Options for ABB drives

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

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List of related manuals

Drive hardware manuals and guides	Code (English)
ACS880-07 drives (560 to 2800 kW) hardware manual	*3AUA0000143261*
ACS880-07 drives (45 to 630 kW, 50 to 700 hp) hardware manual	*3AUA0000105718*
ACS880-17 hardware manual	*3AXD50000020436*
ACS880-37 hardware manual	*3AXD50000020437*

Drive firmware manuals and guides	
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*

PC tool manuals	
Start-up and maintenance PC tool Drive composer user's manual	*3AUA0000094606*
Functional safety design tool user's manual	*3AXD10000102417*

Option manuals and guides	
ACS-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*
Functional safety; Technical guide No. 10	*3AUA0000048753*
Safety and functional safety; A general guide	*1SFC001008B0201*
ABB Safety information and solutions	www.abb.com/safety
Manuals and quick guides for I/O extension modules, fieldbus adapters, etc.	

You can find manuals and other product documents in PDF format on the Internet. See section *Document library on the Internet* on the inside of the back cover. For manuals not available in the Document library, contact your local ABB representative.

ACS880-07 (45 to 630 kW) manuals

ACS880-07 (560 to 2800 kW) manuals

ACS880-17 manuals

ACS880-37 manuals

User’s manual

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

Table of contents

4. Start-up and acceptance test

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3AUA0000145922 Rev C
EN
EFFECTIVE: 2016-01-15

Table of contents

List of related manuals 2

1. Introduction to the manual

Contents of this chapter 7
Applicability 7
Safety instructions 8
Target audience 8
Contents 9
Related documents 9
Abbreviations 9
Exclusion of liability 10
Quick reference guide for implementing a safety system 11

2. Option description and instructions

Contents of this chapter 13
Overview 13
  Summary of wirings and settings 14
Operation principle 15
  Time scheme 15
  Circuit diagram 16
Wiring 17
Use of the safety function 18
  Activating 18
  Resetting 18
POUS indications 18
Fault reaction function 18
  FSO module 18
  FSE module 19
  Safety encoder 19
  STO function in the drive 19

3. Parameter settings

Contents of this chapter 21
Introduction 21
FSO module 21
  General parameters 22
  Parameters for the STO function 22
  Parameters for the SSE function 23
  Parameters for the POUS function 23
  FSE module and safety pulse encoder parameters 24
Drive 25
  Parameter 31.22 STO indication run/stop 25
  Safety pulse encoder parameters 25

4. Start-up and acceptance test

Contents of this chapter 27

Safety encoder interface 27
Start-up and acceptance test 28
Checks and settings with no voltage connected 28
Settings with voltage connected 28
Acceptance test procedure 28

5. Maintenance

Contents of this chapter 29
Maintenance 29
Proof test interval 30
Competence 30
Residual risk 30
Intentional misuse 30
Decommissioning 30

6. Technical data

Contents of this chapter 31
Safety data 31
Safety performance with different safety pulse encoders 31
Safety data values 32
Safety component types 32
Safety block diagram 32
Relevant failure modes 32
Fault exclusions 33
Operation delays 33
General rules, notes and definitions 34
Validation of the safety functions 34
Validation procedure 34
Acceptance test reports 34
Competence 34
Ambient conditions 34
Reporting problems and failures related to safety functions 34
Related standards and directives 35
Compliance with the European Machinery Directive 35

Further information

Product and service inquiries 37
Product training 37
Providing feedback on ABB Drives manuals 37
Document library on the Internet 37

1

Introduction to the manual

Contents of this chapter

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

Applicability

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

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.

Safety instructions

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.

WARNING! This safety function does not disconnect the voltage of the main and auxiliary circuits from the drive. Never work on the electrical parts of the drive or the motor before you have also disconnected the drive system from the electric supply, from rotating permanent magnet motors and from rotating motors equipped with sine filters, and made sure by measuring that there is no dangerous voltage present.

WARNING! After you have made additions to the drive safety circuit or modified it, changed circuit boards inside the drive, replaced the FSO or FSE module or modified FSO module parameters, always test the operation of the safety circuit according to its acceptance test procedure. The change can affect unexpectedly. All customer-made changes are on the customer's responsibility.

WARNING! The Safe torque off functionality is only achieved through the XSTO connector of the inverter or drive control unit. True Safe torque off functionality is not achieved through the XSTO connectors of the supply control unit. In the supply unit, the XSTO input must not be used for any safety function purposes to ensure personnel safety. The Safe torque off function is supported by any ACS880 inverter or drive firmware. It is not supported by supply firmware.

WARNING! (With permanent magnet or synchronous reluctance [SynRM] motors only) In case of a multiple inverter IGBT failure, the inverter 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! Read and obey all safety instructions in the drive hardware manual. If you ignore them, injury or death, or damage to the equipment can occur.

This manual does not repeat the complete safety instructions of the drive but it only includes the instructions related to the scope of this manual.

Target audience

This manual is intended for people who install, start up, use and service the drive safety option. Read the manual before working on the drive. You are expected to know the fundamentals of electricity, wiring, electrical components, electrical schematic symbols, and functional safety.

Contents

The chapters of this manual are briefly described below.

Introduction to the manual (this chapter) introduces this manual and gives safety instructions.

Option description and instructions describes the safety function and instructs how to wire and use it.

Parameter settings lists the parameters that you have to set for the safety function.

Start-up and acceptance test gives instructions on how to start up, test and validate the safety function.

Maintenance gives instructions on how to maintain the safety function.

Technical data gives general rules, notes and definitions related to safety functions and lists the related standards and directives. The safety data is also given.

Related documents

- Product manuals (see the inside of the front cover)
- Circuit diagrams delivered with the drive
- Part lists delivered with the drive
- Safety data report (if the safety circuit is application engineered)

Abbreviations

Abbreviations used in this manual are listed below.

Abbreviation	Description	Reference
Cat.	Classification of the safety-related parts of a control system. The categories are: B, 1, 2, 3 and 4.	EN ISO 13849-1
CCF	Common cause failure (%)	EN ISO 13849-1
DC	Diagnostic coverage	EN ISO 13849-1
DI	Digital input	
DO	Digital output	
HFT	Hardware fault tolerance	IEC 61508, EN 62061
Frame (size)	Relates to the construction type of the drive in question. For example, several drive types with different power ratings can have the same basic construction, and a frame size is used in reference to all those drive types. With the ACS880-07 (smaller), the frame size marking of the drive indicates the physical size of the drive, eg, R6. With the ACS880-07 (larger), the frame size marking of the drive indicates the quantity and frame size of the diode supply modules plus the quantity and frame size of the inverter modules, eg, “2×D8T +3×R8i”. With the ACS880-17 and ACS880-37, the frame size marking of the drive indicates the quantity and frame size of the IGBT supply modules plus the quantity and frame size of the inverter modules, eg, “2×R8i +3×R8i”.	
FSE-31	Pulse encoder interface module	
FSO-12	Safety functions module which does not support the use of encoders	

Abbreviation	Description	Reference
FSO-21	Safety functions module which supports the FSE-31 module and the use of safety encoders	
GND	Ground	
HFT	Hardware fault tolerance	IEC 61508, EN/IEC 62061
IGBT	Insulated gate bipolar transistor	
PFD	Probability of dangerous failure on demand	IEC 61508
PFH	Probability of dangerous failures per hour	IEC 61508, EN ISO 13849-1, EN/IEC 62061, EN/IEC 61800-5-2
PL	Performance level (levels are: a, b, c, d and e). Corresponds to SIL.	EN ISO 13849-1
POUS	Prevention of unexpected start-up	EN 1037
R8i	Frame size designation of the inverter unit	
SC	Systematic capability	IEC 61508
SIL	Safety integrity level (levels are: 1, 2, 3 and 4)	IEC 61508, IEC 61511, EN/IEC 62061, EN/IEC 61800-5-2
SILCL	SIL claim limit. Maximum SIL that can be claimed for a safety function or subsystem	EN 62061
SSE	Safe stop emergency	
STO	Safe torque off. In this manual, this term is used in two different contexts: • the STO circuit in the drive (the drive STO function) • the STO safety function in the FSO module. Safety functions in the FSO module (eg, STO, SSE, SS1 and POUS) activate the drive STO function, that is, open the drive STO circuit. In addition, some safety functions can activate the STO safety function in the FSO module, which in turn opens the drive STO circuit.	EN/IEC 61800-5-2
T1	Proof test interval. T1 is a parameter used to define 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 stated cannot be regarded as a guarantee or warranty. See also section *Proof test interval* on page 29.	IEC 61508, EN/IEC 62061
TP	Test pulse	

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 all relevant standards, directives and local electrical code, and that the system is tested, verified and validated correctly.

Quick reference guide for implementing a safety system

Task	☑
Select the appropriate functional safety standard for the implementation: EN ISO 13849-1, EN/IEC 62061, IEC 61511 or other.	☐
If you select EN/IEC 62061 or IEC 61511, make a safety plan. See EN/IEC 62061 or IEC 61511.	☐
Assess safety: analyze and evaluate risks (estimate SIL/PL) and define risk reduction strategies. Define the safety requirements.	☐
Design the safety system. The part of the design made by ABB is described in chapter *Option description and instructions* on page *13*.	☐
Verify the achieved SIL/PL with, for example, FSDT-01 Functional safety design tool or similar. See *Functional safety design tool user's manual* (3AXD10000102417 [English]).	☐
Connect the wiring. See section *Wiring* on page *17*.	☐
Set the necessary parameters. See chapter *Parameter settings* on page *21*.	☐
Validate that the implemented system meets the safety requirements: • Do the acceptance test. See chapter *Start-up and acceptance test* on page *27*.	☐
Write the necessary documentation.	☐

2

Option description and instructions

Contents of this chapter

This chapter describes the operation of the option +Q950: Prevention of unexpected start-up and instructs how to wire and use it.

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.

When a safety pulse encoder is used in the safety application, also the FSE-31 pulse encoder interface module (option +L521) is installed in the drive. ABB installs the FSE module to the drive and sets default parameter values at the factory.

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, he/she actually activates the Safe torque off (STO) function in the drive. 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. With this function, the user can do short-time operations (like cleaning) and/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 (option +Q978):
If the user activates the POUS 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 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 +Q978) for ACS880-07/17/37 drives user's manual* (3AUA0000145920 [English]).

Note: ACS880-07 drives, frames nxDXT + nxR8i with a main contactor/breaker (option +F250/+F255) and ACS880-17/37 drives, frames nxR8i + nxR8i: 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]).

For more information on the FSE module, see *FSE-31 pulse encoder interface module user's manual* (3AXD50000016597 [English]).

The design principles of the option +Q950 comply with EN ISO 13850.

The STO function complies with EN/IEC 61800-5-2:2007. For a complete list of related standards and European directives, see section *Related standards and directives* on page *35.*

Summary of wirings and settings

The wirings and settings of the POUS function are:

- The drive is equipped with the FSO safety functions module (option +Q973 or +Q972). ABB installs the module at the factory.
- The user must wire a dual-channel POUS switch to the FSO module. See section
- The user can wire 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.

Additional wirings when a safety pulse encoder is used:

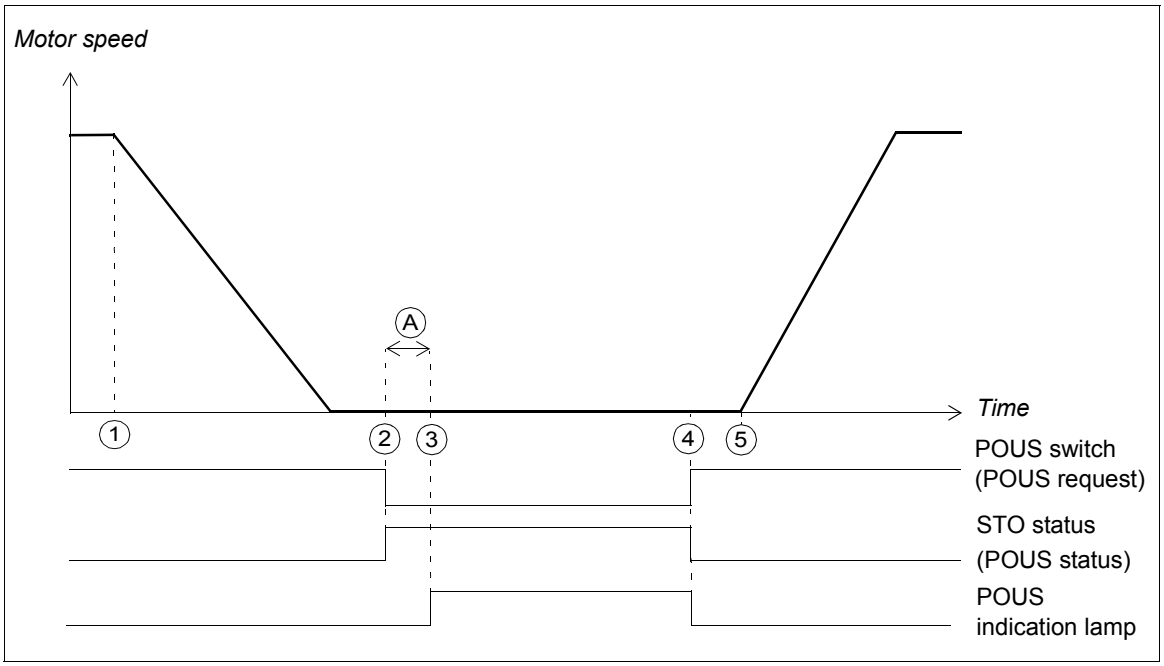
- The drive is equipped with the FSE-31 pulse encoder interface module (option +L521). ABB installs the module at the factory.
- The motor must be equipped with a safety pulse encoder. The user installs the safety pulse encoder and wires it to the FSE module. The user must make sure that the required safety integrity (SIL/PL) can be achieved with the used safety encoder(s).

For a detailed description of wirings, see sections *Circuit diagram* on page *16* and *Wiring* on page *17*. For a detailed description of parameter settings, see chapter *Parameter settings* on page *21*.

Operation principle

Time scheme

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

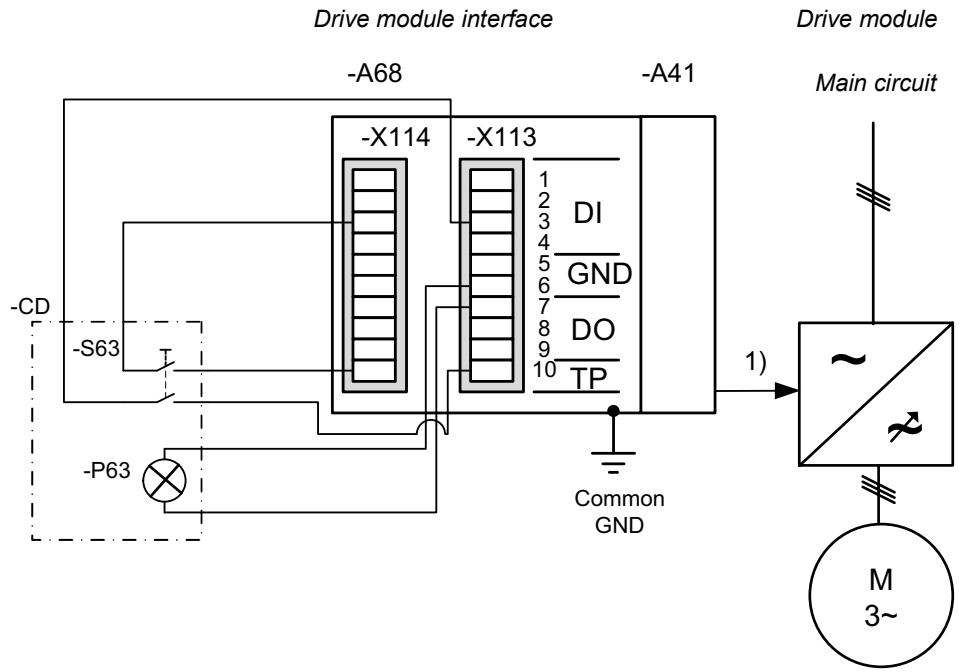


A POUS indication delay (see parameter *POUS.13*): An additional security delay. The POUS completed indication (parameter *POUS.22*) becomes active after this delay.

Step	Description
1	The user stops the motor.
2	After the motor has reached the zero speed, 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.

Circuit diagram

This diagram shows the connections of an FSO module (without the safety encoder interface). For more information, see the circuit diagrams of the delivery.



1)	STO signal to the drive/inverter unit IGBT	A41	Control board
S63	POUS switch (user-defined)	X113	Terminal block in the FSO module
P63	POUS indication lamp (user-defined)	X114	Terminal block in the FSO module
A68	FSO module		

The dashed dot line (— · —) indicates a user-defined installation.

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

Step	Operation
1.	The user activates the POUS function by switching off the POUS switch [S63]. This activates the POUS function in the FSO module.
2.	The FSO module de-energizes the Safe torque off (STO) inputs on the drive control board [A41]. This activates the drive STO function. The drive indicates the status. See section *POUS indications* on page *18*.
3.	The POUS indication lamp [P63] 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 [S63] • resets the drive (if parameter *31.22 STO indication run/stop* has been set so that a fault is generated, see page *25*).

Wiring

The POUS switch and 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]. This table shows the connections between the extension terminal block and the FSO module.

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

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

There is a separate user interface (terminal block [X957]) inside the 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 [X957] terminals (user interface) 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 a shielded, twisted pair cable. 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 in the [X957] terminal block. 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 *Circuit diagram* on page *16* and the circuit diagrams of the delivery.

When a safety pulse encoder is used, ABB installs the FSO-21 and FSE-31 modules and the wirings between the FSO module and the drive at the factory.

The user must wire the safety pulse encoder to the FSE module on site. Obey these rules:

- Use a double-shielded, twisted pair cable.
- The maximum allowed cable length between the safety pulse encoder and the FSE module is 300 m (980 ft).

For more information, see *FSE-31 pulse encoder interface module user's manual* (3AXD50000016597 [English]).

Use of the safety function

Activating

Switch off the POUS switch.

Resetting

You do not need to push any reset button to restore to normal operation after deactivating the POUS function. The reset input in the FSO module is set to auto reset mode at the factory. However, you must reset the drive if it has tripped on fault at the activation of the POUS function. The drive reaction depends on parameter settings. See chapter *Parameter settings* on page *21*.

POUS indications

When the POUS function is active:

- the POUS indication lamp is on.

The indications that the FSO module generates are configurable. For more information, see chapter *Parameter settings* on page *21* and chapter *Fault tracing* in the FSO module user's manual.

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,
- any internal failure within the FSO or FSE modules, the safety encoder or drive STO.

This section describes the fault reaction functions in the FSO and FSE modules, the safety encoder and the drive.

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 on the drive STO function. The drive STO function is active until the fault has been repaired.

The FSO module goes into the Fail-safe mode. The FSO module LED STATUS/FAULT 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 FSO reboot*. For more information, see the drive firmware manual and the FSO module user's manual.

FSE module

When a safety function is active, the fault reaction function of the FSO module trips the drive if it detects a failure in the FSE module. The FSO module activates the STO function. This activates the drive STO function. The drive STO function is active until the fault has been repaired.

When there are no active safety functions, the fault reaction function depends on the value of FSO parameter *S_ENCGEN.11 FSE diagnostic failure reaction* (see section *General parameters* on page *22*).

The FSO module goes into the Fail-safe mode. The FSO module LED STATUS/FAULT is red and the FSE module LED STATUS is off until the fault has been repaired. Also the drive indicates some of the FSE module faults.

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 FSO reboot*.

For more information, see the drive firmware manual, *FSO-21 safety functions module user's manual* (3AXD50000015614 [English]) and *FSE-31 pulse encoder interface module user's manual* (3AXD50000016597 [English]).

Safety encoder

The FSE module indicates the internal faults of the safety encoder as cabling faults. This activates the fault reaction function in the FSE module. This causes the FSO module to go into the Fail-safe mode (see previous sections).

The FSO module LED STATUS/FAULT is red and the FSE module LED ENC STATUS is off until the fault has been repaired. Also the drive indicates the safety encoder fault.

The FSO module LED STATUS/FAULT is red and the FSE module LED ENC STATUS is off until the fault has been repaired. Also the drive indicates the safety encoder fault.

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 FSO reboot*.

The safety encoder goes into the Safe state. To exit the Safe state, remove the cause of the fault and reboot the safety encoder (for example, by switching the power off and on).

For more information, see the drive firmware manual, *FSO-21 safety functions module user's manual* (3AXD50000015614 [English]) and *FSE-31 pulse encoder interface module user's manual* (3AXD50000016597 [English]).

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.

3

Parameter settings

Contents of this chapter

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

Introduction

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 example parameter values in this chapter are valid for the example POUS safety function presented in this manual (+Q950). We also assume that the FSO module is only used in this safety function and not in any other safety function at the same time. However, the actual deliveries vary. You must always check the pre-set parameter values against the delivery specific circuit diagrams and your application needs, and adjust the parameters values when necessary.

FSO module

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 the parameters, or 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 set always and parameters that are related only to certain safety functions. 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.

Index	Name	Example value	Description
FSOGEN.21	Motor nominal speed	1500 rpm	Sets the nominal motor speed. Adjust the default value to meet the ratings of the motor in use.
FSOGEN.22	Motor nominal frequency	50 Hz	Sets the nominal motor frequency. Adjust the default value to meet the ratings of the motor in use.
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.

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*). **Note**: The default value after factory reset is *Manual*. Always check this parameter after factory reset.
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*. **Note**: The default value after factory reset is *DI X113:1&X114:1*. Always check this parameter after factory reset.

Index	Name	Example value	Description
STO.14	Time to zero speed with STO and modoff	2000 ms	Sets the time after which the acknowledgement is allowed after coast stop in the STO, SSE and SS1 functions. This parameter is relevant only when the FSO module activates the STO or SSE function in internal fault situations. Set this value always at the start-up. Use the estimated time in which the motor coasts to a stop from the maximum speed. **Note**: The default value after factory reset is 3,600,000 ms. Always check this parameter after factory reset. When a safety encoder is used: This parameter is relevant only if an encoder or FSE module failure occurs. The FSO module goes into the Fail-safe mode and activates the STO function. For more information, see the FSO-21 module user's manual.

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 drive STO function immediately after the SSE request. *Emergency ramp*: 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 *Immediate STO* at the factory. Adjust the default value when necessary. **Note**: The default value after factory reset is *Emergency ramp*. Always check this parameter after factory reset.

Parameters for the POUS function

These parameters are related to the POUS function.

Index	Name	Example value	Description
POUS.01	POUS activity and version	Version 1	Activates or deactivates the POUS function and shows the version of the POUS function. *Version 1*: Activates version 1 of the POUS function.
POUS.02	POUS acknowledgement	Automatic	Sets the POUS acknowledgement method. *Automatic:* The FSO module generates the POUS acknowledgement signal automatically after the POUS request signal has been removed. Make sure that this value is *Automatic*. **Note**: The default value after factory reset is *Manual*. Always check this parameter after factory reset.
POUS.11	POUS input	DI X113:3 & X114:3	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.
POUS.13	POUS delay for completion	0 ms	Sets the time after which the POUS completed indication (*POUS.22*) is activated after the POUS request. Adjust the default value if necessary.

Index	Name	Example value	Description
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 has been 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 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.
I/O parameters			
SAFEIO.35	DI X113:3 Diag pulse on/off	On *)	Sets the diagnostic pulse of digital input X113:3 on or off. *On*: The input monitors that it receives test pulses.
SAFEIO.39	DI X114:3 Diag pulse on/off	On *)	Sets the diagnostic pulse of digital input X114:3 on or off. *On*: The input 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 by default.

*) The safety data (see page *31*) 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.

FSE module and safety pulse encoder parameters

Set these parameters when you use a safety pulse encoder in the safety application.

Index	Name	Example value	Description
200.231	FSE 3X act and par version	Version 1	Activates the FSE-31 encoder interface and shows the version of the encoder parameter groups (91 and 92).
200.232	Number of encoders	Single encoder CH1	Shows the number of safety pulse encoders connected to the FSE module.
S_ENCGEN.01	Safe pulse encoder version	Version 1	Activates the safety pulse encoder and shows the version parameter group S_ENCGEN.
S_ENCGEN.11	FSE diagnostic failure reaction	STO	Sets the action taken when there is a problem with the FSE module. *STO*: The FSO module goes into the Fail-safe mode and activates the drive STO function. **Note**: This parameter is relevant only when there are no active safety functions.
S_ENCGEN.14	Enc speed cross comp tolerance	1 rpm	Sets the encoder speed cross comparison tolerance. This defines how much the axle speed of the motor can change within 1 ms. Adjust the default value to meet the motor in use.
S_ENCGEN.41	Gear numerator encoder 1	1	Sets the rotation direction for the safety pulse encoder. With this parameter, you can change the rotation direction of the motor. Adjust the default value if necessary.
91.11	Module 1 type	FSE-31	Sets the type of the safety pulse encoder interface module 1.
91.12	Module 1 location	2	Sets the slot in which the safety pulse encoder interface module 1 is located.

Index	Name	Example value	Description
92.01	Encoder 1 type	HTL1	Activates or deactivates the communication with the safety pulse encoder interface module 1 and sets the type for the safety pulse encoder.
92.02	Encoder 1 source	Module 1	Sets the safety pulse encoder interface module that the safety pulse encoder 1 is connected to.
92.10	Pulses/revolution	2048	Sets the number of HTL pulses per revolution for safety pulse encoder 1. Adjust the default value to meet the safety pulse encoder in use. Make sure that the value is according to the encoder nameplate.
92.17	Accepted pulse freq of encoder 1	300 kHz	Sets the maximum pulse frequency range of encoder 1. Adjust the default value to meet the motor and safety pulse encoder in use. You can use this formula to define the value: r_max x ppr_enc + 10%, where • r_max = the maximum motor speed used in the application (or the motor nominal speed) • ppr_enc = Pulses/revolution of the safety pulse encoder (parameter *92.10*).

Drive

Parameter 31.22 STO indication run/stop

The drive parameter setting in ACS880 primary control program:

- parameter *31.22 STO indication run/stop* is set to value *Warning/Warning*.

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 making a fault every time the FSO module activates the drive STO function.

For more information, see the firmware manual.

Safety pulse encoder parameters

The drive parameter settings in ACS880 primary control program when you use a safety pulse encoder:

- parameter *90.41 Motor feedback selection* is set to value *Encoder 1*.
- parameter *90.45 Motor feedback fault* is set to value *Warning*.
  Note: If you want that the drive trips on encoder faults, set this parameter to value *Fault*. For more information, see the firmware manual.
- parameter *92.21 Encoder cable fault mode* is set to value *A, B, Z*.

4

Start-up and acceptance test

Contents of this chapter

This chapter describes the start-up and acceptance procedure of the safety function.

Safety encoder interface

When you use a safety pulse 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*.

Start-up and acceptance test

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

Initial status: 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.

Action	☑
WARNING! Obey the *Safety instructions*, page *8*. If you ignore them, injury or death, or damage to the equipment can occur.	☐
Checks and settings with no voltage connected	
After you have done the wiring to the POUS switch and indication lamp, check the connections against the appropriate circuit diagrams. Make sure that the POUS request is not on (the POUS switch is closed).	☐
Drives with R8i inverter modules: Check that the STO OUT output on the inverter control unit [A41] is chained to the STO inputs of all inverter modules. The STO circuit is disabled in spare part modules.	☐
Settings with voltage connected	
Make sure that the parameters relevant to the safety function are set as defined in chapter *Parameter settings* on page *21*.	☐
Create a backup file of the drive (button **Backup/restore** in the Drive composer pro PC tool).	☐
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 procedure	
Make sure that you can run and stop the motor freely during the test.	☐
Close the disconnector and switch on the power. Do not start the motor yet (you should activate the POUS function only when the motor is stopped).	☐
Activate the POUS function by switching off the POUS switch.	☐
Make sure that the motor stays at zero speed and the drive indicates POUS as defined in section *POUS indications* on page *18*.	☐
Make sure that you cannot start the drive and motor from any control location: Switch the external start signal off and on (in the external control mode) or push the start key of the control panel (in the local control mode). The LOC and REM buttons of the control panel or the Drive composer PC tool switch between the local and external controls.	☐
Drives with R8i inverter modules: Make sure that “STO hardware failure” (5090) is not generated.	☐
Deactivate the POUS function by switching on the POUS switch. Make sure that the drive does not restart directly after deactivation.	☐
Switch off the drive start signal (only in external control mode). If the drive generates a fault message, reset the drive.	☐
Restart the drive and motor and check that they operate normally.	☐
Fill in and sign the acceptance test report which verifies that the safety function is safe and accepted to operation.	☐

5

Maintenance

Contents of this chapter

This chapter gives maintenance instructions for the safety function.

Maintenance

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

In addition to proof testing, it is a good practice to check the operation of the safety function when other maintenance procedures are carried out on the machinery. Do the acceptance test described in chapter *Start-up and acceptance test* on page *27*.

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

- 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. Obey the rules given in chapter *Start-up and acceptance test* on page *27*.
- 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 safety function must be maintained 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 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. Do the test as described in section *Start-up and acceptance test* on page *27*.

The person responsible for the design of the complete safety function 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 modules and the STO circuit of the drive do not contain any electromechanical components.

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 circuit or a drive, make sure that the safety of the machine is maintained until the decommissioning is complete.

6

Technical data

Contents of this chapter

This chapter gives general rules, notes and definitions related to safety functions and lists the related standards and directives. The safety data is also given.

Safety data

Safety performance with different safety pulse encoders

See *FSE-31 pulse encoder interface module user's manual* (3AXD50000016597 [English]).

Safety data values

The safety data given below is valid for the default design of the safety circuit presented 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.

Drive module frame size	SIL / SILCL	SC	PL	PFH [1/h]	PFD	DC[1] [%]	Cat.	HFT	CCF	Lifetime [a]	T1[2] [a]
R6, R7	3	3	e	2.5E-9	2.9E-05	>90	3	1	80	20	20 / 2
R8, R9	3	3	e	3.9E-9	2.9E-05	>90	3	1	80	20	20 / 2
R10, R11	3	3	e	4.0E-9	3.7E-05	>90	3	1	80	20	20 / 2
1×R8i	3	3	e	1.1E-10	3.3E-06	>90	3	1	80	20	20 / 2
2×R8i	3	3	e	1.1E-10	3.4E-06	>90	3	1	80	20	20 / 2
3×R8i	3	3	e	1.3E-10	3.5E-06	>90	3	1	80	20	20 / 2
4×R8i	3	3	e	1.3E-10	3.5E-06	>90	3	1	80	20	20 / 2
5×R8i	3	3	e	1.4E-10	3.6E-05	>90	3	1	80	20	20 / 2
6×R8i	3	3	e	1.5E-10	3.7E-06	>90	3	1	90	20	20 / 2

1) DC applies both for the high and low demand of operations (determined by the DC of the worst component in the subsystem).

3AXD10000097591 Rev C

2) T1 = 20a is used with high demand mode of operation. T1 = 2a is used with low demand mode of operation. See also section *Proof test interval* on page *30*.

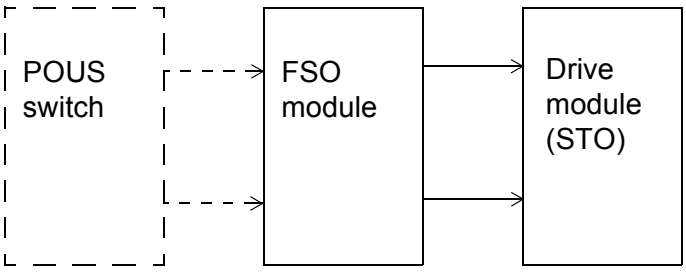
Safety component types

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 diagram

The components that are included in the safety data calculations are shown in the safety block diagram below (the POUS switch is not included in the calculations).



Relevant failure modes

Relevant failure modes are:

- the FSO module detects any open circuits and short circuits and redundancy failures of the POUS input signal wirings. Similarly, it detects redundancy failures of the POUS switch when the POUS request 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 and fault reaction response time for the POUS function: less than 100 ms (includes the response time of drive STO).

General rules, notes and definitions

Validation of the safety functions

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

Validation procedure

You must do the acceptance test using the checklist given in chapter *Start-up and acceptance test* on page *27*:

- 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 action related to the safety function.

The acceptance test must include at least the following steps:

- having an acceptance test plan
- testing all commissioned functions for proper operation, from each operation location
- documenting all acceptance tests
- signing and storing 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.

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.

Ambient conditions

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

Reporting problems and failures related to safety functions

Contact your local ABB representative.

Related standards and directives

Standard	Name
EN 60204-1:2006 + AC:2010 IEC 60204-1:2005 + A1:2008	*Safety of machinery – Electrical equipment of machines – Part 1: General requirements*
IEC 61508:2010	*Functional safety of electrical/electronic/programmable electronic safety-related systems.* Contains all parts 1…7 of IEC 61508.
EN/IEC 61800-5-2:2007	*Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional*
EN/IEC 62061:2005 + A1:2013	*Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems*
EN ISO 12100:2010	*Safety of machinery – General principles for design – Risk assessment and risk reduction*
EN ISO 13849-1:2008 + AC:2009 ISO 13849-1:2006	*Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design*
EN ISO 13849-2:2012	*Safety of machinery – Safety-related parts of control systems – Part 2: Validation*
EN 1037:1995 + A1:2008	*Safety of machinery. Prevention of unexpected start-up*
IEC 61511:2003	*Functional safety - Safety instrumented systems for the process industry sector*
IEC 61326-3-1: 2008	*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*
2006/42/EC	*European Machinery Directive*
Other	Machine-specific C-type standards

Compliance with the European Machinery Directive

The drive is an electronic product which is covered by the European Low Voltage Directive. However, the drive internal safety function of this manual (option +Q950) 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

For information on ABB product training, navigate to new.abb.com/service/training.

Providing feedback on ABB Drives manuals

Your comments on our manuals are welcome. Navigate to new.abb.com/drives/manuals-feedback-form.

Document library on the Internet

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3AUA0000145922 Rev C (EN) 2016-01-15

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