OPTIONS FOR ABB DRIVES

Prevention of unexpected start-up (option +Q950) for ACS880 multidrives

User's manual

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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 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 or auxiliary circuits from the power supply. Before you do work on the drive, or its main or auxiliary circuits, 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 180/2*p* (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, commissioning 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.

Do 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.
   - Open the charging switch if present.
   - Open the disconnector of the supply transformer. (The main disconnecting device in the drive cabinet does not disconnect the voltage from the AC input power busbars of the drive cabinet.)
   - If the drive is equipped with a DC/DC converter unit (optional) or a DC feeder unit (optional): Open the DC switch-disconnector ([Q11], option +F286 or +F290) of the unit. Open the disconnecting device of the energy storage connected to the unit (outside the drive cabinet).
   - Open the auxiliary voltage switch-disconnector (if present), and all other possible disconnecting devices that isolate the drive from dangerous voltage sources.
   - In the liquid cooling unit (if present), open the switch-disconnector of the cooling pumps.
   - 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. Use a quality voltage tester. If the measurement requires removal or disassembly of shrouding or other cabinet structures, obey the local laws and regulations applicable to live working (including – but not limited to – electric shock and arc protection).
   - 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.

Important! Repeat the measurement also with the DC voltage setting of the tester. Measure between each phase and ground. There is a risk of dangerous DC voltage charging due to leakage capacitances of the motor circuit. This voltage can remain charged for a long time after the drive power-off. The measurement discharges the voltage.

- 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.

WARNING!
The busbars inside the cabinet of liquid-cooled drives are partially coated. Measurements made through the coating are potentially unreliable, so only measure at uncoated portions. Note that the coating does not constitute a safe or touch-proof insulation.

6. Install temporary grounding as required by the local regulations.
7. Ask for a permit to work from the person in control of the electrical installation 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 air-cooled and liquid-cooled multidrives 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	☑
Connect the user-defined wiring (if any). Refer to the wiring instructions in this manual and the circuit diagrams delivered with the drive.	☐
Check and/or set the safety function related parameters (as listed in this manual).	☐
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.	☐
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.	☐

Related manuals

Manual	**Code**
Drive hardware	
ACS880 multidrive cabinets mechanical installation instructions	3AUA0000101764
ACS880 liquid-cooled multidrive cabinets mechanical installation instructions	3AXD50000048635
ACS880 multidrive cabinets and modules electrical planning instructions	3AUA0000102324
ACS880 liquid-cooled multidrive cabinets and modules electrical planning	3AXD50000048634
Supply units	
ACS880-207 IGBT supply units hardware manual	3AUA0000130644
ACS880-207LC IGBT supply units hardware manual	3AXD50000174782
ACS880-307…+A003 diode supply units hardware manual	3AUA0000102453
ACS880-307…+A018 diode supply units hardware manual	3AXD50000011408
ACS880-307LC…+A018 diode supply units hardware manual	3AXD50000579662
ACS880-907 regenerative rectifier units hardware manual	3AXD50000020546
Inverter hardware	
ACS880-107 inverter units hardware manual	3AUA0000102519
ACS880-107LC inverter units hardware manual	3AXD50000196111
Drive firmware	
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

Manual	Code
ACS880 regenerative rectifier control program firmware manual	3AXD50000020827
PC tools	
Drive Composer start-up and maintenance PC tool user's manual	3AUA0000094606
Functional safety design tool user’s manual	3AXD10000102417
Safety	
ACS880 multidrive cabinets and modules safety instructions	3AUA0000102301
ACS880 liquid-cooled multidrive cabinets and modules safety instructions	3AXD50000048633
Functional safety; Technical guide No. 10	3AUA0000048753
ABB Safety information and solutions	www.abb.com/safety
Options	
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
Other documents	
Circuit diagrams	Delivered with the drive
Part lists	Delivered with the drive
Safety data report (if ordered with option code +P947)	

You can find manuals and other product documents in PDF format on the Internet at www.abb.com/drives/documents.

Terms and abbreviations

Term	Description
Control unit	The part in which the control program runs.
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.
Mission time	The period of time covering the intended use of the safety function/device. After the mission time elapses, the safety device must be replaced. Note that any mission time values given cannot be regarded as a guarantee or warranty. (EN ISO 13849-1)
modoff	No modulation
PL	Performance level. Levels a...e correspond to SIL (EN ISO 13849-1)
POUS	Prevention of unexpected start-up
SIL	Safety integrity level (1…3) (IEC 61508, IEC 62061, IEC 61800-5-2)
SSE	Safe stop emergency
STO	Safe torque off (IEC/EN 61800-5-2)
Supply unit	Supply module(s) under control of one control unit, and related components.
Validation	Confirmation by, for example, analysis that the safety system meets the functional safety requirements of the specific application.

Term	Description
Verification	Confirmation by, for example, testing that the safety system meets the requirements set by the specification.
Zero speed	For safety functions, the zero speed limit indicates the completion of the safe stopping function.

3

Option description

Contents of this chapter

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

Overview

A drive with 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 modules to the inverter units 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. Refer to 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 inverter units. The Safe torque off function disables the control voltage of the power semiconductors of the inverter unit output stage. This prevents the inverter units from generating the torque required to rotate the motors. 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 inverter units.

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 (option +Q979): If the user activates the POUS function during the emergency stop deceleration ramp, it overrides the emergency stop function. This activates the inverter unit STO and the motor coasts to a stop. For more information on the emergency stop function, see *Emergency stop, configurable stop category 0 or 1 (option +Q979) for ACS880 multidrives user's manual* (3AUA0000145933 [English]).

For a detailed description of the inverter unit STO function, refer to the inverter unit 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, refer to section *Related standards and directives (page 40)*.

Summary of wirings and settings

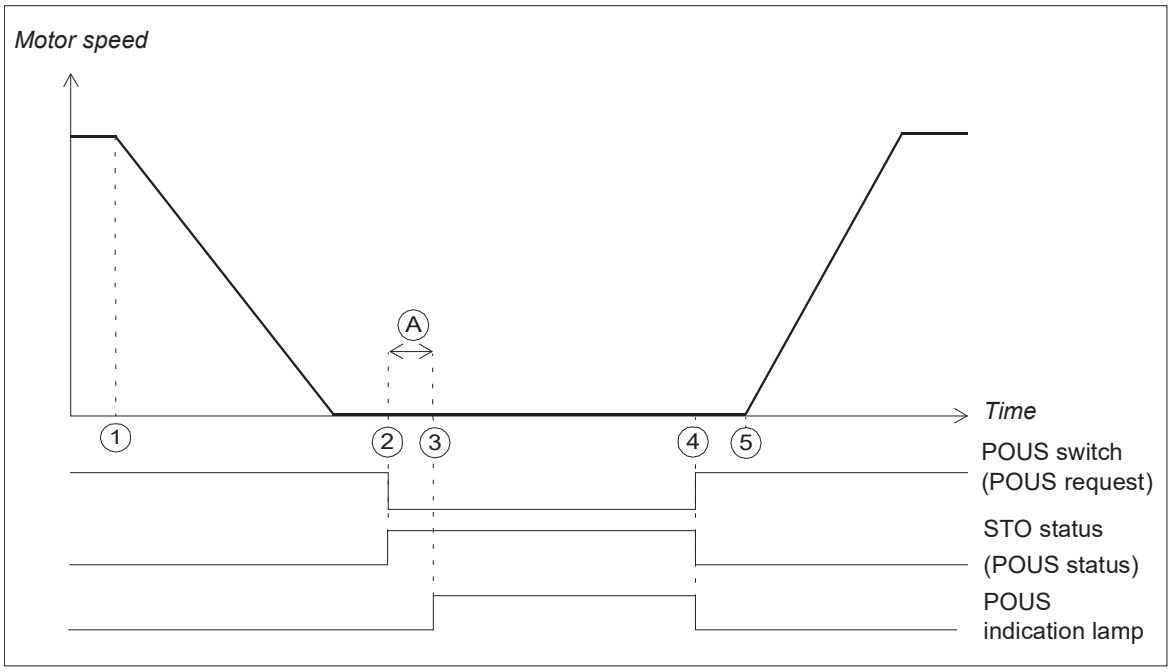
The wirings and settings of the POUS function are:

- The inverter units are equipped with the FSO safety functions modules (option +Q973 or +Q972). ABB installs the modules at the factory.
- The user must connect a dual-channel POUS switch to the FSO module. Refer to 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, refer to the FSO module user's manual.



A POUS indication delay (see parameter *POUS.13*): 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 motors have stopped, the user sets the POUS switch to the open position. The FSO module activates the STO function in the inverter units.

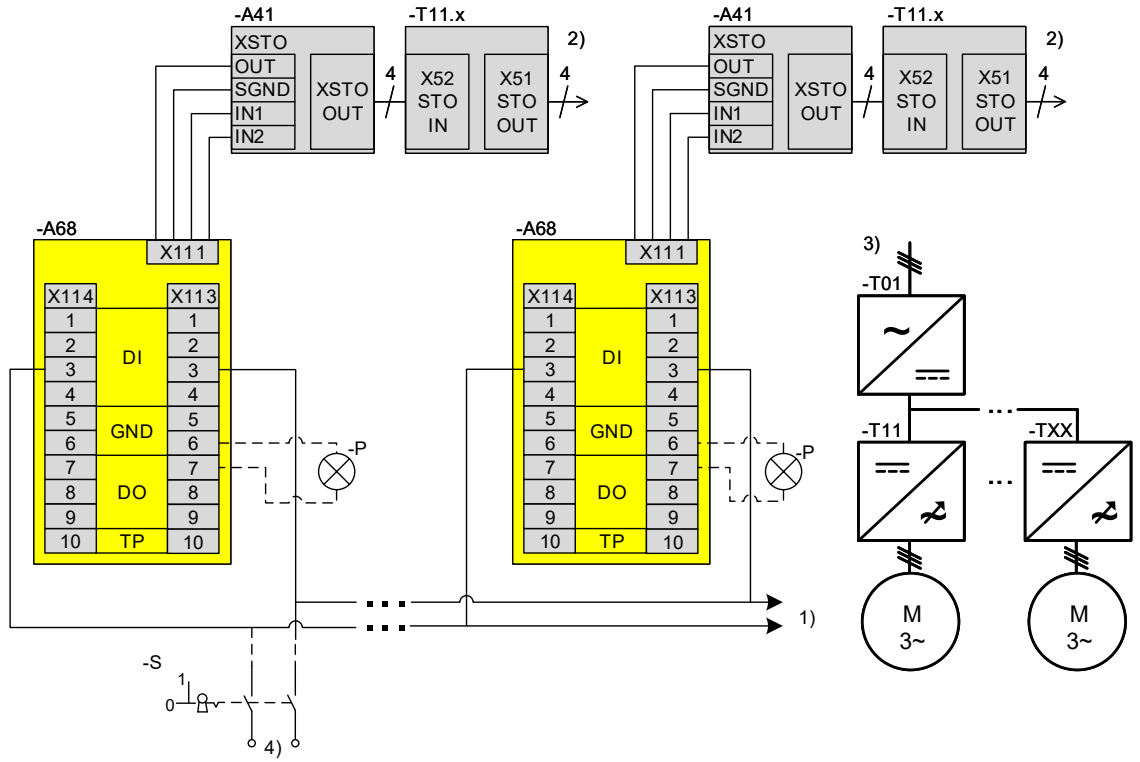
   Note: If the user activates the POUS function when the motors are running, the FSO module activates the inverter unit STO function, the motors coast to a stop and the FSO module generates a fault.
3. After time A has elapsed, the POUS indication lamp comes on (POUS completed indication).

   Note: If the time specified by parameter *POUS.13* is not sufficient, the motors 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 inverter unit STO function. The POUS indication lamp goes off. The user can start the motors 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 two FSO modules in a network (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.
A41	Inverter control unit
A68	Safety functions module FSO-12/-21
P	POUS indication lamp (user-defined)
S	POUS switch (user-defined)
T01	Supply unit
T11 … Txx	Inverter unit(s)
T11.x	Inverter module(s) under inverter unit T11
X111	STO connections to inverter control unit
X113, X114	Terminal block in the FSO module
X113:3	POUS request 1
X114:3	POUS request 2
X113:6	POUS indication ground
X113:7	POUS indication
1)	To parallel FSO modules (if any)

2)	To parallel inverter modules (if any)
3)	Main circuit
4)	24 V DC supply for POUS input

Step	Operation
	Initial status: The drive is in operation, but the motor is **not** 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.
2	The FSO module [A68] de-energizes the Safe torque off (STO) inputs on the inverter control units [A41], which activates the STO function in the inverter units. The inverter units show an indication.
3	The POUS indication lamp [P] comes on.
4	The user cannot start the motor while STO is active.
5	Normal operation continues after the user: • sets the POUS switch [S] to the closed position • resets the inverter units, if they are configured to generate a fault when STO is activated • makes sure that the drive receives the start signal (depends on the configuration, see the firmware manual).

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 inverter unit STO.

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

FSO module

The fault reaction function of the FSO module trips the inverter unit if it detects a failure. The FSO module activates the STO function or the Safe stop emergency (SSE) function. This activates the inverter unit STO function. The inverter unit 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.

For more information, refer to the inverter unit 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 inverter unit parameter *96.09 FSO reboot*.

Inverter unit STO function

The inverter unit 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. Refer to the hardware and firmware manuals of the inverter unit.

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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

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, commissioning or maintenance work.

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

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

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

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

ABB installs the FSO modules and the wiring between the FSO modules and the inverter units 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 inverter unit and the POUS switch is 250 m (820 ft).
5. Obey the general control cable installation instructions given in the inverter unit hardware manual.

If you use a POUS indication lamp, connect it to the applicable terminals in the terminal block [X68]. ABB recommends an LED indication lamp. The maximum permitted cable length between the inverter unit and the indication lamp (for the whole loop) is 250 m (820 ft).

5

Parameter settings

Contents of this chapter

This chapter gives the parameters that you must set in the FSO modules and the inverter units.

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, refer to the FSO module user’s manual. For more information on Drive Composer pro, refer to *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, refer to the FSO module user's manual.

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 some 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. *Automatic*: It is not necessary to push a reset button after energizing 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 Acknowledgement button input*. 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* is set to *Manual*. In the safety function described in this manual, parameters *FSOGEN.41 Power-up acknowledgement* and *STO.02 STO acknowledgement* are set to *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.

Index	Name	Example value	Description
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*).
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 *None*.
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 the 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.). When an encoder is used: This parameter is relevant only if there is an encoder failure and the FSO module activates the STO function.

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. *Immediate STO*: The FSO module activates the inverter unit STO function immediately after the SSE request. *Emergency ramp:* The FSO module decelerates the motor to zero speed, and then activates the inverter unit STO function. SAR0 parameters define the deceleration ramp. For more information, refer to the FSO module user's manual. For option +Q950, ABB sets this parameter to value *Immediate STO* at the factory. Adjust the default value when necessary.

Parameters for the POUS function

These parameters are related to the POUS function in all FSO modules in the network.

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. *Version 1*: Activates the POUS function.
POUS.02	POUS acknowledgement	Automatic	Sets the POUS acknowledgement method. Set this parameter according to the application requirements. *Automatic*: The FSO module generates the POUS acknowledgement signal automatically after the POUS request signal is removed. *Manual*: The FSO module reads the POUS acknowledgement signal through the digital input defined by parameter *FSOGEN.42 Acknowledgement button input*. The FSO module accepts the acknowledgement after the POUS request is removed. If you set this parameter to *Manual*, you must implement a manual acknowledgement for the POUS function.
POUS.11	POUS input	DI X113:3 & X114:3	Sets the digital input that is connected to the POUS input. For option +Q950, ABB has configured the POUS request signal to these digital inputs at the factory. Make sure that this value corresponds to the actual wiring. Refer to the circuit diagrams of the delivery.
POUS.13	POUS delay for completion	0 ms	Sets the time after which the POUS completed indication (*POUS.22 POUS completed output*) is activated after the POUS request. Adjust the default value if necessary.
POUS.21	POUS output	None	Sets the digital output that indicates the activity of the POUS function. Active from the POUS request until the function is acknowledged. The safety function described in this manual does not use this digital output.
POUS.22	POUS completed output	DO X113:7	Sets the digital output that indicates the active state of the POUS function (that is, the motor is stopped and the inverter unit STO is active). Active after the time defined by parameter *POUS.13 POUS delay for completion* has elapsed from the POUS request until the POUS request is removed and the POUS function is acknowledged (automatic acknowledgement is used by default, see parameter *POUS.02 POUS acknowledgement*). 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. Refer to the circuit diagrams of the delivery.

Index	Name	Example value	Description
I/O parameters			
SAFEIO.35	DI X113:3 Diag pulse on/off	Off	Sets the diagnostic pulse of digital input X113:3 on or off. *Off*: The input monitors that it does not receive test pulses.
SAFEIO.39	DI X114:3 Diag pulse on/off	Off	Sets the diagnostic pulse of digital input X114:3 on or off. *Off*: The input monitors that it does not receive 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 option +Q950, ABB has configured the POUS indication signal to this digital output at the factory.

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

Inverter unit parameter settings

The table that follows gives the parameters related to the safety function in the ACS880 primary control program. The parameters are set at the factory.

No.	Name	Default value [1)]	Description
31.22	STO indication run/stop	Warning/Warning	Selects which indications are given when the Safe torque off (STO) function is activated. *Warning/Warning* is the recommended setting. **Note:** ABB recommends that you do not set this parameter to *Fault/Fault*, *Fault/Warning*, or *Fault/Event*. These values will cause the inverter units to trip on a fault each time that the FSO module activates the inverter unit STO function.

[1)] Value set by ABB at the factory for the default design.

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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

Activate the POUS function only when the motors are 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 installed).

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

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 make sure that the safety function operates correctly and according to the safety requirements.

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. Refer to the FSO module user's manual, chapter *Verification and validation*.

You must do the validation test using the checklist given in this manual and the validation test plan of the complete safety system:

- 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 changes related to the power unit or its circuit boards
- after maintenance work related to the safety function
- at the proof test of 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 correct 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 pro PC tool to do the start-up and validation test.

Action	☑
WARNING! Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.	☐
Initial status	
Safety encoder interface: If you use a safety encoder in the safety application, validate the safety encoder interface as described in *FSO-21 safety functions module user's manual* (3AXD50000015614 [English]), chapter *Verification and validation*.	☐
Make sure that the drive is ready for use, that is, you have done the tasks of the drive start-up procedure. Refer to the hardware manuals.	☐
Make sure that the FSO STO function is configured and validated. Refer to the FSO module user's manual. 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. **Note:** If parameter *S_ENCGEN.11* is set to *Est switch not active load*, both STO function with speed estimate and STO function with encoder feedback must be tested - most importantly, the value of parameter *STO.14* must be set according to the application requirements.	☐

Action	☑
Checks and settings with no voltage connected	
Stop the drive and do the steps in section *Electrical safety precautions (page 9)* before you start the work.	☐
After you connect the POUS switch and indication lamp to the drive, do a check of the connections against the applicable circuit diagrams. Do the check also if you made other connections to the safety circuit on site (for example, connected shipping splits of large drives).	☐
Make sure that the POUS request is not on (the POUS switch is in the closed position).	☐
Inverter units with parallel R8i inverter modules: Make sure that the XSTO.OUT output on the inverter control unit [A41] is chained to the STO inputs of all inverter modules.	☐
Settings with voltage connected	
Close the cabinet doors and power up the drive. Refer to the hardware manual.	☐
Make sure that the parameter settings related to the safety functions are correct. Refer to chapter *Parameter settings*.	☐
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.	☐
Validation test	
ABB recommends that you monitor at least 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 (%) • 06.18 Start inhibit status word • 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 motors during the test.	☐
Start the drive and make sure that the motors are running. Then stop the motors.	☐
Make sure that the motors are stopped.	☐
Activate the POUS function: set the POUS switch to the open position.	☐
Make sure that the correct warnings and indications are shown. If there is more than one POUS group in the system, make sure that only the correct inverter units indicate POUS.	☐

Action	☑
Make sure that the POUS indication is activated. For example, if you installed a POUS indication lamp, make sure that it comes on. If there is more than one POUS group in the system, make sure that only the correct inverter units indicate POUS.	☐
Make sure that the inverter unit generates none of these faults: • STO hardware failure (5090) • Safe torque off 1 loss (FA81) • Safe torque off 2 loss (FA82) If the inverter unit generates these faults, refer to the hardware and firmware manuals for fault tracing instructions. If the FSO module generates a fault, refer to the FSO module user's manual, chapter *Fault tracing*.	☐
Make sure that you cannot start the inverter units or motors from any control location. Make sure that the inverter units or motors do not start when you switch the start signal off and on, or push the start key of the panel when the panel is in local control mode.	☐
Deactivate the POUS function: set the POUS switch to the closed position. **Note:** If the POUS function is in the automatic reset mode, the drive can restart automatically when you deactivate the POUS function.	☐
Make sure that the POUS indication lamp goes off and the related warning is no longer shown.	☐
Restart the inverter units and motors. Make sure that they operate normally.	☐
Do the validation test for each POUS group.	☐
Create a backup file of the drive parameters with the Drive Composer pro PC tool.	☐
Save the FSO safety file with the button **Save safety file** in the Drive Composer pro PC tool.	☐
Fill in and sign the validation test report. Store the report in the logbook of the machine.	☐

8

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 a power unit or its circuit boards, 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

Proof tests are used to detect failures in the safety function. To do a proof test, use the validation test procedure given in this manual.

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 inverter unit does not have electromechanical outputs. Also, the FSO and FSE-31 modules do not have electromechanical outputs.

Functional safety components

The mission time of functional safety components is 20 years which equals the time during which failure rates of electronic components remain constant. This applies to the components of the standard Safe torque off circuit as well as any modules, relays and, typically, any other components that are part of functional safety circuits.

The expiry of mission time terminates the certification and SIL/PL classification of the safety function. The following options exist:

- Renewal of the whole drive and all optional functional safety module(s) and components.
- Renewal of the components in the safety function circuit. In practice, this is economical only with larger drives that have replaceable circuit boards and other components such as relays.

Note that some of the components may already have been renewed earlier, restarting their mission time. The remaining mission time of the whole circuit is however determined by its oldest component.

Contact your local ABB service representative for more information.

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 an inverter unit, 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 gives the safety data, ambient conditions, and list of standards related to the product.

Safety data

Safety data values

Each multidrives delivery is unique. If the customer has ordered safety data calculations (option +P947), ABB calculates the safety data and delivers it separately to the customer.

For the safety data of the FSO-21 and FSE-31 modules, see *FSO-21 safety functions module user's manual* (3AXD50000015614 [English]). For the safety data of the FSO-12 module, see *FSO-12 safety functions module user's manual* (3AXD50000015612 [English]).

Safety component types

Safety component types as defined in IEC 61508-2:

- FSO module: type B
- FSE module: type B
- inverter unit STO circuit:
  - air-cooled R1i…R7i inverter modules: type A
  - air-cooled R8i inverter modules: type B
  - liquid-cooled R7i…R8i inverter modules: type B.

Safety block diagrams

Each multidrives delivery is unique. If included in the customer order, ABB defines the safety block diagram for the safety function and delivers the diagram separately to the customer.

Relevant failure modes

Relevant failure modes are:

- internal failures of the FSO module, and the inverter unit STO.

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

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.

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 inverter unit hardware manual.

Related standards and directives

Standard	Name
IEC 61800-5-2:2016 EN 61800-5-2:2007	Adjustable speed electrical power drive systems - Part 5-2: Safety requirements – Functional
IEC 62061:2021 EN 62061:2005 + AC:2010 + A1:2013 + A2:2015	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
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
IEC 61508-1:2010	Functional safety of electrical/electronic/programmable electronics safety related systems – Part 1: General requirements
IEC 61508-2:2010	Functional safety of electrical/electronic/programmable electronics safety related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
IEC 61511-1:2016 + A1:2017	Functional safety – Safety instrumented systems for the process industry sector – Part 1: Framework, definitions, system,hardware and application programming requirements
IEC 61000-6-7:2014	Electromagnetic compatibility (EMC) – Part 6-7: Generic standards – Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations

Standard	Name
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
EN ISO 14118:2018	Safety of machinery – Prevention of unexpected start-up (ISO 14118:2017)
2006/42/EC	European Machinery Directive
	Supply of Machinery (Safety) Regulations 2008 (UK)
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.

Compliance with the Supply of Machinery (Safety) Regulations (UK)

The drive is an electronic product which is covered by the Electrical Equipment (Safety) Regulations. However, the drive internal safety function of this manual is in the scope of the Supply of Machinery (Safety) Regulations as a safety component. This function complies with designated standards such as 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.

Product training

For information on ABB product training, navigate to 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.

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