Operating Manual
AC Servo Controller YukonDrive®

Harmonic
Drive AG

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Content

The modularity of the YukonDrives® 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 YukonDrive® 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 www.harmonicdrive.de

1. General

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.

1.1.1 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 drive is de-energized!
- 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).

1.2 Intended use

YukonDrive® 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).

The YukonDrive® 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 Harmonic Drive® 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 - Safetyrelated parts of controls" by selecting the circuit category.

Universal servo controller

The YukonDrive® is designed to operate with superimposed CNC controls featuring cyclic set point selection via bus systems. At all times, the modularity of the YukonDrive® family ensures optimum integration of the servo axis into the machine process. Whether in high speed field bus communication with a central machine controller or with distributed motion control intelligence in the servo controller – the YukonDrive® is a master of both. Optimised for the lower power range, the YukonDrive® offers maximum capacity in four compact designs.

The integration of high speed field bus systems and the latest encoder interfaces such as the digital EnDat 2.2 or HIPERFACE DSL interface ensure that future security and flexibility continue to be at the forefront of development. Comprehensive motion control functions provide a variety of possible solutions. Complete plug connections ensure fast installation and commissioning.

We have also considered the safety of your machine. Its SIL3-certified STO function means that the YukonDrive® can be integrated into your safety concept.

Ordering code

Table 7.1

Series	Size	Supply voltage	Peak current	Option 1 Feld bus	Option 2 Technology	Special design
YukonDrive	**102**	**1**	**A**	A B C D **E** F	A **B** C O	According to customer requirements
	103		C			
	104		E			
	102	**2**	**B**			
	103		D			
	104		F			
Ordering Code						
YukonDrive	**– 1022 –**		**B –**	**E –**	**O –**	**SP**

Variations in **bold print** are available at short notice, subject to prior sale.

Table 7.2

Supply voltage		
Size	Ordering Code	Description
102	1	1/3 x 230 VAC
103		
104		
102	2	3 x 400 ... 480 VAC
103		
104		

Table 7.3

Peak current [A_{eff}]			
	Supply voltage		
Ordering Code	1 x 230 VAC	3 x 230 VAC	3 x 400 VAC
A	9	9	-
C	11,8	17,7	-
E	16	24	-
B	-	-	6
D	-	-	10,5
F	-	-	19,5

Data valid for: 4 kHz switching frequency, motor cable length ≤ 10 m, 1 x 230 V AC when used with recommended mains choke

Table 7.4

Feld bus	
Ordering Code	Description
A	EtherCAT®
B	Sercos II
C	Sercos III
D	CANopen
E	PROFIBUS
F	PROFINET IRT

EtherCAT® is a registered trademark and patented technology, licensed by the Beckhoff Automation GmbH, Germany

Table 7.5

Technology	
Ordering Code	Description
A	TTL Encoder simulation / master encoder
B	TTL Encoder with commutation signals
C	2nd SIN/COS Encoder input
O	without

Combinations

Table 8.1

Actuator	Feedback	Size &Versions							
		-1021-Axx	-1031-Cxx	-1041-Exx	-1022-Bxx	-1032-Dxx	-1042-Fxx	-10xx-xxB	-10xx-xxC
FHA-C Mini	D200	●	–	–	–	–	–	●	○
	MZE	●	–	–	–	–	–	–	–
CHA-C-H	SIE	○	○	–	●	●	●	–	○
	SIE-EC	○	○	–	●	●	●	–	●
	MZE	○	○	–	●	●	●	–	○
FHA-C-H	M512P	–	–	–	●	●	–	–	○
	M512P-EC	–	–	–	●	●	–	–	●
FHA-C-L	M512P	○	○	–	–	–	–	–	○
	M512P-EC	○	○	–	–	–	–	–	●
CHA-A-H	M512P	○	○	–	●	●	●	–	○
	M128S	○	○	–	●	●	●	–	○
	M512P-EC	○	○	–	●	●	●	–	●
CHA-A-N	M128S	○	○	–	●	●	●	–	○
	D2048	○	○	–	●	●	●	●	○
LynxDrive®	MGH	○	○	○	●	●	●	–	○
	MKE	○	○	○	●	●	●	–	○
CHM-H	CDO	○	○	○	○	●	●	–	○
TorkDrive®	auf Anfrage	○	○	○	○	●	●	○	○

● Standard mapping   ○ Application dependant   – Not available

2. Mechanical installation

2.1 Notes for operation

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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

Table 9.1   Mechanical installation

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 10.2 and illustration 11.1 and 11.2. 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.	

Note:

For all sizes of the YukonDrive® 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.
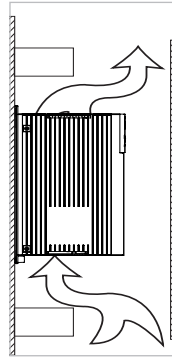
Air flow: min. 1.2 m/s

Illustration 10.1

Dimensions

Table 10.2

YukonDrive®	BG2	BG3	BG4
	-1021 -1022	-1031 -1032	-1041 -1042
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

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 YukonDrive® controllers together with other devices, you must make sure that these devices do not affect one another thermally.

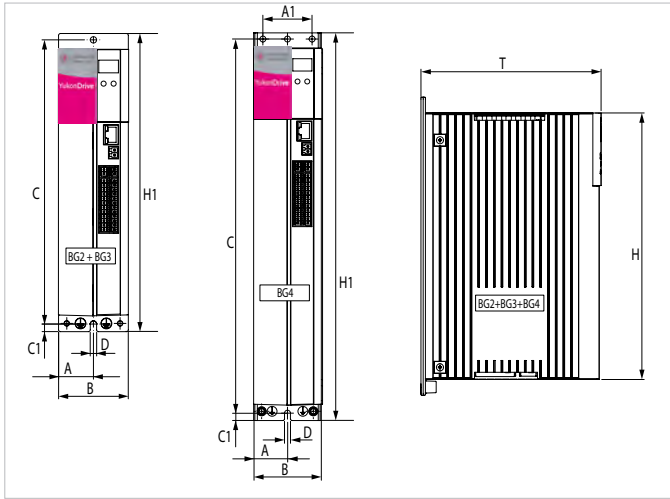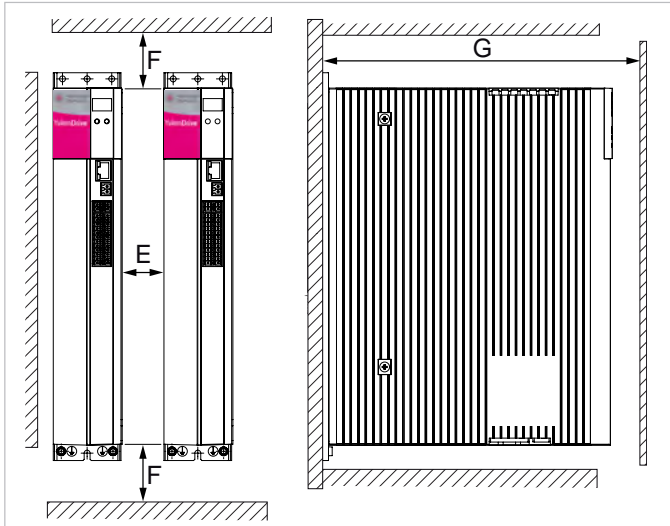1003370   01/2017 V02

Illustration 11.1   Dimensions (in mm) BG2, BG3, BG4

Illustration 11.2   Mounting clearances (in mm)

⚠

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**
  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 our Technical Support Service (see page 47).

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.
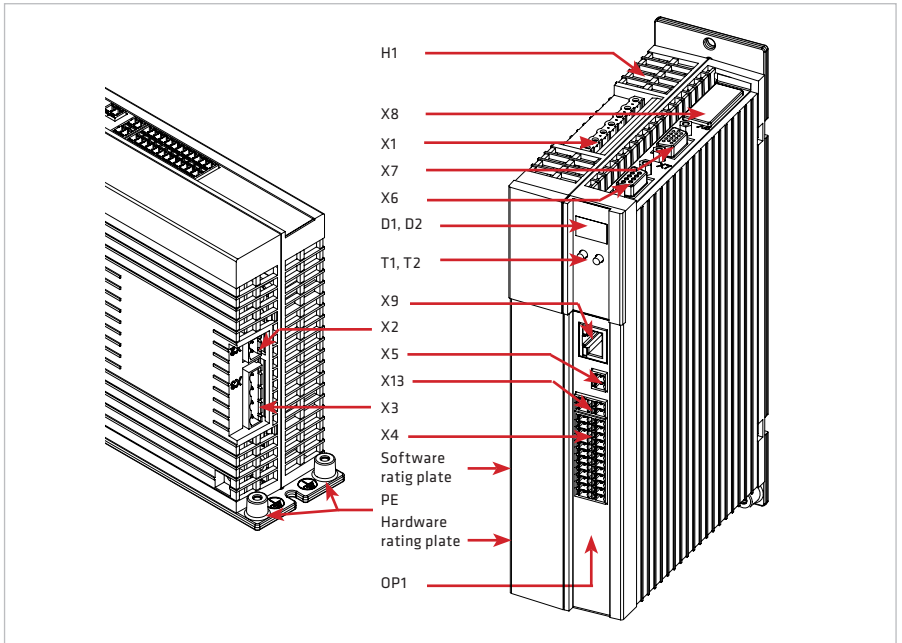
Illustration 13.1   YukonDrive® layout

Table 13.2   Key to YukonDrive® 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 (see page 31)
X6	Resolver connection
X7	Connection for high-resolution encoders
X8	Option 2 (Technology)
X9	Ethernet interface
X13	Connection of motor brake

3.3 Connection diagram

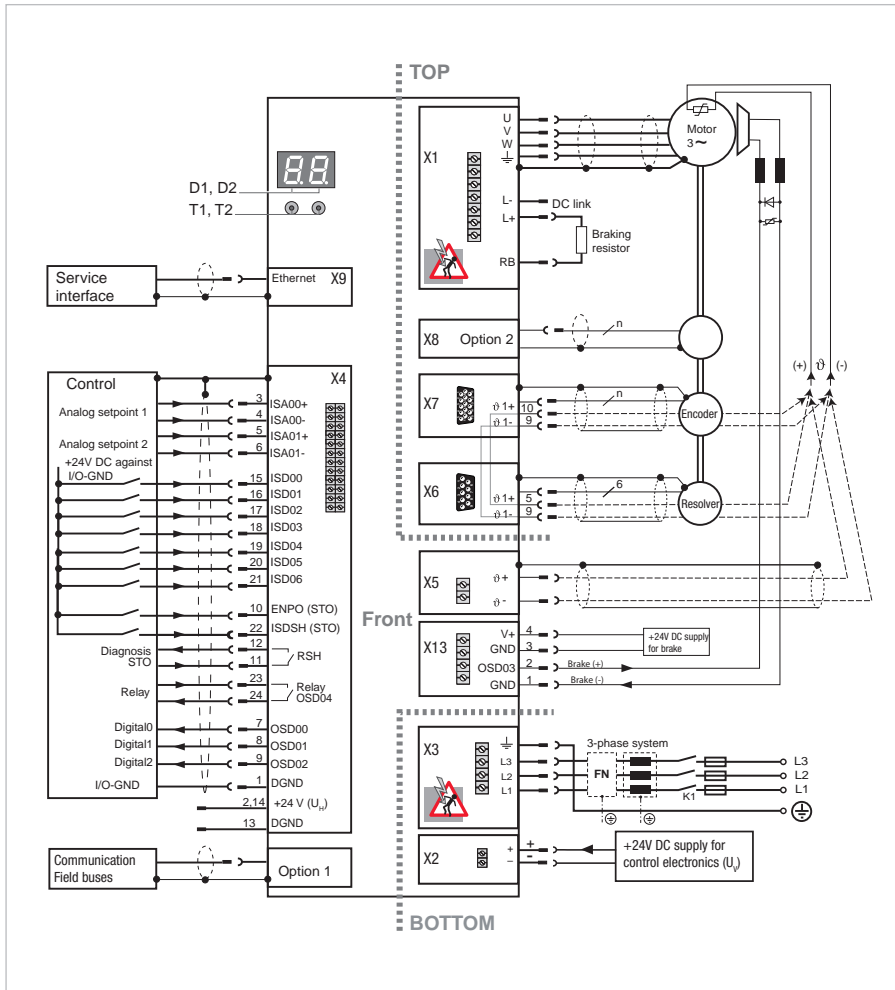Illustration 14.2   Connection diagram

Table 15.1   Key to Connection diagram

No.	Designation	Function	Page
D1, D2	7-Segmentanzeige	Device status display	see p. 42
T1, T2	Pushbuttons	Service functions	see p. 42
X1	Power connection	Motor, braking resistor and connection for measurement of DC link voltage	see p. 27
X2	Connection of control supply U_v	+24 V DC supply voltage for control electronics of drive controller	see p. 15
X3	AC mains connection	Mains supply	see p. 15
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. 31
X6	Resolver connection	Resolver, incl. motor temperature monitor	see p. 29
X7	High-resolution encoder interface	Sin/Cos encoder, TTL encoder, EnDat 2.1 encoder, HIPERFACE® encoder, SSI encoder, incl. motor temperature monitor	see p. 30
Option 1	Communication	Factory installed module for field buses, e.g. SERCOS, EtherCAT	see p. 27
⊕	Protective conductor connection	Connection diagram see section 3.5	see p. 16
X8 Option 2	Technology	Factory installed module e.g for TTL encoder simulation, second SIN/COS encoder or EnDat 2.1	see p. 27
X9	Ethernet interface	Service port, connection to PC	see p. 27
X13	Connection of motor brake	Power output with cable break detector	see p. 31

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

3.4 Effective EMC installation

3.4.1 Interference immunity of drive controllers

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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
Illustration 16.1 presents an overview of the minimum components required:
   A. Backing plate with cable ducts
   B. YukonDrive®
   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 9. The numbered red arrows refer to four very important detailed notices presented on the following pages.

Illustration 16.1   Specimen setup - Overview
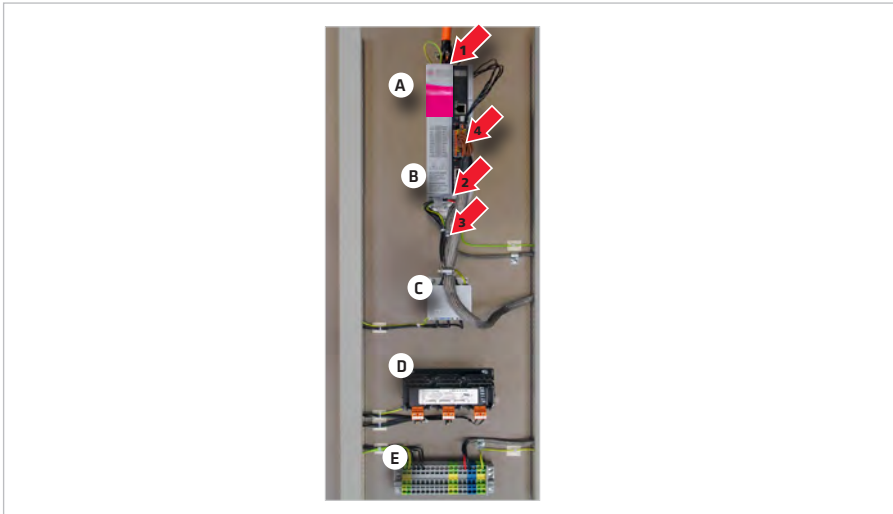
Detail 1: Motor cable

At the motor connection (X1) of the YukonDrive® 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 YukonDrive® and with the backing plate. Use a toothed ring.
- Strip back the shield of the motor cable on the motor connection (X1) of the YukonDrive® 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 Harmonic Drive® servo motors.

Illustration 17.1   Specimen setup - Detail 1: Motor cable
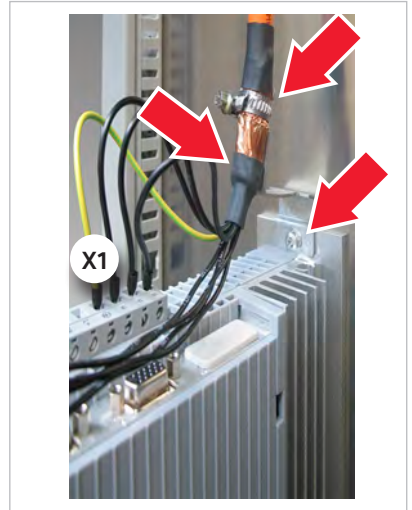
Detail 2: Control supply (+24 V DC)

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 YukonDrive® 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.

Illustration 17.2   Specimen setup - Detail 2: Control supply
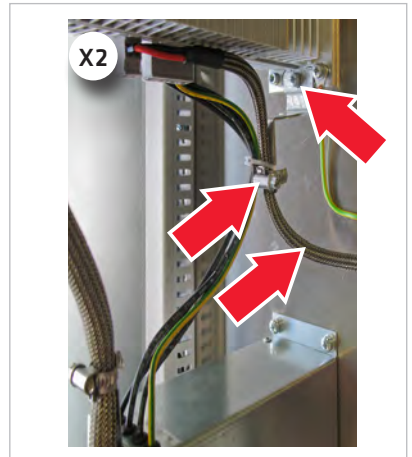
Detail 3: Mains filter and mains connection

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 YukonDrive®. The strands must not be extended, so the mains filter should be installed correspondingly close to the YukonDrive®. But be sure to maintain the necessary minimum clearance (see table 2 on page 6).
- Fix the strands to the shield connection plate using a cable tie as necessary.
- The leakage current of the YukonDrive® is >3.5 mA. So:
  - Connect the protective conductor from the output of the mains filter to the connection (X3) of the Yukon-Drive® **and**
  - one of the PE connections on the heat sink of the Yu-konDrive® via a cable of at least the same cross-section to the main ground of the distributor rail.

Illustration 18.1   Specimen setup - Detail 3: mains filter and mains connection
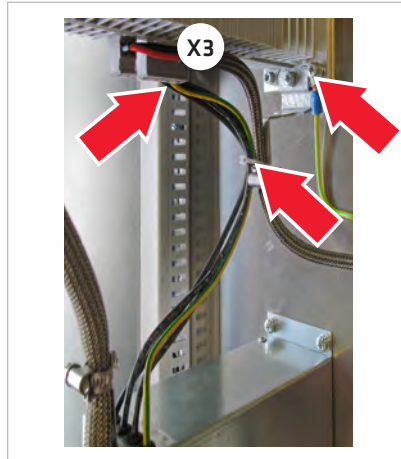
Detail 4: Control cables

At the control terminals (X4) of the YukonDrive® 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 YukonDrive®.

Illustration 18.2   Specimen setup - Detail 4: Control cables

3.5 Protective conductor connection

Table 19.1

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.
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.	Also comply with local and national regulations and conditions. .

Illustration 19.2   Star configuration layout of the PE conductor
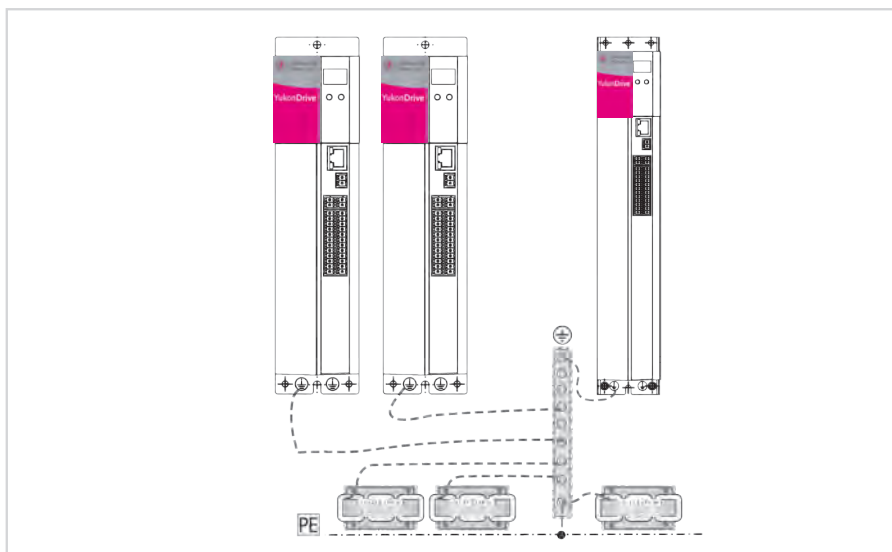
3.6 Electrical isolation method

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

Illustration 20.1   Electrical isolation method YukonDrive®
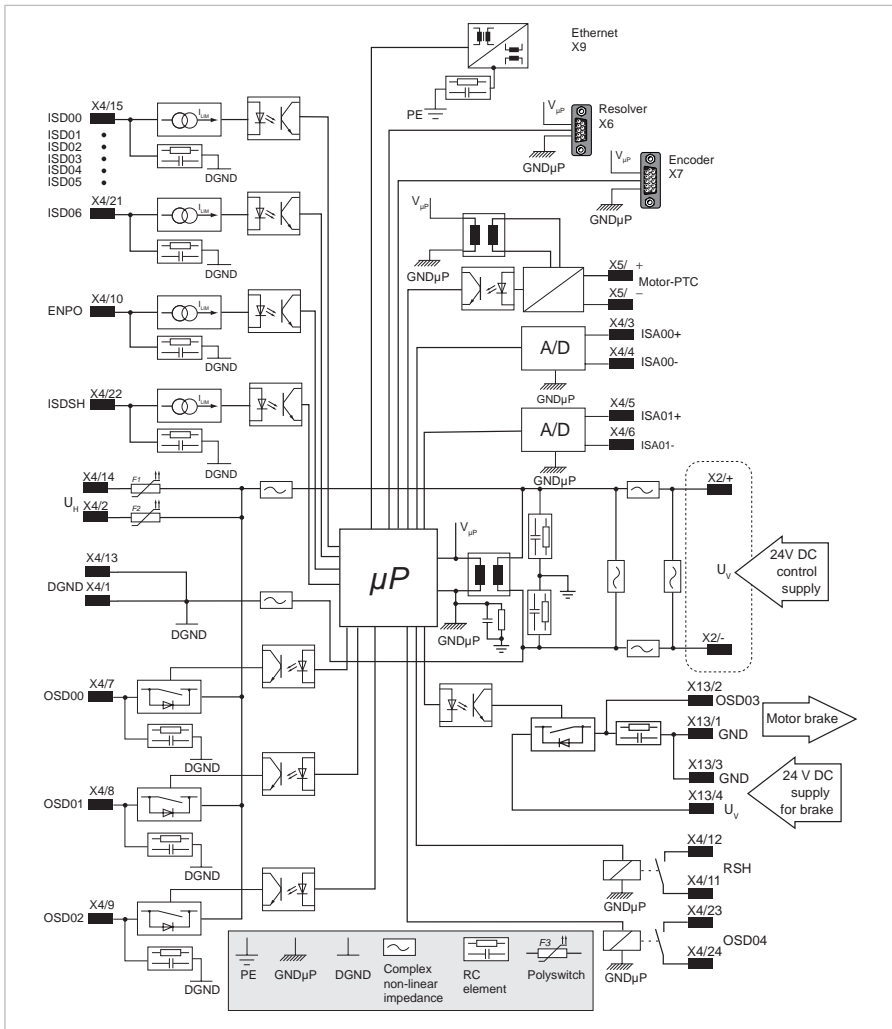
3.7 Connection of supply voltages

The voltage supply to the YukonDrive® 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 YukonDrive® 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)

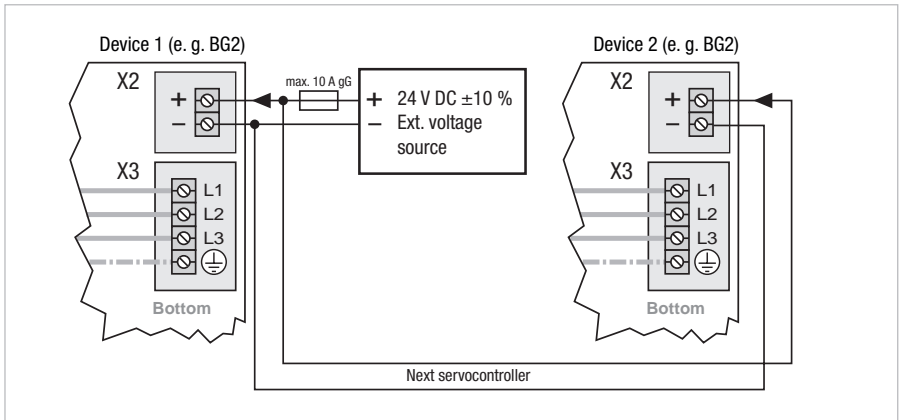Illustration 21.1   YukonDrive® control supply connection

Table 21.2   YukonDrive® control supply specification

Control supply (spezification)		
Connection of control supply	X2/+ X2/–	U_v = 24 V DC ±10 %, stabilized and smoothed. I_v = 2 A (BG2 bis 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

⚠️

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).

Illustration 22.1   BG2 and BG3 mains supply connection 3 x 230 V (YukonDrive®-10x1) or 3 x 400 V (YukonDrive®-10x2) depending on device design
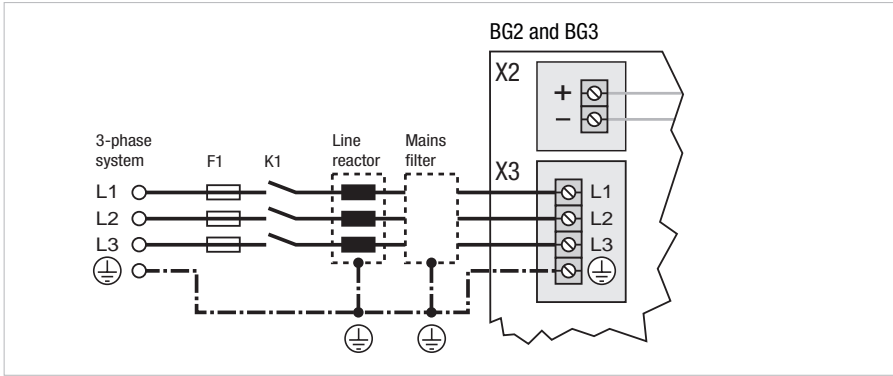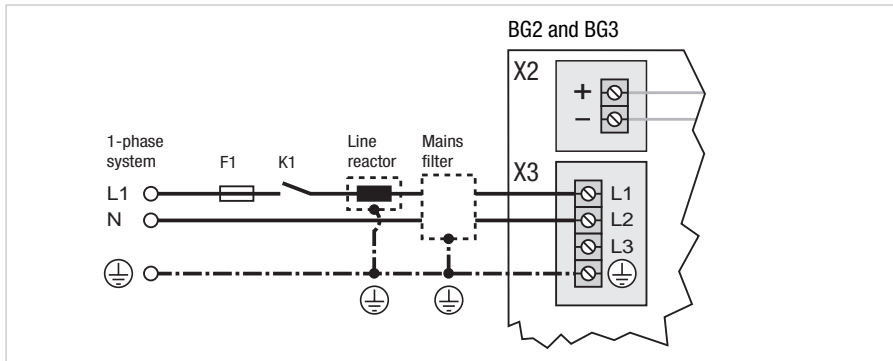

Illustration 22.2   BG2 and BG3 connection to mains supply 1 x 230 V

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).

Illustration 23.1   BG4 mains supply connection 3 x 230 V (YukonDrive®-1041) or 3 x 400 V (YukonDrive®-1042) depending on device design
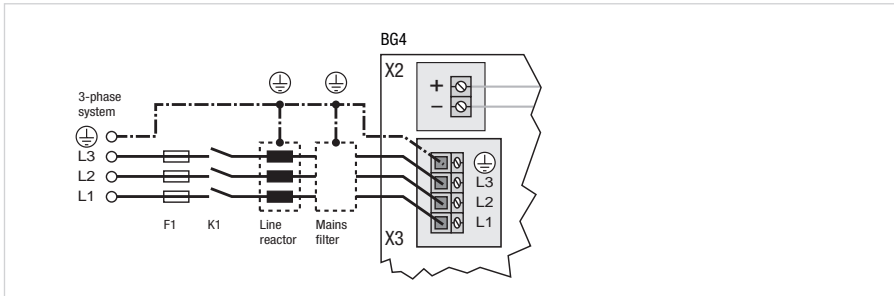
Illustration 23.2   BG4 mains supply connection 1 x 230 V
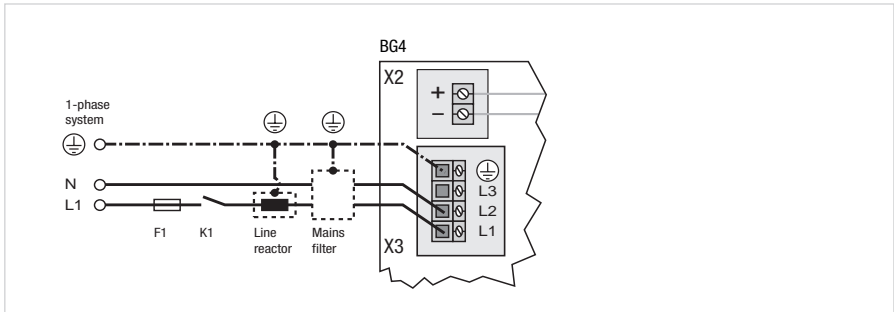
Procedure: Table 23.3

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 reactor*) (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 YukonDrive® 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.

Table 24.1   Connected load and mains fuse

YukonDrive®	Device connected load[1] [kVA]		Max. line crosssection[2] of term. [mm²]	Specified mains fuse. duty class gG [A]
	With line reactor (4 % u)	Without line reactor		
-1021	1.3	1.6	2.5	3 x max. 16
-1022	1.5	1.9	2.5	3 x max. 6
-1031	2.6	3.2	2.5	3 x max. 16
-1032	2.7	3.3	2.5	3 x max. 10
-1041	3.5	4.3	4	3 x max. 20
-1042	5.0	6.1	4	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.

[3] Data not available at time of publication.

3.8 Control connections

Table 25.1

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 mm^2 Flexible conductor sizes: - Ferrule without plastic sleeve: 0.2 to 1.5 mm^2 - Ferrule with plastic sleeve: 0.2 to 0.75 mm^2
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.

Table 26.1   Specification of control connections X4

Bez.	Kl.	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} ca. 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 +20 % I_{IN} bei 24 V = 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 +20 % I_{IN} max bei 24 V = 10 mA, RIN 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. ca. 10 ms Switching level Low/High: ≤ 4,8 V / ≥ 18 V U_{IN} max = 24 V +20 % I_{IN} bei 24 V = 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. Imax = 50 mA, SPS-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	←	ISA+
ISD01	→	16	4	←	ISA0−
ISD00	→	15	3	←	ISA0+
+24 V	↔	14	2	↔	+24 V
DGND	↔	13	1	↔	DGNG

Table 27.1   Specification of control connections X4

Bez.	Kl.	Specification		P.-Trennung
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} bei +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 DC	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 • 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+
+24 V	↔	14	2	↔	+24 V
DGND	↔	13	1	↔	DGNG

3.8.2 Connection of motor brake X13

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

Table 28.1 Specification of terminal connections X13

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"

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:
• Harmonic Drive AG DriveManager 5 for commissioning, service and diagnosis of the YukonDrive®
• CoDeSys 3.x programming system for programming of the YukonDrive® 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

3.10 Option 1

Depending on the YukonDrive® 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 Harmonic Drive® catalogue.
The Operating Manuals for the respective options provide detailed information on commissioning.

3.11 Option 2

Option 2 can be factory-configured with various technology options. Additional or special encoders can be evaluated with it for example. You will find all available options in the Harmonic Drive® catalogue. The Operating Manuals for the respective options provide detailed information on commissioning.

Note:
For the connection of the motor feedback system of the FHA-C-Mini series, Option 2 = B (TTL encoder with commutation signals) should be used!

3.12 Motor- and Encoder connection

The motor connection can be achieved by connector X1 on top of the device.
All encoder connections are located on the top of the unit.

Please use the ready-made cable sets from Harmonic Drive AG to connect motor and encoder.

Following cable sets are availabe at the moment:

Table 29.1   Cable sets

Actuator	Cable length	Cable set Material number	Feedback connection
LynxDrive-xxC-xxx-Ax-L-MGH (-B) CHA-xxA-xxx-L-S1024 (-B) CHA-xxA-xxx-L-M1024 (-B) CHM-xxxxA-Ax-L-SDH-xx (-B) CHM-xxxxA-Ax-L-MDH-xx (-B) FHA-xxC-xxx-L-S1024 (-B) FHA-xxC-xxx-L-M1024 (-B)"	3 m 5 m 10 m	1004153 1004154 1004155	X7
LynxDrive-xxC-xxx-Ax-H-ROO (-B)	3 m 5 m 10 m	314271 314272 314273	X6
LynxDrive-xxC-xxx-Ax-H-MxE (-B)	3 m 5 m 10 m	314260 314261 314262	X7
FHA-xxC-xxx-H-S1024 (-B) -SP FHA-xxC-xxx-H-M1024 (-B) -SP	3 m 5 m 10 m	314224 314225 314226	X7
FHA-xxC-xxx-D200-SP	3 m 5 m 10 m	1010968 1006450 1001325	X8

The cable sets can be used also for actuators with brake.

3.12.1 Resolver connection X6

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

Table 30.1   Pin assignment, X6-resolver connection

Ill.	X6/Pin	Function
X6 (Resolver)	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 on page 28!

3.12.2 Connection for high-resolution encoders X7

Encoder interface X7 enables evaluation of the following encoder types.

Table 30.2

Ill.	Function
X7 (Encoder/ SSI)	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

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 use 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.

Table 31.1 Pin assignment, X7-encoder connection

Ill.	X7/Pin	Function Sin/Cos and TTL	Absolute encoders SSI/EnDat 2.1/2.2	Absolute encoder HIPERFACE®	
	1	A–	A–	REFCOS	The sum of the currents tapped at X7/3 and X6/4 must not exceed the specified value!
	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		
	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	
	13	Sense –		–	After connecting pin 7 to pin 12, a voltage of 11.8 V is set at X7/3 and X6/4!
	14	–	CLK+	–	
	15	–	CLK–	–	

X7 — Encoder/ SSI

[1] Be sure to pay attention to the notice headed below!

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

Table 31.2

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.

⚠

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.

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.

Illustration 32.1   Connection of motor
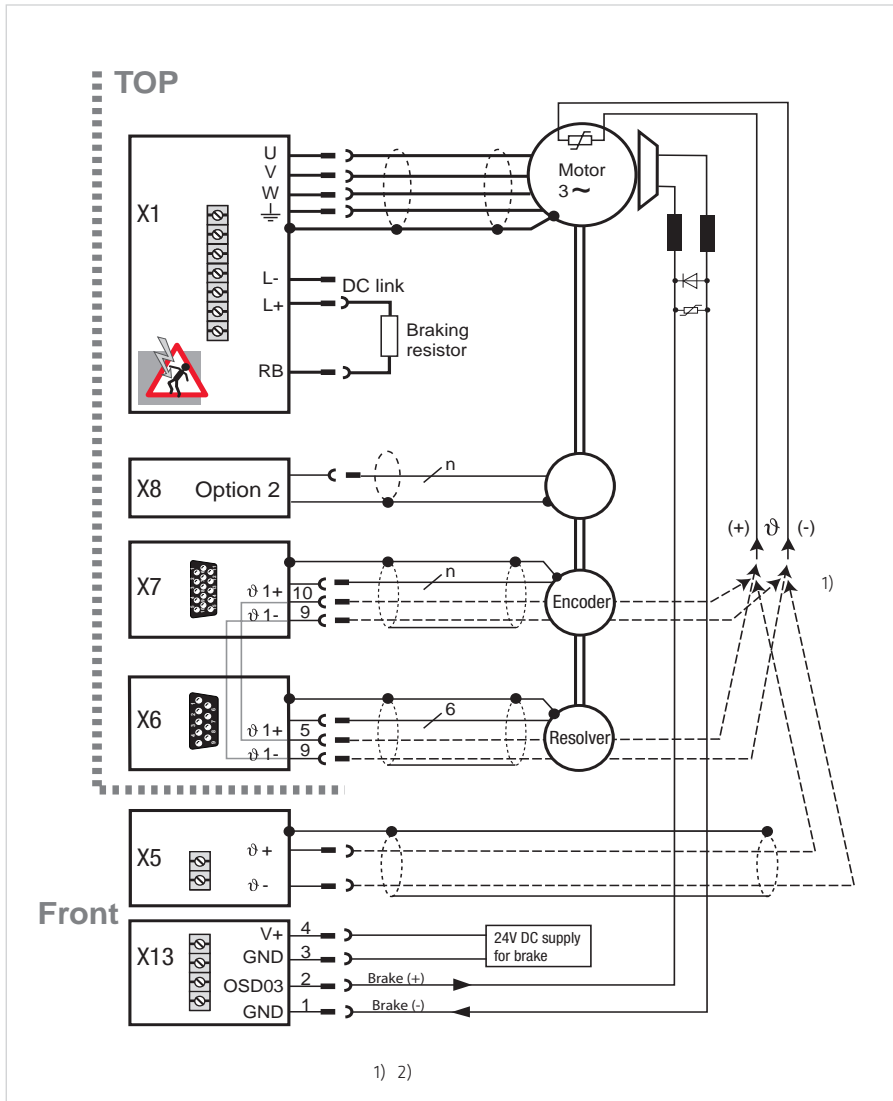
Table 33.1 1) Confirguration of motor cable cores 5,6,7 and 8

Motor cable	Configuration		
Core no.	CHA-A CHM-A Winding: H/L	FHA-C Winding: H	LynxDrive-C Plug connection type:L
5	Brake +	Brake +	PTC
6	Brake -	Brake -	PTC
7	PTC	N.C.	Brake +
8	PTC	N.C.	Brake -

⚠️

Attention:
For security reasons the connection of PTC has to be made via X5!

2) Brake control can also be made external (e.g. via SPS)

⚠️

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

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) to BC_FAIL(56). In the event of a fault the selected output then switches from 24 V to 0 V. This signal can be used to disconnect the drive controller from the mains supply.

For detailed information on parameterization refer to the Operating Manual YukonDrive®.

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. 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.

Table 35.1   Data of the integrated braking resistor

Device	Resistance [Ohm]	Peak performance [W]	braking chopper switch-on threshold [VDC]
YukonDrive®-1021-xxx	550	400	390
YukonDrive®-1022-xxx	7500	200	650 [1]

[1] based on 3 x 400 V mains voltage

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:

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

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 52.
- The braking resistor must be connected by a shielded cable.

Illustration 36.1   Connection of braking resistor - Size BG2 to BG4
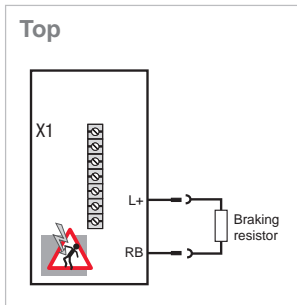
Danger from electrical tension!

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)

Table 36.2   Technical data - braking resistors

Order designation	Continuous braking power	Resistance[1]	Peak braking power P [2]	Protection	Picture
BR-090.01.540,UR	35 W		6250 W	IP54	
BR-090.02.540,UR	150 W	90 Ω	6250 W	IP54	
BR-090.03.540,UR	300 W		6250 W	IP54	
BR-090.10.650,UR	1000 W		6250 W	IP65	BR-090.01,540,UR

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

Hinweis:

Exact specifications, in particular with regard to surface temperature, maximum system voltage and high-voltage strength, are set out download section of our website www.harmonicdrive.de. Please consult your projecting engineer for more detailed information on the design of braking resistors.

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 YukonDrive® 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:

Table 37.1

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 section4.2.3
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 manual 1007417

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

Table 37.1   Switch-on status of YukonDrive® (on connection of +24 V DC control supply)

D1	D2	Action	Explanation
0		Switching on the +24 V DC control supply	Initialization in progress
S	1	Initialization complete	Not ready for start

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.

Note:
- 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.

Note:
- Online Help
  For a detailed description of DriveManager 5 and of the Commissioning Wizard, refer to the DriveManager 5 Online Help.
- Motor data set
  Download under construction
- In conjunction with servo actuators and -motors of Harmonic Drive AG, the YukonDrive® controllers are already set up (motor- and feedback data, control, limits). Only application specific settings have to be done.

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. Harmonic Drive AG 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

Table 39.1   Readout D1/D2 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

Note:
- Inputs "ISDSH" and "ENPO"
  For step 1 from table 39.2 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 39.2 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

Table 39.2   Power-up sequence

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	

Display readout after drive start-up

Table 40.1 Display D1/D2 during motor activation

D1	D2	Action	Reaction	Explanation
		"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 ist transferred directly to the drive when motor control starts.			
		"Start" enabled	ON	Drive powered, control active

For details on optimizing the drive in your application refer to the DriveManager 5 Online Help and the Operating Manual YukonDrive®.

4.3 Serial commissioning

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

4.4 Integrated operator control unit

The built-in operator control unit permits diagnosis of the YukonDrive®. 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)

Illustration 40.2 Integrated operator control unit YukonDrive®
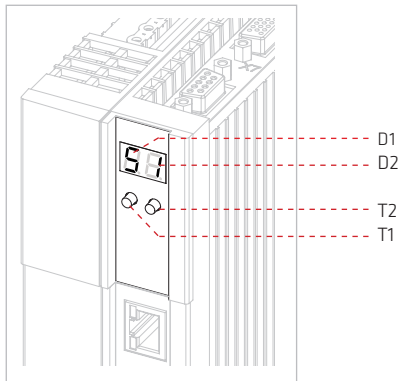
The following functions and displays are available:
• Display of device state (see section 5.1 , "Device states", on page 42) The device state is displayed after switching on the control supply. If no input is made via the keypad for 60 seconds, the display switches back to the device state.
• Display of device error state (see page 42) 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.

Table 41.1   Functions of buttons T1 and T2

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.

4.4.2 Display

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

Table 41.2   Meaning of display

Display	Meaning
PA	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]	[flashing decimal points] Selected function in action
--	[two lines] Entry/function not available
oٰ	[OK] Selected action completed successfully, no errors.
Er	[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 YukonDrive® Application Manual")
10	Numerical values ("10" is by way of example in this case) • On the Parameters menu (PA) error numbers are displayed in decimal format. • All ohter values are displayed in hexademical format. In those cases the displayed „10" would represent the decimal value 16.

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.

Table 42.1 Parameters menu

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

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 "YukonDrive® Operating Manual".

Table 42.2 Error numbers

Error numbers	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

4.4.4 Ethernet IP adress 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.

Table 42.3 IP adress menu

| Menu level		Para-	Value	Meaning	Explanation
1	2	meter	range		
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 (e. g. „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	Subnetmask udate Byte 0	Setting of byte 0 of the IP address in exadecimal format (e. g. „00" for 255.255.255.**0**)
		b1	00..FF	Subnetmask udate Byte 1	Setting of byte 1 of the IP address in hexadecimal format (e. g. „FF" for 255.255.**255**.0)
		b2	00..FF	Subnetmask udate Byte 2	Setting of byte 2 of the IP address in hexadecimal format (e. g. „FF" for 255.**255**.255.0)
		b3	00..FF	Subnetmask udate 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)

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.

Illustration 43.1   Example configuration of subnet mask
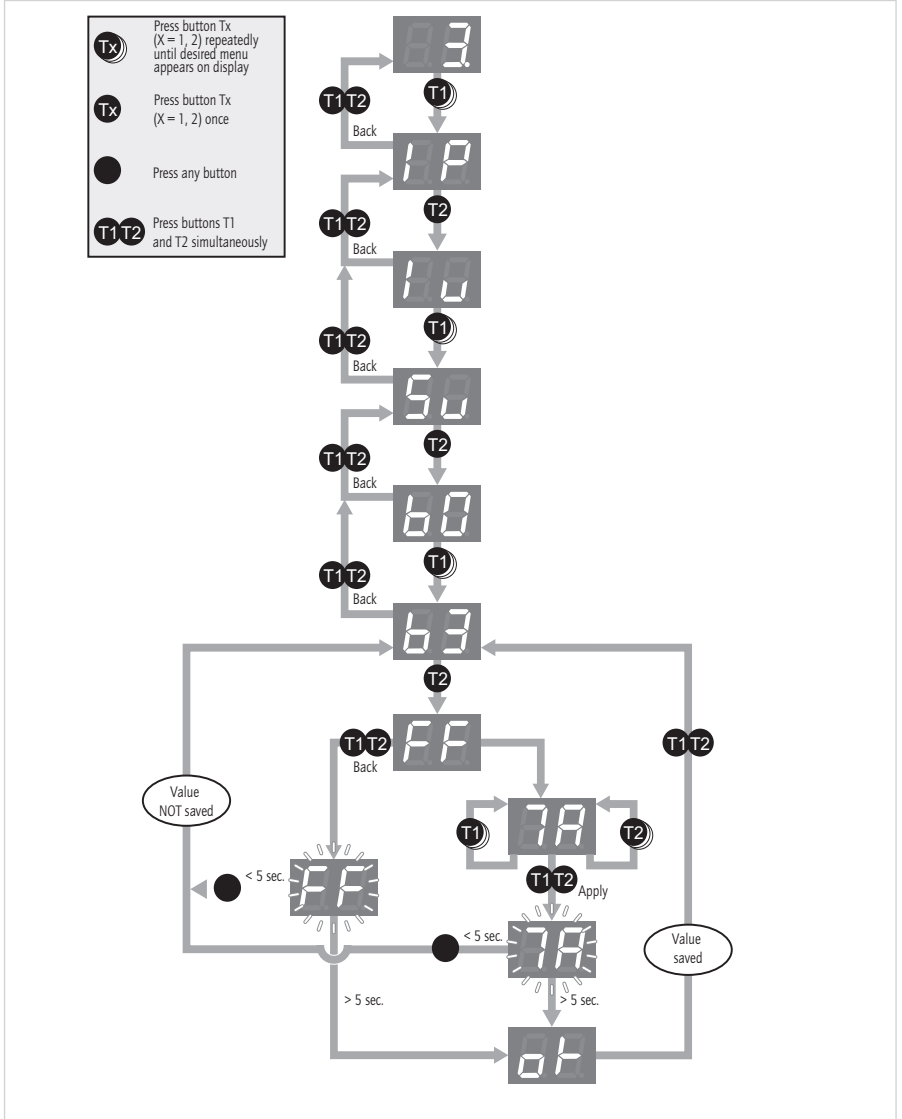
4.4.5 Field bus adress menu (Fb)

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

Table 44.1   Field bus address menu

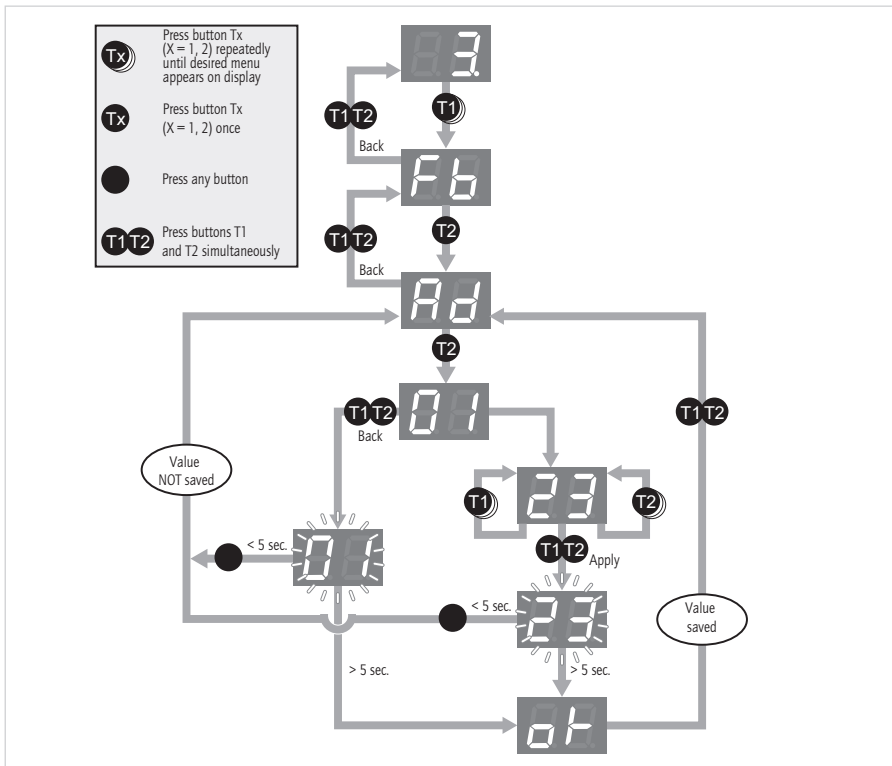| Menu level		Para-meter	Value range	Meaning	Explanation
1	2				
Fb	Ad	–	00..xx or – –	Field bus address	Example configuration of field bus address (only when field bus option used), otherwise display "- -" (The maximum programmable value depends on the option)
	Po	–	0..3 or – –	Transmit power	Setting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

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.

Illustration 44.2   Example configuration of field bus address

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

Table 45.1   Device states

Anzeige	System state
88.	Device in reset state
0	Self-initialization on device start up
S1 *)	Not ready to switch on (no DC-link voltage) [1]
S2 *)	Start inhibit (DC link OK, power stage not ready) [1]
3	Ready (power stage ready)
4	Switched on (drive powered) [2]
5	Drive ready (power applied to drive and drive ready for reference input) [2]
6	Quick stop [2]
7	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.

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.

Table 45.2   Display of error code

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

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 YukonDrive® User Manual.

5.4 Helpline/Support & Service

Our Technical Customer Service 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

6. Safe Torque Off (STO)

All Informations about the STO function can be found in the document "**Description of the STO safety function**" (material number 1007417).

A.1 Current capacity of servocontrollers

The maximum permissible servo controller 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 servo controllers also changes.

YukonDrive® for 1 x 230 V

Table 47.1   Rated current and peak current, BG2 to BG4 (1 x 230 V AC)

Device	Switching frequency of power stage [kHz]	Ambient temperature max. [°C]	Rated current I_N [A_{eff}]	Peak current			
				200 % (2 I_N)		300 % (3 I_N)	
				[A_{eff}]	for time [s]	[A_{eff}]	for time [s]
-1021	4	45	3.0	6.0		9.0	0.08
	8	40	3.0	6.0	10	9.0[1]	0.08[1]
	16	40	2.0	4.0		9.0[1]	0.08[1]
-1031	4	45				–	–
	8	40	5.9	11.8	10	–	–
	16	40				–	–
-1041	4	45	8.0	16.0		–	–
	8	40	8.0	16.0	10	–	–
	16	40	5.4	10.8		–	–

[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.

YukonDrive® for 3 x 230 V

Table 47.2   Rated current and peak current, BG2 to BG4 (3 x 230 V AC)

Device	Switching frequency of power stage [kHz]	Ambient temperature max. [°C]	Rated current I_N [A_{eff}]	Peak current			
				200 % (2 I_N)		300 % (3 I_N)	
				[A_{eff}]	for time [s]	[A_{eff}]	for time [s]
-1021	4	45	3.0	6.0		9.0	
	8	40	3.0	6.0	10	9.0[1]	0.08
	16	40	2.0	4.0		9.0[1]	
-1031	4	45				17.7	
	8	40	5.9	11.8	10	17.7[1]	0.08
	16	40				17.7[1]	
-1041	4	45	8.0	16.0		24.0	
	8	40	8.0	16.0	10	24.0[1]	0.08
	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.

YukonDrive® for 3 x 400/460/480 V

Table 48.1   Rated current and peak current, BG2 to BG4 (3 x 400/460/480 V AC)

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]
-1022	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		2.8[1]	
-1032	4	45	5.5	4.8	4.6	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]	
-1042	4	45	8.5	7.4	7.0	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.

A.2 YukonDrive® technical data

Table 49.1 technical data YukonDrive® - 1021/-1031/-1041

Designation / Technical data		-1021	-1031	-1041
Output. motor side [1]				
Voltage		3-phase U $_{Netz}$		
Effective continuous current (I_N) [2]		3 A	5.9 A	8 A
Peak current (A_{eff})		see table 44.1 and 44.2		
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	14.4 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	150W	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 90Ω [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 33!

[3] Connection of ext. braking resistor not permitted to devices with int.braking resistor!

[4] Braking resistor always integrated. Connection of an external resistor is permissible.

[5] Option

Note:

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

Table 50.1   technical data YukonDrive® -1022/ -1032/ -1042

Technical data / Designation	-1022	-1032	-1042
Output. motor side [1]			
Voltage	3-phase U_{Netz}		
Effective continuous current (I_N) [2]	2 A	3.5 A	6.5 A
Peak current (A_{eff})	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
Braking chopper power electronics			
Peak braking power with int. braking resistor	2400 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 33!

[3] Connection of ext. braking resistor not permitted to devices with int.braking resistor!

[4] Braking resistor always integrated. Connection of an external resistor is permissible

[5] Option

Note:

For more information on the braking chopper switch-on threshold also refer to section 3.14 as from page 34.

A.3 Ambient conditions

Table 50.2   YukonDrive® climatic conditions

Ambient conditions	YukonDrive®
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 51.1 YukonDrive® climatic conditions

Climatic conditions		YukonDrive®
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 bis +40 °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 51.2 YukonDrive® mechanical conditions

Mechanical conditions		YukonDrive®	
Vibration limit in transit	as per EN 61800-2, IEC 60721-3-2 class 2M1)[1]		
	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[3]		
	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.

⚠

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.

The devices are certified according to UL508C.
The following conditions have to be observed:

1. Use in systems with a maximum overvoltage category III.
2. Use in a maximum pollution degree 2 environment only.
3. Multiple rated equipment. For details see tables in chapter A.1, A.2 and A.3 in this manual.
4. Use UL-certified 60/75°C copper conductors only.
5. Internal overload protection operates within max. 10 sec seconds when reaching 200% of the Motor Full Load Current.
6. Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the manufacturer instructions, National Electrical Code and any additional local codes.
7. Suitable for use on a circuit capable of delivering not more than 5000 rms symmetrical amperes @ volts maximum, when protected by class RK5 fuses. Ratings see Table 52.1.
8. Motor overtemperature sensing (such as thermal sensor or switch imbedded in the motor) must be connected during operation of these drives.
9. Control outputs (X4/23; X4/24) and OSD00, OSD01, OSD02: Use secondary isolating source V rated 25 Vac, 30 Vdc or 24 Vdc as appropriate for rating of the given output. Fuse in accordance with UL248, rated 100/V must be connected between the source and the output.

Table 52.1   Tightening torques and mains fusing, BG2 to BG4

Size	Device	Tightening torque mains and motor terminals X3 X1	Tightening torque. control terminals X5. X2. X13	Mains fusing / Class
BG2	-1021-Axx	5 … 7 lb-in 0.56 … 0.79 Nm	5 … 7 lb-in 0.56 … 0.79 Nm	10 A, 250 V / RK5
	-1022-Bxx	5 … 7 lb-in 0.56 … 0.79 Nm	5 … 7 lb-in 0.56 … 0.79 Nm	6 A, 600 V / RK5
BG3	-1031-Exx	5 … 7 lb-in 0.56 … 0.79 Nm	5 … 7 lb-in 0.56 … 0.79 Nm	20 A, 250 V / RK5
	-1032-Cxx	5 … 7 lb-in 0.56 … 0.79 Nm	5 … 7 lb-in 0.56 … 0.79 Nm	15 A, 600 V / RK5
BG4	-1041-Exx	4.4 … 5.3 lb-in 1,7 Nm	5 … 7 lb-in 0.56 … 0.79 Nm	25 A, 250 V / RK5
	-1042-Fxx	1.7 Nm	5 … 7 lb-in 0.56 … 0.79 Nm	20 A, 600 V / RK5
BG5	1052-Gxx	in preparation		
	1052-Fxx	in preparation		

Tabelle 52.2   Certifications
The YukonDrive servocontroller has the following acceptance:

Servocontroller	Certification
-1021-Axx	UL Recognized
-1022-Bxx	UL Listed
-1031-Exx	UL Listed
-1032-Cxx	UL Recognized
-1041-Exx	UL Listed
-1042-Fxx	UL Listed