OPTIONS FOR ABB DRIVES

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

User's manual
Prevention of unexpected start-up (option +Q950) for ACS880-07/17/17LC/37/37LC drives

User's manual

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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 repeat the complete safety instructions of the drive but only includes the instructions related to the scope of this manual.
Only a qualified electrician who has appropriate knowledge on functional, machine, and process safety is allowed to install, start up and maintain the safety circuit. All user-made changes are on the user’s responsibility.

**WARNING!** This safety function does not disconnect the voltage of the main and auxiliary circuits from the drive. Do not work on the electrical parts of the drive or the motor before you have isolated the drive system from all power supplies and made sure by measuring that there is no dangerous voltage present.

**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!** Always test the operation of the safety circuit according to its acceptance test procedure at the start-up and after any changes to the safety circuit.

**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 electrician, 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 any 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.
   • Use a multimeter with an impedance greater than 1 Mohm.
   • Make sure that the voltage between the drive input power terminals (L1, L2, L3) and the grounding (PE) busbar is close to 0 V.
   • Make sure that the voltage between the drive output terminals (T1/U, T2/V, T3/W) and the grounding (PE) busbar is close to 0 V.
6. Ask the person in control of the electrical installation work for a permit to work.
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

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

For the option +Q950, ABB installs the FSO-12 safety functions module (option +Q973) or the FSO-21 safety functions module (option +Q972) to the drive. When a safety pulse encoder is used, ABB installs the FSE-31 pulse encoder interface module (option +L521) and the FSO-21 module to the drive. Only the FSO-21 module supports the FSE-31 module and the use of safety pulse encoders.

Note: If you are using a safety pulse encoder/FSE-31 pulse encoder interface module, refer to *FSE-31 pulse encoder interface module user’s manual* (3AXD50000016597 [English]) for more information.

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.
12 Introduction to the manual

Target audience

The manual is intended for people who install, start up, 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

<table>
<thead>
<tr>
<th>Task</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Connect the user-defined wiring (if any). See the wiring instructions in this manual and the circuit diagrams delivered with the drive.</td>
<td>✅</td>
</tr>
<tr>
<td>Check and/or set the safety function related parameters (as listed in this manual).</td>
<td></td>
</tr>
<tr>
<td>Do the acceptance test to ensure that the implemented system meets the safety requirements. Instructions for the acceptance test can be found in this manual.</td>
<td></td>
</tr>
<tr>
<td>Document the acceptance test procedure. Guidelines for the acceptance test report can be found in this manual.</td>
<td></td>
</tr>
</tbody>
</table>

Related manuals

<table>
<thead>
<tr>
<th>Manual</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drive hardware</strong></td>
<td></td>
</tr>
<tr>
<td>ACS880-07 drives (560 to 2800 kW) hardware manual</td>
<td>3AUA0000143261</td>
</tr>
<tr>
<td>ACS880-07 drives (45 to 710 kW, 50 to 700 hp) hardware manual</td>
<td>3AUA0000105718</td>
</tr>
<tr>
<td>ACS880-17 drives (160 to 3200 kW) hardware manual</td>
<td>3AXD5000020436</td>
</tr>
<tr>
<td>ACS880-17 drives (45 to 400 kW) hardware manual</td>
<td>3AXD5000035158</td>
</tr>
<tr>
<td>ACS880-17LC hardware manual</td>
<td>3AXD50000250295</td>
</tr>
<tr>
<td>ACS880-37 drives (160 to 3200 kW) hardware manual</td>
<td>3AXD5000020437</td>
</tr>
<tr>
<td>ACS880-37 drives (45 to 400 kW) hardware manual</td>
<td>3AXD5000035159</td>
</tr>
<tr>
<td>ACS880-37LC hardware manual</td>
<td>3AXD50000251407</td>
</tr>
<tr>
<td><strong>Drive firmware</strong></td>
<td></td>
</tr>
<tr>
<td>ACS880 primary control program firmware manual</td>
<td>3AUA0000085967</td>
</tr>
<tr>
<td>ACS880 primary control program quick start-up guide</td>
<td>3AUA0000098062</td>
</tr>
<tr>
<td>ACS880 diode supply control program firmware manual</td>
<td>3AUA0000103295</td>
</tr>
<tr>
<td>ACS880 IGBT supply control program firmware manual</td>
<td>3AUA0000131562</td>
</tr>
<tr>
<td><strong>PC tools</strong></td>
<td></td>
</tr>
<tr>
<td>Drive composer start-up and maintenance PC tool user's manual</td>
<td>3AUA0000094606</td>
</tr>
<tr>
<td>Functional safety design tool user’s manual</td>
<td>3AXD10000102417</td>
</tr>
</tbody>
</table>
### Manual

<table>
<thead>
<tr>
<th>Code</th>
<th>Manual</th>
</tr>
</thead>
<tbody>
<tr>
<td>3AUA0000048753</td>
<td>Functional safety; Technical guide No. 10</td>
</tr>
<tr>
<td>1SFC001008B0201</td>
<td>Safety and functional safety; A general guide</td>
</tr>
<tr>
<td></td>
<td>ABB Safety information and solutions</td>
</tr>
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</table>

### Options

<table>
<thead>
<tr>
<th>Code</th>
<th>Manual</th>
</tr>
</thead>
<tbody>
<tr>
<td>3AUA0000085685</td>
<td>ACX-AP-x assistant control panels user’s manual</td>
</tr>
<tr>
<td>3AXD50000015612</td>
<td>FSO-12 safety functions module user’s manual</td>
</tr>
<tr>
<td>3AXD50000015614</td>
<td>FSO-21 safety functions module user’s manual</td>
</tr>
<tr>
<td>3AXD50000016597</td>
<td>FSE-31 pulse encoder interface module user’s manual</td>
</tr>
<tr>
<td></td>
<td>Manuals and quick guides for I/O extension modules, fieldbus adapters, etc.</td>
</tr>
</tbody>
</table>

### Other documents

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit diagrams</td>
<td>Delivered with the drive</td>
</tr>
<tr>
<td>Part lists</td>
<td>Delivered with the drive</td>
</tr>
<tr>
<td>Safety data report</td>
<td>(if the safety circuit is application-engineered)</td>
</tr>
</tbody>
</table>

You can find manuals and other product documents in PDF format on the Internet. See [Document Library](http://www.abb.com/safety). For manuals not available in the Document library, contact your local ABB representative.


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### QR Codes

- ACS880-07 (45 to 710 kW) manuals
- ACS880-07 (560 to 2800 kW) 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
### Terms and abbreviations

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat.</td>
<td>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)</td>
</tr>
<tr>
<td>CCF</td>
<td>Common cause failure (%) (EN ISO 13849-1)</td>
</tr>
<tr>
<td>DC</td>
<td>Diagnostic coverage (EN ISO 13849-1)</td>
</tr>
<tr>
<td>Frame, frame size</td>
<td>Physical size of the drive or power module</td>
</tr>
<tr>
<td>FSE-31</td>
<td>Optional pulse encoder interface module for safety encoder</td>
</tr>
<tr>
<td>FSO-21</td>
<td>Safety functions module which supports the FSE-31 module and the use of safety encoders</td>
</tr>
<tr>
<td>FSO-12</td>
<td>Safety functions module which does not support the use of encoders</td>
</tr>
<tr>
<td>HFT</td>
<td>Hardware fault tolerance (IEC 61508)</td>
</tr>
<tr>
<td>IGBT</td>
<td>Insulated gate bipolar transistor</td>
</tr>
<tr>
<td>PFD_{avg}</td>
<td>Average probability of dangerous failure on demand (IEC 61508)</td>
</tr>
<tr>
<td>PFH</td>
<td>Average frequency of dangerous failures per hour (IEC 61508)</td>
</tr>
<tr>
<td>PL</td>
<td>Performance level. Levels a...e correspond to SIL (EN ISO 13849-1)</td>
</tr>
<tr>
<td>POUS</td>
<td>Prevention of unexpected start-up</td>
</tr>
<tr>
<td>SC</td>
<td>Systematic capability (IEC 61508)</td>
</tr>
<tr>
<td>SIL</td>
<td>Safety integrity level (1...3) (IEC 61508)</td>
</tr>
<tr>
<td>SIL_{CL}</td>
<td>Maximum SIL (level 1...3) that can be claimed for a safety function or subsystem (IEC/EN 62061)</td>
</tr>
<tr>
<td>SSE</td>
<td>Safe stop emergency</td>
</tr>
<tr>
<td>STO</td>
<td>Safe torque off (IEC/EN 61800-5-2)</td>
</tr>
<tr>
<td>T1</td>
<td>Proof test interval. Defines the probabilistic failure rate (PFH or PFD) for the safety function or subsystem. Performing a proof test at a maximum interval of T1 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 T1 values given cannot be regarded as a guarantee or warranty.</td>
</tr>
<tr>
<td>TP</td>
<td>Test pulse</td>
</tr>
</tbody>
</table>
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 installs and wires an operating switch and an indication lamp (optional) on site. These are not included in the delivery.

The user activates the POUS function with an operating switch mounted, for example, on a control desk. When the switch is open (off), the POUS function is active and the POUS indication lamp is on.

When the user switches off the POUS switch, the Safe torque off (STO) function in the drive is activated. The STO 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(s). With this 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:** Drives with the Emergency stop, stop category 1 function (options +Q978 and +Q979):

If the user activates the POU function during the emergency stop deceleration ramp, it overrides the emergency stop function. This activates the STO function of the drive, opens the main contactor/breaker (in option +Q978) and 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 ACS880-07/17/17LC/37/37LC drives user's manual (3AUA0000145920 [English]) and Emergency stop, configurable stop category 0 or 1 (option +Q979) for ACS880-07/17/17LC/37/37LC drives user's manual (3AUA0000145921 [English]).

**Note:** ACS880-07 drives, frames nxDXT + nxR8i with a main contactor/breaker (option +F250/+F255), ACS880-17/17LC/37/37LC drives, frames nxR8i + nxR8i, and ACS880-17/37 drives, frames R8 and R11: When the STO function is activated in the inverter unit, 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 Safe torque off function, see the drive 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 EN/IEC 61800-5-2. For a complete list of related standards and European directives, see section Related standards and directives.

### Summary of wirings and settings

The wirings and settings of the POU 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 wire a dual-channel POU switch to the FSO module. See section Wiring.
- The user can wire a POU indication lamp to the FSO module (optional).
- The digital input of the FSO module to which the POU switch is connected, is selected as the input for the POU 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 POU indication lamp is connected, is selected as the output for the POU completed signal. This is an FSO module parameter that ABB sets at the factory. The user must check the setting at the start-up.

For a detailed description of wirings, see sections Operation principle diagram and Wiring. For a detailed description of parameter settings, see section Parameter settings.

### Operation principle

#### Time scheme

This time scheme diagram illustrates the operation of the POU function. This safety function uses the POU function of the FSO module. For more information, see the FSO module user’s manual.
1. The user stops the motor.
2. After the motor has stopped, the user switches the POUS switch off (open). 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 turns on (POUS completed indication).
4. The user switches the POUS switch on (closed). The FSO module deactivates the drive STO function and turns off the POUS indication lamp. 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 motor.

### 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, see the circuit diagrams delivered with the drive.
The dashed line in the figure indicates 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

Initial status: The drive is in operation and the motor is not running.

1. The user activates the POUS function by switching off the POUS switch [S]. This activates the POUS function in the FSO module.

2. The FSO module de-energizes the Safe torque off (STO) inputs on the inverter control unit [A41]. This activates the drive STO function. The drive indicates the status. See section Activating the safety function.

3. The POUS indication lamp [P] switches on.

4. The user cannot start the motor while the drive STO function is on.

5. Normal operation resumes after the user:
   • switches on the POUS switch [S]
   • resets the drive (if parameter 31.22 STO indication run/stop has been set so that a fault is generated).
Fault reaction function

Definition: The safety function has a ‘fault reaction function’ that attempts to bring the systems to a safe state if it detects any failure within the safety system:

- a short or open circuit or redundancy failure of the POUS switch wiring chain, or
- any internal failure within 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 or Safe stop emergency (SSE) function. This activates the drive STO function. The drive STO function is active until the fault has been repaired.

  The FSO module goes into Fail-safe mode. The STATUS/FAULT LED of the FSO module is red until the fault has been repaired.

  To exit the Fail-safe mode, remove the cause of the fault and reset the FSO module by switching the power off and on, by pressing the Boot FSO button on the Safety view of Drive composer pro or with drive parameter 96.09 FS0 reboot.

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

- **STO function in the drive**

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

Parameter settings

This section lists the parameters that you have to set in the FSO module and the drive.

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 as well as the configuration of the FSO module. We recommend our training courses on the FSO module.

The parameter values given in this chapter are example values for the POUS safety function(s) presented in this manual. Actual parameter values of the delivery may vary. You must always check that the parameter settings match your application needs.

- **FSO module parameter settings**

  You need the Drive composer pro PC tool to set the FSO module parameters, and a password to be able 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 the Drive composer pro PC tool, see Start-up and maintenance PC tool Drive composer user’s manual (3AUA0000094606 [English]).

  Note: When the motor is running, you cannot change the password, adjust parameter values, nor upload or download the FSO configuration file.

  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 the option +Q950. The example values apply only to the option +Q950.
General parameters
These parameters are common to all safety functions.

<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSOGEN.21</td>
<td>Motor nominal speed</td>
<td>1500 rpm</td>
<td>Sets the nominal motor speed. Adjust the default value to meet the ratings of the motor in use.</td>
</tr>
<tr>
<td>FSOGEN.22</td>
<td>Motor nominal frequency</td>
<td>50 Hz</td>
<td>Sets the nominal motor frequency. Adjust the default value to meet the ratings of the motor in use.</td>
</tr>
</tbody>
</table>
| FSOGEN.41 | Power-up acknowledgement      | Automatic     | Sets the power-up acknowledgement method of the FSO module.  
Automatic: 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.  
Manual: The FSO module reads the external acknowledgement signal through the digital input defined by parameter FSOGEN.42.  
Make sure that the value is Automatic. |
| FSOGEN.42 | Acknowledgement button input | None          | Selects the digital input for the acknowledgement signal when parameter FSOGEN.41 Power-up acknowledgement or STO.02 STO acknowledgement has value Manual.  
In the safety function described in this manual, parameters FSOGEN.41 Power-up acknowledgement and STO.02 STO acknowledgement have value Automatic, 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.

<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
</table>
| STO.02 | STO acknowledgement         | Automatic     | Sets the acknowledgement method used in the STO, SSE and SS1 functions.  
Automatic: The FSO module generates the STO acknowledgement signal automatically, and the user does not have to press a reset button (see parameter FSOGEN.42 Acknowledgement button input).  
Note: The default value after factory reset is Manual. Always check this parameter after factory reset. |
### 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.

<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSE.13</td>
<td>SSE function</td>
<td>Immediate STO or Emergency ramp</td>
<td>Sets the type of the SSE function. <strong>Immediate STO</strong>: The FSO module activates the drive STO function immediately after the SSE request. <strong>Emergency ramp</strong>: The FSO module first ramps down the motor speed and when the speed is below the zero speed limit, it activates the STO function. SAR0 parameters define the deceleration ramp (for more information, see the FSO module user’s manual). For the +Q950 option, ABB has set this parameter to value <strong>Immediate STO</strong> at the factory. Adjust the default value when necessary. <strong>Note</strong>: The default value after factory reset is <strong>Emergency ramp</strong>. Always check this parameter after factory reset.</td>
</tr>
</tbody>
</table>

### Parameters for the POUS function

These parameters are related to the POUS function.

<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
</table>

---
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>POUS.01</td>
<td>POUS activity and version</td>
<td>Version 1</td>
<td>Activates or deactivates the POUS function and shows the version of the POUS function. <strong>Version 1</strong>: Activates the POUS function.</td>
</tr>
<tr>
<td>POUS.02</td>
<td>POUS acknowledgement</td>
<td>Automatic</td>
<td>Sets the POUS acknowledgement method. <strong>Automatic</strong>: The FSO module generates the POUS acknowledgement signal automatically after the POUS request signal has been removed. Make sure that this value is <strong>Automatic</strong>. Note: The default value after factory reset is <strong>Manual</strong>. Always check this parameter after factory reset.</td>
</tr>
<tr>
<td>POUS.11</td>
<td>POUS input</td>
<td>DI X113:3 &amp; X114:3</td>
<td>Sets the digital input that is connected to the POUS input. For the option +Q950, ABB has configured the POUS request signal to these digital inputs at the factory.</td>
</tr>
<tr>
<td>POUS.13</td>
<td>POUS delay for completion</td>
<td>0 ms</td>
<td>Sets the time after which the POUS completed indication (POUS.22) is activated after the POUS request. Adjust the default value if necessary.</td>
</tr>
<tr>
<td>POUS.21</td>
<td>POUS output</td>
<td>None</td>
<td>Sets the digital output that indicates the activity of the POUS function. Active from the POUS request until the function has been acknowledged. The safety function described in this manual does not use this digital output.</td>
</tr>
<tr>
<td>POUS.22</td>
<td>POUS completed output</td>
<td>DO X113:7</td>
<td>Sets the digital output that indicates the completion of the POUS function. Active after the time defined by parameter POUS.13 has elapsed from the POUS request until the POUS request has been removed and the POUS function has been acknowledged (automatic acknowledgement is used, see parameter POUS.02 POUS acknowledgement). For the 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.</td>
</tr>
</tbody>
</table>

**I/O parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAFEIO.35</td>
<td>DI X113:3 Diag pulse on/off</td>
<td>On (^1)</td>
<td>Sets the diagnostic pulse of digital input X113:3 on or off. <strong>On</strong>: The input monitors that it receives test pulses.</td>
</tr>
<tr>
<td>SAFEIO.39</td>
<td>DI X114:3 Diag pulse on/off</td>
<td>On (^1)</td>
<td>Sets the diagnostic pulse of digital input X114:3 on or off. <strong>On</strong>: The input monitors that it receives test pulses.</td>
</tr>
</tbody>
</table>
Set the diagnostic pulse of digital output X113:7 on or off. 
*On:* The output monitors that it receives test pulses.

| SAFEIO.53 | DO X113:7 Diag pulse | On | Sets the diagnostic pulse of digital output X113:7 on or off. 
*On:* 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. 
*Active high:* The digital output is on when the indicated signal is active. 
For the option +Q950, ABB has configured the POUS indication signal to this digital output at the factory. |

1) 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

The parameter setting in ACS880 primary control program:

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Default value</th>
<th>Description</th>
</tr>
</thead>
</table>
| 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. 
*Warning/Warning* is the recommended setting. |

We recommend that you do not set parameter 31.22 **STO indication run/stop** to value 0, 1 or 2. This prevents the drive from generating a fault every time the FSO module activates the drive STO function.

For more information, see the firmware manual.
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 (if any).

Wiring

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

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

<table>
<thead>
<tr>
<th>FSO X113</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8, 9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13, 14, 15, 16</th>
</tr>
</thead>
<tbody>
<tr>
<td>X68</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14, 15, 16</td>
</tr>
</tbody>
</table>

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

There is a separate user interface (terminal block [X957]) inside the drive cabinet.

ABB installs the FSO module and the wirings 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. Wire the POUS switch to the terminals according to the circuit diagrams of the delivery. Obey these general rules:
1. Use only double-contact switches. We recommend approved and lockable switches.
2. Connect the switch with two conductors (two-channel connection).
Note: Keep the channels separate. If you use only one channel, or if the first and second channels are connected together (for example, in a chain), the cross-fault detection of the FSO module trips and activates the STO function of the drive.

Note: If you change the input and the parameter settings in the FSO module into a one-channel implementation, it affects the safety integrity of the safety function. The safety data that ABB has calculated for the function is not valid.

3. Use shielded, twisted pair cables. We recommend a double-shielded cable and gold-plated contacts in the POUS switch.

4. The maximum allowed cable length between the drive and the POUS switch (for the whole loop) 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, wire it to the appropriate terminals. We recommend an LED indication lamp. The maximum allowed cable length between the drive and the indication lamp (for the whole loop) is 250 m (820 ft). See the table above, section Operation principle diagram, and the circuit diagrams of the delivery.
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
1. Switch off the POUS switch.
   When the POUS is activated, the following indications are shown:
   • AA97 FSO POUS request
   • the POUS indication lamp is on.

A5A0 Safe torque off is indicated when drive STO is activated.

The indications that the FSO module generates are configurable. For more information, see chapter Parameters settings in this manual and chapter Fault tracing in the FSO module user’s manual.

Resetting the safety function
No manual reset is necessary after you have deactivated the POUS function. The reset method for the POUS function is set to automatic by ABB. However, you must reset the drive if it has tripped on a fault at the activation of the POUS function. The drive reaction depends on the parameter settings. See section Parameter settings.
Contents of this chapter
This chapter describes the start-up, acceptance test procedure, and validation of the safety function.

Validation of the safety functions
You must do an acceptance test (validation) to validate the correct operation of safety functions.

- Competence
The acceptance test of the safety function must be carried out by a competent person with expertise and knowledge of the safety function as well as functional safety, as required by IEC 61508-1 clause 6. The test procedures and report must be documented and signed by this person.

- Validation procedure
You must do the acceptance test using the checklist given in section Start-up and acceptance test:
  - at initial start-up of the safety function
  - after any changes related to the safety function (wiring, components, safety-function-related parameter settings, etc.)
  - after any maintenance work related to the safety function.

The acceptance test must include at least the following steps:
  - you must have an acceptance test plan
  - you must test all commissioned functions for proper operation, from each operation location
  - you must document all acceptance tests
you must sign and store the acceptance test report for further reference.

## Acceptance test reports

You must store the signed acceptance 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 acceptance test reports performed due to changes or maintenance in the logbook of the machine.

### Start-up and acceptance test

You need the Drive composer PC tool to perform the start-up and acceptance test.

<table>
<thead>
<tr>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Action</strong></td>
</tr>
<tr>
<td><strong>Initial status</strong></td>
</tr>
<tr>
<td><strong>Safety encoder interface:</strong> When you use a safety pulse encoder in the safety application, validate the safety encoder interface as described in <em>FSO-21 safety functions module user’s manual</em> (3AXD5000015614 [English]), chapter Verification and validation.</td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td><strong>WARNING!</strong> Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.</td>
</tr>
<tr>
<td><strong>Checks and settings with no voltage connected</strong> Stop the drive and do the steps in section <em>Electrical safety precautions (page 8)</em> before you start the work.</td>
</tr>
<tr>
<td>After you have done the wiring to the POU switch and to the indication lamp, check the connections against the appropriate circuit diagrams. Make sure that the POU request is not on (the POU switch is closed).</td>
</tr>
<tr>
<td>Inverter units with parallel R8i inverter modules: Check that the XSTO.OUT output on the inverter control unit [A41] is chained to the STO inputs of all inverter modules.</td>
</tr>
<tr>
<td><strong>Settings with voltage connected</strong> Close the cabinet doors and power up the drive. See the hardware manual.</td>
</tr>
<tr>
<td>Check the parameters that are relevant to the safety function. If necessary, set the parameters according to your application needs as defined in section Parameter settings.</td>
</tr>
<tr>
<td>Create a backup file of the drive (button <strong>Backup/restore</strong> in the Drive composer pro PC tool).</td>
</tr>
</tbody>
</table>
**Action**

Save the FSO safety file (button **Save safety file** in the Drive composer pro PC tool).

**Note:** The FSO safety file is not included in the drive backup process.

---

**Acceptance test**

We recommend that you monitor these signals with the Drive composer PC tool:

- 01.01 Motor speed used (rpm)
- 01.02 Motor speed estimated (rpm)
- 01.07 Motor current (A)
- 01.10 Motor torque (%)  
- 23.01 Speed ref ramp input (rpm)
- 23.02 Speed ref ramp output (rpm)
- 90.01 Motor speed for control (rpm)
- 90.10 Encoder 1 speed (rpm)
- 200.01 FSO speed ch1 (rpm)
- 200.02 FSO speed ch2 (rpm)
- 200.03 FSO DI status
- 200.04 FSO DO status
- 200.05 FSO control word 1
- 200.06 FSO control word 2
- 200.07 FSO status word 1
- 200.08 FSO status word 2
- 200.09 Drive status word 1
- 200.10 Drive status word 2

Make sure that it is safe to start, run and stop the motor(s) during the test.

Start the drive and make sure that the motor is running. Then stop the motor. The POUS function should be activated only when the motor is stopped.

Activate the POUS function by switching off the POUS switch.

Make sure that the control panel displays a related warning. See sections Operation principle and Activating the safety function.

Make sure that the POUS indication lamp switches on.

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).

Deactivate the POUS function by switching on the POUS switch. Make sure that the drive does not restart directly after deactivation.

Make sure that the POUS indication lamp switches off and the related warning is no longer shown.

Make sure that "STO hardware failure" (5090) is not generated.

Switch off the drive start signal. If the drive generates a fault message, reset the drive.

Restart the drive and ensure that the drive and the motor operate normally.

If you made any changes in the FSO parameters, save the FSO safety file (button **Save safety file** in the Drive composer pro PC tool).

Fill in and sign the acceptance test report which verifies that the safety function is safe and accepted for operation.
Maintenance

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

Safety circuit maintenance
After the operation of the safety circuit is tested at start-up, it does not need any scheduled maintenance during its specified lifetime.

It is a good practice to check the operation of the safety function when other maintenance routines are carried out on the machinery. Include this check in the routine maintenance program of the machinery that the drive runs.

If you change any wiring or 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.
  • Test the safety function again after the change. Do the start-up and acceptance test of the safety function.
  • Document the tests and store the report into the logbook of the machine.

Proof test interval
After the operation of the safety function is validated at start-up, the operation of the safety function must be ensured by periodic proof testing. 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, EN/IEC 62061 and EN ISO 13849-1). Regardless of the mode of operation, it is a good practice to check the operation of the safety function at least once a year by doing the start-up and acceptance test of the safety function.
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 performed 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 performed 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 contain electromechanical outputs. The FSO and FSE-31 modules and the STO circuit of the drive do not contain electromechanical outputs.

**Competence**

The maintenance and proof test activities of the safety function must be carried out by a competent person with expertise and knowledge of the safety function as well as 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. Therefore 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 safety of the machine is maintained until the decommissioning is complete.
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. In case the final design differs from the default, ABB calculates new safety data and delivers it separately to the customer.

The POUS switch is not included in the calculation since 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.

<table>
<thead>
<tr>
<th>Drive module frame size</th>
<th>SIL / SIL CL</th>
<th>SC</th>
<th>PL</th>
<th>PFH 1) [1/h]</th>
<th>PFD avg (T 1 =2a)</th>
<th>PFD avg (T 1 =5a)</th>
<th>DC 2) [%]</th>
<th>Cat.</th>
<th>HFT</th>
<th>CCF</th>
<th>Mission time [a]</th>
<th>T 1 3) 4) [a]</th>
</tr>
</thead>
<tbody>
<tr>
<td>R6, R7</td>
<td>3</td>
<td>3</td>
<td>e</td>
<td>3.3E-09</td>
<td>2.7E-05</td>
<td>6.8E-05</td>
<td>&gt;90</td>
<td>3</td>
<td>1</td>
<td>80</td>
<td>20</td>
<td>20/5/2</td>
</tr>
<tr>
<td>R8, R9</td>
<td>3</td>
<td>3</td>
<td>e</td>
<td>3.3E-09</td>
<td>2.7E-05</td>
<td>6.8E-05</td>
<td>&gt;90</td>
<td>3</td>
<td>1</td>
<td>80</td>
<td>20</td>
<td>20/5/2</td>
</tr>
<tr>
<td>R10, R11</td>
<td>3</td>
<td>3</td>
<td>e</td>
<td>3.7E-09</td>
<td>3.3E-05</td>
<td>8.2E-05</td>
<td>&gt;90</td>
<td>3</td>
<td>1</td>
<td>80</td>
<td>20</td>
<td>20/5/2</td>
</tr>
<tr>
<td>1×R8i</td>
<td>3</td>
<td>3</td>
<td>e</td>
<td>1.1E-10</td>
<td>1.1E-06</td>
<td>2.6E-06</td>
<td>&gt;90</td>
<td>3</td>
<td>1</td>
<td>80</td>
<td>20</td>
<td>20/5/2</td>
</tr>
<tr>
<td>2×R8i</td>
<td>3</td>
<td>3</td>
<td>e</td>
<td>1.3E-10</td>
<td>1.2E-06</td>
<td>2.9E-06</td>
<td>&gt;90</td>
<td>3</td>
<td>1</td>
<td>80</td>
<td>20</td>
<td>20/5/2</td>
</tr>
<tr>
<td>3×R8i</td>
<td>3</td>
<td>3</td>
<td>e</td>
<td>1.4E-10</td>
<td>1.3E-06</td>
<td>3.1E-06</td>
<td>&gt;90</td>
<td>3</td>
<td>1</td>
<td>80</td>
<td>20</td>
<td>20/5/2</td>
</tr>
</tbody>
</table>
36 Technical data

<table>
<thead>
<tr>
<th>Drive module frame size</th>
<th>SIL / SILCL</th>
<th>SC</th>
<th>PL</th>
<th>PFH (^1) ([1/h])</th>
<th>PFD(_{avg}) ((T_1=2a))</th>
<th>PFD(_{avg}) ((T_1=5a))</th>
<th>DC (^2) ([%])</th>
<th>Cat.</th>
<th>HFT</th>
<th>CCF</th>
<th>Mission time ([a])</th>
<th>(T_1 (^3) (a))</th>
</tr>
</thead>
<tbody>
<tr>
<td>4×R8i</td>
<td>3</td>
<td>3</td>
<td>e</td>
<td>1.5E-10</td>
<td>1.4E-06</td>
<td>3.4E-06</td>
<td>&gt;90</td>
<td>3</td>
<td>1</td>
<td>80</td>
<td>20</td>
<td>20/5/2</td>
</tr>
<tr>
<td>5×R8i</td>
<td>3</td>
<td>3</td>
<td>e</td>
<td>1.6E-10</td>
<td>1.5E-06</td>
<td>3.6E-06</td>
<td>&gt;90</td>
<td>3</td>
<td>1</td>
<td>80</td>
<td>20</td>
<td>20/5/2</td>
</tr>
<tr>
<td>6-8×R8i</td>
<td>3</td>
<td>3</td>
<td>e</td>
<td>1.94E-10</td>
<td>1.9E-06</td>
<td>4.3E-06</td>
<td>&gt;90</td>
<td>3</td>
<td>1</td>
<td>80</td>
<td>20</td>
<td>20/5/2</td>
</tr>
</tbody>
</table>

\(^1\) PFH values are according to EN ISO 13849.
\(^2\) DC for low demand mode is 90\% (determined by the DC of the worst component in the subsystem).
\(^3\) See the Recommendation of Use CNB/M/11.050 published by the European co-ordination of notified bodies for lower \(T_1\) requirement.
\(^4\) \(T_1 = 20a\) is used with high demand mode of operation. \(T_1 = 2a/5a\) is used with low demand mode of operation. See also section Proof test interval.

**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) below. 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 any 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 and FSE modules and the STO function in the drive.

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

**Fault exclusions**

Fault exclusions (not considered in the calculations):

- any short and open circuits in the cables of the safety circuit
- any 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 hardware manual of your drive.

Related standards and directives

<table>
<thead>
<tr>
<th>Standard</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN ISO 13849-1:2015</td>
<td>Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design</td>
</tr>
<tr>
<td>IEC 60204-1:2016</td>
<td></td>
</tr>
<tr>
<td>IEC 61326-3-1:2017</td>
<td>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</td>
</tr>
<tr>
<td>IEC 61511-1:2016</td>
<td>Functional safety – Safety instrumented systems for the process industry sector – Part 1: Framework, definitions, system, hardware and application programming requirements</td>
</tr>
<tr>
<td>2006/42/EC</td>
<td>European Machinery Directive</td>
</tr>
<tr>
<td>Other</td>
<td>Machine-specific C-type standards</td>
</tr>
</tbody>
</table>

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 EN/IEC 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.

Product training
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