item

item Controller BL 1-04 /C – 0.0.698.50

Product manual

Original Product manual

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1 About this Product manual

The purpose of this Product manual is to ensure the safe use of the servo drives of the BL 1-04 /C series and of the item MotionSoft® parameterisation software (abbreviated "iMS®").

The safety instructions and warnings in this Product manual must always be followed.

1.1 Explanations and notation

1.1.1 Structure of the warning notes

Warning notes have the following structure:

- Signal word "NOTE"
- Introductory phrase
- Explanations and special tips

Signal words

DANGER	Indicates an imminent hazard. If the situation is not avoided, extremely serious and possibly fatal injuries will result.
⚠ WARNING	Indicates a potentially hazardous situation. If the situation is not avoided, extremely serious and possibly fatal injuries may result.
⚠ CAUTION	Indicates a potentially hazardous situation. If the situation is not avoided, slight or minor injuries may result.
⚠ NOTICE	Warns against damage to property.

Warning signs as per ISO 7010

Warning sign	Explanation
	Warning against fatal electric voltage.
	Warning against hot surfaces.

1.1.2 Notation in this product manual

Structure of notes

The notes in this Product manual have the following structure:

- Signal word "NOTE"
- Introductory phrase
- Explanations and special tips

Operating elements, menus

Operating elements, menus and menu paths are written in orange.

Example: Double-clicking the desired device or clicking the button Establish connection will establish an online connection.

1.2 Additional documents

Further information can be found in the following manuals:

- EtherCAT and CANopen manual Servo Positioning Controller C-Series:This manual describes the commissioning procedure for the servo drives C-Series or BL 1-04 /C with a CANopen or EtherCAT control system.
- PROFIBUS/PROFINET manual Servo Positioning Controller C-Series / BL 1-04 /C: This manual describes the commissioning procedure for the servo drives C-Series or BL 1-04 /C with a PROFINET control system.

You can find all of these documents on our homepage for download. Certificates and declarations of conformity for the products described in this manual can also be found at our homepage: https://www.item24.com

1.3 Order numbers

Order number	Description
0.0.698.50	Controller BL 1-04 /C
0.0.688.62	I/O Transfer Module C-Series
0.0.689.27	I/O Cable C-Series
0.0.703.51	Power Cable BL SC1 04/5
0.0.704.65	Power Cable BL SC1 04/10
0.0.704.66	Power Cable BL SC1 04/15
0.0.704.71	Data Cable BL RSC/5
0.0.704.72	Data Cable BL RSC/10
0.0.704.73	Data Cable BL RSC/15
0.0.704.75	Data Cable BL AKSC/5
0.0.704.76	Data Cable BL AKSC/10
0.0.704.77	Data Cable BL AKSC/15

1.4 Applicable standards

Standard	Description
EN 13849-1:2015	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
EN 50581	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances
EN 60204-1	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN 61800-3	Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods
EN 61800-5-1	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy
EN 61800-5-2	Adjustable speed electrical power drive systems - Part 5-2: Safety requirements - Functional
EN 62061	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
EN ISO 12100	Safety of machinery - General principles for design - Risk assessment and risk reduction
IEC 61508 Teil 1-7	Functional safety of electrical/electronic/programmable electronic safety-related systems
IEC 82079-1	Preparation of instructions for use - Structuring, content and presentation - Part 1: General principles and detailed requirements
UL 61800-5-1	Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements - Electrical, Thermal and Energy
CSA C22.2 No. 274	Adjustable speed drives

2 For your own safety

2.1 General information

Servo drives of the BL 1-04 /C series can only be used safely if you read and comply with this document.

The servo drive has a safe design. However, certain hazards exist in the context of certain activities. These hazards can be avoided by following the correct procedures. The correct procedures for avoiding these hazards are described in this document.

In addition to the instructions described in this document, there may be additional health and safety instructions as well as general safety instructions that you must comply with. Keep informed about all of these aspects.

Professional project planning is a prerequisite for the correct and trouble-free operation of the servo drive.

The following requirements must be fulfilled to ensure the trouble-free and safe operation of the servo drive.

- Proper and correct transport
- Proper storage
- Proper installation
- Proper project planning taking in consideration all of the potential risks, necessary protective and emergency measures and the installation
- Careful operation and proper maintenance.

Only trained and qualified personnel in accordance with section 2.3 Target group on page 9 are authorised to work with or on the electrical systems.The following instructions must be read and understood prior to the initial operation of the system in order to prevent injuries and/or damage to property. The following safety instructions must be complied with at all times:

- Do not attempt to install or start the servo drive without having read all of the safety instructions in this document concerning the electrical drives and controllers. These safety instructions and all other user notes must be read prior to performing any work with the servo drive.
- If the servo drive is sold, rented out or otherwise distributed to third parties, these safety instructions must be included.
- The user must not open the servo drive for safety and warranty reasons.

2.2 Intended use

The electronic drive control unit (servo drive) is intended for operation in combination with electric motors in an industrial environment. The handling of the servo drive requires qualified personnel that have been trained in terms of general and, in particular, electrical safety. The intended use also includes compliance with the information and instructions in this manual.

Any use going beyond or deviating from the intended use will be considered as misuse.

⚠ WARNING **Hazards caused by misuse**

Misuse of the servo drive will lead to dangerous situations.

- Use the servo drive only under the ambient conditions that are specified in section 8.
- Do not use the servo drive outdoors or in explosive atmospheres.
- Use suitable and qualified specialist personnel for any type of work on the servo drive.
- Always comply with the voltage ranges that are specified in section 8 Technical data on page 33.
- Follow all of the instructions in this manual concerning the safe use of the servo drive.

2.3 Target group

Over its entire service life, work on the servo drive, with the exception of its operation, may only be performed by specialist personnel and/or instructed persons who have been trained for the required tasks. The servo drive is to be operated by the user.

Trained and qualified personnel

Qualified personnel in the sense of this product manual are persons who are sufficiently familiar with the project, set-up, installation, commissioning and operation of the servo drive as well as with all of the warnings and precautions and who are sufficiently qualified in their field of expertise:

- They have been trained, instructed and authorised to perform the switching and earthing (grounding) of the devices/systems in line with the applicable safety standards and to label them accordingly as per the job requirements.
- The service and maintenance personnel have undergone special training in the context of ESD protection measures.
- They have been trained and instructed in line with the applicable safety standards in terms of the maintenance and use of adequate safety equipment.
- They have completed first aid training.

2.4 General safety instructions

DANGER ⚠ **Danger to life due to electric shock!**

Non-compliance with the safety instructions will lead to a potentially fatal electric shock.

The general set-up and safety rules and regulations concerning the work on power installations (e.g. DIN, VDE, EN, IEC or any other national or international rules and regulations) must be complied with.

- Safety-critical applications of the servo drive are not allowed unless specifically approved by the manufacturer.
- For information about the EMC-compliant installation, see section 9.1 Notes concerning the safe and EMC-compliant installation on page 52. The manufacturer of the machine or system is responsible for ensuring compliance with the limits that are specified by the applicable national rules and regulations.
- The ambient conditions that are specified in the product manual must be strictly observed.
- The technical data as well as the connection and installation conditions of the servo drive are stated in this document and must be complied with at all times.
- The servo drive has an IP20 protection rating and a pollution degree rating of 2. Ensure that the environment corresponds to this protection rating and pollution degree rating.
- Use only original accessories and original spare parts that have been approved by the manufacturer.
- The servo drives must be connected to the mains power supply in accordance with the country-specific regulations (EN standards, VDE rules) so that they can be disconnected from the mains power supply by way of suitable disconnectors (e.g. main switches, contactors, circuit breakers).
- Use gold contacts or contacts with a high contact pressure for switching the control contacts.
- You can protect the servo drive with an AC/DC-sensitive residual-current device (RCD) with 300 mA minimum.
- Preventive interference suppression measures should be taken for the switchgear. This can be done, for example, by connecting RC circuits or diodes to the contactors and relays.

2.5 Personal protective equipment

Always use personal protective equipment during the transport, installation, start-up, cleaning, maintenance and removal of the servo drive, for example:

- Protective gloves
  To prevent superficial hand injuries.
- ESD safety shoes
  To prevent foot injuries caused by falling parts. To prevent electrostatic charging.
- Protective work clothes
  To prevent superficial injuries and soiling.
- Protective goggles
  To prevent eye injuries caused by dust or shards/splinters.
- Light respiratory protection
  To prevent the inhalation of harmful substances.

2.6 Safety notes for installation and maintenance

DANGER ⚠ Dangerous electrical voltage!

Prior to performing any maintenance tasks, you need to ensure that the power supply and the external power supply of the servo drive have been disconnected and secured against reconnection and that the DC bus has discharged.

During the operation of the servo drive and up to 10 minutes thereafter, the corresponding connections and an external braking resistor carry dangerous DC bus voltages. Contact with these voltages may result in serious or even fatal injuries.

Wait 10 minutes prior to performing any work on the connections. Always measure the voltage with a suitable instrument.

⚠ WARNING ⚠ Risk of burns due to hot surfaces!

The servo drive and, in particular, the (external or internal) braking resistor may become hot during operation. Always wait a sufficient amount of time prior to touching these parts.

Always use suitable personal protective equipment to avoid severe burns.

⚠ CAUTION Risk of injury for unqualified personnel!

Only personnel who are trained and qualified for working on or with electrical devices are authorised to install, maintain and repair the servo drive.

To prevent accidents, injuries and damage to property:

Perform a risk assessment and follow all of the statutory and local safety instructions and accident prevention regulations when installing or maintaining the system.

Ensure that the AC or DC power supplies are switched off and locked prior to performing any work in the area of the machine. The deactivation of the output stages or servo drive enable signals is not a suitable means of locking. In the case of a malfunction, the drive may accidentally be put into action. This does not apply to drives with the special "Safe Torque Off" feature in accordance with EN 61800-5-2.

Electronic devices are never completely fail-safe. It is the user's responsibility to ensure that the system is brought to a safe state if the electrical device fails.

Disconnect the electric equipment from the power supply via the main switch and secure it against reconnection. Wait until the DC bus has discharged in the following cases:

- maintenance and repairs
- cleaning
- long downtimes

The standard motor holding brake that is included in the scope of supply or any other external motor holding brake that is actuated by the servo drive is not suitable for the protection of the operators if used alone!

Be particularly careful during the installation process. During the installation and also later on during the operation of the drive, ensure that no drilling chips, metal dust or installation parts (screws, nuts, cable sections) can fall into the servo drive.

Use suitable personal protective equipment during the installation.

Vertical axes must be additionally secured against falling down or lowering after the motor has been switched off, for example by way of the following:

- mechanical locking of the vertical axis,
- external braking, catching or clamping devices, or
- sufficient weight counterbalance of the axis

Perform the start-up process with idling motors. This is to avoid mechanical damage, e.g. due to an incorrect direction of rotation.

2.7 Protection against contact with electrical parts

DANGER ⚠ Dangerous electrical voltage!

In certain device constellations, the rapid discharge of the DC bus voltage of the servo drive may be rendered ineffective. In these cases, the servo drives may still carry dangerous voltage levels up to 10 minutes after they have been switched off (residual capacitor charge).

Wait 10 minutes prior to performing any work on the connections. Always measure the voltage with a suitable instrument.

To prevent accidents, injuries and damage to property:

Follow the national accident prevention regulations (for Germany, this is DGUV regulation 3 (formerly BGV A3)).

Do not touch the electrical connections of the components when they are switched on.

Prior to accessing electrical parts carrying voltages above 50 V, disconnect the device from the mains power supply or voltage source. Secure it against reconnection.

Install the respective covers and guards against accidental contact prior to switching the device/system on. Rack-mounted devices must be protected against accidental contact by way of an enclosure, e.g. a switch cabinet.

Prior to start-up and even for brief measurements or tests, connect the protective earth conductor (ground conductor) of all of the electrical devices in accordance with the circuit diagram (see section 9 Electrical installation on page 52) in a fixed manner (hardwiring) to the supply network or to the earthing system on site.

Comply with the minimum copper cross-section for the protective earth conductor (ground conductor) over its entire length (see EN 61800-5-1). Otherwise, the housing may carry high voltages which can cause electric shock.

Due to the integrated line filters, the leakage current exceeds 3.5 mA. This is why two connection points must be hard-wired

The magnitude of the DC bus voltage must be taken into consideration during the installation process in order to ensure proper insulation and protection. Ensure proper earthing (grounding), conductor rating and protection against short circuits.

2.8 Protection against electric shock by way of protective extra-low voltage (PELV)

DANGER Dangerous electrical voltage!

There is a risk of high electrical voltage due to incorrect electrical connections. Always follow the safety instructions stated hereinbelow.

All of the connections and terminals with voltages up to 50 V of the servo drive have protective extra-low voltage. They are protected against contact in accordance with IEC 61800-5-1 and EN 61800-5-1.

Only devices, electrical components and wires or cables with protective extra-low voltage (PELV) may be connected to connectors and terminals with voltages from 0 to 50 V.

When connecting voltages and circuits, ensure that they are securely isolated from any dangerous voltages. This isolation can be realised by way of isolation transformers, safe optocouplers or battery operation without mains power.

2.9 Protection against dangerous movements

⚠ WARNING Risk of injury due to dangerous movements

Always follow the safety instructions stated hereinbelow.

Dangerous movements can be caused by the faulty actuation of the connected motors. Causes may be as follows:

- improper or faulty wiring or cabling
- errors during the operation of the components
- errors of the sensors and transducers
- defective or non-EMC-compliant components
- software errors in the superordinate control system.

These errors can occur directly after the activation of the device or after some time during the operation.

The monitoring systems in the drive components exclude any malfunction in the connected drives to the greatest possible extent. However, in view of the protection of the operators, particularly in terms of the risk of injuries and damage to property, relying solely on this measure is not recommended. Until the built-in monitoring systems become effective, faulty drive movements should always be anticipated. The extent of these faulty drive movements depends on the type of control and on the operating state.

For the reasons mentioned above, protection must be ensured by monitoring or by superordinate measures. This must be implemented by the system manufacturer based on the specific system situation and on a hazard and fault analysis. This also includes the safety rules and regulations that apply to the system. Random movements of the machine or other malfunctions may be caused by deactivating, bypassing or failing to activate the safety devices.

2.10 Protection against contact with hot parts

⚠ WARNUNG Risk of burns due to hot surfaces

The servo drive and, in particular, the (external or internal) braking resistor may become hot during operation. Always wait a sufficient amount of time prior to touching these parts.

Always use suitable personal protective equipment to avoid severe burns.

2.11 Protection during the handling and installation of the devices

⚠ CAUTION **Risk of injury caused by crushing, shearing, cutting or impacts**

Improper handling and installation of certain parts will cause injuries. Always follow the safety instructions stated hereinbelow.

- When installing the servo drive, ensure that it can be installed, operated and removed without any danger.
- Appropriate installation clearances must also be defined.
- Comply with the intended use of the servo drive.
- When transporting the servo drive, pay particular attention to the edges and corners of housings and other components. Use suitable personal protective equipment.
- If you install the components of the system on a wall or on the floor, dust may be created by drilling. Use suitable personal protective equipment.
- Use only suitable installation and transport equipment.
- Prevent trapping and crushing by suitable protective measures.
- Use only suitable tools. If specified, use special tools.
- Use lifting equipment and tools in a proper manner.
- Do not step under suspended loads.
- Liquid spills on the floor must be removed immediately.

3 Product description

The servo drives of the smartServo BL 4000-C series are smart AC servo drives for controlling three-phase synchronous motors, torque motors and linear motors. The servo drives can be used in a universal manner, since they can be combined with a wide range of encoder systems and motors. Due to their extensive parameterisation options, they can be adapted to a variety of different applications. Servo drives of the BL 4000-C series are intended for use as devices installed in control cabinets.

The connection to a superordinate control system can be realised by way of the integrated EtherCAT/Profinet or CAN interface.

Parameter sets that have been created for the Servo Positioning Controller C-Series series can be used for the BL 1-04 /C and vice versa.

3.1 Type designation

Type key using the example of a BL 4104-C.

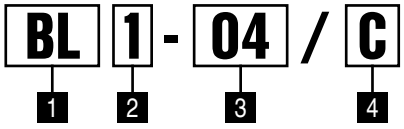
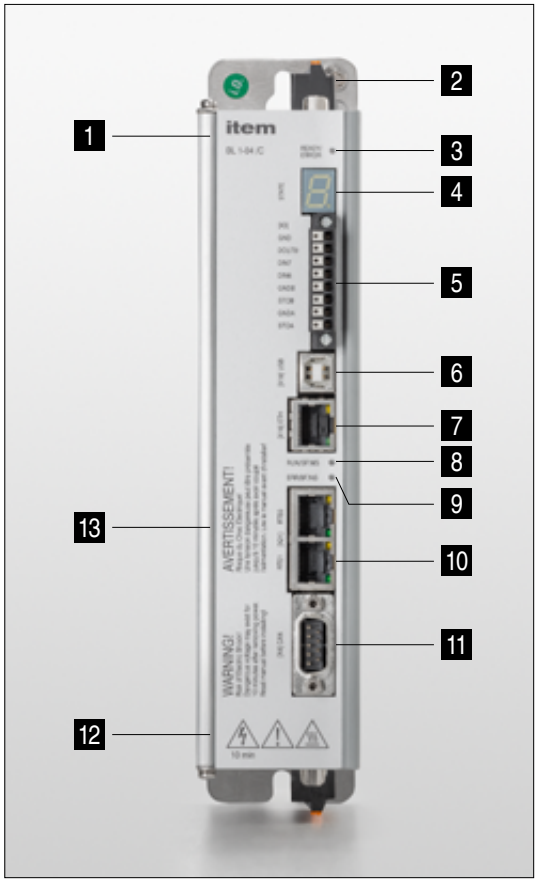


Figure 1: Nomenclature

1 Type designation: Basic Line
2 Power line connection: single-phase
3 Nominal current in [A eff]
4 Cabinet (control cabinet device)

3.2 Device view

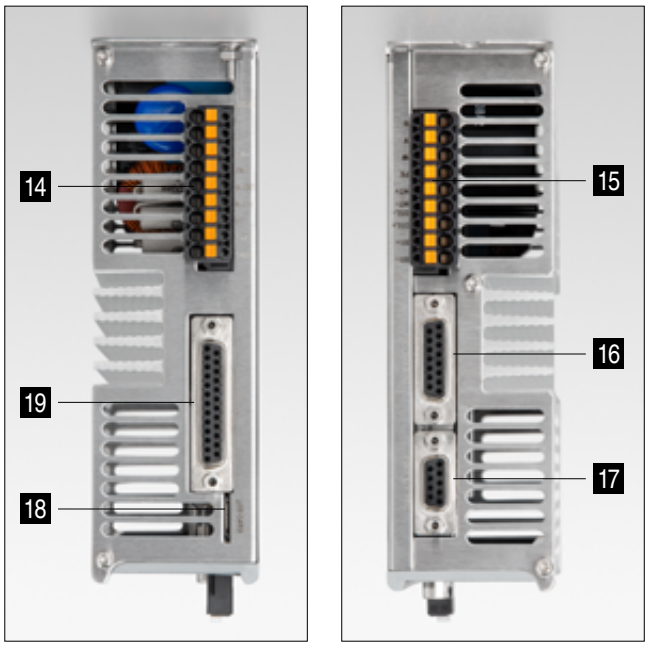
Front view



1 Product name
2 Earthing screw
3 Status indicator LED (READY, ERROR, ENABLE)
4 Seven-segment status indicator
5 [X3] STO interface (STOA, STOB), Limit switch (DIN6, DIN7), Dig. output (DOUT0)
6 [X19] USB interface
7 [X18] Ethernet interface
8 LED (RUN/SF/MS)
9 LED (ERR/BF/MS)
10 [X21] Real-time Ethernet interface
11 [X4] CANopen interface
12 Safety Symbols as per ISO 7000
13 Warnings

Figure 2: Front view of a BL 1-04 /C

Top view / Bottom view



14 [X9] Power supply
15 [X6] Motor connection
16 [X2B] Multi-encoder
17 [X2A] Resolver/ analogue Hall sensors
18 Slot for microSD cards
19 [X1] I/O communication

Figure 3: Top view (left) / Bottom view (right) of a BL 1-04 /C

3.3 Features

All of the servo drives of this series have the following features

Integrated fieldbus interfaces

- CANopen interface for the integration in automation systems
- EtherCAT interface (CoE)
- ProfiNet interface (Item standard telegrams, based on PROFIdrive)

Integrated universal shaft encoder evaluation for the following encoder types:

- Resolvers
- Analogue and digital incremental encoders with and without commutation signals
- High-resolution Stegmann incremental encoders with HIPERFACE®
- High-resolution Sick incremental encoders with HIPERFACE DSL (single-cable variant)
- High-resolution Heidenhain incremental encoders with EnDat 2.2 (ENDAT22)
- Master frequency input/output and pulse direction interface

Suitable motors

- Permanent-magnet synchronous machines with sinusoidal EMF
- Torque motors
- Linear motors
- Air-core and iron-core linear motors with a low motor inductance (0.5 ... 4 mH)
- Automatic determination of the motor parameters

User-friendly parameterisation with the item MotionSoft® software

- Adjustment of all of the parameters via a PC and online representation of operating parameters and diagnostic messages
- User-guided initial start-up, loading and saving of parameter sets as well as offline parameterisation are possible
- Oscilloscope function for optimising the drive and for analysing the PLC I/O coupling
- Supported languages: German, English, French, Spanish, Italian, Polish
- Automatic motor identification and procedures for the automatic determination of the commutation position in the case of encoders without a commutation track
- Automatic adjustment of the control circuits for current, speed and position control

Integrierte Funktionale Sicherheit

- "Safe Torque Off (STO)" safety function integrated in the device
- SS1 functionality possible

Homing and positioning

- Integrated positioning control with a wide range of functions as per "CAN in Automation (CiA) DSP402" plus numerous additional application-specific functions.
- Jerk-free or time-optimal positioning, relative or absolute with regard to a reference point. Point-to-point positioning with and without smooth position transitions.
- High-speed sample inputs for triggering the storage of position marks
- Numerous homing methods
- Rotor and position triggers

Brake control and automatic brake

- Direct control of a holding brake in the motor with high current. As a result, an external relay is not necessary. In addition, variable delays can be used.
- "Automatic brake" for deactivating the power section during longer breaks to save energy

Electrical characteristics

- Wide-range supply input (AC)
- "Soft switch-on" features for the soft precharging and quick charging of the DC bus
- DC bus coupling between devices with the same mains power supply for buffering the brake energy
- Improved monitoring and analysis of the mains power supply by a direct measurement of the mains voltage

Applications

- Speed- and angle-synchronous operation with an electronic gear unit via the incremental encoder input or fieldbus. Extensive modes of operation for synchronisation, e.g. "flying saw"
- Jog mode, teach-in mode, motion programs, torque-limited set control and much more

Special control features

- High control quality due to high-quality sensors, far superior to conventional market standards, and above-average processor resources
- Short cycle times, bandwidth in the current control circuit approx. 2 kHz (with ti= 32 µs), in the speed control circuit approx. 500 Hz (with tn= 64 µs)
- Parameterisable band-stop filters for suppressing the natural frequency of the controlled system
- Load torque compensation for vertical axes
- Synchronisable internal clock system for the synchronisation with external clock sources for CANopen and EtherCAT fieldbus systems by way of an internal PLL

Certification and qualification

- Compliance with the current CE and EN standards without any additional external measures
- UL certification
- Completely closed, EMC-optimised housing for mounting on conventional switch cabinet mounting plates. The devices have an IP20 degree of protection.
- Integration of all of the required filters, e.g. line filters, filters for the 24 V supply and filters for the inputs and outputs, into the device in order to ensure compliance with the EMC regulations during operation (industrial environment)

4 STO (safe torque off)

The purpose of this chapter is to ensure the safe use of the STO (safe torque off) safety function that is integrated in the servo drive.

This documentation refers to the following versions:

- Controller BL 1-04 /C with the STO function, revision 1.0 or higher
- item MotionSoft parameterisation program version 3.0 or higher.

4.1 Special safety instructions

DANGER ⚠ Dangerous electrical voltage!

Always follow the safety instructions for electric drives and control systems in section 2. For your own safety on page 8.

⚠ WARNING Hazards due to the loss of the safety function

If you do not comply with the specified ambient and connection conditions, the safety function will be lost. This may lead to injuries in the worst case.

Always comply with the specified ambient and connection conditions. This applies particularly to the input voltage tolerances. See section 8.11 STO [X3] on page 47.

4.2 Certification/safety level

A servo drive of the BL 1-04 /C series with an integrated safety function is a safety device in accordance with the EC Machinery Directive 2006/42/EC and it bears the CE mark.

Information about the product-relevant EC Directives can be found in the declaration of conformity in section 11.2 CE conformity (Machinery Directive) on page 74.

The achievable safety level depends on the other components that are used to implement a safety function. This has been certified by an independent testing authority.

4.3 Requirements for using the product

Make this documentation available to the design engineer, installation technician and personnel responsible for commissioning the machine or system in which this product is used.

Ensure that the specifications of the documentation are always complied with. Also take into account the documentation for the other components (e.g. safety relays, cables, etc.).

Take into consideration the legal regulations applicable at the installation site as well as:

- regulations and standards
- regulations of the testing organisations and insurers
- national specifications
- all of the safety instructions in section 2 For your own safety on page 8
- the special safety instructions in section 4.1 Special safety instructions on page 17

For emergency stop applications, protection against automatic restarting must be provided in accordance with the required safety category. This can be realised, for example, by way of an external safety relay.

4.3.1 Qualification of the specialist personnel (personnel requirements)

The device may only be set into operation by a qualified electrical technician who is familiar with:

- the installation and operation of electrical control systems
- the applicable regulations for operating safety-oriented systems
- the applicable regulations for accident protection and industrial safety
- the documentation for the product.

4.3.2 Diagnostic coverage (DC)

The diagnostic coverage depends on the integration of the safety functions, which are integrated in the servo drive, into the overall system and on the implemented diagnostic measures.

If a malfunction is detected during the diagnosis process, appropriate measures must be taken to maintain the safety level.

INFO Cross-circuit detection

Check whether your application requires a cross-circuit detection of the input circuit and of the connecting wiring.

If necessary, use a safety relay with cross-circuit detection for actuating the safety function

4.4 Purpose

As processes become increasingly automated, protecting persons against potentially hazardous movements is continuously gaining in importance. Functional safety describes the necessary measures in the form of electrical or electronic devices for the reduction or elimination of hazards caused by malfunctions. Under normal operating conditions, protective devices and guards prevent human access to danger areas. However, in certain operating modes, e.g. during set-up, persons are required to be present in these danger areas. In these situations, the machine operator must be protected by way of drive- and control-system-related measures.

The integrated functional safety technology provides the control-system- and drive- specific conditions for the optimal realisation of protective functions. As a result, planning and installation become less labour-intensive. The use of integrated functional safety technology leads to an enhanced machine functionality and availability compared to the levels achieved by conventional safety technology.

4.5 Principle of operation and use

The STO function includes the feature "Realisation of the "Safe Torque Off" (STO) function".

The "Safe Stop 1" (SS1) function can be realised with a suitable external safety relay and by suitable wiring of the servo drive.

4.5.1 Description of the STO safety function

Use the "Safe Torque Off" (STO) function if you need to disconnect the motor safely from the energy supply for your application. The "Safe Torque Off" function switches off the driver supply for the power semiconductors. This prevents the power output stage from providing the voltage that is required by the motor. As a result, the motor cannot start unexpectedly. See the following illustration.

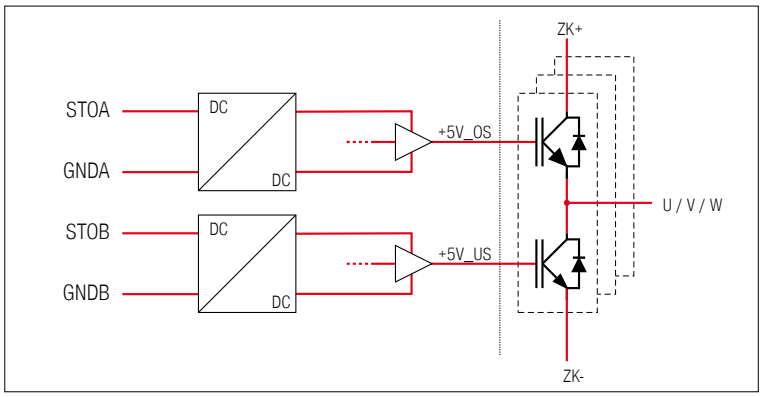


Figure 4: "Safe Torque Off" - principle of operation

When the "Safe Torque Off" (STO) function is active, the energy supply to the drive is interrupted in a safe manner. The drive can neither generate any torque nor any dangerous movements. In the case of suspended loads or other external forces, additional measures must be taken in order to prevent the load from sagging (e.g. mechanical holding brakes). In the "Safe Torque Off" (STO) state, the standstill position will not be monitored.

⚠ NOTICE **Risk of a jerky movement of the drive in the case of multiple errors**

If the output stage of the servo drive fails while in the STO state (simultaneous short circuit of 2 power semiconductors in different phases), a limited dwell movement of the rotor may result. The angle of rotation/distance corresponds to one pole pitch.

Examples:

- Rotary axis, synchronous machine, 8 poles
  → movement < 45° of the motor shaft.
- Linear motor, pole pitch 20 mm
  → movement < 20 mm of the moved part.

4.5.2 Overview of the [X3] interface

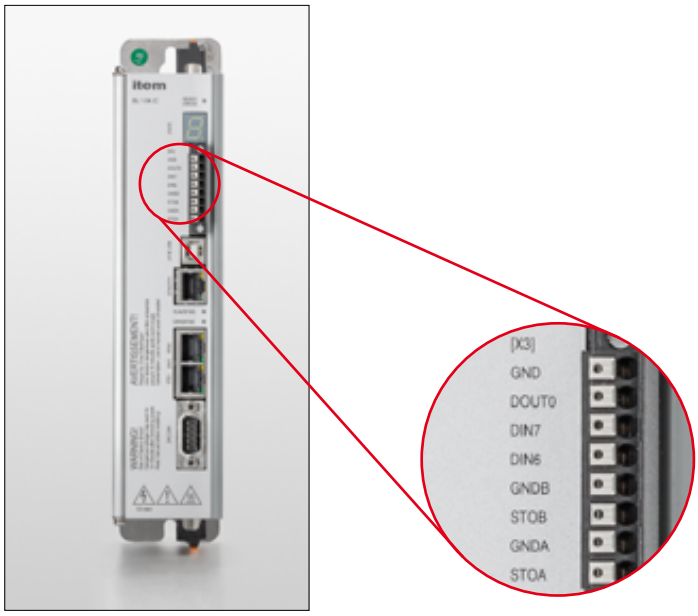


Figure 5: Position of connector X3

At its front, the servo drive has an 8-pin connector [X3] for

- the STO control inputs,
- the digital output DOUT0, and
- the digital inputs DIN 6 and DIN

The STO safety function is requested exclusively via the two digital control inputs STOA and STOB. The safety-oriented integration of additional interfaces is not necessary/intended.

The servo drive does not monitor the input circuit for cross-circuit faults.

The [X3] interface enables the direct connection of active and passive sensors as DOUT0/GND provide a short-circuit-proof 24 V supply voltage (see section 9.12 Connector: STO [X3] on page 70).

4.5.3 Control inputs STOA, GNDA/STOB, GNDB [X3]

The control inputs STOA and STOB are used for requesting the STO safety function ("Safe Torque Off") via two channels. They enable the direct connection of safe semiconductor outputs (electronic safety relays, active safety sensors, e.g. light grid with OSSD signals) and of switching contacts (safety relays with relay outputs, passive safety sensors, e.g. positively driven position switches). See, for example, section 9.12 Connector: STO [X3] on page 70.

To request the STO safety function ("Safe Torque Off"), the 24 V control voltage is switched off at both control inputs STOA and STOB (0 V). If both control inputs are switched off simultaneously or within a predefined discrepancy time, the STO function becomes active.

The table in section 8.11.1 Electrical data of the STO function on page 47 includes the technical data of the control inputs for the specified operating range of logic voltages.

Certain tolerance ranges have been defined for the input voltage range of the control inputs STOA and STOB. The amount of energy that is stored in the components of the STO circuit (e.g. capacitors) depends on this input voltage. During switching processes, this energy must be charged or discharged. This results in specific values for the switch-off time for the transition

to the safe state (STO) and for the tolerance time with regard to the OSSD signals (buffer time). These values depend on the input voltage.

The time response is described in section 8.11.2 Time response on page 48.

4.5.4 Discrepancy time

The transition between the safe and unsafe state is initiated by level changes at the control inputs STOA and STOB of the servo drive. In accordance with the specification of the safety function, both levels must be identical. Otherwise, an error message will be generated. The finite state machine in the servo drive monitors the driver supply voltage as a result of the actuation of the control inputs. Usually, these level changes do not occur exactly at the same time, e.g. due to component tolerances or bouncing outputs of safety control systems. The firmware tolerates this as long as the second input follows within a predefined time, the so-called discrepancy time. If it is exceeded, the servo drive will generate an error message.

A discrepancy time of 100 ms is preset. Recommendation: Ensure to always switch STOA and STOB simultaneously.

In addition, to the integrated STO circuit, the finite state machine in the servo drive has its own status. Due to the evaluation of the discrepancy time, this finite state machine may reach the "safe state" only with a considerable delay. Consequently, this state can only be signalled via the digital outputs or a fieldbus with a considerable delay. The power output stage has already been "switched off safely" when this happens. The status of the finite state machine is processed every 10 ms.

4.5.5 Test pulses

Temporary test pulses from safety control systems are tolerated, i.e. they do not trigger any STO function request.

The tolerance with regard to test pulses from sensors with OSSD signals is rated for the operating range as per section 8.11.1 Electrical data of the STO function on page 47.

4.5.6 Auxiliary supply [X3]

The servo drive with an integrated STO function provides a switchable 24 V output DOUT0 at [X3]. It can be used for the supply of external active sensors.

4.5.7 Additional diagnostics functions

The following functions integrated in the servo drive are not certified in accordance with the Machinery Directive 2006/42/EC. They are functional extensions and offer additional diagnostics options.

Error messages that are generated by the integrated STO circuit, e.g. when the discrepancy time is exceeded, are registered and evaluated by the non-safety-relevant finite state machine of the servo drive. If the conditions for an error state are detected, an error message will be generated. In this case, it cannot be absolutely guaranteed that the power output stage has been switched off safely.

The integrated STO function does not have any inherent error assessment mechanisms and it cannot indicate any errors.

INFO **Acknowledgement of error messages**

When error messages are acknowledged, all of the acknowledgeable errors concerning the functional safety technology will also be acknowledged at the same time. See section 4.11 Diagnostics and fault clearance on page 27.

The servo drive monitors the status of the control inputs STOA and STOB.

This enables the firmware of the servo drive to detect the request of the STO safety function ("Safe Torque Off") and various non-safety-oriented functions will be performed:

- Detection of the disconnection of the driver supply for the power semiconductors by the integrated STO circuit
- Deactivation of the drive control and also of the actuation of the power semiconductors (PWM)
- Deactivation of the holding brake actuation (if configured)
- Finite status machine of the servo drive including an assessment of the actuation (discrepancy time monitoring)
- Detection of application-related error states
- Hardware diagnosis
- Status and error indication via displays, digital outputs, fieldbuses, etc.

⚠ WARNING **Brake output not safety-oriented**

The brake is actuated via the non-safety-oriented firmware of the servo drive. If the application requires the safe actuation of the brake, additional external measures must be implemented.

⚠ NOTICE **Motor coasts down in an unbraked manner**

If one of the control inputs STOA or STOB is deactivated while the power output stage is active, the drive will coast down in an unbraked manner if the holding brake is not connected. As a result, the machine will be damaged.

Connect the holding brake to the servo drive.

⚠ NOTICE **Undersized holding brake**

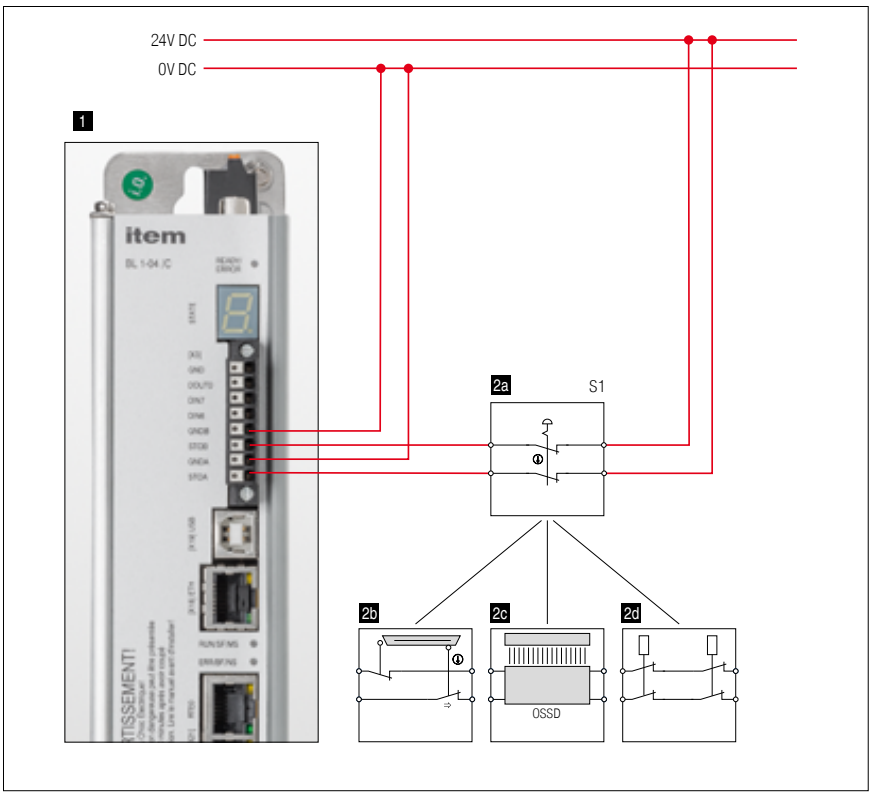
Check whether your motors with a holding brake are suitable for braking and stopping the motor in the event of an error by way of the holding brake.

It is possible to request the safe state while the actuation of the power semiconductors (PWM) is active. However, an acknowledgeable error message will be issued. The status of the voltages will be checked and assessed every 10 ms. If they are unequal over a longer period of time, an error message will be issued. See section 4.11 Diagnostics and fault clearance on page 27.

4.6 Circuit examples

The following sections provide circuit examples with detailed drawings and notes. The wiring is identical for all servo drives of the BL 1-04 /C series. The examples show the connection of a BL 1-04 /C.

4.6.1 Safe torque off (STO)



1 Servo drive with an integrated STO function (only the relevant connections are shown)

2a Emergency stop button

2b Safety gate

2c Light grid

2d Safety relay

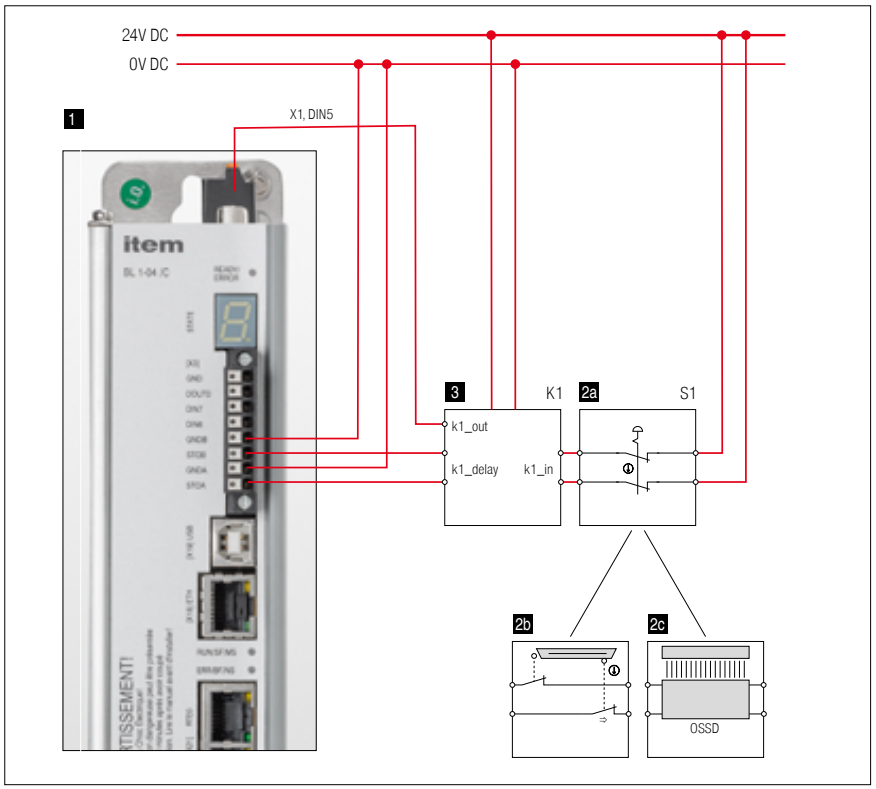
Figure 6: Connection of the integrated STO function (single-phase servo drive)

The "Safe Torque Off" (STO) safety function can be requested by various devices. Switch S1 can be, for example, an emergency-stop switch, a switch of a protective gate, a light grid or a safety relay. The safety request is realised via two channels and via the switch S1. As a result, the output stage will be switched off via two channels.

Notes concerning the circuit example

- The servo drive with an integrated STO function does not include any cross-circuit detection. In the case of a direct wiring of light grids, the cross-circuit detection will be performed by the light grid, provided that it is suitable for this purpose.
- The circuit example has a two-channel structure that is suitable for category 3 and 4 if additional measures are implemented. The additional measures depend on the area of application and on the safety concept of the machine.

4.6.2 Deceleration and safe torque switch off (SS1, "Safe Stop 1")



1 Servo drive with an integrated STO function (only the relevant connect ions are shown)

2a Emergency stop button

2b Safety gate

2c Light grid

3 Safety relay K1 with a delayed output

Figure 7: Circuit example "Deceleration and safe torque switch-off" (SS1, "Safe Stop 1") (single-phase servo drive)

The safety function "Safe Stop 1" (SS1, type C) can be requested by various devices. The switch S1 can be, for example, an emergency-stop switch, the switch of a safety gate or a light grid. The safety request is transferred to the safety relay via two channels and via the switch S1.

The safety relay disables the servo drive. When the servo drive is disabled, the movement will be automatically decelerated. If a brake is configured, the system waits for the activation of the brake. Then, the control circuit will be switched off. After a certain time that is defined in the safety relay, the output stage will be switched off via two channels via STOA/B.

⚠ WARNING **Hazards due to the loss of the safety function**

A loss of the safety function can result in serious, irreversible injuries, e.g. due to uncontrolled movements of the connected actuators.

Use the integrated STO safety function only if all of the required safety measures have been implemented. Validate the safety function at the end of the commissioning process. See section 4.9 Functional test, validation on page 27.

Incorrect wiring or the use of external components that have not been selected in line with the safety category will result in a loss of the safety function.

Perform a risk assessment for your application and select the circuitry and components accordingly.

Notes concerning the circuit example

- The safety relay that is used must switch off the servo drive enable signal (X1, pin 9, DIN5) without any delay and the inputs STOA and STOB (X3, pin 1, pin 3) with a delay.
- The necessary delay depends on the application and must be determined specifically for the application. The delay must be chosen so that, even at top speed, the drive is decelerated to zero speed by way of the quick-stop ramp before the inputs STOA and STOB are switched off.
- The electrical installation must fulfil the requirements of the applicable standards listed in section 1.4 Applicable standards on page 7. If, for example, the safety relay and the servo drive are located inside the same control cabinet, it can be

assumed that cross-circuit and earth faults between the individual wires are excluded (acceptance inspection of the control cabinet for correct wiring).

- The circuit example has a two-channel structure that is suitable for category 3 and, if additional measures are implemented, also for category 4. The additional measures depend on the area of application and on the safety concept of the machine.

4.7 Prior to commissioning

Perform the following steps as a preparation for the commissioning process:

1. Ensure that the servo drive has been properly installed (see section 10 Maintenance, cleaning, repair and disposal on page 71 and section 9 Electrical installation on page 52).
2. Check the electrical installation (connecting cables, pin assignment, see section 9.12 Connector: STO [X3] on page 70).
3. Check whether all of the PE conductors are connected.

4.8 item MotionSoft® safety functions

The window Safety module (integrated) of item MotionSoft® can be used to view status data concerning the integrated STO safety function. The integrated STO safety function itself does not require any parameterisation.

4.8.1 Servo drive type indication and safety function

In the iMS® menue "Parameters - Basic configuration" there is a controller icon. This is where the servo drive type and information about the integrated safety function (in the case of the BL 1-04 /C servo drive always "STO integrated") is displayed.

Figure 8: STO status bar

In addition, the window Safety module (integrated) provides also information about the circuit design of the integrated STO safety function. See section 4.8.3 "Safety module (integrated)" window on page 26.

4.8.2 Status indication of the finite state machine

Figure 9: Status window with an indication of the safety status

The status window (permanent window in the online mode) also displays the status of the functional safety system of the servo drive firmware.

It is not a representation of the electrical status of the two STO inputs though. Instead it is an indication of the status of the finite state machine that results from the evaluation of the driver supply voltages of the integrated STO safety function. Regardless of the indication, the power output stage may have already been switched off safely by the integrated STO safety function.

The status of the internal finite state machine is also indicated in the window Safety module (integrated).

4.8.3 "Safety module (integrated)" window

The window Safety module (integrated) can be opened as follows in item MotionSoft®:

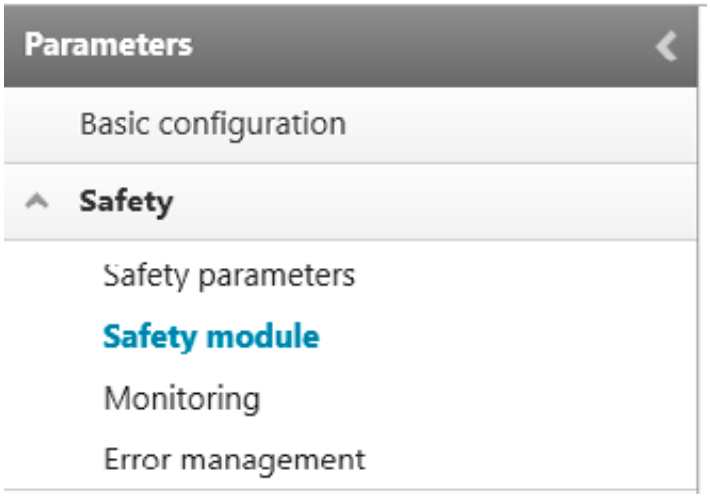


Figure 10: "Safety module (integrated)" window

The window shows the status data of the integrated STO safety function.

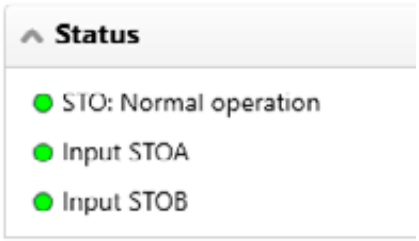


Figure 11: Safety module Status window

The window has several areas:

The first three LEDs indicate the status of the functional safety system in the servo drive firmware as it has been recognised by the finite state machine of the servo drive.

The LEDs Input STOA and Input STOB indicate the state of the digital inputs as it has been recognised by the servo drive firmware. The indication in MotionSoft is of an informative nature and not part of the safety function itself.

4.9 Functional test, validation

The STO function must be validated after the installation or after the installation has been changed.

This validation must be documented by the person performing the commissioning process. To assist you with the commissioning process, section 11 Appendix on page 73 provides example checklists with questions for a risk reduction. However, these checklists are no substitute for safety training. No guarantee can be provided for the completeness of the checklists.

4.10 Operation

Obligations of the owner/operator

The safety system must be checked for correct operation at appropriate intervals. It is the responsibility of the owner/operator to choose the type of check and the time intervals in the specified time period. The check is to be conducted such that the correct operation of the safety system can be verified based on an interaction of all of the components.

Maintenance and care

A servo drive of the BL 1-04 /C series with an integrated STO function is maintenance- free.

4.11 Diagnostics and fault clearance

STO-based fault messages

Error messages that are issued with regard to the functional safety system have error numbers from 51 to 52. These messages are described in the error table.

If an error message cannot be acknowledged, its cause must be remedied by applying the recommended measures. Then, reset the servo drive and check whether the cause of the error, and the error message, have been eliminated.

5 Fault messages

Servo drives of the BL 1-04 /C series have an extensive sensor system that monitors the controller unit, power output stage and motor as well as the communication with the outside world. Most errors will cause the controller unit to shut down the servo drive and the power output stage. The power output stage cannot be switched back on until the cause of the error has been eliminated and the error has been cleared.

If an error occurs, the servo drive will display an error message cyclically by way of its seven-segment display. The error message consists of the letter E (for error), a main index and a subindex, e.g.: E 0 1 0.

Warnings have the same number as an error message. As a distinguishing feature, warnings have centre segment before and after the number, e.g. - 1 7 0 -.

A complete list of events, warnings and error messages can be found in section 11.6 Error messages and warnings on page 80.

⚠ NOTICE Damage to property caused by errors

In most cases, the drive will be caused to coast down if an error occurs. However, if the range of movement of the axis is limited, the coast-down may lead to damage to the machine.

On the other hand, errors of the shaft encoder lead to a quick stop of the drive (even if there is no information about the commutation position). It is only then that the power output stage will be switched off.

The operator must check whether the parameterisation of the error responses is correct.

When an error occurs, the following three steps must be performed:

1. Error analysis: If the error text displayed by item MotionSoft® is not sufficiently self- explaining, additional error causes are listed in the online help of item MotionSoft® or in section 11.6 Error messages and warnings on page 80.
2. Error elimination: Eliminate the cause of the error in compliance with the safety instructions (section 2.4 General safety instructions on page 9).
3. Error acknowledgement: Clear the error by clicking the button Clear in the item MotionSoft® error window. Alternatively, the error can also be acknowledged via a bus system.

⚠ NOTICE Risk of damage to property

Clearing an error via item MotionSoft® can lead to a sudden restart if the superordinate control system or an external logic system enables the power automatically.

If the drive is checked in order to find the cause of an error, suitable interrupting devices (STO inputs, deactivation of the power supply) must be present and activated.

The following precautionary measures can be applied:

- Disconnection of the mains power supply connector
- Activation of the STO safety function
- Deactivation of the bus system via item MotionSoft® or by disconnecting the bus connector
- Interruption of the connection to the motor
- Disconnection of the shaft connection (coupling) between the motor and output shaft in order to test the motor without damaging the machine.

5.1 Fehlermanagement

The window Error/Error management can be used to define the reactions of the servo drive to various operating states. The following window will be displayed:

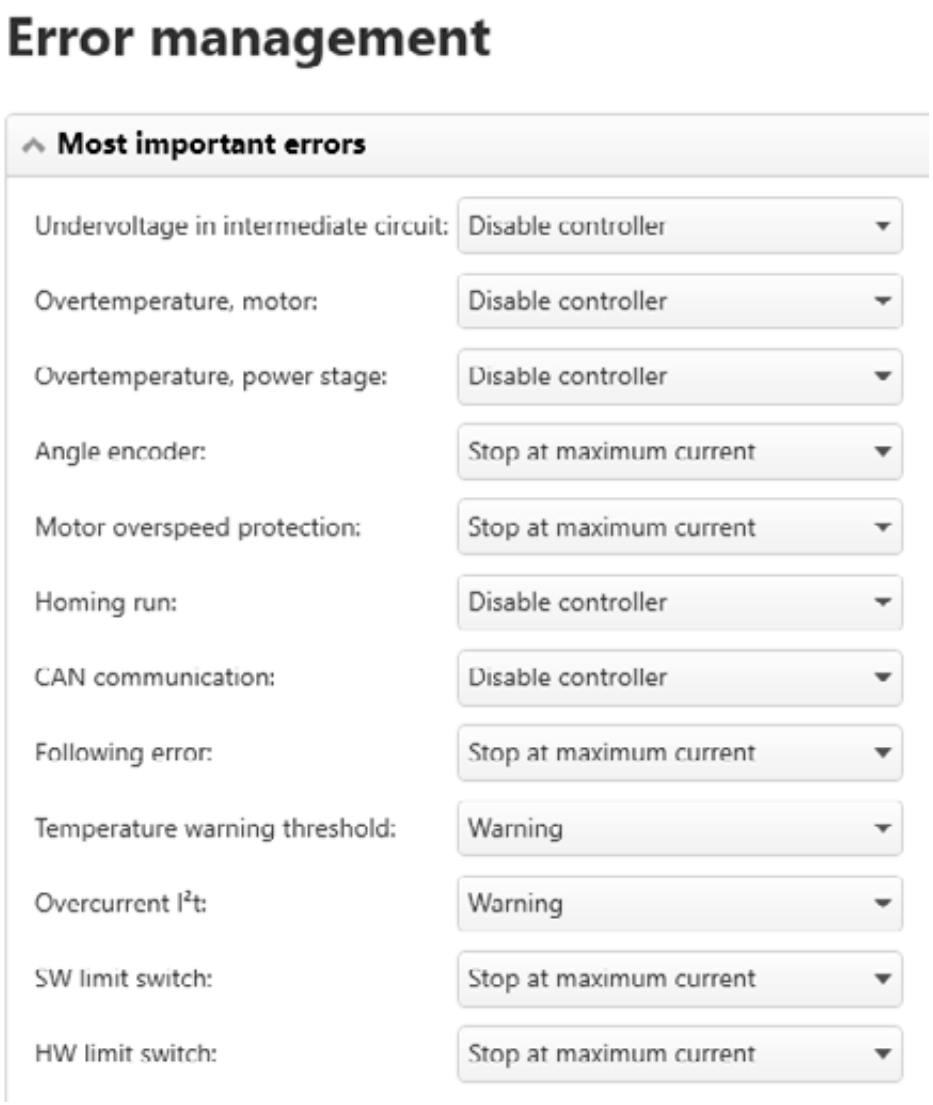


Figure 12: "Error management" window

You can use this window to define the reaction of the servo drive in the event of an error. Different responses can be assigned to every individual group. First select the group (by clicking) and then assign the responses. The following list shows the responses with a rising priority.

Entry into buffer: The event will simply be saved in the error buffer. The event will not be displayed, and the application continues to run without being affected by the event.

Warning: The event will be displayed briefly on the seven-segment display of the servo drive.

Disable servo drive: The application will be stopped by way of the emergency stop ramp.

Stop at maximum stage immediately: The drive will be stopped with maximum current.

Disable power stage immediately: Some of the events are so serious that certain responses cannot be deselected. In this case, the associated checkboxes are greyed out.

The configuration always applies to an entire group of errors. It is not possible to apply it to individual events.

5.2 Error buffer

Error/Error buffer

The Error buffer window shows all of the errors, warnings and events that have occurred since the last activation.

The following information is provided:

- Error number
- System time (hours, minutes, seconds)
- Error description (text)
- Constant and free parameter

The window itself does not check whether there are any new errors. If a new error occurs while the window is open, select the button Refresh to refresh the error buffer.

If you want to print the error events, select the Print button. The button Save can be used to store the list of error messages or warnings and events as a text file or CSV file (comma-separated list).

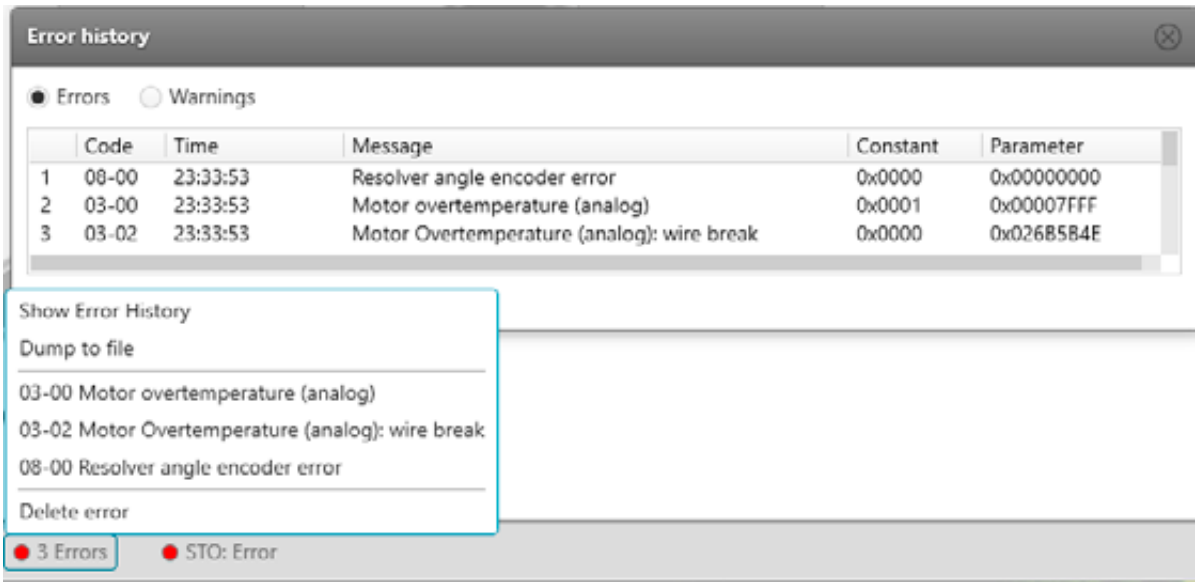


Figure 13: "Error buffer" and "Error messages" windows

INFO **Error messages for the Application Engineering department**

If you want to forward an error to the Application Engineering department, you should always save the error messages as a file and hand over this file as well. The file includes all of the relevant information (system time, constant, free parameter) that can be useful for the quick identification of the error cause.

The tab Permanent event memory shows error messages that are stored in the internal EEPROM of the servo drive in a non-volatile manner so that they can still be read out after a "power off". Error messages with the main index 00 are no runtime errors. They include information that is stored in the permanent event memory of the servo drive and that will not be displayed on the seven-segment display (e.g. the event "Error acknowledged"). In general, no activities by the user are required.

6 Storage/transport

The following requirements must be fulfilled for the storage and transport of the servo drive:

Storage

- Store the servo drive in line with the specified storage temperatures. Use only its original packaging.
- After approximately six months of storage, the oxide layer of the capacitors may become damaged. This is why the servo drive must be supplied with power for approximately 1 hour every six months (24 V and 230 V) in order to preserve the oxide layer.

Transport

⚠ CAUTION **Risk of injury due to improper transport**

Follow these instructions to ensure the safe transport of the servo drive and to avoid injuries.

- Use only qualified personnel for the transport of the servo drive.
- Transport the servo drive only in its original packaging.
- Use only suitable transport equipment.
- Use suitable personal protective equipment.
- If you notice that the packaging is damaged, notify the carrier without delay. Then, inspect the servo drive for any signs of external or internal damage.

Transport damage

DANGER ⚠ **Dangerous electrical voltage!**

Transport damage to the servo drive may compromise the insulation between the low- voltage part and the high-voltage part. This results in an extremely dangerous electrical voltage.

Do not use the servo drive in this case. The servo drive needs to be checked by the sales partner or manufacturer.

In case of external damage (dents, deformed mounting flange, etc.) it must be presumed that some of the components have come loose and the breakdown strength concerning the high-voltage part may no longer be existent.

7 Installation

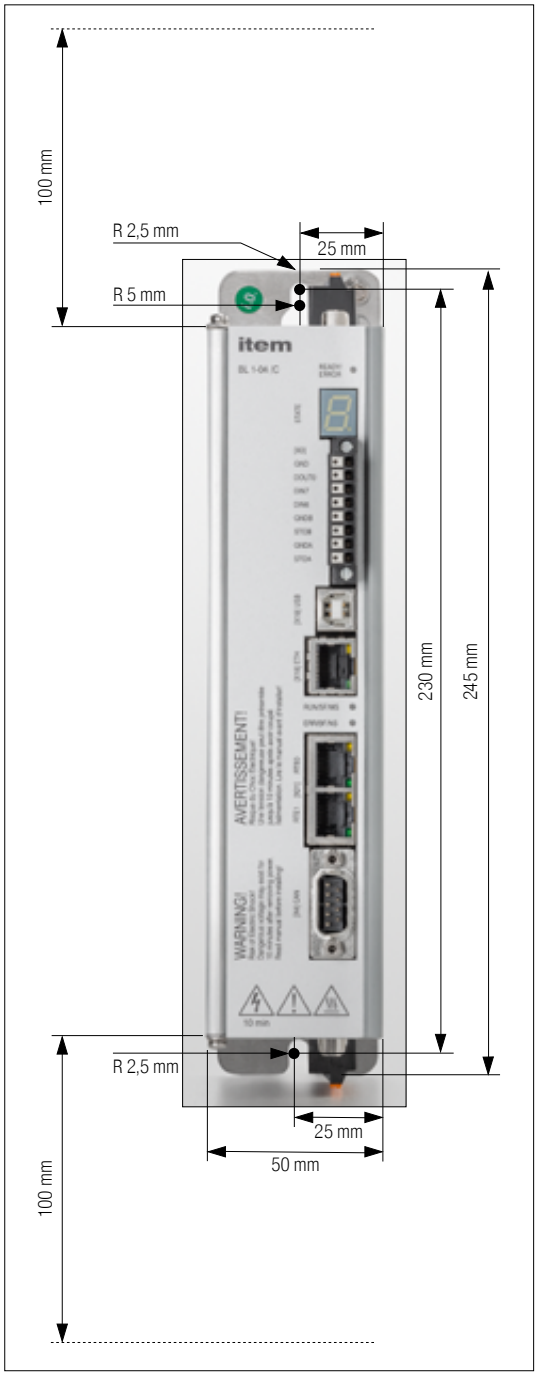


Figure 14: Servo drive BL 1-04 /C

The following requirements must be fulfilled for the installation of the servo drive:

- Follow the general set-up and safety rules and regulations concerning the installation.
- Follow the safety instructions in section 2.6 Safety notes for installation and maintenance on page 10.
- Use only suitable tools. If specified, use special tools.
- Always use suitable personal protective equipment, see section 2.5 Personal protective equipment on page 10.
- Servo drives of the BL 1-04 /C series are intended for use as devices installed in control cabinets.
- Installation position: Vertical with supply lines [X9] on top.

- The BL 1-04 /C servo drives have fastening tabs at the top and bottom. These tabs are used to mount the servo drive vertically to a control cabinet plate with two M5 screws. Recommended tightening torque for an M5 screw of property class 5.6: 2.8 Nm.
- Keep a minimum distance of 100 mm above and under the device with regard to other components in order to ensure sufficient ventilation. For optimal wiring of the motor cable and angle encoder cable under the device, an installation clearance of 150 mm is recommended.
- The BL 4000-C servo drives may be installed directly next to one another on a heat- dissipating back plate, provided that they are installed properly and used as intended. Excessive heating may cause premature ageing and/or damage.

8 Technical data

This chapter provides all of the relevant technical data of the BL 1-04 /C servo drive with an integrated "Safe Torque Off (STO)" safety function.

8.1 General technical data

Ambient conditions and qualification

Characteristic	Value
Storage temperature	-25 °C bis +70 °C
Ambient temperature	0°C to +40°C +40°C to +50°C with a power reduction of 2.5%/K
Permissible installation altitude	Max. installation altitude 2,000 m above MSL; with a power reduction of 1% per 100 m as of 1,000 m above MSL
Atmospheric humidity	Relative humidity up to 90%, non-condensing
Type of enclosure	IP20
Protection class	I
Pollution degree rating	2

INFO **Compliance with the pollution degree rating**

The integrated safety technology requires compliance with pollution degree rating 2 and thus a protected enclosure (IP54). This must always be ensured through appropriate measures, e.g. through installation in a control cabinet.

Dimensions and weight*)

Characteristic	Value
Dimensions including the mounting plate (H * W * D)	245 mm * 50 mm * 163 mm
Housing dimensions (H * W * D)	200 mm * 50 mm * 163 mm
Weight	approx. 1.5 kg

*) Device dimensions without the mating connector.

8.2 BL 1-04 /C: Power supply [X9]

Power Data

Characteristic	BL 1-04 /C
Supply voltage	1 x 75 ... 230 VAC [± 10 %], 50 ... 60 Hz
Supply network type	TN, TT
Maximum mains current in continuous operation (S1) *1)	6 A_{eff}
DC bus voltage	325 VDC (with Umains = 230 VAC)
24 V supply	24 VDC [± 20 %] (0.35 A) *2)

*1) with a supply voltage of 230 V and power factor 0.6

*2) plus the current consumption of a holding brake and I/Os (if included)

INFO Low-voltage operation

- If low-voltage operation is necessary, we recommend using a series transformer or isolating transformer for decreasing the voltage.

Internal braking resistor

Characteristic	Value
Braking resistor	75 Ω
Peak power	2 kW
Continuous power	8 W

External braking resistor

Characteristic	Value
Braking resistor	≥ 75 Ω
Nominal power	≥ 8 kW
Peak power	≥ 2,5 W

INFO Additional information

The external braking resistor must be connected in parallel to the internal braking resistor. As a result, the continuous power and pulse power can be doubled if a 75 Ω resistor is used.

8.3 BL 1-04 /C: Motor connector [X6]

Performance data

Supply voltage 230 VAC [± 10%], 50 Hz, f_{PWM} = 10 kHz, f_{el} > 2 Hz

Characteristic	BL 1-04 /C
Nominal output power	800 W
Maximum output power for 2 s	2 kW
Nominal output current	4 A_{eff}
Max. output current for 2 s	12 A_{eff}
Power loss/efficiency*)	5 % / 95 %

*) As a guide value for the control cabinet cooling system.

Current derating

The BL 1-04 /C series servo drives have a current derating during nominal operation. The rated current and the duration of the maximum permissible peak current of the servo drive depend on several factors. These factors are:

- Output current level: The higher the output current is, the shorter the permissible time will be.
- Clock frequency of the power output stage: The higher the clock frequency is, the shorter the permissible time will be.
- Rotational frequency of the motor: The lower the rotational frequency is, the shorter the permissible time will be.

The current derating begins as of a PWM frequency of 10 kHz (f_{PWM}) and is linear between the reference values that are stated in the following table:

PWM frequency f_{PWM}*)	BL 1-04 /C	
	I_{nenn}	I_{max}
10 kHz	4 A	12 A
16 kHz	3 A	9 A

*) The PWM frequency is the reciprocal of half of the current controller cycle time ti. The variable cycle times enable particularly high dynamics combined with reduced power data.

The maximum overload time is also subject to derating as a function of the rotational frequency (= rotational speed * number of pole pairs). It begins with values below 2 Hz and is linear up to 0.

f_{el}	t_{max}
0	0,2 s
>= 2 Hz	2 s

Motor cable requirements

Characteristic	Value
Cable length	l ≤ 25 m See section 9.1 Notes concerning the safe and EMC-compliant installation on page 52
Cable capacity	C‘ ≤160 pF/m of one phase

Motor temperature monitoring system

Dangerous electrical voltage!

DANGER ⚠ Dangerous electrical voltage!

The signals for the temperature sensor "MT-" and "MT+" at the motor connector [X6] must be connected to protective extra-low voltage (PELV) on the motor side and they must be insulated against the motor phases.

⚠ NOTICE Electronic motor overload protection

The servo drive features electronic overload protection with thermal memory retention.

To ensure effective protection, the rated current and maximum current of the motor and the overload time (I2t time) must be parametrised as described in the product manual.

Characteristic	Value
Sensor type	Analogue
Sensor type	Silicon temperature sensor PTC/NTC, e.g. KTY84-130 or similar
Linear/non-linear, parameterisable (10 nodes)	Linear/non-linear, parameterisable (10 nodes)
Measuring range	from 300 Ω to 20 kΩ (+-10%)
Output voltage	+ 3,3 V
Output current	1.7 mA max. (via 2 kΩ measuring resistor)
Internal resistance	approx. 2 kΩ

Output for the holding brake in the motor

Characteristic	Value
Nominal voltage	24 V
Nominal current	2 A (total of all digital outputs and of the holding brake: 2.5 A max.)
Voltage drop referred to the 24 V input with a load current of 2 A	approx. 1.5 V
Overload protection	Yes, current limitation to 3 A max.
Overvoltage protection	up to 60 V
Internal flyback diode	Yes

HIPERFACE DSL® connector [X6]

Characteristic	Value
HPF_DSL-, HPF_DSL+	In accordance with the HIPERFACE DSL®
Baud rate	9.37 MHz
Frame rate	12.1 to 27 µs
Supply voltage	10 V (250 mA)
Supported transfer modes	Transfer of short and long messages with storage of the set of parameters in the encoder
Characteristic impedance of the cable and line termination	110 Ω

8.4 Resolver connector [X2A]

Characteristic	Value
Transformation ratio	1:2 to 1:4
Carrier frequency	5-10 kHz
Excitation voltage	5-6 Veff, short-circuit-proof
Excitation impedance (at 10 kHz)	4 Ω
Stator impedance	> 30 Ω
Measuring range (for Hall sensors)	7 V_{ss}
Resolution	14 bits
Signal detection delay	< 200 µs
Speed resolution	approx. 5 rpm
Actual speed value filter	400 µs
Absolute angle detection accuracy	< 0,022°
Max. speed	16.000 rpm

8.5 Encoder connector [X2B]

INFO **Possibly not all encoders of a manufacturer are supported**

It is possible that not all encoders of a manufacturer are fully supported. In individual cases it is therefore always recommended to test the encoder in advance in the intended application.

Power supply output

The power supply for the encoders can be changed.

⚠ NOTICE **Risk of destruction due to excessive voltage**

If the voltage is too high, the angle encoder may be destroyed. Ensure that you have selected the correct supply voltage prior to connecting the encoder to the [X2B] connector.

Characteristic	Value A	Value B
Output voltage	5,4 V	10,4 V
Output current	250 mA	200 mA
Short-circuit strength	Yes	Yes
Control via sense leads	Yes	Yes

Digital incremental encoders

Digital incremental encoders with RS422-compatible A/B/N signals with a line count of up to 16,384 lines can be connected (e.g. ERN 420). In addition, Hall generator signals with a TTL level for determining the commutation position can also be connected.

Characteristic	Value
Parameterisable number of encoder lines	1 to 2^{18} lines/revolution
Track signals A, B (Z0 track)	In accordance with RS422 Input 0.4 V with a common-mode level of -0.3 to 5 V
Track signal N (index pulse)	In accordance with RS422 Input 0.4 V with a common-mode level of -0.3 to 5 V
Hall generator input	TTL level (<0.5 V = Low, > 2 V = Hi) 2 kW pull-up
Error input (pin 6)	TTL level (<0.5 V = Low, > 2 V = Hi) 2 kW pull-up
Track signal input impedance	Differential input 120 Ω
Limit frequency	10 MHz

Analogue incremental encoders with commutation signals

Analogue incremental encoders with RS422-compatible 1 VSS signals (e.g. ERN 1387) can be connected.

Characteristic	Value
Parameterisable number of encoder lines	1 to 218 lines/revolution
High position resolution of the AB track (Z0) and commutation track (Z1)	12 bits/period
Track signals A, B (Z0 track)	1.2 VSS differential
Track signal N (index pulse) switching threshold	0.1 VSS differential
Commutation track (Z1 track)	1.2 VSS differential
Error input (pin 6)	TTL level (<0.5 V = Low, > 2 V = Hi) 2 kΩ pull-up
Track signal input impedance	Differential input 120 Ω
Z0 track limit frequency	f_{limit} > 300 kHz
Z1 track limit frequency	f_{limit} approx. 10 kHz (commutation track)

HIPERFACE® encoders

Shaft encoders with HIPERFACE® made by Sick-Stegmann are supported in the single- turn and multi-turn variants. The following encoder models can be connected:

- Single-turn SinCos encoders: SCS 60/70, SKS 36, SRS 50/60/64, SEK 34/37/52
- Multi-turn SinCos encoders: SCM 60/70, SKM 36, SRM 50/60/64, SEL 34/37/52
- Single-turn SinCos encoders for hollow shaft drives: SCS-Kit 101, SHS 170, SCK 25/35/40/45/50/53
- Multi-turn SinCos encoders for hollow shaft drives: SCM-Kit 101, SCL 25/35/40/45/50/53

In addition, the following Sick-Stegmann encoder systems can be connected and evaluated:

- Absolute, non-contact length measuring systems L230 and TTK70 (HIPERFACE®)
- Digital incremental encoder CDD 50

Characteristic	Value
Parameterisable number of encoder lines	depending on the encoder
Track signals A, B (Z0 track)	As per RS485 Input: 0.4 V, output: 0.8 V to 2 V
Hall generator input	TTL Pegel (<0.5 V = Low, > 2 V = Hi) 2 kΩ Pullup
Error input (pin 6)	TTL level (<0.5 V = Low, > 2 V = Hi) 2 kΩ pull-up
Track signal input impedance	Differential input 120 Ω
Limit frequency	Up to 10 MHz, depending on the encoder system
Supported operating modes	Storage of the parameter set in the encoder in the case of Endat and HIPERFACE®

Angle encoders made by Sick with the HIPERFACE DSL® interface (e.g. EKM36) are supported. They must be connected to X6. See section 8.3 BL 1-04 /C: Motor connector [X6] on page 35.

EnDat encoders

Incremental and absolute encoders by Heidenhain with the ordering code ENDAT22 can be evaluated. The following encoder models can be connected:

- Analogue incremental encoders: ROD 400, ERO 1200/1300/1400, ERN 100/400/1100/1300
- Single-turn encoders (ENDAT22): ROC 425, ECI 119/1118/1319, ECN 125/425/1023
- Multi-turn encoders (ENDAT22): ROQ 437/1035, EQI 1131/1331, EQN 437/1035/1135/1337
- Absolute length measuring systems (ENDAT22): LC 115/415
- Battery-buffered encoders (ENDAT22): EBI 135/1135/4010
- Angle encoder modules (ENDAT22): MRP 2010/5010/8010

BiSS encoders®

Type C BiSS encoders are supported. The evaluation of the internal type plate, however, is not supported. The storage of data in the encoder is not possible.

Encoders made by Hengstler, Kübler and Balluff are supported.

8.6 USB [X19]

Communication interface	Value
Function	USB 2.0, USB-B, slave–client,
Connector type	USB-B
Current consumption	None (self-powered)
Protocol	item-specific (generic device)

8.7 Standard Ethernet [X18]

Communication interface	Value
Function	Ethernet, 10/100 Mbaud, UDP communication
Connector type	RJ45
Protocol	TCP/IP

8.8 Real-time Ethernet [X21]

At present, the servo drives of the BL 1-04 /C product range support the following fieldbuses and application protocols:

Fieldbus	Profile
CAN	CAN CiA DS 402 CANopen V 2.0
PROFINET	item-specific protocol (based on PROFIdrive V3.1)
EtherCAT	CoE (Can over EtherCAT)

The support of these fieldbus types is integrated in the servo drive. Additional modules are not required. The parameterisation is performed with the aid of item MotionSoft®.

For further information about the fieldbus connection, see the fieldbus-specific product manuals (see the section 1.2 Additional documents on page 6).

Suitable EDS (CANopen), GSDML (PROFINET) and XML (EtherCAT) files for the integration of the fieldbus slave into the environment of an external control system can be found at https://www.item24.com.

INFO **Compatibility with servo drives of the C-Series**

The behaviour on the bus and the object directory is largely compatible with the behaviour of the C-Series Controller. There are certain differences, e.g. in terms of the device IDs (CANopen product_code ID 1018_02).

8.9 CAN bus [X4]

Communication interface	Value
Standard	ISO/DIS 11898-2, CAN 2 0A
Baud rates	50, 100, 125, 250, 500, 1000 kBit/s
Protocol	CANopen, as per DS301 and DSP402

8.10 I/O Interface [X1]

Servo drives of the BL 4000-C series have 3 digital outputs (DOUT), 9 digital inputs (DIN) and 2 analogue inputs (AIN).

Digital outputs

Characteristic	Value
Nominal voltage	24 V
Output current	Approx. 1 A per output, but 2.5 A max. in total, including the brake output

Digital inputs

Eigenschaft	Value
Nominal voltage	24 V as per DIN EN 61131-2 (15 V, < 10 V low to 30 V high)
Current consumption	3.2 mA max.

The mode of operation of the digital outputs can be configured to a large extent. The default setting is stated in brackets.

Characteristic	Value	Filter time	Max. jitter
DIN0...DIN3	Freely configurable (position selector)	4 x t_x*)	1 x t_x
DIN5	Controller enable signal	4 x t_x	1 x t_x
DIN6, DIN7	Limit switch 0, 1	4 x t_x	1 x t_x
DIN4	Freely configurable (positioning start)	4 x t_x	1 x t_x (15 ns for Sampling)
DIN8	Freely configurable (sampling, flying saw)	4 x t_x	1 x t_x (15 ns for Sampling)

*) t_x corresponds to the configurable position controller cycle time

Analogue input AIN0

Characteristic	Value
Input range	± 10 V
Resolution	12 Bit
Filter time	configurable: 2 x t_i to 200 ms

*) t_i corresponds to the configurable current controller cycle time

Analogue input AIN1

Characteristic	Value
Input range	± 10 V
Resolution	12 bits
Filter time	4 x t_i

*) t_i corresponds to the configurable current controller cycle time

Master frequency input X1

This input cannot only be used for the connection of the master frequency output of another BL 1-04 /C. It can also be used for the connection of encoders as per the RS422 industry standard or of encoders with "single-ended" TTL output or "open-collector" outputs. If TTL encoders are used, it must be taken into consideration that the hysteresis is negligible. In addition, the requirements concerning the signal shield must be fulfilled.

As an alternative, the A and B track signals of the device are interpreted as pulse direction signals by the device so that the servo drive can also be controlled by stepper motor control boards.

Ensure the correct configuration of the interface. This is important since the master frequency input can also be used as the master frequency output.

Characteristic	Value
Parameterisable line count	1 to 2^{18} lines/revolution
Track signals A, B, N	as per the RS 422 specification
Special feature	N track can be deactivated
Maximum input frequency	10 Mhz
Filtering	Quadruple oversampling
Supply output	5 V, 200 mA, short-circuit-proof – not overvoltage-proof

Master frequency output X1

The connector X1 also accommodates the master frequency output (encoder emulation). To use this function, X1 must be configured as the master frequency output.

Characteristic	Value
Number of lines	Programmable 1 to 213 and 214 lines/revolution
Track signals A, B, N	as per the RS422 specification
Special feature	N track can be deactivated
Limit frequency	f_{limit} > 10 MHz

The signals are generated based on the angle of rotation of the encoder with a freely programmable line count.

In addition to the track signals A and B, the master frequency output also provides an index pulse. Once per revolution, this index pulse turns high (for the programmed number of lines) for half of a signal period.

Please also note that the track signals will not be automatically output with a constant frequency. They may also be generated as so-called "pulse packets" depending on the covered rotational angle of the source. This means that the interface for any downstream circuits must be suitable for incremental encoders. As a result, the measurement of gate times or the analysis of the time between two lines for determining a speed value is possible only to a limited extent.

8.10 Time response of the digital inputs

The digital inputs are digitally filtered to improve the interference suppression. The following illustration shows the filter time mechanism. In addition, the special reaction to the "Positioning start" function is also shown. Although the signal is evaluated during the position controller cycle t_x the start of a movement will be performed within the interpolation cycle time matrix t_p.

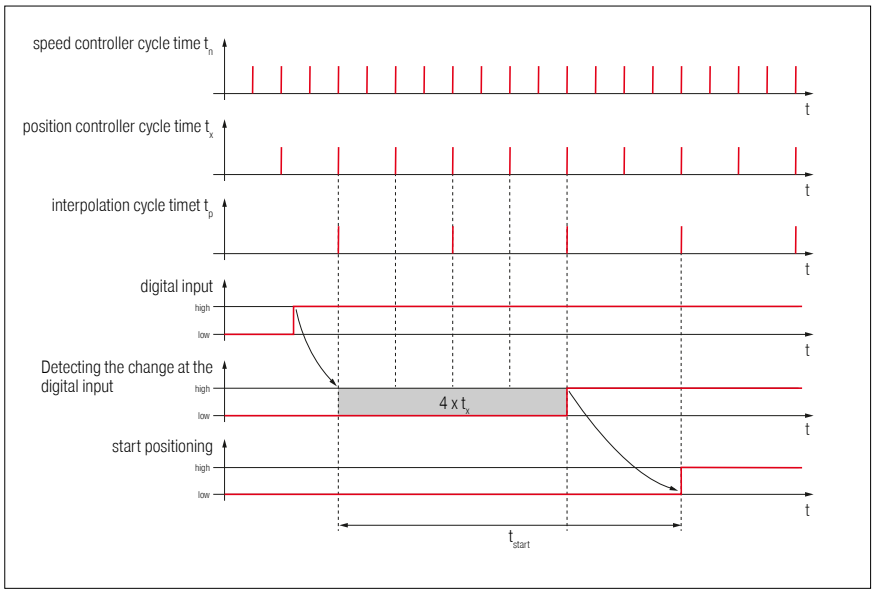


Figure 15: Filter time mechanism in the case of digital inputs

Parameter	Max.
Maximum delay until the start of a position set becomes active t_{start}	$5 \bullet t_x + t_p$
Current rise time (with current feedforward control)	$t_n + t_i + t_{pwm}$

t_x = position controller cycle time (typically 200 µs with a current controller cycle time ti of 50 µs)
t_n = speed controller cycle time (typically 100 µs with a current controller cycle time ti of 50 µs)
t_{pwm} = half the cycle time of the PWM (corresponds to t_i)

8.10.2 Time response of the digital outputs

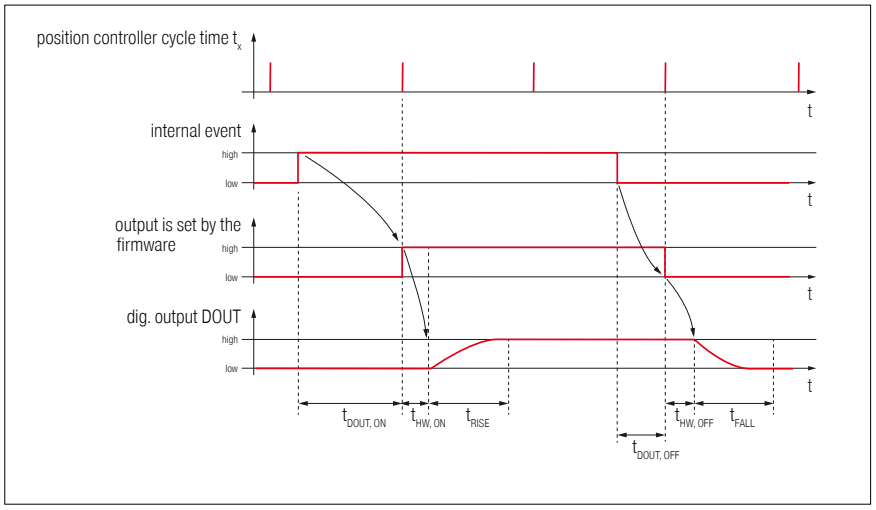


Figure 16: Filter time mechanism in the case of digital outputs

Parameter	Value
Delay caused by the firmware t_{DOUT_ON}/ t_{DOUT_OFF}	t_x
DOUT $t_{HW, ON}$	typically 100 µs
DOUT $t_{HW, OFF}$	typically 300 µs
t_{RISE}	typically 100 ms with 2 A and inductive load
t_{FALL}	typically 100 ms with 2 A and inductive load

t_x = position controller cycle time (typically 200 µs with a current controller cycle time ti of 50 µs)

8.10.3 Time response during power ON

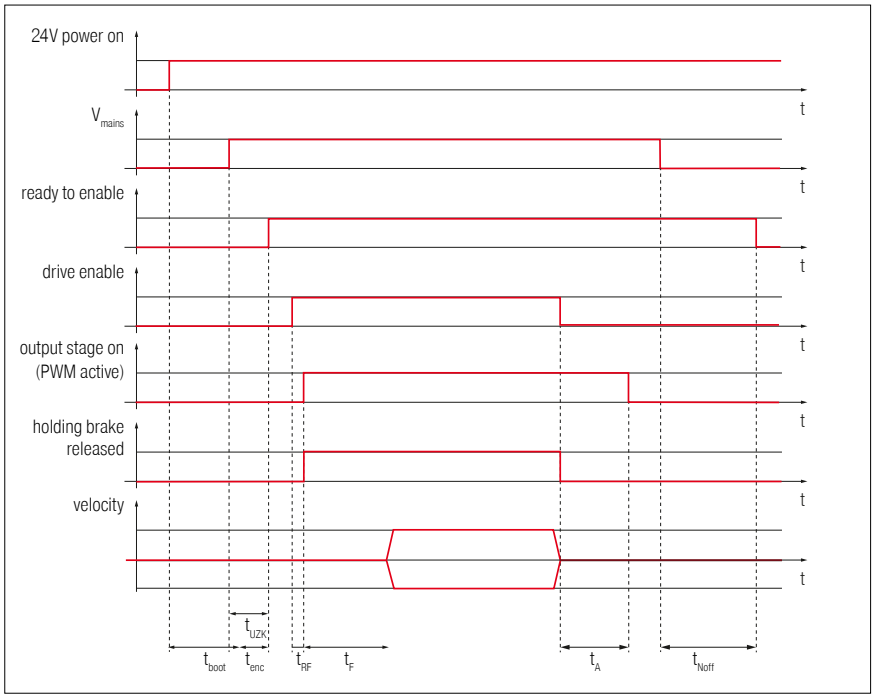


Figure 17: Time diagram of the servo drive

Parameter	Min.	Typ.	Max.
Start of the firmware after power ON t_{boot}			4 s
Encoder start time t_{enc}	0.7 s (resolver)		2 s (Hiperface DSL®)
DC bus charging time t_{UZK}		1 s	
Output stage active after servo drive enabling t_{RF}		6 ms	
Movement start delay t_F (parameterisable)	0		32 s
Stop delay t_A (parameterisable)	0		32 s
Detection of mains power OF t_{Noff}		0.6 s	

8.11 STO [X3]

Characteristic values

Characteristic	Value
Safety level	Category 4 and performance level e or SIL3/SIL CL3.
PFH(Probability of dangerous Failure per Hour)	3 x 10^{-11}
PFD (Probability of dangerous Failure on Demand)	5 x 10^{-6}
DCavg (Average Diagnostic Coverage)	High
MTTFd (Mean time to dangerous failure)	Limited to 100 years (cat. 3) Limited to 2,500 years (cat. 4)

See also section 11.2 CE conformity (Machinery Directive) on page 74.

INFO **Proof-testing of the STO function**

Comply with the following test intervals in order to reach the specified values:

- For SIL 2, PL d/category 3: 1x per year
- For SIL 3, PL e/category 3: every 3 months
- For SIL 3, PL e/category 4: daily

8.11.1 Electrical data of the STO function

Control inputs STOA/STOB [X3]

Characteristic	Value
Nominal voltage	24 V (referred to GNDA/GNDB)
Voltage range	19.2 V... 28.8 V
Permissible ripple	2 % (referred to a nominal voltage of 24 V)
Nominal current	20 mA typ., 30 mA typ.
Switch-on input voltage threshold	>= 16 V
Switch-off input voltage threshold	< 5 V

For the technical data of the digital inputs DIN6 and DIN7 or of the digital output DIN0, see the section 8.10 I/O Interface [X1] on page 42.

Response time until power output stage inactive and maximum OSSD test pulse duration

Characteristic	Value		
Input voltage (STOA/STOB)	19.2 V	24 V	28.8 V
Typical response time	2 ms	3 ms	4 ms
Max. test pulse duration (OSSD)	0.5 ms	1 ms	1.5 ms

The maximum response time $t_{STOAB/OFF}$ is described in section 8.11.2.1 Time response of the STO activation during operation with a restart on page 48.

8.11.2 Time response

INFO Equal inputs in terms of their functionality

The inputs STOA and STOB are absolutely equal in terms of their functionality, which is why the switching sequence of STOA/STOB is interchangeable in all of the diagrams.

8.11.2.1 Time response of the STO activation during operation with a restart

The illustration shows the time response starting with the disconnection of the control voltage at STOA/B and the sequence that is necessary for restarting the device.

- The actuation of the holding brake is realised via the basic device and not in a safety-oriented manner.
- The illustration shows the coasting of the motor regardless of the activation/deactivation of the brake
- The setpoint will not be enabled until the holding brake delay TF has elapsed.
- An error will be issued as the STO inputs are deactivated while the output stage is active. It is not included in the drawing.

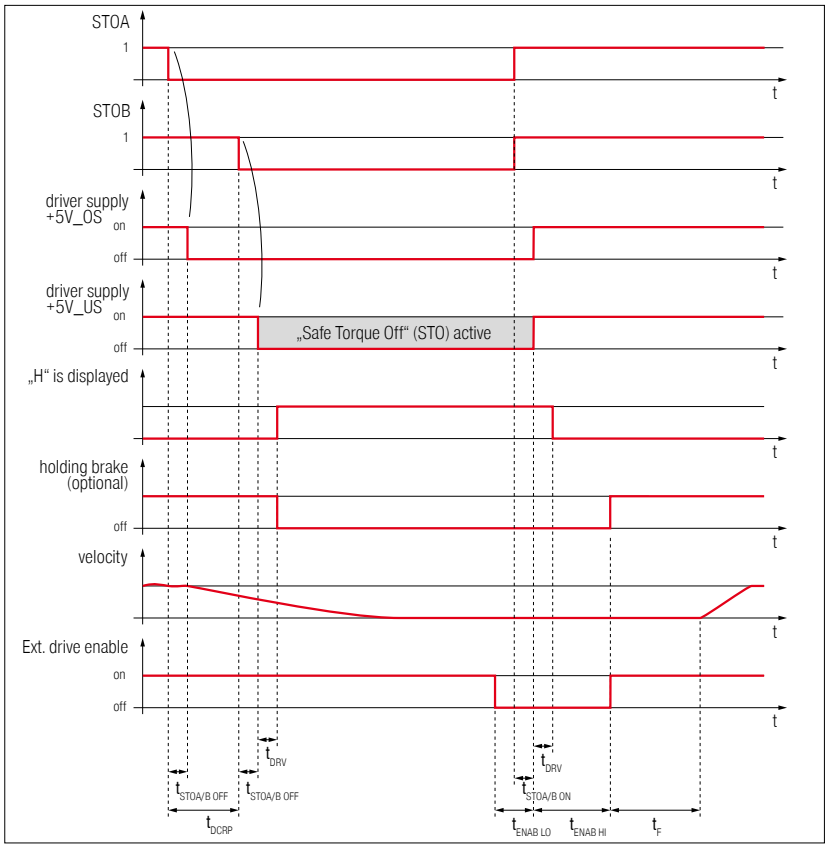


Figure 18: Time response of the activation of the STO safety function with a restart

Time	Description	Value
t_{DCRP}	Maximum permissible discrepancy time without the servo drive issuing an error	100 ms
$t_{STOA/B\ OFF}$	STOA/B – switching time from high to low (See also section Response time until power output stage inactive and maximum OSSD test pulse duration on page 48)	Maximum response time 5 ms
$t_{STOA/B\ ON}$	STOA/B switching time from low to high	0.6 ms typ., 1 ms max.
t_{DRV}	Delay of the internal sequence control of the servo drive	10 ms max.
$t_{ENAB\ LO}$	Time that the servo drive enable signal (DIN5 or bus enable signal) must be low before STOA/B will be activated	0
$t_{ENAB\ HI}$	Time that the servo drive enable signal (DIN5 or bus enable signal) must be low after STOA/B has been reactivated and the status of the STO circuit has changed	> 20 ms
t_F	Switch-on delay of the holding brake	

8.11.2.2 Time response of the SS1 activation during operation with a restart

The time response is based on the SS1 example circuit in section 4.6.2 Deceleration and safe torque switch off(SS1, "Safe Stop 1") on page 24.

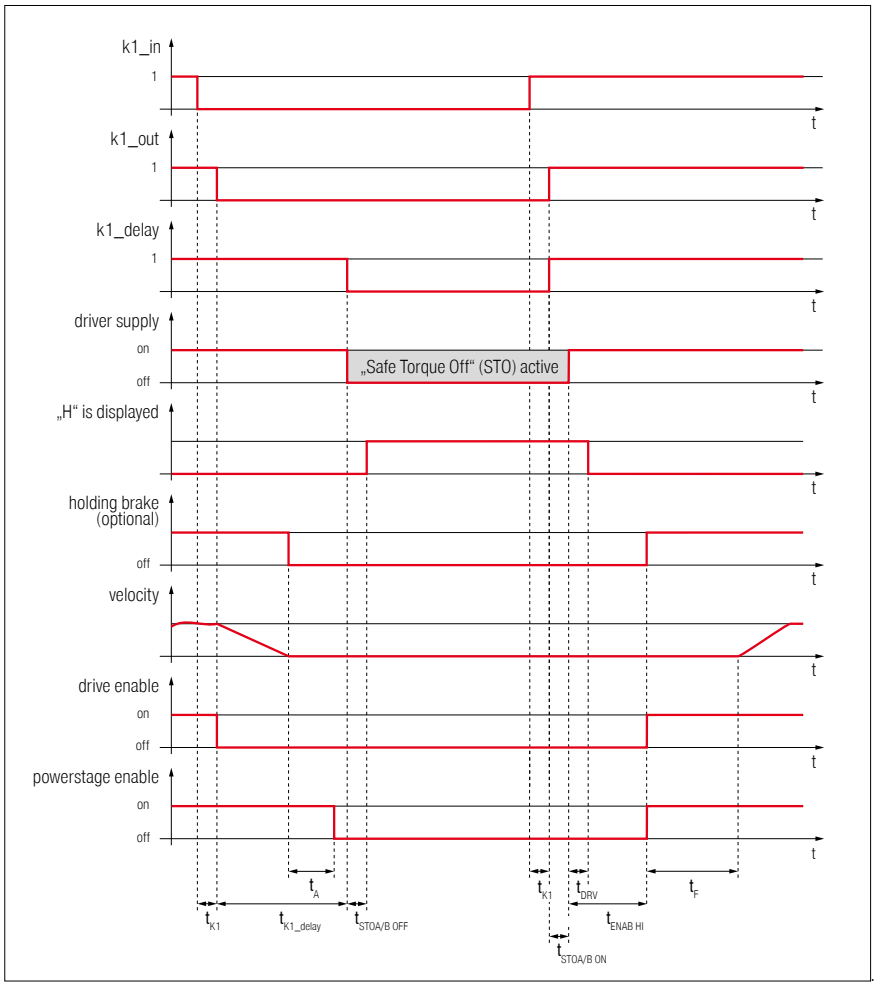


Figure 19: Time response during the activation of the SS1 safety function (external switching) with a restart

Time	Description	Value
t_{K1}	Delay between the switching of S1 and the closing of the undelayed contact K1	See the data sheet of the safety relay
t_{K1_delay}	Delay between S1 and the opening of the off- delayed contacts K1	Can be adjusted on the safety relay
$t_{STOA/B\ OFF}$	STOA/B – switching time from high to low (See also section Response time until power output stage inactive and maximum OSSD test pulse duration on page 48)	Maximum response time 5 ms
$t_{STOA/B\ ON}$	STOA/B – switching time from high to low	0.6 ms typ., 1 ms max
t_{DRV}	Delay of the internal sequence control of the servo drive	10 ms max.
$t_{ENAB\ HI}$	Time that the servo drive enable signal (DIN5 or bus enable signal) must be low after STOA/B has been reactivated and the status of the STO circuit has changed	> 20 ms
t_A	Switch-off delay of the holding brake	
t_F	Switch-on delay of the holding brake	

8.12 MicroSD card

Communication interface	Value
File system	FAT16, FAT32
Connector type	microSD card
File names	Only file and folder names that comply with the 8.3 standard are supported.

9 Electrical installation

This chapter provides all of the relevant information for the electrical installation of a servo drive of the BL 4000-C series with an integrated "Safe Torque Off (STO)" safety function.

9.1 Notes concerning the safe and EMC- compliant installation

9.1.1 Explanations and terminology

Electromagnetic compatibility (EMC) or electromagnetic interference (EMI) includes the following requirements:

- Sufficient **immunity** of an electrical installation or an electrical device against external electrical, magnetic or electromagnetic interferences via cables or the environment.
- Sufficiently small **unwanted emission** of electrical, magnetic or electromagnetic interference from an electrical installation or an electrical device to other devices in the vicinity via cables or the environment.

9.1.2 General information about electromagnetic compatibility

The interference emission and interference immunity of a servo drive always depend on the overall drive concept consisting of the following components:

- Power supply
- Servo drive
- Motor
- Electromechanical system
- Configuration and type of wiring
- Superordinate control system

In order to increase interference immunity and to decrease interference emissions, the servo drive has integrated filters so that it can be used without additional shielding and filtering devices in most applications.

9.1.3 Proper wiring

Comply with following instructions to ensure the safe and EMC-compliant set-up of the drive system:

DANGER ⚠ Dangerous electrical voltage!

For safety reasons, all of the PE earth (ground) conductors must be connected prior to the initial operation of the system.

The shields must be connected on both sides.

The EN 61800-5-1 regulations concerning protective earthing (grounding) must be complied with during the installation.

- In order to keep the leakage currents and losses in the motor connecting cable as small as possible, the servo drive should be located as close to the motor as possible (see also section 9.1.4 Operation with long motor cables on page 53).
- The motor cable and angle encoder cable must be shielded.
- Connect the shield of the motor cable to the back panel of the control cabinet by way of suitable shield terminals. The unshielded cable end should not be longer than 80 mm.
- The mains-end PE connector must be connected to the PE connection point of the supply connector [X9].

- The earthing (grounding) screw of the mounting plate (see section 3.2 Device view on page 14) must also be connected to the mains-side PE connector via a separate earth lead.
- The cross-section of each earth lead must not be smaller than the cross-section of the supply leads (L/N or L1-L3).
- The inner PE conductor of the motor cable must be connected to the PE connection point of the motor connector [X6].
- The signal lines must be as far away from the power cables as possible. They should not be laid in parallel. If intersections cannot be avoided, they should be installed at right angles if possible.
- Unshielded signal and control lines should not be used. If their use is inevitable, they should at least be twisted.
- Even shielded cables will inevitably have short unshielded ends (unless shielded connector housings are used).

In general, the following applies:

- Connect the inner shields to the associated pins of the connectors.
- Connect the overall shield on the motor side to the connector or motor housing over a large contact area.

9.1.4 Operation with long motor cables

INFO Compliance with the EMC standard EN 61800-3

Compliance with the EMC standard EN 61800-3 is ensured only for a motor cable length of 25 m maximum.

Operation with longer cables is not permissible.

In applications involving long motor cables and/or in the case of unsuitable motor cables with a non-permissible high cable capacity, the filters, power output stage and sensors may be overloaded.

9.1.5 ESD protection

⚠ NOTICE Damage to property due to ESD (electrostatic discharge)

At unassigned plug connectors, damage can occur to the device or to other system parts as a result of ESD (electrostatic discharge).

To prevent this type of damage, comply with the following:

- Ensure proper earthing of all of the system components and wire the servo drive completely prior to switching on the voltage supply.
- The person commissioning the system as well as the service and maintenance personnel must have undergone ESD training and wear corresponding footwear.
- When handling the system, e.g. the USB connector, it is useful to touch the control cabinet housing (should be at PE potential) with your hand prior to touching one of the connectors of the servo drive.

9.2 Additional requirements for the UL approval

Mains power supply protection

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.

- BL 1-04 /C: Suitable For Use On A Circuit Capable Of Delivering Not More Than 5,000 rms Symmetrical Amperes, 240 Volts Maximum When Protected by A Circuit Breaker Having An Interrupt Rating Not Less Than 10 rms Symmetrical Amperes, 240 Volts Maximum.

Observe the following specification for the main fuse: Listed Circuit Breaker according to UL 489, rated 277 Vac, 10 A, SCR 10 kA

Wiring requirements and environmental conditions

- Use 60 / 75 °C copper conductors.
- For use in Pollution Degree 2 Environment only.

9.3 BL 1-04 /C: Connector: power supply [X9]

Servo drives of the BL 1-04 /C series must be connected to the voltage supply and an optional brake resistor in accordance with the following illustration.

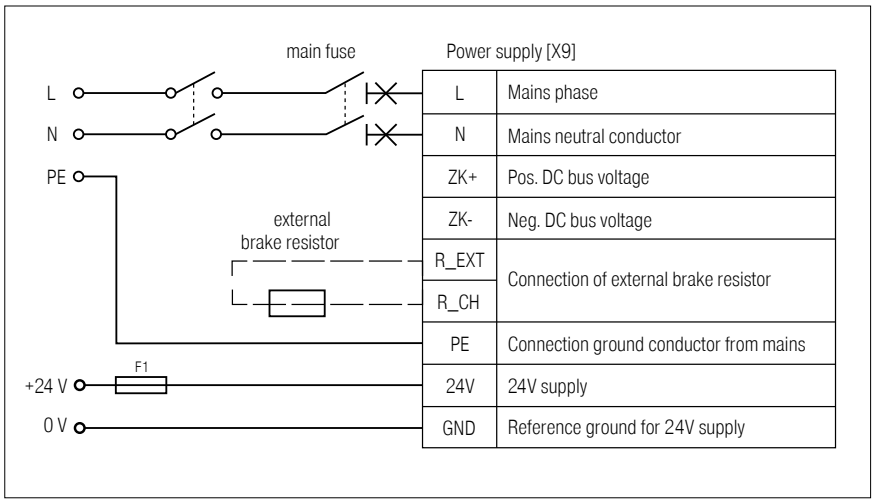


Figure 20: Connection of a BL 1-04 /C to the power supply [X9]

⚠ NOTICE **Risk of damage to the servo drive**

The servo drive will be damaged in the following cases:

- reverse connection of the 24 V operating voltage connections,
- l excessive operating voltage, or
- l accidental interchanging of the operating voltage and motor connectors.

A 24 V supply and a single-phase mains power supply are required to operate a BL 1-04 /C. A single-phase automatic circuit breaker must be installed in the mains power supply line (see section Cable type and configuration [X9] on page 55). Direct DC coupling of the DC buses of several devices with equal DC bus voltage is possible by way of the terminals ZK+ and ZK-. The servo drive has an internal brake chopper and an internal braking resistor. For higher braking power, an external braking resistor can be connected to connector [X9] in parallel to the internal braking resistor.The servo drive must be connected to earth (ground) with its PE connectors (section 9.1.3 Proper wiring on page 52).

First, wire the servo drive completely. Then, switch on the 24 V supply and the mains power supply.

Configuration on the device [X9]

Weidmüller SL 5.08HC/09/90G 3.2SN BK BX

Mating connector [X9]

Weidmüller BLF 5.08HC/09/180 SN BK BX

Pin assignment [X9]

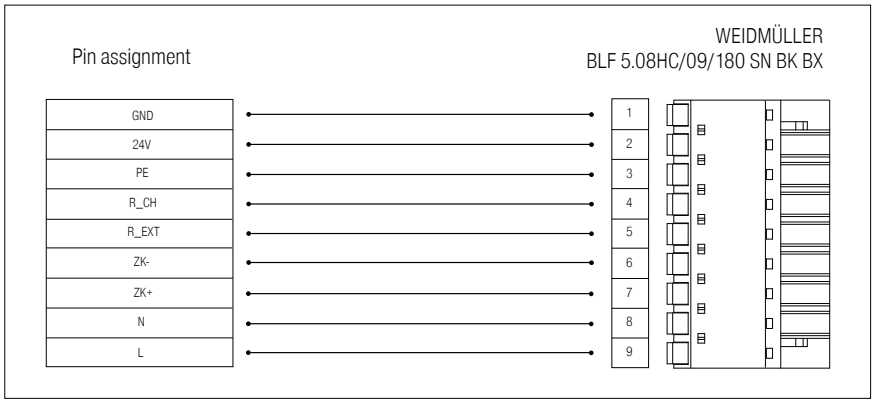


Figure 21: Pin assignment: power supply connector [X9]

Pin	Name	Specification
1	GND	Supply voltage reference potential
2	24V	Supply voltage for the control module and holding brake
3	PE	Connection of the protective earth (ground) conductor of the mains power supply
4	R_CH	Braking resistor connection
5	R_EXT	Braking resistor connection
6	ZK-	Neg. DC bus voltage
7	ZK+	Pos. DC bus voltage
8	N	Neutral conductor
9	L	Phase conductor/mains phase

Cable type and configuration [X9]

The cable names that are stated refer to cables made by Lapp. They have proved to be reliable and are successfully used in many applications. However, it is also possible to use comparable cables from other manufacturers, for example Lütze or Helukabel. A single-phase circuit breaker with the listed characteristics ("Circuit breaker") must be used in the mains supply line.

LAPP KABEL ÖLFLEX CLASSIC 110

Device type	Cable type	Specification (L, N, PE)	Circuit breaker
BL 4102-C	3 G 1.0	3 x 1,0 mm² (AWG 18)	B 10
BL 4104-C	3 G 1.0	3 x 1,0 mm² (AWG 18)	B 10

9.4 BL 1-04 /C: Connector: motor [X6]

Configuration on the device [X6]
Weidmüller SL 5.08HC/09/90G 3.2SN BK BX

Mating connector [X6]
Weidmüller BLF 5.08HC/09/180 SN BK BX

Pin assignment: motor with a motor temperature sensor

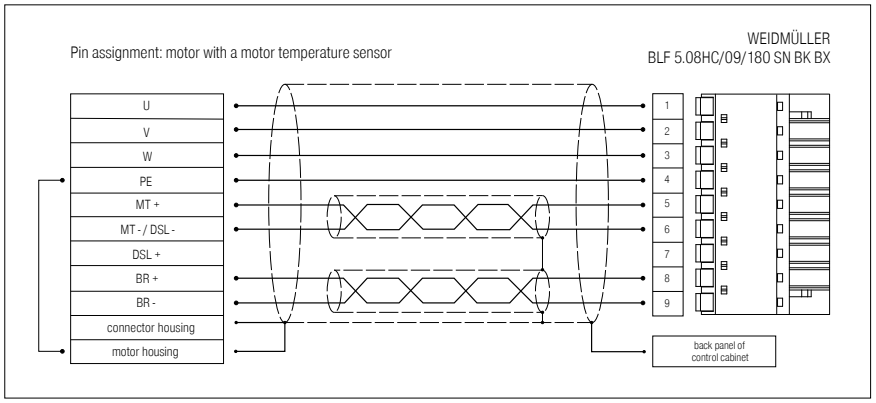


Figure 22: Pin assignment: motor connector (motor temperature sensor) [X6]

Pin	Name	Specification
1	U	Motor phase U
2	V	Motor phase V
3	W	Motor phase W
4	PE	Protective earth conductor of the motor
5	MT+	Motor temperature sensor +
6	MT-/ DSL-	Motor temperature sensor -
7	DSL+	
8	BR+	Holding brake +
9	BR-	Holding brake -

Pin assignment: motor with HIPERFACE DSL®

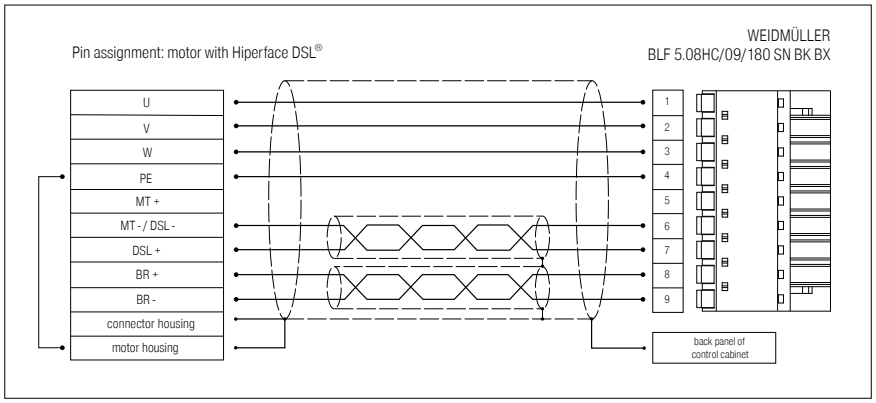


Figure 23: Pin assignment: motor connector (HIPERFACE DSL®) [X6]

Pin	Name	Specification
1	U	Motor phase U
2	V	Motor phase V
3	W	Motor phase W
4	PE	Protective earth conductor of the motor
5	MT+	
6	MT-/ DSL-	HIPERFACE DSL -
7	DSL+	HIPERFACE DSL +
8	BR+	Holding brake +
9	BR-	Holding brake -

Cable type and configuration [X6]

The cable names that are stated refer to cables made by Lapp. However, it is also possible to use comparable cables from other manufacturers, for example Lütze or Helukabel.

LAPP KABEL ÖLFLEX SERVO 719 CY; 4 G 1,5 + 2 x (2 x 0,75);

For fixed installation:

LAPP KABEL ÖLFLEX SERVO FD 796 CP; 4 G 1,5 + 2 x (2 x 0,75)

INFO Comply with the required minimum cross-section

Always observe the minimum cross-sections for the lines U, V, W and PE according to the above table. Comply also with the maximum permissible cable capacity as per section 8.3 BL 1-04 /C: Motor connector [X6] on page 35.

Connection notes [X6]

Connect the inner and outer cable shield with the greatest possible surface area to the back panel of the control cabinet by way of suitable EMC terminals (e.g. icotek LFZ/SKL, SFZ/SKL or PFSZ-MSKL). The unshielded cable end should not be longer than 80 mm.

An existing holding brake in the motor must be connected to the terminals BR+ and BR-. Please note the maximum output current that is provided by the servo drive.

DANGER **Dangerous electrical voltage!**

The signals for the temperature sensor "MT-" and "MT+" at the motor connector [X6] must be connected to protective extra-low voltage (PELV) on the motor side and they must be insulated against the motor phases.

⚠ WARNING **Risk of injury**

The brake output of the servo drive (BR+, BR-) must not be used as the sole stop element in safety-oriented applications.

⚠ NOTICE **Risk of destruction due to the mix-up of connectors**

The servo drive may be irreparably damaged if the connectors for the motor [X6] and supply [X9] are mixed up.

9.5 Connector: resolvers/analogue Hall encoders [X2A]

Two different encoder types can be connected to the 9-pin D-Sub connector:

- Resolvers
- Analogue Hall generators with tracks that are offset by 90° (sine/cosine)

Diverging from the analogue evaluation via the X2B interface, this input has a higher resolution and it is possible to read in higher amplitudes.

Configuration on the device [X2A]

D-SUB connector, 9-pin type, female

Mating connector [X2A]

- D-SUB connector, 9-pin type, male
- Housing for a 9-pin D-SUB connector with locking screws of type 4/40 UNC

Pin assignment [X2A]

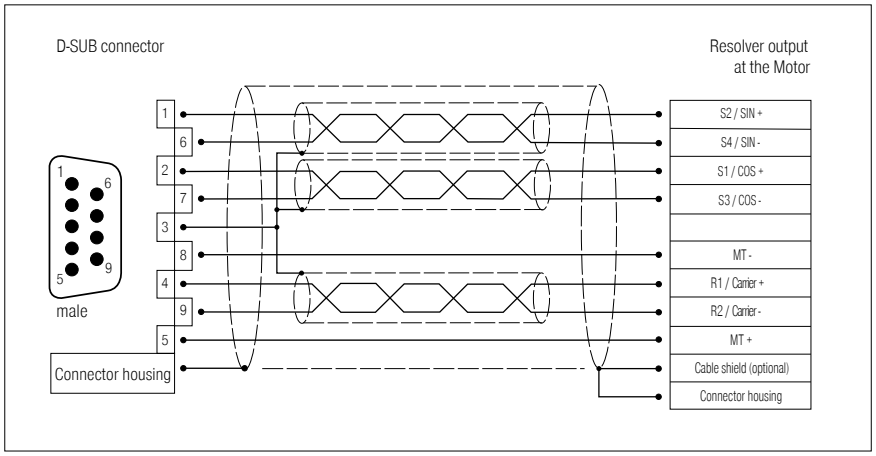


Abbildung 24: Pin assignment: resolver connector [X2A]

- The outer shield is always connected to PE (connector housing) on the servo drive side.
- The three inner shields are connected to PIN 3 of X2A on one side of the servo drive.

Pin		Name	Specification
1		S2	SINE track signal, differential Analogue Hall sensor (SINE)
	6	S4	
2		S1	COSINE track signal, differential Analogue Hall sensor (COSINE)
	7	S3	
3		GND	Shield for signal pairs (inner shield)
	8	MT-	Temperature sensor reference potential
4		R1	Carrier signal for the resolver
	9	R2	
5		MT+	Motor temperature sensor, normally closed contact, PTC, NTC, KTY

INFO Only one motor temperature sensor can be connected

The motor temperature sensor can either be connected to X2A, X2B or X6. It is not possible to connect several sensors at a time.

INFO Avoiding EMC interferences

The outer cable shield must be connected to the housing of the angle encoder connector with the greatest possible surface area (with low impedance).

Cable type and configuration [X2A]

The cable names that are stated refer to cables made by Lapp. However, it is also possible to use comparable cables from other manufacturers, for example Lütze or Helukabel.

LAPP KABEL ÖLFLEX SERVO 728 CY; 3 x (2 x 0.14) + 2 x (0.5);

with an overall tinned CU shield, angle measurement error up to approx. 0.7° with a cable length of 25 m, to be used 2 x (0.5) for the resolver carrier.

For highly flexible applications:

LAPP KABEL ÖLFLEX SERVO FD 798 CP; 3 x (2 x 0.14) + 2 x (0.5);

with an overall tinned CU shield, angle measurement error up to approx. 0.7° with a cable length of 25 m, to be used 2 x (0.5) for the resolver carrier.

9.6 Connector: encoder [X2B]

Different types of encoders can be connected to the 15-pin D-Sub connector (see section 8.5 Encoder connector [X2B] on page 38):

- Analogue incremental encoders (1 Vss)
- Incremental encoders with a serial interface (RS485 level, e.g. EnDat, HIPERFACE®, BISS)
- Digital incremental encoders (RS422, HALL sensors)

It is also possible to evaluate an optional error signal (AS/NAS) via pin 6. With some incremental encoders, it is possible to detect and signal soiling or other faults/malfunctions of the measuring system via an output (AS or NAS). The error signal can be evaluated by digital as well as analogue incremental encoders.

In the case of analogue incremental encoders, the evaluation is only possible if no commutation track (Z1) is parameterised and connected. The evaluation of the error signal can be inverted.

Configuration on the device [X2B]

D-SUB connector, 15-pin type, female

Mating connector [X2B]

- D-SUB connector, 15-pin type, male
- Housing for a 15-pin D-SUB connector with locking screws of type 4/40 UNC

⚠ NOTICE **Damage to property caused by an incorrect power supply**

If an incorrect power supply is used, the encoder may be destroyed. Ensure that the correct voltage is activated prior to connecting the encoder to [X2B].

To do so, start the item MotionSoft® parameterisation software and select the Parameters/Device parameters/Angle encoder settings.

Pin assignment: analogue incremental encoders

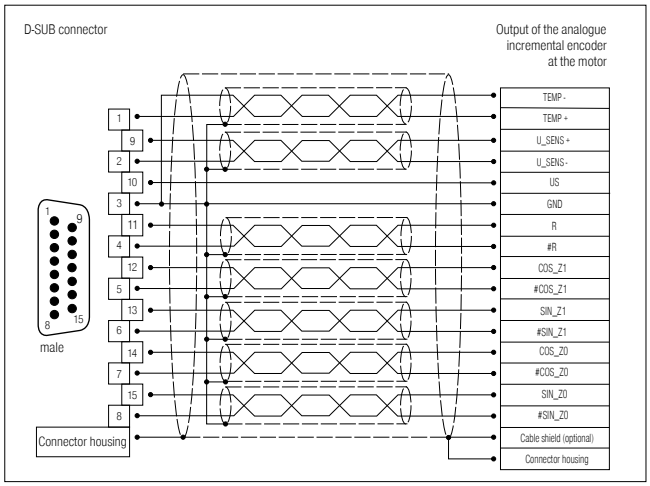


Figure 25: Pin assignment: analogue incremental encoders [X2B]

Pin		Name	Specification
1		MT+	Motor temperature sensor, normally closed contact, PTC, NTC, KTY
	9	U_SENS+	Sensor cables for the encoder supply. In case of long cables, connect to US/GND at the motor end.
2		U_SENS-	
	10	US	Operating voltage for incremental encoders
3		GND	Associated reference potential
	11	R	Index pulse track signal (differential) of the high-resolution incremental encoder
4		#R	
	12	COS_Z1 / D+	COSINE commutation signal (differential) of the high-resolution incremental encoder
5		#COS_Z1 / D-	
	13	SIN_Z1 / C+	SINE commutation signal (differential) of the high-resolution incremental encoder
6		#SIN_Z1 / C-	
	14	COS_Z0 / B+	COSINE track signal (differential) of the high-resolution incremental encoder
7		#COS_Z0 / B-	
	15	SIN_Z0 / A+	SINE track signal (differential) of the high-resolution incremental encoder
8		#SIN_Z0 / A-	

INFO Avoiding EMC interferences

The outer cable shield must be connected to the housing of the angle encoder connector with the greatest possible surface area (with low impedance).

Pin assignment: incremental encoder with a serial interface

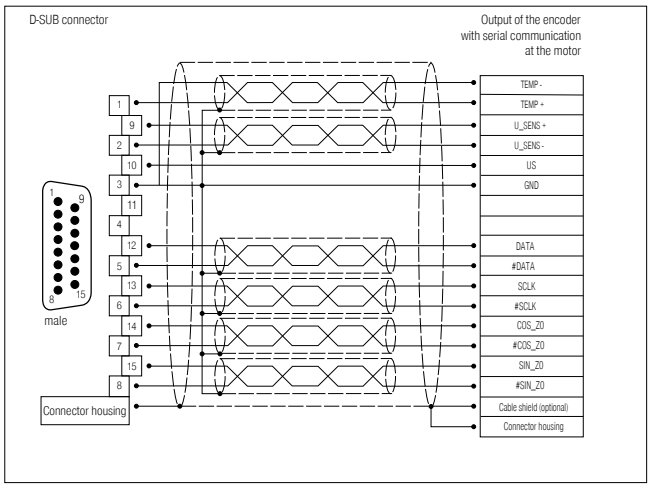


Figure 26: Pin assignment: incremental encoder with a serial interface [X2B]

Pin		Name	Specification
1		MT+	Motor temperature sensor, normally closed contact, PTC, NTC, KTY
	9	U_SENS+	Sensor cables for the encoder supply. In case of long cables, connect to US/GND at the motor end.
2		U_SENS-	
	10	US	Operating voltage
3		GND	Associated reference potential
	11		
4			
	12	DATA / SL+	Bidirectional RS485 data line (differential) (EnDat/HIPERFACE®, BISS)
5		#DATA / SL-	
	13	SCLK / MA+	Clock pulse output RS485 (differential) (EnDat, BiSS)
6		#SCLK / MA-	
	14	COS_Z0 / B+	COSINE track signal (differential) of the high-resolution incremental encoder
7		#COS_Z0 / B-	
	15	SIN_Z0 / A+	SINE track signal (differential) of the high-resolution incremental encoder
8		#SIN_Z0 / A-	

INFO Avoiding EMC interferences

The outer cable shield must be connected to the housing of the angle encoder connector with the greatest possible surface area (with low impedance).

Pin assignment: digital incremental encoder (RS422)

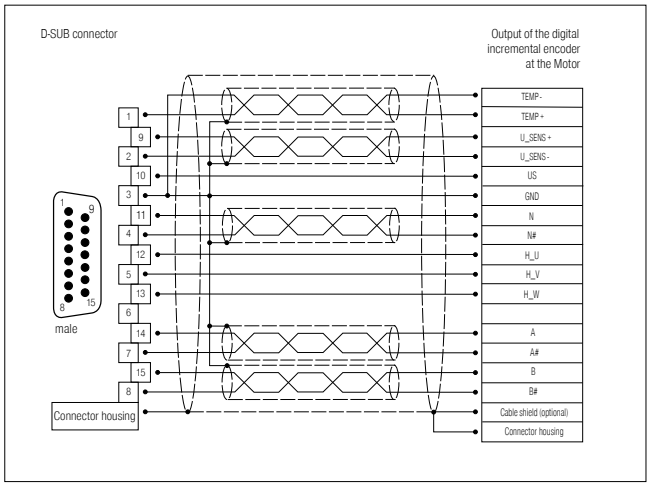


Figure 27: Pin assignment: digital incremental encoder (RS422) [X2B]

Pin		Name	Specification
1		MT+	Motor temperature sensor, normally closed contact, PTC, NTC, KTY
	9	U_SENS+	Sensor cables for the encoder supply. In case of a long cable, connect to US/GND at the motor end.
2		U_SENS-	
	10	US	Operating voltage for incremental encoders
3		GND	Associated reference potential
	11	N / U_{a0}	Index pulse RS422 (differential) of the digital incremental encoder
4		#N / $\bar{U}_{a0}$	
	12	H_U	Phase U of the Hall sensor for commutation
5		H_V	Phase V of the Hall sensor for commutation
	13	H_W	Phase W of the Hall sensor for commutation
6			
	14	A / $\bar{U}_{a1}$	A track signal RS422 (differential) of the digital incremental encoder
7		#A / U_{a1}	
	15	B / U_{a2}	B track signal RS422 (differential) of the digital incremental encoder
8		#B / $\bar{U}_{a2}$	

INFO **Avoiding EMC interferences**

The outer cable shield must be connected to the housing of the angle encoder connector with the greatest possible surface area (with low impedance).

Cable type and configuration [X2B]

We recommend a minimum cross-section of 0.25 mm² for the angle encoder supply US and GND.

9.7 Connector: USB [X19]

The BL 1-04 /C servo drive has a Type B USB connector.

The correct operation requires a short USB cable (< 3 m) and the correct installation and earthing of the servo drive. If excessive malfunctions/faults lead to communication problems (frozen communication), the USB connector can be briefly disconnected to restart the communication.

In addition, we recommend using certified, double-shielded cables of the AB type (USB

2.0 connecting cable, type A connector to type B connector) AWG28-1P, AWG24-2C with shielded connectors.

INFO **Non-EMC-compliant wiring of the servo drive and motor**

In case of non-EMC-compliant wiring of the servo drive and motor, compensating electric current may flow via the connected computer and the USB interface. This may lead to communication problems.

To avoid this, we recommend using an electrically isolated USB adapter "Delock USB Isolator" (type 62588 by Delock) or a comparable adapter.

Configuration on the device [X19]

USB connector (female), type B

Mating connector [X19]

USB connector (male), type B

Pin assignment USB [X19]

Interface cable for the USB interface, 4 cores, shielded and twisted (type B).

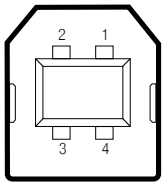


Figure 28: Pin assignment of the USB connector

Pin		Name	Specification
	1		
2		D-	Data -
3		D+	Data +
	4	GND	GND

9.8 Connector: standard Ethernet [X18]

The BL 1-04 /C servo drive has a network connector of the RJ45 type.

Configuration on the device [X18]

Female RJ45 connector, cat. 6

Mating connector [X18]

Male RJ45 connector

Pin assignment of the network connector [X18]

Cat.6 patch cable RJ45 LAN cable S-FTP/PIMF.

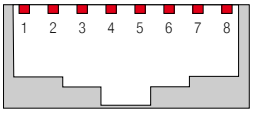


Figure 29: Pin assignment of the network connector

Pin	Name	Description	Colour
1	TX+	Transmission signal +	Yellow
2	TX-	Transmission signal -	Orange
3	RX+	Reception signal +	White
4	-	-	
5	-	-	
6	RX-	Reception signal -	Blue
7	-	-	
8	-	-	

9.9 Connector: real-time Ethernet [X21]

The connection to an EtherCAT or PROFINET network must be realised via two female RJ45 connectors. Details can be found in the Fieldbus manuals.

Configuration on the device [X21]

Female RJ45 connector, cat. 6

Mating connector [X21]

Male RJ45 connector

Pin assignment of the real-time Ethernet connector [X21]

Cat.6 patch cable RJ45 LAN cable S-FTP/PIMF.

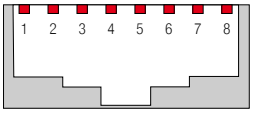


Figure 30: Pin assignment of the real-time Ethernet connector

Pin	Name	Description	Colour
1	TX+	Transmission signal +	Yellow
2	TX-	Transmission signal -	Orange
3	RX+	Reception signal +	White
4	-	-	
5	-	-	
6	RX-	Reception signal -	Blue
7	-	-	
8	-	-	

9.10 Connector: CAN bus [X4]

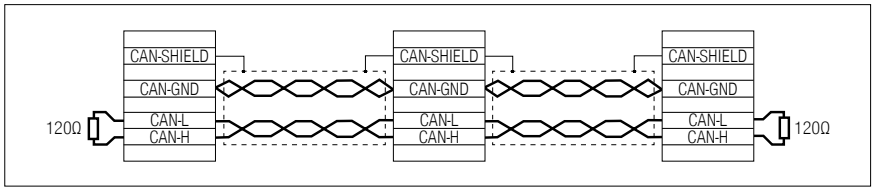


Figure 31: CAN bus cabling example

- Ideally, the individual nodes of the networks are always connected in a linear manner so that the CAN cable is looped through from servo drive to servo drive.
- A terminating resistor of 120 Ω, 5%, must be present on both ends of the CAN bus cable.
- Shielded cables with exactly two twisted pairs must be used for cabling.
- Use one twisted pair to connect CAN-H and CAN-L.
- The cores of the other pair are used jointly for CAN-GND.
- The shield of the cable is led to the CAN shield connections for all nodes.
- We advise against the use of plug adaptors for cabling the CAN bus. However, if this is necessary, use metal connector housings for connecting the cable shield.

In order to keep interferences as low as possible ensure that

- the motor cables are not installed parallel to signal lines
- the motor cables comply with the Item specification
- the motor cables are properly shielded and earthed (grounded)

Configuration on the device [X4]

D-SUB connector, 9-pin type, male

Mating connector [X4]

- D-SUB connector, 9-pin type, female
- Housing for a 9-pin D-SUB connector with locking screws of type 4/40 UNC

Steckerbelegung [X4]

Pin		Name	Specification
1			Not used
	6	GND	CAN-GND, directly coupled to GND in the servo drive
2		CANL	CAN low signal line
	7	CANH	CAN high signal line
3		GND	See pin no. 6
	8		Not used
4			Not used
	9		Not used
5		Shield	Connector for the cable shield

*) To terminate the CAN bus at both ends, an external terminating resistor is required.

Cable type and configuration [X4]

The cable names that are stated refer to cables made by Lapp. However, it is also possible to use comparable cables from other manufacturers, for example Lütze or Helukabel.

Technical data of the CAN bus cable: 2 pairs of 2 twisted cores, d ≥ 0.22 mm2, shielded, loop resistance < 0.2 Ω/m, characteristic impedance 100-120 Ω

LAPP KABEL UNITRONIC BUS CAN; 2 x 2 x 0.22; 7.6 mm, with CU shielding

For highly flexible applications:

LAPP KABEL UNITRONIC BUS CAN FD P; 2 x 2 x 0.25; 8.4 mm, with CU shielding

9.11 Connector: I/O interface [X1]

The BL 1-04 /C servo drive has two differential inputs (AIN) for analogue input voltages in the range of ±10 V.The inputs AIN and #AIN are connected to the control system via twisted cables (twisted-pair type). Alternatively, it is also possible to use a shielded cable.

If the control system is equipped with single-ended outputs, the output is connected to AIN and #AIN is connected to the reference potential of the control system. If the control system is equipped with a differential output, it must be connected 1:1 to the differential inputs of the servo drive.

The reference potential GND24 must be connected to the reference potential of the control system. This is necessary in order to prevent the differential input of the servo drive from being overridden by high "common-mode interference".

Despite the differential design of the analogue input, using unshielded cables for the analogue signals is not recommended, since interferences, e.g. caused by switching contactors, or output stage interferences of the converters can reach high amplitudes.

The 24 V connections inside the control cabinet can be made without a shield. In the case of long cables (l > 2 m) towards the PLC or outside the control cabinet, shielded cables must be used. The shields of these cables must be connected to PE on both ends. The cable shield can then be connected to the back panel of the control cabinet, for example.

For optimal interference suppression on the analogue signal lines, the cores for the analogue signal must be shielded separately. It may be useful to run the analogue signal in a separate, shielded cable.

The servo drive provides an auxiliary voltage of 24 V. As a result, the inputs can be activated directly via switches.

The digital outputs are designed as so-called "high-side switches". This means that only these 24 V are supplied to the output in the active state. In the passive state, the output has a high resistance and the level is defined only by the flyback diode and a high internal resistance.

Configuration on the device [X1]

D-SUB connector, 25-pin type, female

Mating connector [X1]

- D-SUB connector, 25-pin type, male
- Housing for a 25-pin D-SUB connector with locking screws of type 4/40 UNC

Pin assignment [X1]

Pin		Name	Specification
1		#AIN1	Analogue input 1, input voltage 30 V max.
	14	AIN1	
2		#AIN0	Analogue input 0, input voltage 30 V max.
	15	AIN0	
3		A / CLK	Incremental encoder signal A/stepper motor signal CLK
	16	A# / CLK	Incremental encoder signal A#/stepper motor signal CLK
4		B / DIR	Incremental encoder signal B/stepper motor signal DIR
	17	B# / DIR	Incremental encoder signal B#/stepper motor signal DIR
5		N	Incremental encoder index pulse N
	18	#N	Incremental encoder index pulse N#
6		GND24	Reference potential for I/Os at X1
	19	DIN0	Digital input 0 (target 0)
7		DIN1	Digital input 1 (target 1)
	20	DIN2	Digital input 2 (target 2)
8		DIN3	Digital input 3 (target 3)
	21	DIN4	Digital input 4 (input)
9		DIN5	Digital input 5 (servo drive enable signal)
	22	DIN6	Digital input 6 (limit switch 0)
10		DIN7	Digital input 7 (limit switch 1)
	23	DIN8	Input (flying saw)
11		5 V	Encoder supply (see pin 3 to 18)
	24	24 V	Auxiliary voltage for I/Os at X1
12		DOUT0	Freely programmable output
	25	DOUT1	Freely programmable output
13		DOUT2	Freely programmable output

Cable type and configuration [X1]

The cable name that is stated refers to a cable made by Lapp. However, it is also possible to use comparable cables from other manufacturers, for example Lütze or Helukabel.

LAPP KABEL UNITRONIC LiYCY (TP); 25 x 0.25mm²

9.12 Connector: STO [X3]

DANGER ⚠ Dangerous electrical voltage!

Use only PELV circuits for the STO wiring!

Make sure that no jumpers or the like can be inserted parallel to the safety wiring. For example, use the maximum wire cross-section of 1.5 mm² or suitable wire end sleeves with insulating collars for the connection to the associated connector.

Configuration on the device [X3]

SC 3.81/08/90F 3.2SN BK BX

Mating connector

BCF 3.81/08/180F SN BK BX

Pin assignment [X3]

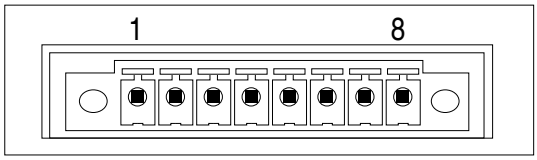


Figure 32: STO connector [X3]

Pin	Name	Description
1	STOA	Control input A for the STO function
2	GNDA	Reference potential for STO-A
3	STOB	Control input B for the STO function
4	GNDB	Reference potential for STO-B
5	DIN6	Connected to X1, pin 22
6	DIN7	Connected to X1, pin 10
7	DOUT0	Connected to X1, pin 12
8	GND	Reference potential for the auxiliary supply voltage

To ensure the STO ("Safe Torque Off") function, the control inputs STOA and STOB must be connected in a dual-channel manner with parallel wiring. See section 4.6.1 Safe torque off (STO) on page 23. This type of connection can be part of an emergency stop circuit or safety door setup, for example.

Cable type and configuration [X3]

Characteristic	Value
Max. cable length, unshielded	30 m
Max. cable length, shielded	> 30 m
Shielding	In the case of wiring outside the control cabinet and with cable lengths > 30 m, the shield must be led into the control cabinet.
Cable cross-section (flexible conductors, wire end sleeve with insulating collar), one conductor	0,25 mm²... 0,5 mm²

Minimum wiring for commissioning [X3]

DANGER Danger to life due to bypassed safety functions

Safety functions must never be bypassed.

For the commissioning of the system without any safety systems, STOA and STOB can be connected to the 24 V supply and GNDA and GNDB can be connected to GND in a fixed manner.

Perform the minimum wiring of the inputs STOA/STOB and GNDA/GNDB for the commissioning process in such a way that it must be removed when the final safety wiring is performed.

10 Maintenance, cleaning, repair and disposal

The following requirements must be fulfilled for the maintenance, cleaning, repair and disposal of the servo drive:

Maintenance

Servo drives of the BL 1-04 /C device series are maintenance-free.

Cleaning

NOTICE Damage to the servo drive due to improper cleaning

To remove surface soiling, e.g. residues of adhesive labels, the servo drive can be cleaned carefully on the outside with suitable tools.

It must be absolutely ensured that liquids of any kind cannot penetrate the servo drive. Seals may be destroyed which, in turn, would to lead to short circuits.

Use the servo drive in a clean environment. Soiling due to dust, oil, oil vapour, grease, fibres or similar inside the device will compromise the insulation with regard to the high- voltage part. Stop using the device immediately if this is the case.

Repair

Opening the device is not permissible and will render the warranty null and void. Only the manufacturer is authorised to perform repairs. Please contact your sales partner.

Disposal, removal, decommissioning, replacement

DANGER **Dangerous electrical voltage!**

Following the instructions stated hereinbelow to ensure the safe decommissioning of the servo drive.

- Switch the power supply completely off.
- Disconnect the mains power connectors.
- Lock the system so that it cannot be reactivated.
- Check whether the device is really voltage-free (measure the voltage at the mains power connectors and between the ZK+ and ZK- connectors at X9).
- Wait 10 minutes. Do not attempt to remove the device before this waiting period has elapsed.
- Contact a sales partner in terms of a return or replacement of the device.

11 Appendix
11.1 CE conformity (EMC, RoHS, Low Voltage Directive)

EC Declaration of Conformity

We hereby declare that the servo controller:
0.0.698.50 Controller BL 1-04 /C

Product description: Servo Controller to control linear units

complies with the following harmonised standards:
The product is developed and produced in accordance with the EMC directive 2014/30/EU and the low voltage directive 2014/35/EU. It is in conformity with Directive 2011/65/EU of the European Parlament and of the Council (RoHS II) of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, including the supplementary directive EU 2015/863.

Essential requirements that have been applied, the references of which have been published in the Official Journal of the European Union:

EN 50581:2012
Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Specific Requirements:
According to the EMC Directives, the listed device is a not independently operable product. Compliance of the directive requires the correct installation of the product, the observance of the specific installation notes and product documentation. This was tested in specific system configurations.
This declaration certifies compliance with the stated Directive, but implies no warranty of properties.

Authorised representative for compiling the relevant technical documentation:

Solingen, 10.12.2020	Markus Allwicher, Documentation	
Place / Date	Signatory information	Signature

EC-Declaration of Conformity was issued:

Solingen, 10.12.2020	Stephan Buchmann, General Manager	
Place / Date	Signatory information	Signature

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quality management
DIN EN ISO 9001:2015
version: 12/2020

11.2 CE conformity (Machinery Directive)

EC Declaration of Conformity

item

We hereby declare that the safety function STO:
part of the article, Controller BL 1-04 /C

Product description: Integrated safety module for Servo Drive to control linear units

complies with the following harmonised standard:
The product is developed and produced in accordance with the machinery directive 2006/42/EC.

Essential requirements that have been applied, the references of which have been published in the Official Journal of the European Union:
EN 61800-5-2:2017
max. SIL 3 - (safety functions see manual). Adjustable speed electrical power drive systems - Part 5-2: Safety requirements
EN 62061:2005+A0:2010+A1:2013+A2:2015
max. SIL CL 3 - (safety functions see manual). Sicherheit von Maschinen - Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
EN ISO 13849-1:2015
max. Kategorie 4, PL e - (safety functions see manual). Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
IEC 61508 Teil 1-7:2010
max. SIL 3 - (safety functions see manual). Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements

Konformitätsbewertung:
The designated product offers the integrated safety function STO. It is confirmed, that the product under test complies with the requirements for machines defined in Annex I of the EC Directive 2006/42/EC.
Notified Body: TÜV Rheinland Industrie Service GmbH
Certification Body for Machinery, NB 0035
Alboinstrasse 56
12103 Berlin / Germany
Certificate: 01/205/5701.00/19
Date of expiry: 2024-01-31

Specific Requirements:
This declaration certifies compliance with the stated Directive, but implies no warranty of properties.
These product is intended for installation in machines. Operation is prohibited until it has been determined that the machines in which these product is to be installed, confirm to the above mentioned EC Directive.

Authorised representative for compiling the relevant technical documentation:

Solingen, 10.12.2020	Markus Allwicher, Documentation
Place / Date	Name, Signatory information

Signature

EC-Declaration of Conformity was issued:

Solingen, 10.12.2020	Stephan Buchmann, General Manager
Place / Date	Name, Signatory information

Signature

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DIN EN ISO 9001:2015
version: 12/2020

11.3 cULus certification

CERTIFICATE OF COMPLIANCE

Certificate Number	E475045
Report Reference	E475045-20160413
Issue Date	2020-NOVEMBER-17
Issued to:	Item Industrietechnik GmbH Friedenstrasse 107-109 42699 Solingen, GERMANY
This certificate confirms that representative samples of	Power Conversion Equipment See addendum page for models
	Have been investigated by UL in accordance with the component requirements in the Standard(s) indicated on this Certificate. UL Recognized components are incomplete in certain constructional features or restricted in performance capabilities and are intended for installation in complete equipment submitted for investigation to UL LLC.
Standard(s) for Safety:	See addendum page for Standards
Additional Information:	See the UL Online Certifications Directory at https://iq.ulprospector.com for additional information.

This *Certificate of Compliance* does not provide authorization to apply the UL Recognized Component Mark. Only the UL Follow-Up Services Procedure provides authorization to apply the UL Mark.

Only those products bearing the UL Recognized Component Mark should be considered as being UL Certified and covered under UL's Follow-Up Services.

Look for the UL Recognized Component Mark on the product.

Bruce Mahrenholz, Director North American Certification Program

UL LLC

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CERTIFICATE OF COMPLIANCE

Certificate Number	E475045
Report Reference	E475045-20160413
Issue Date	2020-NOVEMBER-17

This is to certify that representative samples of the product as specified on this certificate were tested according to the current UL requirements.

Power conversion equipment open type, Models:
Steuerung C1-02, Steuerung C1-05, Steuerung C1-08, Steuerung C3-05, Steuerung C3-10,

Listed to Safety Standards:
UL508C - Power Conversion Equipment
CAN/CSA C22.2 No. 274-13 - Adjustable Speed Drives

Power Conversion Equipment, Models:
BL 1-02 /C, BL 1-04 /C

Listed to Safety Standards:
UL 61800-5-1 - Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements - Electrical, Thermal and Energy
CSA-C22.2 No. 274 - Adjustable Speed Drives

Bruce Mahrenholz, Director North American Certification Program

UL LLC

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11.4 Safety technology glossary

Term/abbreviation	Description
CCF	Common cause failure in accordance with EN ISO 13849-1
DC avg	Average diagnostic coverage in accordance with IEC 61508 and EN 61800-5-2.
HFT	Hardware fault tolerance in accordance with IEC 61508.
Cat.	Safety category in accordance with EN ISO 13849-1, level 1- 4.
iMS®	item MotionSoft®, software for configuration and start-up.
MTTFd	Mean time to dangerous failure. Time in years until the first dangerous failure will have occurred with 100% probability, in accordance with EN ISO 13849-1.
Emergency off	In accordance with EN 60204-5-1 Electrical safety is ensured in case of an emergency by switching off the electrical energy supply to the entire installation or part of it. An emergency off is to be used where a risk of electric shock or other electrical risk exists.
Emergency stop	In accordance with EN 60204-5-1 In an emergency, functional safety is ensured by stopping a machine or moving parts. An emergency stop is used to stop a process or a movement which has become hazardous.
OSSD	Output signal switching device, output signals with 24 V level cycle rates for error detection.
PFD	Probability of failure on demand in accordance with IEC 61508.
PFH	Probability of dangerous failures per hour in accordance with IEC 61508.
PL	Performance level in accordance with EN ISO 13849-1: Levels a to e
PWM	Pulse width modulation. Stands for the digital actuation of the power semiconductors with a variable duty cycle in order to adjust a voltage at the motor output.
SFF	Safe failure fraction [%], ratio between the failure rates of safe and dangerous (but recognisable) failures and the total number failures in accordance with IEC 61508.
Safety relay	Device for executing safety functions or for establishing a safe state of the machine by switching off the energy supply for dangerous machine functions. The desired safety function can be achieved only in combination with other risk reduction measures, e.g. by switching off a servo drive.
SIL	Safety integrity level. Discrete levels for defining the requirements for the safety integrity of safety functions in accordance with IEC 61508, EN 62061 and EN ISO 13849.
SIL CL	Maximum SIL that can be required from a sub-system.
SS1	Safe stop 1 in accordance with EN 61800-5-2.
STO	Safe torque off in accordance with EN 61800-5-2.
T	Duration of use in accordance with EN ISO 13849-1.

11.5 Risk reduction questions

Questions for a validation in accordance with EN ISO 12100- 1:2010 (example)

No.	Question	Yes / No		Completed
1	Have all of the operating conditions and interventions been taken into account?	Yes	No	
2	Has the "3-step method" for risk reduction been applied? ▪ Inherently safe design ▪ Technical safety measures and additional safeguarding (if necessary) ▪ User information about the residual risk	Yes	No	
3	Have the hazards been eliminated or has the hazard risk been reduced as far as practically possible?	Yes	No	
4	Can it be guaranteed that the implemented measures will not pose new hazards?	Yes	No	
5	Have the users been adequately informed and warned about the residual risks?	Yes	No	
6	Can it be guaranteed that the operators‘ working conditions have not deteriorated due to the safeguarding undertaken?	Yes	No	
7	Is the safeguarding mutually compatible?	Yes	No	
8	Has adequate consideration been given to the potential consequences of using a machine designed for commercial/industrial purposes in a non- commercial/industrial area?	Yes	No	
9	Can it be guaranteed that the implemented measures will not severely impair the machine‘s ability to perform its function?	Yes	No	

Questions for a validation in accordance with EN ISO 13849-1 and -2 (example)

No.	Questions		Yes / No		Completed
1	Has a risk assessment been conducted?		Yes	No	
2	Have an error list and a validation plan been drawn up?		Yes	No	
3	Has the validation plan, including an analysis and test/inspection, been executed and has a validation report been compiled? The validation procedure must include the following tests/inspections as a minimum:		Yes	No	
	a.	Inspection of components: Is the servo drive a BL 1-04 /C servo drive (check against the type plates)?	Yes	No	
	b.	Is the wiring correct (check against the wiring diagram)?	Yes	No	
		Have any jumpers been removed?	Yes	No	
		Has a safety relay been connected to X3?	Yes	No	
		Has the safety relay been certified and wired in accordance with the requirements of the application?	Yes	No	
	c.	Functional tests: Actuation of the emergency cut-out switch of the system. Does the drive stop?	Yes	No	
		If only STO-A is activated, does the drive stop immediately and is the error "Discrepancy time" (52-1) signalled after the discrepancy time has elapsed?	Yes	No	
		If only STO-B is activated, does the drive stop immediately and is the error "Discrepancy time" (52-1) signalled after the discrepancy time has elapsed?	Yes	No	
		Does the system detect a short circuit between STO-A and STO-B or has a suitable fault exclusion been defined?	Yes	No	
		Is a restart effectively prevented? This means that if the emergency cut-out switch has been actuated and if the enable signals are active, there will be no movement following a start command unless an acknowledgement has been given.	Yes	No	

11.6 Error messages and warnings

Group 0: Events		
0-0	Invalid error	An invalid (corrupted) entry in the error buffer has been marked with this error number. Entry in the permanent event memory. No measures required.
0-1	Invalid error detected and corrected	An invalid (corrupted) error entry has been detected and corrected in the error buffer. The debug information includes the original error number. Entry in the permanent event memory. No measures required.
0-2	Error cleared	The active errors have been acknowledged. Entry in the permanent event memory. No measures required.
0-4	Serial number / device type (module replacement)	A replaceable error memory module (service module) has been plugged into another device. Entry in the permanent event memory. No measures required.
0-7	Additional log entry	Entry in the permanent event memory. No measures required.
0-8	Servo drive switched on	Log entry proving that the servo drive has been switched on. Entry in the permanent event memory. No measures required.
0-9	Servo drive: safety parameters changed	Logging of the parameterisation of the FSM 2.0 - MOV. Entry in the permanent event memory. No measures required.
0-11	FSM module replacement (previous type)	Logging of the module replacement. Entry in the permanent event memory. No measures required.
0-12	FSM-Modulwechsel (neuer Typ)	Logging of the module replacement. Entry in the permanent event memory. No measures required.
0-21	FSM module replacement (current type)	Logging of events in the FSM. Entry in the permanent event memory. No measures required.
0-22	Default parameter set loaded	Log entry proving that the default parameter set has been loaded. Entry in the permanent event memory. No measures required.
Group 1: Stack overflow		
1-0	Stack overflow	Incorrect firmware? Load the most recent firmware. Please contact the Technical Support team.
Group 2: Undervoltage		
2-0	Undervoltage of DC bus circuit	Check the error handling settings (error management). Check the power supply voltage. Check (measure) the DC bus circuit voltage. Check the response threshold of the DC bus monitoring system.

Group 3: Overtemperature motor		
3-0	Motor overtemperature (analogue)	Motor too hot? Check the parameterisation. Correct sensor? Sensor defective? Check the parameterisation of the sensor or the sensor characteristics. If the error still occurs after the sensor has been bypassed, replace the servo drive.
3-1	Motor overtemperature (digital)	
3-2	Motor overtemperature (analogue): wire break	Check the connecting cables of the temperature sensor (broken wire). Check the parameterisation of wire break detection system (threshold value).
3-3	Motor overtemperature (analogue): short circuit	Check the connecting cables of the temperaturesensor (short circuit). Check the parameterisation of the short-circuit monitoring system (threshold value).

Group 4: Overtemperature		
4-0	Overtemperature power output stage	Plausible temperature indication? Check the installation conditions. Are the filter mats of the control cabinet fan soiled? Is the fan defective?
4-1	Overtemperature DC bus circuit	

Group 5: Internal voltage supply		
5-0	Failure of internal voltage 1	Disconnect the servo drive from the entire periphery and check whether the error is still present after a reset. If the error is still present, replace the servo drive.
5-1	Failure of internal voltage 2	
5-2	Driver supply failure	
5-3	Undervoltage digital I/Os	Check the outputs for short circuits or specified load. Please contact the Technical Support team.
5-4	Overcurrent digital I/Os	
5-5	Technology module voltage supply failure	Technology module defective? Replace the technology module. Please contact the Technical Support team.
5-6	X10, X11 or RS232 voltage supply failure	Check the pin assignment of the connected peripheral equipment. Check the connected peripheral equipment for short-circuits.
5-7	Safety module internal voltage failure	Is the technology module defective? Replace the technology module. Please contact the Technical Support team.
5-8	Failure of internal voltage 3	Replace the servo drive.
5-9	Failure of encoder supply	

Group 6: Short circuit in the power output stage		
6-0	Short circuit in the power output stage	Is the motor defective? Is there a short circuit in the cable? Is the power output stage defective?
6-1	Brake chopper overcurrent	Check the external braking resistor for short circuits. Check whether the resistance value is too small. Check the brake chopper output of the servo drive.

Group 7: Overvoltage		
7-0	Overvoltage DC bus circuit	Check the connection to the braking resistor (internal/external). Is the external braking resistor overloaded? Check the rating.
7-1	Overvoltage at power input	Disconnect the device immediately from the mains power supply and check the voltage at the main power input. Check the quality of the power supply (voltage peaks).
Group 8: Angle encoder		
8-0	Resolver/Hall angle encoder error	See the measures for 08-2 to 08-8.
8-1	Rotating direction of serial and incremental position evaluation not identical	Have the A and B tracks been mixed up? Check the connection of the track signals.
8-2	Incremental encoder: Z0 track signals error	Is the angle encoder connected? Is the angle encoder cable defective? Is the angle encoder defective? Check the configuration of the angle encoder interface. The encoder signals are disturbed: Check the installation for compliance with the EMC recommendations.
8-3	Incremental encoder: Z1 track signals error	
8-4	Digital incremental encoder: track signals error	
8-5	Incremental encoder: hall signals error	
8-6	Angle encoder communication error	
8-7	Master frequency input: Incorrect signal amplitude incremental track	
8-8	Internal angle encoder error	The internal monitoring system of the angle encoder at [X2B] has detected an error. Communication error? Please contact the Technical Support team.
8-9	Encoder at [X2B/X6] not supported	Please contact the Technical Support team.
Group 9: Encoder parameter set		
9-0	Encoder parameter set: out-of-date format	Save the parameter set in the encoder EEPROM (reformatting).
9-1	Encoder parameter set cannot be decoded	Is the angle encoder defective? Check the configuration of the angle encoderinterface. The encoder signals are disturbed. Check the installation for compliance with the EMC recommendations.
9-2	Encoder parameter set: unknown version	Save the data into the encoder again.
9-3	Encoder parameter set: corrupted data structure	If necessary, redetermine the data and save it in the encoder.
9-4	Encoder parameter set: faulty customer-specific configuration	Motor repaired: Perform a homing run and save the parameter set in the angle encoder. Then, save it in the servo drive. Motor replaced: Parameterise the servo drive, perform a homing run, save the data in the angle encoder, and then save to the servo drive.
9-5	Encoder parameter set: read/write error	Please contact the Technical Support team.

9-7	Encoder EEPROM is write protected	Please contact the Technical Support team.
9-9	Too small memory size of encoder EEPROM	Please contact the Technical Support team.
Group 10: Motor overspeed protection		
10-0	Overspeed (motor over-speed protection)	Check the offset angle. Check the parameterisation of the limit value.
10-1	Overspeed according to Dual-Use Regulation 600 Hz	Please contact the Technical Support team.
Group 11: Homing run		
11-0	Error when homing run is started	Servo drive not enabled.
11-1	Error during homing run	The homing run has been interrupted, e.g. because the enable signal has been withdrawn.
11-2	Homing: no valid index pulse	The required index pulse is not provided. Check the index pulse. Check the angle encoder settings
11-3	Homing: timeout	The maximum permissible time for the homing run has been reached before the homing run could be completed. Check the time value.
11-4	Homing: incorrect / invalid limit switch	Has the associated limit switch not been connected? Have the limit switches been mixed up?
11-5	Homing: I^2t / following error	Unsuitable parameterisation of the acceleration ramps. The stop has been reached, e.g. because no reference switch has been installed.
11-6	Homing: end of search distance reached	The maximum distance for the homing run has been covered, but the reference point or the target of the homing run have not been reached.
11-7	Homing: encoder difference monitoring	The deviation fluctuates, e.g. due to gear slackness. If necessary, increase the switch-off threshold. Check the connection of the actual value encoder.
Group 12: CAN communication		
12-0	CAN: duplicate node number	Check the configuration of the devices that are connected to the CAN bus.
12-1	CAN: communication error, bus OFF	Check the wiring: compliance with the cable specification, cable break, maximum cable length exceeded, correct terminating resistors, cable shield earthed, all signals connected?
12-2	CAN: communication error (sending)	
12-3	CAN: communication error (receiving)	
12-4	CAN: Node Guarding	Failure of the PLC or the cycle time of the remote frames of the servo drive and PLC do not match.
12-5	CAN: RPDO too short	The number of bytes of a received RPDO is smaller than the number that is parameterised in the servo drive.
12-9	CAN: protocol error	Please contact the Technical Support team.

Group 13: Timeout CAN-Bus		
13-0	Timeout CAN bus	Check the CAN parameterisation.

Group 14: Motor and resolver identification		
14-0	Insufficient DC bus circuit voltage	Check the power supply voltage. Check the motor resistance.
14-1	Identification current controller: measuring cycle insufficient	The automatic parameter identification process delivers a time constant beyond the value range that can be parameterised. The parameters must be optimised manually.
14-2	Power output stage could not be enabled	The power output stage has not been enabled. Check the connection of DIN4.
14-3	Power output stage prematurely disabled	The power stage has been disabled while the identification process was still running (for example via DIN 4 or via PLC).
14-4	Angle encoder not supported	The identification cannot be performed with the current angle encoder settings. Check the angle encoder configuration. Please contact the Technical Support team.
14-5	Index pulse not found	The index pulse could not be found after the maximum permissible number of electrical revolutions. Check the index pulse signal. Check the angle encoder settings.
14-6	Invalid hall signals	The pulse sequence or the segmentation of the Hall signals is unsuitable. Check whether the encoder provides 3 Hall signals with 120° or 60° segments. Check the wiring.
14-7	Identification not possible	Check the DC bus voltage. Check whether the motor is blocked (for example holding brake not released).
14-8	Invalid number of pole pairs	The calculated number of pole pairs is beyond the parameterisation range. Check the data sheet of the motor. Please contact the Technical Support team.

Group 16: Program execution		
16-0	Incorrect program execution	Please contact the Technical Support team.
16-1	Illegal interrupt	
16-2	Initialisation error	
16-3	Unexpected state	
16-4	Unexpected hardware error	

Group 17: Max. following error exceeded		
17-0	Max. following error exceeded	Increase the error window. Decrease the acceleration.
17-1	Encoder difference monitoring	External angle encoder not connected or defective? The deviation fluctuates, e.g. due to gear slackness. If necessary, increase the switch-off threshold.
17-2	Current spike monitoring	Please contact the Technical Support team.
Group 18: Temperature warning threshold		
18-0	Analogue motor temperature: warning threshold reached	Motor too hot? Check the parameterisation (current controller, current limits). Correct sensor? Sensor defective? Check the parameterisation of the sensor or the sensor characteristics. If the error still occurs after the sensor has been bypassed, replace the servo drive.
Group 21: Current measurement		
21-0	Error 1 current measurement U	Please contact the Technical Support team.
21-1	Error 1 current measurement V	
21-2	Error 2 current measurement U	
21-3	Error 2 current measurement V	
Group 22: PROFIBUS		
22-0	PROFIBUS: incorrect initialisation	Is the technology module defective? Please contact the Technical Support team.
22-2	PROFIBUS: communication error	Check the specified slave address. Check the bus termination. Check the wiring.
22-3	PROFIBUS: invalid slave address	The communication has been started with slave address 126. Select another slave address.
22-4	PROFIBUS: range overflow	Mathematical error during the conversion of physical units. The value ranges of the data and of the physical units do not match. Please contact the Technical Support team.
22-5	PROFIBUS: access violation	Please contact the Technical Support team.
Group 23: Actual position saving/restoring		
23-0	No usable record	Failure of the actual position saving and restoration process. Perform a homing run of the drive.
23-1	Record with invalid checksum	
23-2	Flash content inconsistent	

Group 24: Analogue input monitoring		
24-0	Analogue input above maximum limit	Check the parameterisation of the maximum limit. Check the wiring.
24-1	Analogue input below minimum limit	Check the parameterisation of the minimum limit. Check the wiring.

Group 25: Invalid device type		
25-0	Invalid device type	Replace the device.
25-1	Device type not supported	
25-2	Hardware revision not supported	Load the most recent firmware. Please contact the Technical Support team.
25-3	Device functionality restricted	The desired functionality is not available on this servo drive. Please contact the Technical Support team.
25-4	Invalid power output stage type	Load the most recent firmware. Please contact the Technical Support team.
25-5	Incompatibility Firmware/ Hardware	The customer-specific firmware is not compatible with the servo drive. Please contact the Technical Support team.

Group 26: Flash		
26-0	No user parameter set	Load the default parameter set. If the error is still present, replace the servo drive.
26-1	Checksum error	The error cannot be eliminated by the user. Please contact the Technical Support team.
26-2	Flash: write error	
26-3	Flash: erase error	
26-4	Flash: error in internal flash	
26-5	No calibration data	
26-6	No user position data sets	Save the parameter set and perform a reset. If the error is still present, contact the Technical Support team.
26-7	Error in data tables (CAM)	Load the default parameter set. If the error is still present, contact the Technical Support team.

Group 27: Following error monitoring		
27-0	Following error warning threshold	Check the parameterisation of the following error. Is the motor blocked?

Group 28: Operating hours meter		
28-0	Missing operating hours meter	Please contact the Technical Support team.
28-1	Operating hours meter: write error	
28-2	Operating hours meter corrected	Acknowledge the error. If the error recurs, contact the Technical Support team.
28-3	Operating hours meter converted	

Group 29: SD card		
29-0	No SD card	The option "Transfer the parameter file after Reset and Power on" is active, but an SD card has not been inserted. Insert an SD card.
29-1	SD card: initialisation error	Unsuitable SD card? Card write protection activated? BOOT DIP switch activated (firmware download)? Please contact the Technical Support team.
29-2	SD card: parameter set error	
29-3	SD card: write error	
29-4	SD card: firmware download error	

Group 30: Internal calculations		
30-0	Internal calculation error	Please contact the Technical Support team.

Group 31: I²t		
31-0	I²t motor	Is the motor blocked? Check the power rating of the drive
31-1	I²t servo drive	Check the power rating of the drive package.
31-2	I²t-PFC	Check the power rating of the drive package. Select operation without PFC.
31-3	I²t braking resistor	Braking resistor overloaded. Use external braking resistor.
31-4	I²t active power overload	Check the power rating of the drive package.

Group 32: PFC		
32-0	DC bus circuit charging time exceeded	Bridge for the internal braking resistor installed?Check the connection of the external braking resistor.Please contact the Technical Support team.
32-1	Undervoltage for active PFC	Check whether the power supply complies with the nominal data.
32-5	Brake chopper overload. DC bus circuit could not be discharged	Check the power on/off cycles of the power supply. Check the braking resistor.

32-6	Discharging period DC bus circuit exceeded	Bridge for the internal braking resistor installed?Check the connection of the external braking resistor. Please contact the Technical Support team.
32-7	Supply voltage missing for enabling	No DC bus voltage.
32-8	Supply voltage breakdown while servo drive enabled	Interruption/failure of the mains power supply. Check the power supply.
32-9	Phase failure	Failure of one or several phases. Check the power supply.
Group 33: Following error encoder emulation		
33-0	Following error encoder emulation	Check the settings of the incremental encoder emulation (line count).
Group 34: Fieldbus		
34-0	No synchronisation via fieldbus	No synchronisation messages from the master?
34-1	Fieldbus synchronisation error	No synchronisation messages from the master?Insufficient synchronisation interval?
Group 35: Linear motor		
35-0	Overspeed protection of linear motor	The encoder signals are disturbed. Check the installation for compliance with the EMC recommendations.
35-5	Error during the commutating position determination	The selected method is not suitable for the motor. Please contact the Technical Support team.
Group 36: Parameters		
36-0	Parameter limited	Check the user parameters set.
36-1	Parameter not accepted	
Group 37: Sercos		
37-0	Sercos: received data disturbed	Check the Sercos wiring (clean the optical fibre, for example). Check the optical output settings. Check the baud rate.
37-1	Sercos: fiber optic ring interrupted	Check the Sercos wiring (optical fibre) for breaks. Check the connections.
37-2	Sercos: MST missing twice	Check the Sercos wiring (fiber optic cables). Check the control system (are all of the MSTs being transmitted?)
37-3	Sercos: invalid phase requested by master	Check the program in the Sercos master.
37-4	Sercos: MDT missing twice	Check the Sercos wiring (optical fibre). Check the control system: Are all of the MDTs being sent?

37-5	Sercos: unknown operation mode selected	Check the settings for the operating modes in the IDNs S-0-0032 to S-0-0035.
37-6	Sercos: T3 invalid	Increase the baud rate. Shift T3 manually.
37-7	Sercos III: communication error	Please contact the Technical Support team.
Group 38: Sercos		
38-0	Sercos: SERCON Status event	No measures required.
38-1	Sercos: no module present	Sercos has been activated, but no technology module has been inserted. Is the technology module correctly inserted?Is the technology module defective?Replace the technology module. Please contact the Technical Support team.
38-2	Sercos: defective module	Replace the technology module. Please contact the Technical Support team.
38-3	Sercos: S-0-0127: invalid data in S-0-0021	Check the configuration (cyclic data for MDT and AT). Check the time slot calculation by the master.
38-4	Sercos: S-0-0127: impermissible IDNs in AT or MDT	Check the configuration for the cyclic data transfer.
38-5	Sercos: S-0-0128: invalid data in S-0-0022	Check the scaling settings. Check the operating mode settings. Check the internal/external angle encoder settings.
38-6	Sercos: S-0-0128: incorrect scaling	Check the scaling settings.
38-7	Sercos: invalid IDN in S-0-0026 / S-0-0027	Check the configuration of the signal status and signal control word (S-0-0026/S-0-0027).
38-8	Sercos: conversion error	Check the scaling settings. Please contact the Technical Support team.
38-9	Sercos: SERCON 410b mode active	Replace the technology module. Please contact the Technical Support team.
Group 39: Sercos		
39-0	Sercos: list S-0-0370: incorrect configuration of the MDT data container	Please contact the Technical Support team.
39-1	Sercos: list S-0-0371: incorrect configuration of the AT data container	
39-2	Sercos: error in the cyclic channel MDT	
39-3	Sercos: error in the cyclic channel AT	
39-4	Sercos: error in the cyclic data container MDT	
39-5	Sercos: error in the cyclic data container AT	

Group 40: SW limit switches		
40-0	Negative SW limit switch reached	Check the permissible positioning range.
40-1	Positive SW limit switch reached	
40-2	Target position beyond the negative SW limit switch	The start of a positioning run has been suppressed, since the target is located beyond the respective software limit switch. Check the target position. Check the positioning range.
40-3	Target position beyond the positive SW limit switch	

Group 41: Course program		
41-0	Course program: synchronisation error	Flying saw: Check the parameterisation of the lead distance.

Group 42: Positioning		
42-0	Positioning: no follow-up position: stop	The positioning target cannot be reached with the current options. Check the parameterisation of the position sets.
42-1	Positioning: reversal of rotation not permissible: stop	
42-2	Positioning: reversal of rotation after stop not permissible	
42-3	Positioning start rejected: wrong operation mode	The change of the mode of operation could not be performed by way of the position set.
42-4	Homing run required	Reset the option "Homing run required". Perform a homing run.
42-5	Rotary axis: rotating direction not permissible	The calculated direction of rotation of the rotary axis is not permissible in the selected mode. Check the selected mode.
42-9	Error at positioning start	Check the speed and acceleration parameters. Please contact the Technical Support team.

Group 43: HW limit switches		
43-0	Limit switch: negative setpoint inhibited	The drive has left the intended range of movement. Technical defect of the system?Check the limit switches.
43-1	Limit switch: positive setpoint inhibited	
43-2	Limit switch: positioning suppressed	

Group 44: CAM disc		
44-0	CAM table error	Check whether the index has been assigned correctly. Check whether there are cam discs present in the device.
44-1	CAM: drive not referenced	Ensure that the drive has been homed prior to the activation of the cam disc. Deselect the option "Homing run required". Ensure that a cam disc will not be started during a homing run.
Group 45: IGBT driver supply		
45-0	Driver supply cannot be switched off	Technical defect? Please contact the Technical Support team.
45-1	Driver supply cannot be switched on	
45-2	Driver supply has been activated	
Group 47: -up mode		
47-0	Set-up mode: timeout	The speed has not fallen below the speed required for the set-up mode in time. Check the processing of the request by the PLC. Check the speed threshold. Check the timeout.
Group 48: Operation mode		
48-0	Homing run required	Perform a homing run.
Group 49: DCO (Device Communication Objects)		
49-1	DCO file: servo drive password protected, wrong password	Enter the correct password into the DCO file.
49-2	DCO file: data error	Please contact the Technical Support team.
Group 50: CAN communication		
50-0	Too many synchronous PDOs	Deactivate some of the PDOs or increase the SYNC interval. The maximum number of PDOs must not be greater than the factor tp between the position controller and IPO. Please contact the Technical Support team.
50-1	SDO error occurred	Please contact the Technical Support team.

Group 51: FSM 2.0		
51-0	No / unknown FSM module or driver supply faulty	Cause: No safety module detected or unknown module type. ▪ Measure: ▪ Install a safety module or fieldbus activation module that is suitable for the firmware and hardware. ▪ Load a firmware that is suitable for the safety module or fieldbus activation module into the servo drive. See the type designation on the module. Cause: ▪ Internal voltage error of the safety module or fieldbus activation module. Measure: ▪ The module may be defective. Replace it, if possible.
51-2	FSM: unequal module type	Cause: Type or revision of the module does not fit the project planning. Measure: ▪ Check whether correct module type and correct version are being used. ▪ After module replacement: Module type not yet accepted. Accept currently integrated safety or fieldbus activation module.
51-3	FSM: unequal module version	Cause: Type or revision of the module is not supported. Measure: ▪ Install safety or fieldbus activation module appropriate for the firmware and hardware. ▪ Load firmware appropriate for the module into the servo drive, see type designation on the module. Cause: The module type is correct but the module version is not supported by the servo drive. Measure: ▪ Check module version; if possible use module of same version after replacement. Install suitable safety or fieldbus activation module for the firmware and hardware. ▪ If only a module with a more recent version is available: Load firmware appropriate for the module into the servo drive, see type designation on the module.
51-4	FSM: error in SSIO communication	Cause: Error in the internal communication connection between the servo drive and the safety module. Measure: ▪ Identify any source of interfering radiation in the environment of the servo drive. ▪ Replace the module or the servo drive. ▪ Please contact the Technical Support team.

51-5	FSM: error in brake activation	Cause: Internal hardware error (brake activation control signals) of the safety module or fieldbus activation module. Measure: Module presumably defective. If possible, replace with another module. Cause: Error in brake driver circuit section in the servo drive. Measure: Servo drive presumably defective. If possible, replace with another servo drive.
51-6	FSM: unequal serial number	Cause: Serial number of currently inserted safety module is different from the stored serial number. Measure: Error only occurs after replacement of the FSM 2.0 – MOV. After module replacement: Module type not yet accepted. Accept currently inserted FSM 2.0 –MOV. Check the parameterisation of the FSM 2.0 – MOV in view of the application, since the modules have been replaced.
Group 52: FSM 2.0 STO		
52-1	FSM: Diskrepanzzeit abgelaufen	Cause: Control ports STO-A and STO-B are not actuated simultaneously. Measure: Check discrepancy time. Cause: Control ports STO-A and STO-B are not wired in the same way. Measure: Check circuitry of the inputs. Cause: Upper and lower switch supply not simultaneously activated (discrepancy time exceeded) ▪ Error in control / external circuitry of safety module. ▪ Error in safety module. Measure: ▪ Check circuitry of the safety module – are the inputs STO-A and STO-B switched off on two channels and simultaneously? ▪ Replace safety module if you suspect it is defective
52-2	FSM: STOA/STOB deactivated while power output stage enabled	Cause: Failure of driver supply voltage with active PWM. Measure: The safe status was requested with power output stage enabled. Check integration into the safety-orientated wiring.

52-3	FSM: Limitation error	Cause: Servo drive reports error if the currently requested direction of movement is not possible because the safety module has blocked the setpoint value in this direction. Error may occur in connection with the SSFx safe speed functions if an asymmetrical speed window is used where one limit is set to zero. In this case, the error occurs when the servo drive moves in the blocked direction in the Positioning mode. Measure: Check application and change if necessary.
Group 53: FSM: Violation of safety conditions		
53-0	USF0: safety condition violated	Cause: Violation of monitored speed limits of the SSF0 in operation / when USF0 / SSF0 requested. Measure: Check when the violation of the safety condition occurs: a) During dynamic braking to safe rotational speed b) After the drive has reached the safe speed. ▪ With a) Check of braking ramp – record the speed - can the drive follow the ramp? ▪ Change parameters for the slowdown ramp or start time / delay times for monitoring. ▪ With b) Check how far the current speed is from the monitored limit speed; increase distance if necessary (parameter in safety module) or correct speed specified by control.
53-1	USF1: safety condition violated	Cause: Violation of monitored speed limits of the SSF1 in operation / when USF1 / SSF1 requested. Measure: See USF0, error 53-0.
53-2	USF2: safety condition violated	Cause: Violation of monitored speed limits of the SSF2 in operation / when USF2 / SSF2 requested. Measure: See USF0, error 53-0.
53-3	USF3: safety condition violated	Cause: Violation of monitored speed limits of the SSF3 in operation / when USF3 / SSF3 requested. Measure: See USF0, error 53-0.

Group 54: FSM: Violation of safety conditions		
54-0	SBC: safety condition violated	Cause: Brake should engage; no feedback received within the expected time. Measure: ▪ Check how the feedback signal is configured – was the correct input selected for the feedback signal? ▪ Does the feedback signal have the correct polarity? ▪ Check whether the feedback signal is actually switching. ▪ Is the parameterised time delay for the analysis of the feedback signal appropriate to the used brake (measure switching time if necessary)?
54-2	SS2: safety condition violated	Cause: Actual speed outside permitted limits for too long. Measure: Check when the violation of the safety condition occurs: a) During dynamic braking to zero. b) After the drive has reached zero speed. • With a) Check of braking ramp – record the speed - can the drive follow the ramp? Change parameters for the slowdown ramp or start time /delay times for monitoring. • With a) If the option "Activate quick stop ramp in base device" is activated: Check of the servo drive‘s quick stop ramp. • With b) Check whether the drive continues to oscillate after reaching the zero speed or remains at idle and stable – increase monitoring tolerance time if necessary. • With b) If the actual speed value is very noisy when at rest. Check and if necessary adjust expert parameters for speed recording and detection of standstill.
54-3	SOS: safety condition violated	Cause: ▪ Angle encoder analysis reports "Motor running" (actual speed exceeds limit). ▪ Drive has rotated out of its position since reaching the safe state. Measure: ▪ Check the position tolerance for the SOS monitoring and increase if necessary, if this is permissible. ▪ If the actual speed value is very noisy when at rest: Check and if necessary adjust expert parameters for speed recording and detection of idling.

54-4	SS1: safety condition violated	Cause: Actual speed outside permitted limits for too long. Measure: Check when the violation of the safety condition occurs: a) During dynamic braking to zero. b) After the drive has reached zero speed. ▪ With a) Check of braking ramp – record the speed - can the drive follow the ramp? Change parameters for the slowdown ramp or start time /delay times for monitoring. ▪ With a) If the option "Activate quick stop ramp in base device" is activated: Check of the servo drive‘s quick stop ramp. ▪ With b) Check whether the drive continues to oscillate after reaching the zero speed or remains at idle and stable – increase monitoring tolerance time if necessary. ▪ With b) If the actual speed value is very noisy when at rest: Check and if necessary adjust expert parameters for speed recording and detection of standstill.
54-5	STO: safety condition violated	Cause: Internal hardware error (voltage error) of the safety module. Measure: Module presumably defective. If possible, replace with another module. Cause: Error in driver circuit section in the servo drive. Measure: Servo drive presumably defective. If possible, replace with another servo drive. Cause: No feedback received from servo drive to indicate that output stage was switched off. Measure: Check whether the error can be acknowledged and whether it occurs again upon a new STO request – if yes: Servo drive presumably defective. If possible, replace with another servo drive.
54-6	SBC: brake not released for > 24 hrs	Cause: Error occurs when SBC is requested and the brake has not been released by the servo drive in the last 24 hours. Measure: ▪ If the brake is actuated via the brake drivers in the servo drive [X6]: The brake must be energised at least once within 24 hours before the SBC request because the circuit breaker check can only be performed when the brake is switched on (energised). ▪ Only if brake control takes place via DOUT4x and an external brake controller: Deactivate 24 hr monitoring in the SBC parameters if the external brake controller allows this.
54-7	SOS: SOS requested > 24 hrs	Cause: If SOS is requested for more than 24 hours, the error is triggered. Measure: Terminate SOS and move axle at least once during this time.

Group 55: FSM: Actual value evaluation 1		
55-0	FSM: no actual speed / position value available or standstill for > 24 hrs	Cause: • Subsequent error when a position encoder fails. • Safety function SSF, SS1, SS2 or SOS requested and actual rotational speed value is not valid. Measure: Check the function of the position encoder(s) (see following error).
55-1	FSM: SINCOS-Geber [X2B] - signal error	▪ Vector length $\sin^2+\cos^2$ is outside the permissible range. ▪ The amplitude of one of the two signals is outside the permissible range. ▪ Offset between analogue and digital signal is greater than 1 quadrant Measure: ▪ Error may occur with SIN/COS and HIPERFACE encoders. ▪ Check the position encoder. ▪ Check the connection wiring (broken wire, short between two signals or signal / shield). ▪ Check the supply voltage for the position encoder. ▪ Check the motor cable / shield connection on motor and drive side. EMC malfunctions may trigger the error.
55-2	FSM: SINCOS encoder [X2B] - standstill > 24 hrs	Cause: Input signals of the SinCos encoder have not changed by a minimum amount for 24 hours (when safety function is requested). Measure: Terminate SS2 or SOS and move axle at least once during this time.
55-3	FSM: Resolver [X2A] -signal error	Cause: ▪ Vector length $\sin^2+\cos^2$ is outside the permissible range. ▪ The amplitude of one of the two signals is outside the permissible range. ▪ Input signal is static (same values to right and left of maximum). Measure: ▪ Check the resolver. ▪ Check the connection wiring (broken wire, short between two signals or signal / shield). ▪ Check for a failure of the exciting current. ▪ Check the motor and encoder cable / shield connection on motor and drive side. EMC malfunctions can trigger the error.
55-7	FSM: other encoder [X2B] - Faulty angle information	Cause: ▪ "Angle faulty" message is sent from servo drive when status lasts for longer than the allowed time. ▪ Encoder at X2B is analysed by the servo drive ▪ Encoder is defective. Measure: ▪ Check the position encoder at X2B. ▪ Check the connection wiring (broken wire, short between two signals or signal / shield). ▪ Check the supply voltage for the EnDat encoder. ▪ Check the motor cable / shield connection on motor and drive side. EMC malfunctions may trigger the error.

55-8	FSM: impermissible acceleration detected	Cause: ▪ Error in connected position encoder. ▪ EMC malfunctions affecting the position encoder. ▪ Impermissibly high acceleration rates in the movement profiles. ▪ Acceleration limit parameterised too low. ▪ Angle jump after homing run in the position data transmitted from the servo drive to the safety module. Measure: ▪ Check the connected position encoders: If further error messages occur in conjunction with the encoders, then eliminate their cause first. ▪ Check the motor and encoder cable / shield connection on motor and drive side. EMC malfunctions can trigger the error. ▪ Check the setpoint specifications / motion profiles of the control: Do they contain impermissibly high accelerations above the limit value for acceleration monitoring (P06.07)? ▪ Check whether the limit value for acceleration monitoring was parameterised correctly - the limit value (P06.07) should be at least 30% ... 50% above the maximum acceleration actually occurring. ▪ In case of an angle jump in the position data transmitted from the servo drive - acknowledge error once.
Group 56: FSM: Actual value evaluation 2		
56-8	FSM: speed / angle difference encoder 1 - 2	Cause: ▪ Rotational speed difference between encoders 1 and 2 of one µC outside the permissible range for longer than the allowed time. ▪ Angle difference between encoders 1 and 2 of one µC outside the permissible range for longer than the allowed time. Measure: ▪ Problem may occur if two position encoders are used in the system and they are not "rigidly coupled". ▪ Check for elasticity or backlash, improve mechanical system. ▪ Adjust the expert parameters for the position comparison if this is acceptable from an application point of view.
56-9	FSM: error cross comparison encoder evaluation	Cause: Cross-comparison between µC1 and µC2 has detected an angle difference or rotational speed difference or a difference in capture times for the position encoders. Measure: Timing disrupted. If the error occurs again after a reset, the safety module is presumably defective.

Group 57: FSM: Inputs/Outputs		
57-0	FSM: I/O - Self test error (internal/external)	Cause: ▪ Internal error of digital inputs DIN40 ... DIN43 (detected via internal test signals). ▪ Error at brake output at X6 (signalling, detected by test pulses). ▪ Internal error of brake output (detected via internal test signals). ▪ Internal error of digital outputs DOUT40 –DOUT42 (detected via internal test signals). Measure: ▪ Check the connection wiring for the digital outputs DOUT40...DOUT42 (short circuit, cross circuit, etc.). ▪ Check the connection wiring for the brake (short circuit, cross circuit, etc.). ▪ Brake connection: The error may occur with long motor cables if: 1. The brake output X6 was configured for the brake (this is the case with factory settings!) and 2. A motor without a holding brake is used and the brake connection lines in the motor cable are terminated at X6. In this case: Disconnect the brake connection lines at X6. ▪ If there is no error in the connection wiring, there may be an internal error in the module (check by replacing the module).
57-1	FSM: digital inputs -signal level error	Cause: Exceeding / violation of discrepancy time with multi-channel inputs (DIN40 ... DIN43, two-handed control device, mode selector switch). Measure: ▪ Check the external active and passive sensors – do they switch on two channels and simultaneously (within the parameterised discrepancy time). ▪ Two-handed control device: Check how the device is operated by the user – are both pushbuttons pressed within the discrepancy time? Give training if necessary. ▪ Check the set discrepancy times – are they sufficient?
57-2	FSM: digital inputs -test pulse error	Cause: • One or more inputs (DIN40 ... DIN49) were configured for the analysis of the test pulses of the outputs (DOUT40 ... DOUT42). The test pulses from DOUTx do not arrive at DIN4x. Measure: • Check the wiring (shorts after 0 V, 24 V, cross circuits). • Check the assignment – correct output selected / configured for test pulse?

57-6	FSM: overtemperature	Cause: ▪ The safety module's temperature monitor has been triggered; the temperature of µC1 or µC2 was below -20° or above +75°C. Measure: ▪ Check the operating conditions (ambient temperature, control cabinet temperature, installation situation in the control cabinet). ▪ If the servo drive is experiencing high thermal load (high control cabinet temperature, high power consumption / output to motor, large number of occupied slots), a servo drive of the next higher output level should be used.

Group 58: FSM: Communication / Parameterisation		
58-0	FSM: plausibility check of parameters	Cause: The plausibility check in the safety module has revealed errors, e.g. an impermissible angle encoder configuration; the error is triggered when a validation code is requested by the SafetyTool and when parameters are backed up in the safety module. Measure: Note instructions for SafetyTool for complete validation; check parameterisation.
58-1	FSM: general error parameterisation	Cause: Parameterisation session active for > 8 hrs. The safety module has thus terminated the parameterisation session. The error message is saved in the permanent event memory. Measure: Terminate parameterisation session within 8 hrs. If necessary, start a new parameterisation session and continue.
58-4	FSM: buffer internal communication	Cause: ▪ Communication connection disturbed. ▪ Timeout / data error / incorrect sequence (packet counter) in data transmission between the servo drive and the safety module. ▪ Too much data traffic, new requests are being sent to safety module before old ones have been responded to. Measure: ▪ Check communication interfaces, cabling, shield connection etc. ▪ Check whether other devices have read access to the servo drive and the safety module during a parameterisation session. This may overload the communication connection. ▪ Check whether the firmware versions of safety module and servo drive and the versions of parameterisation program and SafetyTool are compatible.
58-5	FSM: communication safety module - servo drive	Cause: ▪ Packet counter error during transmission between µC1 and µC2. ▪ Checksum error during transmission between µC1 and µC2. Measure: ▪ Internal malfunction in the servo drive. ▪ Check whether the firmware versions of safety module and servo drive and the versions of parameterisation program and SafetyTool are compatible.

58-6	FSM: error in cross comparison for processors 1 - 2	Cause: Timeout during cross-comparison (no data) or cross-comparison faulty (data for µC1 and µC2 are different). ▪ Error in cross-comparison for digital I/O. ▪ Error in cross-comparison for analogue input. ▪ Error in cross-comparison for internal operating voltage measurement (5 V, 3.3 V, 24 V) and reference voltage (2.5 V). ▪ Error in cross-comparison for SIN/COS angle encoder analogue values. ▪ Error in cross-comparison for programme sequence monitoring. ▪ Error in cross-comparison for interrupt counter. ▪ Error in cross-comparison for input map. ▪ Error in cross-comparison for violation of safety conditions. ▪ Error in cross-comparison for temperature measurement. Measure: This is an internal error in the module that should not occur during operation. ▪ Check the operating conditions (temperature, air humidity, condensation). ▪ Check the EMC wiring as specified and shield design; are there any external interference sources? ▪ Safety module may be defective – is error eliminated after replacing the module? ▪ Check whether a new firmware for the servo drive or a new version of the safety module is available.

Group 59: FSM: Internal Error		
59-1	FSM: failsafe supply /safe pulse inhibitor	Cause: Internal error in module in failsafe supply circuit or in the driver supply for the upper and lower switches. Measure: Module defective, replace.
59-2	FSM: error external power supply	Cause: • Reference voltage 2.5 V outside tolerance. • Logic supply overvoltage +24 V detected. Measure: Module defective, replace.
59-3	FSM: error internal power supply	Cause: Voltage (internal 3.3 V, 5 V, ADU reference) outside the permissible range. Measure: Module defective, replace.

59-4	FSM: error management: too many errors	Cause: Too many errors have occurred simultaneously. Measure: ▪ Clarify: What is the status of the inserted safety module - does it contain a valid parameter set? ▪ Read out and analyse the permanent event memory of the servo drive via the parameterisation program. ▪ Eliminate causes of error step by step. ▪ Install safety module with "delivery status" and perform commissioning of servo drive. ▪ If this is not available: Set factory settings in the safety module, then copy data from the servo drive and perform complete validation. ▪ Check whether the error occurs again.
59-7	FSM: flash checksum error	Cause: • Voltage interruption / power off while parameters were being saved. • Flash memory in safety module corrupted (e.g. by extreme malfunctions). Measure: Check whether the error recurs after a reset. If it does: parameterise the module again and validate the parameter set again. If error persists: safety module defective, replace.
59-8	FSM: internal monitoring, processor 1 - 2	Cause: • Serious internal error in the safety module: Error detected while dynamising internal signals • Disrupted programme sequence, stack error or OP code test failed, processor exception /interrupt. Measure: Check whether the error recurs after a reset. If it does: Safety module defective, replace.
59-9	FSM: other unexpected error	Cause: Triggering of internal programme sequence monitoring. Measure: ▪ Check the firmware version of the servo drive and the version of the safety module – update available? ▪ Safety module defective, replace.
Group 60: Ethernet		
60-0	Ethernet user-specific (1)	Please contact the Technical Support team.
Group 61: Ethernet		
61-0	Ethernet user-specific (2)	Please contact the Technical Support team.

Group 62: EtherCAT		
62-0	EtherCAT: general bus error	There is no EtherCAT bus. Check the wiring.
62-1	EtherCAT: initialisation error	Replace the technology module. Please contact the Technical Support team.
62-2	EtherCAT: protocol error	Is the protocol incorrect (no CAN over EtherCAT)? Check the EtherCAT wiring.
62-3	EtherCAT: invalid RPDO length	Check the RPDO configuration of the servo drive and PLC.
62-4	EtherCAT: invalid TPDO length	Check the TPDO configuration of the servo drive and PLC.
62-5	EtherCAT: faulty cyclic data transfer	Check the EtherCAT wiring. Check the configuration of the PLC.
Group 63: EtherCAT		
63-0	EtherCAT: defective module	Replace the technology module.
63-1	EtherCAT: invalid data	Check the protocol. Check the wiring.
63-2	EtherCAT: TPDO data have not been read	Reduce the cycle time (EtherCAT bus).
63-3	EtherCAT: no distributed clocks active	Check whether the control system supports the "Distributed Clocks" feature. Please contact the Technical Support team.
63-4	EtherCAT: Missing SYNC message in IPO cycle	Check the cycle times of the servo drive and PLC.
63-5	EtherCAT: wrong firmware found	Please contact the Technical Support team.
63-6	EtherCAT: mode of operation requires DC	Activate Distributed Clocks (DC) in the PLC or select a different mode of operation.
Group 64: DeviceNet		
64-0	DeviceNet: duplicate MAC ID	Change the MAC ID.
64-1	DeviceNet: bus power missing	Check the DeviceNet wiring. 24 V must also be connected to the DeviceNet module.
64-2	DeviceNet: RX queue overrun	Decrease the scan rate.
64-3	DeviceNet: TX queue overrun	Increase the baud rate. Decrease the number of nodes. Decrease the scan rate.
64-4	DeviceNet: I/O send error	Increase the baud rate. Decrease the number of nodes. Decrease the scan rate. Check whether the wiring complies with the EMC specifications.
64-5	DeviceNet: Bus Off	Increase the baud rate. Decrease the number of nodes. Decrease the scan rate. Check whether the wiring complies with the EMC specifications.
64-6	DeviceNet: CAN controller overrun	Increase the baud rate. Decrease the number of nodes. Decrease the scan rate.

Group 65: DeviceNet		
65-0	DeviceNet active, but no module	Deactivate the DeviceNet communication or insert a module.
65-1	Timeout I/O Connection	An I/O message has not been received within the expected time.
Group 66: Modbus		
66-0	Modbus: no free TCP/IP connection	Reduce the number of TCP/IP connections.
Group 67: Modbus		
67-0	Modbus: timeout TCP/IP	Check the connection to the master.
67-1	Modbus: timeout Modbus TCP/IP	Check the connection to the master.
67-2	Modbus: buffer overflow	In the master, reduce the cycle time for the transfer of messages to the servo drive.
67-3	Modbus: message length too short	Check the configuration of the master.
67-4	Modbus: message length too long	Check the configuration of the master.
Group 68: Ethernet/IP		
68-0	Ethernet/IP: general error	Replace the module. Please contact the Technical Support team.
68-1	Ethernet/IP: communication error	Check the connection to the PLC.
68-2	Ethernet/IP: connection closed	Re-establish the connection.
68-3	Ethernet/IP: connection timeout	Check the wiring.
68-4	Ethernet/IP: duplicate IP address	Use an IP address only once on an Ethernet/IP network.
Group 69: Ethernet/IP		
69-0	Ethernet/IP: general error	No measures required.
69-1	Ethernet/IP: invalid IP configuration	Check the IP configuration.
69-2	Ethernet/IP: no technology module	Insert an Ethernet/IP module into TECH2 or deactivate Ethernet/IP.
69-3	Ethernet/IP: unequal module version	Update the firmware of the servo drive.

Group 72: PROFINET		
72-0	PROFINET: initialisation error	Replace the PROFINET module.
72-1	PROFINET: bus error	Communication is not possible, e.g. because the bus cable has been disconnected. Check the wiring and restart the PROFINET communication.
72-2	PROFINET: range overflow	Mathematical error during the conversion of physical units. Adapt the parameterisation.
72-3	PROFINET: invalid IP configuration	Check whether the IP address, subnet mask and gateway address are valid or permissible. Change the IP configuration.
72-4	PROFINET: invalid device name	Use a valid PROFINET device name (Name of Station).
72-5	PROFINET: defective module	Replace the PROFINET module.
72-6	PROFINET: invalid /unsupported indication	The PROFINET feature that has been used is not supported by the module. Please contact the Technical Support team.
72-7	PROFINET: different module configuration Master/Slave	Check whether the telegram lengths set in the PROFINET telegram editor match the setting in the master.
72-8	PROFINET: failure in cyclic data	Check wiring.
72-9	PROFINET: communication error	Check the telegram configuration in the master.
Group 73: PROFINET		
73-0	PROFIenergy: state not possible	Request the PROFIenergy state again when the motor is stopped.
73-1	PROFINET: wrong firmware found	Please contact the Technical Support team.
Group 78: NRT communication		
78-0	NRT: frame send error	In general, no measure is required. It may be helpful to reduce the bus load, e.g. by reducing the number of devices connected to a branch.
Group 79: RS232 communication		
79-0	RS232 communication	Please contact the Technical Support team.
Group 80: IRQ_0_3		
80-0	Time overflow current control IRQ	Select longer cycle times for the current, speed and position controllers or interpolator. Please contact the Technical Support team.
80-1	Time overflow speed control IRQ	
80-2	Time overflow position control IRQ	
80-3	Time overflow interpolator IRQ	

Group 81: IRQ_4_5		
81-4	Time overflow low-level IRQ	Please contact the Technical Support team.
Group 82: Internal sequence control		
82-0	Sequence control+	Internal sequence control: The process was aborted. For information only. No measures required.
82-1	Concurrent CO write access	Please contact the Technical Support team.
Group 83: Technology modules		
83-0	Technology module: slot/ combination	The technology module cannot be used in the current slot or the combination of technology modules is not permissible. Contact the Technical Support team.
83-1	Technology module not supported	Load the most recent firmware.
83-2	Technology module: HW revision not supported	Load the most recent firmware.
83-3	Service module: write error	Please contact the Technical Support team.
83-4	MC2000 Watchdog	Please contact the Technical Support team.
Group 84: Internal sequence control		
84-0	Conditions for controller enable not fulfilled	Enable the servo drive again after a short period of time. If the error recurs, check the following: ▪ Are there still errors? ▪ Is the angle encoder ready? ▪ Has DIN4 been set? ▪ Is MOTID still being executed? ▪ Is there a running TFTP download? ▪ Has an energy-saving mode been activated via PROFIenergy? ▪ Does the FSM 2.0 – MOV (SBC) block the enable signal?

Group 90: HW initialisation		
90-0	Missing hardware component (SRAM)	Please contact the Technical Support team.
90-1	Missing hardware component (FLASH)	
90-2	Error during booting of FPGA	
90-3	Error during start of SD-ADUs	
90-4	Synchronisation error SD-ADU after start	
90-5	SD-ADU not in synchronism	
90-6	IRQ0 (current controller): trigger error	
90-7	CAN controller not available	
90-8	Device parameters checksum error	
90-9	DEBUG-Firmware loaded	
Group 91: SW initialisation		
91-0	Internal initialisation error	Please contact the Technical Support team.
91-1	Memory error (copy)	
91-2	Reading of the controller/power output stage type failed	
91-3	Internal software initialization error	
Group 92: Bootloader/Firmware update		
92-0	Error during firmware download	The firmware file is corrupted, e.g. due to a mail client or virus scanner. Request the firmware file again or transfer it as a ZIP file. If the error is still present, contact the Technical Support team.
92-1	Error during bootloader update	
92-2	Erase error (int. flash)	
92-3	Programming error (int. flash)	
92-4	Erase error (int. flash)	
92-5	Programming error (ext. flash)	
92-6	Firmware file: format error	

item

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