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Product Manual

Servo Positioning Controller DIS-2 310/2 FB

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1 General

1.1 Documentation

This product manual serves the purpose of a safe use of the DIS-2 310/2 FB series servo positioning controller. It contains safety notes, which must be complied with.

Further information can be found in the following manuals of the DIS-2 310/2 FB product range:

- **“Mounting Instructions Decentral Intelligent Servo DIS-2 310/2 FB”:** Instruction manual concerning the installation of the DIS-2 310/2 FB servo positioning controller.
- **CANopen Manual “Servo Positioning Controller DIS-2“:** Description of the implemented CANopen protocol as per DSP402.
- **PROFIBUS Manual “Servo Positioning Controller DIS-2”:** Description of the implemented PROFIBUS-DP protocol.
- **EtherCAT Manual “ Servo Positioning Controller DIS-2”**: Description of the implemented EtherCAT protocol.
- **Software manual "Servo Positioning Controller DIS-2":** Description of the device functionality and the software functions of the firmware including the RS232 communication. Description of the DIS-2 ServoCommander™ parameterisation program with instructions concerning the start-up of DIS-2 servo positioning controllers.

All manuals are available for download on the Metronix website under www.metronix.de.
Further, the manuals are located on the CD ROM DIS-2 ServoCommander™.

The described functionality in this manual are based on the product step 3.3.

1.2 Scope of supply

The DIS-2 310/2 FB is available in three different versions. The technology modules (CAN, Profibus, EtherCAT) are factory integrated and not provided by an exchange by the users.

Table 1: Scope of supply DIS-2 310/2 FB CANopen

1x	DIS-2 310/2 FB CANopen servo positioning controllers	Metronix order no: 9019-3103-00

Table 2: Scope of supply DIS-2 310/2 FB PROFIBUS

1x	DIS-2 310/2 FB PROFIBUS servo positioning controllers	Metronix order no: 9019-3103-04

Table 3: Scope of supply DIS-2 310/2 FB EtherCAT

1x	DIS-2 310/2 FB EtherCAT servo positioning controllers	Metronix order no: 9019-3103-05

Counterplugs, control panel, line filter, cable for communication and brake chopper are not included in the standard scope of supply. They can be ordered as accessories:

Table 4: Scope of supply DIS-2 310/2 FB

1x	Connector set: DIS-2 310/2 FB			Metronix order no: 9019-3120-00
	Content:	1x	22-pin Phoenix connector, consist of: VARICON mating connector, Sleeve frame and sleeve housing	
		1x	16-pin mating connector for angle encoder, incl. crimp contacts from company Molex	
		1x	2-pin mating connector for holding brake, incl. crimp contacts from company JST	
		1x	5- pin mating connector for motor incl. crimp contacts from company JST	
1x	Control panel DIS-2 310/2 FB			Metronix order no: 9019-0330-00
1x	External line filter Necessary to fulfill the EMC regulations EN 61800-3			Metronix order no: 9504-0005

1x	RS232 connecting cable for DIS-2 310/2 FB Assembled connecting cable for the controller parameter configuration, length approx. 150 cm, M8 circular connector for connection to the controller, DSUB 9-pin connector for connection to the COM port of the PC.	Metronix order no: 9019-0221-00
1x	Braking resistor for DIS-2 310/2 FB Plate resistor assembled, company Metallux PLR 100.61.41, 100 Ω ± 10%, 30 W continuous power, dimensions 61 mm x 40,5 mm, height: approx. 1.5 mm, height in the area of the connecting cable: 4 mm, with strands l = 105 mm + connector from company JST (VHR-2N and contacts SVH-41T-P1.1)	Metronix order no: 9519-0002-00

2 Safety notes for electrical drives and controllers

2.1 Used symbols

Information

Important information and notes.

Caution!

Nonobservance may result in severe property damages.

DANGER!

Nonobservance may result in **property damages** and in **personal injuries**.

Caution! Dangerous voltages.
The safety note indicates a possible perilous voltage.

2.2 General notes

In case of damage resulting from non-compliance with the safety notes in this manual, Metronix Meßgeräte und Elektronik GmbH will not assume any liability.

Prior to the initial use you must read the chapters *2 Safety notes for electrical drives and controllers* and chapter *7.4 Notes concerning safe and EMC-compliant installation.*

If the documentation in the language at hand is not understood accurately, please contact and inform your supplier.

Sound and safe operation of the servo drive controller requires proper and professional transportation, storage, assembly and installation as well as proper operation and maintenance. Only trained and qualified personnel may handle electrical devices:

TRAINED AND QUALIFIED PERSONNEL

in the sense of this product manual or the safety notes on the product itself are persons who are sufficiently familiar with the project, the setup, assembly, commissioning and operation of the product as well as all warnings and precautions as per the instructions in this manual and who are sufficiently qualified in their field of expertise:

- Education and instruction concerning the standards and accident prevention regulations for the application, or authorisation to switch devices/systems on and off and to ground them as per the standards of safety engineering and to efficiently label them as per the job demands.

  Education and instruction as per the standards of safety engineering regarding the maintenance and use of adequate safety equipment.

- First aid training.

The following notes must be read prior to the initial operation of the system to prevent personal injuries and/or property damages:

These safety notes must be complied with at all times.

Do not try to install or commission the servo drive controller before carefully reading all safety notes for electrical drives and controllers contained in this document. These safety instructions and all other user notes must be read prior to any work with the servo drive controller.

In case you do not have any user notes for the servo drive controller, please contact your sales representative. Immediately demand these documents to be sent to the person responsible for the safe operation of the servo drive controller.

If you sell, rent and/or otherwise make this device available to others, these safety notes must also be included.

The user must not open the servo drive controller for safety and warranty reasons.

Professional control process design is a prerequisite for sound functioning of the servo drive controller!

DANGER!

Inappropriate handling of the servo drive controller and non-compliance of the warnings as well as inappropriate intervention in the safety features may result in property damage, personal injuries, electric shock or in extreme cases even death.

2.2.1 Danger resulting from misuse

DANGER!

High electrical voltages and high load currents!

Danger to life or serious personal injury from electrical shock!

DANGER!

High electrical voltage caused by wrong connections!

Danger to life or serious personal injury from electrical shock!

DANGER!

Surfaces of device housing may be hot!

Risk of injury! Risk of burning!

DANGER!

Dangerous movements!

Danger to life, serious personal injury or property damage due to unintentional movements of the motors!

2.3 Safety notes

2.3.1 General safety notes

The servo drive controller corresponds to IP20 class of protection as well as pollution level 1. Make sure that the environment corresponds to this class of protection and pollution level.

Only use replacements parts and accessories approved by the manufacturer.

The devices must be connected to the mains supply as per EN regulations, so that they can be cut off the mains supply by means of corresponding separation devices (e.g. main switch, contactor, power switch).

The servo drive controller may be protected using an AC/DC sensitive 300mA fault current protection switch (RCD = Residual Current protective Device).

Gold contacts or contacts with a high contact pressure should be used to switch the control contacts.

Preventive interference rejection measures should be taken for control panels, such as connecting contactors and relays using RC elements or diodes.

The safety rules and regulations of the country in which the device will be operated must be complied with.

The environment conditions defined in the product documentation must be kept. Safety-critical applications are not allowed, unless specifically approved by the manufacturer.

For notes on installation corresponding to EMC, please refer to *chapter 7.4* Notes concerning safe and EMC-compliant installation. The compliance with the limits required by national regulations is the responsibility of the manufacturer of the machine or system.

The technical data and the connection and installation conditions for the servo drive controller are to be found in this product manual and must be met.

DANGER!

The general setup and safety regulations for work on power installations (e.g. DIN, VDE, EN, IEC or other national and international regulations) must be complied with.

Non-compliance may result in death, personal injury or serious property damages.

Without claiming completeness, the following regulations and others or standards apply:

VDE 0100	Regulations for the installation of high voltage (up to 1000 V) devices
EN 60204-1	Electrical equipment of machines
EN 50178	Electronic equipment for use in power installations
EN ISO 12100	Safety of machinery – Basic terminology, general principles for design
EN 1050	Safety of machinery – Principles for risk assessment
EN 1037	Safety of machinery – Prevention of unexpected start-up
EN 954-1	Safety-related parts of control systems

2.3.2 Safety notes for assembly and maintenance

The appropriate DIN, VDE, EN and IEC regulations as well as all national and local safety regulations and rules for the prevention of accidents apply for the assembly and maintenance of the system. The plant engineer or the operator is responsible for compliance with these regulations:

The servo drive controller must only be operated, maintained and/or repaired by personnel trained and qualified for working on or with electrical devices.

Prevention of accidents, injuries and/or damages:

Additionally secure vertical axes against falling down or lowering after the motor has been switched off, e.g. by means of:

- Mechanical locking of the vertical axle,
- External braking, catching or clamping devices or
- Sufficient balancing of the axle.

The motor holding brake supplied by default or an external motor holding brake driven by the drive controller alone is not suitable for personal protection!

Render the electrical equipment voltage-free using the main switch and protect it from being switched on again until the DC bus circuit is discharged, in the case of:

- Maintenance and repair work
- Cleaning
- long machine shutdowns

Prior to carrying out maintenance work make sure that the power supply has been turned off, locked and the DC bus circuit is discharged.

The external or internal brake resistor carries dangerous DC bus voltages during operation. Contact may result in death or serious personal injury.

The servo drive controllers can carry voltage until up to 5 minutes after being switched off (residual capacitor charge). Please wait this time until you work to implement appropriate connections. For safety reasons, control the intermediate circuit by measurement. Contact may result in death or serious personal injury.

Be careful during the assembly. During the assembly and also later during operation of the drive, make sure to prevent drill chips, metal dust or assembly parts (screws, nuts, cable sections) from falling into the device.

Also make sure that the external power supply of the controller (24V) is switched off.

The DC bus circuit or the mains supply must always be switched off prior to switching off the 24V controller supply.

Carry out work in the machine area only, if AC and/or DC supplies are switched off. Switched off output stages or controller enablings are no suitable means of locking. In the case of a malfunction the drive may accidentally be put into action.

Initial operation must be carried out with idle motors, to prevent mechanical damages e.g. due to the wrong direction of rotation.

Electronic devices are never fail-safe. It is the user's responsibility, in the case an electrical device fails, to make sure the system is transferred into a secure state.

The servo drive controller and in particular the brake resistor, externally or internally, can assume high temperatures, which may cause serious burns.

2.3.3 Protection against contact with electrical parts

This section only concerns devices and drive components carrying voltages exceeding 50 V. Contact with parts carrying voltages of more than 50 V can be dangerous for people and may cause electrical shock. During operation of electrical devices some parts of these devices will inevitably carry dangerous voltages.

DANGER!

High electrical voltage!

Danger to life, danger due to electrical shock or serious personal injury!

The appropriate DIN, VDE, EN and IEC regulations as well as all national and local safety regulations and rules for the prevention of accidents apply for the assembly and maintenance of the system. The plant engineer or the operator is responsible for compliance with these regulations:

Before switching on the device, install the appropriate covers and protections against accidental contact. Rack-mounted devices must be protected against accidental contact by means of a housing, e.g. a switch cabinet. The regulations VGB4 must be complied with!

Always connect the ground conductor of the electrical equipment and devices securely to the mains supply.

Comply with the minimum copper cross-section for the ground conductor over its entire length as per EN60617!

Prior to the initial operation, even for short measuring or testing purposes, always connect the ground conductor of all electrical devices as per the terminal diagram or connect it to the ground wire. Otherwise the housing may carry high voltages which can cause electrical shock.

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

Prior to accessing electrical parts carrying voltages exceeding 50 Volts, disconnect the device from the mains or power supply. Protect it from being switched on again.

For the installation the amount of DC bus voltage must be considered, particularly regarding insulation and protective measures. Ensure proper grounding, wire dimensioning and corresponding short-circuit protection.

2.3.4 Protection against electrical shock by means of protective extra-low voltage (PELV)

All connections and terminals with voltages between 5 and 50 Volts at the servo drive controller are protective extra-low voltage, which are designed safe from contact in correspondence with the following standards:

International: IEC 60364-4-41

European countries within the EU: EN 50178/1998, section 5.2.8.1.

DANGER!

High electrical voltages due to wrong connections!

Danger to life, risk of injury due to electrical shock!

Only devices and electrical components and wires with a protective extra low voltage (PELV) may be connected to connectors and terminals with voltages between 0 to 50 Volts.

Only connect voltages and circuits with protection against dangerous voltages. Such protection may be achieved by means of isolation transformers, safe optocouplers or battery operation.

2.3.5 Protection against dangerous movements

Dangerous movements can be caused by faulty control of connected motors, for different reasons:

- Improper or faulty wiring or cabling
- Error in handling of components
- Error in sensor or transducer
- Defective or non-EMC-compliant components
- Error in software in superordinated control system

These errors can occur directly after switching on the device or after an indeterminate time of operation.

The monitors in the drive components for the most part rule out malfunctions in the connected drives. In view of personal protection, particularly the danger of personal injury and/or property damage, this

may not be relied on exclusively. Until the built-in monitors come into effect, faulty drive movements must be taken into account; their magnitude depends on the type of control and on the operating state.

DANGER!

Dangerous movements!

Danger to life, risk of injury, serious personal injuries or property damage!

For the reasons mentioned above, personal protection must be ensured by means of monitoring or superordinated measures on the device. These are installed in accordance with the specific data of the system and a danger and error analysis by the manufacturer. The safety regulations applying to the system are also taken into consideration. Random movements or other malfunctions may be caused by switching the safety installations off, by bypassing them or by not activating them.

2.3.6 Protection against contact with hot parts

DANGER!

Housing surfaces may be hot!

Risk of injury! Risk of burning!

Do not touch housing surfaces in the vicinity of heat sources! Danger of burning!

Before accessing devices let them cool down for 10 minutes after switching them off.

Touching hot parts of the equipment such as the housing, which contain heat sinks and resistors, may cause burns!

2.3.7 Protection during handling and assembly

Handling and assembly of certain parts and components in an unsuitable manner may under adverse conditions cause injuries.

DANGER!

Risk of injury due to improper handling!

Personal injury due to pinching, shearing, cutting, crushing!

The following general safety notes apply:

Comply with the general setup and safety regulations on handling and assembly.

Use suitable assembly and transportation devices.

Prevent incarcerations and contusions by means of suitable protective measures.

Use suitable tools only. If specified, use special tools.

Use lifting devices and tools appropriately.

If necessary, use suitable protective equipment (e.g. goggles, protective footwear, protective gloves).

Do not stand underneath hanging loads.

Remove leaking liquids on the floor immediately to prevent slipping.

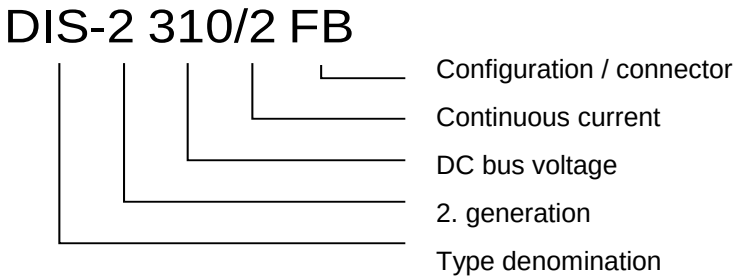
3 Product description

3.1 General

3.1.1 Basic information

The servo positioning controller series DIS-2 310/2 FB (**D**ecentralized **I**ntelligent **S**ervo **2**nd Generation) are intelligent servo inverter with extensive parameterization options. Due to this flexibility, they can be adapted to numerous areas of application.

Type key:



3.1.2 Area of application and intended use

The servo positioning controller DIS-2 310/2 FB was designed for the decentralized control of three-phase magneto-electric synchronous machines. Thanks to numerous options for feedback and to various different control methods, such as "block commutation" and "sine commutation", the controller can be adapted optimally to the motor characteristics.

Normally, it is mounted directly on the motor.

The power supply of the DIS-2 310/2 FB servo positioning controller is supplied with 230 V AC power. At the motor connection, it supplies the synchronous machine with a pulse-width-modulated, symmetrical, 3-phase rotating field with variable frequency, current and voltage.

The controller unit is supplied with 24 V DC through a power supply unit.

The DIS-2 310/ 2 FB was designed for a continuous torque, speed and position control in typical industrial applications such as:

- Positioning and feeding drives in machines
- Palletizing and packaging machines
- Wood-processing machines
- Reeling drives, wire drawing drives etc.
- Drives in tightening and press-fitting applications
- Conveying applications

Prior to using the DIS-2 310/2 FB controller in special areas of application with particularly high normative requirements, e.g. medical technology or avionics, requiring particularly high levels of device safety, the user has to check whether the DIS-2 fulfils the corresponding standards. In case of doubt, please contact your local distributor.

The DIS-2 may only be used if the operating conditions described and the technical data of the controller stated in the appendix in chapter *4 Technical data*

are complied with. In addition, all relevant regulations concerning installation, start-up, dismounting and maintenance have to be complied with.

3.1.3 DIS-2 310/2 FB features

The DIS-2 310/2 FB has the following features:

- Compact design. The housing (closed on five sides) can be mounted on the motor either directly or using an adapter plate (see chapter *6.4 Mounting*).
- Highly precise control thanks to a high-quality sensor system.
- Full integration of all components for the controller and power section
- RS232 interface for PC communication and a fieldbus interface (CANopen, Profibus or EtherCAT) are realised with an integrated interface, which is pluged in and connected to the main board.
- Easy connection to a superordinated control system, e.g. to a PLC on the I/O level or via a field bus.
- Integrated universal rotary encoder evaluation for the following encoder types:
  - Resolvers
  - Analog Hall sensors
  - Stegmann incremental encoders, singleturn and multiturn absolute encoders with HIPERFACE interface
  - Digital Hall sensors (Six-step Hall encoders)
  - Incremental encoders with Hall sensors as commutation signals
- Integrated driver stage for 24 V holding brakes
- Compliance with current CE and EN standards with an additional external line filter. Other filter, e.g. filter for 24V-supply as well as inputs and outputs are integrated.
- EMC-optimized metal housing for direct mounting on the motor. The device has an IP54 degree of protection. Depending on the mounting methods and the seals used, a degree of protection up to IP67 can be reached.
- Can be used as a torque controller, speed controller or position controller.
- Operation for synchronization with use of the digital I/O-interface
- Integrated positioning control with extensive
- Jerk-free or time-optimal positioning, relative or absolute with regard to a reference point.
- Point-to-point positioning with and without spot tracing.

- Speed- and angle-synchronous operation with an electronic
- Numerous homing methods.
- Integrated course program to create simple positioning sequences with or without dependence on digital inputs.
- Jogging
- Teaching
- Programmable digital outputs.
- High-resolution 12-bit analog input.
- User-friendly parameterization using the DIS-2 ServoCommander™ PC program.
- Automatic motor identification.
- I²t monitoring system to limit the average power loss in the power stage and in the motor.
- Integrated brake chopper. The brake resistor can be mounted on an adapter plate between motor and servo positioning controller (chapter *4 Technical data*
- *)*.
- Fieldbus connection to
  - CANopen in accordance with "CAN in Automation (CiA) DSP402".
  - Profibus in accordance DP-V0, based on PROFIVIdrive, version 3.1
  - EtherCAT in accordance to CoE (CANopen over EtherCAT)

3.2 Power supply

3.2.1 Single-phase AC supply

- Supply voltage 230 V AC
- Frequency range nominal 50-60Hz ±10%.

3.2.2 DC bus coupling, DC supply

A DC bus coupling of multiple servo positioning controllers DIS-2 310/2 FB via the [X1] connector is possible. The pin assignment of [X1] is described in chapter *7.2.1 Pin configuration Power supply and* I/O [X1]

.

The direct DC supply is supported for a nominal voltage of 310 V DC by using L1 and N. The connectors ZK+ and ZK- are designed to realize the DC bus coupling, not for the DC supply.

3.2.3 Mains fuse

A slow-blow (B10) single-phase automatic circuit breaker of 10 A has to be installed in the mains supply line (chapter *7.1 Connection to Power Supply and control in system*).

3.3 Brake chopper

The DIS-2 310/2 FB consist of an integrated brake chopper. A brake resistor is available as scope of supply (Metronix order no: 9519-0002-00, see also chapter *1.2 Scope of supply*

) as plate resistor. Normally, the braking resistor is installed on the mounting plate between motor and servo positioning controller (see also chapter *6.4 Mounting)*. If during the generator operation the permissible charging capacity of the DC bus is exceeded, the braking energy can be converted into heat by the internal braking resistor. The brake chopper is software-driven.

3.4 Communication interfaces

The servo positioning controller DIS-2 310/2 FB has several communication interfaces. Next to the RS232 interface, a number of fieldbus interfaces are available. In any case, the servo positioning controller of this design always works as a slave to the fieldbus.

3.4.1 RS232 interface

The RS232 protocol is mainly intended to be a parameterization interface, but also allows the control of the servo positioning controller DIS-2 310/2 FB. The parameterization can be done by using the DIS-2 ServoCommander™.

3.4.2 CAN-Bus

The CANopen protocol in accordance to CAN in Automation (CiA) as per DS301 with application profile DSP402 is implemented.

3.4.3 Profibus

The Profibus communication is in accordance to DP-V0 implemented. For drive technology applications the functions as per PROFIdrive version 3.1 are available. The features include functions as per Application Class 1 (speed and torque control) as well as per Application Class 3 (point-to-point positioning).

It is also possible to include the device into control systems via an I/O mapping via Profibus. From a control point of view, this option offers the same functionality as a conventional PLC coupling via parallel wiring with the device's digital I/Os.

Via a special Metronix telegram it is also possible to access all device-specific functions, exceeding the functionality defined by Profidrive.

3.4.4 EtherCAT

The EtherCAT interface of the servo positioning controller DIS-2 310/2 FB supports the CoE- protocol (CANopen over EtherCAT) based on the FPGA image ESC10.
Features: EtherCAT in accordance IEEE-802.3u (100Base-TX) with 100Mbps (full-duplex)

3.4.5 I/O functions and device controller

Ten digital inputs provide the elementary control functions (see chapter *4.5.2 I/O- interface* [X1]).

The DIS-2 310/2 FB comprises a target table, in which the positioning targets are stored and from which they can later be retrieved. At least four digital inputs serve the purpose of target selection; one input is used as a start input.

The limit switches serve the safety limitation of the motion space. During a homing one of the two limit switches may serve as a reference point for the positioning control.

One inputs is used for the power stage enabling on the hardware side as well as for the controller enabling on the software side.

The servo positioning controller DIS-2 310/2 FB has two analog inputs for input levels in the range of *+10V* to *-10V*. Both inputs are is designed as a differential inputs (12 bit), to guarantee high interference immunity. The analog signals are quantized and digitalized by an analog-digital converter at a resolution of 12 bit. The analog signals provide the setpoints (speed or torque) for the control.

A synchronous operation is possible via the digital I/O-interface. For this the digital inputs DIN4, 5 and 6 are useable as incremental inputs and the digital outputs DOUT1 and DOUT2 as incremental encoder emulation.

4 Technical data

4.1 Ambient conditions and qualification

Table 5: Technical data: Ambient conditions and qualification

Range	**DIS-2 310/2 FB**	
Admissible temperature ranges	Storage temperature:	-25°C to +70°C
	Housing temperature:	0°C to +80°C Temperature switch-off at approx. 85°C
	Ambient temperature at nominal power:	0°C to +30°C With power derating respectively output current derating of 3% / K from 30°C
Admissible installation height	Up to 1000 m above a.m.s.l., 1000 to 4000 m above a.m.s.l. with power derating	
Humidity	Relative humidity up to 90%, no bedewing	
Protection class	IP54, dependent on mounting IP67 may be achieved	
Pollution degree	1	
CE conformity: Low-voltage directive EMC regulation Interference emission Interference immunity	 EN 50 178 EN 61 800 – 3 (with external line filter END-230/4; 9504-0005) Category C2 Category C3	

Table 6: Technical data: Dimensions and weight

Parameter	**Value**
Dimensions: H*W*D	56*80*112 mm (without mounting plate and mating plugs)
Weight	approx. 500 g

4.2 Performance data power supply [X1]

Table 7: Technical data: Performance data [X1]

Parameter	Value
Input supply voltage	1x 230 V_{rms} AC ± 10%, approx. 2 A Single phase supply voltage
24 V logic supply	24 V DC [± 20%] / 0,20 A [1)] internal protected with poly-switch, triggered at approx. 1 A [1)] plus supply current of the optional holding brake and driven I/Os of approx. 0,7 A
Brake Chopper	Brake Chopper is integrated; $U_{Chop} \approx 380$ V
External brake resistor	Possible screwed mounting on mounting plate (Type: PLR of Metallux; Metronix order no: 9519-0002-00)
Resistance	100 Ω
Continuous power / pulse power	30 W / 600 W

4.3 Motor connection [X6]

Table 8: Technical data: Motor connection specifications [X6]

Parameter	Value
Specifications for operation with 230 V_{rms} / $T_{Housing}$ = 80°C	
Output nominal power	300 W
Output nominal current	2 A_{rms}
Max. output current for 1 s	6 A_{rms}
PWM frequency	10 kHz

Table 9: Technical data: Motor temperature monitoring [X2]

Parameter	Value
Digital Sensor	Normally closed contact: $R_{cold} < 500\ \Omega$ $R_{hot} > 100\ k\Omega$
Analogue Sensor	Silicon temperature sensors KTY series
	KTY81-2x0; KTY82-2x0 $R_{25} \approx 2000\ \Omega$
	KTY81-1x0; KTY81-2x0 $R_{25} \approx 1000\ \Omega$
	KTY83-1xx $R_{25} \approx 1000\ \Omega$
	KTY84-1xx $R_{100} \approx 1000\ \Omega$

4.4 Motor feedback connection [X2]

Different feedback systems can be connected to the servo positioning controller DIS-2 310/2 FB via the universal encoder interface:

- Resolvers
- Analogue Hall sensors
- Digital Hall sensors (Six-step Hall encoders)
- Incremental encoders with Hall sensors as commutation signals
- Stegmann incremental encoders, single- and multiturn absolute encoders with HIPERFACE interface

The encoder type is determined in the DIS-2 ServoCommander™ parameterization software.

Table 10: Technical data: Resolver evaluation [X2]

Parameter	**Value**
Suitable resolver	Industry standard, single speed
Transformation ratio	0.5
Carrier frequency	10 kHz
Resolution	> 12 Bit (typ. 15 Bit)
Delay time signal detection	< 200 µs
Speed resolution	ca. 4 min^{-1}
Absolute accuracy of angle detection	< 10´
Max. rotational speed	16.000 min^{-1}

Table 11: Technical data: Evaluation of analogue Hall sensor signals [X2]

Parameter	**Value**
Suitable Hall sensors	HAL400 (Micronas), SS495A (Honeywell) and others Output type: differential analogue output, V_{CM} = 2.0 V...3.0 V Signal amplitude: max. 4,8 V_{ss} differential [1)]
Resolution	> 12 Bit (typ. 15 Bit)
Delay time signal detection	< 200 µs
Speed resolution	ca. 10 min^{-1}
Absolute accuracy of angle detection	< 30´
Max. rotational speed	16.000 min^{-1}

1) Other Signal levels on request as custom specific version, please contact your local supplier.

Table 12: Technical data: Evaluation of Six-Step-Sensors (Hall) and block commutation mode [X2]

Parameter	Value
Suitable Six-Step-Sensors	HALL-Sensors with +5 V supply; 120 ° phase shift between phases; open collector or push-pull output; $i_{out} > 5$ mA;
Resolution	6 steps per electric turn
Delay time signal detection	< 200 µs
Speed resolution	Depends on number of poles of the motor
Max. rotational speed	3.000 min^{-1} with a 4 pole motor

Table 13: Technical data: Evaluation of Incremental encoder [X2]

Parameter	Value
Suitable encoder pulse counts	Programmable 32 to 1024 periods per turn, is equivalent to 128 to 4096 lines/turn
Input signal level	5 V differential inputs / RS422-standard
Power supply for encoder	+5 V / 100 mA max.
Input impedance	$R_i \approx 1600\ \Omega$
Max. input frequency	$f_{max} > 100$ kHz (pulses/s)

Table 14: Technical data: Evaluation of HIPERFACE® Encoders [X2]

Parameter	Value
Suitable Encoder	Stegmann Hiperface SCS / SCM60; SRS / SRM50; SKS / SKM36 other types – please contact supplier
Resolution	Up to 16 Bit (depends on number of increments)
Delay time signal detection	< 200 µs
Speed resolution	approx. 4 min^{-1}
Absolute accuracy of angle detection	< 5´
Max. rotational speed	6.000 min^{-1}, 3.000 min^{-1} with lines / turn at 1024

4.5 Communication interfaces

4.5.1 RS232 [X5]

Table 15: Technical data: RS232 [X5]

Parameter	Value
RS232	As per RS232 specification, 9600 Baud to 115.2kBaud

4.5.2 I/O- interface [X1]

Table 16: Technical data: Digital inputs and outputs [X1]

Parameter	Value	
Signal level	24V (8V...30V) active high, conforming with EN 1131-2	
DIN0 DIN1 DIN2 DIN3	Bit 0 \ Bit 1, \ Target selection for positioning Bit 2, / 16 targets selectable from target table Bit 3 /	
DIN4 (usable as encoder input A-signal)	Bit 4 \ Target Group selection \ Target selection for positioning / 4 target groups with separate positioning parameter Bit 5 / (speed, acceleration, positioning mode e.g.) selectable	
DIN5 (usable as encoder input B-signal)		
DIN6 (usable as encoder input N-signal)	Control signal Start positioning	
DIN7	Limit switch input 0	
DIN8	Limit switch input 1	
DIN9	Controller enable at high, clear error high-low transition at Low	
Logic outputs general	24V (8V...30V) active high, short circuit rated to GND	
DOUT0	Operational state / Ready	24 V, max. 20 mA
DOUT1	Freely configurable, usable as Encoder output A-Signal	24 V, max. 20 mA
DOUT2	Freely configurable, usable as Encoder output B-Signal	24 V, max. 20 mA
DOUT3 **on [X3]**	Holding brake	24 V, max. 700 mA

Table 17: Technical data: Analogue inputs and outputs [X1]

Parameter	Value
High resolution Analogue Inputs	±10V input range, 12 Bit resolution , differential input stage < 250µs delay time, Input protection up to 30 V
Analogue Inputs AIN0 / #AIN0	Analogue input, used as an input for the current or speed setpoint; (Pins shared with DIN0 and DIN1)
Analogue Inputs AIN1 / #AIN1	Analogue input, used as an input for the current or speed setpoint; (Pins shared with DIN2 and DIN3)
Analogue monitor output: AMON0	0 V...10 V output range, 8 bit resolution, $f_{Limit} \approx 1kHz$

4.5.3 Incremental encoder input and output [X1]

With the incremental digital inputs and outputs a master-slave synchronization can be realized. Moreover, with the incremental inputs an synchronization to an external single-ended A-B-N signal can be realised.

Alternatively, the A and B encoder signals are interpreted by the device as pulse-direction signals, so that the controller can also be driven by stepping motor control boards.

Table 18: Technical data: Incremental encoder input [X1] (DIN4, DIN5, DIN6):

Parameter	Value
Number of lines	Programmable 32 / 64 / 128 / 256 / 512 / 1024 lines / turn
Connection level	24 V single ended / 24V (8V...30V) active high, conforming with EN 1131-2
Max. input frequency	f_{Limit} = 50 kHz (lines/s); f_{limit} depends on input filter, data measured with R_{Input} = 13,3 kΩ and C_{Input} = 470 pF

The output provides incremental encoder signals for processing in superimposed controls.

The signals are generated from the encoder's angle of rotation with a programmable number of lines.

The emulation provides a single ended signal A und B.

Table 19: Technical data: Incremental encoder output [X1] (DOUT1, DOUT2):

Parameter	**Value**
Number of lines	Programmable 32 / 64 / 128 / 256 / 512 / 1024 lines / turn
Connection level	24 V single ended / maximum 20 mA output current
Output impedance	$R_a \approx 300\ \Omega$
Limit frequency	$f_{Limit} > 100$ kHz (lines/s); f_{limit} depends on line length, data measured with $R_{Load} = 1\ k\Omega$ and $C_{Load} = 1$ nF , which equals 5 m cable length

4.6 Technical data fieldbus interfaces

One of the following technology modules can be integrated in the base unit DIS-2 310 / 2 FB. The technology modules (CAN, Profibus, EtherCAT) are factory integrated and not provided by an exchange by the users.

4.6.1 CAN-Bus [X401] / [402]

Table 20: Technical data: CAN-Bus [X401] / [X402]

Communication interface	Value
CAN controller	TJA 1050, full-CAN-controller, 1Mbaud; adjustable max. 500kBit /s
CANopen protocol	CANopen protocol as per DS301 and DSP402
current supply of the activated CAN technologie modul	5 mA

4.6.2 Profibus [X401] / [402]

Table 21: Technical data: Profibus [X401] / [X402]

Communication interface	Value
Controller	Profibus-controller VPC3+C, max. 12 Mbaud
Protocol	Profibus DP, max. 32 byte telegrams which consist of programmable operation specific parameter
current supply of the activated PROFIBUS technologie modul	20 mA

4.6.3 EtherCAT [X401] / [402]

Table 22: Technical data: EtherCAT [X401] / [X402]

Communication interface	Value
Controller	ESC10, slave
EtherCAT protocol	CoE, CANopen over EtherCAT
Signal level	0 ... 2,5 V DC
differential input voltage	1,9 ... 2,1 V DC
current supply of the activated EtherCAT technologie modul	35 mA

5 Function overview

5.1 Motors

5.1.1 Synchronous servo motors

Typically, permanently excited synchronous motors with sinusoidal EMF are used. The servo positioning controller DIS-2 310/2 FB is a universal servo drive controller, which can be operated with standard servo motors. The motor specifications are determined and parameterized by means of an automatic motor identification.

5.2 Current and speed controlled mode

The current and speed control system is a cascade control structure with an internal current control circuit and a superimposed speed control circuit. These controllers are PI controllers. The setpoint selectors are used to transfer setpoints from various different sources to the corresponding controllers.

Possible setpoint sources are:

- 2 analog inputs:
  - AIN 0, AIN 1
- RS232
- Fieldbus
  - CANopen -interface or
  - PROFIBUS-DP- interface or
  - EtherCAT- interface
- Synchronization

The basic structure is shown in the block diagram in Figure 1.

Due to the rotor-oriented control principle, two phase currents and the rotor position are measured. At first, the currents are transformed into an imaginary part and a real part with the help of a Clark transformation. Then they are transformed back into the rotor coordinates using a Park transformation. This allows the rotor currents to be controlled to corresponding rotor voltages using PI-controllers and to transform them back into the stator system. The driver signal generation uses a symmetrical pulse width modulation for the power stage in sine commutation with the third harmonic.

An integrator monitors the current^2-time-integral of the controller. If a maximum value (maximum current for 1s) is exceeded, a warning will be issued and the current will be limited to the rated current.

In torque-controlled mode, a current setpoint **i_set** is predefined for the active current controller. In this operating mode, only the current controller in the servo positioning controller is active. As the torque

generated on the motor shaft is approximately proportional to the active current in the motor, one can justifiably talk about torque control.

The accuracy of the torque control depends mainly on the motor and the sensor system used to measure the rotor position.

With a good synchronous machine, a high-resolution rotary encoder (SINCOS encoder) and good controller adjustment, the DIS-2 can reach a torque ripple in the range of 1% to 3% referred to the maximum current or the associated maximum torque of the motor.

In speed-controlled mode, a certain speed setpoint is assigned. The DIS-2 servo positioning controller determines the current actual speed **n_actual** through the encoder evaluation. To make sure that the speed setpoint is complied with, the current setpoint **i_set** is determined.

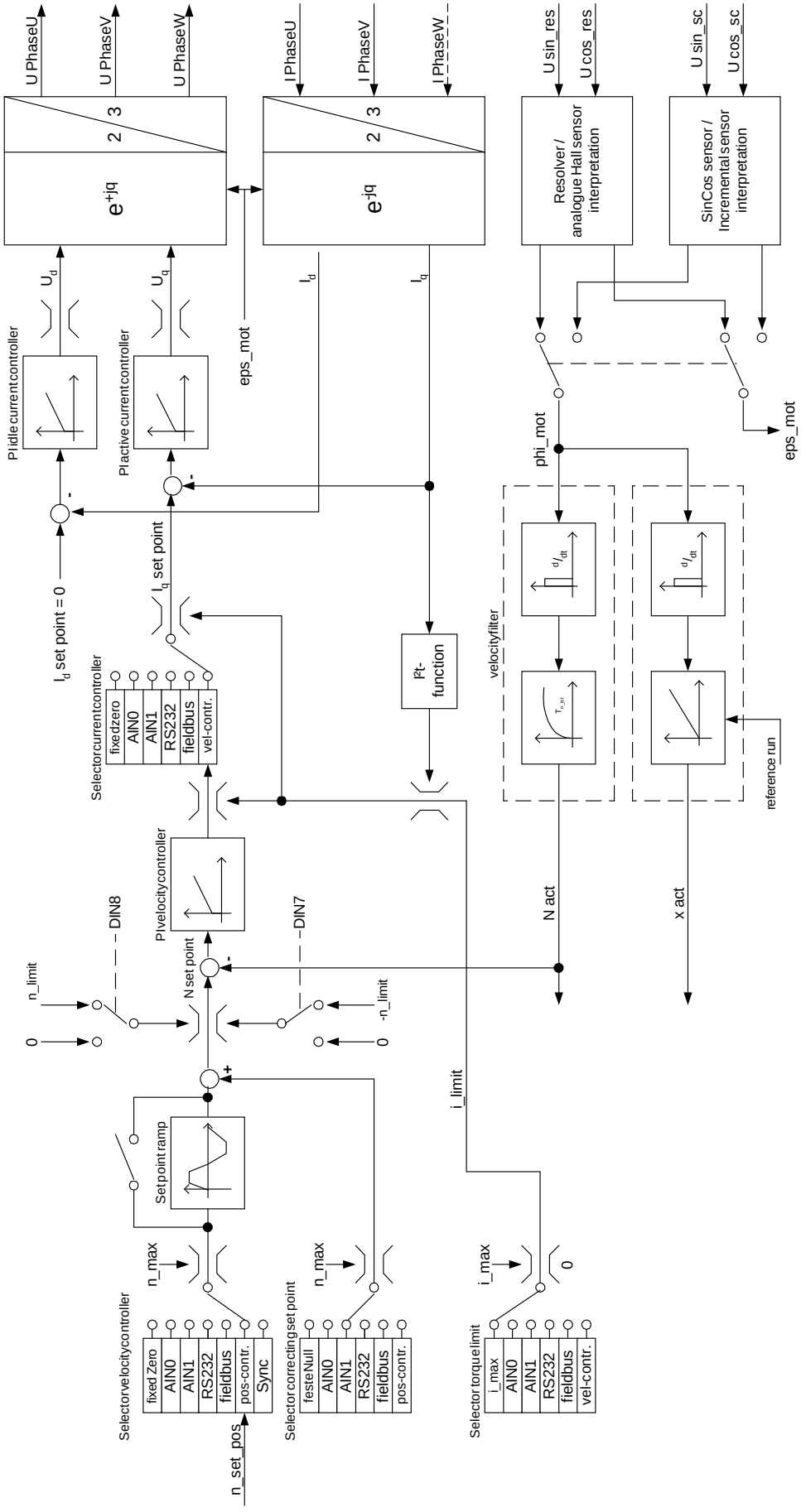


Figure 1: **Control scheme of the controller cascade**

5.3 Function overview

In the positioning mode, a positioning control is superimposed on the speed control. In the positioning mode, a specified position is set. The motor has to move to this position automatically, i.e. without any interaction with an external control system. In this operating mode, the controller cascade in the DIS-2 310/2 FB controller will be extended as shown in Figure 2.

- The position controller is a proportional controller (short: P-controller). The current position is determined using the information of the internal encoder evaluation. The position deviation is processed in the position controller and passed on to the speed controller as a speed setpoint.

- A trajectory generator computes the motion profile needed to reach the target based on the current position and on the current speed. It provides the position setpoint for the position controller and a pilot speed for the speed controller to improve the control dynamics in the event of rapid positioning processes.

- The positioning control provides numerous messages required for the external control system, e.g. a target-reached messages and a following error message.

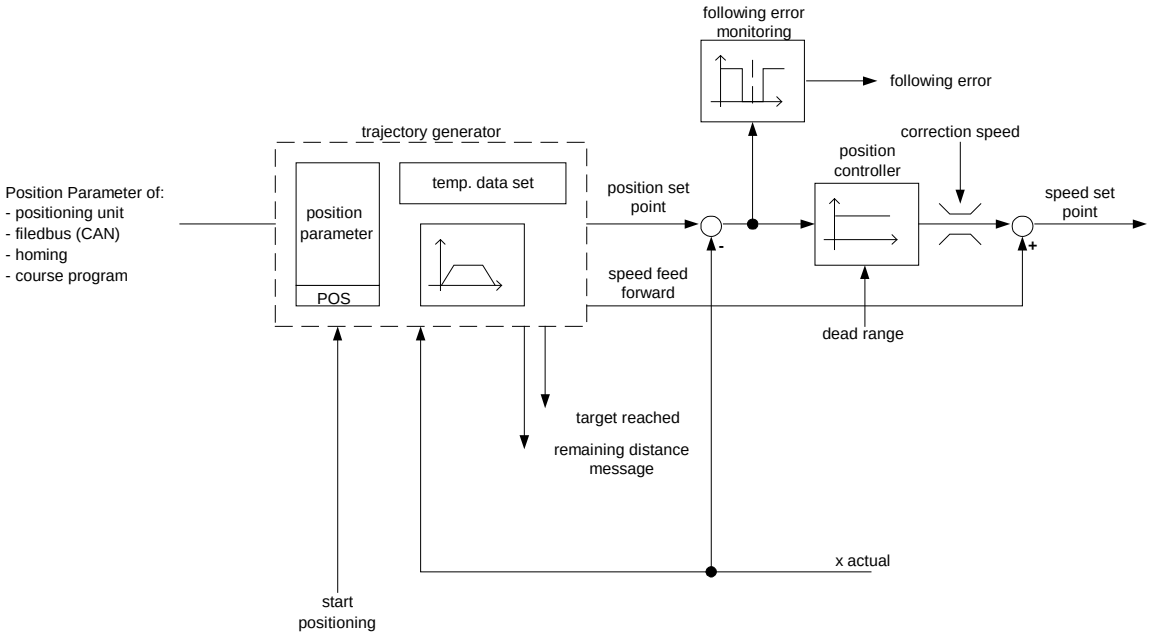


Figure 2: Positioning control block diagram

> In contrast to many competition products, the DIS-2 310/2 FB controller recalculates the entire movement process in every control cycle. This means that positioning processes can be changed or aborted at any time even during the movement. This concept is supported by the high level of performance of the Motion-Control-DSP inside the DIS-2 310/2 FB controller.

The high-performance positioning control system in the DIS-2 310/2 FB controller has numerous parameter and position data sets. Up to 64 position sets can be stored in a non-volatile manner in the DIS-2 310/2 FB and approached with the help of the trajectory generator.

Each of the 64 position sets includes a separate target position (destination). The other parameter of the 64 position sets are divided into 4 groups. The following parameter can be set for each of the 4 position groups:

- Accelerations
- Running speed
- Selection of the type of acceleration:
  Jerk-limited speed profile or time-optimal (constant acceleration)
- Relative or absolute positioning
- Wait for end of running positioning run or reject
- Start delay

The destination is individual for each positioning set. The message for the remaining distance organized over all 64 positioning sets.

As an alternative, the DIS-2 310/2 FB also allows to save all the parameter of a position set individually for each position set. This means a higher level of flexibility in the various motion profiles. As a result, the maximum number of available position sets is reduced to 16.

The maximum number of available position sets, i.e. 16 or 64, can be set through the DIS-2 Servo-Commander™.

In addition, there are position data sets for positioning processes using the CAN bus (DSP402) and position sets for homing.

The positioning control thus supports point-to-point movements with the final speed zero (standstill at target point). Positioning process can be aborted during the movement and the next position can be directly approached.

The groups and positions are selected through the digital inputs. The RS232 interface or partly by fieldbus can be used alternatively for the selection.

The position data sets for homing or for positioning processes through CAN (DS402), PROFIBUS or EtherCAT are fed directly to the trajectory generator.

5.3.1 Synchronisation, electrical transmissions

The servo positioning controller DIS-2 310/2 FB allows master-slave operation, which in the following will be called synchronisation. The controller can serve as master or slave.

If the servo positioning controller DIS-2 310/2 FB is the master, the drive provides an encoder signal with A and B single ended-signals on 24 V level to the salve.

If the servo positioning controller DIS-2 310/2 FB works as a slave, A, B and N- single ended signals on 24 V level can used.

This applies for speed control and positioning mode. The external inputs can be weighed with transmission factors

The internal encoder can optionally be shut off, if another input is selected as setpoint encoder. This also applies for speed control mode. The external inputs can be weighed with transmission factors. Further on, the number of increments for the encoder emulation and encoder input is programmable.

5.3.2 Pulse direction Interface

Alternative to synchronisation the A- and B-signals can be used as pulse direction signals, as generated by control boards for stepper motors.

5.3.3 Cycle times

The cycle times of the controllers are:

- Current controller: 100 µs
- Speed controller: 200 µs
- Position controller: 400 µs

5.3.4 Homing

Every positioning control requires a defined zero at startup, which is determined by means of a homing. The servo positioning controller DIS-2 310/2 FB can do this homing on its own. As reference signals it evaluates different inputs, e.g. the limit switch inputs.

A homing can be started by means of a command via the communication interface or automatically with the controller enabling. Optionally a start via a digital input can be programmed using the parameterization program DIS-2 ServoCommander™, to carry out a specific homing independent of the controller enabling. The controller enabling acknowledges e.g. error messages and can be switched off depending on the application, without requiring another homing with a new enabling.

Several methods as per the CANopen manual and following DSP 402 are implemented for the homing. Most methods first search for a switch at search velocity. The further movement depends on the method of communication. If a homing is activated via the fieldbus, there is generally no following positioning to zero. By starting the homing via digital input, a optional run to zero position after homing is possible. The default setting is „no following positioning “.

Ramps and velocities for the homing are parameterizable via DIS-2 ServoCommander™. The homing can also be time-optimal and jerk-limited.

The complete description of all homing methods is written in the DIS-2 ServoCommander™ software manual.

5.3.5 Relative positioning

In the case of relative positioning, the target position is added to the current position. Since no fixed zero is required, referencing is not compulsory. It does, however, make sense in many cases, in order to bring the drive to a defined position.

Adding of relative positioning allows for example endless positioning in one direction for a trimming unit or a conveyor belt (incremental dimension).

To calculate an following position to the actual positioning during a actual running position, the option *relative to last destination* can be used.

5.3.6 Absolute positioning

The target position is approached independent of the current position. In order to execute an absolute positioning we recommend prior referencing of the drive. But this is not mandatory and will not take place in the use of absolute encoders. In the case of absolute positioning the target position is a fixed (absolute) position referred to the zero or reference point.

Also currently running positioning can be interrupt by a new positioning without stopping the drive.

5.3.7 Driving profile generator

Driving profiles are categorized in time-optimal and jerk-limited positioning. In the case of time-optimal positioning the maximum set acceleration is used for starting and braking. The drive approaches the target in the shortest time possible, the velocity profile is trapezoidal, and the acceleration profile is block-shaped. In the case of jerk-limited positioning the acceleration profile is trapezoidal and the velocity profile is therefore of third order. Since the acceleration changes continuously, the drive is extremely gentle on the mechanics.

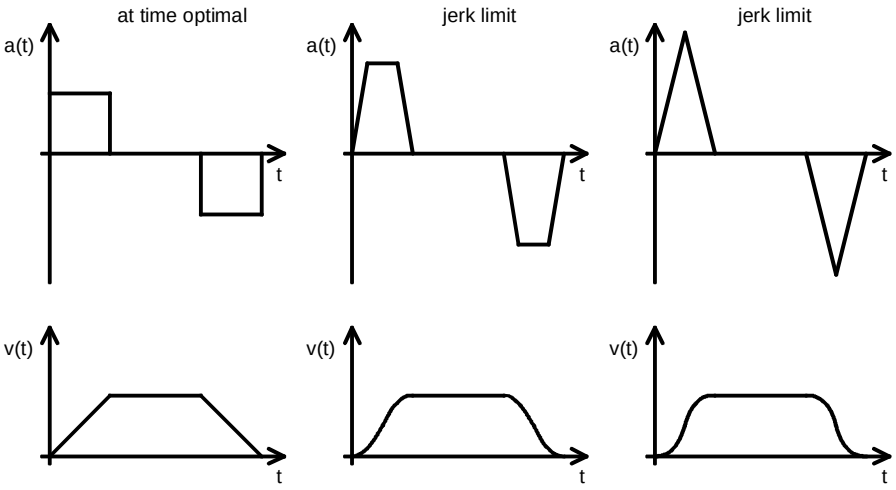


Figure 3: **Driving profiles of servo positioning controller DIS-2 310/2 FB**

5.3.8 Positioning sequences

Positioning sequences consist of a series of positioning sets. These are run consecutively. A positioning set can be made part of a path program by means of its path program options, thus generating a linked list of positions:

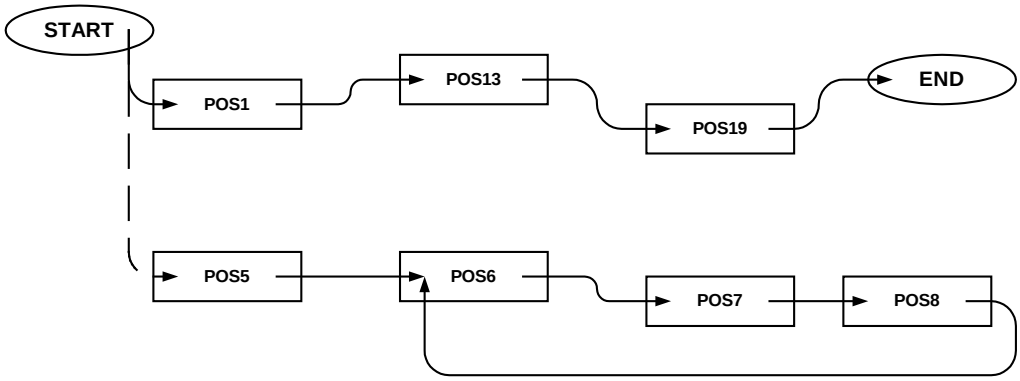


Figure 4: Course program

The servo positioning controller DIS-2 310/2 FB supports the these methods to link the positioning sets to a course program. The complete description to generate a course program is written in the DIS-2 ServoCommander™ software manual.

5.3.9 Software limit switches (positioning range)

The positioning range of the DIS-2 310/2 FB can be reduced by using the software limit switches via DIS-2 ServoCommander™.

5.3.10 Brake management

The servo positioning controller DIS-2 310/2 FB can directly actuate a holding brake. The holding brake is operated with programmable delay times via DIS-2 ServoCommander™. A delay to unlock the brake and delay until the brake is locked is separate programmable.
In positioning mode an additional automatic braking function can be activated, which shuts down the power stage of the DIS-2 310/2 FB after a parameterized idle time and which lets the brake fall in.

5.4 Use of digital and analogue in- and outputs

The two differential analogue inputs, AIN0 and AIN1 can be used as digital inputs. So four more digital inputs are available.
The parameterization ensured by DIS-2 ServoCommander™.

5.5 Jogging and Teaching

The function is used to approach and program any desired target position through the digital inputs into the internal positioning sets of the DIS-2 310/2 FB. The running speed, acceleration and the jerkfree positioning of jogging is programmable by DIS-2 ServoCommander™.

6 Mechanical installation

6.1 Important notes

- The DIS-2 310/2 FB was originally designed for direct mounting on one side of the motor.
- Optimum cooling will be achieved, if the DIS-2 310/2 FB is mounted vertical, this means that connector [X1] is directed to the floor or to the sky.
- Maximum allowable housing temperature of the DIS-2 310/2 FB is 80 °C to ensure the specified lifetime of the electronic!
- The connection cable to [X1] should be fixed (to some machine parts e.g.) close to the DIS-2 310/2 FB to achieve the maximum reliability of the wiring.
- Installation spaces:
  Keep a minimum distance of 100 mm to other components / motors each above and underneath the device to ensure sufficient venting.

6.2 Position and alignment of the connectors

The DIS-2 310/2 FB contains the following connectors:

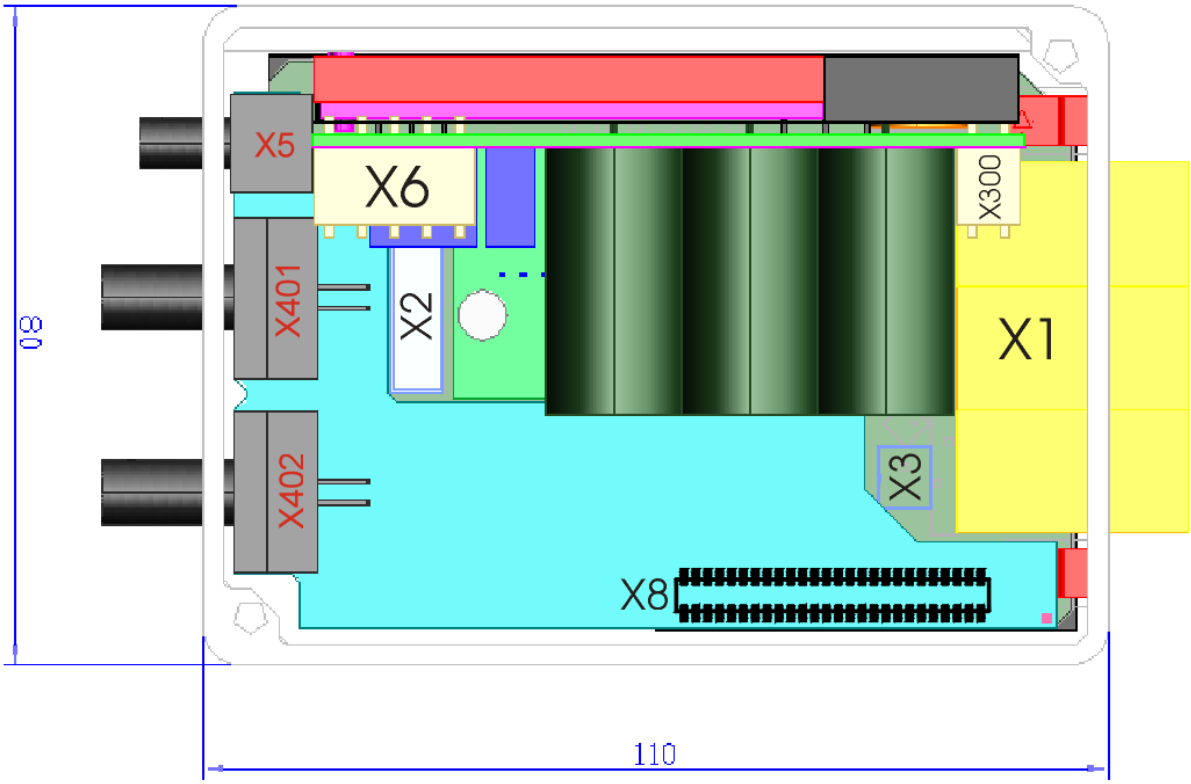


Figure 5: DIS-2 310/2 FB view into the housing – location of the connectors

6.2.1 Connectors on the main board:

[X1]: The only IO connector led to the outside. It includes digital and analogue inputs and outputs, as well as the power supply and some debug signals.

[X2]: Is used to connect the angle encoders.

[X3]: Connector for the holding brake at the motor

[**X300]:** Connector for the brake resistor which has to be screwed on the mounting plate

[X6]: Connector for the three motor phases U, V ,W and PE

[X8]: Is an expansion interface for the fieldbus-modules

6.2.2 Connectors for RS232 and fieldbus-modules (CANopen, PROFIBUS, EtherCAT):

[X5]: Connector for the RS232 communication to parameterise or control the DIS-2 310/2 FB

[X401]: Fieldbus connector which can be used for bus IN or bus OUT

[X402]: Second fieldbus connector for bus IN or bus OUT

6.3 Dimensions of the housing

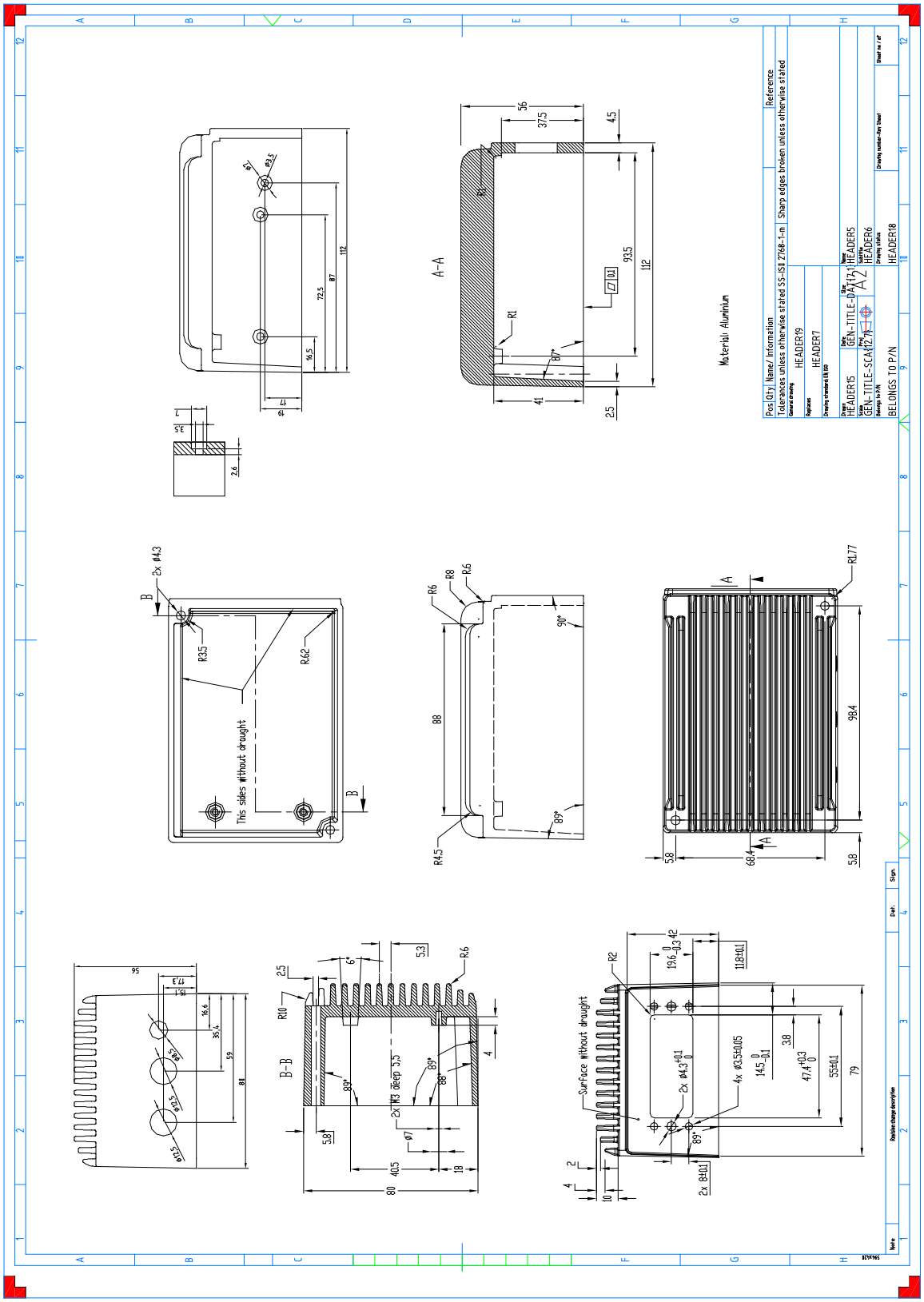


Figure 6: DIS-2 dimensions of the housing

6.4 Mounting

The electronic will be mounted directly to the motor using a seal. The mounting flange at the motor should have a smooth surface with a circular slot to achieve the highest protection against water (see *Figure* 7 and *Figure 8*). Achieving the protective class of IP67 is possible by using a good mechanical construction. It is recommended that the brake resistor is screwed on the mounting plate.

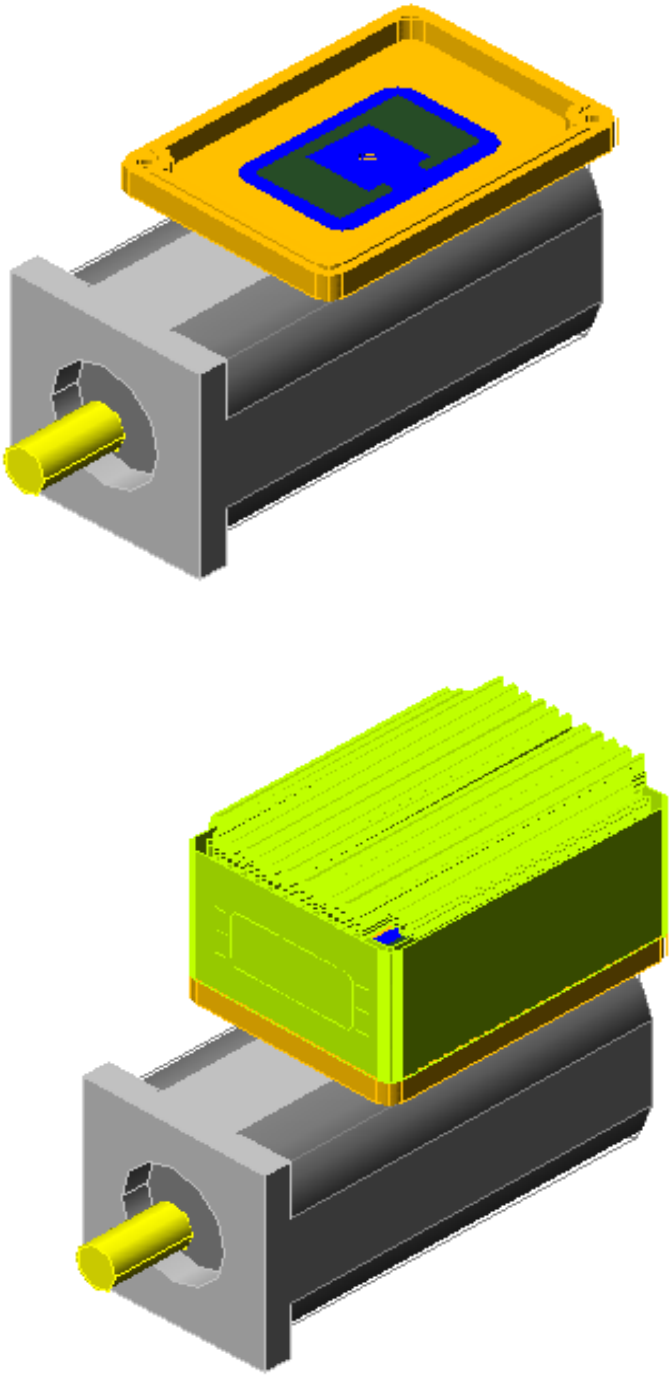


Figure 7: DIS-2 310/2 FB mounting example – synchronous servo motor, mounting plate with brake resistor and servo positioning controller DIS-2 310/2 FB

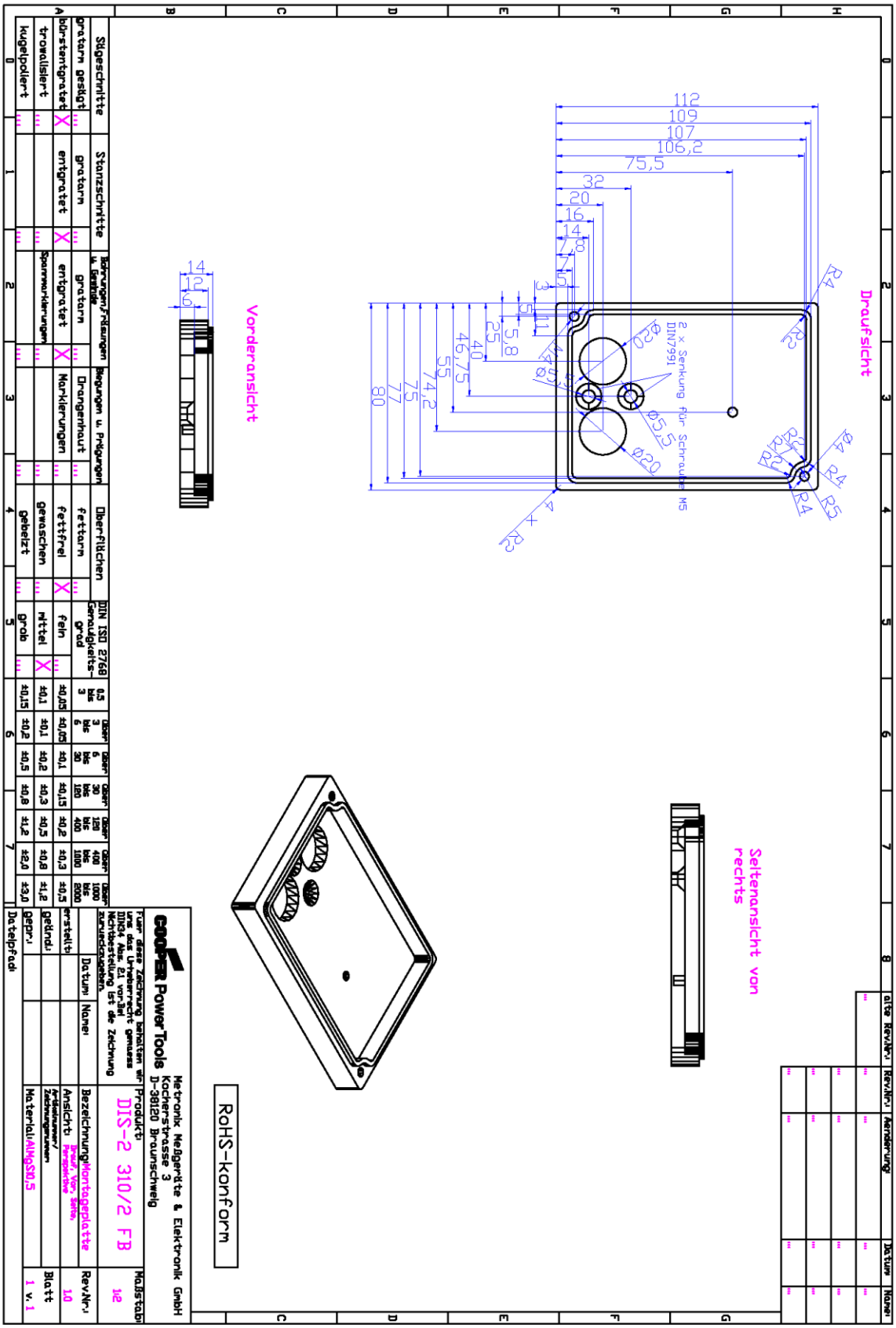


Figure 8: Example of a mounting plate for a motor

7 Electrical installation

7.1 Connection to Power Supply and control in system

The following illustration shows a typical application with two or more DIS-2 310/2 FB servo positioning controllers with a connection to 230 V AC power supply, to a 24 V DC logic supply and to a control or to a PLC.
The mains power supply with the master contactor, fuses and an EMERGENCY OFF device is not shown. The connection is described in chapter *7.6 EMERGENCY OFF / EMERGENCY STOP wiring examples.*

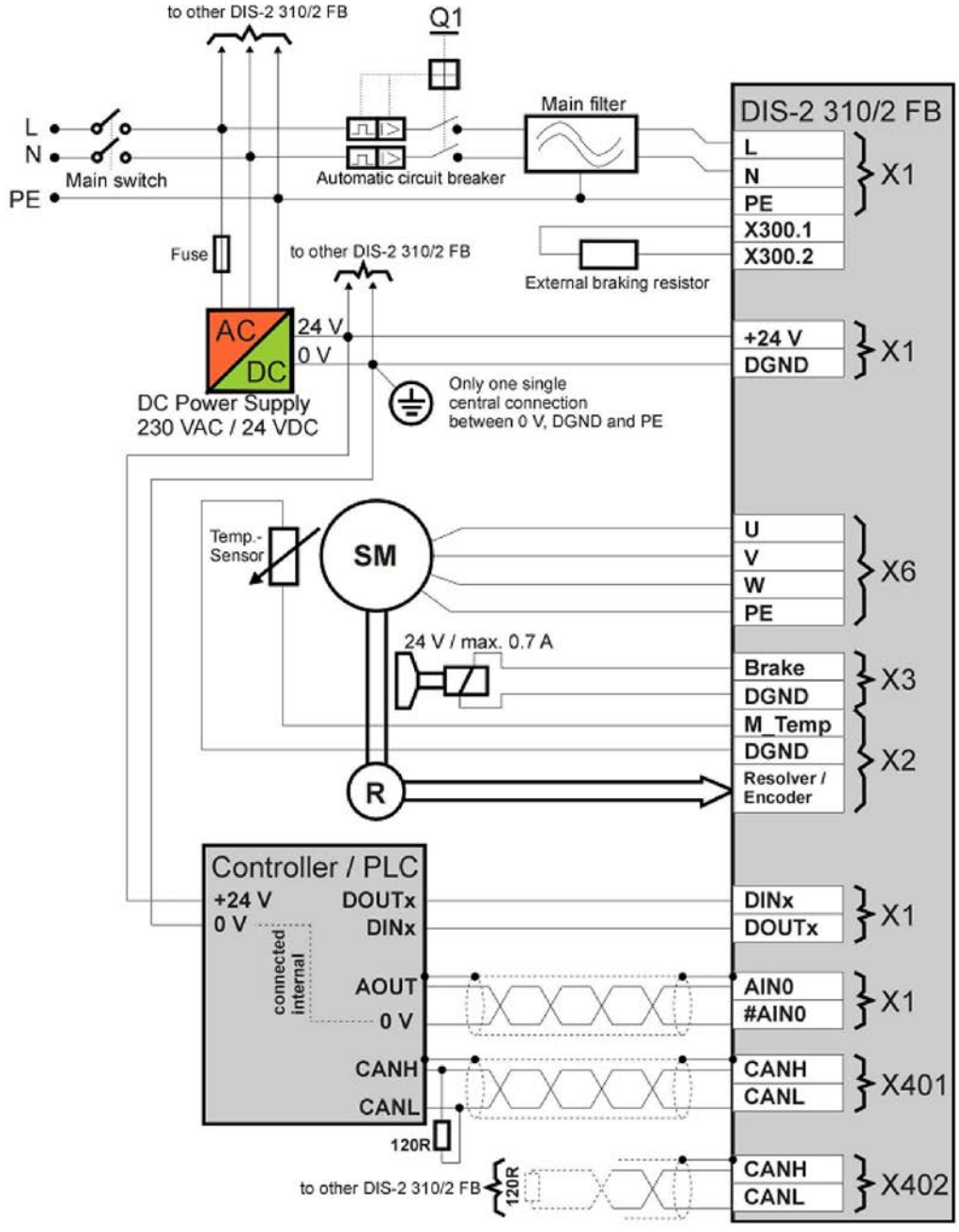


Figure 9: Connection to power supply, control and motor

Figure 9 shows a typical application with a DIS-2 310/2 FB connected to the 230 VAC power supply. A slow-blow two-pole automatic circuit breaker of 10 A (B10) is recommended and has to be installed in the mains supply line.

To fulfil the standard an external line filter is necessary (chapter *1.2).*In complex systems with many servo positioning controllers of type DIS-2 310 / 2 FB, the use of a suitable common line filter for cost reasons can be more useful.

The logic power supply is 24 V DC. A shared reference potential (GND) is used. A central star point near the power supply units for all GND connections reduces the "ground bouncing" effects between the controllers.

The motor is connected to terminals U, V, W and PE at connector [X6] on the board of the DIS-2 310/2 FB. The DIS-2 310/2 FB controls an optional existing holding brake through connector [X3]. The encoder and the temperature sensor have to be connected through the recessed connector [X2] on the circuit board

The DIS-2 310/2 FB has an additional integrated brake chopper. It is therefore possible to connect the braking resistor through the connector [X300] on the circuit board as shown in Figure 9. Normally, the braking resistor is installed on the mounting plate for the electronics housing.

DANGER!
Please use only by the manufacturer released braking resistor. The braking resistor must be used in a high pulse load capacity in order to brief load peaks permanently to be able to cope. Inappropriate braking resistors fail much earlier, they can cause fires and even an electrical hazard! As a result, the DIS-2 310 / 2 FB can damage.

To control the DIS-2 310/2 FB via analogue input, it is strongly recommended to use a shielded and twisted pair for AINx / #AINx. Even if the PLC provides a single ended analogue output only, this technique should be used. By connecting #AINx to the reference 0V at the PLC, common mode voltages between the PLC and the DIS-2 310/2 FB due to the high currents flowing through the power stage and the external wiring will be eliminated. The shield of the cable will protect the analogue input from noise. The shield should be connected on both sides - to the housing of the DIS-2 310/2 FB and to the PLC housing.

The CAN bus should be cabled in the same way as the analogue inputs. In case terminating resistors are necessary, e.g. terminating resistor for CAN bus of 120Ω / 1%, they have to be installed at both ends of the CAN bus network. The individual nodes of the network are always connected in line so that the CAN cable is looped through from controller to controller. The CAN bus is connected via [X401] and [X402] through the DIS-2 310/2 FB.

The DIS-2 310/2 FB has a separate serial service interface, connector [X5], to connect by PC. On this way the servo positioning controller DIS-2 310/2 FB can be parameterized or analyzed by using the software DIS-2 ServoCommander™ or to control the DIS-2 310/2 FB. The RS232 connector is located on the fieldbus module and is connect to the main board.

The digital IO signals DINx and DOUTx do not need a shield to protect them from incoming noise, but a shielded cable between DIS-2 310/2 FB and PLC will improve the EMC emission of the whole system.

For synchronisation mode use the DIN4, 5, 6 as incremental encoder input signals and DOUT1, 2 as incremental encoder output signals.

Make sure that the DIS-2 310/2 FB servo positioning controller is completely connected prior to switching on the power supply for the intermediate circuit (DC bus) and the logic system. If the power supply connections are reversed, if the power supply is too high or if the connections of the intermediate supply and the logic supply are mixed up, the DIS-2 310/2 FB servo positioning controller may be permanently damaged.

Verify that the power supply used for the power and logic part fulfil the specifications for the DIS-2 310 / 2 FB and be resistant to:

Power supply: 230 V AC ± 10%, 45 Hz .. 66 Hz

Logic supply: 24 V DC ± 20%, min. 0.2 A (min. 0.7 A with holding brake)

Danger!
Wrong connections around the power supply can destroy the servo positioning controller DIS-2 310/2 when the power is switch on. This is particularly true for the connection of the mains, the protection earth, the motor phases and the brake resistor.

Also high voltages lead to the destruction of the device. A high power can occur if the neutral conductor does not load, or a neutral conductor interruption in the wiring cabinet or externally occurs!

7.2 Pin configuration main board DIS-2 310/2 FB

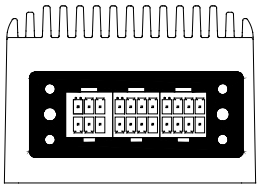
7.2.1 Pin configuration Power supply and I/O [X1]

Connector type at DIS-2 310/2 FB: Phoenix PLUSCON – VARIOCON

Counter Plug: Phoenix PLUSCON – VARIOCON Set, with:

1x VC-TFS6
2x VC-TFS8
1x VC-TR2/3M
1x VC-MEMV-T2-Z
1x VC-EMV-KV-PG21-(11,5-15,5/13,5)

Dimensions approx. L x B x H = 86 mm x 80 mm x 32 mm



C			B				A			
6	5	4	8	7	6	5	8	7	6	5
3	2	1	4	3	2	1	4	3	2	1

Figure 10: Connector and pin configuration [X1]

Table 23: Pin configuration [X1]

Pin No.	Denomination	Value	Specification
A1	DOUT0 / READY	0 V / 24 V	Output operational / no error
A2	DIN8	0 V...24 V	Input limit switch 1 (locks n > 0)
A3	DIN5	0 V...24 V	Input Target selection positioning group Bit 1 / Incremental encoder input B-Line
A4	#AIN1 (DIN3)	-10 V...10 V (0 V...24 V)	Inverse setpoint input 1, differential with AIN1/ (Input Target selection positioning Bit 3)
A5	DIN9	0 V...24 V	Input Power stage enable
A6	DIN7	0 V...24 V	Input limit switch 0 (locks n < 0)
A7	DIN4	0 V...24 V	Input Target selection positioning group Bit 0 / Incremental encoder Input A-Line
A8	AIN1 (DIN2)	-10 V...10 V (0 V...24 V)	Setpoint input 1, differential with #AIN1/ (Input Target selection positioning Bit 2)
B1	#AIN0 (DIN1)	-10 V...10 V	Inverse setpoint input 0, differential with AIN0/ (Input Target selection positioning Bit 1)
B2	DOUT2	0 V...24 V	Output freely programmable / Incremental encoder output B-Line
B3	AMON0	0 V...10 V; 2 mA	Analogue monitor output 0
B4	GND	0 V	Common Ground Potential for IO signals

Pin No.	Denomination	Value	Specification
B5	AIN0 (DIN0)	-10 V...10 V	Setpoint input 0, differential with #AIN0 / (Input Target selection positioning Bit 0)
B6	DOUT1	0 V...24 V	Output freely programmable / Incremental encoder output A-Line
B7	DIN6	0 V...24 V	Input for positioning start / Incremental encoder Input N-Line
B8	+24V logic	+24 V / I_{Logik} = 200 mA...1000 mA	24 V power supply for internal logic and IOs
C1	PE	PE	Protective earth
C2	ZK+	+310 V	Intermediate circuit voltage plus
C3	ZK-	Bench mark for ZK+	Intermediate circuit voltage minus
C4	PE	PE	Protective earth
C5	N	230V AC ± 10%	Input power supply N
C6	L	230V AC ± 10%	Input power supply L

7.2.2 Pin configuration motor phases [X6]

Connector type at DIS-2 310/2 FB: JST No. B5P-VH-B
Counter Plug: JST No. VHR-5N with 4 contacts JST No. SVH-41T-P1.1

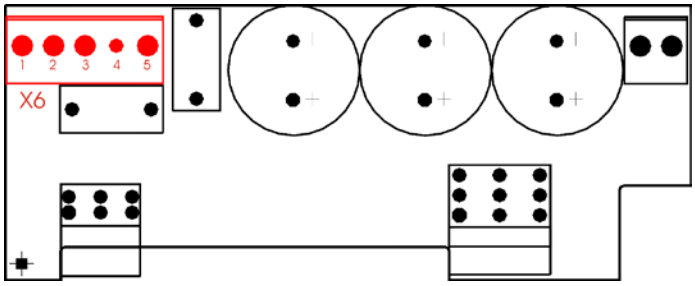


Figure 11: Pin configuration motor phases

Table 24: Pin configuration [X6]

Pin No.	Denomination	Value	Specification
1	PHASE_W	3 x 0 V...300 V 2 $A_{RMS,nom}$ 6 $A_{RMS,max}$ 0 Hz...300 Hz	Connection to the 3phase synchronous motor
2	PHASE_V		
3	PHASE_U		
4	n.c		Safety clearance between PE an motor phase
5	PE		Protective earth

7.2.3 Pin configuration Encoder Interface [X2]

Connector type at DIS-2 310/2 FB: Molex No. 87832-1614
Counter Plug: Molex No. 51110-1651 with up to 16 contacts Molex No. 50394-8051

X2

2	1
4	3
6	5
8	7
10	9
12	11
14	13
16	15

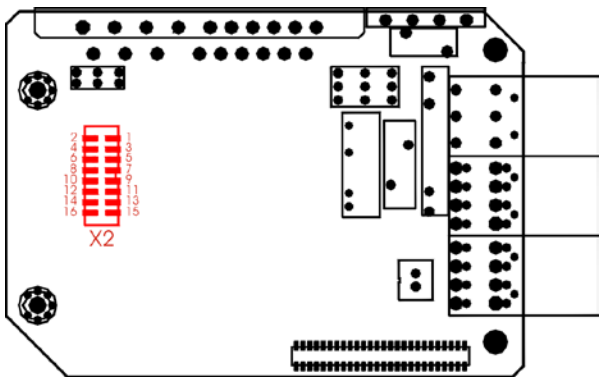


Figure 12: Pin configuration Encoder Interface

Table 25: Pin configuration [X2]

Pin No.		Denomination		Value	Specification
1st row	2nd row	Resolver	Others	(Resolver Version)	
1		GND		0 V	Reference GND for incremental encoder / analogue hall sensor / Stegmann Hiperface encoder
	2	GND		0 V	Reference GND for hall sensors and / or motor temperature sensor
3		+5V		+5 V / 100 mA	+5 V power supply for hall sensors or incremental encoders
	4	+5V		+5 V / 100 mA	+5 V power supply for hall sensors for commutation
5		COS	A	1.5 $V_{RMS,diff}$ / R_i > 10 kΩ	Resolver: connect to resolver line S1 Others: connect to incremental line A
	6	HALL_U		0 V / 5 V R_i = 5 kΩ	Phase U hall sensor for commutation; input with pull-up 4,7 kΩ to +5 V
7		#COS	#A	1.5 $V_{RMS,diff}$ / R_i > 10 kΩ	Resolver: connect to resolver line S3 Others: connect to incremental line #A
	8	HALL_V		0 V / 5 V R_i = 5 kΩ	Phase V hall sensor for commutation; input with pull-up 4,7 kΩ to +5 V
9		SIN	B	1.5 $V_{RMS,diff}$ / R_i > 10 kΩ	Resolver: connect to resolver line S2 Others: connect to incremental line B
	10	HALL_W		0 V / 5 V R_i = 5 kΩ	Phase W hall sensor for commutation; input with pull-up 4,7 kΩ to +5 V
11		#SIN	#B	1.5 $V_{RMS,diff}$ / R_i > 10 kΩ	Resolver: connect to resolver line S4 Others: connect to incremental line #B
	12	MTEMP		0 V / 3.3 V R_i = 2 kΩ	Motor temperature sensor of type closed contact, PTC, or analogue sensor KTY82; connected to GND
13		REF	N	3 $V_{RMS,diff}$ / max. 50 mA_{RMS}	Resolver: connect to resolver line R1 Others: connect to incremental line N / DATA
	14	+12V		+12 V / 100 mA	+12 V power supply for Stegmann Hiperface encoder
15		#REF	#N	3 $V_{RMS,diff}$ / max. 50 mA_{RMS}	Resolver: connect to resolver line R2 Others: connect to incremental line #N /#DATA
	16	n.c.		-	-

7.2.4 Pin configuration holding brake [X3]

Connector type at DIS-2 310/2 FB: JST No. B02B-XASK-1
Counter Plug: JST No. XAP-02V-1 with 2 contacts JST No. SXA-001T-P0.6

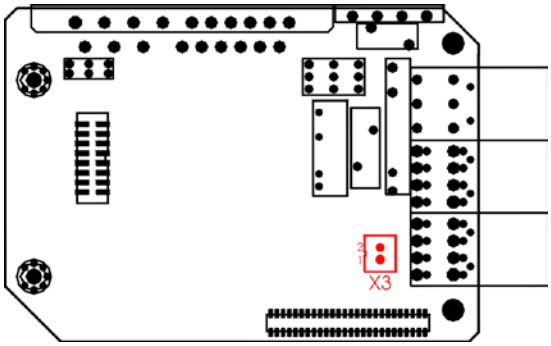


Figure 13: Pin configuration holding brake

Table 26: Pin configuration [3]

Pin No.	Denomination	Value	Specification
1	DOUT3	0 V / 24 V max. 500 mA	Output (high active) for holding brake on motor shaft, internal power supply via 24 V logic supply
2	GND	0 V	Reference potential for holding brake

7.2.5 Pin configuration brake resistor [X300]

Connector type at DIS-2 310/2 FB: JST No. B2P-VH-B
Counter Plug: JST No. VHR-2N with 2 contacts JST No. SVH-41T-P1.1

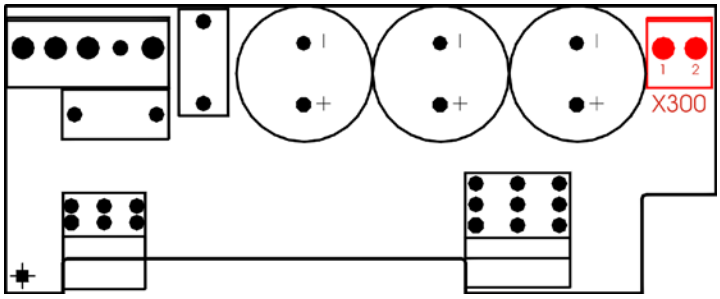


Figure 14: Pin configuration brake resistor

Table 27: Pin configuration [X300]

Pin No.	Denomination	Value	Specification
1	ZK+	380 V / 4 $A_{nom.}$	Connection for brake resistor to intermediate voltage
2	BR-CH	0 V / 380V	Connection for brake resistor to brake chopper

7.2.6 Pin configration expansion interface for the fieldbus-modules [X8]

Connector type at DIS-2 310/2 FB: 2 x 26 RM 1.27 mm female connector
Counter Plug [X8]: 2 x 26 RM 1.27 mm male connector

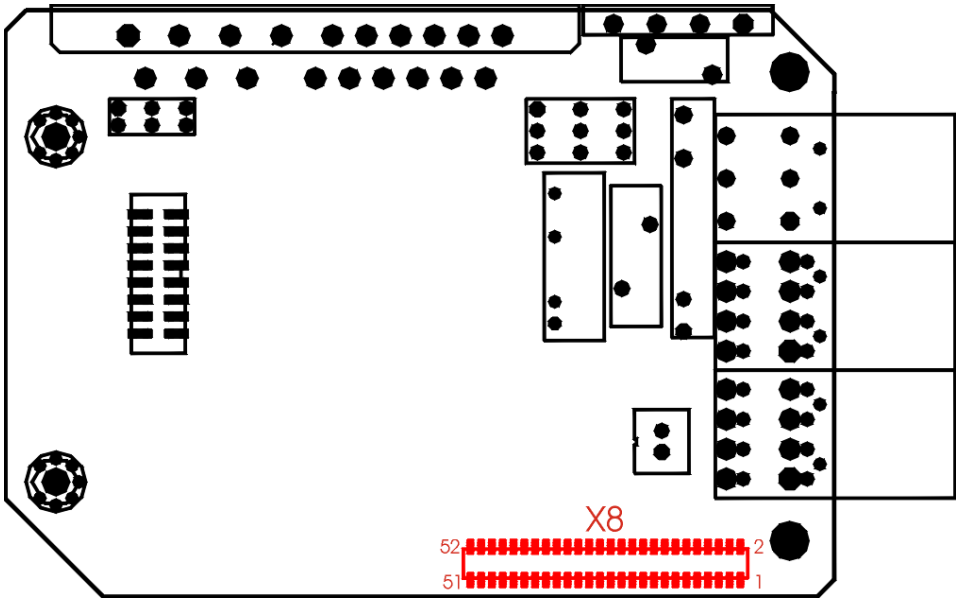


Figure 15: Position and pin configuration technology module

Table 28: Pin configuration [X8]

Pin No.		Denomination	Value	Specification
1		n.c.	all signals with 3,3 V CMOS logic level	Not used
	2	+24 V	+ 24 V / max. 100 mA	Withdrawal of the protected logic supply of + 24 V for future applications / device variants
3		DIN8	0 V / 24 V	Digital 24 V input for limit switches, parallel to X1
	4	DIN7	0 V / 24 V	Digital 24 V input for limit switches, parallel to X1
5		GND	0 V	Reference potential
	6	GND	0 V	Reference potential
7		RxD	+/- 10 V	Serial interface signal RxD
	8	TxD	+/- 10 V	Serial interface signal TxD
9		CANHI_NDR	0 V / 5 V	Field bus signal CAN_H before “filter”
	10	CANLO_NDR	0 V / 5 V	Field bus signal CAN_L before “filter”
11		+3.3 V	3,3 V +/- 2%	Technology module power supply 100 mA max. (together with 5 V)
	12	+5 V	5,0 V +/- 5%	Technology module power supply 100 mA max. (together with 3.3 V)

Continuation of the table (B): Pin assignment of connector [X8]

Pin Nr.		Bezeichnung	Value	Spezifikation
13		D14	all signals with 3,3 V CMOS logic level	16 bit parallel interface– data bus
	14	D15		
15		D12		
	16	D13		
17		D10		
	18	D11		
19		D8		
	20	D9		
21		D6		
	22	D7		
23		D4		
	24	D5		
25		D2		
	26	D3		
27		D0		
	28	D1		
29		A11	all signals with 3,3 V CMOS logic level	16 bit parallel interface– address bus
	30	A12		
31		A9		
	32	A10		
33		A7		
	34	A8		
35		A5		
	36	A6		
37		A3		
	38	A4		
39		A1		
	40	A2		
41		#DS	all signals with 3,3 V CMOS logic level	Bus control signals for access to technology modules via the data and address bus, and synchronous-serial interface for access to technology modules with an SSIO interface
	42	A0		
43		#RD		
	44	#WR		
45		#IRQB (SYNC)		
	46	#IRQA		
47		MOSI		
	48	SCLK		
49		MISO		
	50	#SS		
51		GND	0 V	Reference potential
	52	GND	0 V	Reference potential

7.3 Pin configuration fieldbus-modules DIS-2 310/2 FB

One of the following technology modules can be integrated in the base unit DIS-2 310 / 2 FB. The technology modules (CAN, Profibus, EtherCAT) are factory integrated and not provided by an exchange by the users.
The RS232 interface is integrated on each technology module.

7.3.1 Pin configuration RS232 interface [X5]

Connector type at DIS-2 310/2 FB: M8 flush-type socket, 3-pin type
Position: Front – right, see *Figure 16*
Counter Plug: M8 mating connector for free configuration, e.g.
Phoenix No. 1506901 respectively
RS232-cable: 9019-0221-00

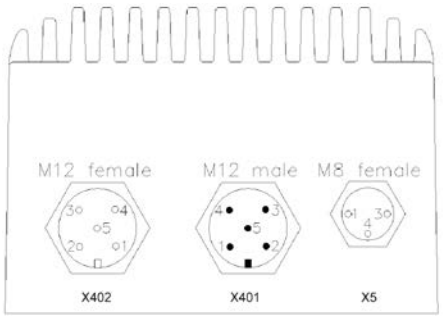


Figure 16: Position and pin configuration RS232 interface

Table 29: Pin configuration [X5]

Pin no.	Denomination	Value	Specification
1	RxD	+/-10 V	Receive line, RS232 specification
3	TxD	+/-10 V	Transmitting line, RS232 specification
4	GND	0 V	Reference potential for the serial interface, internally connected with the common reference potential for the logic system

Table 30: Pin assignment to set up an RS232 adapter cable for connection to a PC/notebook

[X5] pin assignment at DIS-2 310/2 FB		9-pole D-SUB connector for connection by PC		Specification
Pin no.	Denomination	Pin no.	Denomination	Specification
1	RxD	3	TxD_PC	Transmit signal, RS232 specification
3	TxD	2	RxD_PC	Receive signal, RS232 specification
4	GND	5	GND	Reference potential for the serial interface, galvanically connected with the common reference potential for the intermediate circuit and the logic system
-	Shield	-	Shield	Connect the cable shield on both sides of the connector housing

7.3.2 Pin configuration CANopen [X401] and [X402]

Connector type at DIS-2 310/2 FB: [X401] M12 flush-type plug, 5-pin type, A-coded
[X402] M12 flush-type socket, 5-pin type, A-coded

Position: [X401] Front – middle see, see *Figure 17*
[X402] Front – left see, see *Figure 17*

Counter Plug: Assembled M12 bus cable, e.g. made by Phoenix,
one end socket straight, shielded M12-A-coded, 5-pole,
other end pin straight, shielded M12-A-coded, 5-pole,
prefabricated lengths, order name: SAC-5P-MS/xxx-920/FS SCO,
xxx defines the length in [m]. The following lengths are available: xxx = 0.3 / 0.5 / 1.0 / 2.0 / 5.0 / 10.0 / 15.0

Terminating resistor CANopen M12: Order number: 1507816

length in [m]	order number
0,3	1518258
0,5	1518261
1,0	1518274
2,0	1518287

length in [m]	order number
5	1518290
10	1518300
15	1518813

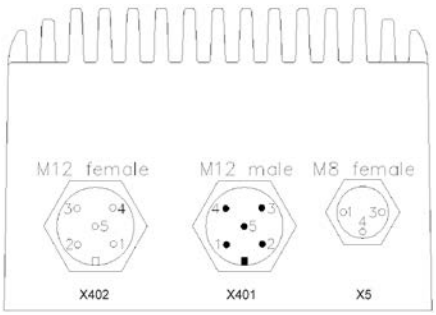


Figure 17: Position and pin configuration CAN interface

Table 31: Pin configuration [X401] and [X402]

Pin no.	Denomination	Value	Specification
1	Shield	PE	Contact for cable shield, in the DIS-2 connected with the housing
2	--	--	Not used
3	CAN_GND	0 V	Reference potential for the CAN bus, internally connected to the common reference potential of the logic system
4	CAN_HI	0 V / 5 V	Signal CAN_HI according to CAN bus specification
5	CAN_LO	0 V / 5 V	Signal CAN_LO according to CAN bus specification

7.3.3 Pin configuration PROFIBUS [X401] and [X402]

The PROFIBUS interface at the servo positioning controller DIS-2 310/2 FB is in accordance with EN 50170 as 5-pin M12 plug (B-coded, at the technology plug-in module, as socket and as plug)

Connector type at DIS-2 310/2 FB: [X401] M12 flush-type plug, 5-pin type, B-coded
[X402] M12 flush-type socket, 5-pin type, B-coded

Position: [X401] Front – middle see, see *Figure 17*
[X402] Front – left see, see *Figure 17*

Counter Plug: Assembled M12 bus cable, e.g. made by Phoenix Contact, one end socket straight, shielded M12-B-coded, 2-pole, other end pin straight, shielded M12-B-coded, 2-pole, prefabricated lengths, order name:
SAC-2P-MSB/xxx-910/FSB SCO,
xxx defines the length in [m]. The following lengths are available: xxx = 0.3 / 0.5 / 1.0 / 2.0 / 5.0 / 10.0 / 15.0

Terminating resistor PROFIBUS M12: Order number: 1507803

length in [m]	order number
0,3	1518106
0,5	1518119
1,0	1518122
2,0	1518135

length in [m]	order number
5	1518148
10	1518151
15	1518164

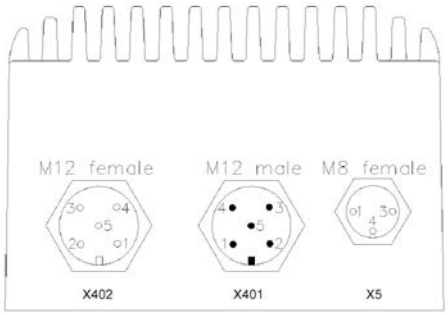


Figure 18: Position and pin configuration Profibus interface

Table 32: Pin configuration [X401] and [X402]

Pin no.	Denomination	Value / color	Specification
1	+5V	+5V	
2	A-line	green	Signal A according to PROFIBUS specification
3	0V	0 V	Internally connected with the common reference potential the logic system
4	B-line	red	Signal B according to PROFIBUS specification
5	Shield	PE	Contact for cable shield, in the DIS-2 310/2 FB connected with the housing

7.3.4 Pin configuration EtherCAT [X401] and [X402]

The EtherCAT-Interface at the servo positioning controller DIS-2 310/2 FB is in accordance with IEC 61076-2-101 as 4-pole M12 socket (shielded und D-coded)

Connector type at DIS-2 310/2 FB:	[X401]	M12 flush-type socket, 4-pin type, D-coded
	[X402]	M12 flush-type socket, 4-pin type, D-coded
Position:	[X401]	Front – middle see, see *Figure 19*
	[X402]	Front – left see, see *Figure 19*
Counter Plug:		Assembled M12 bus cable, e.g. made by Phoenix Contact, shielded M12-D-coded, 4-pole, prefabricated lengths and part numbers:

length in [m]	order number
0,3	1523065
0,5	1523078
1,0	1523081
2,0	1521533

length in [m]	order number
5	1524051
10	1524064
15	1524077

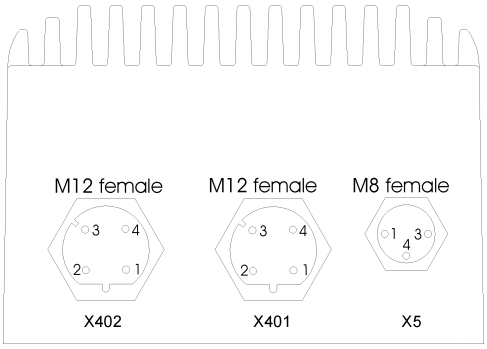


Figure 19: Position and pin configuration EtherCAT interface

Table 33: Pin configuration [X401] und [X402]

Pin no.	Denomination	Value	Specification
1	TX+	0 ... 2,5 V DC	Transmission Data +
2	RX+	0 ... 2,5 V DC	Receive Data +
3	TX-	0 ... 2,5 V DC	Transmission Data -
4	RX-	0 ... 2,5 V DC	Receive Data -

7.4 Notes concerning safe and EMC-compliant installation

7.4.1 Definitions 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 of an electrical installation or an electrical device to other devices in the vicinity via cables or through the environment.

7.4.2 General information concerning EMC

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

- Power supply
- Servo positioning controller
- Motor
- Electromechanical system
- Configuration and type of wiring
- Superimposed control system

DIS-2 310/2 FB servo positioning controllers are certified in accordance with product standard EN 61800-3 for electrical drives in cooperation with an external line filter.

The declaration of conformity for the EMC is available from the manufacturer.

Warning!

This product can cause high-frequency interference in residential areas, which could require measures for radio interference suppression.

7.4.3 EMC ranges: First and second environment

Proper installation and wiring of all connecting cables provided, the DIS-2 310/2 FB servo positioning controllers fulfil the requirements of product standard EN 61800-3. This standard no longer refers to "classes", but to so-called environments. The first environment includes mains supply networks supplying residential buildings. The second environment includes mains supply networks exclusively supplying industrial buildings.

Furthermore, these environments are divided into categories:

First environment, limited availability → Category C2 (Rated voltage < 1000 V)

Second environment → Category C3 (Rated voltage < 1000 V)

7.4.4 EMC-compliant cabling

- The mains-end PE connection is connected to the PE connection point of the supply connection.
- The inner PE conductor of the motor cable is connected to the PE connection point of the motor connection [X6].
- The signal lines must be as far away from the power cables as possible. They should not be placed parallel. If intersections cannot be avoided, they should be perpendicular (i.e. at a 90° angle), if possible.

DANGER!

For safety reasons, all PE ground conductors must be connected prior to initial operation.

The EN 50178 regulations for protective earthing must be complied with during installation!

7.5 EMERGENCY OFF / EMERGENCY STOP – terminology and standards

In accordance with a danger analysis / risk assessment following the machinery directives 98/37/EEC, EN ISO 12100, EN 954-1 and EN 1050, the machine manufacturer has to plan the safety system for the entire machine whilst taking into account all components integrated. Among these are also electric drives. The standstill of the machine has to be initiated and ensured by the control system of the machine. This applies particularly to vertical axes without self-locking mechanism or weight compensation

The standard EN 954-1 subdivides the requirements placed on control systems into five categories graduated according to the level of risk (see *Table 34*).

Table 34: Description of the requirements for the categories in accordance with EN 954-1

Category [1)]	**Summary of requirements**	**System behaviour** [2)]	**Principles to achieve safety**
B	Safety-related parts of control systems and/or their protective equipments, as well as their components, shall be designed, constructed, selected, assembled and combined in accordance with relevant standards to that they can withstand the expected influence.	The occurrence of a fault can lead to the loss of the safety function.	Mainly characterised by selection of components.
1	The requirements of category B must be met. Well-tried components and well-tried safety principles must be used.	The occurrence of a fault can lead to the loss of the safety function but the probability of occurrence is lower than for category B.	

Category [1]	Summary of requirements	System behaviour [2]	Principles to achieve safety
2	The requirements of category B and the use of well-tried safety principles shall apply. The safety function must be checked by the control system of the machine at regular intervals.	The occurrence of a fault can lead to the loss of the safety function between the checks. The loss of a safety function is detected by the checks.	Mainly characterised by structure
3	The requirements of category B and the use of well-tried safety principles shall apply. Safety-relevant parts must be designed as follows: - it is not acceptable for a fault in any one of the parts to cause a loss of the safety function. - the single fault is detected as soon as possible in a reasonable manner	When a single fault occurs, the safety function will remain intact. Some but not all faults will be detected. Accumulation of undetected faults can lead to the loss of the safety function.	
4	The requirements of category B and the use of well-tried safety principles shall apply. Safety-relevant parts must be designed with two channels; permanent self-monitoring; complete error detection!	When faults occur, the safety function always remains intact. Faults will be detected in time to prevent the loss of the safety function.	

1) The categories are not meant to be applied in any given sequence or hierarchic order in terms of safety requirements.

2) The risk assessment will indicate whether the total or partial loss of the safety function(s) arising from faults is acceptable.

The standard EN 60204-1 describes possible actions for emergency situations and defines the terms EMERGENCY OFF and EMERGENCY STOP (see Table 35)

Table 35: EMERGENCY OFF and EMERGENCY STOP as per EN 60204-1

Action	Definition (EN 60204-1)	Emergency situation
EMERGENCY OFF	This intervention is used to achieve electrical safety in an emergency situation by disconnecting the electrical power to a complete system or installation or part of it.	An EMERGENCY OFF has to be used if there is a risk of electric shock or another risk caused by electricity.
EMERGENCY STOP	This intervention is used to achieve functional safety in an emergency situation by stopping a machine or moving parts.	An EMERGENCY STOP is used to stop a process or a movement which has become hazardous.

The “safe stop” function will not cause an electrical isolation. It therefore provides no protection against electric shock. It is thus impossible to achieve an EMERGENCY OFF in the normative sense by using the "safe stop" function, because in order to do so, the entire system would have to be shut down via the power switch (main switch or power contactor).

There are three stop categories for an EMERGENCY STOP as per EN 60204-1 which can be used depending on a risk analysis (see *Table 36: Stop categories*).

Table 36: Stop categories

Stop category 0	Uncontrolled stop. Standstill by immediate disconnection from power.	EMERGENCY OFF or EMERGENCY STOP
Stop category 1	Controlled stop. Power is disconnected when the machine has come to a standstill.	EMERGENCY STOP
Stop category 2	Controlled stop. Power is not disconnected when the machine is at a standstill.	not suitable for EMERGENCY OFF or EMERGENCY STOP

7.6 EMERGENCY OFF / EMERGENCY STOP wiring examples

Figure 20 on the next page shows a realization example for a system that comprises one or several DIS-2 310/2 FB units, power supply units with a mains power connection, a control system and switching elements to realize the EMERGENCY STOP function in accordance with EN 60204-1, stop category 1.

The system comprises the following components:

- S1 Mains power switch
- F1 Fuse for the 24 V logic supply
  The logic supply is supplied with 230 V AC on the primary side through L1 and N.
- Q1 3-phase circuit breaker. The rating depends on the number of DIS-2 units and on the requirements of the power supply unit.
- K1 Power contactor
- F2 Fuse in the +48 V power stage supply system. Every DIS-2 needs a separate fuse.
- ECS EMERGENCY STOP switching device. A safety chain is connected to this device.
- PLC An SPC or an industrial PC that is used to control the system.

Under normal operating conditions, the switching contacts in the ECS are closed. The SPC actuates the power contactor K1 through a digital output.

Every DIS-2 unit signals to the SPC that it is ready for operation via DOUT0. Thus, every DIS-2 unit requires one digital input at the SPC. The SPC uses a second digital output to control the controller enabling signal DIN9 of all the connected DIS-2 units. This common enabling signal is also fed through the ECS. In the event of an error (EMERGENCY OFF, EMERGENCY STOP), the intermediate circuit supply and the controller enabling signal will be disconnected.

The selection of a suitable ECS depends on the actual application. In the simplest case, no ECS is used. Instead, multipolar switching contacts are used in the safety chain.

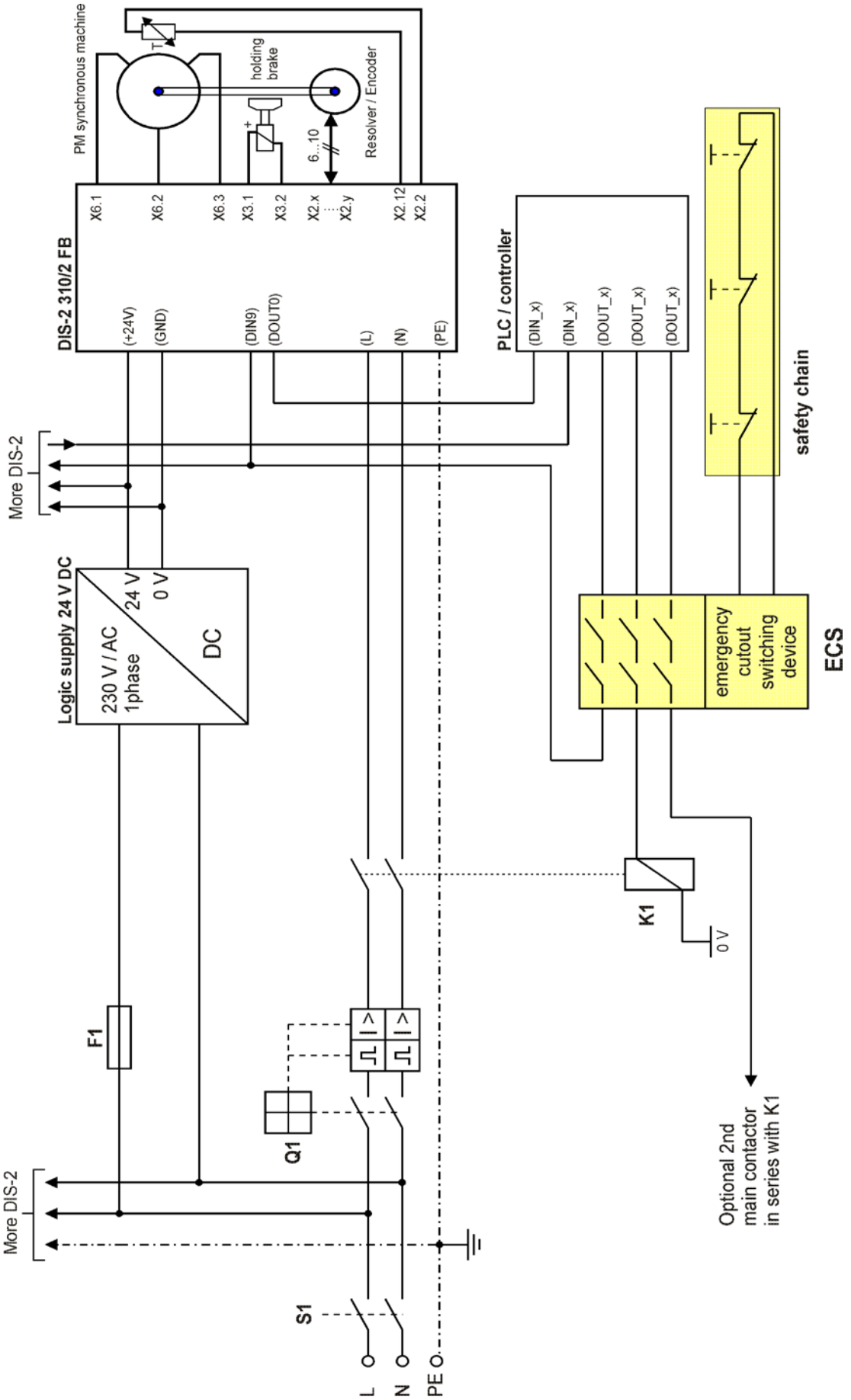


Figure 20: Wiring example for the power supply and EMERGENCY OFF / EMERGENCY STOP

7.6.1 EMERGENCY OFF (stop category 0):

In an EMERGENCY OFF situation, the safety chain is activated. Depending on the actual machine, the safety chain comprises various elements, e.g. EMERGENCY OFF buttons, key-operated switches, start buttons etc. The ECS also checks the safety chain for faults, such as line breaks, short-circuits etc. In the event of an error or if the chain is open, it ensures that K1 is switched off safely. The mains power supply will be interrupted.

The connection example shown may differ from the actual connection depending on the required safety category:

The connection example shown in *Figure 20* → fulfils the requirements of EN 954, safety category 1

The connection example shown in *Figure 20* may be extended by a second power contactor and an ECS unit in accordance with EN 954, safety category 3 → fulfils the requirements of EN 954, safety category 3.

After the disconnection of the mains power supply, there is still some residual energy in the intermediate circuit capacitors of the DIS-2 310/2 FB. The elimination of this energy by internal discharging resistors in the DIS-2 310/ 2 FB and in the power supply unit takes some time (duration: > 5 minutes).
With $U_{DC\ bus}$ = 400 V, the electrical energy per DIS-2 310/2 FB unit is: $P_{C,\ DC\ bus} \approx 20$ Ws
In applications where this is not acceptable, the intermediate circuit has to be quickly discharged with the help of an additional contact connected to K1 and a suitably rated discharging resistor.

EMERGENCY STOP (stop category 1):

An additional contact set in the ECS also disconnects the controller enabling signal from the DIS-2 310/ 2 FB.
The drives decelerate along the quick-stop ramp to zero speed. Then the DIS-2 310/ 2 FB switches the output stage off.

The connection example shown may differ from the actual connection depending on the required safety category:

The connection example shown in *Figure 20* → fulfils the requirements of EN 954, safety category 1

The connection example shown in *Figure 20* as well as drives with a holding brake, delayed disconnection of the 24 V logic supply of the DIS-2 310/ 2 FB through the ECS. ECS in accordance with EN 954, safety category 3 → fulfils the requirements of EN 954, safety category 3.

DANGER !

The EMERGENCY OFF and EMERGENCY STOP wiring described herein is only <u>one</u> possible realization example. Depending on the application, broader or completely different regulations concerning the design of these functions may apply.

The machine manufacturer or the project manager has to gather all the necessary information concerning the actual safety requirements, work out a safety concept for the system and then select the connection and the components accordingly.

8 Initial operation

8.1 General notes on connection

Since the laying of the connection cables is very important in terms of EMC, make sure to comply with the previous *chapter 7.4 Notes concerning safe and EMC-compliant installation*!

DANGER!

Noncompliance with *chapter 2 Safety notes for electrical drives and* controllers may result in property damage, person injury, electric shock or in extreme cases in death.

8.2 Tools / material

- PC with parameterisation program DIS-2 ServoCommander™
- Serial interface cable
- Control panel DIS-2 310/2 FB or PLC
- Power supply cable
- Screw driver or Allen key, depends of the fastening screw of the DIS-2 310/2 FB to the motor

8.3 Connecting the motor

- Connect the motor connector (see connector set in chapter *1.2 Scope of supply*) to the motor cable and plug it into interface [X6] of the DIS-2 310/2 FB
- Connect the encoder connector (see connector set in chapter *1.2 Scope of supply*) to the encoder cable and if a temperature sensor exist to them plug it into interface [X2] of the DIS-2 310/2 FB
- If exist a holding brake, connect the holding brake connector (see connector set in chapter *1.2 Scope of supply*) to the holding brake cable and plug it into interface [X3] of the DIS-2 310/2 FB
- If a brake resistor is necessary, connect the brake resistor (see connector set in chapter *1.2 Scope of supply*) to the interface [X300] of the DIS-2 310/2 FB and screw tight the brake resistor at the mounting plate
- Check all connections again.

8.4 Connecting the servo positioning controller DIS-2 310/2 FB to the power supply, control panel or plc

- Make sure that the power supply has been switched off.

- ❖ Plug the connector of the control panel to the servo positioning controller DIS-2 310/2 FB interface [X1]
- ❖ Connect an optional field bus system to the field bus interface [X401] / [X402]
- ❖ Connect the 24V connections to a suitable power supply unit.
- ❖ Make mains supply connections.
- ❖ Check all connections again.

A "good" PE connection has only a low impedance even in the case of very high interference frequencies. An optimum PE connection can be obtained by mounting the DIS-2 controller directly on the motor. If you want to mount the DIS-2 310/2 FB controller and the motor separately, make sure to mount them on the same (metal) part of the machine. In this case, the surface of the machine part should be made of uncoated aluminium or galvanized sheet metal!

- ❖ To fulfil the emission limits, a screened 230 V AC supply cable between line filter and DIS-2 310/2 FB is recommended. The max. length is 10 m.

8.5 Connecting the PC

- ❖ Plug the connector of the serial interface cable (see chapter *1.2 Scope of supply*) into the interface [X5] of the DIS-2 310/2 FB
- ❖ Plug the D-Sub connector of the serial interface cable into the socket for the serial interface of the PC and fasten the bolting screws
- ❖ Check all connections again.

The further description is explained in the software manual.

8.6 Checking operability

1. Make sure the controller enable input (DIN9) is disabled.
2. Switch on the power supply of all devices.
3. Start the parameterisation program DIS-2 ServoCommander™
4. The communication to the controller is established
5. Parameterisation the servo positioning controller depends of the application

In case the communication between PC and servo positioning controller is not active, there is a malfunction. In this case please follow these steps:

1. Switch off the power supply.
2. Wait 5 minutes, so the DC bus can discharge.
3. Check all connection cables.
4. Check the functionality of the 24 V power supply.
5. Switch the power supply back on.

9 Service functions and error messages

9.1 Protection and service functions

9.1.1 Overview

The servo positioning controller DIS-2 310/2 FB has a powerful sensor analysis, which monitors the proper functioning of the controller, power output stage, motor and communication with the outside world. All occurring errors are stored in an internal error memory. Most errors will cause the controller unit to shut down the servo positioning controller and the power output stage. They can only be switched on again after the error memory has been deleted by acknowledging the error and after the error has been eliminated or no longer exists.

A powerful sensor analysis and monitoring function provides operational safety:

- Measuring of motor temperature
- Measuring of power section temperature
- Measuring of in housing temperature
- Detection of ground faults (PE)
- Detection of connections between two motor phases
- Detection of short circuit of the brake resistor
- Detection of overvoltage / undervoltage in the DC bus
- Detection of errors with the internal voltage supply
- Measuring of average power loss (I^2t monitoring) of the controller and motor
- Failure of the supply voltage.
- Detection of failures of the current measurement
- Detection of angle encoder errors
- Detection of error of the automatic motor identification
- Motion sequence monitoring
- Detection of internal failures

9.1.2 Overcurrent and short-circuit monitoring

- **Overcurrent and short-circuit monitoring:** This monitor responds as soon as the current in the DC bus exceeds twice the maximum current of the controller. It detects short-circuits between two motor phases as well as short-circuits at the motor output terminals against the positive and negative reference potential of the DC bus and against PE. If the error monitoring detects an overcurrent, the power output stage will shut down immediately to guarantee the ability to withstand short-circuits. Further more, a short circuit of the brake resistor during brake chopper operation will be detect.
- **I²t current monitoring with controller warning:** The DIS-2 310/2 FB servo positioning controller has an I²t monitoring system to limit the average power loss in the power output stage. Since the power loss in the electronic power system and in the motor increases in a square manner with the current in the worst case, the squared current value is taken as the measure for the power loss. When 80% of the maximum integrated value are reached, a warning (parameterizable) will be issued. When 100% is reached, the maximum current will be limited to the rated current.
- **Current measurement check and offset calibration when the power stage is turned on:** When the power stage is turned on, an automatic offset calibration of the current measurement will be performed. If the offset lies beyond the permissible tolerances, an error will be issued.

9.1.3 DC bus voltage monitoring

- **Overvoltage monitoring:** The overvoltage monitoring system of the DC bus (intermediate circuit) responds as soon as the DC bus voltage exceeds the operating voltage range. As a result, the power output stage will be shut down.
- **Undervoltage monitoring:** The system checks whether the intermediate circuit voltage (DC bus voltage) is above a certain minimum limit. The response to this error can be configured.

9.1.4 Logic supply monitoring

- **24V overvoltage / undervoltage monitoring:** The power supply of the logic component of the DIS-2 310/2 FB servo positioning controller is monitored. If the power supply of the logic component is too high or too low, a fault message will be issued.
- **Internal operating voltages:** All operating voltages generated internally, such as the 3.3 V supply of the processor, are monitored.

9.1.5 Heat sink temperature monitoring

- **Shut-down at overtemperature:** The heat sink temperature of the power stage is measured with a IGBT module integrated temperature sensor. When the actual temperature reaches the temperature limit, an error message will be issued. In addition, a temperature warning will be issued when the temperature is about 5°C below the limit value.

9.1.6 Motor monitoring

- **Rotary encoder monitoring:** An error in the rotary encoder shuts down the power output stage. For example, in the case of resolvers the track signal is measured. In the case of incremental encoders, the commutation signals are checked. Other "intelligent" encoders have other means of error detection.
- **Motor temperature measurement and monitoring:** The DIS-2 310/2 FB servo positioning controller has an analogue input for detecting and monitoring the motor temperature. Due to the analogue signal detection, also non-linear sensors are supported. The shut-down temperature can be parameterized. Alternatively, the motor temperature can also be monitored with the help of a normally-closed contact or a PTC. In this case, however, the shut-down threshold cannot be parameterized.
- **I^2t current monitoring with motor warning:** The DIS-2 310/2 FB servo positioning controller also has an I^2t monitoring system to limit the average power loss in the motor. Since the power loss in the electronic power system and in the motor increases in a square manner with the current in the worst case, the squared current value is taken as the measure for the power loss. When 80% of the maximum integrated value are reached, a warning (parameterizable) will be issued. When 100% is reached, the maximum current will be limited to the rated current.
- **Automatic motor identification process monitoring:** The system monitors whether the automatic identification of the phase sequence, the number of pairs of poles and the angle encoder offset has been performed successfully.

9.1.7 Motion sequence monitoring

- **Following error:** The deviation between the position setpoint and the actual position is monitored.
- **Positioning range:** A running positioning run is monitored to see whether the positions are within the adjustable positioning range.
- **Limit switches:** If both limit switches are simultaneously active, an error will be issued.
- **Course program:** The course program is monitored to detect invalid commands.

9.1.8 Additional internal monitoring functions

- **Memory test / check sums:** The internal FLASH memory (program and data flash memory) is monitored with the help of a check sum test and the processor stack is also monitored.
- **Operating mode:** Depending on the operating mode, specific monitoring functions are activated.
- **Communication:** The communication through the serial interface and through the field bus is monitored.

9.1.9 Operating hour meter

- The DIS-2 310/2 FB servo positioning controller has an operating hour meter. In the DIS-2 ServoCommander™ parameterization software, it is displayed on the **Times** tab in the **About /About** menu.
- The count of the operating hour meter is saved in the internal flash once in a minute. As a result, there may be deviations of up to 60 seconds after a reset or a power-on.

9.2 Error messages

The following table provides an overview of all possible errors.

In the **Reaction** column, the reactions you can parameterize are marked with an "**X**".

The parameterization of the possible errors is described in the software manual.

The abbreviations **C**, **E** and **W** have the following meaning:

- **C**ritical error: The controlled operation of the motor cannot be guaranteed.
  The power stage will be switched off immediately. The motor will coast down.
- **E**rror: The motor will be decelerated with the quick stop deceleration.
  Then the power stage will be switched off.
- **W**arning: The motor can still be used though perhaps only for a limited amount of time. The user can parameterize whether warning will be displayed or not:
  - Display: The error will be displayed but no other measures are taken.
  - No display: The error will be ignored completely.

Table 37: Error overview

Error no.	CAN error code	Meaning	Possible causes / measures	Release time	Reaction		
					C	E	W
3	4310	Motor over-temperature	Check the configuration of the temperature monitoring system. Temperature sensor correctly wired? Movement of mechanical system impaired, motor too hot?	< 100ms	**X**	**X**	**X**
4	4210	Over-/ under-temperature power stage	Temperature of the electronic power system < -40°C or > 85°C. DIS-2 310/2 FB heated up by the motor? Decouple the DIS-2 310/2 FB thermally if necessary. Check / improve the installation and the cooling conditions.	< 100ms	**X**	**X**	
5	7392	Error SINCOS supply	Angle encoder connected? Angle encoder cable defective? Angle encoder defective? Check the configuration of the angle encoder interface.	< 5ms	**X**		
6	7391	Error SINCOS RS485 communication	Angle encoder connected? Angle encoder cable defective? Angle encoder defective? Check the configuration of the angle encoder interface. New or unknown SINCOS encoder?	< 5ms	**X**		

Error no.	CAN error code	Meaning	Possible causes / measures	Release time	Reaction		
					C	E	W
7	7390	Error of track signals of SINCOS encoder	Angle encoder connected? Angle encoder cable defective? Angle encoder defective? Check the configuration of the angle encoder interface.	< 5ms	X		
8	7380	Error of resolver track signals / carrier failure	Resolver connected? Angle encoder cable defective? Angle encoder defective? Check the configuration of the angle encoder interface.	< 5ms	X		
9	5113	Error 5V - internal supply	The error may be due to a defective angle encoder, due to defective Hall sensors or due to a wiring error of X2. Possible error on technology module X8 Electronic error in the DIS-2 310/2 FB device. The error cannot be eliminated by the user. Send the servo positioning controller to the distributor.	< 5ms	X		
10	5114	Error 12V - internal supply	The error may be due to a defective angle encoder, due to defective SINCOS encoder or due to a wiring error of X2. Electronic error in the DIS-2 310/2 FB device. The error cannot be eliminated by the user. Send the servo positioning controller to the distributor.	< 5ms	X		
11	5112	Error 24V supply	24 V logic supply too high or too low? 24 V logic supply cannot be loaded, e.g. when the holding brake is actuated? Error in the holding brake or in the wiring to X3 or overload of the brake output due to a brake with a too high current consumption. Electronic error in the DIS-2 310/2 FB device. The error cannot be eliminated by the user. Send the servo positioning controller to the distributor.	< 5ms	X		
12	--	Hardware - software conflict	A wrong firmware would be loaded, which is not suitable for this kind of controller, e.g. DIS-2 48/10 FW into DIS-2 310/2 FB.	< 5ms	X		
13	5210	Error offset current metering	The error cannot be eliminated by the user. Send the servo positioning controller to the distributor.	< 5ms	X		
14	2320	DC bus overcurrent / output stage	Motor defective, e.g. winding overloaded and burnt, short-circuit between winding and housing? Short-circuit in the cable between two phases or between a phase and the shield? Insulation of motor phase connections? Defect inside DIS-2 310/2 FB (output stage defective or insulation fault - insulating foil)	< 10µs	X		

Error no.	CAN error code	Meaning	Possible causes / measures	Release time	Reaction		
					C	E	W
15	3220	DC bus undervoltage	DC bus (intermediate circuit) supply too low? DC bus (intermediate circuit) supply cannot be loaded sufficiently, e.g. during acceleration with full current? Check the configuration of the DC bus (intermediate circuit) monitoring system. If necessary, set to 70% to 50% of the rated voltage.	< 1ms	X	X	X
16	3210	DC bus overvoltage	DC bus voltage > 400 V. DC bus (intermediate circuit) supply too high during idling? Check rating. Brake energy too high when axes are decelerated. Capacity in DC bus (intermediate circuit) too low. Install an additional capacitor (approx. 10,000 µF / per 10 A motor current)	< 1ms	X		
17	7385	Error Hall encoder	Angle encoder connected? Angle encoder cable defective? Angle encoder defective? Check the configuration of the angle encoder interface.	< 5ms	X		
19	2312	I^2t error motor (I^2t at 100%)	Angle encoder, number of pairs of poles and direction adjusted correctly - Automatic motor identification performed? Motor blocked? Check the power rating of the drive package.	< 100ms	X	X	X
20	2311	I^2t error controller (I^2t at 100%)	See error 19.	< 100ms	X	X	X
26	2380	I^2t at 80%	Motor blocked? Check the power rating of the drive package.	< 100ms	X	X	X
27	4380	Motor temperature 5°C below maximum	Check the power rating of the drive package.	< 100ms	X	X	X
28	4280	Output stage temperature 5°C below maximum	Check the power rating of the drive package. DIS-2 310/2 FB heated up by the motor? Decouple the DIS-2 310/2 FB thermally if necessary. Check / improve the installation and the cooling conditions.	< 100ms	X	X	X
29	8611	Following error control	Motor blocked? Controller adjusted optimally, particularly the internal control circuits for current and speed? Acceleration parameterization too high? Error window too small. Increase the window.	< 5ms	X	X	X
30	3280	Loading period DC-bus exceeded	Please contact the Technical Support	< 1s	X		

Error no.	CAN error code	Meaning	Possible causes / measures	Release time	Reaction		
					C	E	W
31	8612	Error limit switch	Limit switch correctly wired? Limit switch defective? Check the configuration of the limit switches.	< 1ms	X	X	X
32	3285	Supply power breakdown at controller enable	Interruption / mains failure of power supply. Check the supply	< 100ms	X	X	
35	6199	Timeout: Quick stop	Has an angle encoder error occurred? Motor identification not performed successfully? Acceleration parameterization too high?	< 5ms	X		
36	8A80	Error during homing run	Homing run could not be completed successfully. Check the configuration of the homing run. Parameterization of the controller including the angle encoder configuration OK?	< 5ms	X	X	X
37	--	Error: EtherCAT field bus monitoring	No bus signal at the EtherCAT field bus interface	< 5ms	X		
38	--	Error: EtherCAT technology modul	Is the correct firmware for EtherCAT loaded? Please contact the Technical Support	< 5ms	X		
40	6197	Error: Motor and resolver identification	Angle encoder connected? Angle encoder cable defective? Angle encoder defective? Check the configuration of the angle encoder interface.	< 5ms	X		
43	6193	Course program: unknown command	Please contact the technical support team.	< 5ms	X	X	
44	6192	Course program: invalid branch destination	The digital inputs for START1 & START2 are set simultaneously. An invalid branch destination / an invalid target position will be addressed.	< 5ms	X	X	
46	8120	Exceeded time for node guarding	No received remote frame during parameterized note guarding time	< 5ms	X	X	X
47	--	Error: PROFIBUS technology modul	Is the correct firmware for PROFIBUS loaded? Please contact the Technical Support	< 5ms	X		
48	--	Error: initialising PROFIBUS	Please contact the Technical Support	< 5ms	X		
53	--	EtherCAT communication error	Field bus communication is disturbed: Check installation regarding EMC aspects. Check baud rate Check node number – exist node number twice?	< 5ms	X	X	X
54	--	PROFIBUS communication error	Field bus communication is disturbed: Check the installation regarding EMC aspects. Check the node number setting - node used more than once in the network	< 5ms	X	X	X

Error no.	CAN error code	Meaning	Possible causes / measures	Release time	Reaction		
					C	E	W
55	8100	CAN communication error	Field bus communication disturbed: Check the installation regarding EMC aspects. Check the baud rate setting Check the node number setting - node used more than once in the network?	< 5ms	**X**	**X**	**X**
56	7510	RS232 communication error	Communication disturbed: Check the installation regarding EMC aspects.	< 5ms	**X**	**X**	**X**
57	6191	Error position data set	Conflict between acceleration and running speed. Please contact the technical support team.	< 5ms	**X**		
58	6380	Error: Operating mode	Change of operating mode while the power stage is switched on.	< 5ms	**X**	**X**	**X**
59	6195	Common error in arithmetic	Internal error. Please contact the technical support team.	< 5ms	**X**		
60	6190	Error: Position precomputation	Internal error. Please contact the technical support team.	< 5ms	**X**		
61	8762	Time out SYNC message	No received SYNC message during parameterized SYNC time	< 5ms	**X**	**X**	**X**
62	6180	Stack overflow	Internal error. Please contact the technical support team.	< 5ms	**X**		
63	5581	Check sum error	Internal error. Please contact the technical support team.	< 5ms	**X**		
64	6187	Initialization error	Internal error. Please contact the technical support team.	< 5ms	**X**		

The servo positioning controller internally manages the error no. 1 to no. 64.

If your device respectively the DIS-2 ServoCommander™ displays an error number which is not described in the error table and marked as an "unknown error", please contact your local distributor.

It is possible to assign these error numbers for firmware extensions or customized firmware versions with additional monitoring functions.