LTi DRiVES

ServoOne junior

Operation Manual

Servocontrollers

2.0 A to 8 A

BG2 BG3 BG4

ServoOne junior Operation Manual

ID no.: 1300.20B.1-00

Date: 09/2010

Applicable as from firmware version: V0.25

The German version is the original of this Operation Manual.

ServoOne junior High-Performance Drives

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

We reserve the right to make technical changes.

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

We should nevertheless point out that this document cannot always be updated in line with ongoing technical developments in our products.

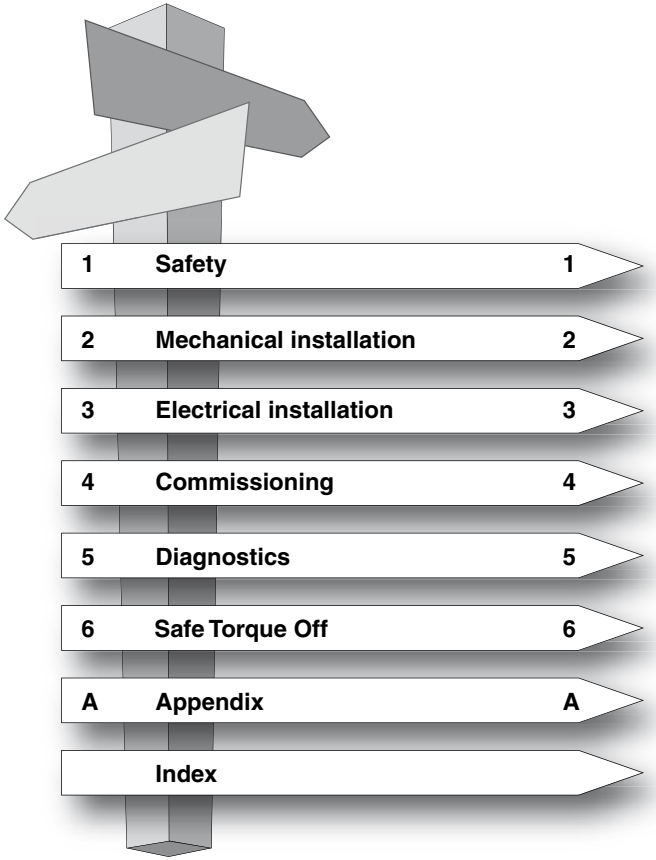
Information and specifications may be subject to change at any time. For information on the latest version please visit http://drives.lt-i.com.

How to use 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 using your new ServoOne junior 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 the ServoOne junior drive system very quickly and easily.	Quick-start guide
2.	Simply follow the step-by-step tables in the various sections.	And away you go!



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Order code

The order designation indicates the relevant design variant of the servocontroller delivered to you. For details on the order code refer to the ServoOne order catalogue.

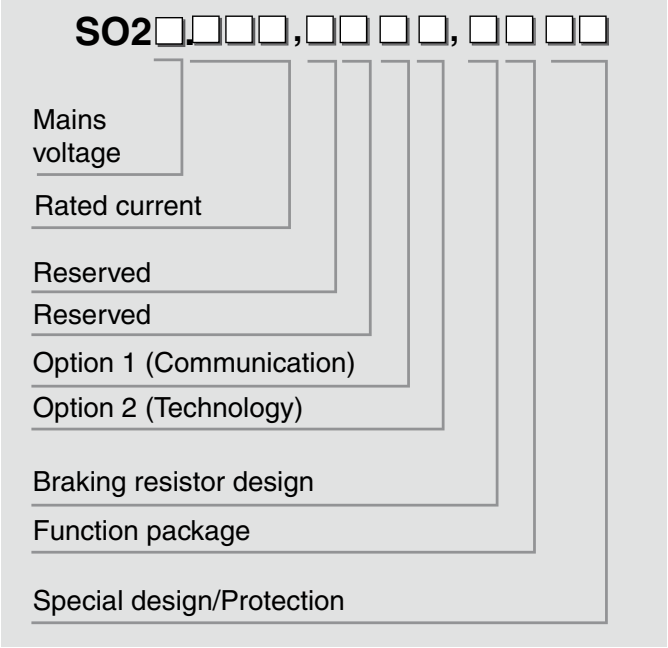

Figure 0.1 ServoOne junior order code

Rating plate

On rating plates of the ServoOne junior drive units you will find the serial number, from which you can identify the date of manufacture based on the following key. For the location of the rating plate on the ServoOne junior refer to figure 3.1 on page 14.

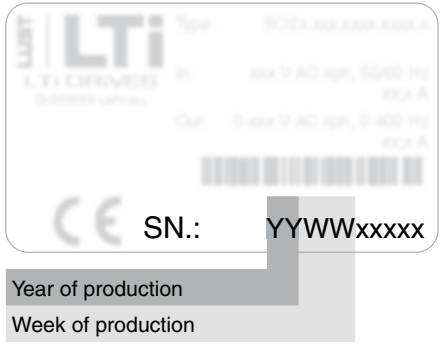

Figure 0.2 ServoOne junior hardware rating plate

Supply package

The supply package includes:

- ServoOne junior drive unit
- Terminal pack for control and power terminals (depending on device power and variant)
- Set of shield connection plates and fixings
- LTi Drives product DVD

Pictograms

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

Warnings (see also section 1.1)	
	ATTENTION! Misoperation may result in damage to the drive or malfunctions.
	DANGER FROM ELECTRICAL TENSION! Improper behaviour may endanger human life.
	DANGER FROM ROTATING PARTS! Drive may start up automatically.
Hints & Tips	
	NOTE: Useful information or reference to other documents
	STEP: Action in a sequence of multiple actions.

EC Declaration of Conformity

The manufacturer	LTi DRiVES GmbH Gewerbestrasse 5-9 35633 Lahnau
hereby declares that the following products	
Product designation:	Positioning controller with Safe Torque Off (STO) safety function
Product series:	ServoOne junior
conform to the safety requirements of the following EC Directive:	
2006/42/EC 2004/108/EC	[Machinery Directive] [EMC Directive]
and that the harmonized standards specified below have been applied:	
	EN ISO 13849-1: 2008 IEC/EN 62061: 2005 EN 61800-5-2: 2003
The following standards have been applied: EC Type Approval Test	
Notified Body:	TÜV Rheinland Industrie Service GmbH Am Grauen Stein, 51105 Köln
Identification number:	0035
EC Type Approval Test	Certificate No.: 01/205/5036/10
Person authorized to compile the technical documentation: Matthias Wagner, Gewerbestrasse 5-9, 35633 Lahnau (Germany)	
Year of CE marking:	2010

Figure 0.3 EC Declaration of Conformity, ServoOne junior

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Space for your own notes

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1. Safety

1.1 Measures for your safety

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

ATTENTION! The ServoOne junior's "Safe Torque Off (STO)" safety function must be 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 61800-5-1 and EN 61508 is ensured.

1.1.1 Read the Operation Manual first!

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

Table 1.1 Safety instructions

1.1.2 Warning symbols

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

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

Table 1.2 Explanations of warning symbols

1.2 Intended use

ServoOne junior drive controllers are components designed solely for vertical installation in stationary electrical systems or machines.

When installed in machines the 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 provisions of the Machinery Directive2006/42/EC; compliance with EN 60204 is mandatory.

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

CE The ServoOne junior conforms to the Low Voltage Directive 2006/95/EC

The drive controllers fulfill the demands of the harmonized product standard EN 61800-5-1:2008.

If the drive controller is used for special applications, such as in areas subject to explosion hazard, the required standards and regulations (e.g. EN 50014, "General provisions" and EN 50018, "Flameproof housing") must always be observed.

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

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

1.3 Responsibility

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

In the section on "Electrical equipment of machines" the standard EN 60204-1/DIN VDE 0113 "Safety of machines" stipulates safety requirements for electrical controls. They are intended to protect personnel and machinery, and to maintain the function capability of the machine or system concerned, and must be observed.

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

2. Mechanical installation

2.1 Notes for operation

Please be sure to avoid:

- penetration of damp into the device;
- aggressive or conductive substances in the immediate vicinity;
- drill chippings, screws or foreign bodies dropping into the device;
- ventilation openings being covered over, as otherwise the device may be damaged.

Note the following points:

- Cooling air must be able to flow through the device without restriction.
- For mounting in switch cabinets with convection (= heat loss is discharged to the outside via the cabinet walls), always fit an internal air circulation fan.
- The backing plate must be well grounded.
- The device is designed only for vertical installation in switch cabinets. The switch cabinet must as a minimum provide IP4x protection.

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

- To attain the best result for EMC-compatible installation you should use a chromated or galvanized backing plate. If backing plates are varnished, remove the coating from the contact area. The devices themselves have an aluminium back panel.
- Max. pollution severity 2.

Further information on environmental conditions can be found in the appendix.

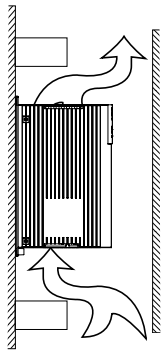
2.2 Wall mounting

Step	Action	Comment
1.	Mark out the position of the tapped holes on the backing plate. Cut a tap for each fixing screw in the backing plate.	For dimensional drawings/hole pitch see table 2.2, figure 2.1 and figure 2.2 The tapping area will provide you with good, full-area contact.
2.	Mount the servocontroller **vertically** on the backing plate.	Observe the mounting clearances! The contact area must be metallically bright.
3.	Mount the other components, such as the mains filter, line reactor etc., on the backing plate.	The cable between mains filter and servocontroller may be max. 30 cm long.
4.	Continue with the electrical installation in section 3.	

Table 2.1 Mechanical installation

NOTE: For all sizes of the ServoOne junior forced cooling by external air flow is necessary. The air must be able to flow unhindered through the device. If a temperature cut-out occurs, the cooling conditions must be improved.

Air flow: min. 1.2 m/s



Dimensions

ServoOne junior	BG2	BG3	BG4
	SO22.003 SO24.002	SO22.006 SO24.004	SO22.008 SO24.007
Weight [kg]	1.0	1.5	2.8
B (width)	55		
H (height) 1)	210		290
T (depth) 1)	142	189	235.5
A	27.5		
A1	-	-	40
C	225		305
C1	5		
D ∅	4.8		
E	Direct end-to-end mounting (see note)		
F 2)	≥ 100	≥ 150	
G 2)	≥ 235		≥ 280
H1	235		315
Screws	2 x M4		4 x M4

All dimensions in mm
1) Without terminals/connectors
2) The bend radius of the connecting cables must be taken into account

Table 2.2 ServoOne junior dimensions - see figure 2.1 and figure 2.2

NOTE: The minimum distance specified in the table for sizes 2-4 applies for devices of 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). This minimizes the thermal influence among each other.

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

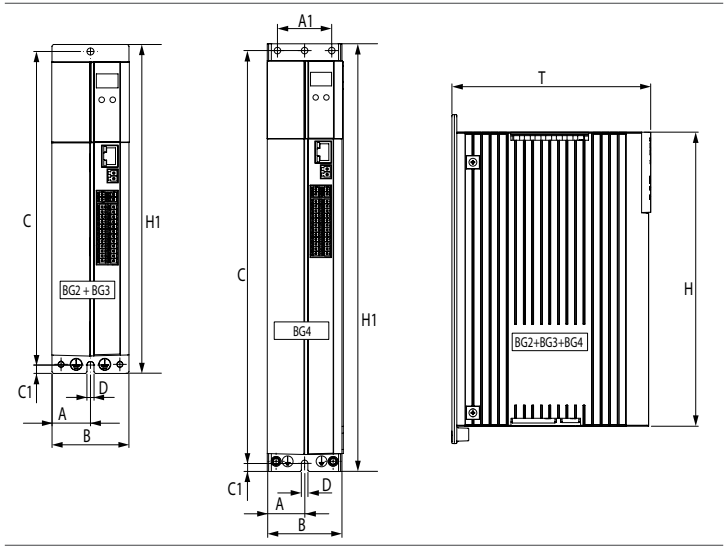


Figure 2.1 Dimensions (in mm) – BG2, BG3, BG4

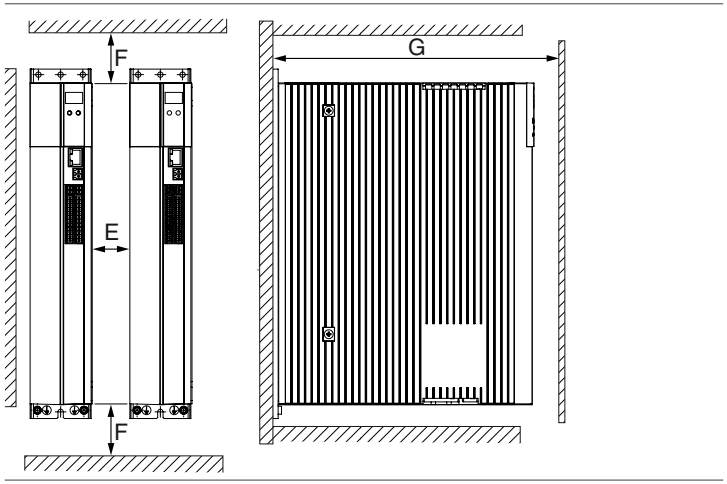


Figure 2.2 Mounting clearances (in mm)

3. Electrical installation

3.1 Notes for installation

ATTENTION!

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

DANGER FROM ELECTRICAL TENSION!

- **Danger to life!**
  – Never wire or disconnect electrical connections while they are live! Disconnect the device from the mains supply (230/400/460/480 V AC) before working on it. Dangerously high voltages of ≥ 50 V may still be present 10 minutes after the power is cut (capacitor charge). Work on the device only once the DC link voltage has fallen below 50 V residual voltage (indicated by monitoring LED H1 **and** measured at terminals X1/L- and L+).
  – Even if the device does not emit any visual or audible signals or show other indications, dangerous voltage may be connected to the device (such as with mains voltage to terminal X3 switched on and no +24 V DC control supply on X2)!

Installation of drive controllers is subject to the following basic rules:

- **Compliance with EMC product standard**
  Compliance with EMC product standard Commissioning (i.e. starting intended operation) is only permitted when strictly complying with EMC product standard EN 61800-3:2004. The installer/operator of a machine and/or item of plant must provide proof of compliance with the protection targets stipulated in the standard.
- **Cable type**
  Use shielded mains, motor and signal cables with double copper braiding, providing 60 to 70 % coverage.
- **Cable laying**
  – Lay mains, motor and signal cables isolated from each other. Maintain a minimum clearance of 0.2 metres wherever possible. They should not run in parallel. If crossovers are unavoidable, they should wherever possible be configured perpendicular (at a 90° angle).
  – Always route the motor cable without interruptions and by the shortest route out of the switch cabinet. If a motor contactor is used, for example, the component should be directly mounted to the drive controller and the shield of the motor cable should not be stripped too soon.
  – As far as possible route signal cables into the switch cabinet from one side only.
  – Cables of the same circuit must be twisted.
  – Avoid unnecessary cable lengths and loops.
- **Grounding measures**
  The grounding measures of relevance to the drive controller are detailed in section 3.5 "Protective conductor connection".
- **Shielding**
  Do not strip the cable shields too soon, and lay them across wide areas both on the component and on the backing plate and PE rail (main ground) of the backing plate.
- **External components**
  – Place larger consumers near the supply.
  – Contactors, relays, solenoid valves (switched inductors) must be wired with fuses. The wiring must be directly connected to the respective coil.
  – Switched inductors should be at least 0.2 metres away from process controlled assemblies.

Supplementary information can also be found in the relevant connection description. If you need more details on installation please contact the LTi Helpline (see page 44).

3.2 Layout

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

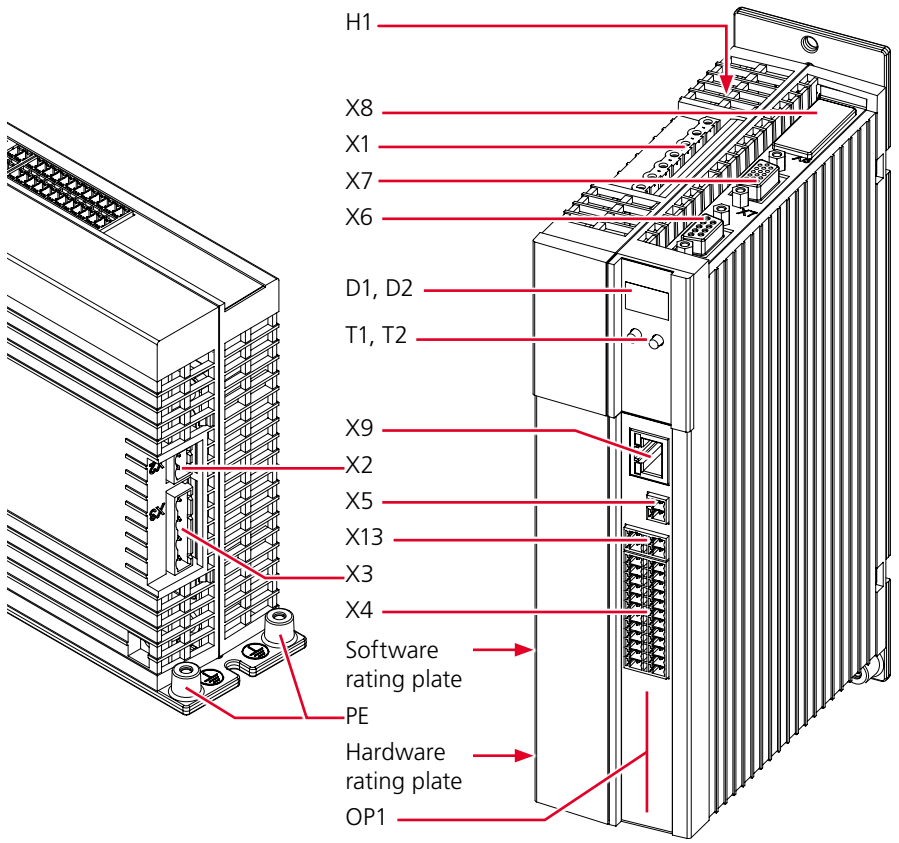


Figure 3.1 ServoOne junior layout

No.	Designation
D1, D2	7-segment display
H1	DC link voltage indicator LED
OP1	Installation space for option 1 (Communication)
PE	Protective conductor connection
T1, T2	Pushbuttons
X1	Power connection
X2	Connection of control supply U_V
X3	AC mains connection
X4	Control terminals
X5	Motor temperature monitoring
X6	Resolver connection
X7	Connection for high-resolution encoders
X8	Option 2 (Technology)
X9	Ethernet interface
X13	Connection of motor brake

Table 3.1 Key to ServoOne junior layout

3.3 Connection diagram

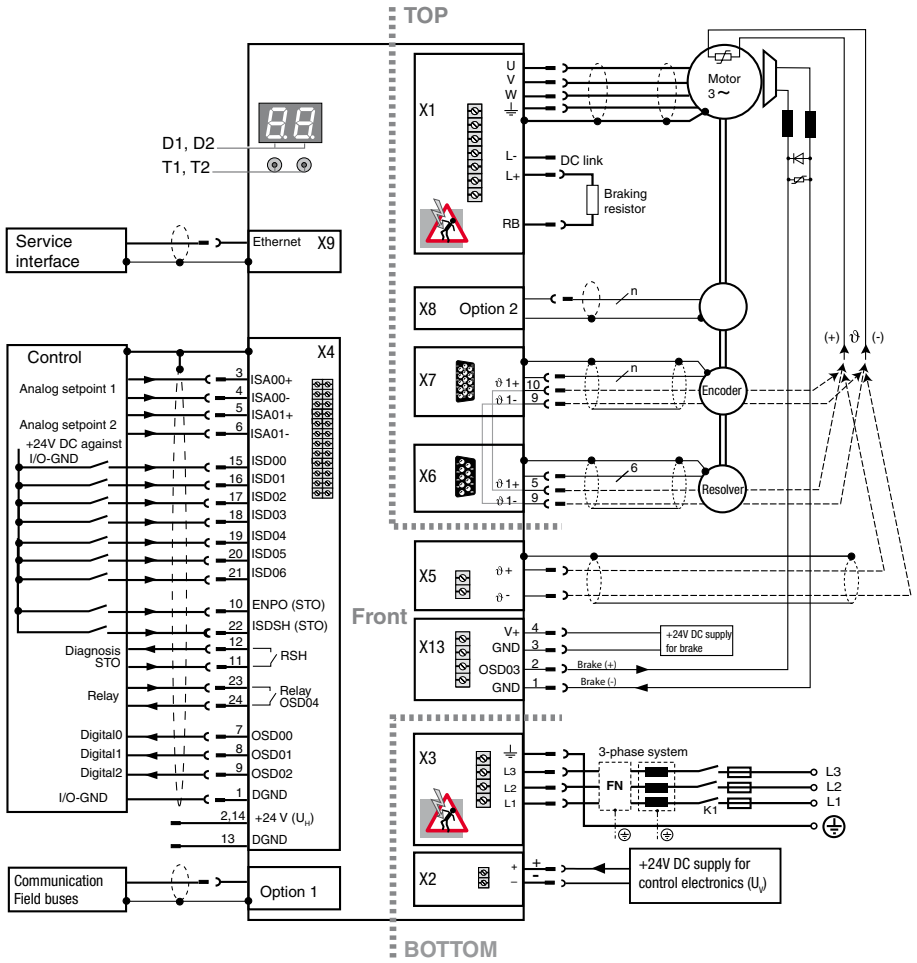


Figure 3.2 Connection diagram

No.	Designation	Function	Page
D1, D2	7-segment display	Device status display	see p.39
T1, T2	Pushbuttons	Service functions	see p.39
X1	Power connection	Motor, braking resistor and connection for measurement of DC link voltage	see p.29
X2	Connection of control supply U_V	+24 V DC supply voltage for control electronics of drive controller	see p.21
X3	AC mains connection	Mains supply	see p.21
X4	Control terminals	Digital inputs/outputs, analog inputs, STO request incl. feedback	see p.24
X5	Motor temperature monitor connection	PTC, based on DIN 44082, Klixon automatic cutout	see p.29
X6	Resolver connection	Resolver, incl. motor temperature monitor	see p.28
X7	High-resolution encoder interface	Sin/Cos encoder, TTL encoder, EnDat 2.1 encoder, HIPERFACE® encoder, SSI encoder, incl. motor temperature monitor	see p.28
Option 1	Communication	Factory installed module for field buses, e.g. SERCOS, EtherCAT	see p.26
⏚	Protective conductor connection	Connection diagram see section 3.5	see p.19
X8 Option 2	Technology	Factory installed module e.g for TTL encoder simulation, second SIN/COS encoder or EnDat 2.1	see p.26
X9	Ethernet interface	Service port, connection to PC	see p.26
X13	Connection of motor brake	Power output with cable break detector	see p.29

1) NOTE: The temperature sensor of the motor winding can be optionally connected via the encoder cables (X6 or X7) or to terminal X5.

Table 3.2 Key to connection diagram

3.4 Effective EMC installation

3.4.1 Interference immunity of drive controllers

ATTENTION! This is a restricted availability product in accordance with IEC 61800-3. This product may cause radio interference in domestic environments; in such cases the operator may need to take appropriate countermeasures.

External radio frequency interference (RFI) suppression filters (EMCxxx) are available for the drive controllers. With the measurement method specified and the external mains filter, these drive controllers conform to the EMC product standard IEC 61800-3 for "First environment" (residential C2) and "Second environment" (industrial C3).

3.4.2 Specimen setup

The specimen setup presented on the following pages is intended to illustrate the key measures necessary to ensure EMC-compatible setup.

NOTE:
The specimen setup merely presents a recommendation, and does not automatically guarantee compliance with applicable EMC directives. The installer/operator of a machine and/or item of plant must provide proof of compliance with the protection targets stipulated in the standard.

Overview

Figure 3.3 presents an overview of the minimum components required:

A. Backing plate with cable ducts
B. ServoOne junior
C. Mains filter
D. Line reactor
E. Distributor rail for AC power supply and control supply (+24 V DC)

The layout and cabling are based on the instructions set out in section 3.1, "Notes for installation", on page 13. The numbered red arrows refer to four very important detailed notices presented on the following pages.

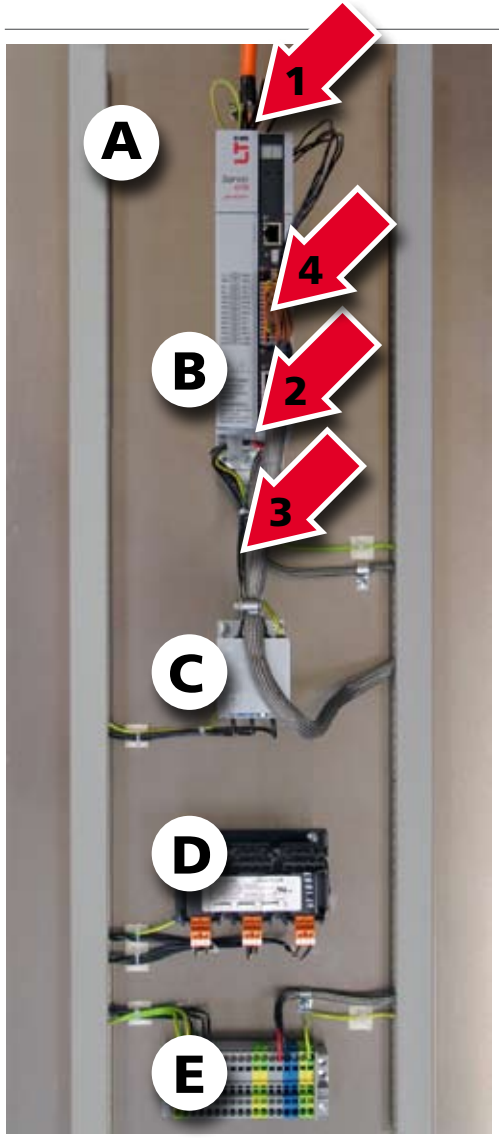


Figure 3.3 Specimen setup - Overview

Detail 1: Motor cable

At the motor connection (X1) of the ServoOne junior note the following points:

- Secure one of the two supplied shield connection plates by the screw to the mount on the top of the unit. Ensure the plate contacts across a wide area with the heat sink of the ServoOne junior and with the backing plate. Use a toothed ring.
- Strip back the shield of the motor cable on the motor connection (X1) of the ServoOne junior as little as absolutely necessary.
- Connect the motor cable shield across a wide area to the shield connection plate by the clamp supplied.

NOTE:
Ready made-up motor cables are available for LTi DRiVES servomotors. For details refer to the Servomotors order catalogue (ID no.: 0814.05B.x).

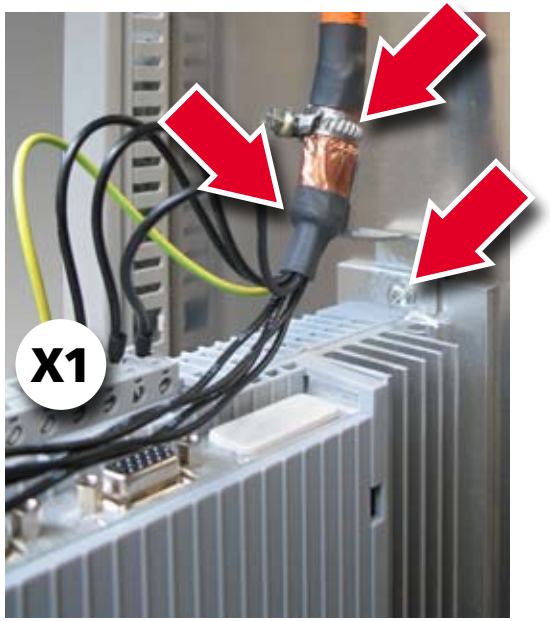


Figure 3.4 Specimen setup - Detail 1: Motor cable

Detail 2: Control supply (+24 V DC)

At the control supply connection (X2):

- Secure the second of the two supplied shield connection plates by the screw to the mount on the bottom of the unit. Ensure the plate contacts across a wide area with the heat sink of the ServoOne junior and with the backing plate. Use a toothed ring.
- Slot a shield tube over the control supply cable and strip it back only as short as necessary before the control supply connection (X2).
- Connect the shielding tube of the control supply cable across a wide area to the shield connection plate by the clamp supplied.

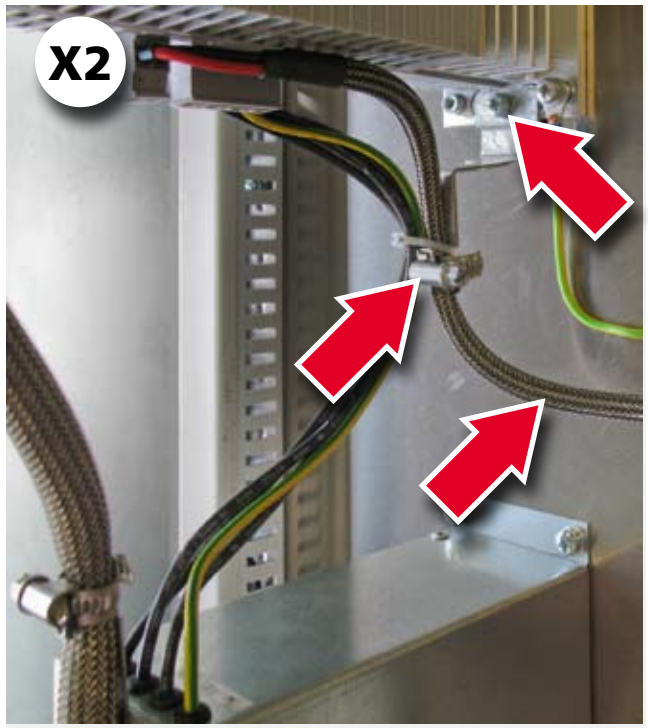


Figure 3.5 Specimen setup - Detail 2: Control supply

Detail 3: Mains filter and mains connection

At the output of the mains filter and at the AC mains connection (X3):

- Connect the wire strands at the output of the mains filter directly to the AC mains connection (X3) of the ServoOne junior. The strands must **not** be extended, so the mains filter should be installed correspondingly close to the ServoOne junior. But be sure to maintain the necessary minimum clearance (see table 2.2 on page 12).
- Fix the strands to the shield connection plate using a cable tie as necessary.
- The leakage current of the ServoOne junior is >3.5 mA. So:
  - Connect the protective conductor from the output of the mains filter to the connection (X3) of the ServoOne junior **and**
  - one of the PE connections on the heat sink of the ServoOne junior via a cable of at least the same cross-section to the main ground of the distributor rail.

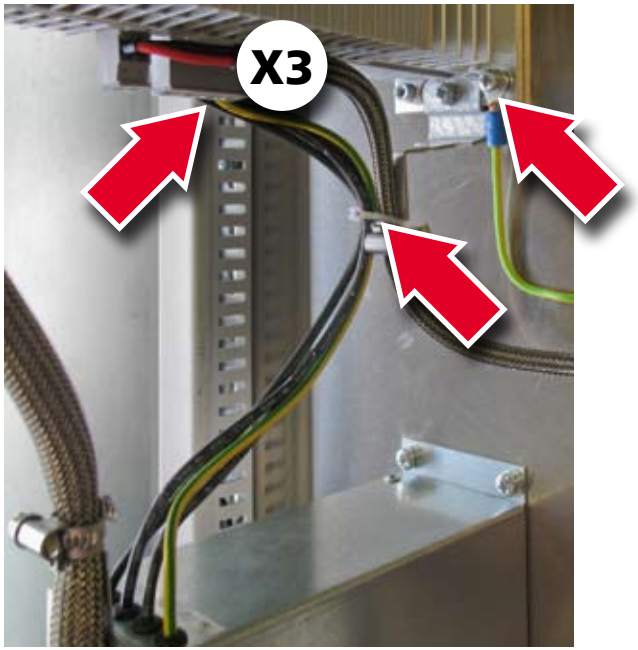


Figure 3.6 Specimen setup - Detail 3: Mains filter and mains connection

Detail 4: Control cables

At the control terminals (X4) of the ServoOne junior note the following points:

- Strip the shielding of the control cables back only as short as absolutely necessary.
- Connect the control cable shields across a wide area to the shield connection tab of the mains filter by the clamp supplied. If this is not possible, lay the control cable shielding directly across a wide area on the backing plate directly adjacent to the ServoOne junior.

Figure 3.7 Specimen setup - Detail 4: Control cables

3.5 Protective conductor connection

Step	Action	PE-mains connection to DIN EN 61800-5-1
1.	Ground each of the drive controllers! Connect terminal ⏚ **in star configuration and across a wide area** to the PE rail (main ground) in the switch cabinet.	Rules for the PE terminal as leakage current >3.5 mA): Use protective conductors with the same cross-section as the mains power cables, though at least 10 mm². Also comply with local and national regulations and conditions.
2.	Also connect the protective conductor terminals of all other components, such as line reactors, filters etc. **in star configuration and across a wide area** on the PE rail (main ground) in the switch cabinet.	

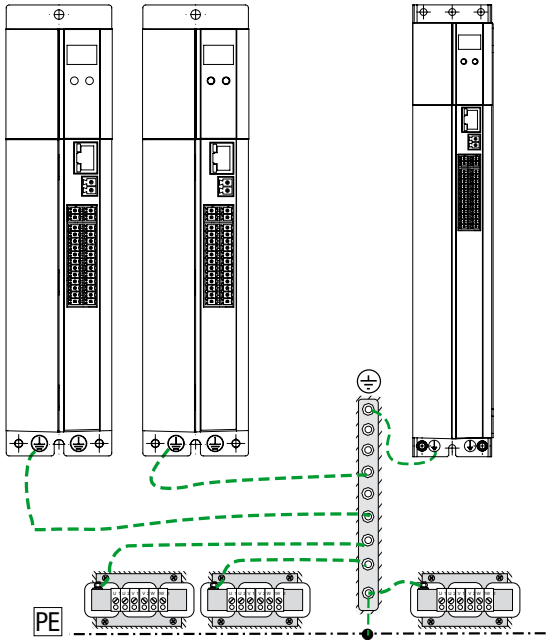


Figure 3.8 Star configuration layout of the PE conductor

3.6 Electrical isolation method

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

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

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

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

SELV = Safety Extra Low Voltage

PELV = Protective Extra Low Voltage

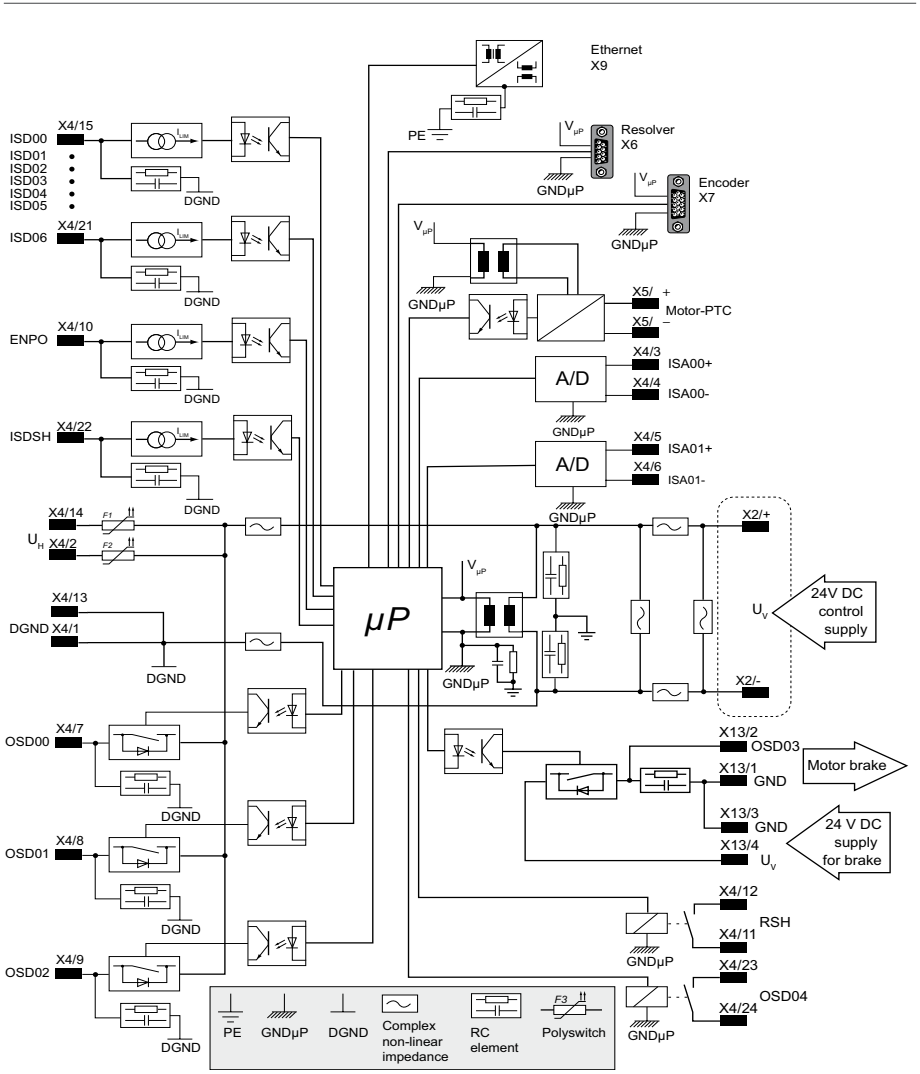


Figure 3.9 ServoOne junior electrical isolation method

3.7 Connection of supply voltages

The voltage supply to the ServoOne junior is separate for the control and power sections. The control supply should always be connected **first**, so that the device can be parameterized with DriveManager 5 and, above all, set to the correct power supply.

ATTENTION! Only when the mains voltage has been set and the ServoOne junior restarted (if the mains voltage or switching frequency has been changed) may the mains power supply be activated. Otherwise the device may be destroyed!

3.7.1 Connection of control supply (+24 V DC)

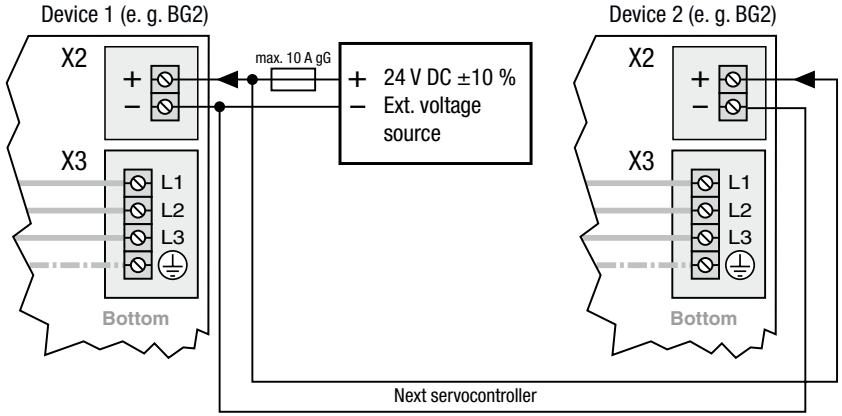


Figure 3.10 ServoOne junior control supply connection

Control supply (specification)		
Connection of control supply	X2/+ X2/-	• U_V = +24 V DC ±10 %, stabilized and smoothed. • I_V = 2 A (BG2 to BG4) • Internal polarity reversal protection • The power supply unit used must have a safe and reliable isolation against the mains system according to EN 50178 or EN 61800-5-1.

Table 3.3 ServoOne junior control supply specification

ATTENTION! Suitable measures must generally be applied to provide adequate line protection.

DANGER FROM ELECTRICAL TENSION! When the mains voltage is switched on at terminal X3 and there is no control supply (+24 V DC at X2) , dangerous voltage is connected to the device with no visual signal on the display or acoustic indication by fan noise. If visible in the installed state, LED H1 (see figure 3.1) indicates whether voltage is connected to the device. Even when H1 is out, X1 must be checked to ensure no voltage is connected.

NOTE: The start-up current for the supply voltage to the BG2 to BG4 may be two to three times the operating current.

3.7.2 Connection of mains supply, BG2 and BG3

NOTE: Before commissioning, the value of the connected mains voltage must be set on the drive controller (factory setting = 3 x 230 V AC / 3 x 400 V AC).

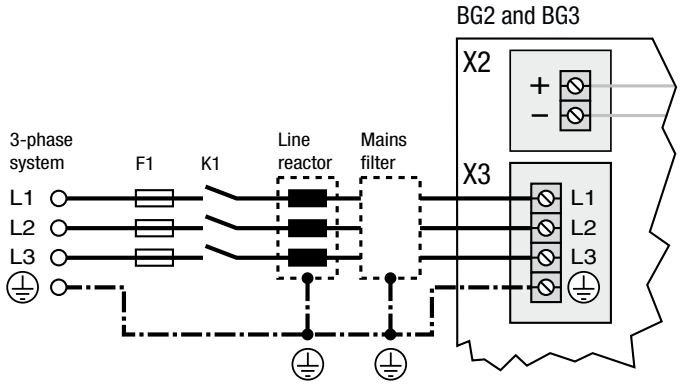


Figure 3.11 BG2 and BG3 mains supply connection 3 x 230 V (SO22.xxx) or 3 x 400 V (SO24.xxx) depending on device design

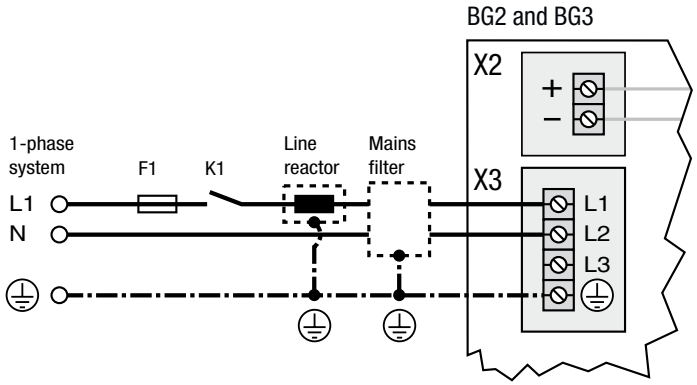


Figure 3.12 BG2 and BG3 connection to mains supply 1 x 230 V

3.7.3 Mains supply connection, BG4

NOTE: Before commissioning, the value of the connected mains voltage must be set on the drive controller (factory setting = 3 x 230 V AC / 3 x 400 V AC).

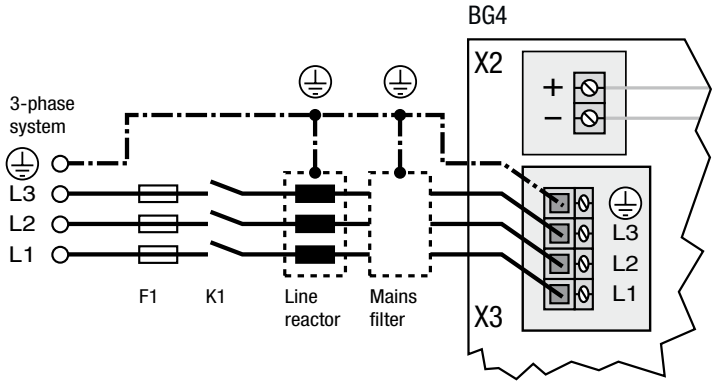


Figure 3.13 BG4 mains supply connection 3 x 230 V (SO22.xxx) or 3 x 400 V (SO24.xxx) depending on device design

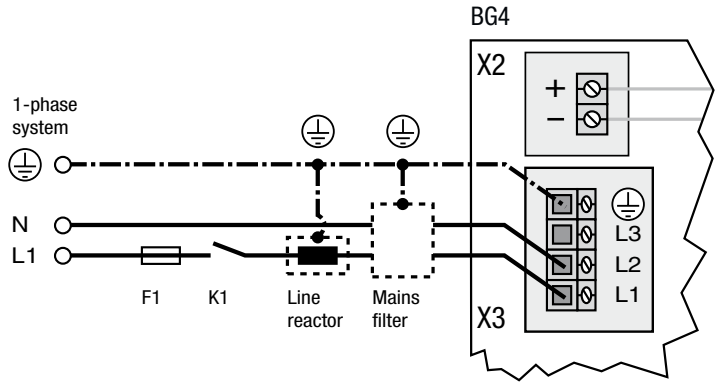


Figure 3.14 BG4 mains supply connection 1 x 230 V

Procedure:

Step	Action	Comment
1.	Specify the cable cross-section dependent on the maximum current and ambient temperature.	Cable cross-section according to local regulations and conditions.
2.	Wire the drive controller with the mains filter *), max. cable length 0.3 m (with non-shielded cable)!	
3.	Wire the line *) (if installed).	Reduces the voltage distortions (THD) in the system and prolongs the life of the drive controller.
4.	Install a K1 circuit breaker (power circuit breaker, contactor, etc.).	Do not switch on the power!
5.	Use mains fuses (duty class gG) to isolate all poles of the drive controller from the mains supply.	For compliance with equipment safety requirements laid down in EN 61800-5-1

*) Optional

DANGER FROM ELECTRICAL TENSION! Danger to life! Never wire or disconnect electrical connections while they are live. Always disconnect the power before working on the device. Dangerously high voltages of ≥ 50 V may still be present 10 minutes after the power is cut (capacitor charging). So always check that the power has been cut!

ATTENTION! If local regulations require the installation of a residual current operated protective device, the following applies:
In case of a fault the drive controller is able to generate d.c. leak currents without zero crossing. Drive controllers therefore must only be operated with RCDs[1] type B for a.c. fault currents, pulsating or smooth d.c. fault currents, which are suitable for servo controller operation, see IEC 60755. RCMs[2] can additionally be used for monitoring purposes.

1) Residual current protective device

2) Residual current monitor

Note the following points:

- 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 ready to start once again.
- TN and TT network: Operation is permitted if:
  - in the case of single-phase devices for 1 x 230 V AC the supply system conforms to the maximum overvoltage category III as per EN 61800-5-1.
  - In the case of three-phase devices with external conductor voltages 3 x 230 V AC, 3 x 400 V AC, 3 x 460 V AC and 3 x 480 V AC
    1. **the neutral point** of the supply system is **grounded** and
    2. the supply system conforms to the maximum overvoltage category III as per EN 61800-5-1 at a system voltage (external conductor neutral point) of maximum 277 V.
- IT network: not permitted!
  - In case of a ground fault the electrical stress is approximately twice as high. Clearances and creepages to EN 61800-5-1 are no longer maintained.
- Connection of the drive controllers by way of a line reactor is mandatory:
  - where the drive controller is used in applications with disturbance variables corresponding to environment class 3, as per EN 61000-2-4 and above (hostile industrial environment);
  - in the case of single-phase mains supply;
  - for compliance with EN 61800-3 or IEC 61800-3.
- For further information on permissible current loads, technical data and ambient conditions please refer to the appendix.

NOTE: Please be aware that the ServoOne junior is not rated for environment class 3. Further measures are essential in order for that environment class to be attained! For further information please consult your project engineer.

Drive controller	Device connected load[1] [kVA]		Max. line cross-section[2] of term. [mm²]	Specified mains fuse, duty class gG [A]
	With line reactor (4 % u_K)	Without line reactor		
SO22.003	1.3	1.6	2.5	3 x max. 16
SO24.002	1.5	1.9		3 x max. 6
SO22.006	2.6	3.2	2.5	3 x max. 16
SO24.004	2.7	3.3		3 x max. 10
SO22.008	3.5	4.3	4	3 x max. 20
SO24.007	5.0	6.1		3 x max. 16

1) At 3 x 230 V AC or 3 x 400 V AC mains voltage

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

Table 3.4 Connected load and mains fuse

3.8 Control connections

Step	Action	Comment
1.	Check whether a complete device setup is already available, i.e. whether the drive has already been configured.	
2.	If this is the case, a special control terminal assignment applies. Please contact your project engineer to obtain the terminal assignment!	
3.	Choose a terminal assignment.	Initial commissioning
4.	Wire the control terminals with shielded cables. The following is strictly required: STO request X4/22, ENPO X4/10 and a start signal (with control via terminal).	Ground the cable shields over a wide area at both ends. Conductor sizes fixed: 0.2 to 1.5 mm² Flexible conductor sizes: - Ferrule without plastic sleeve: 0.2 to 1.5 mm² - Ferrule with plastic sleeve: 0.2 to 0.75 mm²
5.	Keep all contacts open (inputs inactive).	
6.	Check all connections again!	Continue with commissioning in section 4.

Note the following points:

- Always wire the control terminals with shielded cables.
- Lay the control cables separately from the mains power and motor cables.
- A cable type with double copper braiding, with 60 - 70% coverage, must be used for all shielded connections.

3.8.1 Specification of control connections

Des.	Term.	Specification	El.isolation
Analog inputs			
ISA0+ ISA0- ISA1+ ISA1-	X4/3 X4/4 X4/5 X4/6	• U_{IN} = ±10 V DC • Resolution 12-bit; R_{IN} approx. 101 kΩ • Terminal scan cycle 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	• Frequency range < 500 Hz • Terminal scanning cycle = 1 ms • Switching level Low/High: ≤ 4.8 V / ≥ 18 V • $U_{IN\ max}$ = +24 V DC +20 % • I_{IN} at +24 V DC = typ. 3 mA	Yes
ISD05 ISD06	X4/20 X4/21	• Frequency range ≤ 500 kHz • Switching level Low/High: ≤ 4.8 V / ≥ 18 V • $U_{IN\ max}$ = +24 V DC +20 % • $I_{IN\ max}$ with +24 V DC = 10 mA, R_{IN} approx. 3 kΩ • Internal signal delay time < 2 µs suitable as trigger input for quick saving of actual position	Yes
ENPO	X4/10	• Disable restart inhibit (STO) and enable power stage = High 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
Digital outputs			
OSD00 OSD01 OSD02	X4/7 X4/8 X4/9	• No destruction in case of short-circuit (+24 V DC -> DGND), but device may briefly shut down. • I_{max} = 50 mA, PLC-compatible • Terminal scanning cycle = 1 ms • High-side driver	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 3.5 Specification of control connections X4

Des.	Term.	Specification		El.isolation
STO "Safe Torque Off"				
ISDSH (STO)	X4/22	• "Request STO" input = Low level • OSSD-capable • 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 • 30 V / 200 mA AC, cos φ = 1	X4/12 X4/11	Yes
Relay outputs				
REL	X4/23 X4/24	Relay, 1 NO contact • 25 V / 1.0 A AC, cos φ = 1 (AC1) • 30 V / 1.0 A DC, cos φ = 1 (DC1) • Switching delay approx. 10 ms • Cycle time 1 ms	X4/23 X4/24	
Auxiliary voltage				
+24 V	X4/2 X4/14	• Auxiliary voltage output (U_H) to feed the digital control inputs • $U_H = U_V$-ΔU (ΔU typically approx. 1.2 V), no destruction in case of short circuit (+24 V -> DGND), but device may briefly shut down. • I_{max} = 80 mA (per pin) with self-resetting circuit-breaker (polyswitch)		Yes
Digital ground				
DGND	X4/1 X4/13	Reference ground for +24 V DC		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 3.5 Specification of control connections X4

3.8.2 Connection of motor brake X13

Connector X13 (BG2 to BG4) is intended for connection of a motor brake.

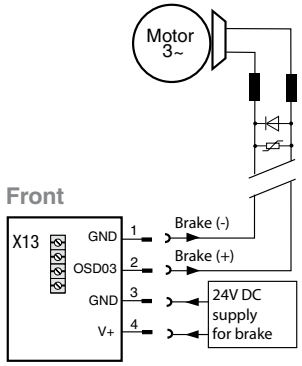
Des.	Term.	Connection	Specification
OSD03 GND GND V+	X13/2 X13/1 X13/3 X13/4		• Short-circuit proof • External control supply +24 V DC (I_{IN} = 2.1 A) required via X13/3 (GND) and X13/4 (V+) • $U_{BR} = U_V$-ΔU` (ΔU` typically approx. 1.4 V) • To actuate a motor holding brake up to I_{BR} = 2.0 A max. (for brakes with higher current requirements a relay must be interposed). • Overcurrent causes cyclic shutdown • Also usable as configurable digital output • Interruptible cable break monitor <200 mA typically in condition "1"

Table 3.6 Specification of terminal connections X13

ID no.: 1300.20B.1-00 - Date: 09/2010

3.9 Specification of Ethernet port

The service and diagnostic interface X9 is executed as a TCP/IP Ethernet port. It is suitable for connection of a PC for commissioning, service and diagnosis and for programming of the drive controller.

The following software can communicate via the Ethernet port with the drive controller:

- LTi DRiVES DriveManager 5 for commissioning, service and diagnosis of the ServoOne junior
- CoDeSys 3.x programming system for programming of the ServoOne junior in the languages of IEC 61131-3. This requires a drive controller licence.

Specification of interface:

- Transfer rate 10/100 MBits/s BASE
- Line protocol IEEE802.3 compliant
- Connection via standard commercially available crosslink cable, CAT 5 (e.g. LTi-DRiVES accessory CC-ECLxx, see also ServoOne order catalogue)

3.10 Option 1

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

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

3.11 Option 2

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

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

3.12 Encoder connection

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

Encoder connection of LSH/T motors

Please use the ready made-up motor and encoder cables from LTi DRiVES GmbH to connect the LSH/T synchronous motors (see Servomotors order catalogue).

Matching motor - encoder cable - drive controller connection

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

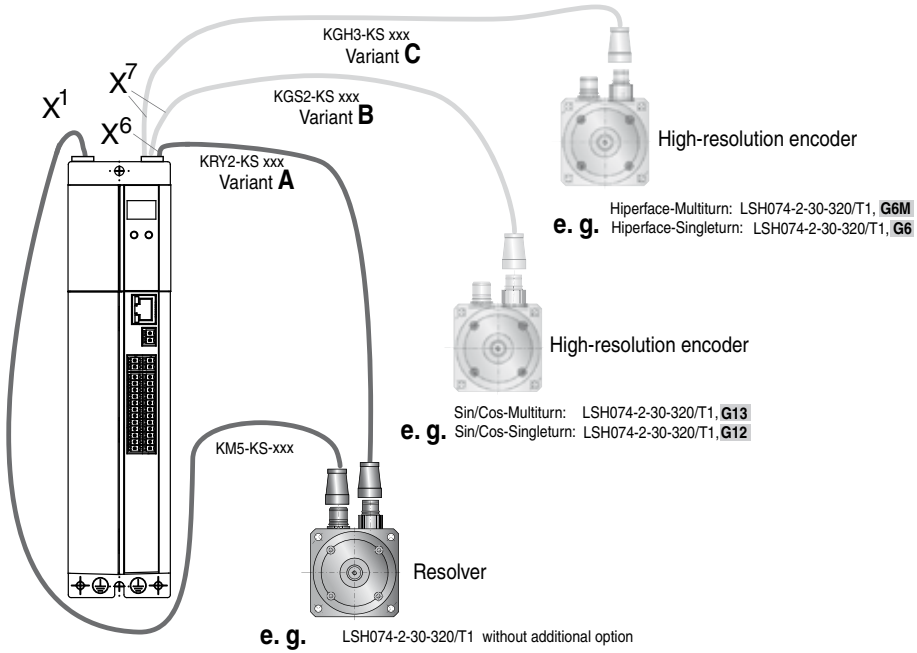


Figure 3.15 Matching motor/encoder cable

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

	Motor (with installed encoder)	Encoder cable	Drive controller connection
Variant A	with resolver e.g. LSH/LST H074-2-30-320/T1 without further options	KRY2-KSxxx	X6
Variant B	G13: = Sin/Cos multi-turn 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 H074-2-30-320T1,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 multi-turn encoder with HIPERFACE®interface e.g. LSH/LST H074-2-30-320/T1,G6M	KGH3-KSxxx	X7

Table 3.7 Variants of motors, encoder type and encoder cable

Ready made-up encoder cables

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

			K	RY2	- KS	xxx
Ready made-up cable						
Encoder system	*Resolver cable*			RY2		
	Encoder cable SSI, EnDat			GS2		
	Encoder cable HIPERFAC®			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/multi-turn encoder with SSI/ Endat interface)	G6, G6.x (single/multi-turn encoder with HIPERFACE®interface)
Controller-end assignment (sub-D connector)	1 = S2 2 = S4 3 = S1 4 = n.c. 5 = PTC+ 6 = R1 7 = R2 8 = S3 9 = PTC-	1 = A- 2 = A+ 3 = VCC (+5 V) 4 = DATA+ 5 = DATA- 6 = B- 8 = GND 11 = B+ 12 = VCC (Sense) 13 = GND (Sense) 14 = CLK+ 15 = CLK- 7, 9, 10 = n.c.	1 = REFCOS 2 = +COS 3 = Us 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 bend radius	90 mm	100 mm	90 mm

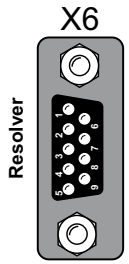
Table 3.8 Technical data – encoder cable

	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 outer sheath	PUR		
Resistance	Resistant to oil, hydrolysis and microbic attack (VDE0472)		
Approvals	UL-Style 20233, 80 °C - 300 V, CSA-C22.2N.210-M90, 75 °C - 300 V FT1		

Table 3.8 Technical data – encoder cable

3.12.1 Resolver connection X6

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

Fig.	X6/Pin	Function
	1	Sin+ / (S2) analog differential input track A
	2	Refsin / (S4) analog differential input track A
	3	Cos+ / (S1) analog differential input track B
	4	Supply voltage 5 ... 12 V, int. connected to X7/3
	5	ϑ+ (PTC, KTY, Klixon) internally connected to X7/10 [1)]
	6	Ref+ analog excitation
	7	Ref- analog excitation (ground reference point to pins 6 and 4)
	8	Refcos / (S3) analog differential input track B
	9	ϑ- (PTC, KTY, Klixon) internally connected to X7/9 [1)]

1) Be sure to pay attention to the notice headed "ATTENTION" in table 3.12!

Table 3.9 Pin assignment, X6-resolver connection

3.12.2 Connection for high-resolution encoders X7

Encoder interface X7 enables evaluation of the following encoder types.

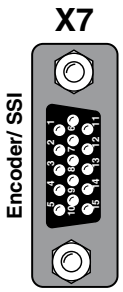
Fig.	Function
	**Sin/Cos encoder with zero pulse:** • e.g. Heidenhain ERN1381, ROD486 • U_V = 5 V ±5 %, I_{max} = 150 mA
	Heidenhain Sin/Cos encoder with EnDat2.1 interface: • e.g. 13-bit single-turn encoder (ECN1313.EnDat01) and 25-bit multi-turn encoder (EQN1325-EnDat01) • U_V = 5 V ±5 %, I_{max} = 150 mA
	Sin/Cos encoder with SSI interface: • e.g. 13-bit single-turn and 25-bit multi-turn encoders (ECN413-SSI, EQN425-SSI) • U_V = 5 V ±5 %, I_{max} = 150 mA
	Sick-Stegmann Sin/Cos encoder with HIPERFACE® interface: • Single-turn and multi-turn encoders, e.g. SRS50, SRM50 • U_V = 7 to 12 V (typ. 11 V) ±5 %, I_{max} = 100 mA

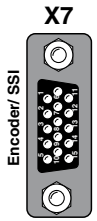
Table 3.10 Suitable encoder types on X7

NOTE: Encoders with a power supply of 5 V ± 5 % must have a separate sensor cable connection. The encoder cable detects the actual supply voltage at the encoder, thereby compensating for the voltage drop on the cable. Only use of the sensor cable ensures that the encoder is supplied with the correct voltage. The sensor cable must always be connected.

Electrical specification of interface X7:

Select the cable type specified by the motor or encoder manufacturer, bearing in mind the following:

- Always used shielded cables. Apply the shield on both sides.
- Connect the differential track signals A, B, R or CLK, DATA to each other via twisted wires.
- Do not separate the encoder cable, for example to route the signals via terminals in the switch cabinet.

Fig.	X7/Pin	Function Sin/Cos and TTL	Absolute encoders SSI/ EnDat 2.1/2.2	Absolute encoder HI-PERFACE®	
	1	A-	A-	REFCOS	
	2	A+	A+	+COS	
	3	+5 V, ±5 % at I_OUT_MAX=250 mA controlled, monitoring via sensor cable		7 to 12 V / (typ. 11 V) 100 mA	The sum of the currents tapped at X7/3 and X6/4 must not exceed the specified value!
	4	R+ / Data +			
	5	R- / Data -			
	6	B -	B -	REFSIN	
	7	-	-	U_S - Switch	
	8	GND	GND	GND	
	9	ϑ- (PTC, KTY, Klixon) internally connected to X6/9. [1]			
	10	ϑ+ (PTC, KTY, Klixon) internally connected to X6/5. [1]			
	11	B+	B+	+SIN	
	12	Sense+		U_S - Switch	After connecting pin 7 to pin 12, a voltage of 11.8 is set at X7/3 and X6/4
	13	Sense-		-	
	14	-	CLK+	-	
	15	-	CLK-	-	

X7

Encoder/ SSI

1) Be sure to pay attention to the notice headed "ATTENTION" in table 3.12!

Table 3.11 Pin assignment, X7-encoder connection

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

3.13 Motor connection

Step	Action	Comment
1.	Specify the cable cross-section dependent on the maximum current and ambient temperature.	Cable cross-section according to local and country-specific regulations and conditions
2.	Connect the shielded motor cable to terminals X1/ U, V, W and connect the motor to ground at ⏚.	Mount shield at both ends to reduce interference emission.
3.	Wire the motor temperature sensor and activate temperature evaluation by means of DriveManager. See also related note.	Mount shield at both ends to reduce interference emission.

Motor temperature sensor

ATTENTION! When connected to terminal X5, the motor temperature sensor must provide **basic insulation,** against the motor coil and, when connected to terminal X6 or X7, must provide **increased insulation** in accordance with EN 61800-5-1.

X5	Temperature switch (Klixon), PTC	Sensor with basic insulation
X6	Temperature switch (Klixon), PTC, KTY	Sensor with increased insulation
X7	Temperature switch (Klixon), PTC, KTY	Sensor with increased insulation

Table 3.12 Motor temperature sensor terminal configuration

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 issued.

3.13.1 Connection of LSH/LST motors

For connection of the servomotor series LSH xxx and LST xxx please use the ready made-up motor cable KM3-KS-xxx (4 x 1.5 mm² + 2 x 2 x 0.75 mm²) or KM4-KS-xxx (4 x 1.5 mm²).

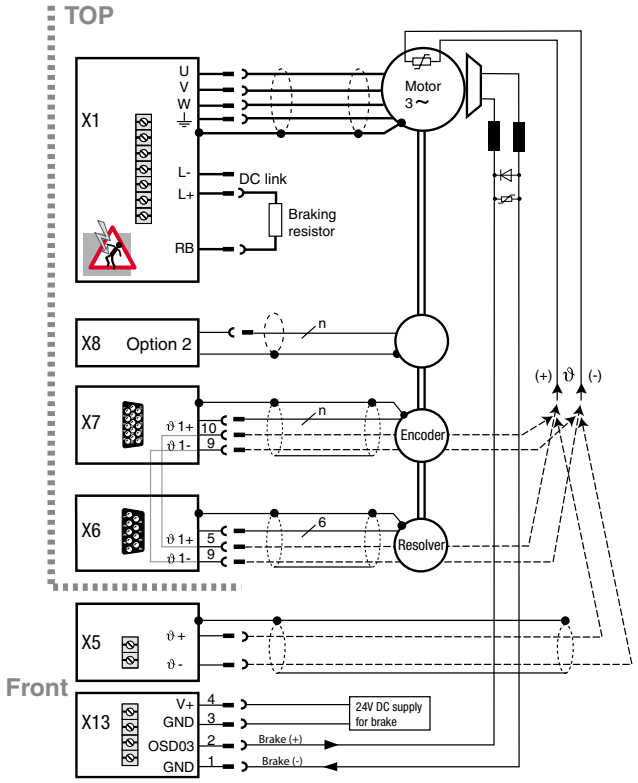


Figure 3.16 Connection of motor

ATTENTION! DC linking of multiple drive controllers is **not** permitted!

Ready made-up motor cable

Motor cable KM5-KSxxx

Order code

KM5 - KS xxx

- KM5: Ready made-up motor cable
- KS: Design, Festoon-compatible
- xxx: Cable length (m)

Order code

Technical data

		KM5-KSxxx
For motors with plug-in power connection		to I_N = 16 A
Minimum bend radius	in fixed installation	90 mm
	in flexible use	120 mm
Temperature range		-30 ... +80 °C
Cable diameter approx.		12 mm
Cable cross-section		(3+T) x 1.5 mm² + 2 x 2 x 0.75 mm²
Outer sheath material		PUR
Resistance		to oil, hydrolysis and microbic attack (VDE0472) UL 1581, flame-resistant (DIN EN 50265-2-1)
Wiring		U = 1 V = 2 W = 3 Ground = ye/gn PTC = 5 PTC = 6 Brake + = 7 Brake - = 8
Approval		UL AWM 80 °C - 600V/1000V CSA AWM 80 °C - 600V/1000V FT1

Table 3.13 Technical data – motor cable

NOTE: Wires 5 and 6 (PTC) are required only for motors in which the motor PTC cannot be connected via the encoder cable. In the case of LSH/LSTxxx motors with resolver, the PTC is connected via the resolver cable.

3.13.2 Switching in the motor cable

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

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

3.14 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 braking transistor is activated and the regenerated power is converted into heat by means of a braking resistor.

3.14.1 Protection in case of braking chopper fault

ATTENTION! If the internal braking 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 by assigning any digital output (DriveManager 5 ►subject area "Configuration of the inputs/outputs" ►Digital outputs ►OSD00 to OSD02) **BC_FAIL(56)**. In the event of a fault the selected output then switches from 24 V to 0 V. This signal ensures that the drive controller is safely disconnected from the mains supply.

For detailed information on parameterization refer to the ServoOne application manual.

3.14.2 Design with integrated braking resistor (BG3+4)

The catalogue only specifies the peak braking power for the drive controllers with integrated braking resistor (model SO2x.xxx.xxxx.1xxx). The permissible continuous braking power must be calculated. It depends on the effective loading of the controller in the corresponding application.

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 current and at maximum ambient temperature.

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

Device	Technology	Rated resistance R_{BR}	Peak braking power P_{PBr}	Pulse energy W_{IBr}	K1
SO22.006	Wire resistance	100 Ω	1500 W *1)*	150 Ws	120
SO24.004		420 Ω	1000 W *2)* 1300 W *3)* 1400 W *4)*	140 Ws	50
SO22.008		90 Ω	1690 W *1)*	6000 Ws	170
SO24.007			4700 W *2)* 6170 W *3)* 6500 W *4)*	6000 Ws	120

1) Value referred to 1 x 230 V AC mains voltage (BR switch-on threshold 390 V DC)
2) Value referred to 3 x 400 V AC mains voltage (BR switch-on threshold 650 V DC)
3) Value referred to 3 x 460 V AC mains voltage (BR switch-on threshold 745 V DC)
4) Value referred to 3 x 480 V AC mains voltage (BR switch-on threshold 765 V DC)

Table 3.14 Data of the integrated braking resistor (design SO2x.xxx.xxxx.1xxx)

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

NOTE: Further calculation assumes that the drive controller is used at maximum permissible ambient temperature. This means that any additional energy input from the internal braking resistor caused by low ambient temperature will be neglected.

Method to calculate the continuous braking power:

- Calculation of effective drive controller loading in a cycle T:

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

- Determination of permissible continuous braking power based on unused drive power:

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

Marginal conditions

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

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

- The continuous braking power calculated for the device must be greater than the effective braking power 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 on-time of the braking resistor over a specified cycle time T with calculated continuous braking power results as:

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

ATTENTION! No additional external braking resistor may be connected to drive controllers SO22.003 to SO24.007 with integrated braking resistor.

3.14.3 Connection of an external braking resistor

ATTENTION!

- Be sure to follow the installation instructions for the external 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 drive controller is disconnected from the mains supply if the braking resistor overheats.
- The minimum permissible connection resistance of the drive controller must not be infringed – for technical data see section A.2 on page 53.
- The braking resistor must be connected by a shielded cable.

Size BG2 to BG4

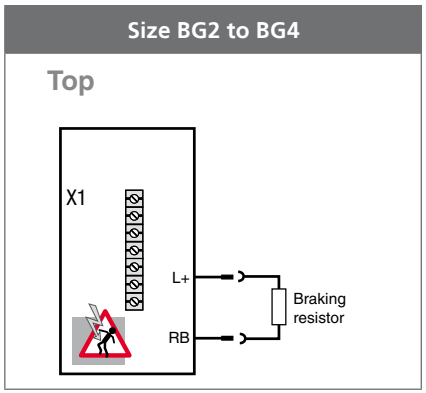


Figure 3.17 Connection of braking resistor

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

DANGER FROM ELECTRICAL TENSION! Danger to life! Never wire or disconnect electrical connections while they are live. Always disconnect the power before working on the device. Dangerously high voltages of ≥ 50 V may still be present 10 minutes after the power is cut (capacitor charging). So check that the power has been cut!

ATTENTION! The external braking resistor must be monitored by the control. The temperature of the braking resistor is monitored by a temperature watchdog (Klixon). In the event of overheating the drive controller must be disconnected from the mains supply.

Available braking resistors (excerpt)

Order designation	Continuous braking power	Resistance[1)]	Peak braking power [2)]	Protection	Picture
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	

1) Tolerance ± 10 %
2) The maximum possible braking power dependent on ON-time and cycle time

Table 3.15 Technical data - braking resistors

NOTE: Exact specifications, in particular with regard to surface temperature, maximum system voltage and high-voltage strength, are set out in the ServoOne order catalogue.

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

Space for your own notes

4. Commissioning

4.1 Notes for operation

ATTENTION!

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

4.2 Initial commissioning

When the ServoOne junior has been installed as per section 2. and wired with all required voltage supplies and external components as per section 3. , initial commissioning is carried out in the following steps:

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

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

4.2.1 Switching on the control supply

For initialization and parameter setting, first switch on only the +24 V DC control supply. Do **not yet** switch on the AC mains supply.

Display readout after switching on the control supply

D1	D2	Action	Explanation
		Switching on the +24 V DC control supply	Initialization in progress
		Initialization complete	Not ready for start

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

NOTE: For details on the control supply refer to section 3.7 , "Connection of supply voltages", starting on page 21.

4.2.2 Connecting the PC and drive controller

The PC can be connected to the drive controller via Ethernet (TCP/IP). Connect the PC and drive controller accordingly using an Ethernet cable.

NOTES:

- **Initialization**
  Communication between the PC and the drive controller can only be established once the drive controller has completed its initialization.
- **TCP/IP configuration**
  If the PC does not detect the connected drive controller, check the Ethernet port settings (see DriveManager 5 Installation Manual).

4.2.3 Parameter setting

For drive system setup DriveManager 5 includes a Commissioning Wizard. Start the Wizard.

NOTES:

- **Online Help**
  For a detailed description of DriveManager 5 and of the Commissioning Wizard, refer to the DriveManager 5 Online Help.
- **Motor data set**
  When using LTi servomotor type LSH or LST, the latest version of the necessary motor data set can be obtained from the "Downloads" section at http://drives.lt-i.com.

4.2.4 Controlling the drive with DriveManager 5

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

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

ATTENTION!

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

- **Destruction of the motor!**
  - Some motors are intended for operation on the drive controller. Direct connection to the mains supply may destroy the motor.
  - The motor surfaces may become extremely hot. Temperature-sensitive items should therefore not be placed on top of or attached to the motors. Protective measures may be needed to prevent touching.
  - In order to avoid overheating of the motor, the temperature sensor installed in the winding must be connected to the terminals of the temperature monitoring system for the drive controller (X5 and 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 a working brake is prohibited.

Display readout after switching on the AC mains supply

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

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

NOTES:

- **Inputs "ISDSH" and "ENPO"**
  For step 1 from table 4.3 the two inputs "ISDSH" and "ENPO" of terminal X4 must be configured as a minimum.
- **Manual mode dialog**
  The best way to execute step 2 from table 4.3 is via the "Manual mode" dialog of DriveManager 5. For details refer to the Online Help.
- **Configuration of inputs/outputs**
  If step 2 is to be executed via the inputs of terminal X4, the sources for "START CONTROL" and speed reference setpoint should be configured accordingly in the "Inputs/outputs" subject area of DriveManager 5.

Power-up sequence to start the drive

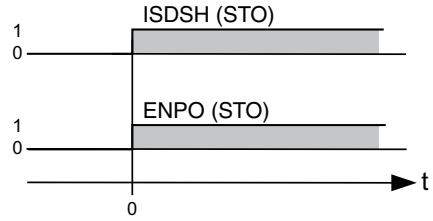
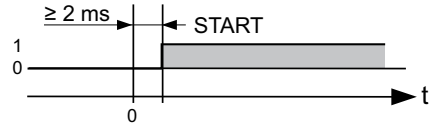
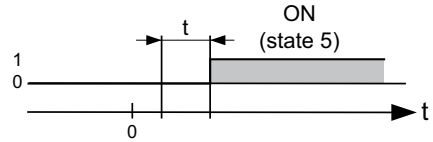
1. Disable "STO" safety function by setting inputs "ISDSH" and "ENPO" (see section 6.)	
2. Activate "START CONTROL" at the earliest 2 ms after step 1 and set the reference speed	
3. Observe your system/ plant and check the drive response.	
t = Motor-dependent delay time	

Table 4.3 Power-up sequence

Display readout after drive start-up

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

Table 4.4 Display D1/D2 during motor activation

For details on optimizing the drive in your application refer to the DriveManager 5 Online Help and the ServoOne Application Manual.

4.3 Serial commissioning

An existing parameter data set can be transferred to other ServoOne junior drive controllers using DriveManager 5. For details refer to the DriveManager 5 Online Help.

4.4 Integrated operator contIrol unit

The built-in operator control unit permits diagnosis of the ServoOne junior. The operator control unit comprises the following elements, all located on the front of the device:

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

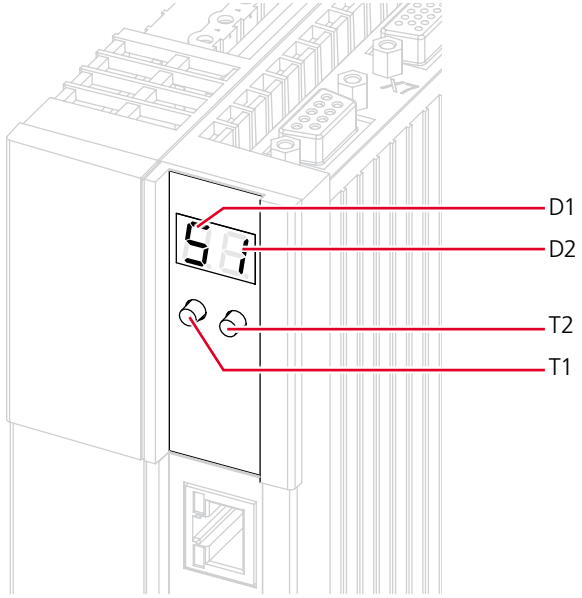


Figure 4.1 ServoOne junior integrated operator control unit

The following functions and displays are available:

- Display of device state (see section 5.1 , "Device states", on page 43)
  The device state is displayed after switching on the control supply. If no input is made via the keypad for 60 seconds, the display switches back to the device state.
- Display of device error state (see page 43)
  If a device error occurs the display immediately switches to show the error code.
- Parameter setting (display "PA") (see section 4.4.3)
  Resetting device parameters to their factory setting
- Ethernet IP address setting (display "IP") (see section 4.4.4)
  Setting of the Ethernet IP address and the subnet mask
- Field bus settings (display "Fb") (see section 4.4.5)
  Setting of field bus address for example

4.4.1 Functions of buttons T1 and T2

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

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

Table 4.5 Functions of buttons T1 and T2

4.4.2 Display

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

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

Table 4.6 Meaning of display

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

4.4.3 Parameters menu (PA)

On the Parameters menu the device settings can be reset to their factory defaults.

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

Table 4.7 Parameters menu

Error numbers

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

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

Error number	Meaning
17	Parameter reset to factory settings failed
18	Parameter write access failed
19	Save parameter data set non volatile failed
20	Not all parameters written
21	Error while reset to factory settings

Table 4.8 Error numbers

4.4.4 Ethernet IP address menu (IP)

An Ethernet TCP/IP port is available as a service and diagnostics interface. The IP address is set by default to 192.168.39.5 and the subnet mask to 255.255.255.0. Both can be changed by way of the IP Address menu.

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

Table 4.9 IP address menu

Example configuration of subnet mask

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

NOTE: Changes on the IP Address menu are only saved when the control electronics are subsequently restarted.

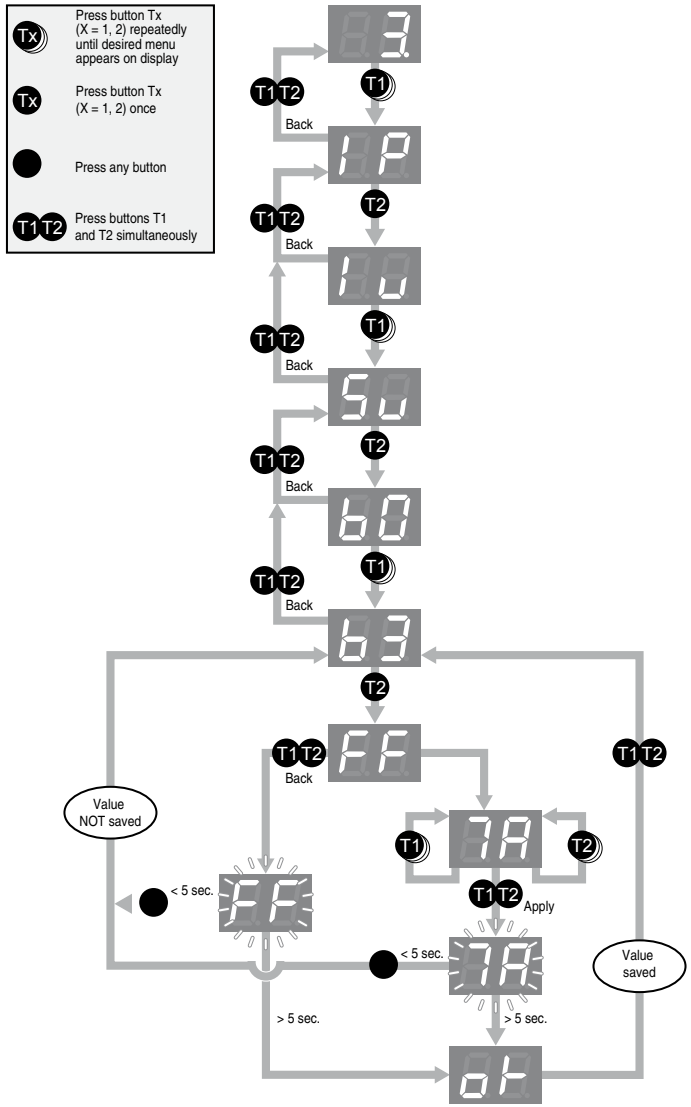


Figure 4.2 Example configuration of subnet mask

4.4.5 Field bus address menu (Fb)

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

Menu level 1	Menu level 2	Para-meter	Value range	Meaning	Explanation
Fb	Ad	-	00..xx *or* - -	Field bus address	Example configuration of field bus address (only when field bus option used), other-wise display "- -" *(The maximum programmable value depends on the option)*
	Po	-	0..3 *or* - -	Transmit power	Setting of fibre-optic power output (only with SERCOS II option), otherwise display "- -"

Table 4.10 Field bus address menu

Example configuration of field bus address

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

NOTE: Changes on the Field Bus Address menu are only saved when the control electronics are subsequently restarted.

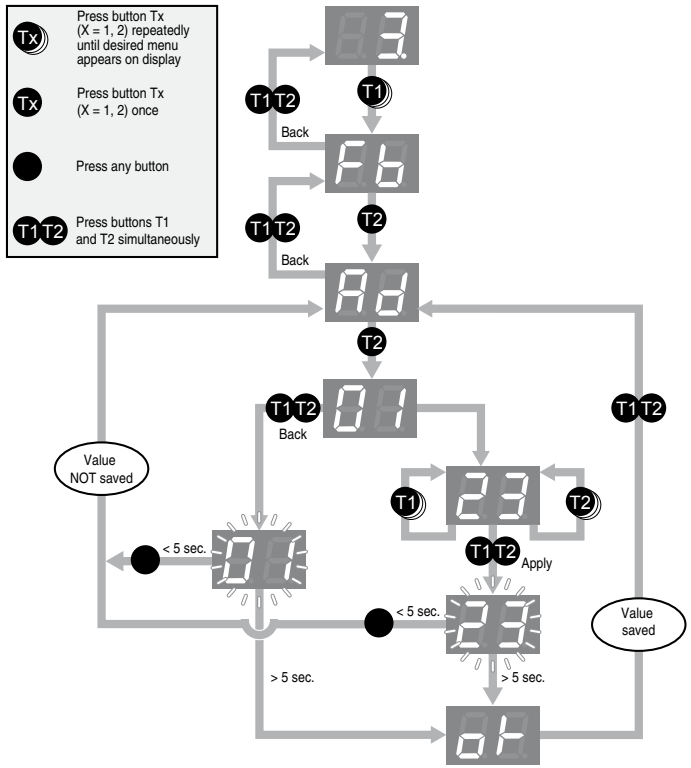


Figure 4.3 Example configuration of field bus address

5. Diagnostics

The device states and error displays are indicated on the device by way of the 7-segment display of the integrated operator control unit.

5.1 Device states

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

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

Table 5.1 Device states

5.2 Error display

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

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

Table 5.2 Display of error code

NOTE: The errors can be reset in accordance with their programmed reaction (ER) or only via a +24 V DC reset (X2) (ER.). Errors marked with a dot can only be reset when the cause of the fault has been eliminated.

5.3 Error codes

NOTE: For detailed information on the error codes and on error management refer to the ServoOne Application Manual.

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5.4 Helpline/Support & Service

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

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

The Helpline is available Monday to Friday from 8 a.m. to 5 p.m. (CET), and can be accessed by telephone, e-mail or over the Internet:

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

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

- Support & Service - How to reach us:

Mo.-Fr.:	8 a.m. - 5 p.m. (CET)
Phone:	+49 6441 966-888
E-mail:	service@lt-i.com

NOTE: If you need more detailed assistance and advice, you will find all the services we offer in the "Support & Service" order catalogue. You can download the order catalogue from the "Support & Service" section of our website at http://drives.lt-i.com.

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 junior 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 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

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 junior 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 junior 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 auto-matically 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.

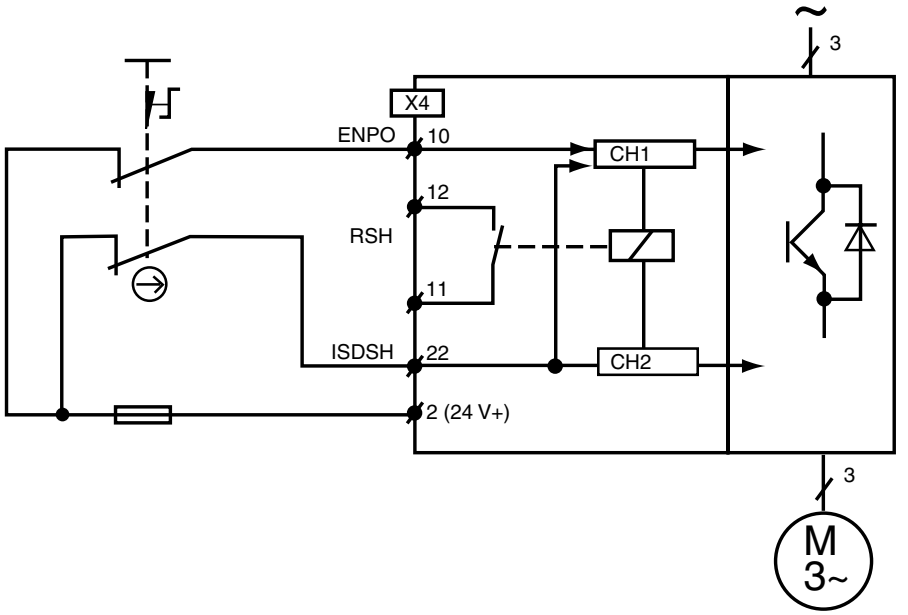

Figure 6.1 *"STO" selection of function via switch with two NC contacts (positively operated)*

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) n order to deactivate the restart inhibit the control signals must be simultaneously (ENPO max. 5ms 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 servo-controller).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 junior (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: .....7.019 a

Safety characteristics to EN 62061 / EN 61508:
SIL: 3
HFT: 1
PFH: 9,2 E-10 1/h

Restart inhibit acceptance test

Safety characteristics to EN ISO 13849:
PL: .....e
Category: 3
MTTFd: .....>10.000 a

Safety characteristics to 62061 / EN 61508:
SIL: 3
HFT: 1
PFH: 4,5 E-11 1/h

A. Appendix

A.1 Current capacity of servocontrollers

The maximum permissible servocontroller output current and the peak current are dependent on the mains voltage, the motor cable length, the power stage switching frequency and the ambient temperature. If the conditions change, the maximum permissible current capacity of the servocontrollers also changes.

ServoOne junior for 1 x 230 V

Device	Switching frequency of power stage	Ambient temperature	Rated current I_N [A_{eff}]	Peak current			
				200 % (2 I_N)		300 % (3 I_N)	
	[kHz]	max. [°C]	at 1 x 230 V	[A_{eff}]	for time [s]	[A_{eff}]	for time [s]
SO22.003	4	45	3.0	6.0	10	9.0	0.08
	8	40	3.0	6.0		9.0 [1]	0.08 [1]
	16	40	2.0	4.0		6.0 [1]	0.08 [1]
SO22.006	4	45	5.9	11.8	10	-	-
	8	40					
	16	40					
SO22.008	4	45	8.0	-	-	-	-
	8	40	8.0				
	16	40	5.4				

1) Automatic power stage switching frequency change to 4 kHz.
Data applies to motor cable length ≤10 m. Maximum permissible motor cable length 30 m.
All current ratings with recommended line reactor.

Table A.2 Rated current and peak current, BG2 to BG4 (1 x 230 V AC)

ServoOne junior for 3 x 230 V

Device	Switching frequency of power stage	Ambient temperature	Rated current I_N [A_{eff}]	Peak current			
				200 % (2 I_N)		300 % (3 I_N)	
	[kHz]	max. [°C]	at 3 x 230 V	[A_{eff}]	for time [s]	[A_{eff}]	for time [s]
SO22.003	4	45	3.0	6.0	10	9.0	0.08
	8	40	3.0	6.0		9.0 [1]	
	16	40	2.0	4.0		6.0 [1]	
SO22.006	4	45	5.9	11.8	10	17.7	0.08
	8	40				17.7 [1]	
	16	40				17.7 [1]	
SO22.008	4	45	8.0	16.0	10	24.0	0.08
	8	40	8.0	16.0		24.0 [1]	
	16	40	5.4	10.8		16.2 [1]	

1) Automatic power stage switching frequency change to 4 kHz.
Data applies to motor cable length ≤10 m. Maximum permissible motor cable length 30 m.

Table A.3 Rated current and peak current, BG2 to BG4 (3 x 230 V AC)

ServoOne junior for 3 x 400/460/480 V

Device	Switching frequency of power stage	Ambient temperature	Rated current I_N [A_{eff}]			Peak current [2]			
						200 % (2 I_N)		300 % (3 I_N)	
	[kHz]	max. [°C]	at 400 V	at 460 V	at 480 V	[A_{eff}]	for time [s]	[A_{eff}]	for time [s]
SO24.002	4	45	2.0	2.0	2.0	4.0	10	6.0	0.08
	8	40	2.0	2.0	1.7	4.0		6.0 [1]	
	16	40	0.7	0.7	-	1.4		2.1 [1]	
SO24.004	4	45	3.5	3.5	3.5	7.0	10	10.5	0.08
	8	40	3.5	3.5	2.6	7.0		10.5 [1]	
	16	40	2.2	1.3	-	4.4		6.6 [1]	
SO24.007	4	45	6.5	6.5	6.5	13.0	10	19.5	0.08
	8	40	6.5	6.5	6.5	13.0		19.5 [1]	
	16	40	4.0	2.4	1.9	8.0		12.0 [1]	

1) Automatic power stage switching frequency change to 4 kHz.
2) Data referred to 3 x 400 V mains voltage
Data applies to motor cable length ≤10 m. Maximum permissible motor cable length 30 m.

Table A.4 Rated current and peak current, BG2 to BG4 (3 x 400/460/480 V AC)

A.2 ServoOne junior technical data

SO22.003, SO22.006 and SO22.008

Technical data \ Designation		SO22.003	SO22.006	SO22.008
Output, motor side [1]				
Voltage		3-phase U_{mains}		
Effective continuous current (I_N) [2]		3 A	5.9 A	8 A
Peak current ($A_{effective}$)		9 A	17.7 A	24 A
Rotating field frequency		0 ... 400 Hz		
Switching frequency of power stage		4, 8, 16 kHz		
Input, mains side				
Mains voltage		(1 x 230 V AC / 3 x 230 V AC) -20 %/+15 %		
Device connected load [1] (with line reactor)		1.3 kVA	2.6 kVA	3.5 kVA
Current [1] (with line reactor)	1 x 230 V AC	5.4 A	10.6 A	-
	3 x 230 V AC	3.3 A	6.5 A	8.8 A
Asymmetry of mains voltage		±3 % max.		
Frequency		50/60 Hz ±10 %		
Power loss at I_N [1]		75 W	150 W	200 W
Braking chopper power electronics				
Peak braking power with int. braking resistor		400 W in 550 Ω (PTC) [4]	1.5 kW in 100 Ω [5]	1.7 kW in 90 Ω [5]
Minimum ohmic resistance of an externally installed braking resistor		72 Ω	72 Ω [3]	72 Ω [3]

1) Values referred to mains voltage 230 V AC and switching frequency 8 kHz,
2) For rated current refer to table A.1 or table A.2!
3) Connection of ext. braking resistor not permitted to devices with int.braking resistor (design SO2x.xxx.xxxx.1xxx)!
4) Braking resistor always integrated. Connection of an external resistor is permissible.
5) Option (SO2x.xxx.xxxx.1xxx)

Table A.5 Technical data SO22.003, SO22.006 and SO22.008

NOTE: For more information on the braking chopper switch-on threshold also refer to section 3.14 as from page 31.

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SO24.002, SO24.004 and SO24.007

Technical data \ Designation	SO24.002	SO24.004	SO24.007
Output, motor side [1]			
Voltage	3-phase U_{mains}		
Effective continuous current (I_N) [2]	2 A	3.5 A	6.5 A
Peak current ($A_{effective}$)	6 A	10.5 A	19.5 A
Rotating field frequency	0 ... 400 Hz		
Switching frequency of power stage	4, 8, 16 kHz		
Input, mains side			
Mains voltage	(3 x 400 V AC / 3 x 460 V AC / 3 x 480 V AC) ±10 %		
Device connected load [1] (with line reactor)	1.5 kVA	2.7 kVA	5.0 kVA
Current [1] (with line reactor)	2.2 A	3.9 A	7.2 A
Asymmetry of mains voltage	±3 % max.		
Frequency	50/60 Hz ±10 %		
Power loss at I_N [1]	42 W	80 W	150 W

1) Values referred to mains voltage 400 V AC and switching frequency 8 kHz,
2) For rated current refer to table A.3!
3) Connection of ext. braking resistor not permitted to devices with int.braking resistor (design SO2x.xxx.xxxx.1xxx)!
4) Braking resistor always integrated. Connection of an external resistor is permissible.
5) Option (SO2x.xxx.xxxx.1xxx)

Table A.6 Technical data SO24.002, SO24.004 and SO24.007

Technical data \ Designation	SO24.002	SO24.004	SO24.007
Braking chopper power electronics			
Peak braking power with int. braking resistor	200 W in 7500 Ω (PTC) [4]	1 kW in 420 Ω [5]	4.7 kW in 90 Ω [5]
Minimum ohmic resistance of an externally installed braking resistor	230 Ω	180 Ω [3]	72 Ω [3]

1) Values referred to mains voltage 400 V AC and switching frequency 8 kHz,
2) For rated current refer to table A.3!
3) Connection of ext. braking resistor not permitted to devices with int.braking resistor (design SO2x.xxx.xxxx.1xxx)!
4) Braking resistor always integrated. Connection of an external resistor is permissible.
5) Option (SO2x.xxx.xxxx.1xxx)

Table A.6 Technical data SO24.002, SO24.004 and SO24.007

NOTE: For more information on the braking chopper switch-on threshold also refer to section 3.14 as from page 31.

A.3 Ambient conditions

Ambient conditions	ServoOne junior
Protection	IP20 except terminals (IP00)
Accident prevention regulations	according to local regulations (in Germany e.g. BGV A3)
Mounting height	to 1000 m above MSL, over 1000 m above MSL with power reduction (1 % per 100 m, max. 2000 m above MSL)
Pollution severity	2
Type of installation	Built-in unit, only for vertical installation in a switch cabinet with min. IP4x protection, when using STO safety function min. IP54

Table A.7 ServoOne junior ambient conditions

Climatic conditions		ServoOne junior
in transit	as per EN 61800-2, IEC 60721-3-2 class 2K3 [1]	
	Temperature	-25 °C to +70 °C
	Relative humidity	95 % at max. +55 °C
in storage	as per EN 61800-2, IEC 60721-3-1 class 1K3 and 1K4 [2]	
	Temperature	-25 °C to +55 °C
	Relative humidity	5 to 95 %
in operation	as per EN 61800-2, IEC 60721-3-3 class 3K3 [3]	
	Temperature	-10 °C to +45 °C (4 kHz), to 55 °C with power reduction (2 %/°C) -10 °C to +40 °C (8, 16 kHz) , to 55 °C with power reduction (2 %/°C)
	Relative humidity	5 to 85 % without condensation

1) *The absolute humidity is limited to max. 60 g/m³. This means, at 70 °C for example, that the relative humidity may only be max. 40 %.*
2) *The absolute humidity is limited to max. 29 g/m³. So the maximum values for temperature and relative air humidity stipulated in the table must not occur simultaneously.*
3) *The absolute humidity is limited to max. 25 g/m³. That means that the maximum values for temperature and relative air humidity stipulated in the table must not occur simultaneously.*

Table A.8 ServoOne junior climatic conditions

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

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

Table A.9 ServoOne junior mechanical conditions

ATTENTION!

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

A.4 UL approbation

Measures to comply with (UL 508C)

1. The devices may only be operated in systems of overvoltage category III.
2. The devices are usable in networks with a maximum current capacity of 5 kA, with phase-symmetrical current and maximum voltage of 480 V, with system-side protection as per table A.9.
3. The devices are rated for installation in an environment of pollution severity 2.
4. The protective device for branch lines must be executed in accordance with the manufacturers' instructions, the requirements of the NEC (National Electrical Code) and other locally applicable standards.
5. Only UL-approved device connection cables (mains, motor and control cables) may be used:
   - Use copper conductors with a temperature resistance of at least 75 °C.
   - Specified tightening torques for the terminals:
6. Maximum temperature of the cooling air (surrounding temperature):

Size	Device	Tightening torque, mains and motor terminals X3 X[illegible]	Tightening torque [illegible] terminals [illegible] X3	Mains fusing / Class
BG2	SO22.003	[illegible]	0.56 - 0.79 Nm	1)
	SO24.[illegible]	0.56 - 0.79 Nm	0.56 - 0.79 Nm	1)
	SO2[illegible]	0.56 - 0.79 Nm	0.56 - 0.79 Nm	1)
BG[illegible]	SO24.004	0.56 - 0.79 Nm	0.56 - 0.79 Nm	1)
BG4	SO22.008	1.7 Nm	0.56 - 0.79 Nm	1)
	SO24.007	1.7 Nm	0.56 - 0.79 Nm	1)

1) *Data not available at time of publication.*

Table A.10 Tightening torques and mains fusing, BG2 to BG4

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Space for your own notes

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We should nevertheless point out that this document cannot always be updated in line with ongoing technical developments in our products.

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ID no.: 1300.20B.1-00

Date: 09/2010

Applicable as from firmware version: V0.25

The German version is the original of this Operation Manual.