

## short description

### SE-Power FS Safety Module FSM 2.0 STO

for the servo controllers of the SE-Power FS series

Translation

English



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→ The full documentation for the safety module and the documentation of the servo controllers SE-Power FS can be found in PDF format on our website at [www.afag.com](http://www.afag.com).

The present short description applies to the following versions:

- SE-Power FS Safety Module FSM 2.0 STO from revision 1.5
- Servo controller SE-Power FS, Firmware from version 4.0

## 1 Safety

### 1.1 General safety notes

- ❖ Observe in addition implicit the „Safety notes for electrical drives and controllers“ for the servo controllers SE-Power FS. These can be found in the corresponding operating instructions.

#### → Note

##### Loss of the safety function!

Non-compliance with environmental and supply conditions can lead to loss of the safety function.

- ❖ Keep the specified ambient and connection conditions, in particular the input voltage tolerances → section 12.

#### → Note

##### Damage to the safety module or the servo controller by improper use.

Improper use can result in damage.

- ❖ Switch off supply voltages before mounting and installation work. Do not switch on supply voltages, where assembly and installation work has been completed.
- ❖ Never pull off or plug the module when the servo controller is energised!
- ❖ Observe the regulations for handling electrostatic sensitive devices.

### 1.2 Proper usage

The SE-Power FS Safety Module STO serves as an extension of the servo controller SE-Power FS to achieve safety function:

- Safe Torque Off (STO) with SIL3 according to EN 61800-5-2 / EN 62061 / IEC 61508 respectively Category 4 / PL e according to EN ISO 13849-1.

The servo controller SE-Power FS with SE-Power FS Safety Module STO is a product with safety features and designed for installation in machines or automated systems and uses the following:

- in perfect technical condition,
- in original condition without unauthorized changes,
- within the limits defined by the technical specifications of the product (→ section 12),
- in the industrial sector.

The functional safety modules of the family SE-Power FS Safety Module can be operated in all servo controllers of the product family SE-Power FS, which have the slot for Functional Safety modules for safety technology. They can't be plugged into one of the expansion slots for technology modules (TECH1 or TECH2).

#### → Note

Any damage resulting from unauthorized interference or improper use voids the warranty and liability claims against the manufacturer.

### 1.3 Foreseeable Misuse

For improper use include the following foreseeable misuse:

- the use in a device other than a SE-Power FS,
- the outdoor use,
- the use in non-industrial areas (living area),
- the use in applications where the shutdown can lead to dangerous movements or states.

#### → Note

- The STO function is, for drives on a permanent moment acts (eg suspended loads), as the sole safety function, not sufficient.
- The bridging of safety devices is not permitted.
- Repairs are not permitted on the module!

The STO (Safe Torque Off) does **not** protect against electric shock, but only against dangerous movements!

→ SE-Power FS operating instructions

### 1.4 Achievable safety level,

#### Safety function according to EN ISO 13849 / EN 61800-5-2

The safety module fulfills the requirements of the test specifications

- Category 4 / PL e according to EN ISO 13849-1,
  - SIL CL 3 according to EN 61800-5-2 / EN 62061 / IEC 61508,
- and can be used in applications up Cat. 4 / PL e according to EN ISO 13849-1 and SIL 3 according to EN 62061 / IEC 61508.

The level of safety can be achieved depends on the other components from which are used to implement a safety function.

## 2 Requirements for product use

- ❖ Make this documentation, to the designer, installer and the staff responsible for commissioning the machine or system to which this product is used, available.
- ❖ Ensure that the requirements of the documentation are always met. Take into account also the documentation for the other components and modules (eg servo controller, cables etc.).
- ❖ Consider the legal provisions applicable to the destination and:
  - regulations and standards,
  - rules of the testing organizations and insurance,
  - National provisions.
- ❖ For emergency stop applications must provide protection against automatic warm restart according to the required safety category. This can be done eg by an external safety switching device.

### 2.1 Technical Requirements

General, always to be followed notes for the proper and safe use of the product:

- ❖ Adhere the in the technical data specified ambient and connection conditions for the Safety Module (→ section 12), the servo controller and all connected components. Only comply with the limits or the maximum loading limits use of the product in accordance with the relevant safety regulations.
- ❖ Follow the instructions and warnings in this manual.

### 2.2 Qualification of technical staff (staff requirements)

The device may only be operated by an electro-technically competent person who is familiar with:

- the installation and operation of electrical control systems,
- the regulations governing the operation of safety instrumented systems,
- the applicable regulations on accident prevention and occupational safety and
- the product documentation.

### 2.3 Diagnostic Coverage (DC)

The diagnostic coverage depends on the integration of the servo controller with safety module into the timing chain as well as of the measures implemented to diagnosis. → section 9.

If a potentially dangerous fault is detected at diagnosis, appropriate measures to maintain the level of safety must be provided.

#### → Note

Check to see if a cross-circuit detection of the input circuit and the wiring connection is required in your application.

If necessary, use an emergency stop device with cross-circuit detection for the control of the safety module.

## 2.4 Application and Approvals

The servo controller with integrated safety module is a safety component according to the Machinery Directive, the servo controller is provided with the CE mark. Standards and test that the product complies with and satisfies, see the section "Technical Data" (→ section 12). Please see the declaration of incorporation for the product relevant EC Directives.

## 3 Product Description

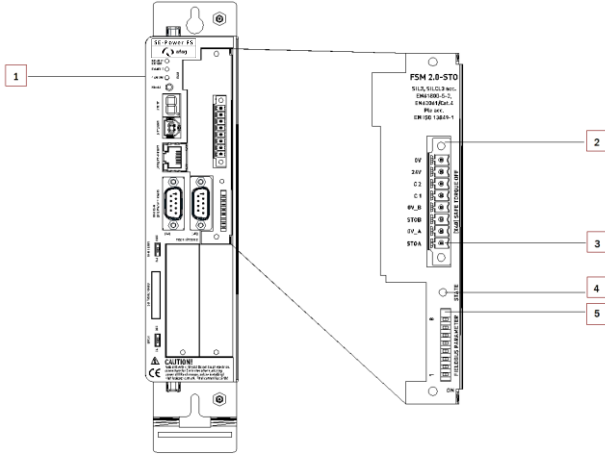
### 3.1 Supported Devices

The SE-Power FS STO safety modules can only be used in servo controllers in accordance with section 1.2.

The servo controller of the SE-Power FS series are in the default factory settings already with the SE Power FS STO safety modules with integrated functional safety function STO (Safe Torque Off) equipped.

### 3.2 Operating elements and connections

The SE-Power FS Safety Module STO has the following controls, connectors and indicators:



- |  |   |
|--|---|
| 1 servo controller SE-Power FS with slot for Functional Safety Modules | 4 LED for indicating the operating status (Status of functional safety)                           |
| 2 Digital I / O interface [X40] to control the STO function            | 5 DIP switches (activation / configuration of the fieldbus communication in the servo controller) |
| 3 Pin 1 on the socket [X40]  |   |

Figure 1: Panel and connectors of the SE-Power FS Safety Module STO

## 4 Function and application

The SE-Power FS Safety Module STO has the following features:

- reaching the function "Safe Torque Off" (STO),
- Floating feedback contact,
- Designed as plug-in module from the outside,
- Only suitable for servo controllers of the product family SE-Power FS.

### 4.1 Description of the safety function

With active safety function STO "Safe Torque Off" the power supply of the drive is interrupted for safe. The drive can't generate torque and thus no dangerous movements. There is no monitoring of the standstill position.

The shutdown of the machine must be initiated and ensured safety-related, eg via a safety relay. This applies especially for vertical axes without self-locking mechanism, locking unit or counterbalance.

#### → Note

There is a risk of jerky movements when multiple faults in the SE Power FS. If, during state STO the power stage of the servo state fails (simultaneous short circuit of two power semiconductors in different phases), there may be a limited stop-motion of the rotor. The Angle / Stroke correspond to a pole pitch. Examples:

- Rotary axis, synchronous machine, 8-pole → Motion < 45° at the motor shaft.
- Linear motor, poles pitch 20 mm → Motion < 20 mm at the moving part.

### 4.2 Control inputs STO-A, 0V\_A / STO-B, 0V\_B [X40]

The STO safety function is requested solely by disconnecting the control voltage (0 V) to the two digital control inputs STO-A and STO-B. A fail-safe wiring of other interfaces on the base unit SE-Power FS is not required or provided.

→ A cross-circuit detection of the input circuit is not performed by the safety module.

According to the specification of the safety function, the voltage level at both STO-A/B must be identical, otherwise an error message is generated. The driver supply voltage is internally monitored by the state machine in the servo controller as a result of actuation of the control inputs. Changing the level of both inputs must be within the discrepancy time (default: 100 ms), otherwise an error message is generated.

Recommendation: Switch STO-A and STO-B is always simultaneously.

Transient test pulses of safety controls are tolerated and don't lead to the requirement of the STO function.

## 4.3 Feedback contact C1, C2 [X40]

A floating feedback contact (NO) reports the state of the servo controller to an external safety switching device back.

→ The feedback contact is implemented through one channel and may be used for diagnostic purposes, but not in safety circuit.

## 5 Assembly / Disassembly

The SE-Power FS Safety Module STO is only suitable for integration into the servo controller SE-Power FS. It can't be operated outside of the servo controller. The servo controller must be disconnected from any live cables before the assembly and disassembly of the safety module.



**Caution**  
Risk of electric shock when the safety module is not mounted.



Touching live parts causes serious injury and can lead to death. Against contact with live parts during maintenance, repair and cleaning work as well as long periods of discontinued:

1. Switch off the electrical equipment with the main switch and secure against restarting.
2. Wait at least 5 minutes off discharge after switching off and check that the power is off before accessing the servo controller.

#### → Note

**Damage to the safety module or the servo controller by improper handling.**

- ❖ Switch off supply voltages before mounting and installation work. Do not switch on supply voltages, where assembly and installation work has been completed.
- ❖ Never pull off or plug the module when the servo controller is energised!
- ❖ Observe the regulations for handling electrostatic sensitive devices. Do not touch the circuit board and the pins of the terminal strip on the servo controller. Access the safety module only on the front panel or on the board edge.

### Assembly the safety module

1. Insert the SE-Power FS Safety Module STO into the empty slot for Functional Safety modules so that the board is in the lateral guides of the slot runs.
2. Insert safety module, when reaching the rear connector strip within of the servo controller press careful until it stops at the edge connector.
3. Finally, tighten safety module with the two screws on the front side of the housing of the servo controller.

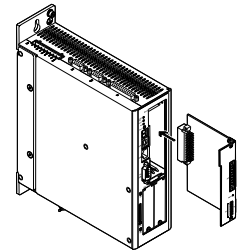


Figure 2: Assembly / Disassembly

Tighten the screws to 0.35 Nm.

### Disassembly the safety module

1. Unscrew the screws on the safety module.
2. Solve security module slightly levers on the front panel or by pulling the plug counter by a few millimetres.
3. Pull-out the security module from the slot.

## 6 Electrical Installation

### 6.1 Safety notes

For installation, the requirements of EN 60204-1 must be met.



**Caution**  
Risk of electric shock from voltage sources without protective measures.



- ❖ Use for electrical logic supply exclusively PELV circuits according to EN 60204-1 (Protective Extra-Low Voltage, PELV). Consider also the general requirements for PELV circuits in accordance with EN 60204-1.
- ❖ Use only power supplies which ensure a reliable electrical isolation of the operating voltage according to EN 60204-1.

Through the use of PELV circuits, protection is provided against electric shock (protection against direct and indirect contact) according to EN 60204-1 (Electrical equipment of machines, General requirements). The 24 V power supply used in the system must meet the requirements of EN 60204-1 for DC power supplies (Response to voltage interruptions, etc.).

➔ Make sure that no bridges or like that may be used wiring in parallel to safety, for example, by using the maximum conductor cross section of 1.5 mm<sup>2</sup> or ferrules with insulating collar. Use for loop of lines between adjacent devices twin wire end ferrules.

### 6.2 ESD protection

At unused connectors is a danger that by ESD (electrostatic discharge) damage to the unit or other equipment arises. Ground the equipment from the installation and use proper ESD equipment (eg, shoes, earth straps, etc.).

### 6.3 Connection [X40]

The SE-Power FS Safety Module STO has a combined interface for control and feedback on the connector [X40].

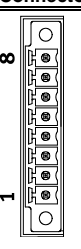
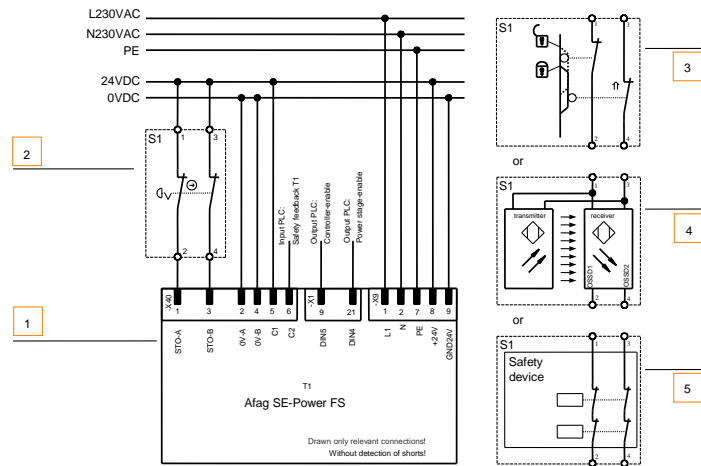
Connector	Pin	Designation	Value	Description
	8	0V	0 V	Reference potential for auxiliary supply voltage.
	7	24V	+24 V DC	Auxiliary supply voltage (24 V DC Lead through logic supply of the servo controller).
	6	C2	–	Feedback contact for the status „STO“ to an external device.
	5	C1		
	4	0V-B	0 V	Reference potential for STO-B.
	3	STO-B	0 V / 24 V	Control input B for the STO function.
	2	0V-A	0 V	Reference potential for STO-A.
	1	STO-A	0 V / 24 V	Control input A for the STO function.

Figure 3: Pin assignment [X40] (Representation of the connector on the module)

To ensure the STO "Safe Torque Off" function, the control inputs STO-A and STO-B are on two channels to be connected in parallel wiring. This connection may be part of an emergency stop circuit or a protective door arrangement eg.



- 1 Servo controller with Safety Module (only relevant connections)
- 2 Emergency stop switch
- 3 Safety door
- 4 Light grid
- 5 Safety switching device

Figure 4: Connection of the SE-Power FS Safety Module STO, Example single phase servo controller SE-Power FS

If at the moment of the commissioning of the servo controller, there's not (yet) a safety orientated connection, the servo controller SE-Power FS with the SE-Power FS Safety Module STO can be commissioned with a minimal wiring according figure 4 with one emergency stop switch (2). Do the minimal wiring of the inputs STO-A/STO-B and 0V-A/0V-B for commissioning such a way that they must be forcibly removed if the final safety circuit will be done.

#### ➔ Note

Safety functions should never be bridged.

## 7 Commissioning



### Caution Loss of the safety function!

Lack of safety function can lead to serious irreversible injuries, such as by involuntary movements of the connected actuators.

- ❖ Only operate with the safety module:
  - when installed and
  - if all precautions are taken.
- ❖ Validate security function for completion of commissioning.

➔ Incorrect wiring, using the wrong safety module or external components, what are not selected according to safety category, lead to loss of the safety function.

- ❖ Perform a risk assessment for your application and select the wiring and the components accordingly.

### 7.1 Before commissioning

Perform the following steps to prepare the commissioning:

1. Ensure that the safety module is installed correctly.
2. Check the electrical installation (cable, contact assignment) ➔ section 6). All protective earth (PE) conductors connected?

### 7.2 DIP switch setting

Set the DIP switches as described in the documentation for the servo controller SE-Power FS or the fieldbus manuals.

### 7.3 Parameter adjustment with the Afag SE-Power ServoCommander

When detecting a change, such as replacing a module, a not acknowledgeable error is raised. To set the application with the servo controller in operation, the change must be "projected". This means that the change is explicitly accepted respectively confirmed.

The acquisition of the parameters occurs in the window **Safety module** of the Afag SE-Power ServoCommander.

### 7.4 Functional test

#### ➔ Note

The STO function must be validated after installation and after changes in the installation.

This validation must be documented by the commissioner. As an aid to commissioning are examples of checklists in the document "SE-Power FS STO manual".

## 8 Operation

### 8.1 Obligations of the operator

The operability of the safety function must be checked at appropriate intervals. It is the responsibility of the operator to select the type of test and the intervals within the specified period. The test shall be performed so that the proper function of the safety device is detected in the interaction of all components.

### 8.2 Maintenance and care

The safety module is maintenance-free.

## 9 Troubleshooting and Diagnostics

### 9.1 Status Display

Mode and faults are displayed directly on the two-color LED of the safety module.

LED	Designation	Description
Off	Not safe = Status STO not active	Safety module or servo controller has no operating voltage.
Green	Not safe = Status STO not active	The power stage in the servo controller for feeding the motor can be active or inactive.
Yellow	Safe = Status STO active	The power stage in the servo for feeding the motor is shut down safely.

Figure 5: Display the safety module


Display	Description
	<p>„H“: The servo controller is in "safe state".</p> <p>This is not synonymous with information about the status of the safety function STO (Safe Torque Off). This can be read only by the status LED of the safety module.</p> <p>For the "unsafe state" no special indication is provided, it will be shown the normal status display of the servo controller.</p>

Figure 6. Seven-segment display on the servo controller

### 9.2 Error Messages

The servo controller shows cyclically disturbances in the seven-segment Display on the front panel of the servo controller.

Error messages will be with "E" (for error), a main index (xx) and a sub-index (y) displayed, eg: E 5 1 0. Warnings have the same number, but are shown with leading and trailing center bar, eg - 1 7 0 -.

In Figure 7 are the, for the functional safety in relation to the SE-Power FS Safety Module STO relevant error messages listed.

→ For more information on other error messages, refer to the corresponding documentation, eg the operating instruction, the software manual or the fieldbus manuals.

When error messages aren't acknowledgeable, you must first remove the cause. Then execute a reset of the servo controller and check if the error cause and thus the error message are eliminated.

Error <sup>1)</sup>	Cause	Measures
51-0 <sup>2)</sup>	No or unknown safety module – No safety module detected or unknown module type	❖ Install a, for the firmware and the hardware suitable safety or fieldbus activation module. ❖ Install a, for the module suitable firmware, comp. type designation.
	– Internally voltage error of the safety module or fieldbus activation module.	❖ Module probably damaged. Swap if possible with another module.
51-2 <sup>2)</sup>	Safety module: different module type – Type or revision of the module does not match the configuration.	❖ When replacing modules: Not yet configured module type. Take over the currently built safety module or fieldbus activation module as accepted.
51-3 <sup>2)</sup>	Safety module: different module version – type or revision of the module is not supported	❖ Install a, for the firmware and the hardware suitable safety or fieldbus activation module. ❖ Install a, for the module suitable firmware, comp. type designation.
52-1	Safety module: discrepancy expired	❖ Control Inputs STO-A and STO-B are not operated simultaneously. ❖ Control Inputs STO-A and STO-B are not connected in the same direction. ❖ Check discrepancy.
52-2	Safety module: Loss driver voltage during active PWM	❖ Configurable: The safe state has been requested with output stage enabled. Check integration into the safety-related connection.

1) Error number: xx-y (xx = main index, y = sub-index)  
2) The messages of the failure group 51 aren't acknowledgeable.

Figure 7: Error numbers in relation to the safety module

## 10 Replace the safety module, Repair

Repair or maintenance of the module is not allowed. If necessary, replace the entire module.

## 11 Decommissioning and Disposal

Please observe the local regulations for environmentally friendly disposal of electronic assemblies.

## 12 Technical data

Safety Technology		
Safety indicators		
Safety function	STO	– Safe Torque Off (STO) according to EN 61800-5-2 with SIL3 – Safe Torque Off (STO) according to EN ISO 13849-1 with category 4 and PL e
SIL	SIL 3 / SIL CL 3	Safety Integrity Level according to EN 61800-5-2
Category	4	Classification in category according to EN ISO 13849-1
PL	Pl e	Performance Level according to EN ISO 13849-1
DCavg [%]	97,5	Average Diagnostic Coverage
HFT	1	Hardware Failure Tolerance
SFF [%]	99,2	Safe Failure Fraction
PFH	$1,07 \times 10^{-10}$	Probability of dangerous Failure per Hour
PFD	$2,3 \times 10^{-5}$	Probability of dangerous Failure on Demand
T [Jahre]	20	Proof Test Interval Service life according to EN ISO 13849-1
MTTFd [Jahre]	100	Mean time to dangerous failure. Computationally 1450 years, limited to 100 years
Safety Information		
Type examination	The functional safety technology of the product has been certified in accordance with section 1.4 by an independent testing centre.	
Certificate issuing authority	TÜV 01/205/5443.00/15	
Approved component	yes	

General		
Mechanical		
Dimension (L x W x H)	[mm]	ca. 112,6 x 87,2 x 28,3
Weight	[g]	ca. 75
Note on materials	RoHS compliant	
Approvals (SE-Power FS Safety Module STO for servo controller SE-Power FS)		
CE mark (see declaration of incorporation)	In accordance with EU EMC directive In accordance with EU machinery directive	
The device is intended for use in industrial areas. In the living area possibly for radio interference suppression measures must be taken.		

Operating and environmental conditions		
Transport		
Admissible temperature range	[°C]	–25 ... +70
Humidity	[%]	0 ... 95, at max. 40 °C ambient temperature
Maximum duration of transport	[Weeks]	maximum of 4 throughout the product life cycle
Storage		
Admissible temperature range	[°C]	–25 ... +55
Humidity	[%]	5 ... 95, non-condensing, resp. protected against condensation
Admissible height	[m]	< 3000 (ASL)
Environmental conditions		
Ambient temperature	[°C]	0 ... +40 (outside the servo controller)
Cooling	Over the ambient air in the servo, no forced ventilation	
Admissible installation high	[m]	< 2000 (ASL)
protection category	IP20 (mounted in the SE-Power FS).	
Humidity	[%]	Relative humidity up to 90%, non-condensing
Degree of pollution according to EN 61800-5-1	2	
The integrated safety technology requires compliance with pollution degree 2 and thus a protected mounting area (IP54). This is to ensure by appropriate means always, eg by mounted in a cabinet.		

Electrical data		
Control inputs STO-A, 0V-A / STO-B, 0V-B [X40]		
Nominal voltage	[V]	24 (based on 0V-A/B)
Voltage range	[V]	19,2 ... 28,8
Admissible residual ripple	[%]	2 (based on nominal voltage 24 V)
Overvoltage shutdown	[V]	31 (Off on error)
Nominal current	[mA]	20 (typical; maximum 30)
Inrush current	[mA]	450 (typical, time ca. 2 ms; max. 600 at 28,8 V)
Input voltage threshold		
Switch-on	[V]	ca. 18
Switch-off	[V]	ca. 12,5
Switching time High to Low (STO-A/B_OFF)	[ms]	10 (typical; maximum 20 at 28,8 V)
Switching time Low to High (STO-A/B_ON)	[ms]	1 (typical; maximum 5)
Maximum positive test pulse length at 0 signal	[µs]	< 300 (based on nominal voltage 24 V and intervals > 2 s between the impulses)
Feedback contact C1, C2 [X40]		
Modality	Relay contact, NO	
Max. voltage	[V DC]	< 30 (overvoltage protected to 60 V DC)
Nominal current	[mA]	< 200 (not short-circuit proof)
Voltage drop	[V]	≤ 1
Residual current (contact open)	[µA]	< 10
Switching time Close (T_C1/C2_ON)	[ms]	< (STO-A/B_OFF + 5 ms)
Switching time Open (T_C1/C2_OFF)	[ms]	< (STO-A/B_ON + 5 ms)
Auxiliary supply 24V, 0V [X40] – Output		
Modality	Logic supply voltage of the servo controller. Reverse polarity protected, overvoltage protected up to 60 VDC	
Nominal voltage	[V]	24
Nominal current	[mA]	100 (short-circuit proof, max 300 mA)
Voltage drop	[V]	≤ 1 (at nominal current)
Electrically isolation		
Electrically isolated potentials areas	STO-A / 0V-A; STO-B / 0V-B; C1 / C2; 24V / 0V	
Cabling		
Max. cable length	[m]	30
Shielding	Use shielded cable for wiring outside the cabinet. Lead shielding to the control cabinet / connect on the cabinet side.	
Conductor cross-section (flexible conductor, Ferrules with insulating collar)		
one conductor	mm <sup>2</sup>	0,25 ... 0,5
two conductor	mm <sup>2</sup>	2 x 0,25 (with twin wire end ferrules)
tightening torque M2	[Nm]	0,22 ... 0,25