Servo Controller
SE-Power FS

- **Operating Instructions**

Operating manual

Declaration of Incorporation

Declaration of incorporation according to the EC Machinery Directive 2006/42/EC notes II, 1B for partly completed machinery.

Manufacturer:	Afag Automation AG Luzernstrasse 32 CH-6144 Zell Switzerland
Person established within the Community who is authorised to compile the relevant technical documents:	Niklaus Röthlisberger Produkte-Manager Afag Automation AG Luzernstrasse 32 CH-6144 Zell Switzerland

Description and identification of the partly complete machinery:

Products SE-Power FS 1kVA, SE-Power FS 3kVA, SE-Power FS 6kVA

The designated products are in conformance with the regulations of the following European Directives:

Number	**2006/95/EG**
Text	Directive of the European Parliament and of the Council of 12 December 2006 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits.
Number	**2004/108/EG**
Text	Council Directives on the approximation of the laws of Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC

Important information!

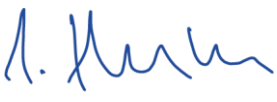
Servo controllers are **no** products in the sense of the EC Machinery Directive.

The servo controllers may only be used in machines or systems after the manufacturer of the machine or system has guaranteed the CE conformity of the overall machine or system.

According to the EMC Directive, the devices mentioned are no products which can be operated as stand-alone products. Compliance with the directive requires correct installation of the products, adherence to the specific installation notes and the product documentation.

Zell, 31.05.2023

Adrian Fuchser



CEO Afag Gruppe

Klaus Bott

CTO Afag Gruppe

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This manual applies to:

Type	Order No.
Servo Controller SE-Power FS STO 1kVA	50036337
Servo Controller SE-Power FS STO 3kVA	50162993
Servo Controller SE-Power FS STO 6kVA	50183996
Accessories	**Order No.**
SE-Power I/O Interface	50038778 **(5.5V not more employ)**
SE-Power I/O Interface 3.3V	50112458 **active 3.3V**
SE-Power Profibus Interface	50036340
SE-Power EtherCAT Interface	50038777

Assembly and initial start-up may be carried out by qualified personnel only and according to these operating instructions.

Caution!

As this manual is a complementary document to the operating instructions it alone is not sufficient to carry out installation and commissioning of the device.

Please pay attention to the notes in:

Fehler! Verweisquelle konnte nicht gefunden werden. Fehler! Verweisquelle konnte nicht gefunden werden.

1 General

1.1 Documentation

For the Servo Controllers of the SE-Power series are considerably documentations available.

There are main documents and complementary documents.

The documents contain safety instructions that must be followed.

Main document:

present	documentation / description
☒	▪ **SE-Power FS Operating manual** Description of the technical data and the functions of the device as well as notes on the plug assignment, installation and operation of the SE-Power FS servo controller series. It is meant for persons who want to get familiar with the SE-Power FS servo controller

Caution!

The operating manual is the main document and must be read by all means before installation and start-up of all devices of the SE-Power FS series.

Complementary documents to the operating manual:

present	documentation / description
☐	▪ **SE-Power FS mounting instructions** This manual is included during delivery of the SE-Power FS devices and provides an extract from the manual represents the installation instructions contained therein make sure that they can easily operate the servo drive.
☐	▪ **SE-Power FS STO-manual** Description of the technical data and the device functionality, installation, and operation of the safety module STO.
☐	▪ **SE-Power FS MOV-manual** Description of the technical data and the device functionality, installation, and operation of the safety module MOV.
☐	▪ **SE-Power Software-manual** Description of the software SE-Commander with the individual functions.
☐	▪ **SE-Power CANopen-manual** Description of the implemented CANopen protocol according to CiA DSP402 and DS301.

☐	▪ **SE-Power FS PROFIBUS/PROFINET-manual** Description of the implemented PROFIBUS-DP and PROFINET protocols, the technical data and the device functionality, installation, and operation of the fieldbus-modules „SE-Power Profibus Interface“ and „SE-Power Profinet Interface“.
☐	▪ **SE-Power EtherCAT-manual** Description of the fieldbus control by using the CoE (CANopen over EtherCAT) protocol, the technical data and the device functionality, installation, and operation of the fieldbus-module „SE-Power EtherCAT Interface“.
☐	▪ **SE-Power FS programming example Siemens S7 V5.5** Description of the configuration and program from the programming example for Siemens S7 V5.5.
☐	▪ **SE-Power FS programming example Siemens S7 TIA V12** Description of the configuration and program from the programming example for Siemens S7 TIA V12.
☐	▪ **SE-Power FS Programming example Profinet Siemens S7 TIA V13/V14** Description of the configuration and program to the programming example for Profinet for Siemens S7 TIA V13.1 and V14.0.

These documents are available for download on our homepage:

www.afag.com

2 Safety notes for electrical drives and controllers

2.1 Used symbols

Information

Important information and notes.

Caution!

No observance may result in severe property damages.

DANGER!

No observance may result in property damages and in personal injuries.

Caution! Life-threatening voltages.
The safety instruction contains a pointer to the occurrence of a possibly life-threatening voltage.

2.2 General Notes

In the case of damage resulting from non-compliance of the safety notes in this manual Afag will assume any liability.

Prior to the initial use you must read the chapters *2 Safety notes for electrical drives and* controller and *8.15 Notes on 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 positioning controller requires proper and professional transportation, storage, mechanical installation, and project planning – with a consideration of the risks as well as the protective and emergency measures – plus the proper and professional electrical installation, operation, and maintenance of the 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 positioning 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 positioning controller.

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

2.3 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!

2.4 Safety notes

2.4.1 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 *8.15 Notes on 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 any claims to completeness, the following specifications shall apply:

VDE 0100	Regulations for the installation of high voltage (up to 1000V) devices
EN 1037	Safety of machinery - Prevention of unexpected start-up
EN 60204-1	Safety of machinery - Electrical equipment of machines Part 1: General requirements
EN 61800-3	Adjustable speed electrical power drive systems Part 3: EMC requirements and specific test methods
EN 61800-5-1	Adjustable speed electrical power drive systems Part 5-1: Safety requirements - Electrical, thermal and energy
EN 61800-5-2	Adjustable speed electrical power drive systems Part 5-2: Safety requirements - Functional
EN ISO 12100	Safety of machinery - General principles for design - Risk assessment and risk reduction
DIN EN ISO 13849-1	Safety of machinery - Safety-related parts of control systems Part 1: General principles for design
EN ISO 13849-2	Safety of machinery - Safety-related parts of control systems Part 2: Validation

More standards to be respected by the user:

EN 574	Safety of machinery - Two-hand control devices
EN 1088	Safety of machinery - Interlocking devices associated with guards
EN 1037	Safety of machinery - Prevention of unexpected start-up
EN ISO 13850	Safety of machinery - Emergency stop

2.4.2 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 positioning 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, for example 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!

Keep 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 of the servo positioning controller and up to 5 minutes thereafter. Contact may result in death or serious personal injury. Wait for this time prior to performing any work on the affected connections. Measure the voltages for your own protection. Contact with these high DC bus circuit voltages 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 (24 V) is switched off.

The DC bus circuit or the mains supply must always be switched off prior to switching off the 24 V 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 enabling's are no suitable means of locking. In the case of a malfunction the drive may accidentally be put into action.

This does not apply to drives with the special "Safe Stop" feature in accordance with EN 954-1 CAT 3 or with the "Safe Torque Off" feature in accordance with EN 61800-5-2. This feature can be achieved with the SE-Power FS by integrating the module SE-Power FS Safety Module STO for example.

Initial operation must be carried out with idle motors, to prevent mechanical damages for example 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 positioning controller and in particular the brake resistor, externally or internally, can assume high temperatures, which may cause serious burns.

2.4.3 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 housing, for example a switch cabinet. The national regulations for safety/accident prevention must be complied with!

Always connect the ground conductor of the electrical equipment and devices securely to the mains supply. Due to the integrated line filter the leakage current exceeds 3.5 mA!

Comply with the minimum copper cross-section for the ground conductor over its entire length (see for example EN 60800-5-1).

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.

The device comprises a rapid discharge circuit for the DC bus as per EN 60204-1. In certain device constellations, however, mostly in the case of parallel connection of several servo positioning controllers in the DC bus or in the case of an unconnected brake resistor, this rapid discharge may be rendered ineffective. The servo positioning controllers can carry voltage until up to 5 minutes after being switched off (residual capacitor charge).

2.4.4 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 positioning 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 61800-5-1

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.

2.4.5 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 super ordinated 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 super ordinated 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.

2.4.6 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!

2.4.7 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 (for example 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

The servo positioning controller SE-Power series is an intelligent AC servo with extensive parameterization and expansion options.

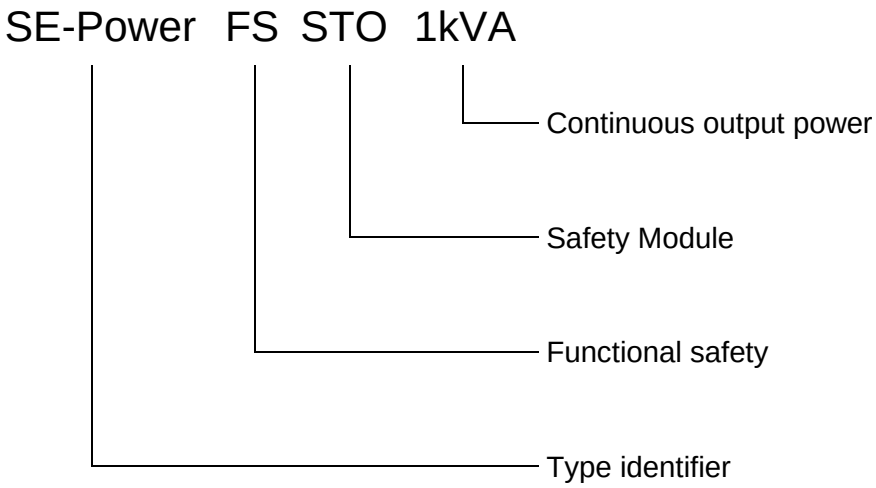


Figure 1: Type key

The servo positioning controller SE-Power FS are connected to the AC mains. The servo positioning controller SE-Power FS 1kVA is single phase and the 3kVA and 6kVA units with three-phase power connected. In this case the respective nominal voltages of the motors have to be observed.

All servo positioning controllers of the SE-Power FS series have the following features:

- Space-saving compact design, directly cascadable
- High quality of control due to extremely high-quality sensor technology, far superior to conventional market standards, and better than average computer resources
- Complete integration of all of the components for the controller and power module, including USB, Ethernet, and RS232 for the PC communication, plus CANopen for the integration into automation system
- SD card: support of FW downloads (initialisation via boot switches) and uploads and downloads of parameter sets
- Integrated universal encoder evaluation for the following encoders:
  - Resolver
  - Incremental encoder with/without commutation signals
  - High-resolution Stegmann incremental encoders, absolute encoders with HIPERFACE
  - High-resolution Heidenhain incremental encoders, absolute encoders with EnDat
- Compliance with current European regulations and associated standards without any additional external measures

- Device design as per UL standards
- Completely closed, EMC-optimized metal housing for mounting to conventional control cabinet plates. All devices comply with the IP20 degree of protection.
- Integration of all filters to fulfil the EMC regulations (industrial) inside the device, for example line filter, motor output filter, filter for 24V-supply as well as inputs and outputs
- Integrated brake resistor. External resistors can be connected for higher braking energies.
- Complete galvanic separation of controller and power output stage as per EN 61800-5-1. Galvanic separation of the 24V potential area with the digital inputs and outputs, analogue electronics and the controller electronics.
- Operation as speed controller, torque controller or positioning controller
- Integrated positioning control with wide range of functions as per CAN in Automation (CiA) DSP402 and numerous additional application-specific functions.
- Jerk limit or time-optimal positioning relative or absolute to a point of reference
- Point-to-point positioning (with or without S-ramps)
- Jogging
- Short cycle times, in current control circuit 50 µs (20 kHz), in speed control circuit 100 µs (10 kHz)
- Freely programmable I/O‘s
- User-friendly parameterisation with the Afag SE-Commander software
- Easy coupling to host controller, e.g. to a PLC via I/O level or fieldbus
- High-resolution 16-bit analogue input
- Technology slots for extensions such as I/O extension module, Profibus interface - or EtherCAT interface.
- Option “STO” (Safe Torque Off, corresponds to EN 60204 Stop 0), SIL 3 in accordance with ISO EN 61800-5-2 / PLe in accordance with ISO EN 13849-1

3.2 Power supply

3.2.1 AC supply

The servo positioning controller SE-Power FS 1kVA fulfils the following demands:

- Wide input voltage range, single phase, rated voltage 230VAC (SE-Power FS 1kVA)
- Wide input voltage range, tree phase, rated voltage 400 VAC (SE-Power FS 3kVA and SE-Power FS 6kVA)
- Frequency range nominal 50-60Hz ±10%
- Electrical impulse load capacity for possible combination of several servo positioning controllers. The servo positioning controller SE-Power FS allows dynamic conversion in both directions between motor and generator operation without dead times.
- No parameterisation by user necessary

Behaviour during switch-on:

- As soon as the servo positioning controller SE-Power FS is supplied with the input voltage, the DC bus is loaded (< 1 s) using the brake resistor as a precharging resistor, the DC link relay deactivated.
- After precharging of the DC bus the relay is energized and the DC bus is coupled hard to the mains power without the precharging resistor.

3.2.2 DC bus coupling, DC supply

DC bus coupling:

- It is possible to couple multiple servo positioning controllers of the SE-Power FS series when they have the same DC bus voltage. For this purpose, the PFC stage has to be deactivated.

DC supply:

- The direct DC supply is supported for a supply with voltages ≥ 60 VDC by the DC-bus connection instead of the connection to the mains.

The digital motor temperature measurement system requires a DC-link voltage of 120VDC minimum. Below this voltage, the system will always identify the digital motor temperature sensor as open.

3.2.3 Mains fuse

A slow-blow (B16) single-phase or tree-phase automatic circuit breaker of 16 A has to be installed in the mains supply line.

> In case of a required UL-certification the following data for the main fuse are to be considered:
> Listed Circuit Breaker according UL 489, rated 277 Vac, 16 A,
> SCR 10 kA

3.3 Brake chopper

A brake chopper with a brake resistor is integrated into the power output stage. 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. The internal braking resistor is overload-protected by means of software and hardware.

If in a special application the power of the internal resistors should be insufficient, they can be cut off by removing the bridge between the pin *BR-CH* and *BR-INT* of the [X9] plug. Instead, an external brake resistor is inserted between the pins *BR-CH* and *ZK+*. This brake resistor must full fill certain minimum specifications (see *Table 8* The output is protected against short-circuiting in the brake resistor or its cable.

> Pin *BR-CH* lies on positive DC bus potential and is thus not protected against ground fault or short-circuits against mains voltage or negative DC bus voltages.

Simultaneous use of the internal and external brake resistors is not possible. The external resistors are not automatically overload-protected by the device.

3.4 Communication interfaces

The servo positioning controller SE-Power FS has several communication interfaces. The basic device itself is already equipped with many of these interfaces.

The following communication interfaces are included in the basic device:

- Serial interface [X5]: RS232/RS485
- USB- interface [X19]: USB
- UDP- interface [X18]: Ethernet
- Fieldbus system [X4]: CANopen
- I/O interface [X1]: Digital and analogue In- and outputs

The serial, Ethernet, and USB interface are particularly important for the connection of a PC and for the use of the Afag SE-Commander parameterisation tool.

The fieldbus systems PROFIBUS-DP and EtherCAT are extension options that can be implemented in the form of plug-in modules. If required, customer-specific fieldbus protocols can also be realised.

In any case, the servo positioning controller of this design always works as a slave to the fieldbus.

3.4.1 Serial interface [X5]

The RS232 protocol is mainly intended to be a parameterisation interface, but also allows the control of the servo positioning controller SE-Power FS.

3.4.2 USB interface [X19]

This interface, too, was mainly intended as a parameterisation interface, but it can also be used for controlling the SE-Power FS servo positioning controller.

3.4.3 UDP- interface [X18]

The UDP communication enables the connection of the SE-Power FS servo positioning controller to the Ethernet fieldbus system. The communication via the UDP interface [X18] is realised with the aid of a standard cabling. The current firmware version 4.0.801.1.2, however, does not support this feature at present.

3.4.4 CAN interface [X4]

The CANopen protocol as per DS301 with application profile DSP402 is implemented.

The servo positioning controller SE-Power FS supports the CANopen protocol as per DS301 with application profile DSP402.

3.4.5 Technology module: PROFIBUS

Support of PROFIBUS communication as per DP-V0. For drive technology applications the functions as per PROFIDRIVE Version 3.0 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/O's.

3.4.6 Technology module: EtherCAT

The EtherCAT interface enables the connection of the SE-Power FS servo positioning controller to the EtherCAT fieldbus system. The communication via the SE-Power EtherCAT interface (IEEE-802.3u) is realised with the aid of EtherCAT standard cabling.

3.4.7 I/O functions and device control

Ten digital inputs provide the elementary control functions (see chapter *4.5.6 I/O interface [*X1*])*:

The SE-Power FS 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.

Two inputs are used for the power stage enabling on the hardware side as well as for the controller enabling on the software side.

High-speed sample inputs are available for different time-critical applications (homing, special applications...).

The servo positioning controller SE-Power FS has three analogue inputs for input levels in the range of *+10V* to *-10V*. One input is designed as a differential input (16 bit), to guarantee high interference immunity. Two inputs (10 bit) are single-ended. The analogue signals are quantized and digitalized by an analogue-digital converter at a resolution of 16 bit or 10 bit. The analogue signals provide the set points (speed or torque) for the control.

4 Technical data

Table 1: Technical data: Ambient conditions and qualification

Range	Values	
Admissible temperature ranges	Storage temperature:	-25°C to +70°C
	Operating temperature:	0°C to +40°C +40°C to +50°C at reduced power 2,5% /K
Admissible installation height	Up to 1000 m above msl, 1000 to 2000 m above msl at reduced power according to EN 61800-5-1	
Humidity	Relative humidity up to 90 %, not bedewing	
Protection class	IP20	
Pollution degree	1	
CE conformity Low-voltage directive: EMC regulation: Current harmonics:	 EN 60 800 – 5 - 1 EN 61 800 - 3 EN 61 000 - 3 – 2	
Further certifications	UL certified	

Table 2: Technical data: Dimensions and weight

Type	SE-Power FS 1kVA	SE-Power FS 3kVA	SE-Power FS 6kVA
Dimensions including the mounting plate (H*W*D)	261mm*54,5mm*205mm	334,5mm*69mm*245,5mm	
Dimensions (H*W*D)	200mm*54mm*200mm	250mm*69mm*240mm	
Weight	approx. 2,1kg	approx. 3,7kg	

Table 3: Technical data: Cable specifications

Range	SE-Power FS 1kVA	SE-Power FS 3kVA	SE-Power FS 6kVA
Maximum motor cable length for interference emission as per EN 61800-3			
Category C2 Switch cabinet assembly (see *chapter 8.15 Notes on safe and EMC-compliant installation*)	l ≤ 25m	l ≤ 50m	
Category C3 (industrial area)	l ≤ 25m	l ≤ 50m	
Cable capacity of a phase against shield or between two lines	C‘ ≤ 200pF/m		

Table 4: Technical data: Motor temperature monitoring

Motor temperature monitoring	Values		
Digital Sensor	Normally closed contact:	R_{cold} < 500 Ω	R_{hot} > 100 kΩ
Analogue Sensor	Silicon temperature sensor, for example KTY81, 82 or similar. R_{25} ≈ 2000 Ω R_{100} ≈ 3400 Ω		

4.1 Operating and display elements

On the front, the servo positioning controller SE-Power FS has tree LED‘s and a seven-segment display to indicate the operating status.

Table 5: Display elements and RESET button

Element	Function
Seven-segment display	Display of operating mode and a coded error number in the case of a malfunction
LED1 (two-colour LED, green/red)	Operational state respectively fault
LED2 (green)	Controller enable
LED3 (yellow)	Status display CAN bus
RESET-Button	Hardware reset for processor

4.2 Supply [X9]

Table 6: Technical data: Performance data [X9]

Type	SE-Power FS 1kVA	SE-Power FS 3kVA	SE-Power FS 6kVA
Supply voltage (ZME, RME)	1 x 48 VAC [± 10%]	-	
Supply voltage (RE)	1 x 230 VAC [± 10%]	-	
Supply voltage (LME, PME, PME-c, PEZ, PDZ, OZ, LE, SA)	1 x 230 VAC [± 10%]	3 x 400 VAC [± 10%] 50…60Hz	
Alternative DC supply (ZME, RME)	48 ... 70 VDC	-	
Alternative DC supply (RE)	320 VDC	-	
Alternative DC supply (LME, PME, PME-c, PEZ, PDZ, OZ, LE, SA)	320 ... 380 VDC	560V DC	
In continuous operation maximum of mains current	4.7 A_{eff}	5 A_{eff}	9 A_{eff}
24V supply	24 VDC [± 20%] (0,65 A) *)	24 VDC [± 20%] (1 A) *)	

*) plus current consumption of a possibly connected holding brake and I/O's

Table 7: Technical data: internal brake resistor [X9]

Type	SE-Power FS 1kVA	SE-Power FS 3kVA	SE-Power FS 6kVA
Brake resistance	60 Ω	68 Ω	
Pulse power	2.8 kW	8.5 kW	
Continuous power	20 W	110 W	
Threshold limit	389 V	760 V	
Over-current detection	400 V	800 V	

Table 8: Technical data: external brake resistor [X9]

Type	SE-Power FS 1kVA	SE-Power FS 3kVA	SE-Power FS 6kVA
Brake resistance external	≥ 50 Ω	≥ 40 Ω	
Continuous power	≤ 2500 W	≤ 5000 W	
Operating voltage	≥ 460 V	≥ 800 V	

4.3 Motor connection [X6]

Table 9: Technical data: Motor connection data [X6]

Type	SE-Power FS 1kVA	SE-Power FS 3kVA	SE-Power FS 6kVA
Specifications for operation with:	1x 230 VAC [± 10%], 50 Hz	3x 400 VAC [± 10%], 50 Hz	
Output power	1,0 kVA	3,0 kVA	6,0 kVA
Max. output power for 5 s	2,0 kVA	3,0 kVA	12,0 kVA
Output current	5 A_{eff}	5 A_{eff}	10 A_{eff}
Max. output current for 5 s	10 A_{eff}	10 A_{eff} (15 A_{eff} for 2 s)	20 A_{eff}
Max. output current for 0.5s	20 A_{eff}	20 A_{eff} (f_{el} ≥ 20 Hz)	40 A_{eff} (f_{el} ≥ 20 Hz)
Current derating from	12 kHz	12,5 kHz	5 kHz
Max. clock frequency	Ca. 20 kHz	4 … 16 kHz	

4.4 Motor feedback connection [X2A] und [X2B]

Different feedback systems can be connected to the servo positioning controller via the universal encoder interface:

- Resolver (interface [X2A])
- Encoder (interface [X2B])
  - Incremental encoders with analogue and digital track signals
  - SinCos encoder (single-turn/multi-turn) with HIPERFACE
  - Multiturn absolute encoder with EnDat

The encoder type is determined in the Afag ServoCommander parameterisation software.

The feedback signal is available via the incremental encoder output [X11] for master-slave applications.

It is possible to evaluate two shaft encoder systems in parallel. Typically, the resolver for the current control is connected to [X2A], and for example an absolute encoder is connected to [X2B] as a feedback system for the positioning control.

4.4.1 Resolver connection [X2A]

Common resolvers are evaluated at the 9-pole D-Sub connector [X2A]. Single-pole and multi-pole resolvers are supported.

Table 10: Technical data: Resolver [X2A]

Parameter	Values
Transformation ratio	0,5
Carrier frequency	5 to 10 kHz
Excitation voltage	7 V_{eff}, short circuit-proof
Impedance excitation (at 10kHz)	≥ (20 + j20)Ω
Impedance stator	≤ (500 + j1000)Ω

Table 11: Technical data: Resolver interface [X2A]

Parameter	Values
Resolution	16 Bit
Delay time signal detection	< 200 µs
Speed resolution	ca. 4 min^{-1}
Absolute accuracy of angle detection	< 5´
Max. rotational speed	16.000 min^{-1}

4.4.2 Encoder connection [X2B]

At the 15-pole D-Sub connection [X2B], motors with encoder can be fed back. The possible incremental encoders for the encoder connection are divided into several groups. If you want to use other types of encoders, please contact your sales representative.

Table 12: Technical data: Encoder evaluation [X2B]

Parameter	Values
Parameterisable number of encoder lines	1 – 2^{18} lines/revolution
Angular resolution / Interpolation	10 Bit / period
Encoder signals A, B	1 V_{SS} differential, 2.5 V Offset
Encoder signal N	0,2 to 1 V_{SS} differential, , 2.5 V offset
Commutation track A1, B1 (optional)	1 V_{SS} differential, , 2.5 V offset
Input impedance encoder signals	Differential input 120 Ω
Limit frequency	I_{imit} > 300 kHz (high-resolution signal) I_{imit} ca. 10 kHz (commutation track)
Additional communication interface	EnDat (Heidenhain) and HIPERFACE (Sick-Stegmann)
Output supply	5 V or 12 V; max. 300 mA; current-limited control via sensor lines Set point programmable via SW

Standard incremental encoders without commutation signals:

This type of encoder is used with low-cost linear motor applications, to save the costs for the provision of the commutation signals (hall sensor). With this type of encoder the servo positioning controller SE-POWER must carry out an automatic pole position determination after power-on.

Standard incremental encoders with commutation signals:

These are standard incremental encoders with three binary hall sensor signals. The number of lines of the encoder can be freely parameterized (1 – 16384 lines/rotation).

There is an additional offset angle for the hall sensor signals. It is determined during motor identification or can be set via the parameterisation software. In general, the hall sensor offset angle is zero.

Sick-Stegmann encoder:

Single-turn and multi-turn shaft encoders with HIPERFACE made by Sick-Stegmann are supported. The following series of encoders can be connected:

- Singleturn SinCos encoders: SCS 60/70, SKS 36, SRS 50/60/64, SEK 37/52
- Multiturn SinCos encoders: SCM 60/70, SKM 36, SRM 50/60/64, SEL 37/52
- Singleturn SinCos Hollow shaft encoders: SCS-Kit 101, SHS 170, SCK 25/35/40/45/50/53
- Multiturn SinCos Hollow shaft encoders: SCM-Kit 101, SCL 25/35/40/45/50/53

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

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

SinCoder® encoders like SNS 50 or SNS 60 are no longer supported.

Heidenhain encoders:

Incremental and absolute encoders by Heidenhain are evaluated. The following series of encoders can be connected:

- Analogue incremental encoders: ROD 400, ERO 1200/1300/1400, ERN 100/400/1100/1300
- Singleturn absolute encoders (EnDat 2.1/2.2): ROC 400, ECI 1100/1300, ECN 100/400/1100/1300
- Multiturn absolute encoders (EnDat 2.1/2.2): ROQ 400, EQI 1100/1300, EQN 100/400/1100/1300
- Absolute length measuring system (EnDat 2.1/2.2): LC 100/400

Yaskawa encoders:

Digital incremental encoders with zero-pulse [Σ (sigma 1), Yaskawa-OEM-protocol] made by Yaskawa are supported.

4.5 Communication interfaces

4.5.1 RS232 [X5]

Table 13: Technical data: RS232 [X5]

Communication interface	Values
RS232	according to RS232 specification 9600 baud to 115.2k baud

4.5.2 USB [X19]

Table 14: Technical data: USB [X19]

Communication interface	Values
Function	USB 2.0, Slave–Client, 12 MBaud to 480 MBaud
Connector type	USB-B, no current consumption from the bus (integrated power supply)
Communication protocol	Manufacturer specific (generic device)

4.5.3 Ethernet [X18]

Table 15: Technical data: Ethernet [X18]

Communication interface	Values
Function	Ethernet, 10/100 MBaud (auto select)
Connector type	RJ45

4.5.4 CAN-Bus [X4]

Table 16: Technical data: CAN-Bus [X4]

Communication interface	Values
CANopen controller	ISODIS 11898, Full-CAN-controller, max. 1M Baud
CANopen protocol	according DS301 and DSP402

4.5.5 SD-/MMC-Card

Table 17: Technical Data: SD-/MMC-Card

Communication interface	Values
Card type	SD, SDHC and MMC
File system	FAT12, FAT16 and FAT32

4.5.6 I/O interface [X1]

Table 18: Technical Data: digital inputs and outputs [X1]

Digital inputs / outputs	Values	
Signal level	24V (8V...30V) active high, conform with EN 1131-2	
Logical inputs general DIN0 DIN1 DIN2 DIN3	 Bit 0 \ Bit 1, \ Target selection for positioning Bit 2, / 16 targets selectable from target table Bit 3 /	
DIN4	Control input stage enable at High	
DIN5	Controller enable at high signal, acknowledge error with falling edge	
DIN6	End switch input 0	If hardware limit switches are required, a parameter file must be requested in accordance with specification Afag.
DIN7	End switch input 1	
DIN8	Homing switch	
DIN9	Control signal Start positioning	
DIN AIN1	Start homing	
DIN AIN2	Set-up mode (low active)	0V ➔ slow 24V ➔ normal operation
Logic outputs general	Galvanically separated, 24V (8V...30V) active high	
DOUT0	Servo controller operational	24 V, max. 100 mA
DOUT1	Homing position valid	24 V, max. 100 mA
DOUT2	In position	24 V, max. 100 mA
DOUT3	Remaining distance	24 V, max. 100 mA
DOUT4 [X6]	Holding brake	24 V, max. 1 A

Table 19: Technical Data: analogue inputs and outputs [X1]

Analogue in-/outputs	Values	
High-resolution analogue input: AIN0	□10V input range, 16 Bit, differentially, < 250µs delay time	
Analogue input: AIN1	This input is default pre-parameterised from Afag as digital input DIN AIN1 with a switching threshold at 8V.	±10V, 10 Bit, single ended, < 250µs delay time
Analogue input: AIN2	This input is default pre-parameterised from Afag as digital input DIN AIN2 with a switching threshold at 8V.	±10V, 10 Bit, single ended, < < 250µs delay time
Analogue outputs: AOUT0 and AOUT1	±10V output range, 9 bit resolution, l_{imit} > 1kHz	

4.5.7 Incremental encoder input [X10]

The input supports all common incremental encoders.

For example encoders corresponding to the industry standard ROD426 by Heidenhain or encoders with single-ended TTL outputs as well as open collector outputs.

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 20: Technical Data: Incremental encoder input [X10]

Parameter	Values
Parameterisable line count	1 – 2^{28} lines/revolution
Trace signals: A, #A, B, #B, N, #N	In accordance with RS422 specification
Max. input frequency	1000 kHz
Pulse direction interface: CLK, #CLK, DIR, #DIR, RESET, #RESET	In accordance with RS422 specification
Supply output	5 V, 100 mA max.

4.5.8 Incremental encoder output [X11]

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

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

Besides the encoder signals A and B, the emulation also provides a reset pulse, which goes to high once per rotation (for the programmed number of lines), for the duration of a ¼ signal period (as long as the encoder signals A and B are high).

Table 21: Technical Data: Incremental encoder output [X11]

Parameter	Value
Number of lines	Programmable 1 – 2^{13} and 2^{14} lines/revolution
Connection level	Differential / RS422 specification
Encoder signals A, B, N	In accordance with RS422 specification
speciality	N-Trace disconnectable
Output impedance	$R_{a,diff}$ = 66 Ω
Frequency limit	l_{imit} > 1,8 MHz (lines/s)
Edge sequence	Can be limited by parameters
Output supply	5 V, 100 mA max.

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 SE-Power FS is a universal servo positioning controller, which can be operated with standard servo motors. The motor specifications are determined and parameterized by means of an automatic motor identification.

5.1.2 Linear motors

Besides rotary applications, the servo positioning controllers SE-Power FS are also suitable for linear drives. Here also, permanently excited synchronous linear motors are supported. Due to the high signal processing quality, the SE-Power FS series is particularly suitable for driving air-core and iron-core synchronous motors with low motor inductances (2 … 4 mH).

5.2 Positioning control

5.2.1 Overview

In positioning mode a certain position is set, which is to be approached by the motor. The current position is derived from the information provided by the internal encoder evaluation. The position deviation is processed in the position controller and is passed on to the speed controller.

The integrated positioning control allows jerk-limited or time-optimal positioning relative or absolute to a point of reference. It provides the position controller and - to improve the dynamics - the speed controller also, with the set points.

In the case of absolute positioning a set target position is directly approached. In the case of relative positioning a parameterized route is run. The positioning space of 2^{32} full revolutions allows any number of relative positioning in one direction.

The positioning control is parameterized via a target table. The target table includes entries for the parameterisation of a target via a communication interface and also target positions, which can be retrieved via the digital inputs. For each entry it is possible to set the positioning method, the driving profile, the acceleration and the deceleration times as well as the maximum speed. All targets can be pre-parameterized. The only thing to do for positioning is then to select an entry and start the action. It is also possible to change the target parameters online via the communication interface.

The servo positioning controller SE-Power FS provides 250 configurable positioning sets.

The following settings are possible for all positioning sets:

- Target position
- Driving speed
- Final speed
- Acceleration
- Deceleration
- Torque feed forward
- Remaining distance trigger
- Additional flags:
  - Relative / relative to last target / absolute
  - Wait for end / interrupt / ignore start
  - Synchronized
  - Rotary axis
  - Option: automatic deceleration in case of missing following positioning

The positioning sets can be activated via all bus systems or via the parameterisation software Afag SE-Commander. The positioning process can be controlled via digital inputs.

5.2.2 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.

5.2.3 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. In the case of absolute positioning the target position is a fixed (absolute) position referred to the zero or reference point.

5.2.4 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.

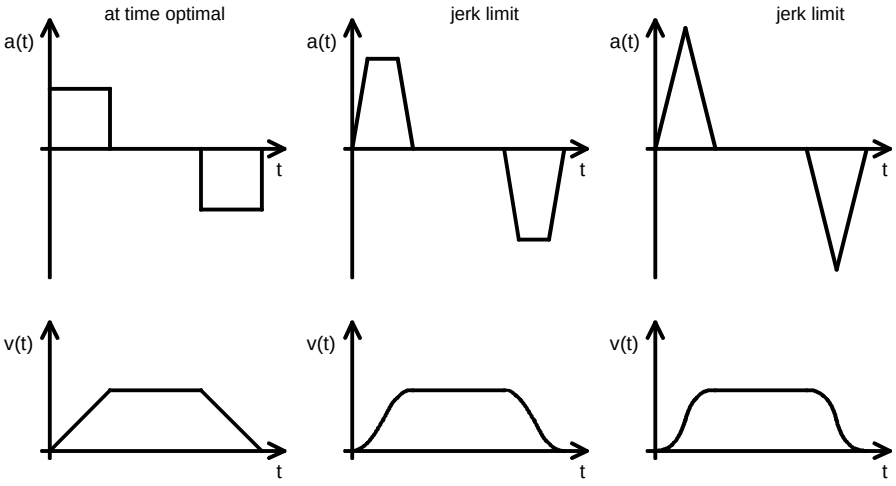


Figure 2: **Driving profiles of the servo positioning controller**

5.2.5 Homing

Every positioning control requires a defined zero at start-up, which is determined by means of a homing. The servo positioning controller SE-POWER can do this homing on its own. As reference signals it evaluates different inputs, e.g. the end switch inputs.

A homing movement can be started with a command via the communication interface or automatically with controller enable. The start of homing can also be triggered by digital input DIN AIN1 to carry out a specific homing and not to make this dependent on the controller enable. The controller enable acknowledged inter alia Error messages and is preconfigured from Afag so that when is enabled again no homing is required. Because the existing digital inputs are in common applications already used, the analogue inputs AIN 1 and AIN 2 can optionally be used as digital inputs DIN AIN 2 and AIN 1.These are already preconfigured from Afag, that the DIN AIN1 is assigned with the function "Start Homing" and DIN AIN 2 with the function "setup-mode".

For homing, several methods are implemented in accordance with DSP 402 CANopen protocol. At the most methods, first a switch is sought with search speed. Further movement will depend on the method of communication. If homing is activated via the CANopen fieldbus, there is no follow positioning to zero. However, this occurs at the start of the controller enable or RS232, Profibus or via the DIN AIN1.

At the Afag default pre-set homing method (not valid for linear motor axes LE) the reference switch is configured as normally closed and the procedure is as follows:

The axis moves in the negative direction with the search speed up the falling edge is detected from the reference sensor. Here the direction is turned and the axis moves in the positive direction with crawl speed down from the reference sensor again until a rising edge is detected from this. Position 0 is set at this point. Then positioning is performed to the following position 0 in theory. However, since no offset is parameterized and the axis is already at position 0, the homing is completed.

For the linear motor axes the process looks as follows:

The axis moves in the negative direction with the search speed till the end plate moves on block. Here the direction is turned and the axis moves in the positive direction with crawl speed till the first zero line of the measurement system is detected. Position 0 is set at this point. Then positioning is performed to the following position 0 in theory. However, since no offset is parameterized and the axis is already at position 0, the homing is completed.

The homing run thus consists of the three phases: Ref search, Ref crawl and Ref running.

If the axis is starting already on the sensor, that is when the signal is 0, only the phase Ref crawl and Ref running will be executed.

If the homing is done over the Fieldbus CANopen, in accordance on his specifications, only the phases Ref search and Ref crawl will be executed.

6 Functional safety technology

6.1 General

With an increasing degree of automation, the protection of persons against dangerous movements becomes increasingly important. The so-called functional safety describes the necessary measures in the form of electrical or electronic devices in order to reduce or eliminate the hazards that are caused by malfunctions. Under normal operating conditions, protective devices prevent human access to dangerous areas. In certain operating modes, however, for example during the set-up, persons are required to be present in these dangerous areas. In these situations, the machine operator must be protected by drive- and control-internal measures.

The integrated safety technology provides the control- and drive-specific conditions for the optimal realisation of protective functions. Planning and installation become less labour-intensive. Compared to conventional safety technology, the machine functionality and availability can be increased by the use of integrated safety technology.

By default, the servo positioning controller SE-Power FS series are delivered with built-in safety module STO. Advanced features for safety-related motion monitoring and motion control are in preparation. Once these are available, the servo positioning controller of the SE-Power FS series can be optionally factory-equipped with a safety module for enhanced safety. Please take this into account when ordering.

If the safety modules of the FSM 2.0 series (**F**unctional **S**afety **M**odule) are used, external monitoring devices are no longer required for numerous applications. The wiring of the entire system is simplified and the number of components as well as the costs of the system solution can be reduced.

The design of the safety modules ensures that they can be simply plugged into the basic device from the outside. As a result, the servo positioning controllers can be quickly adapted to the specific safety requirements of the overall system. Retrofitting of these modules (or the later use of a different safety module), thereby, becomes possible. The module is supplied with power via the power supply of the basic device.

6.1.1 DIP switch

All of the integrated functional safety modules (FSM 2.0) are equipped with a DIP switch (8 poles). Under certain conditions, substantial parts of the parameters of the fieldbus communication can be configured with the aid of this DIP switch. Depending on the fieldbus that is used, it is possible, for example, to adjust the fieldbus node number or the baud rate, and so on This DIP switch does not have a safety-relevant function.

The following applies in order to achieve downward compatibility with the previous SE-Power devices:

- If all of the switches on the module are set to zero (factory setting), the fieldbus communication parameters of the parameter data set of the basic unit will be used.

The position of the DIP switch is read in only once after a reset. Modifications of the switch positions during the operation, therefore, do not affect the current operation.

Table 22: Table overview of the DIP switch functionality

Technology module (type)	Functionality of the DIP switch		
	Communication On/Off	**Baud rate**	**Settings station address**
-- (CAN, in the basic unit)	✓	✓	✓
PROFIBUS	✓	-- (via Master)	✓
EtherCAT	--[1)]	--	--

[1)] The control of EtherCAT via the DIP switches is not planned. By using the EtherCAT fieldbus technology module the bus will be switched on automatically.

6.1.2 Assignment of the DIP switch

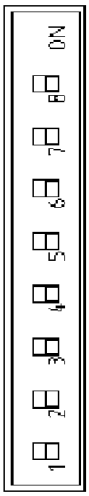
The firmware of the SE-Power FS servo positioning controllers distinguishes itself by the universal support of various types of fieldbuses. Since every fieldbus requires a specific hardware, the fieldbus is selected based on the fieldbus module that is plugged into one of the technology slots. Depending on the identified technology module, the individual switches have an influence on the activation and perhaps also on the configuration of this specific fieldbus. If the system does not find any fieldbus technology module, the switch settings affect the fieldbus CAN whose interface is integrated into the basic device. This means that if, for example, a PROFIBUS-module is installed, the switch positions cannot be used to activate the CAN communication.

The assignment of the individual switch positions to a specific function depends on the fieldbus that is used. As far as this is possible, the function of a switch is the same for all of the fieldbuses such as, for example, switch 8 for activating/deactivating the communication. The functions are listed in *Table 23*.

Applies to the technology modules listed in *Table 23* principle regarding the parameterization of communication:

- Switch position = 0:
  Activation of the communication. The baud rate and the fieldbus address will be taken from the parameter data set or – depending on the parameterisation – optionally also by an addition of digital inputs.
- Switch position <> 0:
  The configuration of the communication parameters via the DIP switch takes precedence over the corresponding settings in the parameter data set:
  - Activation of the communication via DIP switch
  - Selection of the baud rate (if it can be adjusted) via DIP switch
  - Setting of the fieldbus address via DIP switch (addition to the basic node number taken from the parameter data set)
- If the communication is deactivated via the DIP switch, it is optionally possible to reactivate or deactivate it via the Afag SE-Commander parameterisation software
- The fieldbus address that is set via the DIP switch is checked internally for validity and, if necessary, it is limited
- Fieldbus-specific functions (for example CAN: check for double node numbers) are configured via the settings in the parameter data set
- If no fieldbus technology module is connected, the DIP switch is used for the configuration of the CAN hardware that is integrated in the basic device.
  The control of operating parameters for the RS485 communication that is also supported in the basic device is not possible in favour of the parameterisation of the CAN interface.

Table 23: Fieldbus specific assignment of the r DIP switches

DIP switch		Functionality of the DIP switch (fieldbus specific with technology module)		
		CAN (in the basic unit)	PROFIBUS	EtherCAT
	8	Communication: 1: On 0: Off	Communication: 1: On 0: Off	No function
	7	Baud rate: 11: 1 MBaud 10: 500 kBaud 01: 250 KBaud 00: 125 kBaud	Slave address respectively address offset: 0 .. 127 Valid range: 3 .. 125	No function
	6			
	5	Node number respectively address offset: 1 ... 31		
	4			
	3			
	2			
	1			

The activation of a fieldbus via the DIP switch takes precedence over the activation of the fieldbus based on the parameter data set. In order to be nonetheless able to change settings and test different configurations during the operation, the fieldbus menu of the Afag SE-Commander can be used.

After a reset, however, the setting of the DIP switches will be checked and used.

Example:

- DIP switch position <> 0 and DIP8 = ON
  ➔ Fieldbus always activated, can be changed via Afag SE-Commander.
- DIP switch position <> 0 and DIP8 = OFF
  ➔ Fieldbus always off, can be changed via Afag SE-Commander.
- DIP switch position = 0
  ➔ Fieldbus configuration based on the parameter set. Can be changed and saved via Afag SE-Commander (downward-compatible).

6.2 Integrated safety technology (schematic representation)

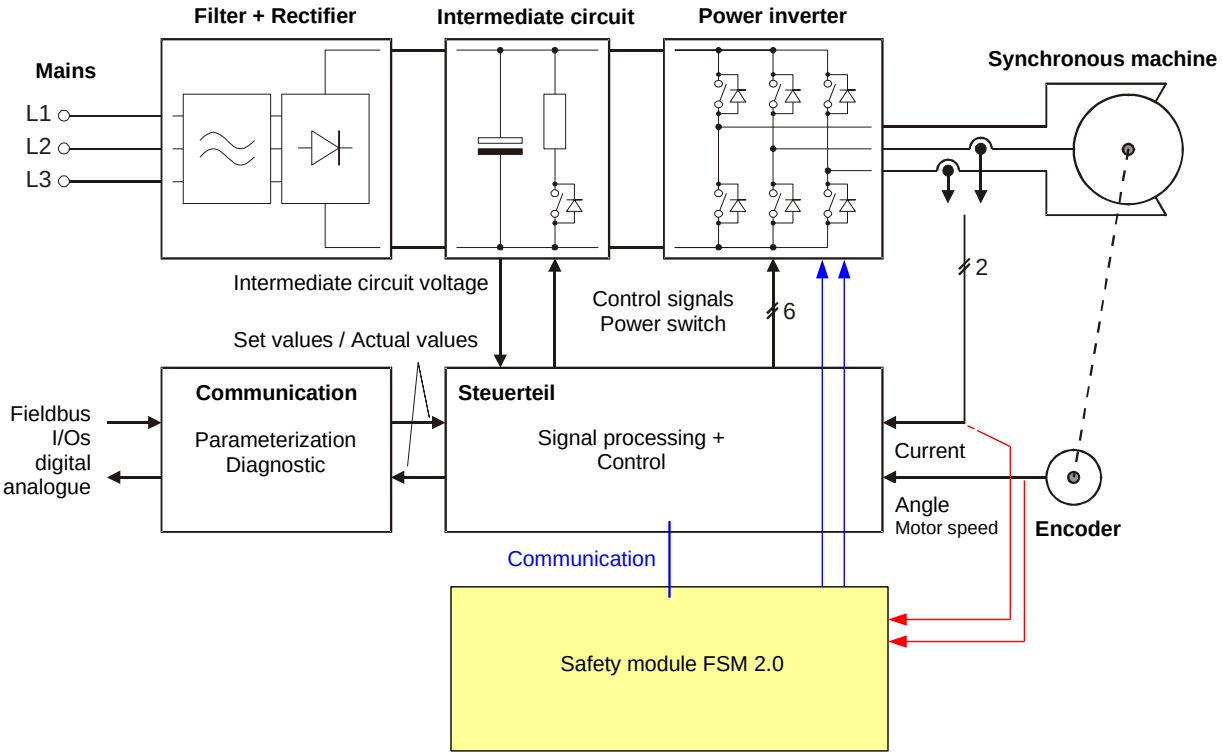


Figure 3: Schematic representation of the integrated safety technology (MOV)

6.3 Module variants

6.3.1 SE-Power FS Safety Module STO (Safe Torque Off)

Please refer to the Original instructions „SE-Power FS STO-manual“ for further information.

6.3.2 SE-Power FS Safety Module MOV

Module for the safety functions SLS, SOS, SBC etc. (in preparation).

7 Mechanical installation

7.1 Important notes

- Only use the servo positioning controller SE-Power FS as a built-in device for switch cabinets
- Mounting position vertical with supply lines [X9] on top
- Mount to control cabinet plate using a fastening strap
- Installation spaces:
  Keep a minimum distance of 100 mm to other components each above and underneath the device to ensure sufficient venting.
  For optimal wiring of the motor or encoder cable at the bottom of the units SE-Power FS 3 kVA and 6 kVA an installation free space of 150mm is recommended!
- The servo positioning controller SE-Power FS may be installed adjacently in one switch cabinet without a gap, proper usage and installation on a heat-dissipating rear panel provided. Please note that excessive heat may cause premature aging and/or damaging of the device. In case the servo positioning controller SE-Power FS are subject to high thermal stress, for the SE-Power FS 1kVA a space of 59 mm and for the SE-Power FS 3kVA respectively 6kVA a space of 75 mm is recommended!

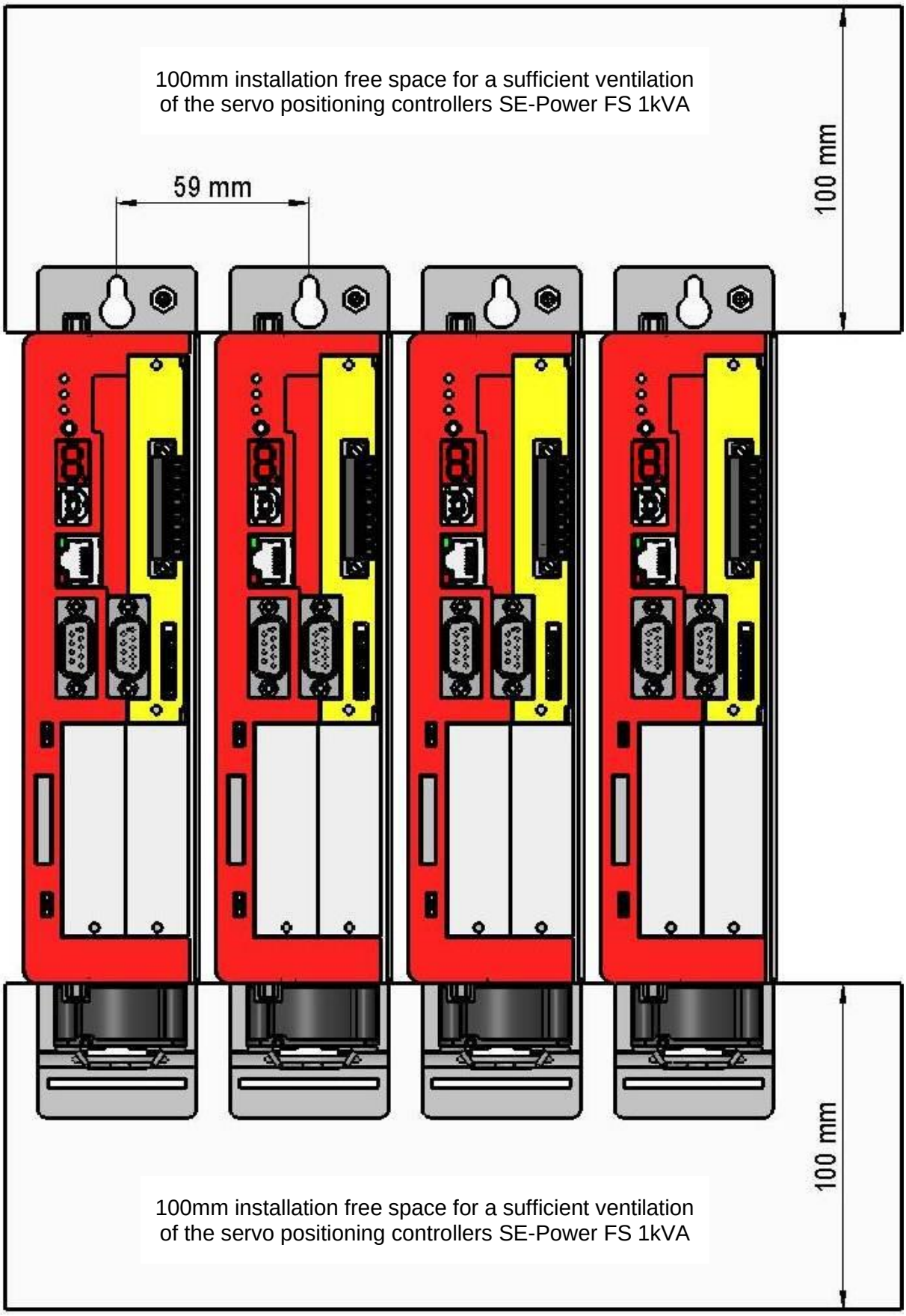


Figure 4: Servo positioning controller SE-Power FS 1kVA: Installation space

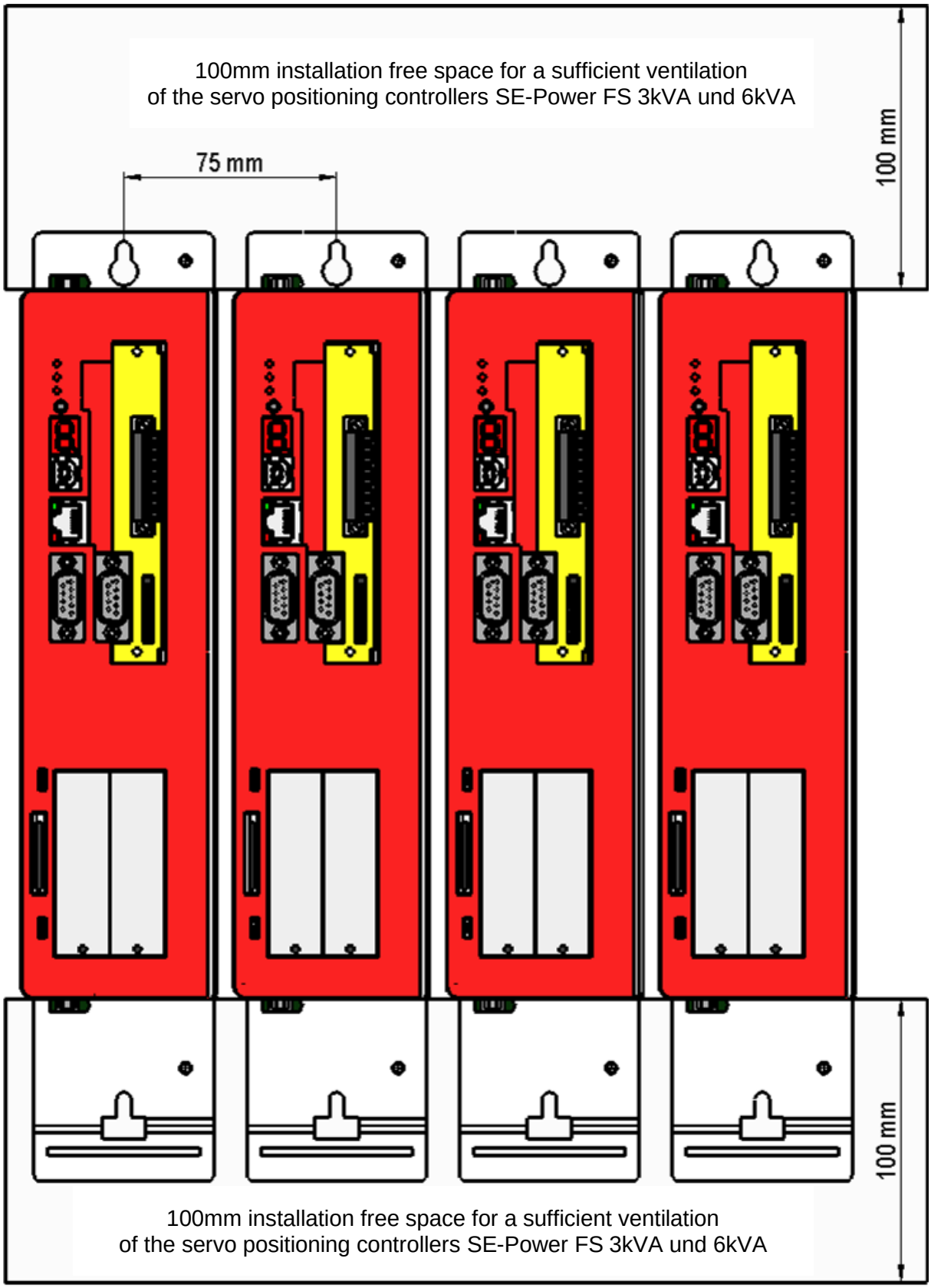


Figure 5: Servo positioning controller SE-Power FS 3kVA and 6kVA: Installation space

7.2 View of the device

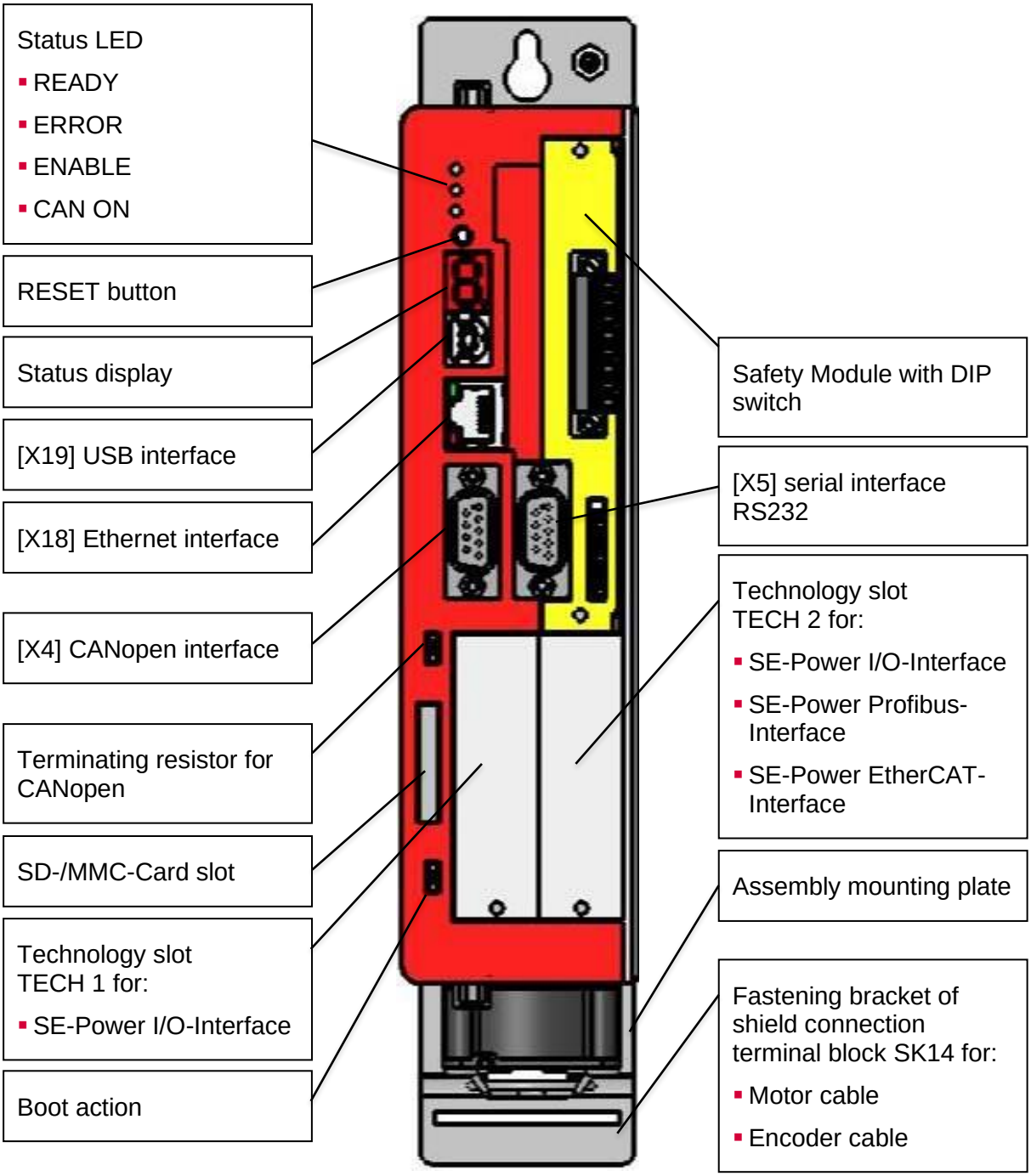


Figure 6: Servo positioning controller SE-Power FS 1kVA: Front view

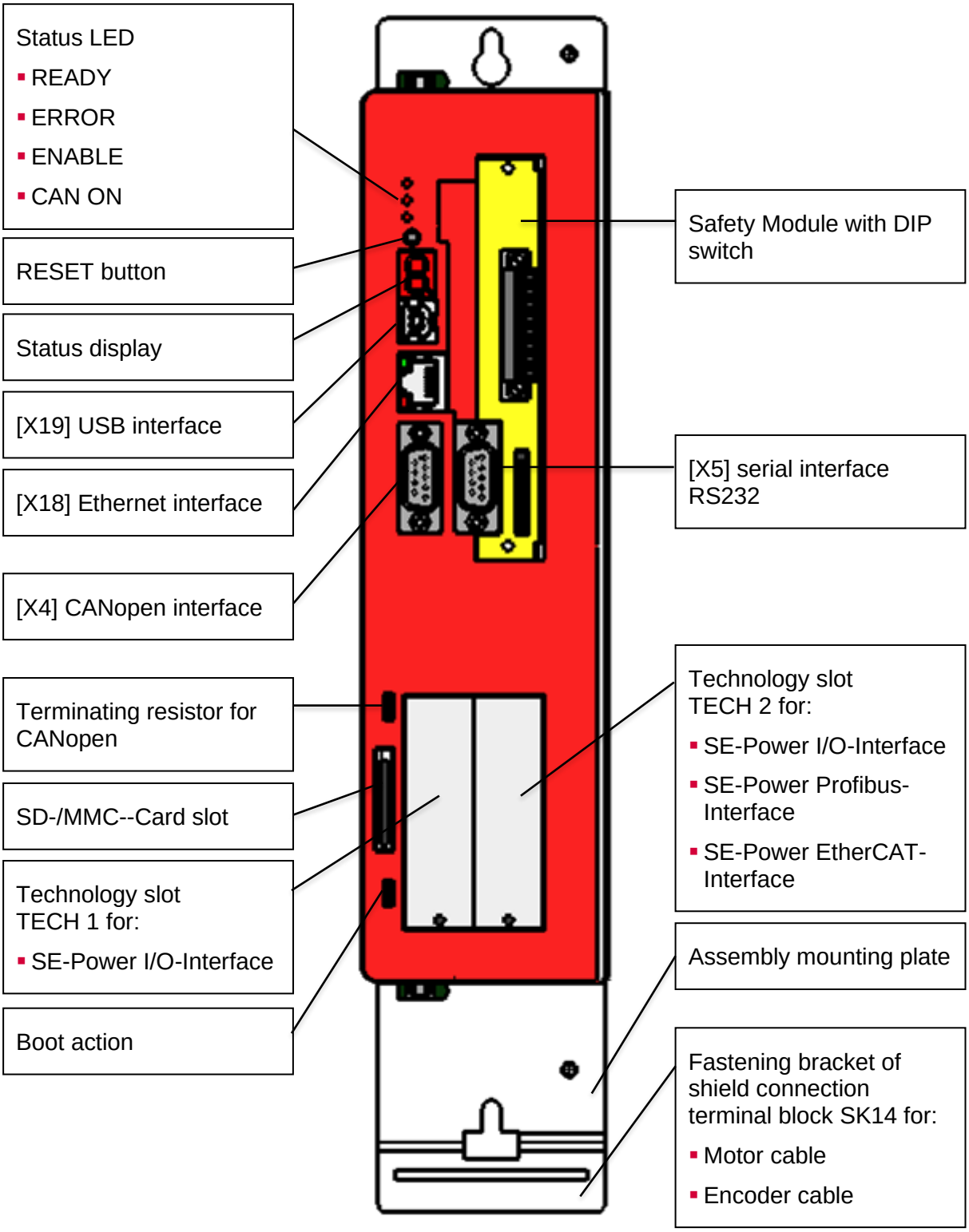


Figure 7: Servo positioning controller SE-Power FS 3kVA and 6kVA: Front view

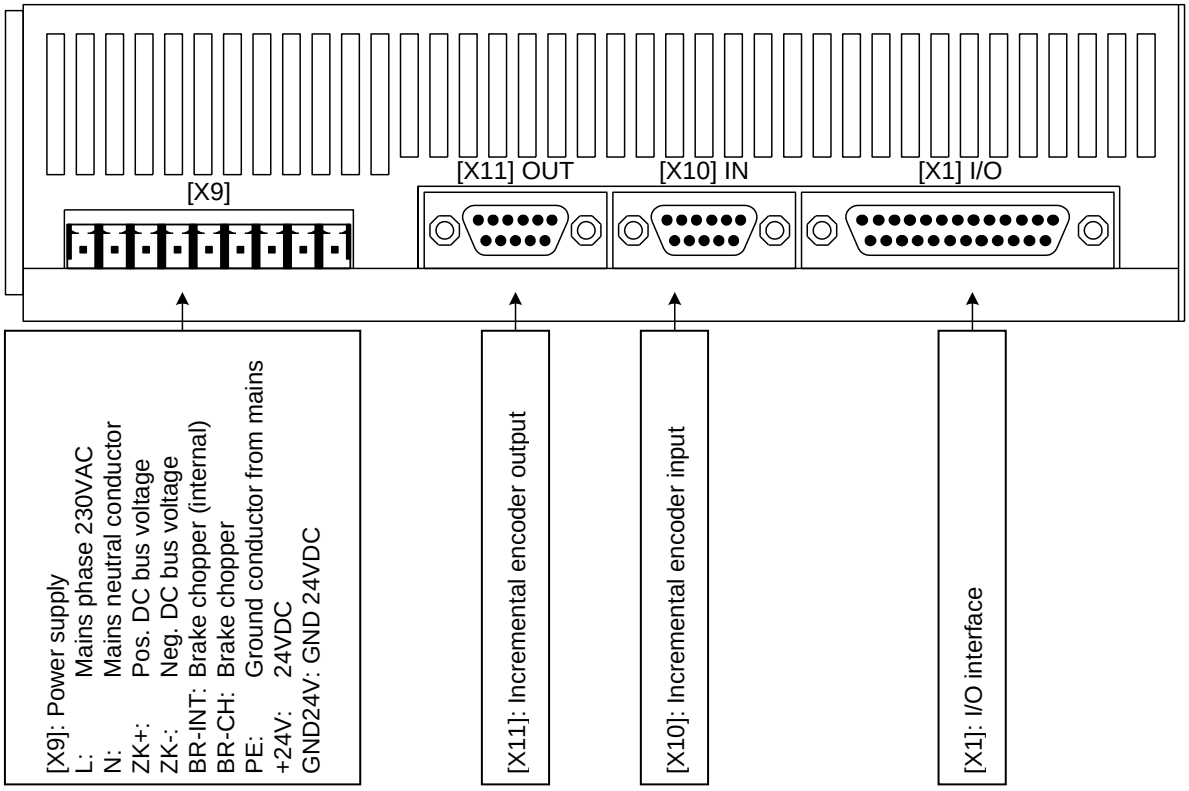


Figure 8: Servo positioning controller SE-Power FS 1kVA: Top view

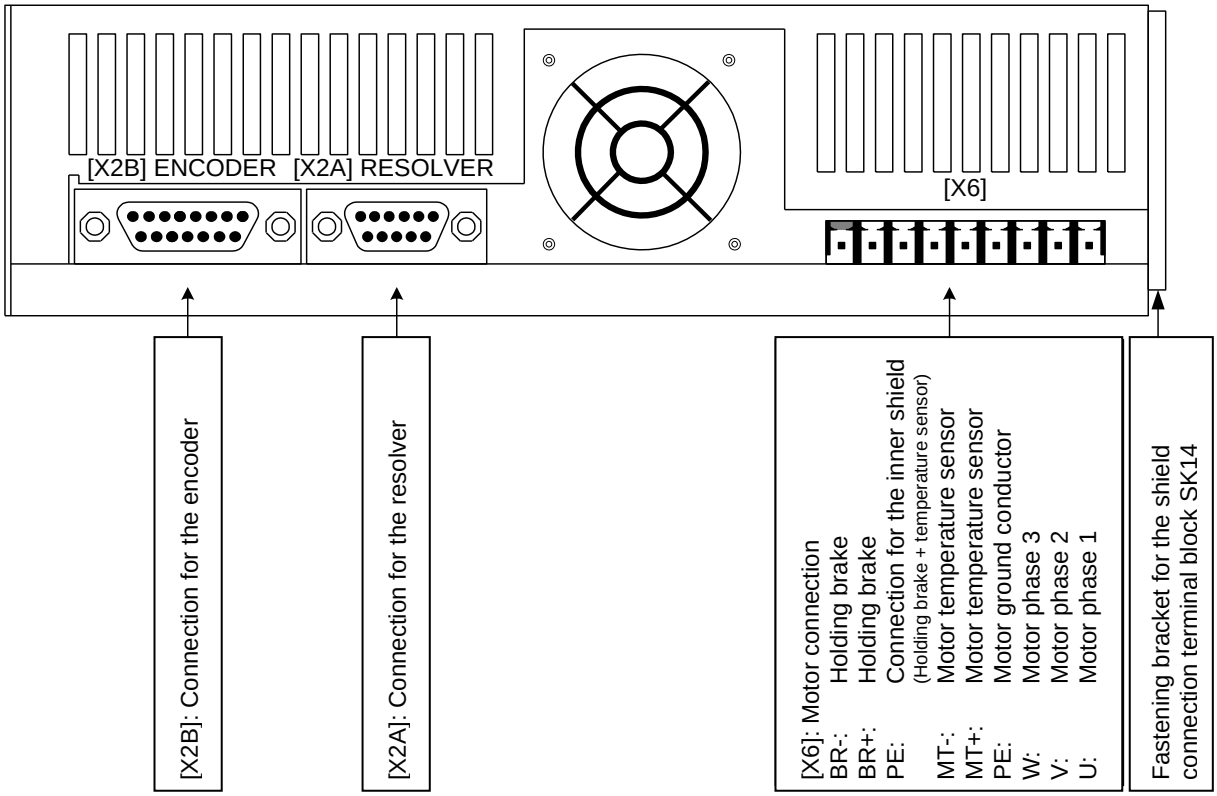


Figure 9: Servo positioning controller SE-Power FS 1kVA: Bottom view

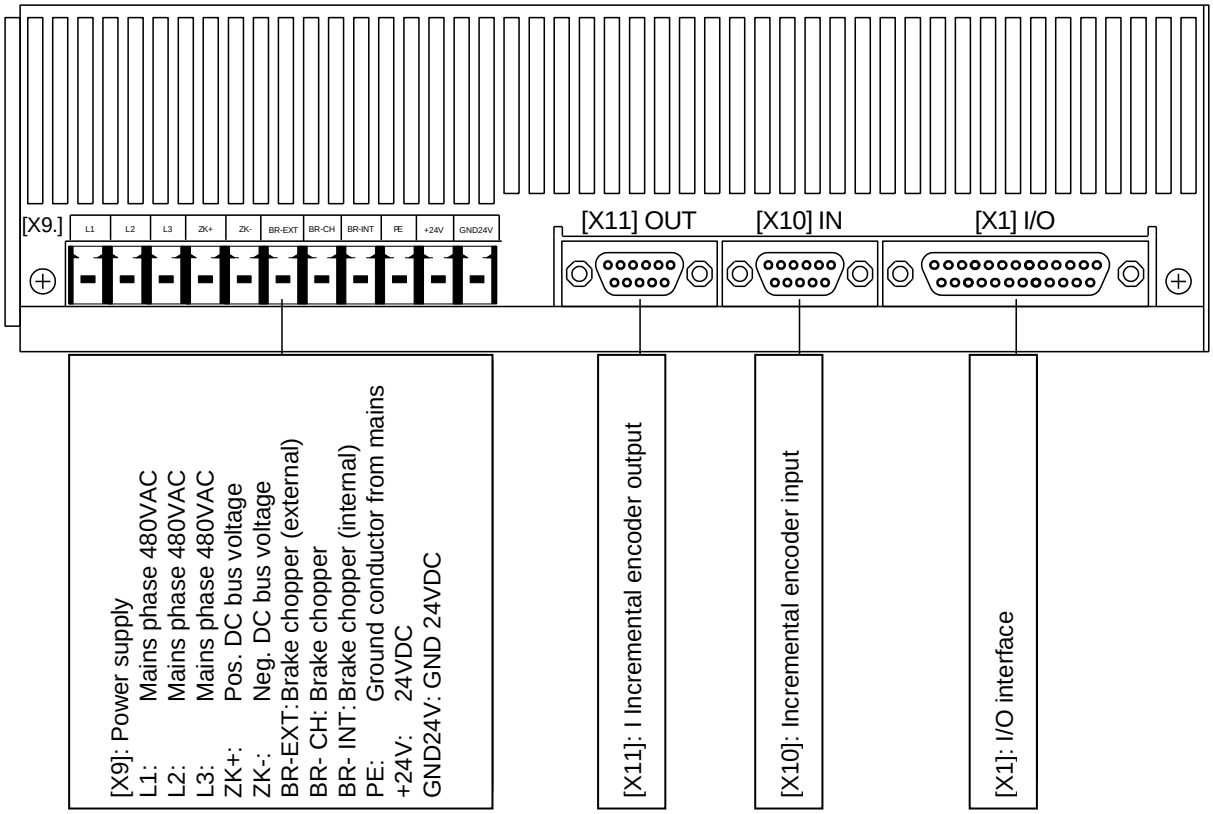


Figure 10: Servo positioning controller SE-Power FS 3kVA and 6kVA: Top view

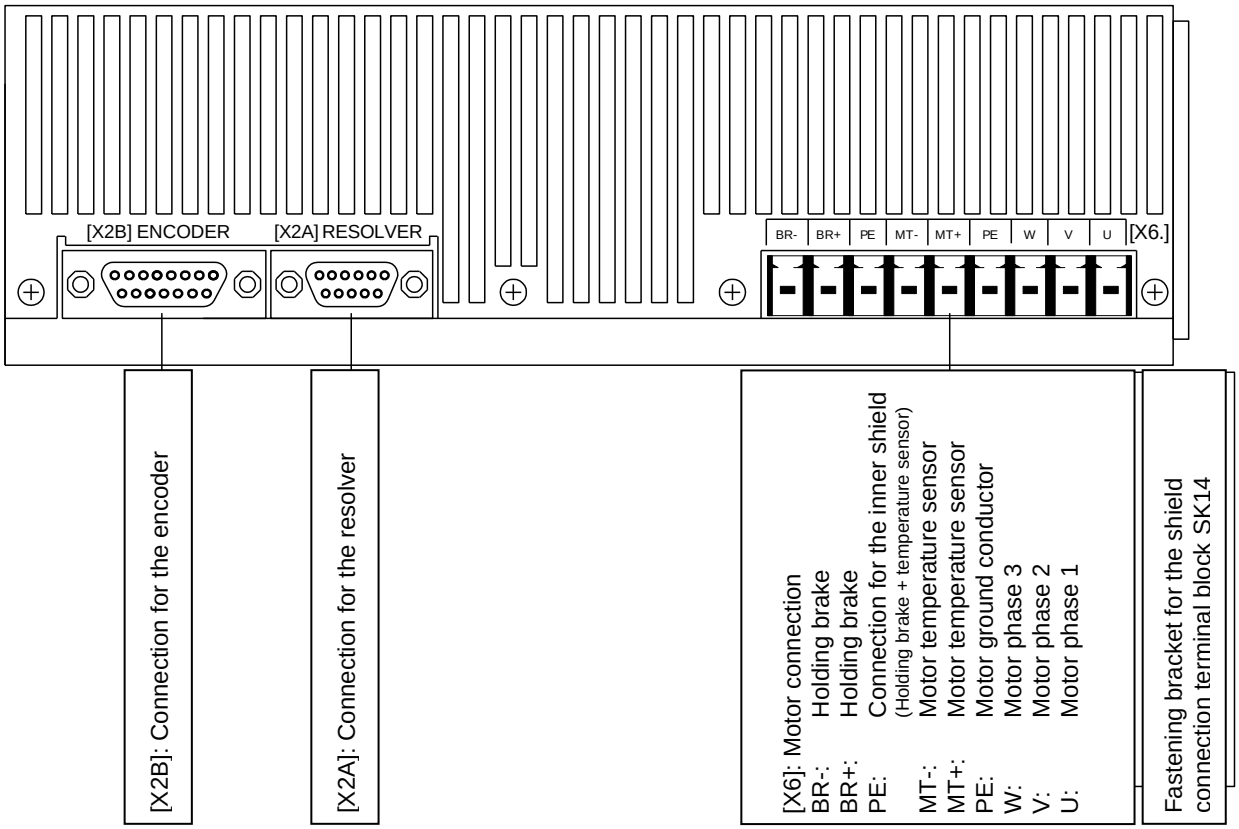


Figure 11: Servo positioning controller SE-Power FS 3kVA and 6kVA: Bottom view

7.3 Mounting

The servo positioning controller SE-Power FS has attachment lugs on the top and the bottom of the device. These lugs are used to mount the servo positioning controller vertically to a control cabinet plate. The lugs are part of the cooling body profile so that good heat transmission to the control cabinet plate must be ensured.

Recommended tightening torque for an M5 screw of property class 5.6: 2.8 Nm.

Please use M5 screws for the mounting of the servo positioning controllers SE-Power FS 1kVA.

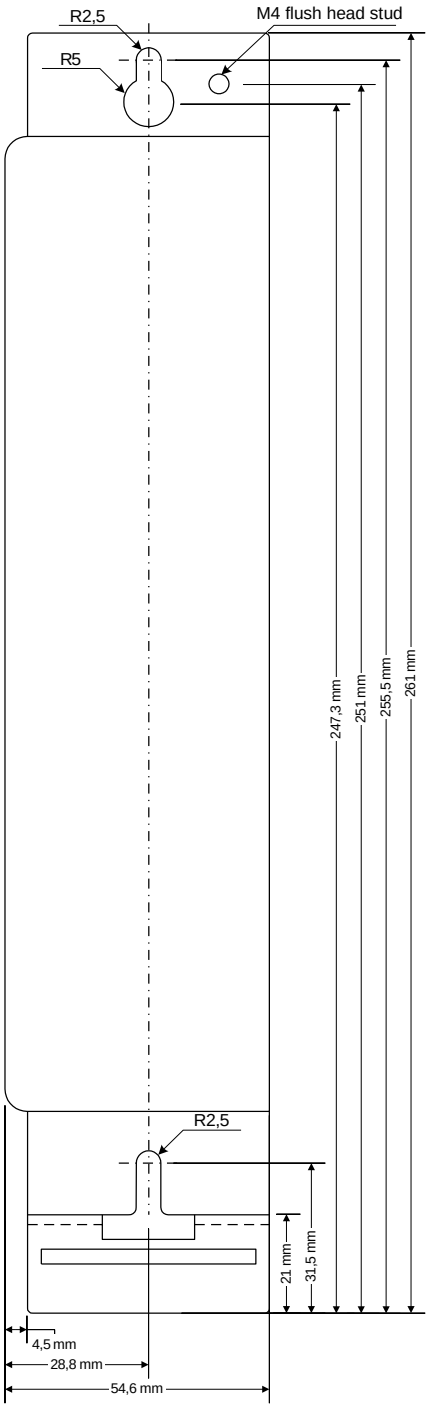


Figure 12: Servo positioning controller SE-Power FS 1kVA: Mounting plate

Please use M5 screws for the mounting of the servo positioning controllers SE-Power 3kVA and SE-Power 6kVA.

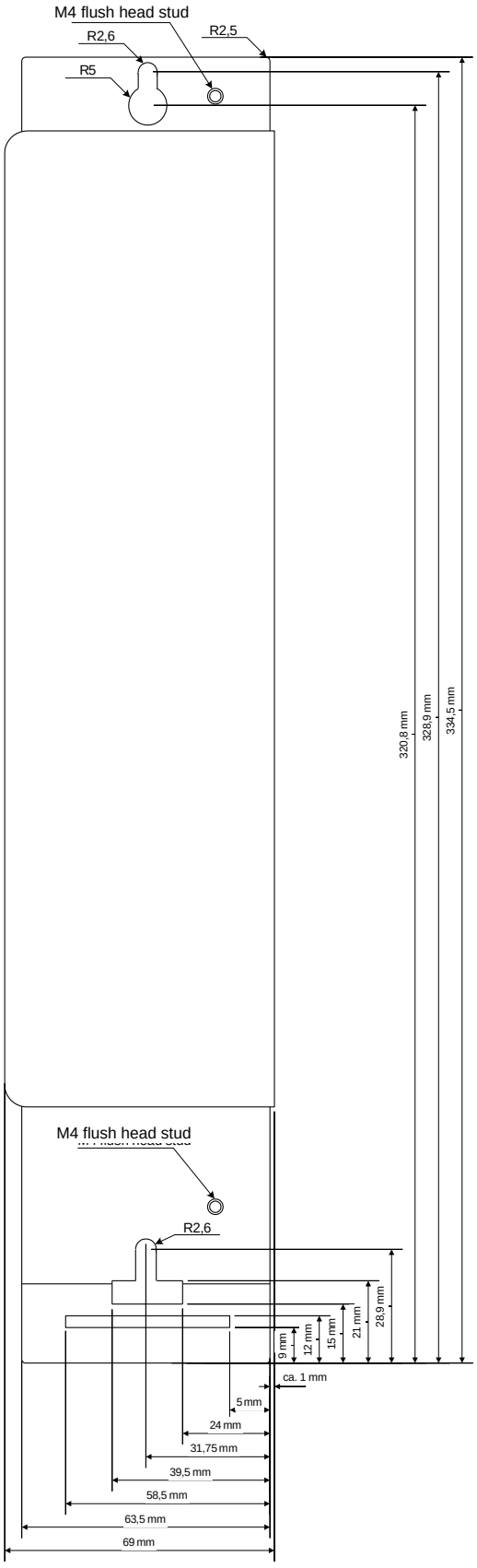


Figure 13: Servo positioning controller SE-Power FS 3kVA and 6kVA: Mounting plate

8 Electrical installation

8.1 Connector configuration (SE-Power FS 1kVA)

The servo positioning controller SE-Power FS 1kVA is connected to the supply voltage, the motor, the optional external brake chopper and the holding brakes as shown in *Figure 14.*

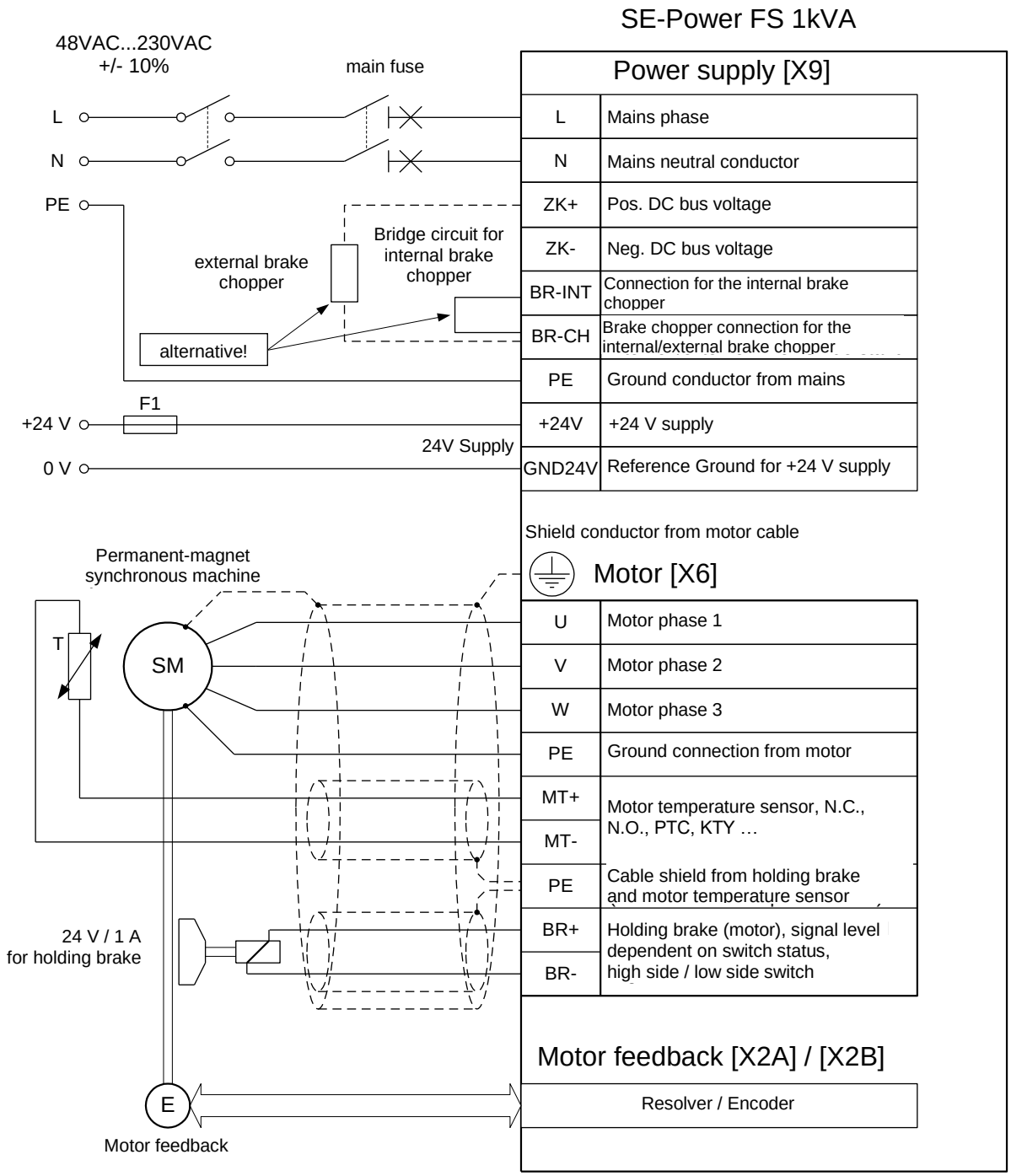


Figure 14: SE-Power FS 1kVA connection to the power supply and motor

8.2 Connector configuration (SE-Power FS 3kVA and 6kVA)

The servo positioning controllers SE-Power FS 3kVA and 6kVA are connected to the supply voltage, the motor, the optional external brake chopper and the holding brakes as shown in *Figure 15.*

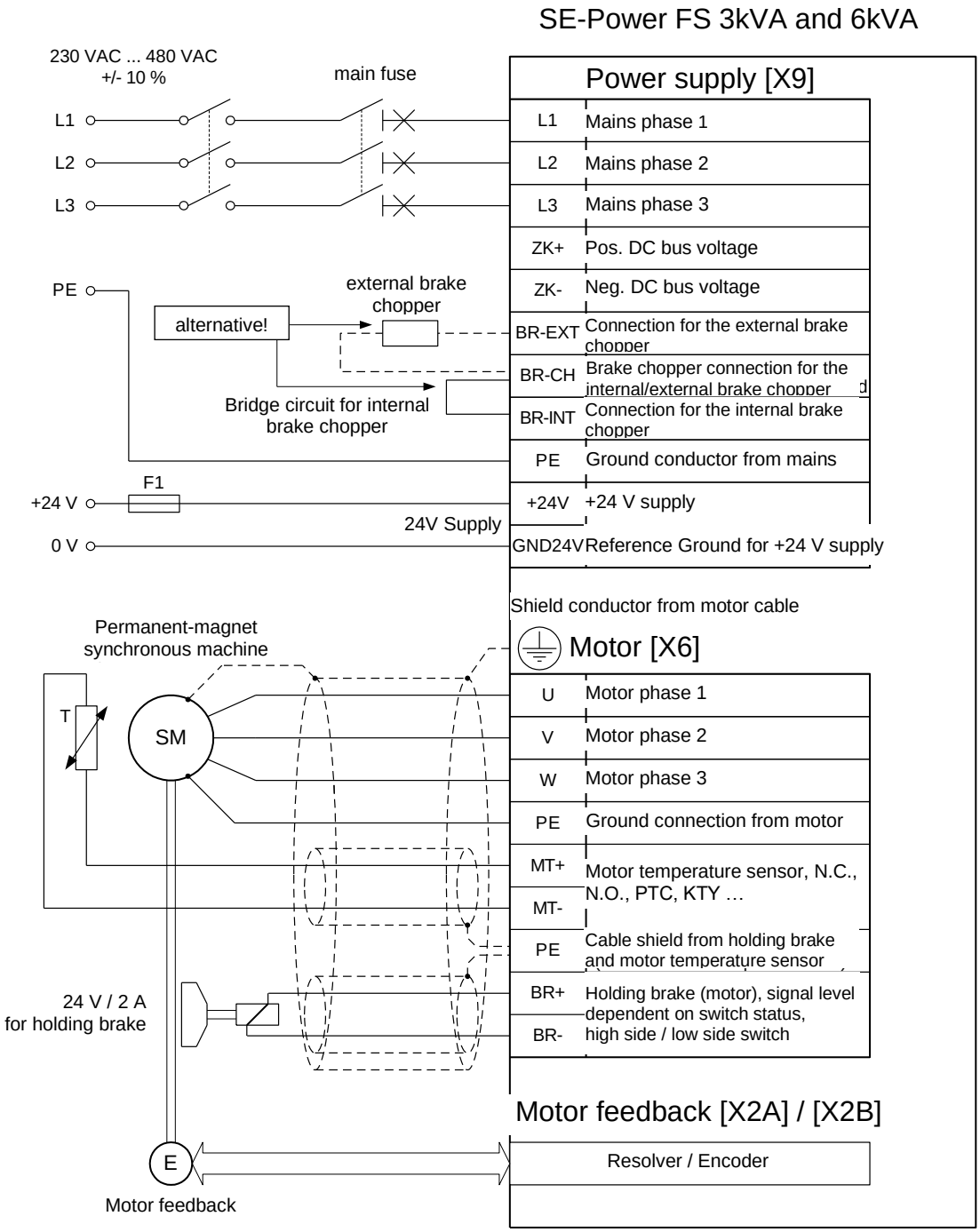


Figure 15: SE-Power FS 3kVA and 6kVA 1kVA connection to the power supply and motor

The operation of the servo positioning controller SE-Power FS requires a 24V voltage supply source for the electronics supply, which is connected to the terminals +24V and GND24V.

The connection to the supply for the power output stage at the SE-Power FS 1kVA is either made to terminals L1 and N for AC supply or to ZK+ and ZK- for DC supply.

The connection to the supply for the power output stage at the SE-Power FS 3kVA and 6kVA is either made to terminals L1, L2 und L3 for AC supply or to ZK+ and ZK- for DC supply.

The motor is connected to terminals U, V and W. The motor temperature switch (PTC or NC contact) is connected to terminals MT+ and MT–, if it is lead into one cable together with the motor phases. If an analogue temperature sensor is used in the motor (for example KTY81), the connection is realized via the encoder cable to [X2A] or [X2B].

The connection of the encoder via the D-Sub connector to [X2A] / [X2B] is roughly shown in *Figure 14* and *Figure 15*.

The servo positioning controller must be connected to ground with its PE connection.

The servo positioning controller must be completely wired first. Only then the operating voltages for the DC bus and the electronics may be switched on. In the case of inversed wiring of the operating voltage connections, excessive operating voltage or in the case of confusing the connections for operating voltage and motor the servo positioning controller will be damaged.

8.3 SE-Power FS complete system

The complete servo positioning controller SE-Power FS system is shown *Figure 16*. The following components are required for using the servo positioning controller:

- Main switch mains supply
- Fault current protection switch (RCD), AC/DC sensitive 300mA (if this is required by an application)
- Automatic circuit breaker
- Servo positioning controller SE-Power FS
- Motor with motor cable
- Mains cable

The parameterisation requires a PC with serial or USB connection.

A slow-blow (B16) automatic circuit breaker of 16 A has to be installed in the mains supply line.

In case of a required UL-certification the following data for the main fuse are to be considered:
Listed Circuit Breaker according UL 489, rated 277 Vac, 16 A, SCR 10 kA

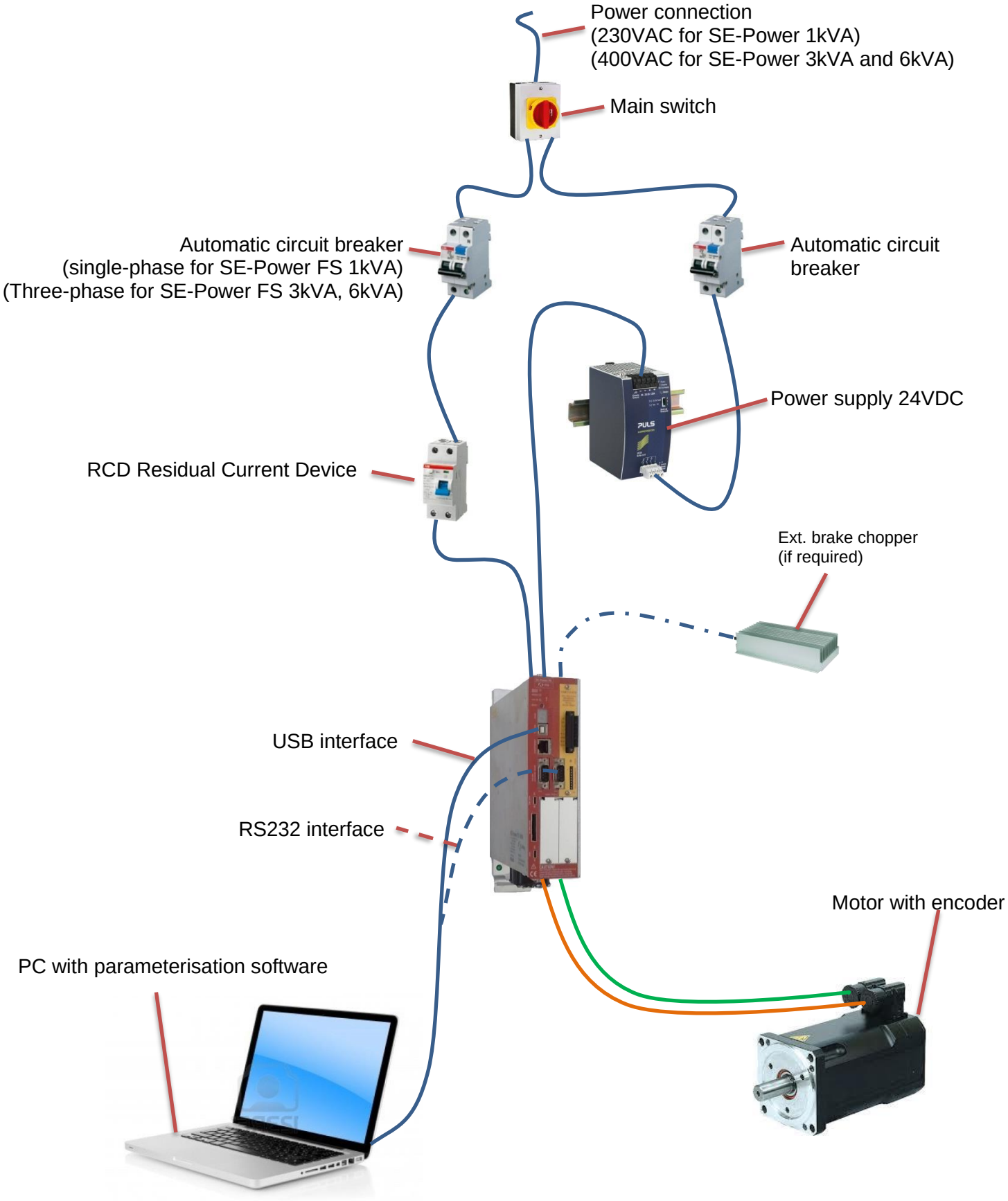


Figure 16: Complete setup of the SE-Power FS with motor and PC

8.4 Connection: Power supply [X9]

The servo positioning controller SE-Power FS receives its 24 VDC power supply for the control electronics via connector [X9].

The mains voltage supply for the SE-Power FS 1kVA is single-phase and for the SE-Power FS 3kVA and 6kVA three-phase. As an alternative to AC feed or for the purpose of DC bus coupling a direct DC supply for the DC bus is possible.

8.4.1 Device side [X9]

- SE-Power FS 1kVA: PHOENIX Mini-Combicon MC 1,5/9-G-5.08 BK
- SE-Power FS 3kVA and 6kVA: PHOENIX Power- Combicon PC 4/11-G-7,62 BK

8.4.2 Mating plug [X9]

- SE-Power FS 1kVA: PHOENIX Mini-Combicon MC 1,5/9-ST-5.08 BK
  Coding on PIN9 (GND24V)
- SE-Power FS 1kVA: PHOENIX Mini-Combicon connector housing
  12-pole, KGG-MC 1,5/12 BK
- SE-Power FS 3kVA and 6kVA: PHOENIX Power- Combicon PC 4 HV/11-ST-7,62 BK

8.4.3 Pin assignment [X9]

Table 24: Pin assignment [X9] SE-Power FS 1kVA

Pin No.	Denomination	Value	Specification
1	L	48...230VAC ±10% 50...60Hz	Phase conductor
2	N		Neutral conductor
3	ZK+	< 440VDC	Pos. DC bus voltage
4	ZK-	GND_ZK	Neg. DC bus voltage
5	BR-INT	< 460VDC	Connection of internal brake chopper (bridge to BR-CH when using the internal chopper)
6	BR-CH	< 460VDC	Brake chopper connection for internal brake chopper against BR-INT or external brake chopper against ZK+
7	PE	PE	Connection ground conductor from mains
8	+24V	+24VDC ±20% / 0,65A *)	Supply for control module and holding brake
9	GND24V	GND24	Reference potential supply

*) Plus current consumption of a possibly connected holding brake and I/O's

Table 25: Pin assignment [X9] SE-Power FS 3kVA und 6kVA

Pin No.	Denomination	Value	Specification
1	L1	230...480VAC ±10% 50...60Hz	Conductor phase 1
2	L2		Conductor phase 2
3	L3		Conductor phase 3
4	ZK+	< 700VDC	Pos. DC bus voltage
5	ZK-	GND_ZK	Neg. DC bus voltage
6	BR-EXT	< 800VDC	Connection of external brake chopper
7	BR-CH	< 800VDC	Brake chopper connection for internal brake chopper against BR-INT or external brake chopper against ZK+
8	BR-INT	< 800VDC	Connection of internal brake chopper (bridge to BR-CH when using the internal chopper)
9	PE	PE	Connection ground conductor from mains
10	+24V	+24VDC ±20% / 1,0A *)	Supply for control module and holding brake
11	GND24V	GND24	Reference potential supply

*) Plus current consumption of a possibly connected holding brake and I/O's

8.4.4 Cable type and design [X9]

The mentioned cable denominations refer to cables by Lapp. They have proven effective and are successfully used in many applications. However, similar cables from other manufacturers, for example Lütze or Helukabel, may also be used or also single strands.

- SE-Power FS 1kVA: For the 230 VAC supply
  LAPP KABEL ÖLFLEX-CLASSIC 110; 3 x 1,5 mm²
- SE-Power FS 3kVA and 6kVA: For the 400 VAC supply
  LAPP KABEL ÖLFLEX-CLASSIC 110; 4 x 1,5 mm²

8.4.5 Connection notes [X9]

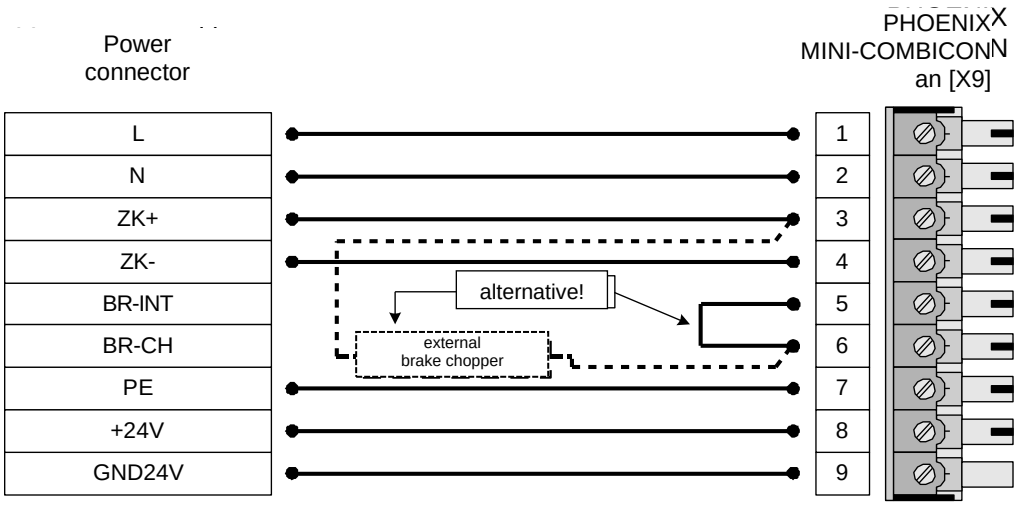


Figure 17: Supply [X9] SE-Power FS 1kVA

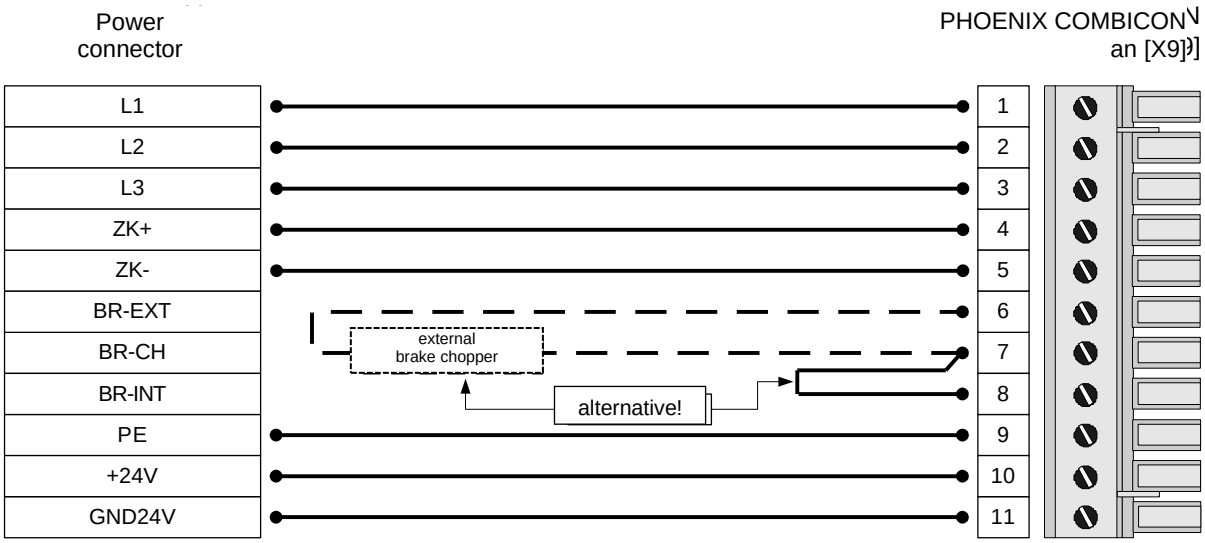


Figure 18: Supply [X9] SE-Power FS 3kVA and 6kVA

Via terminals ZK+ and ZK- the DC buses of several servo positioning controllers can be interconnected if they have the same DC bus voltage. The coupling of the DC bus is interesting for applications with high brake energies or if movements have to be carried out even in the case of power failure.

The servo positioning controller SE-Power FS has an internal brake chopper with braking resistor. For more braking power, an external braking resistor can be connected to the connector [X9].

If no external brake chopper is used, a bridge must be connected. On the SE-Power FS 1kVA between PIN 5 and PIN 6 and on the SE-Power FS 3kVA and 6kVA between PIN7 and PIN8, so that the DC bus pre-charge, when the mains power supply is “ON” and the DC bus rapid discharge can function properly!

8.5 Connection: Motor [X6]

8.5.1 Device side [X6]

- SE-Power FS 1kVA: PHOENIX Mini-Combicon MC 1,5/9-G-5.08 BK
- SE-Power FS 3kVA and 6kVA: PHOENIX Power-Combicon PC 4/9-G-7,62 BK

8.5.2 Mating plug [X6]

- SE-Power FS 1kVA: PHOENIX Mini-Combicon MC 1,5/9-ST-5.08 BK
  Coding on PIN1 (BR-)
- SE-Power FS 1kVA: PHOENIX Mini-Combicon connector housing
  12-pole, KGG-MC 1,5/12 BK
- SE-Power FS 3kVA and 6kVA: PHOENIX Power- Combicon PC 4 HV/9-ST-7,62 BK

8.5.3 Pin assignment [X6]

Table 26: Pin assignment [X6] SE-Power FS 1kVA

Pin No.	Denomination	Value	Specification
1	BR-	0V brake	Holding brake (motor), signal level dependent on switch status, high side / low side switch
2	BR+	24V brake	
3	PE	PE	Connection for inner shield (holding brake + temperature sensor)
4	MT-	GND	Motor temperature sensor, N.C. and N.O. contact, PTC, NTC
5	MT+	+5V / 5mA	
6	PE	PE	Motor ground conductor
7	W	0...270V_{eff} 0...5 A_{eff} 0...1000Hz	Connection of the three motor phases
8	V		
9	U		

The outer cable shield of the motor cable must also be placed flat on the mounting plate of the controller housing to shield terminal SK14.

Table 27: Pin assignment [X6] SE-Power FS 3kVA und 6kVA

Pin No.	Denomination	Value	Specification
1	BR-	0V brake	Holding brake (motor), signal level dependent on switch status, high side / low side switch
2	BR+	24V brake	
3	PE	PE	Connection for inner shield (holding brake + temperature sensor)
4	MT-	GND	Motor temperature sensor, N.C. and N.O. contact, PTC, NTC
5	MT+	+5V / 5mA	
6	PE	PE	Motor ground conductor
7	W	0...360V_{eff} 0...5 A_{eff} SE-Power FS 3kVA 0...10 A_{eff} SE-Power FS 6kVA 0...1000Hz	Connection of the three motor phases
8	V		
9	U		

The outer cable shield of the motor cable must also be placed flat on the mounting plate of the controller housing to shield terminal SK14.

8.5.4 Cable type and design [X6]

- We recommend the use of the motor cable from Afag for each module.

8.5.5 Connecting a holding brake with high current draw

A holding brake can be connected to the terminals BR+ and BR- of the motor. The holding brake is fed by the servo positioning controller's power supply. Note the maximum output current provided by the servo positioning controller SE-Power FS. A relay may have to be placed between the device and the holding brake as shown in *Figure 19*:

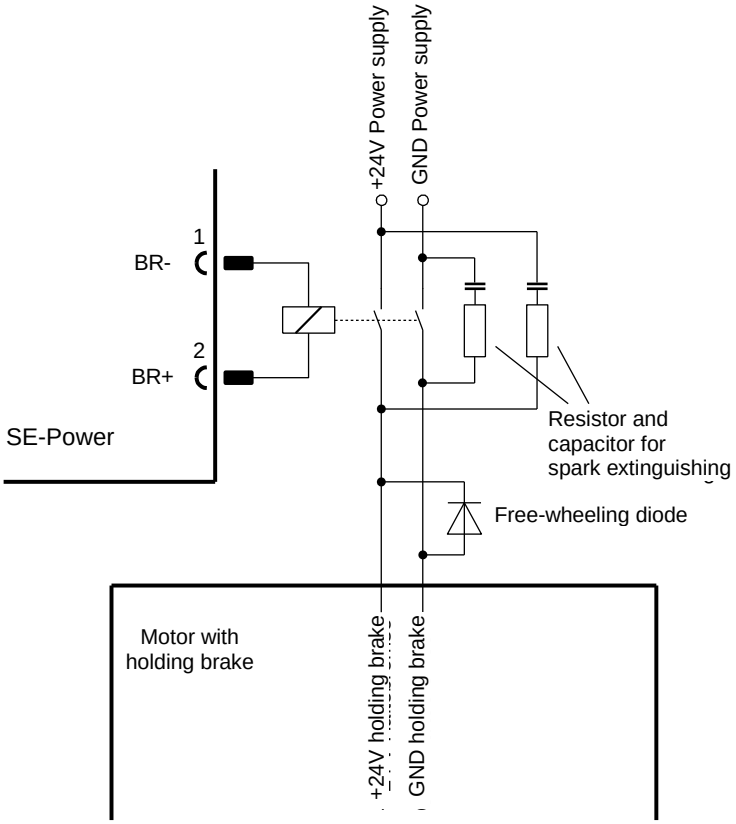


Figure 19: Connecting a holding brake with high current draw (> 1A) to the device

> The switching of inductive direct current via relay produces strong currents and sparking. For interference suppression we recommend integrated RC suppressor elements (RC element with 22Ω in series with 0,47uF).

8.6 Connection: I/O communication [X1]

The following *Figure 20* shows the principle function of the digital and analogue inputs and outputs. The servo positioning controller SE-Power FS is shown on the right hand side, the control system connection on the left. The cable design is also visible.

The servo positioning controller SE-Power FS features two potential ranges:

Analogue inputs and outputs:

All analogue inputs and outputs refer to AGND. AGND is internally connected with GND, the reference potential for the control module with µC and AD converters in the controller. This potential range is galvanically separated from the 24 V range and from the DC bus.

24V inputs and outputs:

These signals refer to the 24 V supply voltage of the servo positioning controller SE-Power FS, which is fed via [X9], and separated from the reference potential of the control module by means of optocouplers.

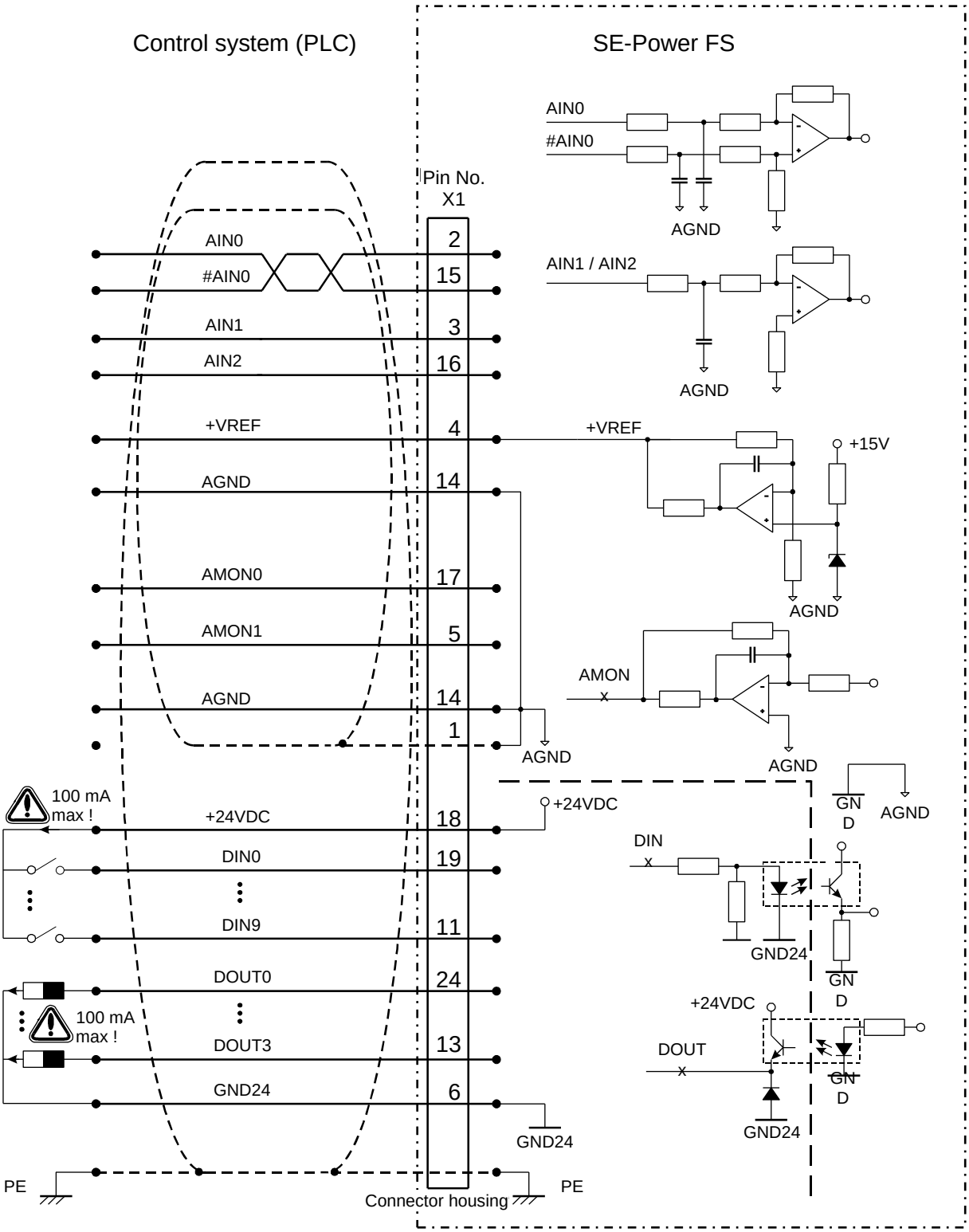


Figure 20: Basic circuit diagram connector [X1]

The servo positioning controller SE-Power FS comprises one differential (AIN 0) and two single-ended analogue inputs, designed for input voltages within a range of +/-10V. The inputs AIN 0 and #AIN 0 are lead to the control via twisted cables (twisted pair design).

If the control comprises single-ended outputs, the output is connected to AIN 0 and #AIN 0 is put on the reference potential of the control. If the control has differential outputs, they are to be connected 1:1 to the differential inputs of the servo positioning controller SE-Power FS.

The reference potential AGND is connected to the reference potential of the control. This is necessary in order to prevent the differential input of the servo positioning controller from being overridden by high "common-mode interference".

There are two analogue monitor outputs with output voltages in the range of +/-10 V and an output for a reference voltage of +10 V. These outputs can be led to the superimposed control, the reference potential AGND must be carried along. If the control has differential inputs, the "+"-input of the control is connected to the output of the servo positioning controller and "-"-input of the control with AGND.

8.6.1 Device side [X1]

- D-SUB connector, 25-pole, female

8.6.2 Mating plug [X1]

- D-SUB connector, 25-pole, male
- Housing for 25-pole D-SUB connector with bolting screws 4/40 UNC

For mode „positioning“, the analogue ground (pin 14) must be connected with the ground of the 24 VDC supply (pin 6)!

8.6.3 Pin assignment [X1]

Table 28: Pin assignment: I/O communication [X1]

Pin No.		Denomination	Values	Specification
1		AGND	0V	Shield for analogue signals, AGND
	14	AGND	0V	Reference potential for analogue signals
2		AIN0	Uln = ±10V RI ≥20kΩ	Set point input 0, differential, max. 30 V input voltage
	15	#AIN0		
3		DIN AIN1	Start_Ref	Start reference run (homing)
	16	DIN AIN2	SET-UP-Mode	Set up mode
4		+VREF	+10V	Reference output for set point potentiometer
	17	AMON0	±10V	Analogue monitor output 0
5		AMON1	±10V	Analogue monitor output 1
	18	+24V	24V / 100mA	24 V supply out
6		GND24	ref. GND	Reference potential for digital I/O's
	19	DIN0	POS Bit0	Target selection positioning Bit0
7		DIN1	POS Bit1	Target selection positioning Bit1
	20	DIN2	POS Bit2	Target selection positioning Bit2
8		DIN3	POS Bit3	Target selection positioning Bit3
	21	DIN4	FG_E	Power stage enable
9		DIN5	FG_R	Input controller enable
	22	DIN6	END0	Input end switch 0 (locks n > 0)
10		DIN7	END1	Input end switch 1 (locks n < 0)
	23	DIN8	Ref	Homing switch
11		DIN9	START	Input for positioning start
	24	DOUT0 / BEREIT	24V / 100mA	Output operational
12		DOUT1	24V / 100mA	Homing position valid
	25	DOUT2	24V / 100mA	In position
13		DOUT3	24V / 100mA	Remaining distance

Note! The grey boxes are not required in the positioning mode.

8.6.4 Cable type and design [X1]

The mentioned cable denominations refer to cables by Lapp. They have proven effective and are successfully used in many applications. However, similar cables from other manufacturers, for example Lütze or Helukabel, may also be used.

- LAPP KABEL UNITRONIC-LiYCY (TP); 25 x 0,25 mm² D=10.7 mm

Figure 20 shows the cable between the servo positioning controller SE-Power FS and the control. The cable shown has two cable shields.

The outer cable shield is connected on both sides to PE. Inside the servo positioning controller SE-Power FS the connector housing of the D-Sub connector is connected to PE. When using metal D-Sub connector housings the cable shield is simply squeezed underneath the strain relief.

Often, an unshielded cable is sufficient for the 24 V signals. In heavily disturbed surroundings or in the case of long cables (l > 2 m) between the control and the servo positioning controller SE-Power FS Afag recommends the use of shielded cables.

In spite of the differential design of the analogue inputs of the servo positioning controller SE-Power FS the cables should not be unshielded, since interferences, for example due to switching contactors or power stage interferences of the converters can reach high amplitudes. They couple into the analogue signals and cause common-mode interference, which may lead to deviation of the analogue measured values.

In the case of limited cable lengths (l < 2 m, wiring inside control cabinet) the outer dual-sided PE shield is enough to guarantee undisturbed operation.

For optimal interference suppression on the analogue signals the cores for the analogue signals are to be shielded together and separate from others. This internal cable shield is connected to AGND (Pin 1 or 14) on one side of the servo positioning controller SE-Power FS. It can be connected on both sides in order to establish a connection between the reference potentials of the control and the servo positioning controller servo positioning controller SE-Power FS. Pins 1 and 14 are directly connected to each other inside the controller.

8.6.5 Connection notes [X1]

The digital inputs are designed for control voltages of 24 V. Due to the high signal level a higher interference immunity of these inputs is already guaranteed. The servo positioning controller SE-Power FS provides a 24 V auxiliary voltage, which may be loaded with a maximum of 100 mA. This way the inputs can be activated directly via switches. Activation via the 24 V outputs of a PLC is, of course, also possible.

The digital outputs are designed as so-called "high-side switches ". That means that the 24 V of the servo positioning controller SE-Power FS are actively switched through to the output. Loads such as lamps, relays, and so on are thus switched from the output to GND24. The four outputs DOUT 0 to DOUT 3 can be loaded with a maximum of 100mA each. The outputs can also be lead directly to 24 V inputs of a PLC.

8.7 Connection: Resolver [X2A]

8.7.1 Device side [X2A]

- D-SUB connector, 9-pole, female

8.7.2 Mating plug [X2A]

- D-SUB connector, 9-pole, male
- Housing for 9-pole D-SUB connector with bolting screws 4/40 UNC

8.7.3 Pin assignment [X2A]

Table 29: Pin assignment [X2A]

Pin No.		Denomination	Values	Specification
1		S2	3,5V_{eff} / 10kHz R_i > 5kΩ	SINE trace signal, differential
	6	S4		
2		S1	3,5V_{eff} / 10kHz R_i > 5kΩ	COSINE trace signal, differential
	7	S3		
3		AGND	0V	Shield for signal pairs (inner shield)
	8	MT-	GND	Reference potential temperature sensor
4		R1	7V_{eff} / $I_A \leq 50mA_{eff}$	Carrier signal for resolver
	9	R2	GND	
5		MT+	+5V / 5mA	Motor temperature sensor, normally closed contact, PTC, KTY

The outer cable shield of the resolver cable must additionally be applied to the mounting plate of the controller housing over a large contact area with the aid of the shield connection terminal SK14.

8.7.4 Cable type and design [X2A]

- We recommend the use of the resolver cable from Afag for each module.

8.8 Connection: Encoder [X2B]

8.8.1 Device side [X2B]

- D-SUB connector, 15-pole, female

8.8.2 Mating plug [X2B]

- D-SUB connector, 15-pole, male
- Housing for 15-pole D-SUB connector with bolting screws 4/40 UNC

8.8.3 Pin assignment [X2B]

Table 30: Pin assignment: Digital incremental encoder – optional [X2B]

Pin No.		Denomination	Values	Specification
1		MT+	+5V / 5mA	Motor temperature sensor, normally closed contact, PTC, KTY
	9	U_SENS+	5V...12V / $R_I \approx 1k\Omega$	Sensor cables for encoder supply
2		U_SENS-		
	10	US	5V..12V/ ±10% I_{max} = 300mA	Supply voltages for high-resolution incremental encoder
3		GND	0V	Reference potential encoder supply and motor temperature sensor
	11	N	$2V_{SS}$.. $5V_{SS}$ $R_I \approx 120\Omega$	Reset pulse trace signal RS422 (differential) from digital incremental encoder
4		#N		
	12	H_U	0V / 5V $R_I \approx 2k\Omega$ an VCC	Phase U hall sensor for commutation
5		H_V		Phase V hall sensor for commutation
	13	H_W		Phase W hall sensor for commutation
6				
	14	A	$2V_{SS}$.. $5V_{SS}$ $R_I \approx 120\Omega$	A trace signal RS422 (differential) from digital incremental encoder
7		#A		
	15	B	$2V_{SS}$.. $5V_{SS}$ $R_I \approx 120\Omega$	B trace signal RS422 (differential) from digital incremental encoder
8		#B		

The outer cable shield of the encoder cable must additionally be applied to the mounting plate of the controller housing over a large contact area with the aid of the shield connection terminal SK14.

8.8.4 Cable type and design [X2B]

- We recommend the use of the encoder cable from Afag for each module.

8.9 Connection: Incremental encoder-input [X10]

8.9.1 Device side [X10]

- D-SUB connector, 9-pole, female

8.9.2 Mating plug [X10]

- D-SUB connector, 9-pole, male
- Housing for 9-pole D-SUB connector with bolting screws 4/40 UNC

8.9.3 Pin assignment [X10]

Table 31: Pin assignment X10: Incremental encoder input

Pin No.		Denomination	Values	Specification
1		A	5V / $R_I \approx$ 120Ω	Incremental encoder signal A
	6	A#	5V / $R_I \approx$ 120Ω	Incremental encoder signal A#
2		B	5V / $R_I \approx$ 120Ω	Incremental encoder signal B
	7	B#	5V / $R_I \approx$ 120Ω	Incremental encoder signal B#
3		N	5V / $R_I \approx$ 120Ω	Incremental encoder index pulse N
	8	N#	5V / $R_I \approx$ 120Ω	Incremental encoder index pulse N#
4		GND	-	Reference GND for encoder
	9	GND	-	Shield for the connection cable
5		VCC	+5V±5% 100mA	Auxiliary supply, to be loaded with maximal 100 mA, but short-circuit-proof!

8.9.4 Cable type and design [X10]

We recommend encoder connection cables twisted in pairs and individually protected.

8.9.5 Connection notes [X10]

Input [X10] can be used to process incremental encoder signals.

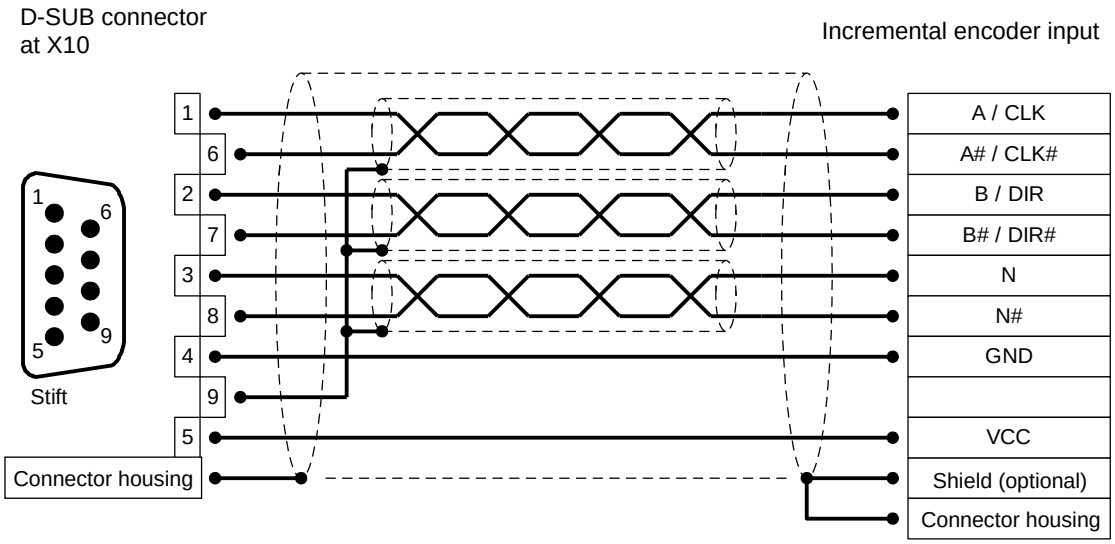


Figure 21: Pin assignment [X10]: Incremental encoder input

8.10 Connection: Incremental encoder output [X11]

8.10.1 Device side [X11]

- D-SUB connector, 9-pole, female

8.10.2 Mating plug [X11]

- D-SUB connector, 9-pole, male
- Housing for 9-pole D-SUB connector with bolting screws 4/40 UNC

8.10.3 Pin assignment [X11]

Table 32: Pin assignment [X11]: Incremental encoder output

Pin No.		Denomination	Values	Specification
1		A	5V / $R_A \approx 66\Omega$ *)	Incremental encoder signal A
	6	A#	5V / $R_A \approx 66\Omega$ *)	Incremental encoder signal A#
2		B	5V / $R_A \approx 66\Omega$ *)	Incremental encoder signal B
	7	B#	5V / $R_A \approx 66\Omega$ *)	Incremental encoder signal B#
3		N	5V / $R_A \approx 66\Omega$ *)	Incremental encoder index pulse N
	8	N#	5V / $R_A \approx 66\Omega$ *)	Incremental encoder index pulse N#
4		GND	-	Reference GND for encoder
	9	GND	-	Shield for the connection cable
5		VCC	+5V ±5% 100mA	Auxiliary supply, to be loaded with maximal 100 mA, but short-circuit-proof!

*) The value for R_A is the differential output resistance.

8.10.4 Cable type and design [X11]

We recommend encoder connection cables twisted in pairs and individually protected.

8.10.5 Connection notes [X11]

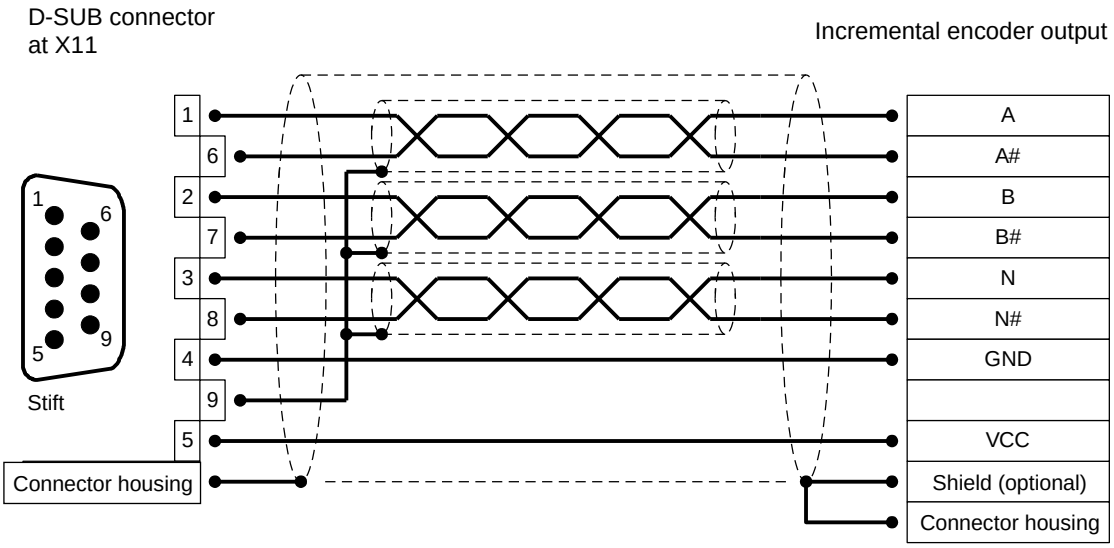


Figure 22: Pin assignment [X11]: Inkrementalgeberausgang

The output driver at the signal output provides differential signals (5 V) as per interface standard RS422.

Up to 32 other servo positioning controllers may be driven by one device.

8.11 Connection: CAN-Bus [X4]

8.11.1 Device side [X4]

- D-SUB connector, 9-pole, male

8.11.2 Mating plug [X4]

- D-SUB connector, 9-pole, female
- Housing for 9-pole D-SUB connector with bolting screws 4/40 UNC

8.11.3 Pin assignment [X4]

Table 33: Pin assignment CAN-Bus [X4]

Pin No.		Denomination	Values	Specification
1		-	-	Not occupied
	6	GND	0V	CAN-GND, galvanically connected to GND in controller
2		CANL	*)	CAN-Low signal line
	7	CANH	*)	CAN-High signal line
3		GND	0V	see Pin Nr. 6
	8	-	-	Not occupied
4		-	-	Not occupied
	9	-	-	Not occupied
5		Shield	PE	Connection for cable shield

*) External terminating resistor 120 Ω required on both ends of the bus. If the bus ends are not formed by SE-Power FS servo positioning controllers with integrated terminating resistors, we recommend using metal film resistors with a 1 % tolerance of type 0207, for example made by BCC, order no.: 232215621201.

8.11.4 Cable type and design [X4]

The mentioned cable denominations refer to cables by Lapp. They have proven effective and are successfully used in many applications. However, similar cables from other manufacturers, for example Lütze or Helukabel, may also be used.

Technical data CAN bus cable: 2 pairs of 2 twisted cores, d ≥ 0,22 mm², shielded, loop resistance < 0,2 Ω/m, characteristic impedance 100-120 Ω.

- LAPP KABEL UNITRONIC BUS CAN; 2 x 2 x 0,22; ∅ 7,6 mm, with total Cu shielding

For highly flexible applications:

- LAPP KABEL UNITRONIC BUS CAN FD P; 2 x 2 x 0,25; ∅ 8,4 mm, with total Cu shielding

8.11.5 Connection notes [X4]

Caution!

When cabling the connector via the CAN bus, make sure to observe the following information and notes, to ensure a stable and interference-free system. Improper cabling may cause the CAN bus to malfunction which in turn can cause the controller to shut down with an error for safety reasons.

The CAN bus provides a simple and fail-safe way of connecting all components of a system, assuming, however, compliance with the following notes on cabling.

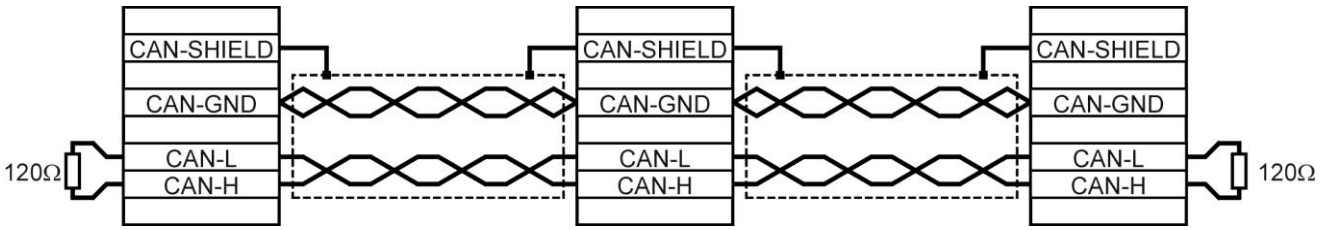


Figure 23: Cabling example for CAN-Bus

- The individual nodes of a network are always connected in line, so that the CAN cable is looped through from controller to controller (see *Figure 23*).
- On both ends of the CAN bus cable must be exactly one terminating resistor of 120Ω +/- 5%. The servo positioning controller SE-Power FS is equipped with an integrated terminating resistor that can be activated/deactivated with the aid of the DIP switch “CAN TERM” that is located on the front panel (see *Figure6, Figure 7* and *Figure 24*.
- **Shielded** cables with exactly two **twisted** pairs must be used for cabling.
- Use a twisted pair for the connection of CAN-H and CAN-L.
- The cores of the other pair are used **jointly** for CAN-GND.
- The shield of the cable is led to the CAN shield connections for all nodes.
- We advise against the use of plug adaptors for CAN bus cabling. Should this be necessary nonetheless, make sure to use metal connector housings to connect the cable shield.
- In order to keep interferences as low as possible make sure that
  - Motor cables are not installed parallel to signal lines.
  - Motor cables comply with Afag specifications.
  - Motor cables are properly shielded and grounded.
- For further information on interference-free CAN bus cabling, please refer to the Controller Area Network protocol specification, Version 2.0 by Robert Bosch GmbH, 1991.

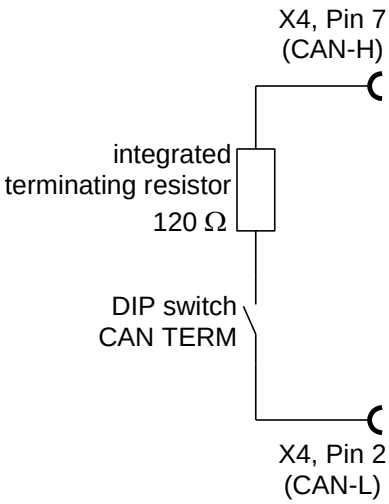


Figure 24: Integrated CAN terminating resistor

8.12 Connection: RS232/COM [X5]

8.12.1 Device side [X5]

- D-SUB connector, 9-pole, male

8.12.2 Mating plug [X5]

- D-SUB connector, 9-pole, female
- Housing for 9-pole D-SUB connector with bolting screws 4/40 UNC

8.12.3 Pin assignment [X5]

Table 34: Pin assignment RS232 interface [X5]

Pin No.		Denomination	Values	Specification
1		-	-	Not occupied
	6	-	-	Not occupied
2		RxD	10 V / R_I > 2kΩ	Receive line, RS232 specification
	7	-	-	Not occupied
3		TxD	10 V / R_A < 2kΩ	Transmitting line, RS232 specification
	8	-	-	Not occupied
4		-	-	Not occupied
	9	-	-	Not occupied
5		GND	0V	Interfaces GND, galvanically connected to GND DGND

8.12.4 Cable type and design [X5]

- Programming cable RS232 SE-Power, 3m (50038526)

8.12.5 Connection notes [X5]

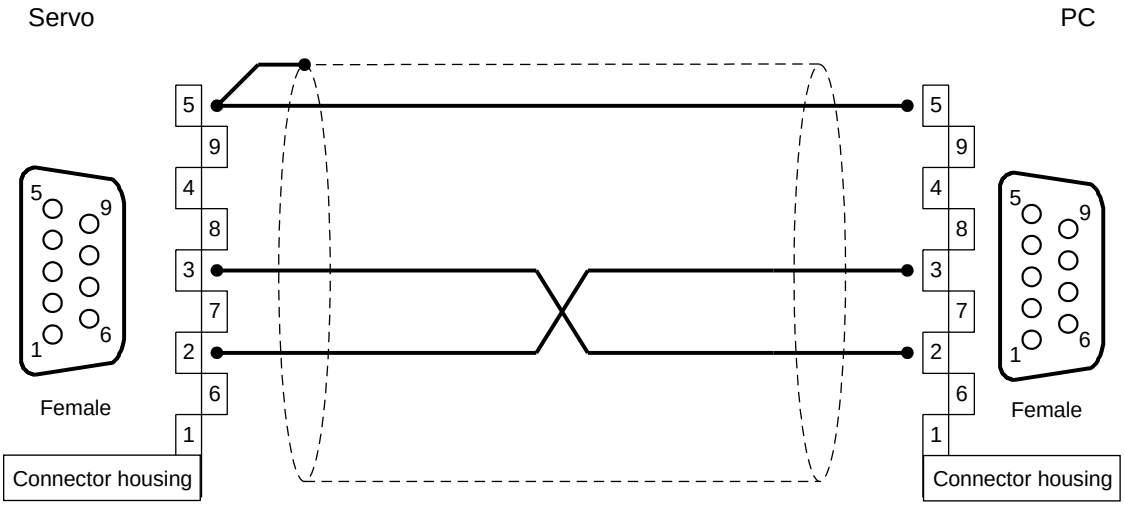


Figure 25: Pin assignment RS232-null modem cable [X5]

8.13 Connection: USB [X19]

8.13.1 Device side [X19]

- USB female, type B

8.13.2 Mating plug [X19]

- USB male, type B

8.13.3 Pin assignment [X19]

Table 35: Pin assignment: USB interface [X19]

Pin No.	Denomination	Values	Specification
1	VCC		+ 5 VDC
2	D-		Data -
3	D+		Data +
4	GND		GND

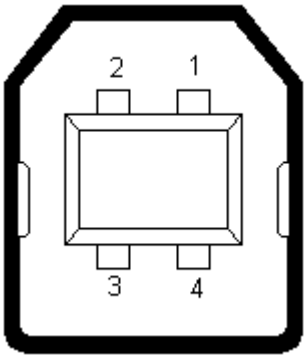


Figure 26: Pin assignment: USB interface [X19], front view

8.13.4 Cable type and design [X19]

- Programming cable USB SE-Power FS, 3m (50395197)

8.14 SD-/MMC-Card

8.14.1 Supported card types

- SD
- SDHC
- MMC

8.14.2 Supported functions

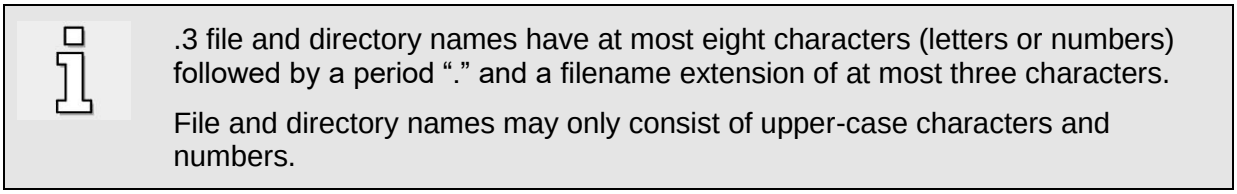
- Load a parameter set (DCO file)
- Save the current parameter set (DCO file)
- Load a firmware file

8.14.3 Supported file systems

- FAT12
- FAT16
- FAT32

8.14.4 File names

Only file and directory names according to the 8.3 standard are supported.



8.14.5 Pin assignment SD-/MMC-Card

Table 36: Pin assignment: SD-Card

Pin No.	Denomination	Values	Specification
1	DATA3/CS	Data Line 3 (Bit 3)	Chip Select
2	CMD/DI	Command/Response	Host to Card Commands and Data
3	Vss1	Supply Voltage Ground	Supply Voltage Ground
4	Vcc	Supply Voltage	Supply Voltage
5	CLK	Clock	Clock
6	Vss2	Supply Voltage Ground	Supply Voltage Ground
7	DAT0/DO	Data Line 0 (Bit 0)	Card to Host Data and Status
8	DAT1	Data Line 1 (Bit 1)	reserved
9	DAT2	Data Line 2 (Bit 2)	reserved

Table 37: Pin assignment: MMC-Card

Pin No.	Denomination	Values	Specification
1	RES/CS	Not connected or Always „1“	Chip Select
2	CMD/DI	Command/Response	Host to Card Commands and Data
3	Vss1	Supply Voltage Ground	Supply Voltage Ground
4	Vcc	Supply Voltage	Supply Voltage
5	CLK	Clock	Clock
6	Vss2	Supply Voltage Ground	Supply Voltage Ground
7	DAT/DO	Data 0	Card to Host Data and Status

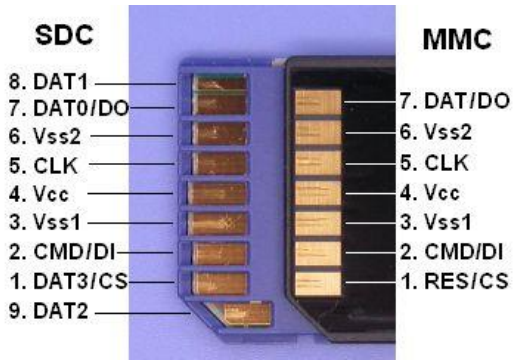


Figure 27: Pin assignment: SD-/MMC-Card

8.14.6 BOOT-DIP-Switch

During a restart/reset, the BOOT-DIP-Switch is used to determine whether to perform a firmware download from the SD-/MMC-Card or not.

- BOOT-DIP-Switch in position “ON” → firmware download requested
- BOOT-DIP-Switch in position “OFF” → firmware download not requested

When there is no SD-/MMC-Card in the card slot of the servo positioning controller and the BOOT-DIP-Switch is in the position “ON” (firmware download requested), the error 29-0 is triggered after a restart/reset.

This error stops all further performances. This means that there is no communication possible via the serial interface (RS232) or USB

8.15 Notes on safe and EMC-compliant installation

8.15.1 Definition and terms

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

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

8.15.2 General information on EMC

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

- Voltage supply
- Servo positioning controller
- Motor
- Electro mechanics
- Execution and type of wiring
- Superimposed control

In order to increase interference immunity and to decrease interference emissions the servo positioning controller SE-Power FS already comprises output chokes and mains filters, so that it can be operated without additional shielding and filtering devices in most applications.

The servo positioning controllers SE-Power FS are certified as per the product standard EN 61800-3 for electrical drive systems.

In most cases no external filtering is required (see below).

8.15.3 EMC areas: first and second environment

Proper installation and wiring of all connecting cables provided, the SE-Power FS 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.

The following applies to SE-Power FS 1kVA servo positioning controllers without external filter measures:

Table 38: EMC requirements: First and second environment (SE-Power FS 1kVA)

EMC type	Environment	Compliance with EMC requirements
Interference emission	First environment (domestic environment), C2	Motor cable length up to 25m
	Second environment (industrial environment), C3	Motor cable length up to 25m
Interference immunity	First environment (domestic environment), C2	Independent of motor cable length
	Second environment (industrial environment), C3	

The following applies to SE-Power FS 3kVA and 6kVA servo positioning controllers without external filter measures:

Table 39: EMC requirements: First and second environment (SE-Power FS 3kVA and 6kVA)

EMC type	Environment	Compliance with EMC requirements
Interference emission	First environment (domestic environment), C2	Motor cable length up to 50m
	Second environment (industrial environment), C3	Motor cable length up to 50m
Interference immunity	First environment (domestic environment), C2	Independent of motor cable length
	Second environment (industrial environment), C3	

8.15.4 EMC compliant cabling

The following must be considered for an EMC-compliant setup of the drive system (see also *chapter 8 Electrical installation*):

- In order to keep the leakage currents and the losses in the motor connection cable as small as possible, the servo positioning controller should be located as close to the motor as possible (see also the following *chapter 8.15.5 Operation with long motor cables)*
- Motor cable and angle encoder cable must be shielded.
- The shield of the motor cable is connected to the housing of the servo positioning controller (shield connection terminal). The cable shield also has to be connected to the associated servo positioning controller so that the leakage currents can flow back into the controller causing the leakage.
- The mains-end PE connection is connected to the PE connection point of the supply connection [X9].
- 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 (that is at a 90° angle), if possible.
- Unshielded signal and control lines should not be used. If their use is inevitable they should at least be twisted.
- Even shielded cables will inevitably have short unshielded ends (unless shielded connector housings are used). In general, the following applies:
  - Connect the inner shields to the corresponding pins of the connectors; Maximum length 40 mm.
  - Length of the unshielded cores 35 mm maximum.
  - Connect the total shield on the controller side plane to the PE terminal; Maximum length 40 mm.
  - Connect the total shield on the motor side plane to the connector housing or motor housing; Maximum length 40 mm.

DANGER!

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

The EN 61800-5-1 regulations for protective earthing must be complied with during installation!

8.15.5 Operation with long motor cables

In applications involving long motor cables and/or unsuitable motor cables with an inadvertently high cable capacity, the filters may be thermally overloaded. To avoid such problems we highly recommend the following procedure for applications that require long motor cables:

- With cable lengths of more than 25m at the servo positioning controller SE-Power FS 1kVA and more than 50m at the servo positioning controllers SE-Power FS 3kVA and 6kVA use only cables with a capacitance per unit length between the motor phase and the shield of less than 150pF/m!

8.15.6 ESD protection

Caution!

Unassigned D-Sub connectors may cause damage to the device or other parts of the systems due to ESD (electrostatic discharge).

To prevent such discharge, protective caps are available (for example Spoerle).

The servo positioning controller SE-Power FS has been designed to provide high interference immunity. For that reason, some individual functional blocks are electrically isolated. Inside the device the signals are transmitted via optocouplers.

The following isolated areas are distinguished:

- Power module with DC bus and mains input
- Control electronics with processing of analogue signals
- 24V supply and digital inputs and outputs

9 Initial operation

9.1 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 *8.15 Notes on safe and EMC-compliant installation*!

DANGER!

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

All regulator parameters was saved on the corresponding Servo Controller by Afag, there's no further parameterization required.

If you have multiple controllers and axes in use, are they explicit identifiable by the labelling.

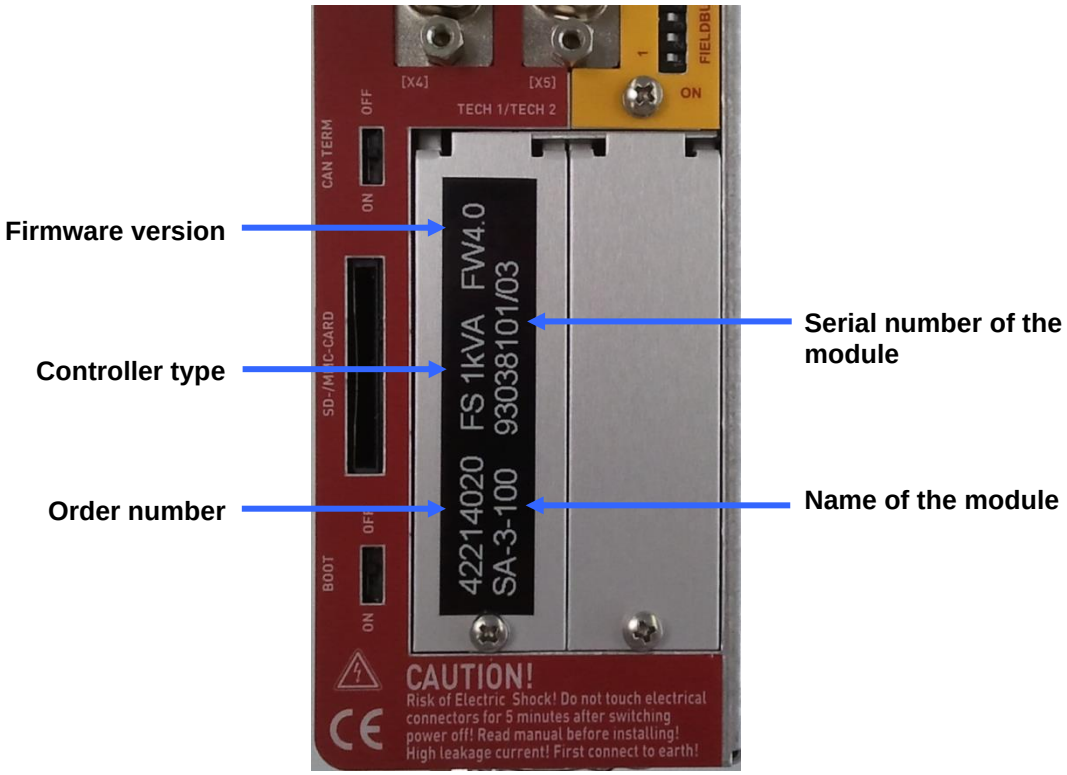


Figure 28: Servo positioning controller: Labelling Order

9.2 Connecting the motor

- Plug the connector of the motor cable into the corresponding socket of the motor and screw tight.
- Plug PHOENIX connector into socket **[X6]** of the device.
- Connect the PE line of the motor to the **PE** socket.
- Plug the connector of the encoder cable into the encoder output socket of the motor and screw tight.
- Plug the D-Sub connector into the socket **[X2A] Resolver** or **[X2B] Encoder** of the device and fasten the bolting screws.
- Connect the overall shield of the motor and encoder cable flat with the SK14 shield clamp
- Check all connections again.

9.3 Connecting the servo positioning controller to the power supply

- Make sure that the power supply has been switched off.
- Plug the PHOENIX connector into socket **[X9]** of the device.
- Connect the PE line of the mains to the **PE** socket.
- Connect the 24V connections to a suitable power supply unit.
- Make mains supply connections.
- Check all connections again.

9.4 Connecting the PC (USB Interface)

- Plug the connector A of the USB interface cable into the socket for the USB interface of the PC.
- Plug the connector B of the USB interface cable into the socket **[X19] USB** of the servo positioning controller SE-Power FS.
- Check all connections again.

9.5 Connecting the PC (RS232 Interface)

- 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.
- Plug the D-Sub connector of the serial interface cable into the socket **[X5] RS232/COM** of the servo positioning controller and fasten the bolting screws.
- Check all connections again.

9.6 Checking operability

1. Make sure the controller enabling switch is turned off.
2. Switch on the power supply of all devices. The READY-LED on the front of the device should now be active.

If the READY-LED is not active, there is a malfunction. If the seven-segment display indicates a number sequence, it is displaying an error message. You have to take care of the corresponding problem. In this case please continue with chapter *11.2.2 Error messages*. If the device displays nothing, 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.

9.7 Scaling check

- Proceed by hand a certain way with the axis and compare whether the travel coincides with the display in the SE-Commander (actual position).
- If the servo positioning controller is controlled by a fieldbus, please check the display of the actual position also there.

9.8 Switch on controller enable

Now the controller enable can be switched on and with this the motor is set under current. The ENABLE-LED on the front side of the devices should be green now.

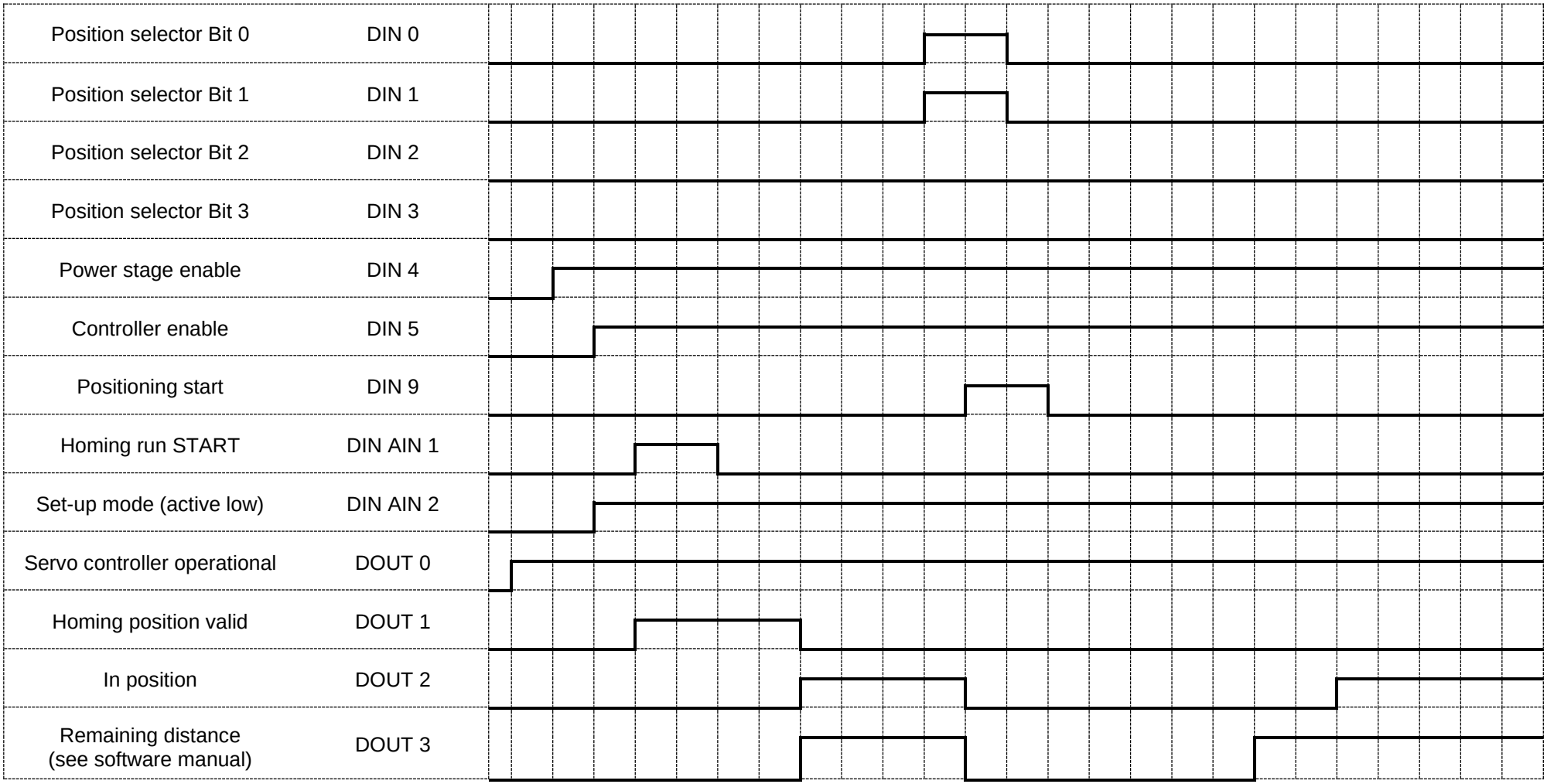
Note also the following table:

Table 40: Dependence power stage and controller enable

Power stage enable DIN4	Controller enable DIN5	Motor
0	0	Not active
0	1	Not active
1	0	Not active
1	1	Active, motor is controlled
1	1 ➔ 0	Controlled deceleration to stop, then motor rotate freely
1 ➔ 0	1	Motor is inactive immediately, drives on uncontrolled

10 Programming (over digital I/O's)

Example to drive to position 3



11 Service functions and error messages

11.1 Protection and service functions

11.1.1 Overview

The servo positioning controller 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 module temperature
- Detection of ground faults (PE)
- Detection of connections between two motor phases
- Detection of overvoltage in the DC bus
- Detection of errors with the internal voltage supply
- Failure of the supply voltage

If the 24 V DC supply voltage fails, approx. 20 ms remain to save parameters and shut down the controller properly for example.

11.1.2 Phase failure and mains failure detection

The servo positioning controller SE-Power FS 3kVA and 6kVA detect a phase failure in the three-phase-mode (phase failure detection) or the failure of one or more phases (mains failure detection) of the mains on the device.

11.1.3 Overcurrent and short-circuit monitoring

The overcurrent and short-circuit monitoring 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.

11.1.4 Overvoltage monitoring for the DC bus

This monitor responds, if the DC bus voltage exceeds the operating voltage range. The power output stage will be shut down.

11.1.5 Temperature monitoring of the heat sink

The heat sink temperature of the power output stage is measured with a linear temperature sensor. The temperature limit varies from device to device. Approx. 5 °C underneath the limit value a temperature warning is issued.

11.1.6 Monitoring of the motor

The servo positioning controller has the following protective functions to monitor the motor and the connected encoder:

Monitoring of the encoder: An error in the encoder shuts down the power output stage. In the case of resolvers, e.g. the encoder signal is monitored. In the case of incremental encoders the commutation signals are checked. Other „intelligent“ encoders provide further means of error detection.

Measurement and monitoring of the motor temperature: The servo positioning controller has a digital and an analogue input for the detection and monitoring of the motor temperature. The analogue signal detection also supports non-linear sensors. The following temperature sensors can be selected:

- At [X6]: Digital input for PTCs, normally closed contacts and normally open contacts.
- At [X2A] and [X2B]: Normally closed contacts and analogue sensors, type KTY.

11.1.7 I²t monitoring

The servo positioning controller comprises an I²t monitoring to limit the average power loss in the power output stage and in the motor. Since the occurring power loss in the power electronics and in the motor in the worst case increases square with the current, the squared current value is assumed as the measure for the power loss.

11.1.8 Power monitoring for the brake chopper

Power monitoring for the internal brake resistor is implemented in the operating software.

When the power monitoring “I²t brake chopper” reaches 100% the power of the internal brake resistor is switched back to the rated output power.

11.2 Display of operating mode and error messages

11.2.1 Operating mode and error display

The system supports a seven-segment display. The following table describes the display and the meaning of the symbols shown:

Table 41: Operating mode and error display

Display	Meaning
	In the operation mode speed control the outer bars “rotate”, depending on the actual speed resp. the actual position of the rotor.
	If the drive is enabled, the center bar of the seven-segment display is on, too.
	The servo positioning controller SE-Power FS still has to be parameterised (seven-segment display = “A”).
	Operating mode torque control, the two bars on the left hand of the display are on (seven-segment display = “I”).
P xxx	Positioning, “xxx” stands for the position number. The numbers are successively indicated.
PH x	Homing (“x“ stands for the currently active phase of the homing run). 0 : Search phase 1 : Crawling phase 2 : Positioning to zero position The numbers are successively indicated.
E xxy	Error message with index “xx” and subindex “y”. The numbers are successively indicated.
-xxy-	Warning message with Index “xx” and subindex “y”. A warning is displayed at least twice on the seven-segment-display. The numbers are successively indicated.
	Option “STO” (Safe Torque-Off) active for the SE-Power FS devices. (seven-segment display = “H”, blinking with a frequency of 2 Hz).

11.2.2 Error messages

If an error occurs, the servo positioning controller SE-Power FS will cyclically show an error message in its seven-segment display. The error message is comprised of an E (for Error), a main index (xx) and a sub index (y), for example **E 0 1 0**.

Warnings have the same code numbers as error messages. As a distinguishing feature, warnings have a centre bar before and after the number, for example **- 1 7 0 -**.

The following *Table 42: Error messages* summarize the meaning of the messages and the corresponding measures.

The error messages with the main index 00 do not reflect run time errors. They contain information and in general there are no measures required by the user. They occur in the error buffer only but will not be shown on the 7-segment display.

Table 42: Error messages

Error message		Meaning of the error message	Measures
Main index	Sub index		
00	0	Invalid error	Information: An invalid (corrupted) entry in the error buffer is marked by this error number. No measures required
	1	Invalid error detected and corrected	Information: An invalid (corrupted) error entry was detected and corrected. The Debug information stores the initially found error number. No measures required
	2	Error cleared	Information: The active errors have been cleared. No measures required
	4	Serial number/device type changed (change of modules)	Information: A flexible error buffer (service memory module) has been plugged into another device. No measures required
01	0	Stack overflow	Incorrect firmware? If necessary, reload the standard firmware again. Contact the Technical Support
02	0	Under voltage of DC-bus	Error reaction set too high? Check power supply. Check (measure) the intermediate circuit voltage Check threshold limit of the DC-link Monitoring
03	0	Over temperature analogue motor	Motor too hot? Check the parameterization (current controller, current limitation).

Error message		Meaning of the error message	Measures
Main index	Sub index		
	1	Over temperature digital motor	Suitable sensor? Sensor defective? Check the parameterization of the sensor or the sensor characteristic curve. Error also occurs if sensor is bypassed: device defective. Please, send the servo positioning controller to our sales partner.
	2	Over temperature motor analogue: Wire break	Check cables of temperature sensor (broken wire). Check the parameterization of wire break monitoring (threshold value).
	3	Over temperature motor analogue: Short circuit	Check cables of temperature sensor (short circuit). Check the parameterization of short circuit monitoring (threshold value).
04	0	Over temperature of the power stage	Plausible temperature display? Check the installation conditions, filter mats of fan dirty? Device fan defective?
	1	Over temperature in the DC-bus	
05	0	Internal under voltage supply 1	Disconnect the device from the entire periphery and check whether the error persists after a reset. If the error persists, please send the servo positioning controller to our sales partner.
	1	Internal under voltage supply 2	
	2	Driver voltage failure	
	3	Under voltage dig. I/O	Check the outputs for short-circuits or specific load. If necessary, contact the Technical Support.
	4	Overcurrent dig. I/O	
	5	Technology module supply voltage failure	Technology module defective? Replace the technology module. If necessary, contact the Technical Support.
	6	X10, X11 and RS232 supply voltage failure	Check the pin assignment of the connected peripheral equipment. Check the connected peripheral equipment for short-circuits.
	7	Safety module internal voltage failure	Safety module defective? Replace the safety module. If the error persists, please send the servo positioning controller to our sales partner.
	8	Internal under voltage supply 3 (15V)	Please send the servo positioning controller to our sales partner.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	9	Encoder supply failure	
06	0	Short circuit in the power stage	Motor defective? Short-circuit in cable? Power stage defective?
	1	Overcurrent brake chopper	Check the external brake resistor: Short circuit or resistance value too low? Check braking chopper output of the device.
07	0	Overvoltage in the DC-bus	Check connection to braking resistor (internal / external). External braking resistor overloaded? Check rating.
08	0	Angle encoder error resolver	See measures 08-2 .. 08-8.
	1	Sense of rotation of the serial and incremental position evaluation is not identical	A and B-track are mixed up? Correct (check) the connection of the tracks.
	2	Error of track signals Z0 Incremental encoder	Angle encoder connected? Angle encoder cable defective? Angle encoder defective? Check the configuration of the angle encoder interface. The encoder signals are disturbed: check the installation for compliance with EMC recommendations
	3	Error of track signals Z1 Incremental encoder	
	4	Error of track signals of digital incremental encoder	
	5	Error of Hall signals incremental encoder	
	6	Communication error encoder	
	7	Signal amplitude incremental track erroneous	
	8	Internal encoder error	Internal monitoring of the angle encoder at [X2B] has identified an error. Communication error? Check the encoder type, contact the Technical Support if necessary.
	9	Encoder at X2B not supported	Please contact the Technical Support
09	0	Old encoder parameter set	Save data into the encoder EEPROM (new format)

Error message		Meaning of the error message	Measures
Main index	Sub index		
	1	Encoder parameter set cannot be decoded	Encoder defect? Check encoder interface configuration. The encoder signals are disturbed. Check the installation for compliance with EMC recommendations
	2	Unknown encoder parameter set version	Save the data into the encoder again.
	3	Corrupted data structure in encoder parameter set	If necessary, determine the data once more and save it into the encoder again.
	4	EEPROM data: Erroneous customer specific configuration	Motor repaired: perform a homing run and save to the angle encoder, and then save to the basic device. Motor replaced: parameterise the basic device, perform a homing run, save to the angle encoder and then save to the basic device.
	7	Write protected EEPROM angle encoder	Please contact the Technical Support.
	9	EEPROM angle encoder too small	
10	0	Over speed (motor over speed protection)	Encoder offset angle correct? Over speed protection limit too small?
11	0	Error at start of homing run	No controller enabling.
	1	Error during homing run	Homing has been interrupted for example by disabling the controller.
	2	Homing run: No valid index pulse	The required index pulse is missing.
	3	Homing run: timeout	The maximum time parameterized for homing has been consummated before the homing run has been completed. Please check the time parameterisation.
	4	Homing run : Wrong or invalid limit switch	The associated limit switch is not connected. Limit switches mixed up? Move the limit switch so that it is not located in the area of the index pulse.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	5	Homing run: I²t / following error	Unsuitable parameterisation of acceleration ramps. Invalid stop reached, for example because no homing switch is connected. Check the connection of a home switch. Contact the Technical Support.
	6	Homing run: End of homing distance	The maximum homing distance has been travelled but the reference point or the destination of the homing run has not been reached.
12	0	CAN: Two nodes with the same ID	Check the configuration of the devices connected to the CAN bus.
	1	CAN: Communication error / bus OFF	Check the cabling (compliance with the cable specification, cable break, maximum cable length exceeded, correct terminating resistors, cable shield grounded, all signals applied?). Replace the device. If the error could be eliminated by replacing the device, please send the replaced device to our sales partner.
	2	CAN: Communication error on send	Check the cabling (compliance with the cable specification, cable break, maximum cable length exceeded, correct terminating resistors, cable shield grounded, all signals applied?). Check the start sequence of the application. Replace the device. If the error could be eliminated by replacing the device, please send the replaced device to our sales partner.
	3	CAN: Communication error on receive	
	4	CAN: Node Guarding	Equalize the cycle time of the remote frames with the PLC resp. failure of the PLC. Signals interfered?
	5	CAN: RPDO too short	Check the configuration.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	9	CAN: Protocol error	Check the command syntax of the control (record the data traffic). Please contact the Technical Support.
13	0	Timeout CAN-Bus	Check CAN parameterisation.
14	0	Insufficient supply for identification	Check the power supply. Check the motor resistor.
	1	Identification current controller: Measurement cycle insufficient	The automatic parameter identification process delivers a time constant beyond the parameterisation value range. The parameters must be optimized manually.
	2	Power stage could not be enabled	The power stage has not been enabled, check the connection of DIN 4.
	3	Power stage prematurely disabled	The power stage has been disabled while the identification process was running (for example via DIN 4).
	4	Identification does not support selected resolver	The identification cannot be performed with the present angle encoder settings. Check the configuration of the angle encoder. If necessary, contact the Technical Support.
	5	No index pulse detected	The index pulse could not be found after the maximum number of electrical rotations. Check the index pulse signal. Check the angle encoder settings.
	6	Invalid hall signals	Check the connection. Check the data sheet as to whether the encoder provides 3 Hall signals with 120° or 60° segments. If necessary, contact the Technical Support.
	7	Identification not possible	Check the DC bus circuit voltage. Check the wiring of the motor/encoder system. Motor blocked (for example holding brake not released)?
	8	Invalid number of pole pairs	The number of pole pairs calculated is beyond the parameterisation range. Check the motor data sheet. If necessary, contact the Technical Support
15	0	Division by zero	Please contact the Technical Support.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	1	Out of range error	
	2	Mathematical underflow	
16	0	Erroneous program execution	Please contact the Technical Support.
	1	Illegal interrupt	
	2	Initialization error	
	3	Unexpected state	
17	0	Max. following error exceeded	Increase error window. Acceleration parameterization too large.
	1	Encoder difference control	Check the connection of the encoders. Check the parameterized gear.
18	0	Warning level analogue motor temperature	Motor too hot? Check the parameterization (current controller, current limitation). Suitable sensor? Sensor defective? Check the parameterisation of the sensor and sensor characteristic. Error also occurs if sensor is bypassed: device defective. Please, send the servo positioning controller to our sales partner.
	1	Warning level temperature power stage	Plausible temperature display? Check the installation conditions, filter mats of fan dirty? Device fan defective?
19	0	Warning level I²t-Motor	Motor blocked?
21	0	Error 1 current measurement V	Please contact the Technical Support.
	1	Error 2 current measurement U	
	2	Error 2 current measurement V	
	3	Error 1 current measurement V	
22	0	PROFIBUS: Wrong initialization	Technology module defective? Replace the technology module. Contact the Technical Support
	1	PROFIBUS: reserved	Please contact the Technical Support.
	2	PROFIBUS: Communication error	Check the slave address. Check the bus terminators. Check the cabling.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	3	PROFIBUS: Invalid slave address	Incorrect slave address. Please select another slave address.
	4	PROFIBUS: Range overflow	Mathematical error during the conversion of physical units. The value range of the data and of the physical units does not match (fieldbus display units). Contact the Technical Support.
25	0	Invalid device type	Please send the servo positioning controller to our sales partner.
	1	Device type not supported	
	2	HW revision not supported	Check the firmware version. If necessary, request an update from the Technical Support.
	3	Device function restricted	Please send the servo positioning controller to our sales partner.
	4	Invalid power stage type	Check the firmware version. If necessary, request an update from the Technical Support.
26	0	No user parameter set	Load the default parameter set. If the error continues to occur, contact the Technical Support.
	1	Checksum error	
	2	Flash: Error during write-operation	Please send the servo positioning controller to our sales partner
	3	Flash: Error during erase-operation	
	4	Flash: Error in internal flash	Re-load the firmware. If the error continues to occur, contact the Technical Support
	5	No calibration data	
	6	Missing user position data sets	Simply perform save & reset. Load the default parameter set. If the error continues to occur, contact the Technical Support.
	7	Faulty data tables (CAM)	Load the default parameter set and commission the servo positioning controller. If necessary, reload parameter set. If the error continues, contact the Technical Support.
27	0	Following error warning level	Check the parameterisation of the following error. Motor blocked?

Error message		Meaning of the error message	Measures
Main index	Sub index		
28	0	Hours-run meter missing	Acknowledge the error. If the error occurs again, contact the Technical Support.
	1	Hours-run meter: write error	
	2	Hours-run meter corrected	
	3	Hours-run meter converted	
29	0	SD-Card not available	Please contact the Technical Support
	1	SD-Card: Initialization error	
	2	SD-Card: Data error	
	3	SD-Card: Write error	
	4	SD-Card: Firmware download error	
30	0	Internal calculation error	Please contact the Technical Support.
31	0	I^2t motor	Motor blocked? Check the power rating of the drive.
	1	I^2t servo positioning controller	Check the power rating of the drive package.
	2	I^2t-PFC	Check the power rating of the drive package. Select operation without PFC?
	3	I^2t-Break resistor	Braking resistor overloaded. Use external braking resistor?
	4	I^2t real power overload	Reduce the real power of the drive.
32	0	Loading period DC-bus exceeded	Bridge for the internal brake resistor installed? Check the connection of the external brake resistor. If necessary, contact the Technical Support.
	1	Under voltage for active PFC	Check whether the power supply complies with the nominal data.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	5	Braking chopper overload. Intermediate circuit couldn't be discharged.	Check the ON/OFF cycles.
	6	Discharge period DC-bus exceeded	Bridge for the internal brake resistor installed? Check the connection of the external brake resistor. If necessary, contact the Technical Support.
	7	Failure of power supply for controller enable	No intermediate circuit voltage? Check the power supply. If necessary, contact the Technical Support.
	8	Supply power breakdown at controller enable	Check the power supply.
	9	Phase failure	
33	0	Following error encoder emulation	Check the settings of the incremental encoder emulation (number of lines). If necessary, contact the Technical Support.
34	0	No synchronisation via field bus	Failure of synchronization messages from master?
	1	Field bus synchronisation error	Failure of synchronization messages from master? Parameterization of synchronization interval too small?
35	0	Speed protection of Linear motor	The encoder signals are disturbed. Check the installation for compliance with EMC recommendations.
	1	Timeout during quick stop	Check the commutation angle.
	5	Error during the determination of the commutation position	For this motor an improper method has been chosen. Please contact the Technical Support.
36	0	Parameter limited	Check user parameter set.
	1	Parameter not accepted	
37	0	sercos: Excessive distortion	Check the sercos wiring (for example clean the optical fibre). Check settings for the luminous power. Check the baud rate.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	1	sercos: Ring not closed	Check the sercos wiring (optical fibre) for breaks. Check the connections.
	2	sercos: MST missing twice	Check the sercos wiring (optical fibre). Check the control system (are all of the MSTs being transmitted?)
	3	sercos: Illegal phase requested by master	Check the program in the sercos master
	4	sercos: MDT missing twice	Check the sercos wiring (optical fibre). Check the control system (are all of the MDTs being transmitted?)
	5	sercos: Unknown operation mode selected	Check the settings for the operating modes in IDN S-0-0032 to S-0-0035
	6	sercos: T3 invalid	Increase the baud rate. Shift the point of time T3 manually.
38	0	sercos: SERCON Status event	Technology module defective? Replace the technology module. If necessary, contact the Technical Support.
	1	sercos: No module	Technology module plugged-in correctly? Technology module defective? Replace the technology module. If necessary, contact the Technical Support.
	2	sercos: Defective module	Replace the technology module. If necessary, contact the Technical Support.
	3	sercos: S-0-0127: Invalid data in S-0-0021	Check the configuration (cyclic data for MDT and AT). Time slot calculation by the master.
	4	sercos: S-0-0127: Illegal IDNs in AT or MDT	Check the configuration (cyclic data transfer).
	5	sercos: S-0-0128: invalid data in S-0-0022	Check the weighting settings. Check the operating mode settings. Check the internal/external angle encoder settings.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	6	sercos: S-0-0128: Invalid scaling	Check the weighting settings.
	7	sercos: Invalid IDN in S-0-0026 / S-0-0027	Check the configuration of the signal status and signal control word (S-0-0026 / S-0-0027).
	8	sercos: Error at conversion	Check the weighting settings. If necessary, contact the Technical Support.
	9	sercos: SERCON 410b mode activated	Technology module defective? Replace the technology module.
39	0	sercos: List S-0-0370: Invalid configuration MDT-Data container	Please contact the Technical Support.
	1	sercos: List S-0-0371: Invalid configuration AT-Data container	
	2	sercos: Cyclic channel fault MDT	
	3	sercos: Cyclic channel fault AT	
	4	sercos: Cyclic data container fault MDT	
	5	sercos: Cyclic data container fault AT	
40	0	Negative SW limit switch reached	Check the negative range limit.
	1	Positive SW limit switch reached	Check the positive range limit.
	2	Target position behind the negative SW limit switch	The start of a positioning run was suppressed as the target lies beyond the respective software limit switch. Check the target data. Check the positioning range.
	3	Target position behind the positive SW limit switch	

Error message		Meaning of the error message	Measures
Main index	Sub index		
41	0	Course program: Synchronization error	Check the parameterization. If necessary, contact the Technical Support.
	8	Course program: unknown command	
	9	Course program: abnormal jump destination	
42	0	Positioning: Missing following position: Stop	The positioning target cannot be reached with the current positioning options or the current boundary conditions. Check the positioning parameters.
	1	Positioning: Reversing the direction not allowed: Stop	
	2	Positioning: Reversing the direction after stop not allowed	
	3	Start positioning rejected: wrong mode of operation	The change of the mode of operation could not be performed by the position set.
	4	Start positioning discarded: homing required	Reset the optional parameterisation “homing required”. Perform a new homing run.
	5	Rotary axis: direction of rotation is not allowed	According to the selected mode of the rotary axis the calculated direction of rotation is not allowed. Check the selected mode.
	9	Error at positioning start	Check speed parameters and acceleration
43	0	Limit switch: Negative set point inhibited	The drive has left the intended motion range. Technical defect in the system? Check the limit switches.
	1	Limit switch: Positive set point inhibited	
	2	Limit switch: Positioning suppressed	
	9	Limit switch: both limit switches are concurrently active	
44	0	CAM table error	Check whether the index has been assigned correctly. Check whether there are cam plates present in the device.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	1	CAM: drive not referenced	Ensure that the drive has been homed prior to the activation of the cam plate. Delete the “homing necessary” option. Ensure that a cam plate cannot be started during a homing run.
45	0	Supply voltage cannot be switched off	Please contact the Technical Support.
	1	Supply voltage cannot be switched on	
	2	Supply voltage has been activated	
	3	Power stage release (DIN 4) not plausible	
47	0	Error set-up mode: timeout expired	Check the processing of the request by the PLC. Speed threshold too low or timeout too small?
49	2	DCO file: Data error	Please contact the Technical Support.
50	0	CAN: Too many synchronous PDOs	Deactivate the PDOs or increase the SYNC interval. The maximum number of PDOs must not be greater than the factor tp between the position controller and IPO (menu: Parameters/Controller parameters/Cycle times)
	1	SDO error occurred	Please contact the Technical Support.
51	0	No or unknown FSM module	Replace the FSM-Module.
	1	FSM: faulty driver supply	Please contact the Technical Support.
	2	FSM: different module type	
	3	FSM: different module version	
	4	Fault: SSIO communication	
	5	Fault: FSM break control	
52	1	FSM: STO inputs have different levels	Please contact the Technical Support.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	2	FSM-STO: Failure of +5 V OS/US supply during the PWM was still active	
53 … 59	0	FSM 2.0	Please contact the Technical Support.
60	0	Ethernet user-specific (1)	Please contact the Technical Support.
61	0	Ethernet user-specific (2)	Please contact the Technical Support.
62	0	EtherCAT: General bus error	No EtherCAT bus available. Check the cabling.
	1	EtherCAT: Initialization error	Replace the technology module. If necessary, contact the Technical Support.
	2	EtherCAT: Protocol error	Wrong protocol (no CAN over EtherCAT)? Check the EtherCAT wiring.
	3	EtherCAT: Invalid RPDO length	Check the protocol. Check the RPDO configuration of the servo positioning controller and of the control system.
	4	EtherCAT: Invalid TPDO length	
	5	EtherCAT: Erroneous cyclic communication	Check the EtherCAT wiring. Check the configuration of the master system.
63	0	EtherCAT: Defective module	Technology module defective? Replace the technology module.
	1	EtherCAT: Invalid data	Check the protocol. Check the EtherCAT wiring.
	2	EtherCAT: TPDO data has not been read	Reduce the cycle time (EtherCAT bus).
	3	EtherCAT: No distributed clocks active	Check whether the master supports the “distributed clocks” feature. If necessary, contact the Technical Support.
	4	Missing SYNC message in IPO cycle	Check the cycle times of the servo positioning controller and of the control system.
64	0	DeviceNet: Duplicate MAC ID	Change the MAC ID.
	1	DeviceNet: Bus power lost	Check the DeviceNet wiring.
	2	DeviceNet: RX queue overrun	Reduce the number of messages per time unit during the transmission.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	3	DeviceNet: TX queue overrun	Reduce the number of message per time unit that are to be transmitted.
	4	DeviceNet: IO send error	Please contact the Technical Support.
	5	DeviceNet: Bus Off	Check the DeviceNet wiring.
	6	DeviceNet: CAN controller overrun	Please contact the Technical Support.
65	0	DeviceNet active, but no module	Technology module defective? Replace the technology module.
	1	Timeout I/O connection	Please contact the Technical Support.
80	0	IRQ: Time overflow current control	Please contact the Technical Support.
	1	IRQ: Time overflow speed control	
	2	IRQ: Time overflow position control	
	3	IRQ: Time overflow interpolator	
81	4	IRQ: Time overflow low-level	Please contact the Technical Support.
	5	IRQ: Time overflow MDC	
82	0	Sequence control: General	Normally just information. No measures required.
	1	Multiple-started CO write access	Please contact the Technical Support.
83	0	Invalid technology module or Technology module: (slot/combination)	Load the correct firmware. Please check the slot. If necessary, contact the Technical Support.
	1	Technology module not supported	Incorrect firmware? Load the correct firmware. If necessary, contact the Technical Support.
	2	Technology module: HW revision not supported	
	3	Service memory module: write error	Please contact the Technical Support.
	4	Technology module: MC2000 watchdog	
90	0	Missing hardware component (SRAM)	Please contact the Technical Support.

Error message		Meaning of the error message	Measures
Main index	Sub index		
	1	Missing hardware component (FLASH)	
	2	Error during booting of FPGA	
	3	Error during start of SD-ADUs	
	4	Synchronisation error SD-ADU after start	
	5	SD-ADU not in synchronism	
	6	IRQ 0 (current controller): Trigger error	
	7	CAN controller not available	
	8	Checksum Error in Device Parameters	
	9	DEBUG-Firmware loaded	
91	0	Internal initialisation error	Please contact the Technical Support.
	1	Memory error	
	2	Reading of the controller/power stage type failed	
	3	Internal software initialization error	
92	0	Error during firmware download	Incorrect firmware? Load the correct firmware. If necessary, contact the Technical Support

12 Technology modules

12.1 SE-Power I/O-Interface

12.1.1 Product description

The technology module SE-Power I/O-Interface can be used in technology slot TECH 1 and/or TECH 2 of the servo positioning controller. Up to two SE-Power I/O-Interfaces can be supported simultaneously.

This technology module can be used to actuate up to 8 digital 24V outputs independently. The outputs are short circuit-proof. Furthermore, 8 digital 24V inputs are available, the state of which can be evaluated by means of the servo positioning controller.

The SE-Power I/O-Interface has the following characteristics:

- Digital 24V inputs
- Digital 24V outputs which can be activated separately and loaded with 100 mA each
- MicroCombicon pin-and-socket connectors made by PHOENIX Contact
- Pin-and-socket connectors via male multipoint connector in accordance with EN 60603-1
- The inputs and outputs are floating due to the optocouplers
- The inputs and outputs are protected against short circuits and overload

12.1.2 Technical data

12.1.2.1 General data

Table 43: Technical data: SE-Power I/O-Interface

Range	Values
Storage temperature range	-25 °C to +75°C
Operating temperature range / derating	0°C to 50°C
Humidity	0..90 %, not bedewing
Altitude	Up to 2000 m above msl
External dimensions (LxWxH):	87mm x 65mm x 19mm; suitable for technology slot TECH 1 and/or TECH 2
Weight:	approx. 50g

12.1.2.2 Digital inputs

8 digital inputs 24V, protected against inverse polarity and short-circuit-proof.

Table 44: Digital inputs [X21]: SE-Power I/O-Interface

Range	Values
Input	High level switches the input
Nominal voltage	24 VDC
Voltage range	-30 V...30 V
"High" detection at	U_{In} > 8 V
"Low" detection at	U_{In} < 2 V
Hysteresis	>1V
Input impedance	≥ 4,7 kΩ
Inverse polarity protection	To -30V
Switching delay up to port pin (low-high transition)	< 100 µs

12.1.2.3 Digital outputs

8 digital outputs 24V, protected against inverse polarity and short-circuit-proof, protection against thermal overload.

Table 45: Digital outputs [X22]: I/O-Interface

Range	Values
Switch type	High-side switch
Nominal voltage	24 VDC
Voltage range	18 V...30 V
Output current (nominal)	$I_{L,nominal}$ = 100 mA
Voltage loss at $I_{L,nominal}$	≤ 1 V
Residual current with switch in OFF position	< 100 µA
Protection against short-circuit / overcurrent	> 500mA (approx. value)
Temperature protection	Shut-down if the temperature is too high, T_J > 150°
Supply	Protection in the case of inductive loads and voltage supply via the output, also if the supply is turned off
Loads	R > 220 Ω; L at random; C < 10nF

Range	Values
Switching delay as of port pin	< 100 µs

12.1.3 Pin assignment and cable specifications

12.1.4 Power supply

- The admissible input voltage range during operation is 15VDC….32VDC.
- The digital outputs of the SE-Power I/O-Interface technology module are supplied with voltage exclusively by an external 24VDC power supply. The nominal input voltage for the I/O supply is 24VDC.
- If digital inputs are used, the reference potential GND24V of the 24VDC supply also has to be connected to the SE-Power I/O-Interface technology module.

12.1.4.1 Pin assignments

The following elements can be found on the front plate of the SE-Power I/O-Interface:

- Connector [X21 for 8 digital inputs: PHOENIX Micro Combicon MC 0,5/9-G-2,5 (9-pole)

Table 46: I/O: Connector [X21] for 8 digital inputs

Pin	1	2	3	4	5	6	7	8	9
Signal	GND 24V	In 1	In 2	In 3	In 4	In 5	In 6	In 7	In 8

- Connector [X22] for 8 digital outputs: PHOENIX Micro Combicon MC 0,5/10-G-2,5 (10-pole)

Table 47: I/O: Connector [X22] for 8 digital outputs

Pin	1	2	3	4	5	6	7	8	9	10
Signal	GND 24V	Out 1	Out 2	Out 3	Out 4	Out 5	Out 6	Out 7	Out 8	+24VDC external

The following *Figure 29* shows the position of the connectors and their numbering:

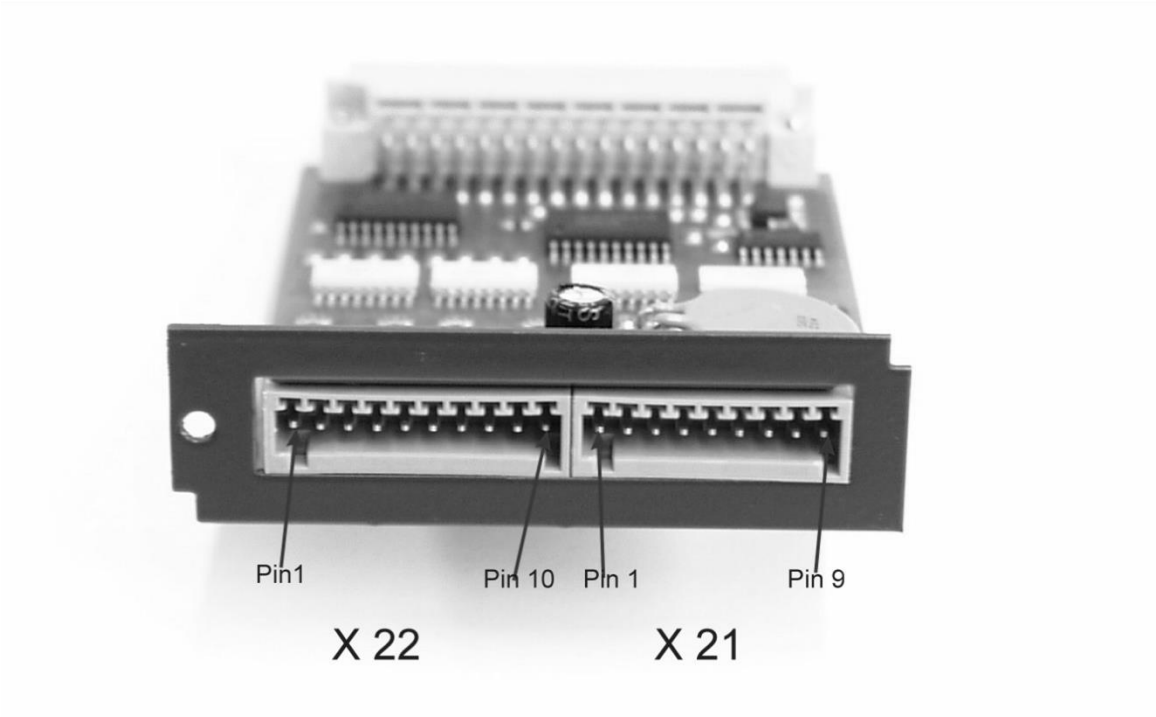


Figure 29: Position of the pin-and-socket connectors [X21] and [X22] at the front plate

12.1.4.2 Mating plug

- Connector [X21] for 8 digital inputs: PHOENIX MicroCombicon FK-MC 0,5/9-ST-2,5
- Connector [X22] for 8 digital outputs: PHOENIX MicroCombicon FK-MC 0,5/10-ST-2,5

12.1.4.3 Connection notes

The MicroCombicon mating plugs made by PHOENIX Contact regarding [X21] (FK-MC 0.5/9-ST-2.5) and [X22] (FK-MC 0.5/10-ST-2.5) are supplied together with the SE-Power I/O-Interface interface technology module. The cables are connected in the form of crimp connections. To do so, first strip the cable at a length of about 8 mm. Then insert it into the desired opening by pressing down the orange crimp lock using a suitable screwdriver, the tip of a ball-pen or something similar. Release the lock to fix the cable in place. The maximum admissible wire cross-section (wire gauge) is 0.5 mm^2 or AWG20.

If the SE-Power I/O-Interface is also used to control digital outputs, an additional external 24V supply voltage has to be connected to [X22], pin 10.

As the lines GND24V and +24Vext. have to transfer the entire current of all outputs connected, their cross-section has to be sized accordingly (recommended: 0,5mm^2 or AWG 20).

12.2 SE-Power Profibus-Interface

12.2.1 Product description

The SE-Power Profibus-Interface provides an additional field bus connection. All functions and parameters can be addressed directly, for example from a Simatic S7 control system. The interface is plugged into the technology slot TECH 2 of the SE-Power servo positioning controller.

> The SE-Power Profibus-Interface is supported solely in the TECH 2 technology slot.
>
> In addition to the SE-Power Profibus-Interface, the TECH 1 technology slot can also be used for the SE-Power I/O-Interface.
>
> Additional technology modules will not be supported if the SE-Power Profibus-Interface is used.
>
> If your specific requirements are more complex, please contact your sales partner in order to find a solution for your particular application.

As a special feature, S7 function blocks have been developed for the servo positioning controllers. Using these function blocks, the servo positioning controllers can be controlled directly by the PLC program and the users can integrate their systems easily and clearly into the Simatic S7 environment.

12.2.2 Technical data

Table 48: Technical data: SE-Power Profibus-Interface: Ambient conditions, dimensions and weight

Range	Values
Storage temperature range	-25 °C to +75°C
Operating temperature range	0°C to 50°C
Humidity	0..90%, not bedewing
Altitude	Up to 2000 m above msl
External dimensions (LxWxH):	approx. 92 x 65 x 19mm suitable for technology slot TECH 2
Weight:	approx. 50g
Slot	Technology slot TECH 2

Table 49: Technical data: SE-Power Profibus-Interface: Interface and communication

Communication interface	Profibus module
Controller	Profibus controller VPC3+, 12 MBaud max.
Protocol	Profibus DP, 32-byte telegrams with operating-mode-depending configuration
Interface	Floating, D-SUB 9-pin, integrated bus terminating resistors (can be activated by DIP switches)
Special functions	Support of diagnosis data, RTS signal led out, fail-safe mode, sync/freeze

The following elements can be found on the front plate of the SE-Power Profibus-Interface (see *Figure 30*)

- a green LED to indicate readiness for operation
- a 9-pin female DSUB connector
- two DIP switches for activating the terminating resistors

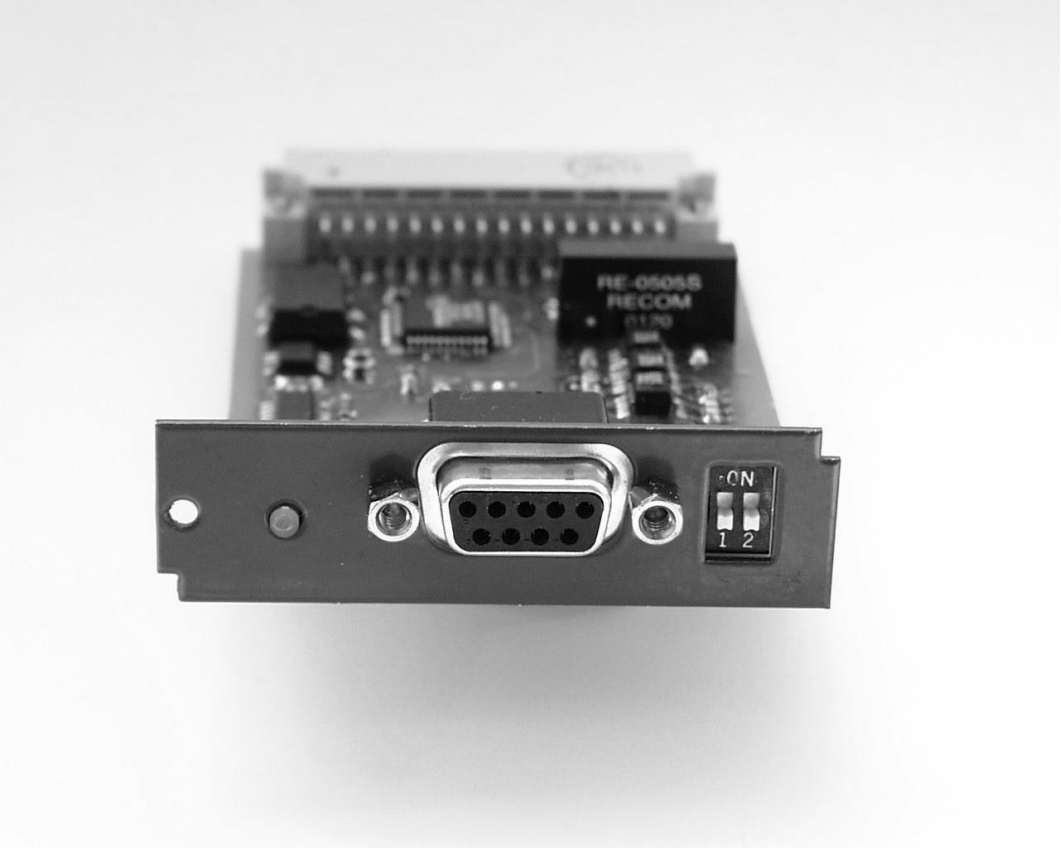


Figure 30: SE-Power Profibus-Interface: Front view

12.2.3 Pin assignment and cable specifications

12.2.3.1 Pin assignments

- 9-pin DSUB connector, female

Table 50: Pin assignment: SE-Power Profibus-Interface

Pin no.		Denomination	Value	Specification
1		Shield	-	Cable shield
	6	+5V	+5 V	+5V – output (floating) [1)]
2		-	-	Not occupied
	7	-	-	Not occupied
3		RxD / TxD-P		B-line transmission / reception data
	8	RxD / TxD-N		A-line transmission / reception data
4		RTS / optical waveguide connection		Request to Send [2)]
	9	-	-	Not occupied
5		GND5V	0 V	Reference potential GND 5V [1)]

1) Can be used for external bus termination or to supply the transmitter/receiver of an external optical waveguide transmission.

2) The signal is optional. It is used to identify the direction of an external optical waveguide connection.

12.2.3.2 Mating plug

- 9-pin DSUB connector, for example Erbic MAX PROFIBUS IDC Switch, made by ERNI

12.2.3.3 Cable type and design

The mentioned cable denominations refer to cables by Lapp. They have proven effective and are successfully used in many applications. However, similar cables from other manufacturers, for example Lütze or Helukabel, may also be used.

- LAPP KABEL UNITRONIC BUS L2/FIP FC; 1 x 2 x0,64; ∅ 7,8 mm,
  with tinned total CU shielding for quick-connect applications with IDC connectors

For highly flexible applications:

- LAPP KABEL UNITRONIC BUS-FD P L2/FIP; 1 x 2 x 0,64; ∅ 8 mm,
  with tinned total CU shielding for highly flexible use in drag chains

12.2.4 Termination and bus terminating resistors

Every bus segment of a PROFIBUS network has to be equipped with bus terminating resistors to minimise line reflections and to adjust a defined rest potential on the line. The bus termination has to be provided at the **beginning** and at the **end of every bus segment**.

Most PROFIBUS connectors come supplied with integrated terminating resistors. For bus connections with connectors without integrated terminating resistors, the PROFIBUS-DP interface has its own terminating resistors. They can be activated with the help of the **two DIP switches** on the module (switch set to ON).

To ensure safe operation of the network, **only one bus termination may be used at a time**.

The external connection can also be set up discretely (see *Figure 31*). The power supply of 5 V required for the externally connected terminating resistors is supplied at the PROFIBUS connector of the SE-Power Profibus-Interfaces (see pin assignment in der *Table 50)*.

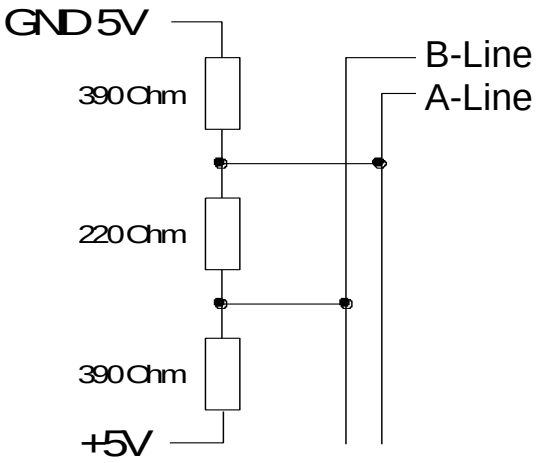


Figure 31: Profibus-DP-Interface: Connection with external terminating resistors

12.3 SE-Power EtherCAT-Interface

12.3.1 Product description

The technology module SE-Power EtherCAT-Interface enables the connection of the SE-Power FS servo positioning controller to the EtherCAT fieldbus system. The communication via the EtherCAT interface (IEEE-802.3u) is realised with the aid of standard EtherCAT cabling and is supported by the SE-Power from **Firmware version 3.5 KM-Release1.7** and the **parameterisation program Afag SE-Commander from version 2.8**.

In the case of the SE-Power FS, Afag supports the CoE-protocol (CANopen over EtherCAT) with the FPGA ESC20 made by Beckhoff.

The SE-Power EtherCAT-Interface is supported solely in the **TECH 2** technology slot.

In addition to the SE-Power EtherCAT -Interface the TECH 1 technology slot can also be used for the SE-Power I/O-Interface.

Additional technology modules will not be supported if the SE-Power Profibus-Interface is used.

If your specific requirements are more complex, please contact your sales partner in order to find a solution for your particular application.

12.3.2 Characteristics

The technology module SE-Power EtherCAT-Interface has the following characteristics:

- It can be fully mechanically integrated in the Afag servo positioning controllers of the SE-Power FS series
- EtherCAT corresponding to IEEE-802.3u (100Base-TX) with 100 Mbps (full duplex)
- Star and line topology
- Connector: RJ45
- Electrically isolated EtherCAT interface
- Communication cycle : 1ms
- 127 slaves max.
- EtherCAT slave implementation based on FPGA ESC20 by Beckhoff
- Support of the “Distributed Clocks” feature for synchronised set value transfer
- LED display for indicating readiness and link-detect

Figure 32: SE-Power EtherCAT-Interface: Front view

12.3.3 Technical data

Table 51: Technical data: SE-Power EtherCAT-Interface: Ambient conditions, dimensions and weight

Range	Values
Storage temperature range	-25 °C to +75 °C
Operating temperature range	0 °C to 50 °C
Humidity	0..90 %, not bedewing
Altitude	Up to 2000 m above msl
External dimensions (LxWxH):	approx. 92 x 65 x 19mm
Weight:	approx. 50g
Slot	Technology slot TECH 2

12.3.4 Display elements

The front panel of the SE-Power EtherCAT-Interface technology module is equipped with two LEDs for indicating the operating states.

Table 52: Display elements

Element	Function
LED 1 multi-colour-LED	Run (green), link/activity EtherCAT port 1 (red), EtherCAT active (yellow)
LED 2 red LED	Link/activity EtherCAT Port 2

12.3.5 EtherCAT-Interface

Table 53: Signal level and difference voltage

Signal level	0 ... 2,5 VDC
Difference voltage	1,9 ... 2,1 VDC

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