shut down • Interruptible cable breakage monitoring < 200 mA typically in condition "1" (up to relay)	

Table 3.12 Specification of terminal connections X44 (BG7)

3.9 Specification USB-interface

The service and diagnostics interface X2 has been realized as USB V1.1-interface. It is solely intended for connecting a PC for commissioning, service and diagnostics with the software DriveManager 5.

Technical specification:

- USB 1.1 Standard - full speed device interface
- Connection via conventional USB-interface cable type A to type B (see also ServoOne system catalogue)

3.10 Specification Ethernet interface

The service and diagnostics interface X3 has been realized as Ethernet interface. It is solely intended for connecting a PC for commissioning, service and diagnostics with the software DriveManager 5.

Technical specification:

- Transfer rate 10/100 MBits/s BASE-T
- Line protocol IEEE802.3 compliant
- Connection via conventional Crosslink cable (see also ServoOne system catalogue)

3.11 Option 1

Depending on the ServoOne design variant, option 1 is provided with various options ex-factory. Field bus options like e.g. EtherCAT or SERCOS are available.

All available options can be found in the ServoOne system catalogue. The user manual for the respective option contains detailed information on commissioning.

3.12 Option 2

Option 2 can be fitted with various technological options in the factory. As an example, additional or special encoders can be evaluated.

All available options can be found in the ServoOne system catalogue. The user manual for the respective option contains detailed information on commissioning.

3.13 Encoder connection

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

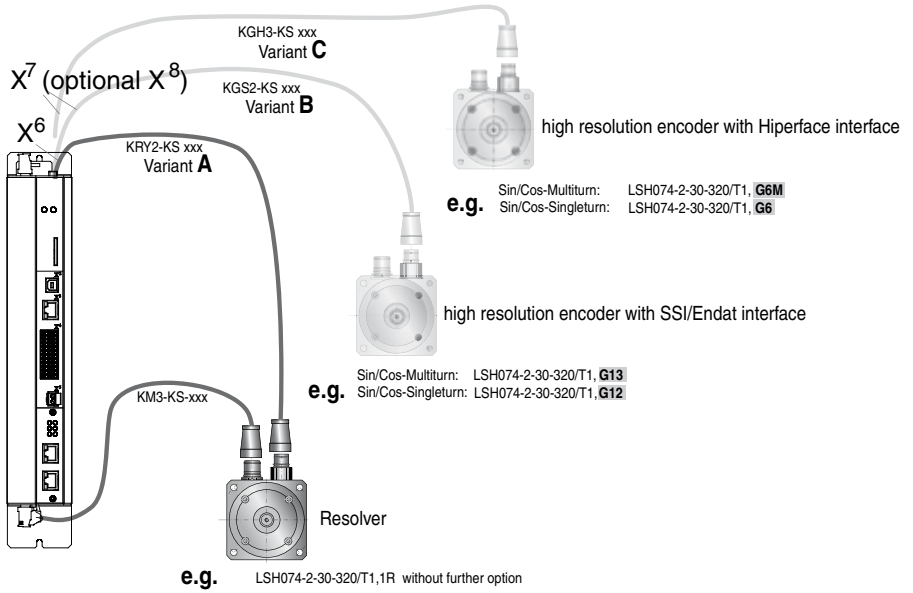


Fig. 3.15 Assignment motor/encoder cable

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3.13.1 Encoder connection on LSH/T-motors

For connecting the LSH/T synchronous motors please use the prefabricated motor and encoder cables from LTi DRiVES GmbH.

3.13.2 Assignment of motor-/encoder cable to drive controller

Compare the type plates on the components. Make absolutely sure to use the correct components according to a variant A, B or C!

	Motor (with integrated encoder)	Encoder cable	Connection of drive controller
Variant A	with resolver e.g. LSH/LST H074-2-30-320/T1, 1R without further options	KRY2-KSxxx	X6
Variant B	G13: = Sin/Cos multiturn encoder with SSI/EnDat-interface e.g. LSH/LST H074-2-30-320/T1, G13	KGS2-KSxxx	X7
	G12: = Sin/Cos single turn encoder with SSI/EnDat-interface e.g. LSH/LST H074-2-30-320/T1, G12	KGS2-KSxxx	X7
Variant C	G6: = Sin/Cos single turn encoder with HIPERFACE® interface e.g. LSH/LST H074-2-30-320/T1, G6	KGH3-KSxxx	X7
	G6M: = Sin/Cos multiturn encoder with HIPERFACE® interface e.g. LSH/LST H074-2-30-320/T1, G6M	KGH3-KSxxx	X7

Table 3.13 Variants of motors, encoder type and encoder cable

NOTE: Do not split the encoder cable, for example to route the signals via terminals in the control cabinet. The knurled screws on the D-Sub plug housing are tightly locked!

3.13.3 Prefabricated encoder cables

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

		K	RY2	-	KS	xxx
Prefabricated cable						
Encoder system	*Resolver cable*		RY2			
	Encoder cable SSI, EnDat		GS2			
	Encoder cable HIPERFACE®		GH3			
Festoon compatible					KS	
Cable length (m)						

Encoder cable KRY2-KS-xxx Order code

Technical data

	KRY2-KSxxx	KGS2-KSxxx	KGH3-KSxxx
Motors with encoder system	Resolver	G3, G5, G12.x (single- / multiturn encoders with SSI-/ Endat interface)	G6, G6.x (single- / multiturn encoders with HIPERFACE® interface)
Assignment on controller side (Sub-D-plug)	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.
Festoon compatible	yes		
Minimum bending radius	90 mm	100 mm	90 mm

Table 3.14 Technical data encoder cable

	KRY2-KSxxx	KGS2-KSxxx	KGH3-KSxxx
Temperature range	-40 ... +85 °C	-35 ... +80 °C	-40 ... +85 °C
Cable diameter approx.	8.8 mm		
Material of oversheath	PUR		
Resistance	against oil, hydrolysis and microbial activity (VDE0472)		
Certifications	UL-Style 20233, 80 °C - 300 V, CSA-C22.2N.210-M90, 75 °C - 300 V FT1		

Table 3.14 Technical data encoder cable

3.13.4 Resolver connection

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

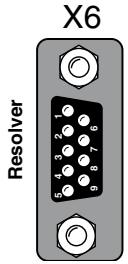
Fig.	X6/Pin	Function
	1	Sin+ / (S2) analog differential input track A
	2	Refsin / (S4) analog differential input track A
	3	Cos+ / (S1) analog differential input track B
	4	Supply voltage 5..12 V, internally connected with X7/3
	5	ϑ+ (PTC, KTY, Klixon) 1)
	6	Ref+ analog excitation
	7	Ref- analog excitation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

Table 3.15 Pin assignment X6

[1] ATTENTION! The motor PTC (also KTY and Klixon) must be designed with reinforced insulation acc. to EN 61800-5-1 against the motor winding.

3.13.5 Connection for high resolution encoders

The interface X7 enables the evaluation of the following encoder types.

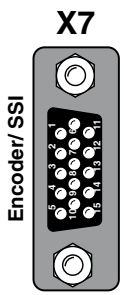
Fig.	Function
	**Sin/Cos encoder with index signal:** • e.g. Heidenhain ERN1381, ROD486 • U_V = 5 V ±5 %, I_{max} = 150 mA
	Heidenhain Sin/Cos encoder with EnDat 2.1-interface: • e.g. 13 bit single turn encoder (ECN1313.EnDat01) and 25 bit multiturn encoder (EQN1325-EnDat01) • U_V = 5 V ±5 %, I_{max} = 150 mA
	Sin/Cos encoder with SSI interface: • e.g. 13 bit single turn and 25 bit multiturn encoders (ECN413-SSI, EQN425-SSI) • U_V = 5 V ±5 %, I_{max} = 150 mA
	Sick-Stegmann Sin/Cos encoder with HIPERFACE® interface: • Single and multiturn encoders, e.g. SRS50, SRM50 • U_V = 7 to 12 V (typ. 11 V) ±5 %, I_{max} = 100 mA

Table 3.16 Suitable encoder types on X7

NOTE: Encoders with a voltage supply of 5 V ± 5 % must have a separate encoder cable connection. The encoder cable serves the detection of the actual supply voltage on the encoder, whereby a compensation of the voltage drop on the cable is achieved. Only the use of the encoder cable assures that the encoder is supplied with the correct voltage. The encoder line must always be connected.

Electrical specification of the interface X7:

Select the cable type specified by the motor or encoder manufacturer. Thereby please observe the following boundary conditions:

- Always used shielded cables. The shielding must be placed on both sides of the cable.
- Connect the differential track signals A, B, R or CLK, DATA to each other via twisted wires.
- Do not separate the encoder cable, for example to route the signals via terminals in the control cabinet.

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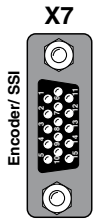
Fig.	X7/Pin	Function Sin/Cos	Absolute encoder SSI/ EnDat 2.1	Absolute encoder HIPERFACE®
	1	A-	A-	REFCOS
	2	A+	A+	+COS
	3	+5 V, ±5 % at 150 mA monitoring via sensor line		7 to 12 V / (typically 11 V) max. 100 mA
	4	-	Data +	
	5	-	Data -	
	6	B-	B-	REFSIN
	7	-	-	U_S - Switch
	8	GND	GND	GND
	9	R-	-	
	10	R+	-	
	11	B+	B+	+SIN
	12	Sense +		U_S - Switch
	13	Sense +		-
	14	-	CLK+	-
	15	-	CLK -	-

After connecting pin 7 and pin 12 a voltage of 11 V will be applied to X7, pin 3!

Table 3.17 Pin assignment of plug connection X7

NOTE: The encoder supply on X7/3 is short-circuit proof in both 5 V and 11 V operation.

3.14 Motor connection

Step	Action	Comment
1.	Determine the cable cross-section, depending on maximum current and ambient temperature.	Cable cross-section acc. to local and country specific regulations and conditions.
2.	Connect the shielded motor cable to the terminals X12/ U, V, W and connect the motor to ground ⏚.	Mount screen at both ends to reduce interference emission. Fasten the shield connecting plate of the motor connection X12 with **both** screws.
3.	Wire the temperature sensor PTC (if available) to X5 with separately shielded cables and activate the temperature evaluation via DriveManager 5.	Mount screen at both ends to reduce interference emission.

ATTENTION!

- The temperature sensor connection can also be routed through the resolver line to X6/5 and 9. However, this requires a reinforced insulation acc. to EN 61800-5-1 between PTC and motor winding (e.g. LSH/LST-motor).
- For the connection X5 it must be assured that the temperature watchdog used is equipped with a basic insulation acc. to EN 61800-5-1 against the motor winding.

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

3.14.1 Motor connection on LSH/LST-motors

NOTE: Please use a prefabricated motor cable to connect servo motors of series LSH xxx and LST xxx.

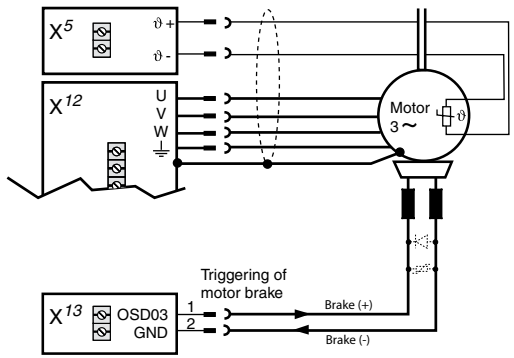


Fig. 3.16 Connection of motor for BG1 to BG4

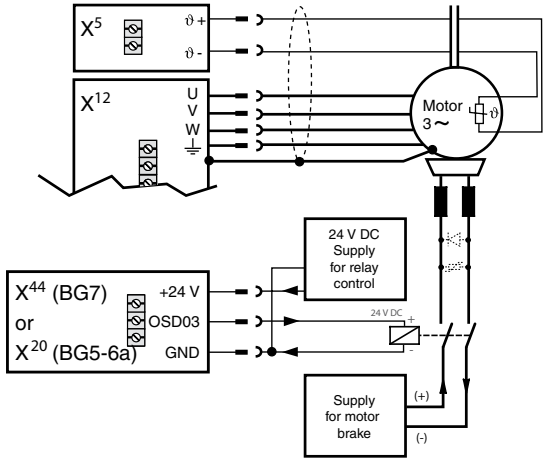


Fig. 3.17 Connection of motor for BG5 to BG7

3.14.2 Prefabricated motor cable

Motor cable KM3-KSxxx

		KMx	- KS	xxx	- xxx
Prefabricated motor cable	4 + 2 x 2 cores	3			
	4 cores	4			
Festoon compatible			KS		
Cable length	in metres				
Motor cable	to I_0 = 16 A				-
	to I_0 = 24 A (only KM3)				24 A
	to I_0 = 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 pluggable power connection		up to I_N = 16 A	up to I_N = 24 A	up to I_N = 63 A
Minimum bending radius	for stationary routing	60 mm	75 mm	110 mm
	for flexible applications	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
Material of oversheath		PUR		
Resistance		oil, hydrolysis and microbe resistant (VDE0472), UL 20233, 80 °C - 300 V		
Assignment of strands		U = 1 V = 2 W = 3 Ground = ye/gn PTC = 5 PTC = 6 Brake + = 7 Brake - = 8		
Certification		UL-Style 20234, 80 °C - 1000 V, CSA-C22.2N.210-M90, 80 °C - 1000 V FT1		

Table 3.18 Technical data motor cable

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NOTE: Strands 5 and 6 (PTC) are only required for motors with optical sensors (G12, G13, G6, G6M). On the LSH/LST xxx motors with resolver PTC-monitoring is connected via the resolver cable.

3.14.3 Switching in the motor cable

ATTENTION! Switching in the motor cable must generally take place in de-energized state and with deactivated power stage, as otherwise problems, such as burned off contactor contacts, will occur. In order to assure de-energized switching on you must make sure that the contacts of the motor contactor are closed before the drive controller power stage is released. In the moment the contactor switches off the contacts must remain closed, until the drive controller power stage has been switched off and the motor current has dropped to 0. This can be achieved by providing the control sequence of your machine with appropriate safety periods for the switching of the motor contactor.

However, despite these measures it cannot be ruled out, that the drive controller will malfunction when switching in the motor cable.

3.15 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 a threshold value, the internal brake chopper transistor is activated and a braking resistor converts the regenerated power into heat.

3.15.1 Protection in case of a brake chopper fault

ATTENTION! If the internal brake chopper transistor is permanently switched on, because it is alloyed through by overload (= 0 Ω), there is a protective function to protect the device against overheating.

You activate this function via DriveManager 5 by assigning "BC_FAIL(56)" to any digital output (expert field “Inputs/outputs” -> “Digital outputs” -> OSD00 to OSD02). In case of a fault the selected output will switch from 24 V to 0 V. This signal ensures that the drive controller is safely disconnected from the mains supply.

Detailed information on parameterization can be found in the ServoOne user manual.

3.15.2 Design with integrated braking resistor

The catalogue only specifies the peak braking power for the drive controller with integrated braking resistor (design SO8x.xxx.xxxx.1xxx, only available up to and including BG4). The permissible permanent braking power must be calculated. It depends on the effective loading of the controller in the corresponding application.

ATTENTION! No additional external braking resistor must be connected to the drive controller SO84.008 to SO84.032 with integrated braking resistor.

In general the drive controller is thermally designed in such a way, that no energy input by the internal braking resistor is permitted during continuous operation with rated AC current and under max. ambient temperature.

Thus the controller design with integrated braking resistor only makes sense, if the effective drive controller load is ≤ 80 %, or the braking resistor has been planned for one-time emergency stopping. In case of an emergency stop the heat capacity of the braking resistance can only be utilized for a single braking operation. The permissible energy W_{IBr} can be taken from the following table.

Device	Technology	Rated resistance R_{BR}	Peak braking power P_{PBr}	Pulse energy W_{IBr}	K1
SO82.004	PTC	90 Ω	1690 W[1)]	600 Ws	95 W
SO84.004 SO84.006			1690 W[2)]		95 W
SO84.008 SO84.012	Wire resistance		4700 W[3)]	6000 Ws	230 W
SO84.016 SO84.020			6170 W[4)]		360 W
SO84.024 SO84.032			6500 W[5)]		480 W

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

Table 3.19 Data of the integrated braking resistor (design 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: Further calculation assumes that the drive controller is used at max. permissible ambient temperature. This means that any additional energy input from the internal braking resistor caused by low ambient temperature will be neglected.

To calculate the continuous braking power please proceed as follows:

- Calculation of the effective drive controller utilization during a cycle T:

$$I_{eff} = \sqrt{\frac{1}{T}\int_0^T i^2\,dt}$$

- Determination of the permissible continuous braking power on basis of unused drive power:

$$P_{DBr} = \left(1 - \frac{I_{eff}}{I_N}\right) \times K1$$

Boundary conditions

- A single braking process must not exceed the maximum pulse energy of the braking resistor.

$$W_{IBr} \geq P_{PBr} \times T_{Br}$$

- The continuous braking power calculated for the device must be greater than the effective braking power of a device cycle.

$$P_{DBr} \geq \frac{1}{T} \times \int_0^T P_{PBr}\,dt_{Br}$$

This results in the minimum permissible cycle time T with calculated continuous braking power:

$$T = \frac{P_{PBr}}{P_{DBr}} \times \int_0^T dt_{Br}$$

The maximum total switch-on time of the braking resistor over a specified cycle time T with calculated continuous braking power results from:

$$T_{BrSum} = \frac{P_{DBr}}{P_{PBr}} \times T$$

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3.15.3 Connection of an external braking resistor

DANGER CAUSED BY HIGH VOLTAGE! Danger to life! Terminal L+ (BG1 to BG4) or BR+ (BG5 to BG7) is fixed connected to DC link (> 300 V DC). The connection is not fuse protected inside the device. Never wire or disconnect electrical connections while these are live! Always isolate the device from the mains supply before working on it. Even 30 minutes after switching off the mains supply dangerously high voltages of ≥ 50 V may still be present (capacitor charge). Therefore check for isolation from supply!

ATTENTION!

- Strictly follow the assembly instructions for the braking resistor.
- The temperature sensor (bimetal switch) on the braking resistor must be wired in such a way, that the power stage is deactivated and the connected servo controller is disconnected from the mains supply if the braking resistor overheats.
- The minimum permissible connection resistance of the servo controller must not be fallen short of, technical data see section A.2 starting with page 66.
- The braking resistor must be connected with a shielded cable.

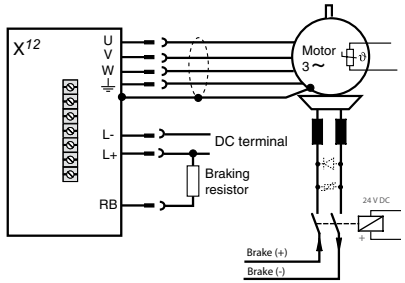
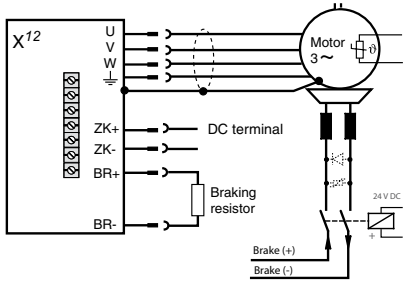
Size BG1 to BG4	Size BG5 to BG7
	

Fig. 3.18 Connection of braking resistor

ATTENTION! No additional external braking resistor must be connected to the drive controller SO84.008 to SO84.032 with integrated braking resistor.

Available braking resistors (excerpt)

Ordering designation	Continuous braking power	Resist-ance[1]	Peak braking power [2]	Degree of protection	Illustration
BR-090.01.540,UR	35 W	90 Ω	6250 W	IP54	 Example: BR-090.01,540,UR
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	

1) Tolerance ±10 %
2) the maximum possible braking power in dependence on ON-time and cycle time

Table 3.20 Technical data - braking resistors

NOTE: Exact specifications, especially with respect to surface temperature, max. connection voltage and high voltage strength can be found in the ServoOne system catalogue.

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

4. Commissioning

4.1 Notes for operation

ATTENTION!

- **Notes on safety**
  During operation pay attention to the notes on safety in chapter 1.
- **During operation**
  Strictly avoid that ...
  – foreign objects or moisture enters into the device
  – aggressive or conductive substances are in the vicinity
  – ventilation openings are covered
- **Cooling**
  – The device heats up during operation and the temperature on the heat sink may reach 100 °C. Danger of skin injury when touching.
  – Cooling air must be able to flow through the device without restriction.

4.2 Initial commissioning

Once the ServoOne has been installed as described in chapter 2. and wired with all required voltage supplies and external components as described in chapter 3., initial commissioning can performed in the following sequence:

Step	Action	Comment
1.	Installation and start of PC software	see installation manual DriveManager 5
2.	Switching on control voltage	see section 4.2.1
3.	Connection between PC and drive controller	see section 4.2.2
4.	Parameter setting	see section 4.2.3
5.	Drive control with DriveManager 5	see section 4.2.4

NOTE: Details concerning STO (Safe Torque Off) have not been taken into account for initial commissioning, see chapter 6.

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4.2.1 Switching on control voltage

2. First only switch on the 24 V control voltage for initializing and parameterizing. Do **not** yet switch on the AC mains supply.

Display reading after switching on the control voltage

D1	D2	Action	Explanation
		Switching on the external 24 V control voltage	Initialization is running
		Initialization completed	Not ready for starting

Table 4.1 Switch-on status of the ServoOne (after connection of the 24 V DC control supply)

NOTE: Details concerning the control voltage can be found in section 3.7 “Connection of supply voltages“ starting at page 26.

4.2.2 Connection between PC and drive controller

3. The PC can be linked with the drive controller via USB or Ethernet (TCP/IP). Connect PC and drive controller with the required connecting cable.

NOTES:

- **Initialization**
  The communication link between PC and drive controller can only be set up after the drive controller has completed the initialization.
- **USB driver and TCP/IP configuration**
  If the PC does not recognize the connected drive controller you should check the driver or the settings for the corresponding interfaces (see installation manual DriveManager 5).

4.2.3 Parameter setting

4. The Commissioning Wizard in DriveManager 5 helps to make settings to the drive system. Start the wizard.

NOTES:

- **Online help**
  A detailed description of DriveManagers 5 as well as the commissioning wizard can be found in the DriveManager 5 Online help.
- **Motor dataset**
  When using LTi servo motors type LSH or LST the latest version of the required motor dataset can be downloaded from http://drives.lt-i.com, category “Downloads”.

4.2.4 Drive control with DriveManager 5

5. Switch on the AC mains supply. Subsequently enable the power stage and activate the controller. The drive should be tested without the coupled mechanics.

DANGER CAUSED BY ROTATING PARTS! Danger to life from uncontrolled rotation! Before starting motors with feather keys in the shaft end these must be reliably secured against being ejected, as far as this is not already prevented by drive elements such as belt pulleys, couplings or similar.

ATTENTION!

- **Avoid damage caused by motor test run!**
  In this case it must be assured that the test will not cause any damage to the system! Pay particular attention to the limitations of the travel range. Please note that you yourself are responsible for safe operation.
  LTi DRiVES GmbH will not assume liability for any occurring damage.

- **Destruction of motor!**
  - Certain motors are intended for operation on the drive controller. Direct connection to the mains supply can destroy the motor.
  - The motor surfaces may become extremely hot. No temperature sensitive parts may touch or be mounted to these areas, appropriate measures to prevent contact must be applied wherever necessary.
  - In order 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 fault-free functioning before commissioning of the motor. Standstill holding brakes are only designed for a limited number of emergency braking operations. Use as working brake is strictly prohibited.

Display reading after switching on the AC mains supply

D1	D2	Action	Reaction	Explanation
		Switching on the AC mains supply	Control ready, power stage ready, control deactivated	Device is ready for switching on

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

NOTES:

- **Inputs "ISDSH" and "ENPO"**
  For step 1 in table 4.3 at least the two inputs "ISDSH" and "ENPO" for terminal X4 must be interconnected.
- **Manual operation dialog**
  Perform step 2 in table 4.3 best via the "Manual operation" dialog of DriveManager 5, details can be found in the Online help.
- **Configuration of inputs/outputs**
  If step 2 is to be executed via the inputs of terminal X4, the sources for "START CONTROL" and speed setpoint must be configured accordingly in the subject area "Inputs/Outputs" of DriveManager 5.

Switching on sequence to start the drive

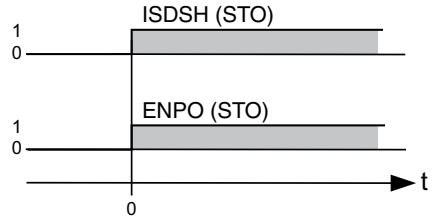
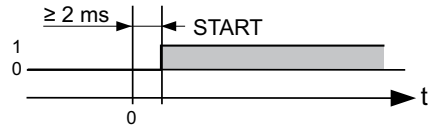
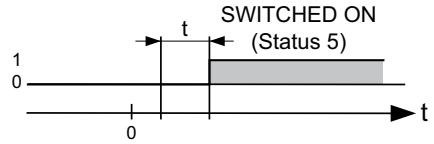
1. Deactivate the safety function "STO" by setting the inputs "ISDSH" and "ENPO" (see chapter 6.)	
2. Activate "START CONTROL" at the earliest 2 ms after step 1 and specify the speed setpoint	
3. Monitor your system or plant and check the drive behaviour.	
t = motor dependent delay time	

Table 4.3 Switching on sequence

Display reading after start of drive

D1	D2	Action	Reaction	Explanation
		Enable "STO" and power stage "ENPO"	Ready for switching on	Power stage ready
		ATTENTION! Before the next step "Enable start" you must specify a plausible setpoint, because the pre-set setpoint is transferred to the drive directly after the motor control has started.		
		"Start" enabled	Switched on	Motor energized, control active

Table 4.4 Display D1/D2 during activation of motor

Details for optimizing the drive on your application can be found in the DriveManager 5 Online help and in the ServoOne application manual.

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4.3 Serial commissioning

An existing parameter dataset can be transferred to other ServoOne drive controllers by using DriveManager 5 or a MMC-card. Details can be found in the DriveManager 5 Online help or in section 4.4 (following page).

NOTE: iPlc programs can only be loaded to a ServoOne drive controller by using the programming software CoDeSys.

4.4 Integrated control unit and MMC-card

The device internal control unit enables diagnosing the ServoOne. Moreover, using the MMC-card eases series commissioning without PC. The control unit consists of the following elements, which are all located on the front of the device.

- 2-digit 7-segment display (D1, D2)
- two buttons (T1, T2)
- MMC-Slot (X1)
  You can use MMC*plus* cards with 128 MB to 1 GB memory and 3.3 V supply voltage (e.g. LTi DRiVES type SC-MMC128, see also ServoOne system catalogue).

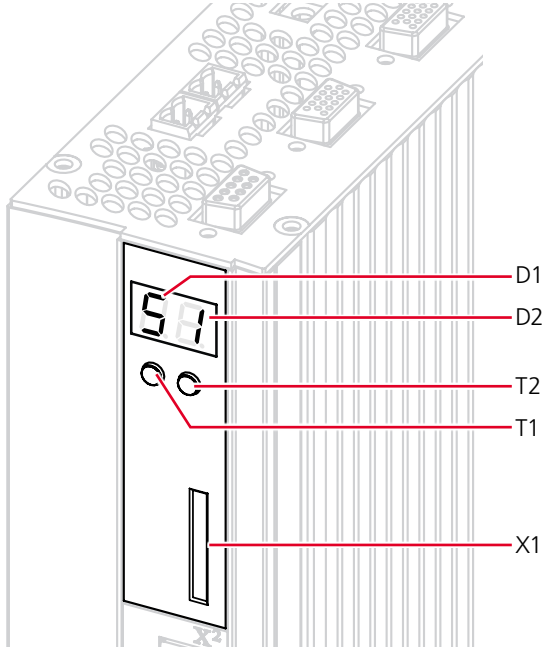

Fig. 4.1 Integrated control unit

The following functions or displays are available:

- Display of device status (see section 5.1.1 from page 51)
  The device status is displayed after the control voltage has been switched on. If no input is made via the keyboard over a period of 60 seconds, the display returns to the device status display.
- Display of device error status (see section 5.1.2 from page 51)
  If a device error occurs the display will immediately change over an display the error code.
- Parameter setting (display "PA") (see section 4.4.3 from page 47)
  To reset the device parameterization to factory settings as well as dataset handling via MMC-card
- Ethernet IP-address setting (display "IP") (see section 4.4.4 from page 48)
  To set the Ethernet IP-address as well as the subnet mask
- Field bus settings (display "Fb") (see section 4.4.5 from page 49)
  To set e.g. the field bus address
- Firmware update with MMC-card (see section 4.4.6 from page 50)

4.4.1 Function of buttons T1 and T2

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

Key	Function	Comment
T1 (left)	• Activation of menu (exit the device status display) • Scrolling through the menus/ sub-menus • Setting of values - left segment display (D1)	The button T1 can be held depressed for any time, because the display will only scroll through the menu options of the corresponding level. No settings will be changed.
T2 (right)	• Selection of chosen menu • Setting of values - right segment display (D2)	The button T2 must **not** be held depressed 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	When pressing T1 and T2 at the same time, the accepted value will be flashing for five seconds. During this time the Save procedure can still be aborted by pressing any button, without the set value being accepted. Otherwise the new value will be saved after 5 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 over a period of 60 seconds, the display returns to the device status display.

Table 4.5 Function of buttons T1 and T2

4.4.2 Display

The following table defines various displays and status information about the display.

Display	Meaning
	Menu entries ("PA" in this case serves as an example, further possible entries see sections 4.4.4 and 4.4.5)
	[flashing decimal points] Selected function in action (e.g. writing/reading the MMC-card)
	[two dashes] Entry/function not available
	[OK] Action executed successfully, no errors
	[Error] • Action via control unit **not** executed successfully, "Er" flashes in alternation with error number (see section 4.4.3) • Display device error, "Er" flashes in alternation with error number and error location (see "ServoOne application manual")
	Numerical values ("10" in this case serves as an example) • In the parameter menu (PA) dataset and error numbers are shown as **decimal**. • All other values are displayed in **hexadecimal** mode. In these cases the displayed 10 would represent the decimal value 16.

Table 4.6 Meaning of display

NOTE: If no input is made via the keyboard over a period of 60 seconds, the display returns to the device status display.

4.4.3 Parameter menu (PA)

In the parameter menu the following functions are available:

- Reset the device setting to the factory setting
- Dataset handling with the MMC-card

NOTES:

- MMC operation is only possible if the power stage is **not** active.
- Accessing attempts to the MMC can take up to 2 minutes. Both decimal points are flashing during this time.

Menu level 1	Menu level 2	Para-meter	Value range	Meaning	Explanation
PA	Pd	-	00..99	Parameter download *)	100 datasets (0..99) can be read from *path: \PARA\TRANSFER\PDSxx.dmd* (xx = 00.99) from the MMC.
	Pu	-	00..99	Parameter upload *)	100 datasets (0..99) can be saved to the MMC in the directory *\PARA\TRANSFER\PDSxx.dmd*. The directory is automatically created. Existing datasets can be overwritten.
	Pr	-	-	Parameter reset	To reset device settings to factory setting
	Pc	-	-	Parameter clear	To delete all datasets on the MMC-card.

) MMC operation is only possible if the power stage is **not active. Accessing attempts to the MMC can take up to 2 minutes.*

Table 4.7 Parameter menu

Error numbers

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

NOTE: The error messages within the scope of user input must not be mistaken as drive error messages. Detailed information concerning the error codes and error management can be found 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
06	MMC create directory failed
07	MMC mounting error
08	MMC unmounting error
09	MMC using not allowed with current technology option card
10	MMC error uninstall X12 card
11	MMC not inserted
12	MMC mounting, create node
13	MMC not supported by hardware (not NSP 257)
14	MMC device in control enabled
15	MMC load parameter dataset to device failed
16	MMC save parameter dataset failed
17	Parameter reset to factory settings failed
18	Parameter write access failed
19	Save parameter data set non volatile failed
20	Not all parameters written
21	Error while reset to factory settings

Table 4.8 Error numbers

4.4.4 Ethernet IP-address menu (IP)

An Ethernet TCP/IP interface serves the purpose of service and diagnostics interface. The IP-address is factory set to 192.168.39.5. It can be changed with the PC software DriveManager 5 or via the display.

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

Table 4.9 IP-address menu

Exemplary configuration of the subnet mask

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

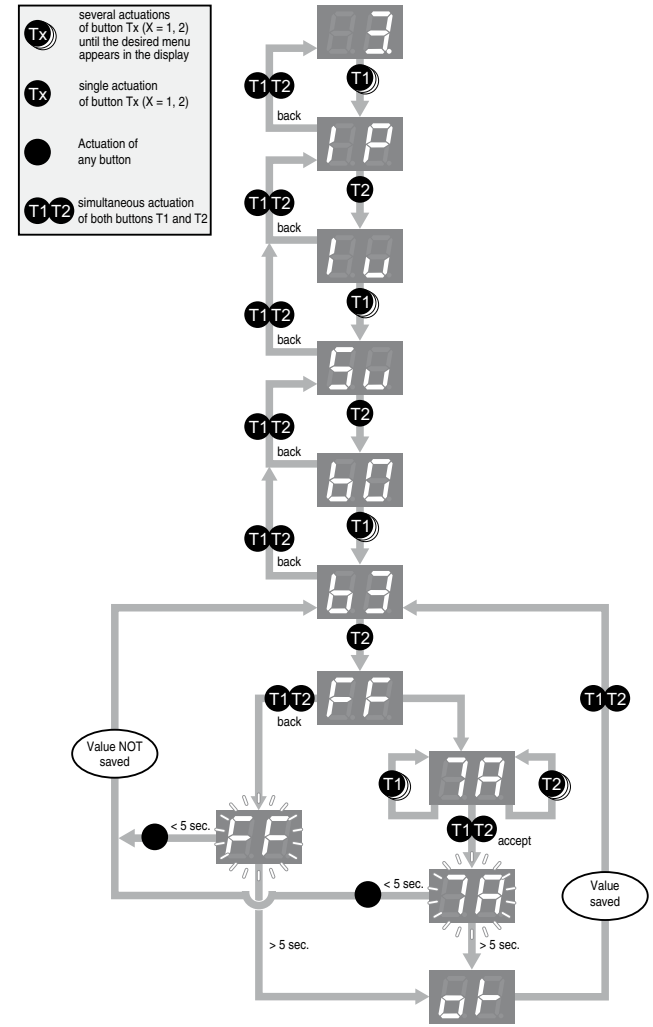

Fig. 4.2 Exemplary configuration of the subnet mask

NOTES:

- During the flashing phases the Save procedure can still be aborted by pressing any button, without the set value being accepted. Otherwise the new value will be saved after 5 seconds.
- Without a restart of the control electronics a changed IP-address will not be accepted.

4.4.5 Field bus address menu (Fb)

The functions available under this menu option depend on the expansion option of the device. Detailed information can be found in the corresponding model description.

Menu level 1	Menu level 2	Para-meter	Value range	Meaning	Explanation
Fb	Ad	-	00..xx *or* - -	Field bus address	Setting the field bus address (only with implemented field bus option), otherwise display "- -" *(the max. adjustable value depends on the option)*
	Po	-	0..3 *or* - -	Transmit power	Setting the light wave power (only with SERCOS II option), otherwise display "- -"

Table 4.10 Field bus address menu

Exemplary configuration of the field bus address

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

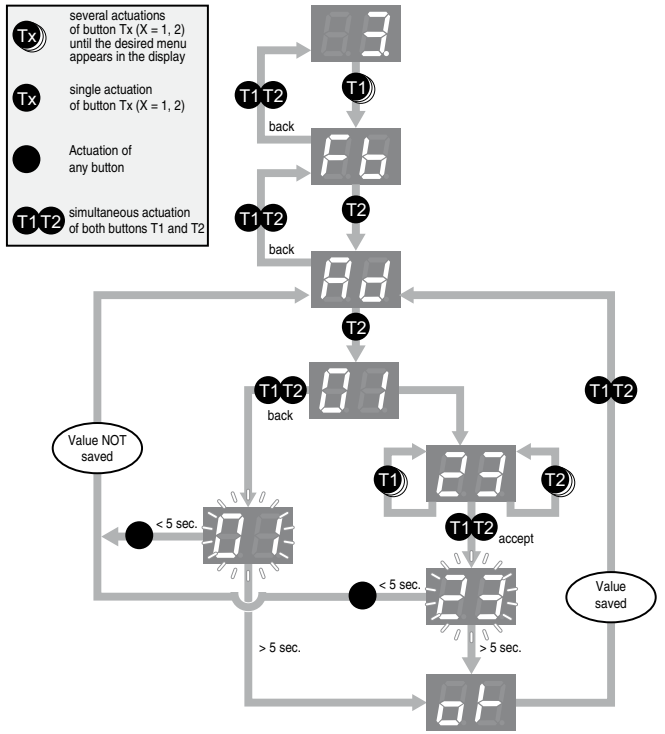

Fig. 4.3 Exemplary configuration of the field bus address

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4.4.6 Firmware update with MMC-card

The MMC-card can be used to perform a Firmware update for the ServoOne. For this purpose the HEX-file of the Firmware to be updated with the file name “main.hex” must be copied into the directory “\Firmware\” in the root directory of the MMC-card.

The MMC-card prepared in this way must then be inserted into the ServoOne. Subsequently reset the 24 V DC control supply, while holding both buttons (T1 and T2) depressed at the same time. Once the display shows the code “c1” you may release both buttons.

The progress of the Firmware update appears in the display in form of a flashing dot after D2 and in succession with “c1” ... “c4”. After a successful update the new Firmware will perform as usual. In case of an error the code “cE” will be displayed. In this case you must reset the 24 V DC control supply and repeat the download process.

5. Diagnose

5.1 Status display on device

The 7-segment display on the device shows the device states.

5.1.1 Device states

Display	System status
	Device in reset state
	Automatic initializing during start-up of device
 *)	Not ready to switch on (no ZK-voltage) [1]
 *)	Starting lockout (ZK OK, power stage not ready) [1]
	Ready to switch on (power stage ready)
	Switched on (drive energized) [2]
	Drive ready (drive energized and ready for setpoint specification) [2]
	Quick stop [2]
	Fault reaction active [2]

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

Table 5.1 Device states

5.1.2 Error display

In each individual case the error codes will be displayed by the 7-segment display. Each error code consists of the repeating sequence of ►"Er" ►Error number ►Error location.

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

Table 5.2 Representation of the error code

NOTES:

- **Acknowledge error**
  The errors can be acknowledged in accordance with their programmed reaction (ER) or only reset via a 24 V reset (X9/10) (ER**.**). Errors marked with a dot can only be reset, after the cause of the error has been eliminated.
- **Error code**
  Detailed information concerning the error codes and error management can be found in the "ServoOne application manual".

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5.2 Status and error displays in DM5

A mouse click on the control button "Device status" in the header of the DM5 opens the "Device status" window.

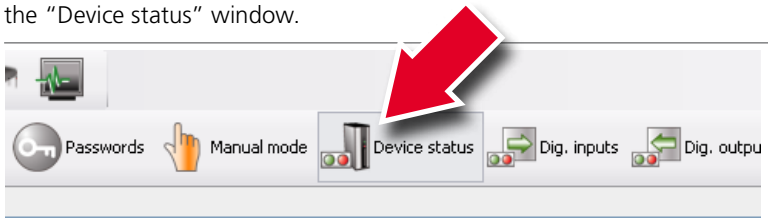

Fig. 5.1 Control button "Drive status" in the header

With the control button "Error history..." you can call up information about the last 20 errors that have occurred.

Fig. 5.2 "Device status" window

If an error occurs a "Pop-up" window with further information about the current error is automatically opened.

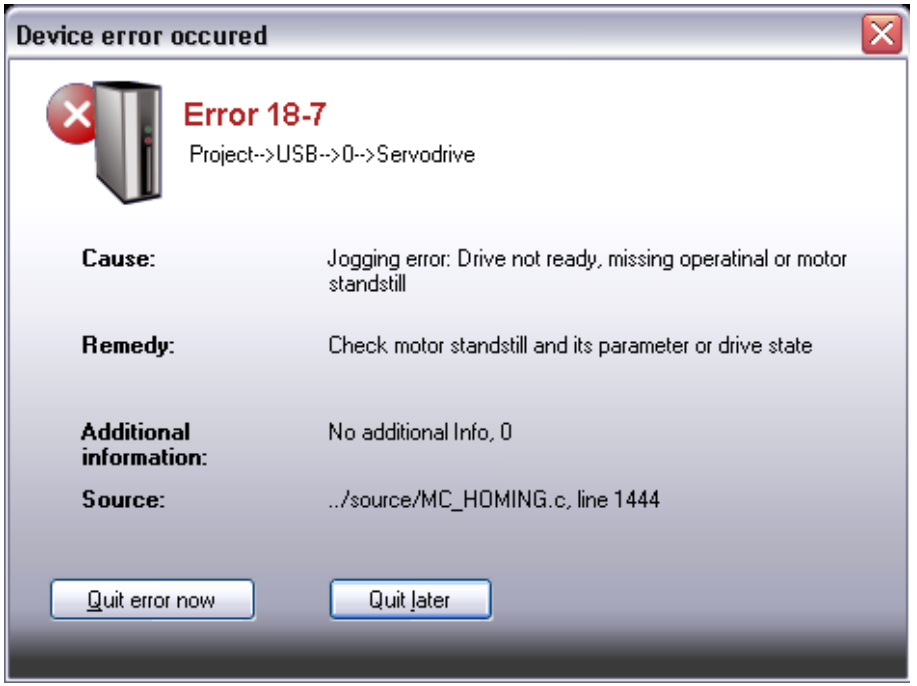

Fig. 5.3 Error message

Parameter 31 "Alarm & warning details" contains additional information on an actual error or a warning.

1. In the top area of the "Project" window choose "Number search" and enter the number "31" into the search field.
2. Then double-click on the lowest level "Alarm & warning details" in the project tree that has just opened.

NOTE: More detailed information on parameter 31 can be found in the "ServoOne application manual".

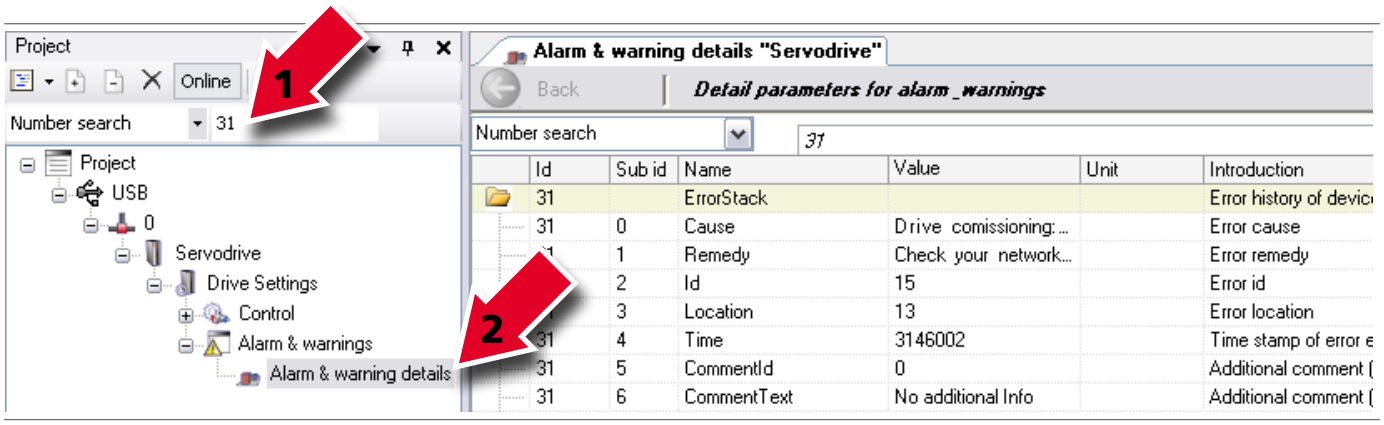

Fig. 5.4 Parameter 31 "Alarm & warning details"

Id.-No.: 1100.20B.5-00 Status: 01/2011

5.3 Helpline/Support & Service

If you have any questions concerning project planning or commissioning of your drive unit our Helpline is able to help you quickly and in an application oriented way. For this purpose you should have the following information at hand before you contact us.

1. Type designation, serial number and software version of the device (see rating plate software)
2. the DriveManager version used (Menu ►Help ►Information... ►Version)
3. displayed error code (as shown by the 7-segment display or the DriveManager)
4. Description of the error, its generation and boundary conditions
5. Save DriveManager device settings in a file
6. Name of company and contact, phone number and e-mail address

Our Helpline is available for you Monday to Friday from 8.00 to 17.00 Uhr (MEZ) and can be contacted via phone, e-mail or internet:

Phone: +49 6441 966-180
E-Mail: helpline@lt-i.com
Internet: http://drives.lt-i.com ►Support & Service ►Trouble Ticket

If you are looking for further assistance in service incidents, we - the specialists from the Service & Support-Center - will be glad to help you.

- Support & Service - Please contact us:
  Mo.-Fr.: 8.00 - 17.00 Uhr (MEZ)
  Phone: +49 6441 966-888
  e-mail: service@lt-i.com

NOTE: If you need any further advice, you will find all services we offer in our order catalogue “Support & Service”. You can download the order catalogue from our website http://drives.lt-i.com under the category with the name.

6. Safe Torque Off (STO)

6.1 Danger analysis and risk assessment

Users of the safety function (STO) must comply with the latest applicable version of the Machinery Directive 2006/42/EEC.

The manufacturer or its representative is obliged to undertake a danger analysis (in accordance with the applicable Machinery Directive) before the market launch of a machine. An analysis of hazards posed by the machine must be conducted and appropriate measures instigated to reduce/eliminate such hazards. With the danger analysis all prerequisites for establishing the required safety functions are fulfilled.

ATTENTION

- The ServoOne safety function "Safe Torque Off (STO)" has been approved by the TÜV-Rheinland accredited certification body. This certification is currently still in preparation. Conformance to parts of EN ISO 13849-1, EN 62061, EN 61800-5-2 and EN 61508 is ensured.
- The acceptance is valid for the drive controller types specified in tables A.1 to and including A.5 (see appendix) and for sizes BG1-BG4 from serial-no. 072900001. For size BG5+6 from serial no. 081750001.
- The operator of the safety-related system is trained in accordance with his/her state of knowledge, appropriate to the complexity and safety integrity level of the safety-related system. This training includes the study of essential features of the production process and knowledge of the relationship between the safety-related system and the equipment under control (EUC).

6.2 Definition of terms

STO = Safe Torque OFF

With the safety function STO the power supply to the drive is safely interrupted (no electrical isolation). The drive must not be able to generate a torque and so perform any hazardous movement. The standstill position is not monitored.

The "STO" function conforms to stop category 0 according to EN 60204-1.

Restart inhibit

The restart inhibit prevents enabling of the evaluation unit (STO) after a shutdown following a change of machine mode or after changing the method of confirmation. The restart inhibit is only cancelled by an external command (such as the On button, or in LTi drive controllers the ENPO).

Emergency stop

In accordance with the national and European preface to EN 60204-1, electrical equipment may also be used for emergency stop devices provided they comply with relevant standard, such as IEC 61508. "STO" can thus be used for emergency stop functions.

NOTE: The term "emergency stop device" has been replaced by the new term „action in case of emergency". The term "emergency stop" has been replaced by "shutdown in case of emergency (emergency stop)" – see paragraph 9.2.5.4.2 in EN 60204-1.

EN ISO 13849-1: 2008

Safety of machines, safety related parts of controls.

The EN ISO 13849 standard emerged from EN 954-1, supplemented by the aspects of quality management and reliability.

EN 62061: 2005

Safety sector standard for machinery, originating from IEC 61508

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IEC 61508: 2010

International basic safety standard specifying the status of safety technology in all its aspects.

EN 61800-5-1: 2007, EN 61800-5-2: 2007

Electrical drives with variable speed. Part 5-1: Requirements concerning electrical, thermal and function safety.

EUC (Equipment Under Control)

EUC system:
A system that responds to the input signals from the process and/or a user and generates output signals which enable the EUC to work as desired.

EUC equipment:
Equipment, machine, apparatus or plant used for the manufacture, production and processing, transportation, medical or other activities.

EUC - risk:
Risk resulting from the EUC or its interaction with the EUC operating equipment.

PFH (Probability of dangerous Failure per Hour)

In respect of a hazardous random hardware failure.

Safety function

Function performed by an E/E/PE (electrical/electronic/programmable electronic) safety-related system, a safety-related system of other technology or external equipment for risk minimization, with the goal of attaining and maintaining a safe state for the EUC, taking into account a particular undesired event.

Validation

Affirmation that the special requirements for a certain purpose of use are fulfilled by investigation and the submission of objective proof.

Validation describes the activity to prove that the safety-related system under investigation meets the specified safety requirements of the safety-related system in every respect, before or after installation.

Positive opening operation of a contact element

Symbol for positive opening operation according to EN 60947-5-1 annex K 

In a positive opening operation of a contact element, the contact separation is achieved as a direct result of a certain movement of the actuating element caused by non-elastic links (no springs).

Safety circuit

A safety circuit is designed with two channels and has been approved by accredited testing bodies on the basis of the standards. There is a large number of manufacturers offering a vast variety of safety circuits for various applications.

6.2.1 Function description

The ServoOne servocontrollers support the "STO" (Safe Torque Off) safety function in accordance with the requirements of EN 61800-5-2, EN ISO 13849-1 "PL e" and EN 61508 / EN 62061 "SIL 3".

The "STO" safety function to EN 61800-5-2 describes a safety measure in the form of an interlock or control function. "Category 3" signifies that the safety function will remain in place in the event of a single fault.

The safety-related parts must be designed in such a way that:

- a single fault in any of the said parts does not result in loss of the safety function and
- the single fault is detected on or before the next request to the safety function.

For the "STO" function the servo controllers are equipped with additional logic circuits and a feedback contact. The logic cuts the power supply to the pulse amplifiers to activate the power stage. In combination with the controller enable "ENPO" the system uses two channels to prevent the motor creating a torque.

6.2.2 Fundamentals

Always draw up a validation plan. The plan specifies which tests and analyses were used by you to determine compliance of the solution with the requirements of the application.

NOTE: Switch cabinet mounting with IP54 protection is mandatory.

DANGER FROM ELECTRICAL TENSION!

- If the servocontroller is in the "STO" state all motor and mains cables, braking resistors and DC link voltage cables conduct dangerous voltages against protective conductors.
- With the "STO" function no "shutdown of voltage in case of emergency" is possible without additional measures. There is no electrical isolation between the motor and servocontroller! This means there is a risk of electric shock or other electrical hazard.

DANGER FROM AXIS MOVEMENT ON THE MOTOR!

- If an external effect of forces can be expected in "STO" safety function, such as with a suspended load, this motion must be reliably prevented by additional measures, such as by two brakes, safety bolts or a clamping device with brake.
- Despite correct shutdown, a short-circuit in each of two remote branches of the power section may electrically trigger an axis movement by max. 180°.

NOTE: The safety circuitry connected to the ServoOne should be designed in such a way that in case of a loss of electrical supply the safe state of the machine can be reached or maintained.

6.2.3 Overview of "STO" connections

ServoOne offers a separate input for the "STO" request, a facility to deactivate the restart inhibit and a separate relay contact for feedback.

Des.	Term.	Specification		Isolation
Digital inputs				
ENPO (STO)	X4/10	• Disable restart inhibit (STO) and enable power stage = High level • "Request STO" input = Low level • OSSD-capable • Reaction time approx. 10ms • 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
STO "Safe Torque Off"				
ISDSH (STO)	X4/22	• "Request STO" input = low level • OSSD-capable • Frequency range <500 Hz • 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	Diagnose STO, both tripping channels active, one NO contact with automatically resetting circuit-breaker (polyswitch) • 25 V / 200 mA AC, cos φ = 1 (AC1) • 30 V / 200 mA DC, cos φ = 1 (DC1)	X4/12 X4/11	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 6.1 Terminal assignment X4

6.2.4 Wiring and commissioning

For the "STO" function the servocontrollers are equipped with additional logic circuits and a feedback contact. The logic cuts the power supply to the pulse amplifiers to activate the power stage. In combination with the controller enable "ENPO", the system uses two channels to prevent the motor creating a torque.

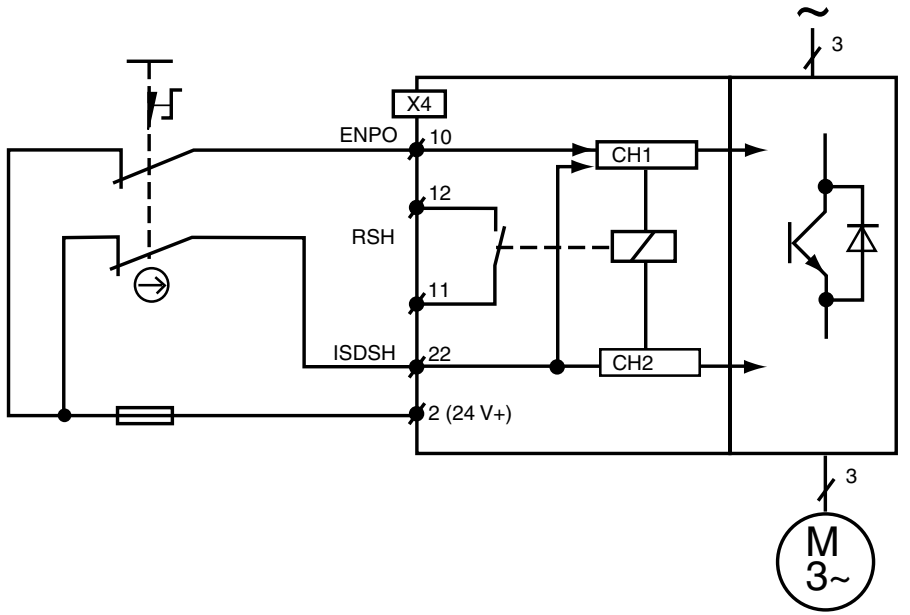

Fig. 6.1 "STO" selection of function via switch with two NC contacts (positively operated)

ENPO	ISDSH	STO	Restart inhibit	Controller state	RSH[1)]
L	L	ON	ON	Power stage disabled via two channels	High
H [3)]	H [3)]	OFF	OFF	Power stage ready	Low
(L) ⇨ H [2)]	(L) ⇨ H [2)]	OFF	OFF	Power stage ready	Low
H	(H) ⇨ L	ON	ON	Power stage disabled via two channels	High
(H) ⇨ L	H	OFF	OFF	Power stage disabled via one channel	Low
(L) ⇨ H	H	OFF	OFF	Power stage ready	Low

( ) Previous status

1) 3 x 10^6 switching cycles at 200 mA (resting: NO contact)

2) In order to deactivate the restart inhibit the control signals must be simultaneously (ENPO max. 5 ms before ISDSH) set to High (H), or ISDSH must be reliably set to High (H) before ENPO.

3) This only applies when STO has been disabled by the process described in "2)"

Table 6.2 Switching response of the safety function

NOTE: The plausibility between input signals (ENPO, ISDSH) and feedback (RSH) must always be monitored.

6.2.5 Testing the STO function

The applied control signals "ISDSH" and "ENPO" must always be checked by the operator or a higher-level control for plausibility to the feedback (RSH).

The occurrence of an implausible status is a sign of a system fault (installation or servocontroller). In this case the drive must be switched off and the fault rectified.

ATTENTION! The "STO" (Safe Torque Off) function must generally be checked for correct functionality:

- after initial commissioning;
- after any modification of the system wiring;
- after replacing one or more items of system equipment.

NOTES:

- There is no protection against unexpected restarting after re-establishing the electrical power supply in the illustrated example circuit, unless an external circuit is used (figure 6.1). If ENPO and ISDSH are High when reconnecting the power supply (see table 6.2), the axle may start up if autostart is programmed. The connected safety circuit on the machine must ensure that the ServoOne (the SRP/CS) can attain and maintain the safe state of the machine.
- If the switch and drive controller are installed in separate locations, it must be ensured that the cables from NC contact 1 to ENPO (STO) and from NC contact 2 to ISDSH (STO) are wired separately, or that possible faults are prevented by using a protective tube for example.
- In order to cancel the STO safety function and deactivate the restart inhibit, the ISDSH signal must be set to High before the ENPO signal, or simultaneously with it.

6.3 Safety acceptance tests

STO shutdown acceptance test

Safety characteristics to EN ISO 13849:
PL: .....e
Category: 3
MTTFd: .....7.105 a

Safety characteristics to EN 62061 / EN 61508:
SIL: 3
HFT: 1
PFH: .....1,73 x 10^{-9} 1/h

Restart inhibit acceptance test

Safety characteristics to EN ISO 13849:
PL: .....e
Category: 3
MTTFd: .....7.105 a

Safety characteristics to 62061 / EN 61508:
SIL: 3
HFT: 1
PFH: .....1,73 x 10^{-9} 1/h

A. Appendix

A.1 Permissible current load for drive controllers

Maximum permissible drive controller output current and peak current depend on the mains voltage, the motor cable length, the power stage switching frequency, the design of cooling technology and the ambient temperature. The maximum permissible current carrying capacity of the drive controllers changes with any change in application related conditions.

A.1.1 Current carrying capacity BG1, air cooling, single-phase

Drive controller	Switching frequency of the power stage	Ambient temperature	Rated current	Peak current [A_{eff}]			
				with linear increasing rotating field frequency 0 to 5 Hz		for intermittent operation	for time [1]
	[kHz]	[°C]	at 230 V_{AC} [A_{eff}]	0 Hz	5 Hz	> 5 Hz	[s]
SO82.004 (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) Shut-down according to I²t-characteristic

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

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

Drive controller	Switching frequency of the power stage	Ambient temperature	Rated current			Peak current [A_{eff}]			
			at 400 V_{AC}	at 460 V_{AC}	at 480 V_{AC}	with linear increasing rotating field current 0 to 5 Hz		for intermittent operation	for time [1]
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	0 Hz	5 Hz	> 5 Hz	[s]
SO84.004 (BG1)	4	45	4.0	4.0	4.0	8.0	8.0	8.0	10
	8	40	4.0	4.0	4.0	8.0	8.0	8.0	
	12		3.7	2.9	2.7	7.4	7.4	7.4	
	16		2.7	1.6	1.3	5.4	5.4	5.4	
SO84.006 (BG1)	4	45	6.0	6.0	6.0	12.0	12.0	12.0	10
	8	40	6.0	6.0	6.0	12.0	12.0	12.0	
	12		5.5	4.4	4.0	11.0	11.0	11.0	
	16		4.0	2.4	1.9	8.0	8.0	8.0	
SO84.008 (BG2)	4	45	8.0	8.0	8.0	16.0	16.0	16.0	10
	8	40	8.0	7.2	6.9	16.0	16.0	16.0	
	12		6.7	5.3	4.9	13.4	13.4	13.4	
	16		5.0	3.7	3.3	10.0	10.0	10.0	
SO84.012 (BG2)	4	45	12.0	12.0	12.0	24.0	24.0	24.0	10
	8	40	12.0	10.8	10.4	24.0	24.0	24.0	
	12		10.0	8.0	7.4	20.0	20.0	20.0	
	16		7.6	5.6	5.0	15.2	15.2	15.2	

Data apply for a motor cable length ≤ 10 m.
1) Shut-down according to I²t-characteristic

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

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Drive controller	Switching frequency of the power stage	Ambient temperature	Rated current			Peak current [A_{eff}]			
			at 400 V_{AC}	at 460 V_{AC}	at 480 V_{AC}	with linear increasing rotating field current 0 to 5 Hz		for intermittent operation	for time [1]
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	0 Hz	5 Hz	> 5 Hz	[s]
SO84.016 (BG3)	4	45	16.0	16.0	16.0	32.0	32.0	32.0	10
	8	40	16.0	13.9	13.3	32.0	32.0	32.0	
	12		11.0	8.8	8.0	22.0	22.0	22.0	
	16		8.0	5.9	5.2	16.0	16.0	16.0	
SO84.020 (BG3)	4	45	20.0	20.0	20.0	40.0	40.0	40.0	10
	8	40	20.0	17.4	16.6	40.0	40.0	40.0	
	12		13.8	11.0	10.0	27.6	27.6	27.6	
	16		10.0	7.4	6.5	20.0	20.0	20.0	
SO84.024 (BG4)	4	45	24.0	24.0	24.0	48.0	48.0	48.0	10
	8	40	24.0	21.0	20.0	48.0	48.0	48.0	
	12		15.8	12.4	11.3	31.6	31.6	31.6	
	16		11.3	9.2	8.4	22.6	22.6	22.6	
SO84.032 (BG4)	4	45	32.0	32.0	32.0	64.0	64.0	64.0	10
	8	40	32.0	28.0	26.7	64.0	64.0	64.0	
	12		21.0	16.5	15.0	42.0	42.0	42.0	
	16		15.0	12.2	11.2	30.0	30.0	30.0	

Data apply for a motor cable length ≤ 10 m.
1) Shut-down according to I²t-characteristic

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

A.1.3 Current carrying capacity BG5-BG6a, air coolin

Drive controller	Switching frequency of the power stage	Ambient temperature	Rated current			Peak current [A_{eff}] [2]			
			at 400 V_{AC}	at 460 V_{AC}	at 480 V_{AC}	with linear increasing rotating field current 0 to 5 Hz		for intermittent operation	for time [1]
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	0 Hz	5 Hz	> 5 Hz	[s]
SO84.045 (BG5)	4	45	45	42	41	90	90	90	3/10 [3]
	8	40	45	42	41	90	90	90	
	12		45	42	41	90	90	90	
	16		42	39	38	84	84	84	
SO84.060 (BG5)	4	45	60	56	54	120	120	120	3/10 [3]
	8	40	60	56	54	120	120	120	
	12		58	54	52	116	116	116	
	16		42	39	38	84	84	84	
SO84.072 (BG5)	4	45	72	67	65	144	144	144	3/10 [3]
	8	40	72	67	65	144	144	144	
	12		58	54	52	116	116	116	
	16		42	39	38	84	84	84	
SO84.090 (BG6)	4	45	90	83	81	170	180	180	30
	8	40	90	83	81	134	180	180	
	12		90	83	81	107	144	144	
	16		72	67	65	86	115	115	

Data apply for a motor cable length ≤ 10 m.
1) Shut-down according to I²t-characteristic
2) supply with 400 V_{AC} at max. 70 % preload
3) 10 s at heat sink temperature <45 °C

Table A.3 Rated and peak current BG5 to BG6a (air cooling)

Drive controller	Switching frequency of the power stage	Ambient temperature	Rated current			Peak current [A_{eff}] 2)			
			at 400 V_{AC}	at 460 V_{AC}	at 480 V_{AC}	with linear increasing rotating field current 0 to 5 Hz		for intermittent operation	for time 1)
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	0 Hz	5 Hz	> 5 Hz	[s]
SO84.110 (BG6)	4	45	110	102	99	170	220	220	30
	8	40	110	102	99	134	165	165	
	12		90	83	81	107	144	144	
	16		72	67	65	86	115	115	
SO84.143 (BG6a)	4	45	143	132	129	190	286	286	30
	8	40	143	132	129	151	215	215	
	12		115	106	104	121	172	172	
	16		92	85	83	97	138	138	
SO84.170 (BG6a)	4	45	170	157	153	190	315	315	10
	8	40	170	157	153	151	220	220	10
	12	-	-	-	-	-	-	-	-
	16	-	-	-	-	-	-	-	-

Data apply for a motor cable length ≤ 10 m.
1) Shut-down according to I²t-characteristic
2) supply with 400 V_{AC} at max. 70 % preload
3) 10 s at heat sink temperature <45 °C

Table A.3 Rated and peak current BG5 to BG6a (air cooling)

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

NOTE: The heat sink shut-down temperature in liquid cooled devices is (internally) 65 °C. The drive controller is shut down and operation can only be resumed after a short cooling phase.

Drive controller	Switching frequency of the power stage	Ambient temperature	Rated current			Peak current [A_{eff}] 2)			
			at 400 V_{AC}	at 460 V_{AC}	at 480 V_{AC}	with linear increasing rotating field current 0 to 5 Hz		for intermittent operation	for time 1)
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	0 Hz	5 Hz	> 5 Hz	[s]
SO84.016 (BG3)	4	40	16.0	16.0	16.0	32.0	32.0	32.0	10
	8		16.0	13.9	13.3	32.0	32.0	32.0	
	12		11.0	8.8	8.0	22.0	22.0	22.0	
	16		8.0	5.9	5.2	16.0	16.0	16.0	
SO84.020 (BG3)	4	40	20.0	20.0	20.0	40.0	40.0	40.0	10
	8		20.0	17.4	16.6	40.0	40.0	40.0	
	12		13.8	11.0	10.0	27.6	27.6	27.6	
	16		10.0	7.4	6.5	20.0	20.0	20.0	
SO84.024 (BG4)	4	40	24.0	24.0	24.0	48.0	48.0	48.0	10
	8		24.0	21.0	20.0	48.0	48.0	48.0	
	12		15.8	12.4	11.3	31.6	31.6	31.6	
	16		11.3	9.2	8.4	22.6	22.6	22.6	
SO84.032 (BG4)	4	40	32.0	32.0	32.0	64.0	64.0	64.0	10
	8		32.0	28.0	26.7	64.0	64.0	64.0	
	12		21.0	16.5	15.0	42.0	42.0	42.0	
	16		15.0	12.2	11.2	30.0	30.0	30.0	

Data apply for a motor cable length ≤ 10 m.
1) Shut-down according to I²t-characteristic
2) supply with 400 V_{AC} at max. 70 % preload

Table A.4 Rated and peak current BG3 and BG4 (liquid cooling)

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

NOTE: The heat sink shut-down temperature in liquid cooled devices is (internally) 65 °C. The drive controller is shut down and operation can only be resumed after a short cooling phase.

Drive controller	Switching frequency of the power stage	Ambient temperature	Rated current			Peak current [A_{eff}] 2)			
			at 400 V_{AC}	at 460 V_{AC}	at 480 V_{AC}	with linear increasing rotating field current 0 to 5 Hz		for intermittent operation	for time 1)
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	0 Hz	5 Hz	> 5 Hz	[s]
SO84.045 (BG5)	4	45	53	49	48	90	90	90	30
	8		53	49	48	90	90	90	
	12		53	49	48	90	90	90	
	16		49	45	44	84	84	84	
SO84.060 (BG5)	4	45	70	65	63	120	120	120	30
	8		70	65	63	120	120	120	
	12		68	63	61	116	116	116	
	16		49	45	44	84	84	84	
SO84.072 (BG5)	4	45	84	78	76	144	144	144	30
	8		84	78	76	144	144	144	
	12		68	63	61	116	116	116	
	16		49	45	44	84	84	84	

Data apply for a motor cable length ≤ 10 m.
1) Shut-down according to I²t-characteristic
2) supply with 400 V_{AC} at max. 70 % preload

Table A.5 Rated and peak current BG5 to BG6a (liquid cooling)

Drive controller	Switching frequency of the power stage	Ambient temperature	Rated current			Peak current [A_{eff}] 2)			
			at 400 V_{AC}	at 460 V_{AC}	at 480 V_{AC}	with linear increasing rotating field current 0 to 5 Hz		for intermittent operation	for time 1)
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	0 Hz	5 Hz	> 5 Hz	[s]
SO84.090 (BG6)	4	45	110	102	99	205	220	220	30
	8		110	102	99	165	187	187	
	12		110	102	99	132	165	165	
	16		90	83	81	106	135	135	
SO84.110 (BG6)	4	45	143	132	129	230	286	286	30
	8		143	132	129	190	215	215	
	12		114	105	103	152	172	172	
	16		91	84	82	122	138	138	
SO84.143 (BG6a)	4	45	170	157	153	230	340	340	10
	8		170	157	153	190	255	255	
	12		136	126	122	152	204	204	
	16		109	101	98	122	163	163	
SO84.170 (BG6a)	4	45	210	194	189	230	340	340	10
	8	45	210	194	189	190	255	255	10
	12	-	-	-	-	-	-	-	-
	16	-	-	-	-	-	-	-	-

Data apply for a motor cable length ≤ 10 m.
1) Shut-down according to I²t-characteristic
2) supply with 400 V_{AC} at max. 70 % preload

Table A.5 Rated and peak current BG5 to BG6a (liquid cooling)

A.1.6 Current carrying capacity BG7, liquid cooling

NOTE: The heat sink shut-down temperature in liquid cooled devices is (internally) 65 °C. The drive controller is shut down and operation can only be resumed after a short cooling phase

Drive controller	Switching frequency of the power stage	Ambient temperature	Rated current			Peak current [A_{eff}] 2)			
			at 400 V_{AC}	at 460 V_{AC}	at 480 V_{AC}	with linear increasing rotating field current 0 to 5 Hz		for intermittent operation	for time 1)
	[kHz]	[°C]	[A_{eff}]	[A_{eff}]	[A_{eff}]	0 Hz	5 Hz	> 5 Hz	[s]
SO84.250 (BG7)	2	40	250	231	225	425			30
	4					375			
SO84.325 (BG7)	2	40	325	300	292	552			30
	4					485			
SO84.450 (BG7)	2	40	450	416	405	765			30
	4					675			

Data apply for a motor cable length ≤ 10 m.
1) Shut-down according to I²t-characteristic
2) supply with 400 V_{AC} at max. 70 % preload

Table A.6 Rated and peak current BG7 (liquid cooling)

A.2 Technical data ServoOne

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

Technical data \ Designation	SO82.004	SO84.004	SO84.006	SO84.008	SO84.012	SO84.016
Output motor side[1]						
Voltage	3-phase U_{mains}					
Rated current, effective (I_N)	4 A	4 A	6 A	8 A	12 A	16 A
Peak current	see table A.1	see table A.2				
Rotating field frequency	0 ... 400 Hz					
Output stage switching frequency	4, 8, 12, 16 kHz					
Input mains supply 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)	1.6 kVA	2.8 kVA	4.2 kVA	5.9 kVA	8.8 kVA	11.1 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 the mains voltage	-	±3 % max.				
Frequency	50/60 Hz ±10 %					
Power loss at I_N [1]	85 W	96 W	122 W	175 W	240 W	330 W

1) Values related to a mains voltage of 3 x 400 V_{eff} (at SO82.004: 1 x 230 V_{eff}) and a switching frequency of 8 kHz
2) without mains choke
3) Values related to a mains voltage of 3 x 480 V
4) Connection of an ext. braking resistor is not permitted for devices with int. braking resistor (version SO8x.xxx.xxxx.1xxx)!

Table A.7 Technical data SO82.004 to SO84.016, air cooling

Technical data \ Designation	SO82.004	SO84.004	SO84.006	SO84.008	SO84.012	SO84.016
DC link						
Capacity	1740 µF	400 µF		725 µF		1230 µF
Brake chopper switch-on threshold [1]	390 V DC	650 V DC				
Peak brake chopper power with internal braking resistor [1] (version SO84.xxx.xxxx.1xxx)	PTC	4.7 kW at 90 Ω				
Minimum ohmic resistance of an externally installed braking resistor [3]	72 Ω [4]			39 Ω [4]		20 Ω [4]

1) Values related to a mains voltage of 3 x 400 V_{eff} (at SO82.004: 1 x 230 V_{eff}) and a switching frequency of 8 kHz
2) without mains choke
3) Values related to a mains voltage of 3 x 480 V
4) Connection of an ext. braking resistor is not permitted for devices with int. braking resistor (version SO8x.xxx.xxxx.1xxx)!

Table A.7 Technical data SO82.004 to SO84.016, air cooling

NOTE: For further information on brake chopper switch-on threshold pleas refer to chapter 3.15.

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

Technical data \ Designation	SO84.020	SO84.024	SO84.032	SO84.045	SO84.060	SO84.072
Output motor side[1]						
Voltage	3-phase U_{mains}					
Rated current, effective (I_N)	20 A	24 A	32 A	45 A	60 A	72 A
Peak current	see table A.2			see table A.3		
Rotating field frequency	0 ... 400 Hz					
Output stage switching frequency	4, 8, 12, 16 kHz					
Input mains supply 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)	13.9 kVA	16.6 kVA	22.2 kVA	31 kVA	42 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 the mains voltage	±3 % max.					
Frequency	50/60 Hz ±10 %					
Power loss at I_N [1]	400 W	475 W	515 W	610 W	830 W	1010 W

1) Values related to a mains voltage of 3 x 400 V_{eff} and a switching frequency of 8 kHz
3) Values related to a mains voltage of 3 x 480 V
4) Connection of an ext. braking resistor is not permitted for devices with int. braking resistor (version SO8x.xxx.xxxx.1xxx)!

Table A.8 Technical data SO82.020 to SO84.072, air cooling

Technical data \ Designation	SO84.020	SO84.024	SO84.032	SO84.045	SO84.060	SO84.072
DC link						
Capacity	1230 µF	2000 µF		430 µF	900 µF	
Brake chopper switch-on threshold	650 V DC [1]			820 V DC		
Peak braking power with internal braking resistor (version SO84.xxx.xxxx.1xxx)	4.7 kW at 90 Ω [1] 6 kW at 90 Ω [3]			-		
Minimum ohmic resistance of an externally installed braking resistor	20 Ω [3] [4]	12 Ω [3] [4]		18 Ω		13 Ω

1) Values related to a mains voltage of 3 x 400 V_{eff} and a switching frequency of 8 kHz
3) Values related to a mains voltage of 3 x 480 V
4) Connection of an ext. braking resistor is not permitted for devices with int. braking resistor (version SO8x.xxx.xxxx.1xxx)!

Table A.8 Technical data SO82.020 to SO84.072, air cooling

NOTE: For further information on brake choppers pleas refer also to chapter 3.15.

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

Technical data \ Designation	SO84.090	SO84.110	SO84.143	SO84.170
Output motor side[1)]				
Voltage	3-phase U_{mains}			
Rated current, effective (I_N)	90 A	110 A	143 A	170 A
Peak current	see table A.3			
Rotating field frequency	0 ... 400 Hz			
Output stage switching frequency	4, 8, 12, 16 kHz			
Input mains supply 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 the mains voltage	±3 % max.			
Frequency	50/60 Hz ±10 %			
Power loss at I_N [1)]	1300 W	1600 W	2100 W	2500 W
DC link				
Capacity	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) Values related to a mains voltage of 3 x 400 V_{eff} and a switching frequency of 8 kHz

Table A.9 Technical data SO82.090 to SO84.170, air cooling

NOTE: Further information on brake chopper and braking resistors can also be found in chapter 3.15 from page 38.

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

Technical data \ Designation	SO84.016	SO84.020	SO84.024	SO84.032	SO84.045	SO84.060
Output motor side[1]						
Voltage	3-phase U_{mains}					
Rated current, effective (I_N)	16 A	20 A	24 A	32 A	53 A	70 A
Peak current	see table A.4				see table A.5	
Rotating field frequency	0 ... 400 Hz					
Output stage switching frequency	4, 8, 12, 16 kHz					
Input mains supply 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)	11.1 kVA	13.9 kVA	16.6 kVA	22.2 kVA	37 kVA	50 kVA
Current [1] (with mains choke)	17.3 A	21.6 A	26.2 A	34.9 A	53 A	70 A
Asymmetry of the mains voltage	±3 % max.					
Frequency	50/60 Hz ±10 %					
Power loss at I_N [1]	330 W	400 W	475 W	515 W	690 W	930 W

1) Values related to a mains voltage of 3 x 400 V_{eff} and a switching frequency of 8 kHz
4) Connection of an ext. braking resistor is not permitted for devices with int. braking resistor (version SO8x.xxx.xxxx.1xxx)!
5) Permanent mean braking power ≤0.75 kW
6) Permanent mean braking power ≤1.5 kW
7) Permanent mean braking power ≤4 kW
8) Cooling power sufficient even with optional internal braking resistor.

Table A.10 Technical data SO82.016 to SO84.060, liquid cooling

Technical data \ Designation	SO84.016	SO84.020	SO84.024	SO84.032	SO84.045	SO84.060
DC link						
Capacity	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 [1]		12 Ω [1]		10 Ω [4) 7)]	10 Ω [4) 7)]
Optional: Internal braking resistor (mounted on cooler floor)	-				1 x 20 Ω[5]	2 x 20 Ω parallel, corres-ponds with 10 Ω[6]
Cooler data						
Coolant pressure (nom. value / max. value)	1 bar / 2 bar					
Coolant flow [8] (nom. value / max. value)	3 l per min / 4 l per min				8 l per min / 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 avoid moisture condensation on the heat sink.					

1) Values related to a mains voltage of 3 x 400 V_{eff} and a switching frequency of 8 kHz
4) Connection of an ext. braking resistor is not permitted for devices with int. braking resistor (version SO8x.xxx.xxxx.1xxx)!
5) Permanent mean braking power ≤0.75 kW
6) Permanent mean braking power ≤1.5 kW
7) Permanent mean braking power ≤4 kW
8) Cooling power sufficient even with optional internal braking resistor.

Table A.10 Technical data SO82.016 to SO84.060, liquid cooling

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A.2.5 SO84.072 to SO84.210, liquid cooling

Technical data \ Designation	SO84.072	SO84.090	SO84.110	SO84.143	SO84.170
Output motor side[1]					
Voltage	3-phase U_{mains}				
Rated current, effective (I_N)	84 A	110 A	143 A	170 A	210 A
Peak current	see table A.5				
Rotating field frequency	0 ... 400 Hz				
Output stage switching frequency	4, 8, 12, 16 kHz				
Input mains supply 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)	58 kVA	76 kVA	99 kVA	118 kVA	128 kVA
Current [1] (with mains choke)	84 A	110 A	143 A	170 A	185 A
Asymmetry of the mains voltage	±3 % max.				
Frequency	50/60 Hz ±10 %				
Power loss at I_N [1] [9]	1130 W	1500 W	1940 W	2380 W	2650 W

1) Values related to a mains voltage of 3 x 400 V_{eff} and a switching frequency of 8 kHz
4) Connection of an ext. braking resistor is not permitted for devices with int. braking resistor (version SO8x.xxx.xxxx.1xxx)!
6) Permanent mean braking power ≤1.5 kW
7) Permanent mean braking power ≤4 kW
8) Cooling power sufficient even with optional internal braking resistor.
9) Data without power loss caused by optional internal braking resistors
10) Permanent mean braking power ≤2.5 kW
11) Permanent mean braking power ≤3 kW
12) Permanent mean braking power ≤10 kW

Table A.11 Technical data SO84.072 to SO84.210, liquid cooling

Technical data \ Designation	SO84.072	SO84.090	SO84.110	SO84.143	SO84.170
DC link					
Capacity	900 µF	2120 µF		4240 µF	
Brake chopper switch-on threshold	820 V DC				
Minimum ohmic resistance of an externally installed braking resistor	10 Ω [4] [7]	12 Ω [4] [12]	10 Ω [4] [12]	8.5 Ω [4] [12]	6.5 Ω [4] [12]
Optional: Internal braking resistor (mounted on cooler floor)	2 x 20 Ω parallel, corresponds with 10 Ω [6]	2 x 15 Ω parallel, corresponds with 7.5 Ω [10]		3 x 15 Ω parallel, coresponds with 5 Ω [11]	
Cooler data					
Coolant pressure (nom. value / max. value)	1 bar / 2 bar				
Coolant flow [8] (nom. value / max. value)	8 l per min / 11 l per min	11 l per min / 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 avoid moisture condensation on the heat sink.				

1) Values related to a mains voltage of 3 x 400 V_{eff} and a switching frequency of 8 kHz
4) Connection of an ext. braking resistor is not permitted for devices with int. braking resistor (version SO8x.xxx.xxxx.1xxx)!
6) Permanent mean braking power ≤1.5 kW
7) Permanent mean braking power ≤4 kW
8) Cooling power sufficient even with optional internal braking resistor.
9) Data without power loss caused by optional internal braking resistors
10) Permanent mean braking power ≤2.5 kW
11) Permanent mean braking power ≤3 kW
12) Permanent mean braking power ≤10 kW

Table A.11 Technical data SO84.072 to SO84.210, liquid cooling

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

Technical data \ Designation	SO84.250	SO84.325	SO84.450
Output motor side[1]			
Voltage	3-phase U_{mains}		
Rated current, effective (I_N)	250 A	325 A	450 A
Peak current	see table A.6		
Rotating field frequency	0 ... 400 Hz		
Output stage switching frequency	2, 4 kHz		
Input mains supply 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 the mains voltage	±3 % max.		
Frequency	50/60 Hz ±10 %		
Power loss at I_N [1]	3960 W	4800 W	6750 W
DC link			
Capacity	3600 µF	5400 µF	7200 µF
Brake chopper switch-on threshold	820 V DC		
Minimum ohmic resistance of an externally installed braking resistor	3.2 Ω	2.5 Ω	1.7 Ω

1) Values related to a mains voltage of 3 x 400 V_{eff} and a switching frequency of 4 kHz
2) Connection of an ext. braking resistor is not permitted for devices with int. braking resistor (version SO8x.xxx.xxxx.1xxx)!
8) Cooling power sufficient even with optional internal braking resistor.

Table A.12 Technical data SO84.250 to SO84.450, liquid cooling

Technical data \ Designation	SO84.250	SO84.325	SO84.450
Cooler data			
Coolant pressure (nom. value / max. value)	1 bar / 2 bar		
Coolant flow [8] (nom. value / max. value)	11 l per min / 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 avoid moisture condensation on the heat sink.		

1) Values related to a mains voltage of 3 x 400 V_{eff} and a switching frequency of 4 kHz
2) Connection of an ext. braking resistor is not permitted for devices with int. braking resistor (version SO8x.xxx.xxxx.1xxx)!
8) Cooling power sufficient even with optional internal braking resistor.

Table A.12 Technical data SO84.250 to SO84.450, liquid cooling

A.3 Terminals for motor cable

Characteristic	BG1 + BG2	BG3 + BG4	BG5	BG6 + BG6a	
				90 - 110 A	143 - 170 A
Connectivity for cables (flexible with ferrules)	0.25 - 4 mm² (AWG 24 - AWG 10) *)	0.75 - 16 mm² (AWG 18 - AWG 6)	max. 25 mm² (AWG 4)	35 - 95 mm² (AWG 2 - AWG 4/0)	50 - 150 mm² (AWG 3 - AWG 5/0)
Tightening torque (Nm)	0.7 - 0.8	1.7 - 1.8	2.5 - 4.5	15 - 20	25 - 30
recommended crimping tool	Phoenix CRIMPFOX 6	Phoenix CRIMPFOX 6 or 16 S	Phoenix CRIMPFOX or similar	-	-

*) *Suitable for ferrules without plastic sleeve up to 6 mm²*

Table A.13 Technical data motor terminals BG1 to BG6a

Characteristic	BG7
Screws for ring terminal end	ZK-, ZK+, RB-, RB+: M10 L1-3, U, V, W: M12
Tightening torque (Nm)	Screws M10: 20-25 Screws M12: 25-30

Table A.14 Technical data for motor connecting bars BG7

A.4 Current demand of control supply

Housing variant	Size	max. starting current	Continuous current
Wall mounting	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 is valid as long as the voltage supply for the power section is switched off. Once the power section is supplied with voltage, an internal high-voltage switch-mode power supply will take over the supply for the control unit.*

Table A.15 Current demand of control supply

A.5 Ambient conditions

Ambient conditions	ServoOne
Degree of protection	IP20 except the terminals (IP00)
Accident prevention instructions	according to local regulations (in Germany e.g. BGV A3)
Mounting height	up to 1000 m above sea level, higher than 1000 m above sea level with reduced power 1% per 100 m, max. 2000 m above sea level
Pollution severity	2
Type of installation	Built-in unit, only for vertical installation in a control cabinet with min. degree of protection IP4x, when using the safety function STO min. IP54.

Table A.16 Ambient conditions ServoOne

Climatic conditions			ServoOne
during transport	acc. to EN 61800-2, IEC 60721-3-2 class 2K3[1)]		
	Temperature		-25 °C to +70 °C
	Relative air humidity		95 % at max. +55 °C
during storage	acc. to EN 61800-2, IEC 60721-3-1 class 1K3 and 1K42		
	Temperature		-25 °C to +55 °C
	Relative air humidity		5 to 95 %
during operation	acc. to EN 61800-2, IEC 60721-3-3 class 3K3[3)]		
	Temperature	Air cooling	**BG1** -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 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	**BG2 and 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 kHz), up to 55 °C with power reduction (2 % per °C)
	Relative air humidity		5 to 85 % without condensation

1) The absolute air humidity is limited to max. 60 g/m³. This means e.g. at 70 °C, that the relative humidity must only be max. 40 %.
2) The absolute air humidity is limited to max. 29 g/m³. The maximum values for temperature and relative air humidity specified in the table must not occur at the same time.
3) The absolute air humidity is limited to max. 25 g/m³. This means, that the maximum values for temperature and relative air humidity specified in the table must not occur at the same time.

Table A.17 Climatic conditions ServoOne

Mechanical conditions			ServoOne
Vibration limit during transport	acc. to 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 during transport	acc. to EN 61800-2, IEC 60721-2-2 class 2M1		
	Dropping height of packed device max. 0.25 m		
Vibration limits of system [1)]	acc. to EN 61800-2, IEC 60721-3-3 class 3M1		
	Frequency [Hz]	**Amplitude [mm]**	**Acceleration [m/s²]**
	2 ≤ f < 9	0.3	not applicable
	9 ≤ f < 200	not applicable	1

1) Note: The devices are solely intended for stationary use.

Table A.18 Mechanical conditions ServoOne

ATTENTION!

- **Control cabinet min. IP54 for STO**
  According to EN ISO 13849-2 the control cabinet must have degree of protection IP54 or higher when using the safety function STO (Safe Torque OFF).
- **No continuous vibrations!**
  The drive controllers must not be installed in areas where they would be permanently exposed to vibrations.

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A.6 Mains filter

Details to the subject "Electromagnetic Compatibility" can be found in section 3.1 "Notes for installation" starting from page 17.

The following table shows the permissible motor cable lengths in accordance with the standard EN 61800-3.

Drive controller	4 kHz power stage cycle frequency		8 kHz power stage cycle frequency		12 kHz power stage cycle frequency		16 kHz power stage cycle frequency	
	Category							
	C3	C2	C3	C2	C3	C2	C3	C2
SO84.004[1]	40 m	20 m	40 m	15 m	40 m	10 m	40 m	8 m
SO84.006[1]	40 m	20 m	40 m	15 m	40 m	10 m	40 m	8 m
SO84.008[1]	40 m	20 m	40 m	15 m	40 m	10 m	40 m	10 m
SO84.012[1]	40 m	20 m	40 m	15 m	40 m	10 m	40 m	10 m
SO84.016[1]	40 m	10 m	40 m	10 m	40 m	10 m	40 m	10 m
SO84.020[1]	40 m	10 m	40 m	10 m	40 m	10 m	40 m	10 m
SO84.024[1]	40 m	10 m	40 m	10 m	40 m	10 m	40 m	10 m
SO84.032[1]	40 m	10 m	40 m	10 m	40 m	10 m	40 m	10 m
SO84.045[2) 3)]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m
SO84.060[2) 3)]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m
SO84.072[2) 3)]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m
SO84.090[2) 3)]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m
SO84.110[2) 3)]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m
SO84.143[2) 3)]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m

C3 = "Second environment" (industrial area)
C2 = "First environment" (residential area)
1) The motor shield terminal is not on the plate screen, but directly on the device terminals.
2) For compliance with the standard mains chokes (uK = 4 % to 32 A / uK = 2 % at 45 to 450 A) must be used
3) Compliance with the standard is only possible when using an external filter (no internal filter present)

Table A.19 Permissible motor cable length

Drive controller	4 kHz power stage cycle frequency		8 kHz power stage cycle frequency		12 kHz power stage cycle frequency		16 kHz power stage cycle frequency	
	Category							
	C3	C2	C3	C2	C3	C2	C3	C2
SO84.170[2) 3)]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m
SO84.250[2) 3)]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m
SO84.375[2) 3)]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m
SO84.450[2) 3)]	25 m	10 m	25 m	10 m	25 m	10 m	25 m	10 m

C3 = "Second environment" (industrial area)
C2 = "First environment" (residential area)
1) The motor shield terminal is not on the plate screen, but directly on the device terminals.
2) For compliance with the standard mains chokes (uK = 4 % to 32 A / uK = 2 % at 45 to 450 A) must be used
3) Compliance with the standard is only possible when using an external filter (no internal filter present)

Table A.19 Permissible motor cable length

A.7 Hydrological data for the liquid cooling

ATTENTION! The temperature of the cooling plate must not drop lower than 10 °C below the ambient temperature. Condensation will damage the device.

NOTE: The customer must ensure sufficient heat discharge from the water cooler. The coolant must be approved by LTi DRiVES.

Requirements	Limits
Coolant quality	Recommended: Drinking water + corrosion inhibitor (e.g. ethylene glycol) Not permitted are: Chloride ions (Cl- > 100 ppm) Calcium carbonate (CaCO3 > 160 ppm)
Pollution	The coolant must be as pure as possible, to prevent clogging of channels. With a suspended matter concentration of more than 15 mg/dm³ continuous cleaning is recommended.
Coolant operating 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 avoid moisture condensation on the heat sink.
Cooler material	Aluminium
Recooling system [1)]	e.g.: Pfannenberg Rack 2400 (BG 6, 6a) Pfannenberg EB 43 WT (BG 7)

1) Rating for devices without internal braking resistor

Table A.20 Requirements on liquid cooling

A.8 Dynamic cooler temperature monitoring

Should the coolant flow be interrupted or not start at all, the power stage may overheat. For this reason the drive controller is equipped with dynamic coolant temperature monitoring, which switches the drive controller off in case of overtemperature. The drive controller switches off at a heat sink temperature of 65 °C, irrespective of the temperature gradient.

A.9 UL-approbation

A.9.1 Measures to comply with the UL-approbation (UL 508C) BG1 to BG4

1. The devices must only be operated on networks of overvoltage category III.
2. The devices can be used in networks with a maximum possible current of 5 kA with phase symmetric current and a max. voltage of 480 V with network fusing acc. to table A.21.
3. The devices are designed for installation in environments with pollution severity 2 acc. to EN 60664-1.
4. The integrated back-up fuse does not serve as protective device for branch lines. The protective device for branch lines must be designed according to the instructions of the manufacturer, the NEC regulations (National Electrical Code) and other locally valid standards.
5. Only UL-qualified device connecting cables (mains, motor and control cables) must be used:
   - Use copper cables with a temperature resistance of min. 75 °C.
   - Required tightening torques for the terminals: see table A.21.
6. Maximum ambient air temperature: see table A.17.

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Size	Device	Tightening torque mains and motor terminals (X11, X12)	Tightening torque control terminals (X5, X9, X10, X13)	Mains fuse / class
BG1	SO82.004	0.56 - 0.79 Nm	0.56 - 0.79 Nm	1 x 20 A / K5
	SO84.004	0.56 - 0.79 Nm	0.56 - 0.79 Nm	3 x 10 A / K5
	SO84.006	0.56 - 0.79 Nm	0.56 - 0.79 Nm	3 x 15 A / K5
BG2	SO84.008	0.56 - 0.79 Nm	0.56 - 0.79 Nm	3 x 20 A / RK5
	SO84.012	0.56 - 0.79 Nm	0.56 - 0.79 Nm	3 x 25 A / RK5
BG3	SO84.016	1.7 Nm	0.56 - 0.79 Nm	3 x 30 A / RK5
	SO84.020	1.7 Nm	0.56 - 0.79 Nm	3 x 40 A / RK5
BG4	SO84.024	1.7 Nm	0.56 - 0.79 Nm	3 x 50 A / K5
	SO84.032	1.7 Nm	0.56 - 0.79 Nm	3 x 60 A / K5

Table A.21 Tightening torques and mains fuse BG1 to BG4

A.9.2 Measures for compliance with the UL-approbation (UL 508C) for BG5, 6 and 6a

1. The devices must only be operated on networks of overvoltage category III.
2. The devices can be used in networks with a maximum possible current of 10 kA with phase symmetric current and a max. voltage of 480 V with network fusing acc. to table A.22.
3. The devices are designed for installation in environments with pollution severity 2 acc. to EN 60664-1.
4. The integrated back-up fuse does not serve as protective device for branch lines. The protective device for branch lines must be designed according to the instructions of the manufacturer, the NEC regulations (National Electrical Code) and other locally valid standards.
5. Only UL-approved circuit breakers and fuses of class RK1 may be used. For details on the fuse rating see table A.22.
6. The device internal overload protection enables 2 times the rated device current for minimum 3 seconds.
7. Only UL-qualified device connecting cables (mains, motor and control cables) must be used:
   - Use copper cables with a temperature resistance of min. 75 °C.
   - Suitable tightening torques for terminals see table A.22
8. If the device is to be operated with an enclosed external braking resistor, this resistor must be separately protected against excessive temperatures.
9. Maximum ambient air temperature: see table A.17.
10. Technical boundary conditions for devices with liquid cooling see table A.20.

Size	Device	Tightening torque PE-conductor and mains terminals	Tightening torque motor terminals	Mains fuse class RK 1
BG5	SO84.045	2.5-4.5 Nm / 22-40 lb-in	2.5-4.5 Nm / 22-40 lb-in	3 x 50 A
	SO84.060			3 x 80 A
	SO84.072			3 x 80 A
BG6	SO84.090	15-20 Nm / 133-177 lb-in	15-20 Nm / 133-177 lb-in	3 x 100 A
	SO84.110			3 x 125 A
BG6a	SO84.143	25-30 Nm / 133-177 lb-in	25-30 Nm / 221-265 lb-in	3 x 175 A
	SO84.170			3 x 200 A

Table A.22 Tightening torques, cable cross-sections and mains fuse BG5, BG6, BG6a

A.9.3 UL-approbation for BG7

An UL-approbation for BG7 is planned.

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LTi DRiVES GmbH

Gewerbestraße 5-9
35633 Lahnau
Germany
Fon +49 (0) 6441/ 96 6-0
FAX +49 (0) 6441/ 96 6-137

Heinrich-Hertz-Straße 18
59423 Unna
Germany
Fon +49 (0) 2303/ 77 9-0
FAX +49 (0) 2303/ 77 9-397

www.lt-i.com
info@lt-i.com

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