

—  
OPTIONS FOR ABB DRIVES

# Prevention of unexpected start-up (option +Q950) for ACS880-07/07LC/17/17LC/37/37LC drives

## User's manual





# Prevention of unexpected start-up (option +Q950) for ACS880-07/07LC/17/17LC/37/37LC drives

User's manual

Table of contents



1. Safety instructions



4. Electrical installation



7. Start-up and validation test





# Table of contents

---

## **1 Safety instructions**

Contents of this chapter .....	7
Use of warnings and notes .....	7
Instructions for functional safety circuits .....	8
Electrical safety precautions .....	9

## **2 Introduction to the manual**

Contents of this chapter .....	11
Applicability .....	11
Target audience .....	11
Exclusion of liability .....	12
Quick reference guide for taking a safety function into use .....	12
Related manuals .....	12
Terms and abbreviations .....	14

## **3 Option description**

Contents of this chapter .....	15
Overview .....	15
Summary of wirings and settings .....	16
Operation principle .....	17
Time scheme .....	17
Operation principle diagram .....	18
Fault reaction function .....	19
FSO module .....	19
Resetting the FSO module .....	19
Drive STO function .....	19

## **4 Electrical installation**

Contents of this chapter .....	21
Wiring .....	21

## **5 Parameter settings**

Contents of this chapter .....	23
Competence .....	23
FSO module parameter settings .....	23
General parameters .....	24
Parameters for the STO function .....	25
Parameters for the SSE function .....	25
Parameters for the POUS function .....	25
Drive parameter settings .....	27

## **6 Use of the safety function**

Contents of this chapter .....	29
Activating the safety function .....	29

---



Resetting the safety function ..... 29

**7 Start-up and validation test**

Contents of this chapter ..... 31  
Validation of the safety functions ..... 31  
    Competence ..... 31  
    Validation procedure ..... 31  
    Validation test reports ..... 32  
Start-up and validation test ..... 32

**8 Maintenance**

Contents of this chapter ..... 35  
Safety circuit maintenance ..... 35  
Proof test interval ..... 35  
Competence ..... 36  
Residual risk ..... 36  
Intentional misuse ..... 36  
Decommissioning ..... 36

**9 Technical data**

Contents of this chapter ..... 37  
Safety data ..... 37  
    Safety data values ..... 37  
    Safety component types ..... 38  
    Safety block diagrams ..... 38  
    Relevant failure modes ..... 38  
    Fault exclusions ..... 39  
    Operation delays ..... 39  
Ambient conditions ..... 39  
Related standards and directives ..... 39  
Compliance with the European Machinery Directive ..... 40

*Further information*



# 1

## Safety instructions

---



### Contents of this chapter

This chapter contains the safety instructions which you must obey when you install, operate and do maintenance on the safety functions of a drive.

### Use of warnings and notes

Warnings tell you about conditions which can cause injury or death, or damage to the equipment. They also tell you how to prevent the danger. Notes draw attention to a particular condition or fact, or give information on a subject.

The manual uses these warning symbols:

**WARNING!**

Electricity warning tells about hazards from electricity which can cause injury or death, or damage to the equipment.

---

**WARNING!**

General warning tells about conditions, other than those caused by electricity, which can cause injury or death, or damage to the equipment.

---

**WARNING!**

Electrostatic sensitive devices warning tells you about the risk of electrostatic discharge which can cause damage to the equipment.

---

## Instructions for functional safety circuits

This manual does not contain the complete safety instructions of the drive. It only includes the instructions related to the scope of this manual.

Only a qualified electrical professional who has sufficient knowledge about functional, machine, and process safety is permitted to install, start up and maintain the safety circuit. All user-made changes are on the user's responsibility.



**WARNING!**

The safety function described in this manual does not isolate the main circuit or auxiliary circuit from the power supply. Do not do work on the drive, motor cable or motor before you have isolated the drive system from all power supplies and measured that there are no dangerous voltages. Before you start the work, do the steps in section *Electrical safety precautions (page 9)*.

---



**WARNING!**

(With permanent magnet or synchronous reluctance [SynRM] motors only)

In case of a multiple IGBT power semiconductor failure, the drive system can produce an alignment torque which maximally rotates the motor shaft by  $180/p$  (with permanent magnet motors) or  $180/2p$  (with synchronous reluctance [SynRM] motors) degrees regardless of the activation of the Safe torque off function.  $p$  denotes the number of pole pairs.

---



**WARNING!**

Do the validation test of the safety function at the start-up and also after you make changes to the safety circuit.

---



**WARNING!**

Make sure that the functional safety of the machine is maintained in situations where the safety option does not provide protection, for example, during commissioning, system maintenance, fault tracing, or decommissioning.

---



**WARNING!**

Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do installation or maintenance work.

---



## Electrical safety precautions

These electrical safety precautions are for all personnel who do work on the drive, motor cable or motor.

**WARNING!**

Obey these instructions. If you ignore them, injury or death, or damage to the equipment can occur.

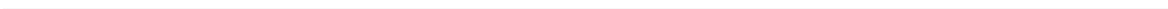
If you are not a qualified electrical professional, do not do installation or maintenance work.

Go through these steps before you begin any installation or maintenance work.

---

1. Clearly identify the work location and equipment.
2. Disconnect all possible voltage sources. Make sure that re-connection is not possible. Lock out and tag out.
  - Open the main disconnecting device of the drive.
  - If you have a permanent magnet motor connected to the drive, disconnect the motor from the drive with a safety switch or by other means.
  - Disconnect all dangerous external voltages from the control circuits.
  - After you disconnect power from the drive, always wait 5 minutes to let the intermediate circuit capacitors discharge before you continue.
3. Protect any other energized parts in the work location against contact.
4. Take special precautions when close to bare conductors.
5. Measure that the installation is de-energized.
  - Before and after measuring the installation, verify the operation of the voltage tester on a known voltage source.
  - Make sure that the voltage between the drive input power terminals (L1, L2, L3) and the grounding (PE) busbar is zero.
  - Make sure that the voltage between the drive output terminals (T1/U, T2/V, T3/W) and the grounding (PE) busbar is zero.
  - Make sure that the voltage between the drive DC terminals (UDC+ and UDC-) and the grounding (PE) terminal is zero. In cabinet-built drives, measure between the drive DC busbars (+ and -) and the grounding (PE) busbar.
6. Install temporary grounding as required by the local regulations.
7. Ask the person in control of the electrical installation work for a permit to work.





# 2

## Introduction to the manual

---

### Contents of this chapter

This chapter describes the manual in short and gives some general information for the reader. This chapter also contains a quick reference guide for implementing a safety system.

### Applicability

This manual is applicable to ACS880-07/07LC/17/17LC/37/37LC drives which have the option: Prevention of unexpected start-up with STO, with FSO (option +Q950).

Required versions with the FSO-12 module:

- ACS880 primary control program: 1.80 or later
- FSO-12 safety functions module: revision C or later
- Drive composer pro: 1.6 or later.

Required versions with the FSO-21 module:

- ACS880 primary control program: 2.2 or later
- FSO-21 safety functions module: revision D or later
- FSE-31 pulse encoder interface module: revision D or later (if used)
- Drive composer pro: 1.8 or later.

This manual shows the default design of the safety circuit ordered with option code +Q950. The actual design can be different from the default design because of customer-defined modifications. Always refer to the documentation delivered with the drive.

### Target audience

This manual is intended for people who install, commission, use and service the safety function. Read the manual before working on the unit. You are expected to know the

---

fundamentals of electricity, wiring, electrical components, electrical schematic symbols, and functional safety.

## Exclusion of liability

ABB is not responsible for the implementation, verification and validation of the overall safety system. It is the responsibility of the system integrator (or other party) who is responsible for the overall system and system safety.

The system integrator (or other responsible party) must make sure that the entire implementation complies with the instructions in this manual, all relevant standards, directives and local electrical code, and that the system is tested, verified and validated correctly.

## Quick reference guide for taking a safety function into use

Task	<input checked="" type="checkbox"/>
Connect the user-defined wiring (if any). See the wiring instructions in this manual and the circuit diagrams delivered with the drive.	<input type="checkbox"/>
Check and/or set the safety function related parameters (as listed in this manual).	<input type="checkbox"/>
Do the validation test to make sure that the implemented system meets the safety requirements. You can find the instructions for the validation test in this manual and in the FSO module user's manual.	<input type="checkbox"/>
Document the validation test procedure. You can find the guidelines for the validation test report in this manual and in the FSO module user's manual.	<input type="checkbox"/>

## Related manuals

Manual	Code
<b>Drive hardware</b>	
ACS880-07 drives (560 to 2800 kW) hardware manual	3AUA0000143261
ACS880-07 drives (45 to 710 kW, 50 to 700 hp) hardware manual	3AUA0000105718
ACS880-07LC drives hardware manual	3AXD50000569786
ACS880-17 drives (160 to 3200 kW) hardware manual	3AXD50000020436
ACS880-17 drives (45 to 400 kW) hardware manual	3AXD50000035158
ACS880-17LC drives hardware manual	3AXD50000250295
ACS880-37 drives (160 to 3200 kW) hardware manual	3AXD50000020437
ACS880-37 drives (45 to 400 kW) hardware manual	3AXD50000035159
ACS880-37LC drives hardware manual	3AXD50000251407
<b>Drive firmware</b>	
ACS880 primary control program firmware manual	3AUA0000085967
ACS880 primary control program quick start-up guide	3AUA0000098062
ACS880 diode supply control program firmware manual	3AUA0000103295
ACS880 IGBT supply control program firmware manual	3AUA0000131562
<b>PC tools</b>	
Drive composer start-up and maintenance PC tool user's manual	3AUA0000094606
Functional safety design tool user's manual	TT201312111015
<b>Safety</b>	
Functional safety; Technical guide No. 10	3AUA0000048753

Manual	Code
ABB Safety information and solutions	<a href="http://www.abb.com/safety">www.abb.com/safety</a>
<b>Options</b>	
ACX-AP-x assistant control panels user's manual	3AUA0000085685
FSO-12 safety functions module user's manual	3AXD50000015612
FSO-21 safety functions module user's manual	3AXD50000015614
FSE-31 pulse encoder interface module user's manual	3AXD50000016597
<b>Other documents</b>	
Circuit diagrams	Delivered with the drive
Part lists	Delivered with the drive
Safety data report (if the safety circuit is different from the default design)	

See [www.abb.com/drives/documents](http://www.abb.com/drives/documents) for all manuals on the Internet.



[ACS880-07 \(45 to 710 kW\) manuals](#)



[ACS880-07 \(560 to 2800 kW\) manuals](#)



[ACS880-07LC manuals](#)



[ACS880-17 \(45 to 400 kW\) manuals](#)



[ACS880-17 \(160 to 3200 kW\) manuals](#)



[ACS880-17LC manuals](#)



[ACS880-37 \(45 to 400 kW\) manuals](#)



[ACS880-37 \(160 to 3200 kW\) manuals](#)



[ACS880-37LC manuals](#)

## Terms and abbreviations

Term	Description
Cat.	Classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behavior in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability. The categories are: B, 1, 2, 3 and 4. (EN ISO 13849-1)
CCF	Common cause failure (%) (EN ISO 13849-1)
DC	Diagnostic coverage (EN ISO 13849-1)
Frame, frame size	Physical size of the drive or power module
FSE-31	Optional pulse encoder interface module for safety encoder
FSO-21	Safety functions module which supports the FSE-31 module and the use of safety encoders
FSO-12	Safety functions module which does not support the use of encoders
HFT	Hardware fault tolerance (IEC 61508)
IGBT	Insulated gate bipolar transistor
Inverter unit	Inverter module(s) under control of one control unit, and related components. One inverter unit typically controls one motor.
$PFD_{avg}$	Average probability of dangerous failure on demand (IEC 61508)
PFH	Average frequency of dangerous failures per hour (IEC 61508)
PL	Performance level. Levels a...e correspond to SIL (EN ISO 13849-1)
POUS	Prevention of unexpected start-up
SC	Systematic capability (IEC 61508)
SIL	Safety integrity level (1...3) (IEC 61508)
SILCL	Maximum SIL (level 1...3) that can be claimed for a safety function or subsystem (IEC/EN 62061)
SSE	Safe stop emergency
STO	Safe torque off (IEC/EN 61800-5-2)
$T_1$	Proof test interval. Defines the probabilistic failure rate (PFH or $PFD_{avg}$ ) for the safety function or subsystem. Performing a proof test at a maximum interval of $T_1$ is required to keep the SIL capability valid. The same interval must be followed to keep the PL capability (EN ISO 13849) valid. Note that any $T_1$ values given cannot be regarded as a guarantee or warranty.
TP	Test pulse



## Option description

---

### Contents of this chapter

This chapter describes the option +Q950, prevention of unexpected start-up, and its settings.

### Overview

The option +Q950 uses the FSO-12 safety functions module (option +Q973) or the FSO-21 safety functions module (option +Q972) for the Prevention of unexpected start-up (POUS) safety function. ABB installs the FSO module to the drive and sets default parameter values for the option at the factory.

The user must install and connect an operating switch and an indication lamp (optional) on site. These are not included in the delivery. The user can install the operating switch on, for example, a control desk. See the machine-specific C-type standards on whether the indication lamp is required.

When the user sets the operating switch to the open position, the POUS function activates the Safe torque off (STO) function in the drive. The Safe torque off function disables the control voltage of the power semiconductors of the drive output stage. This prevents the drive from generating the torque required to rotate the motor. With the POUS function, the user can do short-time operations (like cleaning) or maintenance work on the non-electrical parts of the machinery without switching off and disconnecting the drive.

**Note:** The situations in which you can use the POUS function must always be based on a risk assessment. Refer to IEC 60204-1:2016.

---

**Note:** Drives with the Emergency stop, stop category 1 function (options +Q978 and +Q979): If the user activates the POUS function during the emergency stop deceleration ramp, it overrides the emergency stop function. This activates the drive STO function and opens the main contactor/breaker (in option +Q978). The motor coasts to a stop. For more information on the emergency stop functions, see *Emergency stop, configurable stop category 0 or 1 (option +Q978) for ACS880-07/07LC/17/17LC/37/37LC drives user's manual* (3AUA0000145920 [English]) and *Emergency stop, configurable stop category 0 or 1 (option +Q979) for ACS880-07/07LC/17/17LC/37/37LC drives user's manual* (3AUA0000145921 [English]).

**Note:** ACS880-07/07LC drives, frames n×DXT + n×R8i with a main contactor/breaker (option +F250/+F255), ACS880-17/17LC/37/37LC drives, frames n×R8i + n×R8i, and ACS880-17/37 drives, frames R8 and R11: When the inverter unit STO is activated, the main contactor/breaker is opened after a user-defined delay (defined with parameter 94.11, the default value is 600 s). See the hardware and firmware manuals for more information.

For a detailed description of the drive STO function, see the hardware manual. For more information on the FSO module, see *FSO-12 safety functions module user's manual* (3AXD50000015612 [English]) or *FSO-21 safety functions module user's manual* (3AXD50000015614 [English]).

The design principles of the option +Q950 comply with EN ISO 13850. The STO function complies with IEC/EN 61800-5-2. For a complete list of related standards and European directives, see section [Related standards and directives \(page 39\)](#).

## ■ Summary of wirings and settings

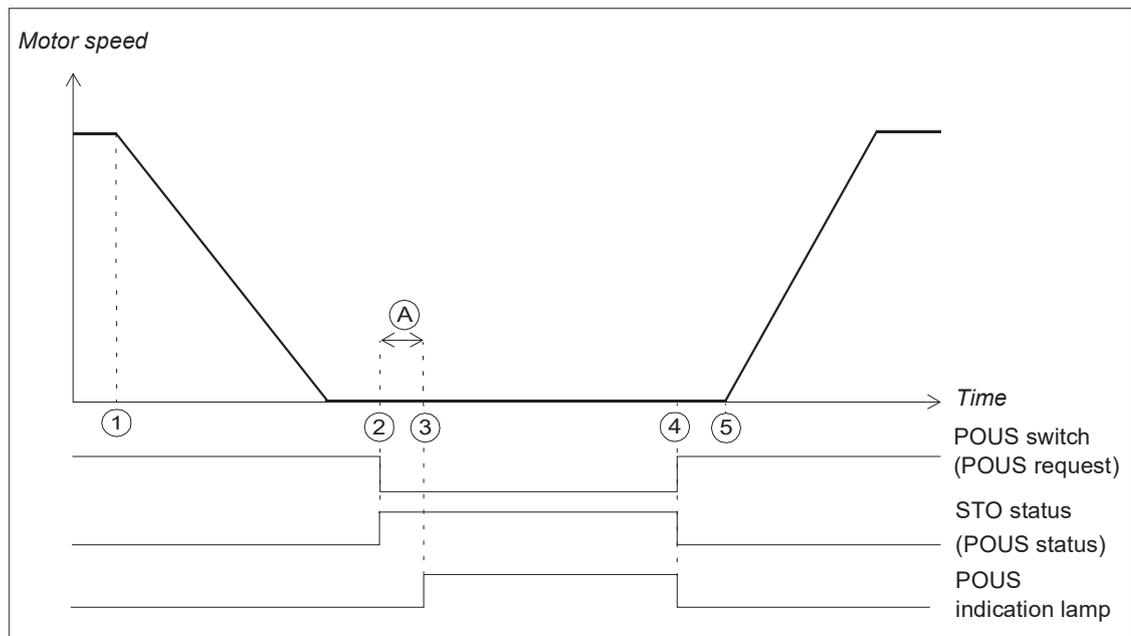
The wirings and settings of the POUS function are:

- The drive is equipped with the FSO safety functions module (option +Q973 or +Q972). ABB installs the module at the factory.
  - The user must connect a dual-channel POUS switch to the FSO module. See section [Wiring \(page 21\)](#).
  - The user can connect a POUS indication lamp to the FSO module (optional).
  - The digital input of the FSO module to which the POUS switch is connected, is selected as the input for the POUS request. This is an FSO module parameter that ABB sets at the factory. The user must check the setting at the start-up.
  - The digital output of the FSO module to which the POUS indication lamp is connected, is selected as the output for the POUS completed signal. This is an FSO module parameter that ABB sets at the factory. The user must check the setting at the start-up.
-

## Operation principle

### ■ Time scheme

This time scheme diagram illustrates the operation of the POUS function. This safety function uses the POUS function of the FSO module. For more information, see the FSO module user's manual.



A POUS indication delay (see parameter *POUS.13 POUS delay for completion*): An additional security delay. The POUS completed indication (parameter *POUS.22*) becomes active after this delay.

1. The user stops the drive.
2. After the motor has stopped, the user sets the POUS switch to the open position. The FSO module activates the drive STO function.
 

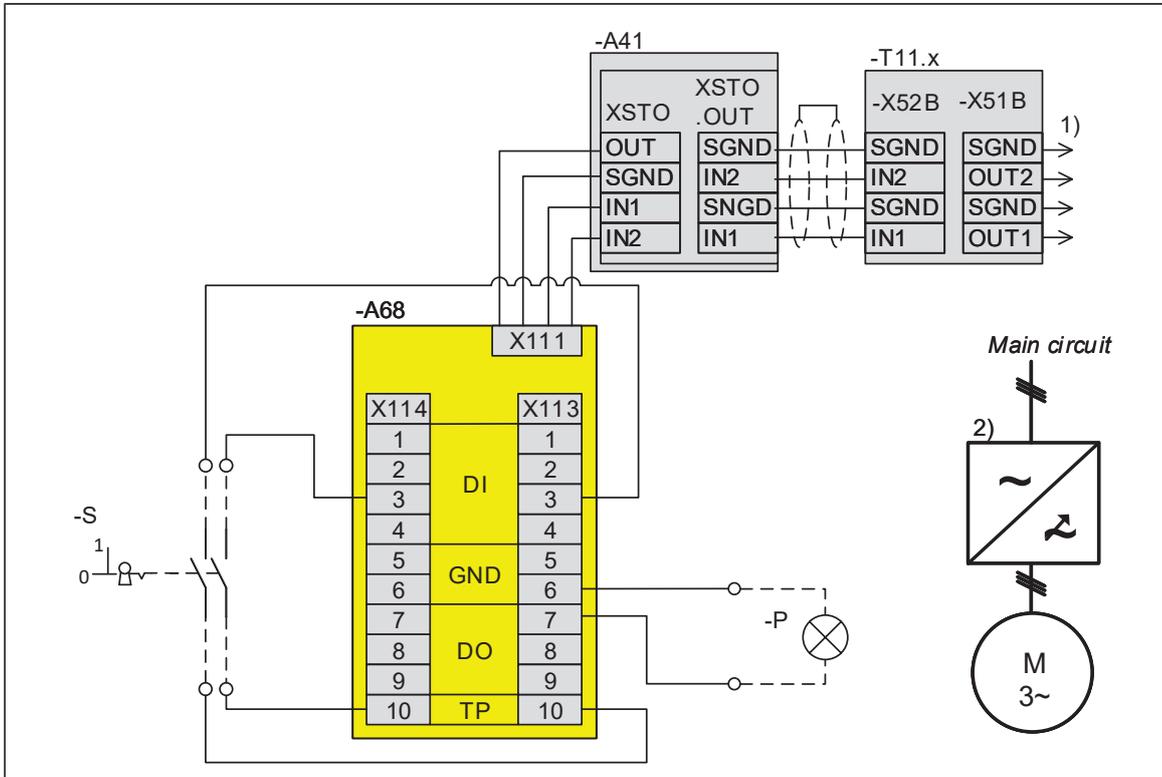
**Note:** If the user activates the POUS function when the motor is running, the FSO module activates the drive STO function, the motor coasts to a stop and the FSO module generates a fault.
3. After time A has elapsed, the POUS indication lamp comes on (POUS completed indication).
 

**Note:** If the time specified by parameter *POUS.13* is not sufficient, the motor can still be coasting when the POUS completed indication comes on.
4. The user sets the POUS switch to the closed position. The FSO module deactivates the drive STO function. The POUS indication lamp goes off. The user can start the motor again.
 

**Note:** In this case, automatic acknowledgement of the POUS function is selected (parameter *POUS.02*).
5. The user restarts the drive.

### ■ Operation principle diagram

This diagram shows the connections of an FSO module (without the safety encoder interface). The figure shows a simplified operation principle. For a more detailed description, refer to the circuit diagrams delivered with the drive.



---	The dashed line in the figure shows a user-defined installation.
1)	To parallel inverter modules (if any)
2)	Drive module
A41	Inverter control unit
A68	Safety functions module FSO-12/-21
S	POUS switch (user-defined)
P	POUS indicator lamp (user-defined)
X113, X114	Terminal block in the FSO module
X111	STO connections to inverter control
T11.x	Inverter module(s) under inverter unit T11 (only for R8i)
TP	Test pulse(s) for digital input

Step	Operation
	Initial status: The drive is in operation, but the motor is <b>not</b> running.
1	The user sets the POUS switch [S] to the open position. This de-energizes the digital inputs of the FSO module and activates the POUS function.

Step	Operation
2	The FSO module [A68] de-energizes the Safe torque off (STO) inputs on the inverter control unit [A41], which activates the drive STO function. The drive shows an indication.
3	The POUS indication lamp [P] comes on.
4	The user cannot start the motor while the drive STO is active.
5	Normal operation resumes after the user: <ul style="list-style-type: none"> <li>• sets the POUS switch [S] to the closed position</li> <li>• resets the drive (if necessary)</li> <li>• makes sure that the drive receives the start signal (depends on the configuration, see the firmware manual).</li> </ul>

## Fault reaction function

**Definition:** A safety function requires a “fault reaction function” that tries to initiate a safe state if it detects a failure in the safety system.

Examples of different failures:

- a short or open circuit or redundancy failure of the POUS switch wiring chain
- an internal failure in the FSO module or the drive STO.

This section describes the fault reaction functions in the FSO module and the drive STO.

### ■ FSO module

The fault reaction function of the FSO module trips the drive if it detects a failure. The FSO module activates the STO function or the Safe stop emergency (SSE) function. This activates the drive STO function. The drive STO function is active until the fault is repaired.

The FSO module goes into Fail-safe mode. The STATUS/FAULT LED of the FSO module is red until the fault is repaired. To exit the Fail-safe mode, remove the cause of the fault and reset the FSO module. See section [Resetting the FSO module \(page 19\)](#).

For more information, see the drive firmware manual and the FSO module user’s manual.

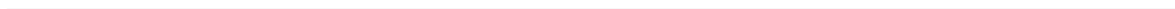
### Resetting the FSO module

To reset the FSO module:

- switch the power off and on, or
- click the Reboot FSO button on the Safety view of the Drive composer pro PC tool, or
- use the drive parameter *96.09 FSO reboot*.

### ■ Drive STO function

The drive STO function has internal fault diagnostics and a fault reaction function, which causes a fault trip if it detects a redundancy fault of STO control signals or an internal failure. See the hardware and firmware manuals of the drive.





## Electrical installation

---

### Contents of this chapter

This chapter describes the wiring of the safety option done at the factory and contains guidelines for making user connections.

### Wiring

The operating switch and the indication lamp for the POUS function are not factory-installed. The user must install and connect them to the drive on site.

There is an extension terminal block [X68] inside the drive cabinet. The tables below show the connections between the extension terminal block [X68] and the FSO module connectors [X113] and [X114].

<b>FSO X113</b>	1	2	3	4	5	6	7	8	9	10
<b>X68</b>	3	4	5	6	7	8, 9	10	11	12	13, 14, 15, 16

<b>FSO X114</b>	1	2	3	4	5	6	7	8	9	10
<b>X68</b>	17	18	19	20	21	22, 23	24	25	26	27, 28, 29, 30

There is a separate user interface terminal block [X957] inside the drive cabinet. The user interface terminal block [X957] is connected to the extension terminal block [X68].

ABB installs the FSO module and the wiring between the FSO module and the drive and user interface at the factory. The FSO module has double terminals for the connection of

---

the POUS switch. Connect the POUS switch to the terminals according to the circuit diagrams of the delivery. Obey these general rules:

1. Use only double-contact switches. ABB recommends approved and lockable switches.
2. Connect the switch with two conductors (two-channel connection). Keep the channels separate.

**Note:** If you use only one channel in a two-channel implementation, or if the channels are connected together, the cross fault detection of the FSO module detects a redundancy fault and activates the fault reaction function.

**Note:** If you change the input and the parameter settings in the FSO module into a one-channel implementation, it has an effect on the safety integrity of the safety function. In this case, the safety data that ABB has calculated for the function is not valid.

**Note:** The safety circuit design can be different when modified according to the customer's safety requirements. Refer to the circuit diagrams delivered with the drive.

3. Use shielded, twisted pair cables. ABB recommends double-shielded cable and gold-plated contacts in the POUS switch.
4. The maximum permitted cable length between the drive and the POUS switch is 250 m (820 ft).
5. Obey the general control cable installation instructions given in the drive hardware manual.

If you use a POUS indication lamp, connect it to the applicable terminals. ABB recommends an LED indication lamp. The maximum permitted cable length between the drive and the indication lamp (for the whole loop) is 250 m (820 ft).



A large, bold, black number '5' is centered within a light grey square with rounded corners.

# Parameter settings

---

## Contents of this chapter

This chapter contains the parameters that you must set in the FSO module and the drive.

## Competence

The person who configures the safety functions in the FSO module must be a competent person as required by IEC 61508-1 clause 6. In this context, the person must have expertise and knowledge of functional safety, the safety functions and the configuration of the FSO module. ABB has training courses on the FSO module.

## FSO module parameter settings

The default parameter values shown below are example values for the safety function described in this manual. Actual parameter values of the delivery can be different. Always make sure that:

- the parameter settings agree with the circuit diagrams, and
- the design agrees with the safety requirements of the application.

You must use the Drive composer pro PC tool to set the FSO module parameters. You also need a password to download the configuration to the FSO module from Drive composer pro. For the default password of the FSO module, see the FSO module user's manual. For more information on Drive composer pro, see *Drive composer start-up and maintenance PC tool user's manual* (3AUA0000094606 [English]).

**Note:** When the motor is running, you cannot change the password, adjust parameter values, or upload or download the FSO configuration file.

---

**Note:** The FSO module has a factory reset button. The factory reset button clears the configuration and sets the parameters to the factory default values. These values are not the same as the pre-set values in an FSO module that was ordered as an option (with a plus code). You cannot restart the drive with the factory default values. If you do a factory reset of the FSO module, you must reconfigure the FSO module and set all applicable parameters. For more information on the factory reset, see the FSO module user's manual.

When using SS1, SLS or SMS safety functions: The FSO module activates the STO function if the motor speed hits a ramp monitoring limit during the deceleration ramp. The FSO module activates the SSE function if the motor speed hits a trip limit during SLS or SMS monitoring. Thus, you must also configure the STO and SSE functions.

Follow the configuration steps described in the FSO module user's manual, chapter *Configuration*.

There are parameters that you must always set and parameters that are related to certain safety functions only. These tables list all the parameters that you must check and set for option +Q950. The example values are applicable only to option +Q950.

### ■ General parameters

These parameters are common to all safety functions.

Index	Name	Example value	Description
FSOGEN.21	Motor nominal speed	1500 rpm	Sets the nominal motor speed. Must be equal to the value on the motor rating plate.
FSOGEN.22	Motor nominal frequency	50 Hz	Sets the nominal motor frequency. Must be equal to the value on the motor rating plate.
FSOGEN.41	Power-up acknowledgement	Automatic	Sets the power-up acknowledgement method of the FSO module. <i>Automatic:</i> You do not need to push a reset button after switching on the FSO module. The FSO module generates the acknowledgement signal automatically after the power-up. <i>Manual:</i> The FSO module reads the external acknowledgement signal through the digital input defined by parameter <i>FSOGEN.42</i> . Make sure that the value is <i>Automatic</i> .
FSOGEN.42	Acknowledgement button input	None	Selects the digital input for the acknowledgement signal when parameter <i>FSOGEN.41 Power-up acknowledgement</i> or <i>STO.02 STO acknowledgement</i> is set to <i>Manual</i> . In the safety function described in this manual, parameters <i>FSOGEN.41 Power-up acknowledgement</i> and <i>STO.02 STO acknowledgement</i> are set to <i>Automatic</i> , and this digital input is not used. The safety function is configured not to require a reset/acknowledgement of the safety function after power-up or the removal of the safety function request.

### ■ Parameters for the STO function

These parameters are related to the STO function of the FSO module. The FSO module can activate the STO function in internal fault situations.

Index	Name	Example value	Description
STO.02	STO acknowledgement	Automatic	Sets the acknowledgement method used in the STO, SSE and SS1 functions. <i>Automatic:</i> The FSO module generates the STO acknowledgement signal automatically, and the user does not have to press a reset button (see parameter <i>FSOGEN.42 Acknowledgement button input</i> ).
STO.11	STO input A	None	Sets the digital input that is connected to the primary input of the STO function. The safety option described in this manual does not use this function and the value must be <i>None</i> .
STO.14	Time to zero speed with STO and modoff	2000 ms	The time it takes for the motor to coast to a standstill from maximum process speed. This must be measured with Drive composer pro PC tool when an encoder is used for motor control (otherwise you have to make sure that the motor shaft has stopped rotating by other means, eg, visually.).

### ■ Parameters for the SSE function

These parameters are related to the Safe stop emergency (SSE) function of the FSO module. The FSO module can activate the SSE function in internal fault situations.

Index	Name	Example value	Description
SSE.13	SSE function	Immediate STO or Emergency ramp	Sets the type of the SSE function. <i>Immediate STO:</i> The FSO module activates the drive STO function immediately after the SSE request. <i>Emergency ramp:</i> The FSO module decelerates the motor to zero speed, and then activates the drive STO function. SAR0 parameters define the deceleration ramp. For more information, see the FSO module user's manual. For option +Q950, ABB sets this parameter to value <i>Immediate STO</i> at the factory. Adjust the default value when necessary.

### ■ Parameters for the POUS function

These parameters are related to the POUS function.

Index	Name	Example value	Description
POUS.01	POUS activity and version	Version 1	Activates or deactivates the POUS function and shows the version of the POUS function. <i>Version 1:</i> Activates the POUS function.

## 26 Parameter settings

Index	Name	Example value	Description
POUS.02	POUS acknowledgement	Automatic	<p>Sets the POUS acknowledgement method. Set this parameter according to the application requirements.</p> <p><i>Automatic:</i> The FSO module generates the POUS acknowledgement signal automatically after the POUS request signal is removed.</p> <p><i>Manual:</i> The FSO module reads the POUS acknowledgement signal through the digital input defined by parameter <i>FSOGEN.42 Acknowledgement button input</i>. The FSO module accepts the acknowledgement after the POUS request is removed.</p> <p>If you set this parameter to <i>Manual</i>, you must implement a manual acknowledgement for the POUS function.</p>
POUS.11	POUS input	DI X113:3 & X114:3	<p>Sets the digital input that is connected to the POUS input.</p> <p>For option +Q950, ABB has configured the POUS request signal to these digital inputs at the factory.</p>
POUS.13	POUS delay for completion	0 ms	<p>Sets the time after which the POUS completed indication (<i>POUS.22 POUS completed output</i>) is activated after the POUS request.</p> <p>Adjust the default value if necessary.</p>
POUS.21	POUS output	None	<p>Sets the digital output that indicates the activity of the POUS function. Active from the POUS request until the function is acknowledged.</p> <p>The safety function described in this manual does not use this digital output.</p>
POUS.22	POUS completed output	DO X113:7	<p>Sets the digital output that indicates the active state of the POUS function (that is, the motor is stopped and the drive STO is active). Active after the time defined by parameter <i>POUS.13</i> has elapsed from the POUS request until the POUS request is removed and the POUS function is acknowledged (automatic acknowledgement is used, see parameter <i>POUS.02 POUS acknowledgement</i>).</p> <p>For option +Q950, ABB has configured the POUS indication signal to this digital output at the factory. Make sure that this value corresponds to the actual wiring. See the circuit diagrams of the delivery.</p>
<b>I/O parameters</b>			
SAFEIO.35	DI X113:3 Diag pulse on/off	On <sup>1)</sup>	<p>Sets the diagnostic pulse of digital input X113:3 on or off.</p> <p><i>On:</i> The input monitors that it receives test pulses.</p>
SAFEIO.39	DI X114:3 Diag pulse on/off	On <sup>1)</sup>	<p>Sets the diagnostic pulse of digital input X114:3 on or off.</p> <p><i>On:</i> The input monitors that it receives test pulses.</p>

Index	Name	Example value	Description
SAFEIO.53	DO X113:7 Diag pulse	On	Sets the diagnostic pulse of digital output X113:7 on or off. <i>On</i> : The output monitors that it receives test pulses.
SAFEIO.71	DO X113:7 logic state	Active high	Sets the logic state of digital output X113:7. <i>Active high</i> : The digital output is on when the indicated signal is active. For option +Q950, ABB has configured the POUS indication signal to this digital output at the factory.

<sup>1)</sup> The safety data is based on the assumption that this diagnostic measure for the POUS switch wiring is active (On). If pulsing is disabled, other measures should be considered to ensure sufficient diagnostic coverage of the POUS switch wiring.

**Note:** The following indications are generated when POUS is activated: *AA97 FSO POUS request warning* and *7A97 FSO premature POUS fault*. These are not user-configurable.

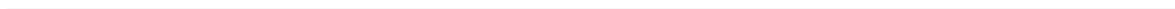
## Drive parameter settings

This section shows the drive parameter settings related to the safety function in the ACS880 primary control program.

The table that follows shows the parameters that are set at the factory.

No.	Name	Default value <sup>1)</sup>	Description
31.22	STO indication run/stop	Warning/Warning	Selects which indications are given when one or both Safe torque off (STO) signals are switched off or lost. <i>Warning/Warning</i> is the recommended setting.  <b>Note:</b> ABB recommends that you do not set this parameter to <i>Fault/Fault</i> , <i>Fault/Warning</i> , or <i>Fault/Event</i> . If you use these settings, the drive will trip on a fault each time that the FSO module activates the drive STO function.

<sup>1)</sup> Value set by ABB at the factory for the default design.



# 6

## Use of the safety function

---

### Contents of this chapter

This chapter describes the use of the safety function with factory default settings.

### Activating the safety function

You should activate the POUS function only when the motor is stopped.

Activation procedure:

1. Set the POUS switch [S] to the open position.  
When POUS is activated, the following indications are shown:
  - AA97 FSO POUS request
  - the POUS indication lamp is on.

If configured with parameter *31.22 STO indication run/stop*, an indication for Safe torque off is shown when the drive STO is activated.

### Resetting the safety function

---



#### **WARNING!**

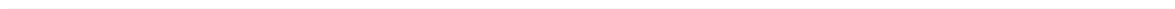
Make sure that the drive does not start accidentally. This can occur with the automatic acknowledgement method of the safety function, if a level-triggered start command and the start enable signal are on at the same time.

---

1. Set the POUS switch [S] to the closed position.
2. If necessary, reset faults from the drive.

A manual acknowledgement is not necessary after you deactivate the POUS function. ABB sets the acknowledgement method for the POUS function to automatic at the factory.

---



# 7

## Start-up and validation test

---

### Contents of this chapter

This chapter describes the start-up, validation test procedure, and validation of the safety function.

### Validation of the safety functions

You must do a validation test to validate the correct operation of safety functions.

#### ■ Competence

The person who does the validation test of the safety function must be a competent person with expertise and knowledge of the safety function and functional safety, as required by IEC 61508-1 clause 6. This person must document and sign the test procedures and report.

#### ■ Validation procedure

You must validate the general settings of the FSO module before you validate the safety function. See the FSO module user's manual, chapter *Verification and validation*.

You must do the validation test using the checklist given in this manual:

- at the initial start-up of the safety function
- after changes related to the safety function (wiring, components, safety function -related parameter settings, etc.)
- after maintenance work related to the safety function.

The validation test must include at least the following steps:

- you must have a validation test plan
  - you must test all commissioned functions for proper operation, from each operation location
- 



- you must document all validation tests
- you must sign and store the validation test report for further reference.

■ **Validation test reports**

You must store the signed validation test reports in the logbook of the machine. The report must include, as required by the referred standards:

- a description of the safety application (including a figure)
- a description and revisions of safety components that are used in the safety application
- a list of all safety functions that are used in the safety application
- a list of all safety-related parameters and their values
- documentation of start-up activities, references to failure reports and resolution of failures
- the test results for each safety function, checksums, date of the tests, and confirmation by the test personnel.

You must store any new validation test reports done due to changes or maintenance in the logbook of the machine.

## Start-up and validation test

You must use the Drive composer PC tool to do the start-up and validation test.

<b>Action</b>	<input checked="" type="checkbox"/>
 <b>WARNING!</b> Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.	<input type="checkbox"/>
<b>Initial status</b>	
<u>Safety encoder interface:</u> If you use a safety encoder in the safety application, validate the safety encoder interface as described in <i>FSO-21 safety functions module user's manual</i> (3AXD50000015614 [English]), chapter <i>Verification and validation</i> .	<input type="checkbox"/>
Make sure that the drive is ready for use, that is, you have done the tasks of the drive start-up procedure. See the hardware manual.	<input type="checkbox"/>
Make sure that the FSO STO function is configured and validated. Internal monitoring of the FSO module can trigger the STO function even if you have not defined an external request signal. The STO function must be validated before other safety functions. <b>Note:</b> If parameter <i>S_ENCGEN.11</i> is set to <i>Est switch not active load</i> , both STO function with speed estimate and STO function with encoder feedback must be tested - most importantly, the value of parameter <i>STO.14</i> must be set according to the application requirements.	<input type="checkbox"/>
<b>Checks and settings with no voltage connected</b>	
Stop the drive and do the steps in section <i>Electrical safety precautions (page 9)</i> before you start the work.	<input type="checkbox"/>
After you have done the wiring to the POUS switch and to the indication lamp, check the connections against the applicable circuit diagrams. Make sure that the POUS request is not on (the POUS switch is in the closed position).	<input type="checkbox"/>



<b>Action</b>	<input checked="" type="checkbox"/>
<u>Inverter units with parallel R8i inverter modules:</u> Make sure that the XSTO.OUT output on the inverter control unit [A41] is chained to the STO inputs of all inverter modules.	<input type="checkbox"/>
<b>Settings with voltage connected</b>	
Close the cabinet doors and power up the drive. See the hardware manual.	<input type="checkbox"/>
Make sure that the parameter settings related to the safety functions are correct. See chapter <i>Parameter settings</i> .	<input type="checkbox"/>
Create a backup file of the drive (button <b>Backup/restore</b> in the Drive composer pro PC tool).	<input type="checkbox"/>
Save the FSO safety file (button <b>Save safety file</b> in the Drive composer pro PC tool). <b>Note:</b> The FSO safety file is not included in the drive backup process.	<input type="checkbox"/>
<b>Validation test</b>	
ABB recommends that you monitor these signals with the Drive composer PC tool: <ul style="list-style-type: none"> <li>• 01.01 Motor speed used (rpm)</li> <li>• 01.02 Motor speed estimated (rpm)</li> <li>• 01.07 Motor current (A)</li> <li>• 01.10 Motor torque (%)</li> <li>• 06.18 Start inhibit status word</li> <li>• 23.01 Speed ref ramp input (rpm)</li> <li>• 23.02 Speed ref ramp output (rpm)</li> <li>• 90.01 Motor speed for control (rpm)</li> <li>• 90.10 Encoder 1 speed (rpm)</li> <li>• 200.01 FSO speed ch1 (rpm)</li> <li>• 200.02 FSO speed ch2 (rpm)</li> <li>• 200.03 FSO DI status</li> <li>• 200.04 FSO DO status</li> <li>• 200.05 FSO control word 1</li> <li>• 200.06 FSO control word 2</li> <li>• 200.07 FSO status word 1</li> <li>• 200.08 FSO status word 2</li> <li>• 200.09 Drive status word 1</li> <li>• 200.10 Drive status word 2</li> </ul>	<input type="checkbox"/>
Make sure that it is safe to start, run and stop the motor(s) during the test.	<input type="checkbox"/>
Start the drive and make sure that the motor is running. Then stop the motor.	<input type="checkbox"/>
Make sure that the motor is stopped.	<input type="checkbox"/>
Activate the POUS function: set the POUS switch to the open position.	<input type="checkbox"/>
Make sure that the control panel displays a related warning.	<input type="checkbox"/>
Make sure that the POUS indication lamp comes on.	<input type="checkbox"/>
Make sure that you cannot start the drive from any control location: Switch the external start signal off and on (in the external control mode) or press the start key of the control panel (in the local control mode).	<input type="checkbox"/>
Make sure that the drive generates none of these faults: <ul style="list-style-type: none"> <li>• STO hardware failure (5090)</li> <li>• Safe torque off 1 loss (FA81)</li> <li>• Safe torque off 2 loss (FA82)</li> </ul> <p>If the drive generates one or more of these faults, see the hardware and firmware manuals for fault tracing instructions. If the FSO module generates a fault, see the FSO module user's manual, chapter <i>Fault tracing</i>.</p>	<input type="checkbox"/>



### 34 Start-up and validation test

<b>Action</b>	<input checked="" type="checkbox"/>
Deactivate the POUS function: set the POUS switch to the closed position. <b>Note:</b> If the POUS function is in the automatic reset mode, the drive can restart automatically when you deactivate the POUS function.	<input type="checkbox"/>
Make sure that the POUS indication lamp goes off and the related warning is no longer shown.	<input type="checkbox"/>
Restart the drive and make sure that the drive and the motor operate normally.	<input type="checkbox"/>
Save the FSO safety file with the button <b>Save safety file</b> in the Drive composer pro PC tool.	<input type="checkbox"/>
Fill in and sign the validation test report. Store the report in the logbook of the machine.	<input type="checkbox"/>





# Maintenance

---

## Contents of this chapter

This chapter contains information for the maintenance and decommissioning of the safety function.

## Safety circuit maintenance

After the safety function is validated, it must be maintained by periodic proof testing.

If you change the wiring or a component after the start-up, replace the FSO or FSE-31 module, modify FSO module parameters, or restore parameters to their factory default values:

- Use only ABB-approved spare parts.
- Register the change to the change log for the safety circuit.
- If parameters were restored to the factory default values: Set the parameters related to the safety function.
- Do the validation test of the safety function.
- Document the tests and store the report into the logbook of the machine.

## Proof test interval

Periodic proof testing of the safety function is necessary to maintain the required SIL/PL-level. In high demand mode of operation, the maximum proof test interval is 20 years. In low demand mode of operation, the maximum proof test interval is 2 or 5 years (high or low demand as defined in IEC 61508, IEC/EN 62061 and EN ISO 13849-1). Regardless of the mode of operation, it is a good practice to do the proof test for the safety function at least once a year. It is also a good practice to include the proof test for the safety function in the routine maintenance program of the machinery.

---

The person responsible for the design of the complete safety system should also note the Recommendation of Use CNB/M/11.050 published by the European co-ordination of Notified Bodies for Machinery concerning dual-channel safety-related systems with electromechanical outputs:

- When the safety integrity requirement for the safety function is SIL 3 or PL e (cat. 3 or 4), the proof test for the function must be done at least every month.
- When the safety integrity requirement for the safety function is SIL 2 (HFT = 1) or PL d (cat. 3), the proof test for the function must be done at least every 12 months.

This is a recommendation and depends on the required (not achieved) SIL/PL. For example, contactors, breakers, safety relays, contactor relays, emergency stop buttons, switches, etc. are typically safety devices which have electromechanical outputs. The STO circuit of the drive does not have electromechanical outputs. Also, the FSO and FSE-31 modules do not have electromechanical outputs.

## **Competence**

The person who does the maintenance and proof test activities of the safety function must be a competent person with expertise and knowledge of the safety function and functional safety, as required by IEC 61508-1 clause 6.

## **Residual risk**

The safety functions are used to reduce the recognized hazardous conditions. In spite of this, it is not always possible to eliminate all potential hazards. Thus, the warnings for the residual risks must be given to the operators.

## **Intentional misuse**

The safety circuit is not designed to protect a machine against intentional misuse.

## **Decommissioning**

When you decommission a POUS group or a drive, make sure that the functional safety of the machine is maintained by other means until the decommissioning is completed.

---

# 9

## Technical data

---

### Contents of this chapter

This chapter lists the safety data, describes the ambient conditions and gives a list of standards related to the product.

### Safety data

#### ■ Safety data values

This safety data is valid for the default design of the safety circuit described in this manual. If the final design is different from the default, ABB calculates new safety data and delivers it separately to the customer.

The POUS switch is not included in the calculations, because it is not included in the delivery.

**Note:** The POUS indication is SIL/PL-rated. For more information, see the FSO module user's manual.

Drive module frame size	SIL / SIL-CL	SC	PL	PFH <sup>1)</sup> [1/h]	PFD <sub>avg</sub> (T <sub>1</sub> =2a)	PFD <sub>avg</sub> (T <sub>1</sub> =5a)	DC <sup>2)</sup> [%]	Cat.	HFT	CCF	Mission time [a]	T <sub>1</sub> <sup>3) 4)</sup> [a]
R6, R7	3	3	e	3.3E-09	2.7E-05	6.8E-05	≥90	3	1	80	20	20/5/2
R8, R9	3	3	e	3.3E-09	2.7E-05	6.8E-05	≥90	3	1	80	20	20/5/2
R10, R11	3	3	e	3.7E-09	3.3E-05	8.2E-05	≥90	3	1	80	20	20/5/2
1×R8i	3	3	e	1.1E-10	1.1E-06	2.6E-06	≥90	3	1	80	20	20/5/2
2×R8i	3	3	e	1.3E-10	1.2E-06	2.9E-06	≥90	3	1	80	20	20/5/2
3×R8i	3	3	e	1.4E-10	1.3E-06	3.1E-06	≥90	3	1	80	20	20/5/2
4×R8i	3	3	e	1.5E-10	1.4E-06	3.4E-06	≥90	3	1	80	20	20/5/2
5×R8i	3	3	e	1.6E-10	1.5E-06	3.6E-06	≥90	3	1	80	20	20/5/2

---

Drive module frame size	SIL / SIL-CL	SC	PL	PFH <sup>1)</sup> [1/h]	PFD <sub>avg</sub> (T <sub>1</sub> =2a)	PFD <sub>avg</sub> (T <sub>1</sub> =5a)	DC <sup>2)</sup> [%]	Cat.	HFT	CCF	Mission time [a]	T <sub>1</sub> <sup>3) 4)</sup> [a]
6...8xR8i	3	3	e	1.94E-10	1.9E-06	4.3E-06	≥90	3	1	80	20	20/5/2
3AXD10000097591 J												

1) PFH values are according to EN ISO 13849.

2) DC applies for both high and low demand mode of operation.

3) See the Recommendation of Use CNB/M/11.050 published by the European coordination of notified bodies for lower T<sub>1</sub> requirement.

4) T<sub>1</sub> = 20a is used with high demand mode of operation. T<sub>1</sub> = 2a/5a is used with low demand mode of operation.

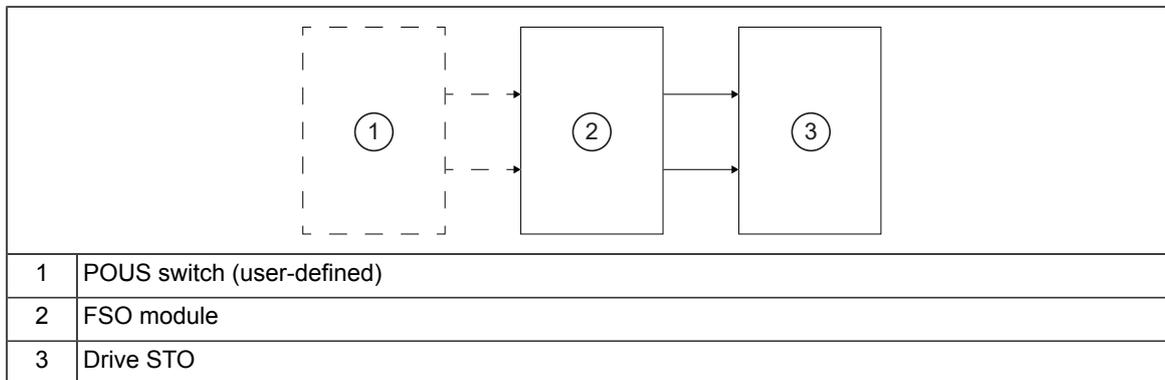
### ■ Safety component types

Safety component types as defined in IEC 61508-2:

- FSO module: type B
- FSE module: type B
- drive STO circuit:
  - frame sizes R1...R9 and drives with R1i...R7i inverter modules: type A
  - frame sizes R10 and R11 and drives with R8i inverter modules: type B.

### ■ Safety block diagrams

The components that are included in the safety data calculations are shown in the safety block diagram(s). The components not included in the delivery are not included in the safety data calculations.



### ■ Relevant failure modes

Relevant failure modes are:

- the FSO module detects open circuits, short circuits and redundancy failures of the POUS input signal wirings. Similarly, it detects redundancy failures of the POUS switch when the POUS request is on.
- internal failures of the FSO module, the FSE module, and the drive STO.

These failures are included in the failure rate value of the function.

### ■ Fault exclusions

Fault exclusions (not considered in the calculations):

- short and open circuits in the cables of the safety circuit
- short and open circuits in the cabinet terminal blocks of the safety circuits.

### ■ Operation delays

Total delay for the POUS function: (less than) 500 ms

## Ambient conditions

For the environmental limits for the safety functions and the drive, refer to the drive hardware manual.

## Related standards and directives

Standard	Name
EN ISO 12100:2010	Safety of machinery – General principles for design – Risk assessment and risk reduction
EN ISO 13849-1:2015	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design
EN ISO 13849-2:2012	Safety of machinery – Safety-related parts of control systems – Part 2: Validation
EN ISO 14118:2018	Safety of machinery – Prevention of unexpected start-up (ISO 14118:2017)
EN 60204-1:2018 IEC 60204-1:2016	Safety of machinery – Electrical equipment of machines – Part 1: General requirements
IEC 61326-3-1:2017	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - General industrial applications
IEC 61508-1:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements
IEC 61508-2:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
IEC 61511-1:2016	Functional safety – Safety instrumented systems for the process industry sector – Part 1: Framework, definitions, system, hardware and application programming requirements
EN 61800-5-2:2007 IEC 61800-5-2:2016	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional
EN 62061:2005 + AC:2010 + A1:2013 + A2:2015 IEC 62061:2015 Ed. 1.2	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
2006/42/EC	European Machinery Directive
Other	Machine-specific C-type standards

## **Compliance with the European Machinery Directive**

The drive is an electronic product which is covered by the European Low Voltage Directive. However, the drive internal safety function of this manual is in the scope of the Machinery Directive as a safety component. This function complies with European harmonized standards such as IEC/EN 61800-5-2. The declaration of conformity is delivered with the drive.

---

# Further information

## **Product and service inquiries**

Address any inquiries about the product to your local ABB representative, quoting the type designation and serial number of the unit in question. A listing of ABB sales, support and service contacts can be found by navigating to [www.abb.com/searchchannels](http://www.abb.com/searchchannels).

## **Product training**

For information on ABB product training, navigate to [new.abb.com/service/training](http://new.abb.com/service/training).

## **Providing feedback on ABB manuals**

Your comments on our manuals are welcome. Navigate to [new.abb.com/drives/manuals-feedback-form](http://new.abb.com/drives/manuals-feedback-form).

## **Document library on the Internet**

You can find manuals and other product documents in PDF format on the Internet at [www.abb.com/drives/documents](http://www.abb.com/drives/documents).



[www.abb.com/drives](http://www.abb.com/drives)



3AUA0000145922H