OPTIONS FOR ABB DRIVES

Emergency stop, configurable stop category 0 or 1 (option +Q979) for ACS880-07/17/17LC/37/37LC drives

User's manual
Emergency stop, configurable stop category 0 or 1 (option +Q979) for ACS880-07/17/17LC/37/37LC drives

User's manual
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Further information
Safety instructions

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

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

The manual uses these warning symbols:

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

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

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

Instructions for functional safety circuits
This manual does not repeat the complete safety instructions of the drive but only includes the instructions related to the scope of this manual.
Only a qualified electrician who has appropriate knowledge on functional, machine, and process safety is allowed to install, start up and maintain the safety circuit. All user-made changes are on the user’s responsibility.

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

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

**WARNING!**
Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur.

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

### Electrical safety precautions

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

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

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

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

1. Clearly identify the work location and equipment.
2. Disconnect all possible voltage sources. Make sure that re-connection is not possible.
   - Lock out and tag out.
   - Open the main disconnecting device of the drive.
   - If you have a permanent magnet motor connected to the drive, disconnect the motor from the drive with a safety switch or by other means.
   - Disconnect any dangerous external voltages from the control circuits.
   - After you disconnect power from the drive, always wait 5 minutes to let the intermediate circuit capacitors discharge before you continue.
3. Protect any other energized parts in the work location against contact.
4. Take special precautions when close to bare conductors.
5. Measure that the installation is de-energized.
   - Use a multimeter with an impedance greater than 1 Mohm.
• Make sure that the voltage between the drive input power terminals (L1, L2, L3) and the grounding (PE) busbar is close to 0 V.
• Make sure that the voltage between the drive output terminals (T1/U, T2/V, T3/W) and the grounding (PE) busbar is close to 0 V.

6. Ask the person in control of the electrical installation work for a permit to work.
Introduction to the manual

Contents of this chapter

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

Applicability

This manual applies to ACS880-07/17/17LC/37/37LC drives which have the option +Q979: Emergency stop, configurable stop category 0 or 1 with STO, with FSO. In this emergency stop option, the Safe torque off (STO) circuit of the drive is opened. The main contactor/breaker of the drive is not opened.

For the option +Q979, 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.
Target audience

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

Exclusion of liability

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

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

Quick reference guide for taking a safety function into use

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

Related manuals

<table>
<thead>
<tr>
<th>Manual</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive hardware</td>
<td></td>
</tr>
<tr>
<td>ACS880-07 drives (560 to 2800 kW) hardware manual</td>
<td>3AUA0000143261</td>
</tr>
<tr>
<td>ACS880-07 drives (45 to 710 kW, 50 to 700 hp) hardware manual</td>
<td>3AUA0000105718</td>
</tr>
<tr>
<td>ACS880-17 drives (160 to 3200 kW) hardware manual</td>
<td>3AXD5000020436</td>
</tr>
<tr>
<td>ACS880-17 drives (45 to 400 kW) hardware manual</td>
<td>3AXD50000035158</td>
</tr>
<tr>
<td>ACS880-17LC hardware manual</td>
<td>3AXD50000250295</td>
</tr>
<tr>
<td>ACS880-37 drives (160 to 3200 kW) hardware manual</td>
<td>3AXD5000020437</td>
</tr>
<tr>
<td>ACS880-37 drives (45 to 400 kW) hardware manual</td>
<td>3AXD50000035159</td>
</tr>
<tr>
<td>ACS880-37LC hardware manual</td>
<td>3AXD50000251407</td>
</tr>
<tr>
<td>Drive firmware</td>
<td></td>
</tr>
<tr>
<td>ACS880 primary control program firmware manual</td>
<td>3AUA0000085967</td>
</tr>
<tr>
<td>ACS880 primary control program quick start-up guide</td>
<td>3AUA0000098062</td>
</tr>
<tr>
<td>ACS880 diode supply control program firmware manual</td>
<td>3AUA0000103295</td>
</tr>
<tr>
<td>ACS880 IGBT supply control program firmware manual</td>
<td>3AUA0000131562</td>
</tr>
<tr>
<td>PC tools</td>
<td></td>
</tr>
<tr>
<td>Drive composer start-up and maintenance PC tool user's manual</td>
<td>3AUA0000094606</td>
</tr>
<tr>
<td>Functional safety design tool user's manual</td>
<td>3AXD10000102417</td>
</tr>
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</table>
**Manual**

<table>
<thead>
<tr>
<th>Manual</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Safety</strong></td>
<td></td>
</tr>
<tr>
<td>Functional safety; Technical guide No. 10</td>
<td>3AUA0000048753</td>
</tr>
<tr>
<td>Safety and functional safety; A general guide</td>
<td>1SFC00100880201</td>
</tr>
<tr>
<td>ABB Safety information and solutions</td>
<td><a href="http://www.abb.com/safety">www.abb.com/safety</a></td>
</tr>
<tr>
<td><strong>Options</strong></td>
<td></td>
</tr>
<tr>
<td>ACX-AP-x assistant control panels user’s manual</td>
<td>3AUA0000085685</td>
</tr>
<tr>
<td>FSO-12 safety functions module user’s manual</td>
<td>3AXD50000015612</td>
</tr>
<tr>
<td>FSO-21 safety functions module user’s manual</td>
<td>3AXD50000015614</td>
</tr>
<tr>
<td>FSE-31 pulse encoder interface module user’s manual</td>
<td>3AXD50000016597</td>
</tr>
<tr>
<td>Manuals and quick guides for I/O extension modules, fieldbus adapters, etc.</td>
<td></td>
</tr>
</tbody>
</table>

**Other documents**

| Circuit diagrams | Delivered with the drive |
| Part lists | Delivered with the drive |
| Safety data report (if the safety circuit is application-engineered) | |

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

### Terms and abbreviations

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat.</td>
<td>Classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behavior in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability. The categories are: B, 1, 2, 3 and 4. (EN ISO 13849-1)</td>
</tr>
<tr>
<td>CCF</td>
<td>Common cause failure (%) (EN ISO 13849-1)</td>
</tr>
<tr>
<td>DC</td>
<td>Diagnostic coverage (EN ISO 13849-1)</td>
</tr>
<tr>
<td>E-stop</td>
<td>Emergency stop</td>
</tr>
<tr>
<td>Frame, frame size</td>
<td>Physical size of the drive or power module</td>
</tr>
<tr>
<td>FSE-31</td>
<td>Optional pulse encoder interface module for safety encoder</td>
</tr>
<tr>
<td>FSO-12, FSO-21</td>
<td>Optional functional safety modules</td>
</tr>
<tr>
<td>HFT</td>
<td>Hardware fault tolerance (IEC 61508)</td>
</tr>
<tr>
<td>IGBT</td>
<td>Insulated gate bipolar transistor</td>
</tr>
<tr>
<td>modoff</td>
<td>No modulation</td>
</tr>
<tr>
<td>NC</td>
<td>Normally closed</td>
</tr>
<tr>
<td>PFD\textsubscript{avg}</td>
<td>Average probability of dangerous failure on demand (IEC 61508)</td>
</tr>
<tr>
<td>PFH</td>
<td>Average frequency of dangerous failures per hour (IEC 61508)</td>
</tr>
<tr>
<td>PL</td>
<td>Performance level. Levels a...e correspond to SIL (EN ISO 13849-1)</td>
</tr>
<tr>
<td>POUS</td>
<td>Prevention of unexpected start-up</td>
</tr>
<tr>
<td>SAR</td>
<td>Safe acceleration range</td>
</tr>
<tr>
<td>SC</td>
<td>Systematic capability (IEC 61508)</td>
</tr>
<tr>
<td>SIL</td>
<td>Safety integrity level (1...3) (IEC 61508)</td>
</tr>
<tr>
<td>SIL\textsubscript{CL}</td>
<td>Maximum SIL (level 1...3) that can be claimed for a safety function or subsystem (IEC/EN 62061)</td>
</tr>
<tr>
<td>SS1</td>
<td>Safe stop 1 (IEC/EN 61800-5-2)</td>
</tr>
<tr>
<td>SSE</td>
<td>Safe stop emergency</td>
</tr>
<tr>
<td>STO</td>
<td>Safe torque off (IEC/EN 61800-5-2)</td>
</tr>
<tr>
<td>T1</td>
<td>Proof test interval. Defines the probabilistic failure rate (PFH or PFD) for the safety function or subsystem. Performing a proof test at a maximum interval of T1 is required to keep the SIL capability valid. The same interval must be followed to keep the PL capability (EN ISO 13849) valid. Note that any T1 values given cannot be regarded as a guarantee or warranty.</td>
</tr>
<tr>
<td>TP</td>
<td>Test pulse</td>
</tr>
<tr>
<td>Zero speed</td>
<td>For safety functions, the zero speed limit indicates the completion of the safe stopping function.</td>
</tr>
</tbody>
</table>
Option description

Contents of this chapter

This chapter describes the operation and settings of the option +Q979: Emergency stop, configurable stop category 0 or 1 with STO, with FSO.

Overview

The option +Q979 uses the FSO-12 safety functions module (option +Q973) or the FSO-21 safety functions module (option +Q972) for the Emergency stop safety function. ABB installs the FSO safety functions module and the emergency stop circuit to the drive and sets default parameter values for the option at the factory. The user tunes the operation of the Emergency stop function with the safety parameters at the start-up, for example, sets the appropriate stop category (0 or 1). ABB sets stop category 0 at the factory.

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-31 module to the drive and sets the delivery configuration for the cabinet safety option at the factory.

- Emergency stop, stop category 0
  This is an uncontrolled stop (EN/IEC 60204-1). When the user pushes the emergency stop button, the Safe torque off (STO) function of the FSO module is activated. This activates the STO function of the drive. The motor(s) coast(s) to a stop.

- Emergency stop, stop category 1
  This is a controlled stop (EN/IEC 60204-1). When the user pushes the emergency stop button, the Safe stop 1 function (SS1) of the FSO module is activated. After the drive has decelerated the motor speed to a user-defined zero speed limit, the FSO module activates the STO function of the drive.
  The SS1 function operates either in time monitoring or in ramp monitoring mode. In time monitoring mode, the FSO module monitors that a user-defined deceleration time limit is not exceeded. In ramp monitoring mode, the FSO module monitors that the motor decelerates along a user-defined stop ramp.
**Note:** The safety function request to the FSO module must be active for at least 20 ms.

The user cannot start the drive before he/she has released the emergency stop button and pushed the emergency stop reset button. This resets the emergency stop circuit and deactivates the drive STO function.

**Note:** The reset button is to be kept pressed for 0.3 s...3 s.

**Note:** ACS880-07 drives, frames nxDXT + nxR8i with a main contactor/breaker (option +F250/+F255), ACS880-17/17LC/37/37LC drives, frames nxR8i + nxR8i and ACS880-17/37 drives, frames R8 and R11: When the STO function is activated in the inverter unit, the main contactor/breaker is opened after a user-defined delay (defined with parameter 94.11, the default value is 600 s). See the hardware and firmware manuals for more information.

For a detailed description of the drive STO function, see the hardware manual of your drive. For more information on the safety functions of 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-31 module, see FSE-31 pulse encoder interface module user’s manual (3AXD50000016597 [English]).

The design principles of the option +Q979 comply with EN ISO 13850.

The STO and SS1 functions comply with EN/IEC 61800-5-2:2007. For a complete list of related standards and European directives, see section Related standards and directives.

### Summary of wirings and settings

The wirings and settings of the emergency stop function are:

- The drive is equipped with the FSO safety functions module (option +Q973 or +Q972). ABB installs the module at the factory.

- One emergency stop button is installed on the cabinet door and wired to the FSO module. ABB wires the button at the factory. The user can add buttons to the emergency stop circuit.

- One emergency stop reset button is installed on the cabinet door and wired to the FSO module. The reset button also includes an emergency stop indication lamp. ABB wires the button and the indication lamp at the factory. The user can add reset buttons to the reset circuit.

- The digital output of the FSO module to which the emergency stop indication lamp is connected, is selected as the output for the Stop completed signal. This is an FSO module parameter that ABB sets at the factory by default and the user must check at the start-up.

**Emergency stop, stop category 0:**

- The digital inputs of the FSO module to which the emergency stop button is connected, are selected as the inputs for the STO request. This is an FSO module parameter that ABB sets at the factory by default and the user must check at the start-up.

**Emergency stop, stop category 1:**

User must set these FSO module parameters at start-up:

- The digital inputs of the FSO module to which the emergency stop button is connected, are selected as the inputs for the SS1 request.

- The SS1 function is set to use either the time monitoring or ramp monitoring mode.

- The stop ramp that is used to decelerate the motor(s) and the monitoring limits (stop ramp time or ramp monitoring limits) are set according to application needs.
Additional wirings and settings 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 and wires the safety pulse encoder to the FSE-31 module. The user must make sure that the required safety integrity (SIL/PL) can be achieved with the used safety encoder.

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

Operation principle

The operation and configuration of the Emergency stop function is slightly different with and without a safety encoder. Only the FSO-21 module supports the safety encoder interface, and you can also use it without a safety encoder.

**Note:** The Emergency stop, stop category 1 function uses the SS1 function of the FSO module. The SS1 function uses SAR1 parameters to define the stop ramp. In some situations (for example, in internal fault situations or due to another safety function) the FSO module can activate the Safe stop emergency (SSE) function. The SSE function uses SAR0 parameters to define the stop ramp.

**Note:** If the FSO module activates the SSE function while the SS1 function is active, the SSE function overrides the SS1 function. Therefore, SAR0 parameters are used instead of SAR1 parameters to define the stop ramp. You must take this into account when you use the SS1 function to implement an emergency stop (stop category 1).

- **Time schemes with a speed estimate (no safety encoder)**

**Emergency stop, stop category 0**

This time scheme diagram illustrates the operation of the Emergency stop, stop category 0 safety function. This option uses the Safe torque off (STO) function of the FSO module.
The operation and configuration of the Emergency stop function is slightly different with and without a safety encoder. Only the FSO-21 module supports the safety encoder interface, and you can also use it without a safety encoder.

**Time schemes without a safety encoder**

**Emergency stop, stop category 0**

This time scheme diagram illustrates the operation of the Emergency stop, stop category 0 safety function. This option uses the Safe torque off (STO) function of the FSO module. For more information, see the FSO module user’s manual.

- **A** Time to zero speed: Time from the activation of the STO function to the moment when the STO function is completed. The indication lamp goes on. The user must set this time longer than the time the motor coasts from the maximum speed to zero speed (parameter STO.14 Time to zero speed with STO and modoff).

- **B** Restart delay: Delay from pushing the emergency stop button (and activation of the STO function) to the moment that the user can push the reset button at the earliest (and acknowledge the STO function). With this parameter, it is possible to allow a restart of the drive while the motor is still running (fly-start) (parameter STO.13 Restart delay after STO).

1. The user pushes the emergency stop button. The FSO module activates the FSO and drive STO functions. The FSO module starts timers for delays A and B.
2. The user releases the emergency stop button.
3. Time B has elapsed. The user can push the reset button, that is, acknowledgement of the STO function is possible even though the motor is still running. (In this example, the user pushes the reset button in step 5.)
4. Time A has elapsed. The motor has stopped and the emergency stop indication lamp goes on.
5. The user pushes the reset button (this resets the emergency stop circuit and acknowledges the STO function).
6. The FSO module deactivates the STO function in the drive. The emergency stop indication lamp goes off. The drive is ready for a restart.

**Emergency stop, stop category 1 with time monitoring**

This time scheme diagram illustrates the operation of the Emergency stop, stop category 1 safety function with time monitoring. This option uses the Safe stop 1 (SS1) function of the FSO module.
**Case A: The motor speed reaches the zero speed limit within the user-defined time**

1. The user pushes the emergency stop button (this activates the SS1 function of the FSO module). The FSO module starts a timer for delay A.
2. The drive starts to decelerate the motor along the user-defined stop ramp (SAR1 parameter 200.112 SAR1 ramp time to zero).
3. a) The motor speed goes below the zero speed limit (B). The FSO module activates the drive STO function.
   **Note:** You can set an additional delay for the STO activation (parameter SS1.15 SS1-ramp zero speed delay for STO).
4. a) Time A has elapsed. The STO function is already active. In this case, this time has no effect.
5. a) The user releases the emergency stop button.
6. a) The user pushes the reset button (this resets the emergency stop circuit and acknowledges the STO function).
7. a) The FSO module deactivates the STO function in the drive. The emergency stop indication lamp goes off. The drive is ready for a restart.

**Case B: The motor speed does not reach the zero speed limit within the user-defined time**

Time A has elapsed from the emergency stop command (step 1) but the motor speed still exceeds the zero speed limit.
Security delay: When time A has elapsed from the start of the counter (step 1), the FSO module activates FSO and the drive STO functions (case B). In case A, the FSO module has already activated the STO function. This is a user-defined value (parameter SS1.14 SS1-t delay for STO).

Zero speed limit: Speed limit for activating the drive STO function. This is a user-defined value (parameter FSOGEN.51 Zero speed without encoder).

Safety function response time.

Time to zero speed: When time D has elapsed from the start of the counter (step 3b, activation of the STO function), the user can push the reset button, that is, the acknowledgement of the STO function is possible. The user must set this time longer than the time the motor coasts from the maximum speed to zero speed (parameter STO.14 Time to zero speed with STO and modoff).

1. The user pushes the emergency stop button (this activates the SS1 function of the FSO module). The FSO module starts a timer for delay A.
2. The drive starts to decelerate the motor along the user-defined stop ramp (SAR1 parameter 200.112 SAR1 ramp time to zero).
3. b) The FSO module activates the FSO and drive STO functions (case B) and starts a counter for time D. The motor coasts to a stop.
4. b) The user releases the emergency stop button.
5. b) Time D has elapsed. The motor has stopped and the emergency stop indication lamp goes on. The user can push the reset button, that is, the acknowledgement of the STO function is possible.
6. b) The user pushes the reset button (this resets the emergency stop circuit and acknowledges the STO function).
7. b) The FSO module deactivates the STO function in the drive. The emergency stop indication lamp goes off. The user must reset the drive before it is ready for a restart (this is because the FSO module generates a fault to the drive after a limit hit [parameter FSOGEN.62 STO indication safety limit]).
Emergency stop, stop category 1 with ramp monitoring

This time scheme diagram illustrates the operation of the Emergency stop, stop category 1 safety function with ramp monitoring. This option uses the Safe stop 1 (SS1) function of the FSO module.

Case A: The motor speed reaches the zero speed limit within the user-defined stop ramp monitoring window

1. The user pushes the emergency stop button (this activates the SS1 function of the FSO module).
2. The drive starts to decelerate the motor along the user-defined stop ramp. The FSO module starts the ramp monitoring (SAR1 parameters 200.112, SARx.21, SARx.22 and SARx.02).
3. a) The motor speed reaches the zero speed limit. The FSO module activates the drive STO function and stops the ramp monitoring. The emergency stop indication lamp goes on.
   
   Note: You can set an additional delay for the STO activation (parameter SS1.15 SS1-ramp zero speed delay for STO).
4. a) The user releases the emergency stop button.
5. a) The user pushes the reset button (this resets the emergency stop circuit and acknowledges the STO function).
6. a) The FSO module deactivates the STO function in the drive. The emergency stop indication lamp goes off. The drive is ready for a restart.
22 Option description

Case B: The motor speed does not follow the user-defined stop ramp monitoring window

![Diagram of motor speed and time scheme]

A) Safety function response time.

B) Zero speed limit: Speed limit for activating the drive STO function. This is a user-defined value (parameter FSOGEN.51 Zero speed without encoder).

C) Time to zero speed: When time C has elapsed from the start of the counter (step 3b, activation of the STO function), the user can push the reset button, that is, the acknowledgement of the STO function is possible. The user must set this time longer than the time the motor coasts from the maximum speed to zero speed (parameter STO.14 Time to zero speed with STO and modoff).

1. The user pushes the emergency stop button (this activates the SS1 function of the FSO module).
2. The drive starts to decelerate the motor along the user-defined stop ramp. The FSO module starts the ramp monitoring (SAR1 parameters 200.112, SARx.21, SARx.22 and SARx.02).
3. b) The FSO module activates the FSO and drive STO functions and stops the ramp monitoring. The FSO module starts a counter for (C). The motor coasts to a stop.
4. b) The user releases the emergency stop button.
5. b) Time C has elapsed. The motor has stopped. The emergency stop indication lamp goes on. The user can push the reset button (that is, acknowledgement of the STO function is possible).
6. b) The user pushes the reset button (this resets the emergency stop circuit and acknowledges the STO function).
7. b) The FSO module deactivates the STO function in the drive. The emergency stop indication lamp goes off. The user must reset the drive before it is ready for a restart (this is because the FSO module generates a fault to the drive after a limit hit [parameter FSOGEN.62 STO indication safety limit]).
**Time schemes with a safety encoder**

**Emergency stop, stop category 0**

This time scheme diagram illustrates the operation of the Emergency stop, stop category 0 safety function when a safety encoder is used. This option uses the Safe torque off (STO) function of the FSO-21 module.

---

**A** Zero speed with encoder: Speed limit at which the motor has stopped, the safety function is completed and the emergency stop indication lamp goes on (parameter FSOGEN.52 Zero speed with encoder).

**B** Restart delay: Delay from pushing the emergency stop button (and activation of the STO function) to the moment that the user can push the reset button at the earliest (and acknowledge the STO function). With this parameter, it is possible to allow a restart of the drive while the motor is still running (fly-start) (parameter STO.13 Restart delay after STO).

1. The user pushes the emergency stop button. The FSO module activates the FSO and drive STO functions. The FSO module starts a timer for delay B.
2. The user releases the emergency stop button.
3. Time B has elapsed. The user can push the reset button, that is, the acknowledgement of the STO function is possible even though the motor is still running. (In this example, the user pushes the reset button in step 5.)
4. The motor speed goes below the zero speed limit (A). The motor has stopped and the emergency stop indication lamp goes on.
5. The user pushes the reset button (this resets the emergency stop circuit and acknowledges the STO function).
6. The FSO module deactivates the STO function in the drive. The emergency stop indication lamp goes off. The drive is ready for a restart.
Emergency stop, stop category 1 with time monitoring

This time scheme diagram illustrates the operation of the Emergency stop, stop category 1 safety function with time monitoring when a safety encoder is used. This option uses the Safe stop 1 (SS1) function of the FSO-21 module.

Case A: The motor speed reaches the zero speed limit within the user-defined time

<table>
<thead>
<tr>
<th>Time</th>
<th>Motor speed</th>
<th>E-stop button (SS1 request)</th>
<th>Drive STO status</th>
<th>Reset button</th>
<th>Indication lamp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>SS1.14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7a</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A  Security delay: When time A has elapsed from the start of the timer (step 1), the FSO module activates FSO and drive STO functions (case B). In case A, the FSO module has already activated the STO function. This is a user-defined value (parameter SS1.14 SS1-t delay for STO).

B  Zero speed limit: Speed limit for activating the drive STO function. This is a user-defined value (parameter FSOGEN.52 Zero speed with encoder).

C  Safety function response time.

1. The user pushes the emergency stop button (this activates the SS1 function of the FSO module). The FSO module starts a timer for delay A.
2. The drive starts to decelerate the motor along the user-defined stop ramp (SAR1 parameter 200.112 SAR1 ramp time to zero).
3. a) The motor speed goes below the zero speed limit (B). The FSO module activates the drive STO function. The emergency stop indication lamp goes on.
   
   Note: You can set an additional delay for the STO activation (parameter SS1.15 SS1-ramp zero speed delay for STO).

4. a) Time A has elapsed. The STO function is already active. In this case, this time has no effect.
5. a) The user releases the emergency stop button.
6. a) The user pushes the reset button (this resets the emergency stop circuit and acknowledges the STO function).
7. a) The FSO module deactivates the STO function in the drive. The emergency stop indication lamp goes off. The drive is ready for a restart.

Case B: The motor speed does not reach the zero speed limit within the user-defined time

Time A has elapsed from the emergency stop command (step 1) but the motor speed still exceeds the zero speed limit.

<table>
<thead>
<tr>
<th>Motor speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>A SS1.14</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
</tbody>
</table>

Security delay: When time A has elapsed from the start of the timer (step 1), the FSO module activates FSO and drive STO functions (case B). In case A, the FSO module has already activated the STO function. This is a user-defined value (parameter SS1.14 SS1-tdelay for STO).

Zero speed limit: Speed limit for activating the drive STO function. This is a user-defined value (parameter FSOGEN.52 Zero speed with encoder).

Safety function response time.

1. The user pushes the emergency stop button (this activates the SS1 function of the FSO module). The FSO module starts a timer for delay A.
2. The drive starts to decelerate the motor along the user-defined stop ramp (SAR1 parameter 200.112 SAR1 ramp time to zero).
3. b) The FSO module activates the FSO and drive STO functions. The motor coasts to a stop.
4. b) The motor speed reaches the zero speed limit (B). The emergency stop indication lamp goes on. The motor has stopped. The user can push the reset button, that is, the acknowledgement of the STO function is possible.
5. b) The user releases the emergency stop button.
6. b) The user pushes the reset button (this resets the emergency stop circuit and acknowledges the STO function).
7. b) The FSO module deactivates the STO function in the drive. The emergency stop indication lamp goes off. The user must reset the drive before it is ready for a restart.
(this is because the FSO module generates a fault to the drive after a limit hit [parameter FSOGEN.62 STO indication safety limit]).

**Emergency stop, stop category 1 with ramp monitoring**

This time scheme diagram illustrates the operation of the Emergency stop, stop category 1 safety function with ramp monitoring when a safety encoder is used. This option uses the Safe stop 1 (SS1) function of the FSO-21 module.

**Case A:** The motor speed reaches the zero speed limit within the user-defined stop ramp monitoring window

1. The user pushes the emergency stop button (this activates the SS1 function of the FSO module).
2. The drive starts to decelerate the motor along the user-defined stop ramp. The FSO module starts the ramp monitoring (SAR1 parameters 200.112, SARx.21, SARx.22 and SARx.02).
3. a) The motor speed reaches the zero speed limit (B). The FSO module activates the drive STO function and stops the ramp monitoring. The emergency stop indication lamp goes on.
   
   **Note:** You can set an additional delay for the STO activation (parameter SS1.15 SS1-ramp zero speed delay for STO).

4. a) The user releases the emergency stop button.
5. a) The user pushes the reset button (this resets the emergency stop circuit and acknowledges the STO function).
6. a) The FSO module deactivates the STO function in the drive. The emergency stop indication lamp goes off. The drive is ready for a restart.

Case B: The motor speed does not follow the user-defined stop ramp monitoring window

1. The user pushes the emergency stop button (this activates the SS1 function of the FSO module).
2. The drive starts to decelerate the motor along the user-defined stop ramp. The FSO module starts the ramp monitoring (SAR1 parameters 200.112, SARx.21, SARx.22 and SARx.02).
3. b) The FSO module activates the FSO and drive STO functions and stops the ramp monitoring. The motor coasts to a stop.
4. b) The user releases the emergency stop button.
5. b) The motor speed reaches the zero speed limit (B). The emergency stop indication lamp goes on. The motor has stopped. The user can push the reset button, that is, the acknowledgement of the STO function is possible.
6. b) The user pushes the reset button (this resets the emergency stop circuit and acknowledges the STO function).
7. b) The FSO module deactivates the STO function in the drive. The emergency stop indication lamp goes off. The user must reset the drive before it is ready for a restart (this is because the FSO module generates a fault to the drive after a limit hit [parameter FSOGEN.62 STO indication safety limit]).

Operation principle diagrams

This diagram is an example circuit diagram without the safety encoder interface.
This figure shows a simplified operation principle. For a more detailed description, see the circuit diagrams delivered with the drive.

---

The dashed line in the figure indicates a user-defined installation.

1) To parallel inverter modules (if any)

2) Drive module

A41 Inverter control unit

A68 Safety functions module FSO-12/-21

S61 Emergency stop button

S62 Emergency stop reset button with indicator light

X111 STO connections to inverter control unit

X113, X114 Terminal block in the FSO module

T11.x Inverter module(s) under inverter unit T11 (only for R8i)

TP Test pulse(s) for digital input

Initial status: The drive is in operation and the motor is running.

1. The user activates the emergency stop function by pushing the emergency stop button [S61]. This activates the safety function in the FSO module.

2. The drive decelerates/coasts the motor to zero speed using the user-defined stop category (0 or 1). The STO circuit in the drive/inverter unit is opened.

3. The emergency stop reset button indicator light [S62] is lit.

4. Normal operation resumes after the user:
   • releases the emergency stop button [S61] to normal (up) position
   • resets emergency stop circuit by pushing the emergency stop reset button [S62]
   • switches the external start signal of drive off and on (only in external control mode)
• resets the drive if a fault is generated (see FSO parameter FSOGEN.61 STO indication ext request and drive parameter 31.22 STO indication run/stop in section Parameter settings).

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 emergency stop button wiring chain, or
- any internal failure within the FSO or FSE-31 modules, the safety encoder or the drive STO.

This section describes the fault reaction functions in the FSO and FSE-31 modules, the safety encoder and the drive STO.

### FSO module

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

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

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

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

### FSE-31 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-31 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).

The FSO module goes into Fail-safe mode. The STATUS/FAULT LED of the FSO module is red and the STATUS LED of the FSE-31 module is off until the fault has been repaired. Also the drive indicates some of the FSE-31 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

Internal faults of the safety encoder and the FSE-31 module will cause the FSO module to go into Fail-safe mode.
The STATUS/FAULT LED of the FSO module is red and the ENC STATUS LED of the FSE-31 module is off until the fault has been repaired. Also the drive indicates a 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 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.

**Parameter settings**

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

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

The parameter values given in this chapter are example values for the Emergency stop, stop category 0 and 1 safety function(s) presented in this manual. Actual parameter values of the delivery may vary. You must always check that the parameter settings match your application needs.

- **FSO module parameter settings**

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

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

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

  There are parameters that you must always set and parameters that are related to certain safety functions only. These tables list all the parameters that you must check and set for the option +Q979. The example values apply only to the option +Q979.

**General parameters**

These parameters are common to all safety functions.
<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSOGEN.11</td>
<td>Stop completed output</td>
<td>DO X114:7</td>
<td>Sets the digital output that indicates the completion of any stop function. Active when the FSO module has completed the STO, SSE or SS1 function. For the option +Q979, ABB has configured the emergency stop indication lamp to this digital output at the factory. Make sure that this value corresponds to the actual wiring. See the circuit diagrams of the delivery.</td>
</tr>
<tr>
<td>FSOGEN.21</td>
<td>Motor nominal speed</td>
<td>1500 rpm</td>
<td>Sets the nominal motor speed. Adjust the default value to meet the ratings of the motor in use.</td>
</tr>
<tr>
<td>FSOGEN.22</td>
<td>Motor nominal frequency</td>
<td>50 Hz</td>
<td>Sets the nominal motor frequency. Adjust the default value to meet the ratings of the motor in use.</td>
</tr>
</tbody>
</table>
| FSOGEN.41 | Power-up acknowledgement         | Automatic     | Sets the power-up acknowledgement method of the FSO module.  
  Automatic: You do not need to push a reset button after switching on the FSO module. The FSO module generates the acknowledgement signal automatically after the power-up.  
  Manual: The FSO module reads the external acknowledgement signal through the digital input defined by parameter FSOGEN.42. Make sure that the value is Automatic. |
| FSOGEN.42 | Acknowledgement button input     | DI X114:2     | Sets the digital input for the acknowledgement signal when parameter FSOGEN.41 Power-up acknowledgement or STO.02 STO acknowledgement has value Manual.  
  For the option +Q979, ABB has configured the emergency stop reset button to this digital input at the factory. Make sure that this value corresponds to the actual wiring. See the circuit diagrams of the delivery. |
| FSOGEN.51 | Zero speed without encoder       | 90 rpm        | Sets the general zero speed limit for safety functions when no safety encoder is in use.  
  Emergency stop, stop category 0: This value has no effect in the operation.  
  Emergency stop, stop category 1: The FSO module activates the drive STO function when the drive has decelerated the motor speed below this value. Adjust the default value when necessary. |
<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSOGEN.52</td>
<td>Zero speed with encoder</td>
<td>10 rpm</td>
<td>Sets the general zero speed limit for safety functions when a safety encoder is in use. <strong>Emergency stop, stop category 0</strong>: The indication lamp goes on when the motor speed goes below this value. Adjust the default value when necessary. <strong>Emergency stop, stop category 1</strong>: The FSO module activates drive STO function when the drive has decelerated the motor speed below this value. Adjust the default value when necessary. <strong>Note</strong>: This parameter is used only with FSO-21 and when a safety encoder is used in the application.</td>
</tr>
<tr>
<td>FSOGEN.61</td>
<td>STO indication ext request</td>
<td>Warning</td>
<td>Sets the type of the indication that the FSO module generates and sends to the drive after external requests that end to a successful activation of the drive STO function (STO, SSE or SS1). In the safety functions described in this manual, you can use this indication as the Emergency stop indication message. Adjust the default value when necessary.</td>
</tr>
<tr>
<td>FSOGEN.62</td>
<td>STO indication safety limit</td>
<td>Fault</td>
<td>Sets the type of the indication that the FSO module generates and sends to the drive/inverter unit for limit hits during ramp and time monitoring of safety ramps SAR0 and SAR1. <strong>Emergency stop, stop category 0</strong>: This value has no effect in the operation. <strong>Emergency stop, stop category 1</strong>: When the motor speed does not follow the stop ramp or the time limit is exceeded, the FSO module activates the STO function and generates this user-defined indication. Check the default setting and adjust if necessary. If you select Fault, you must reset the drive before you can restart it.</td>
</tr>
</tbody>
</table>

**Parameters for the STO function**

These parameters are related to the STO function of the FSO module. The Emergency stop, stop category 0 option uses this function. The FSO module can activate the STO function in internal fault situations.
<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
</table>
| STO.02 | STO acknowledgement   | Manual                      | Sets the acknowledgement method used in the STO, SSE and SS1 functions.  

*Manual*: The FSO module reads the external acknowledgment signal through the digital input defined by parameter FSOGEN.42.  

In the safety functions described in this manual, the user acknowledges the safety function manually with the emergency stop reset button. Make sure that the value is *Manual*.  

⚠️ **WARNING!** If the value is *Automatic*, the FSO module resets the STO function automatically after the user has released the emergency stop button and the drive can restart automatically (if automatic start mode is used). This can cause danger. |
| STO.11 | STO input A           | Stop cat. 0: DI X113:1 & X114:1  
Stop cat. 1: None | Sets the digital input that is connected to the primary input of the STO function.  

**Emergency stop, stop category 0**: For the option +Q979, ABB has connected the emergency stop button to this digital input at the factory. Make sure that the setting corresponds to the circuit diagrams of the delivery.  

**Emergency stop, stop category 1**: Make sure that this parameter has value None. (An external signal cannot start the STO function.)  

**Note**: The default value after factory reset is *DI X113:1 & X114:1*. Always check this parameter after factory reset. |
| STO.13 | Restart delay after STO | 2000 ms                    | Sets the time after which the restart of the drive is allowed after the FSO module has activated the drive STO function. With this parameter, you can allow a restart of the drive before the motor has stopped (fly-start). This parameter is valid only if the STO function is requested from STO input A (STO.11).  

**Emergency stop, stop category 0**: Adjust the value when necessary. If you do not want to use the fly-start feature, set this parameter to the same value as parameter STO.14.  

**Emergency stop, stop category 1**: This value has no effect. |
<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>STO.14</td>
<td>Time to zero speed with STO and modoff</td>
<td>2000 ms</td>
<td>Sets the time after which the acknowledgement (and restart of the drive) is allowed after coast stop in the STO, SS1 and SSE 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. Emergency stop, stop category 0: This parameter sets the time after which the STO function is completed. Parameter STO.13 defines the time after which the restart of the drive is allowed. Adjust the value when necessary. Emergency stop, stop category 1: This parameter is used only when the motor speed does not follow the ramp settings or the time monitoring limit is exceeded and the FSO module activates the STO function. Adjust the value when necessary. 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-31 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.</td>
</tr>
</tbody>
</table>

**SBC usage**

| SBC.11 | STO SBC usage   | None         | Sets how the mechanical brake is used together with the STO function. None: This feature is not in use. In this manual, we assume that you do not use a brake. If you do, you must take care of its on/off control by the FSO module and change this and other settings. See the FSO 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 safety functions described in this manual do not use this function, but the FSO module can activate the SSE function in internal fault situations.
Set 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 has reached the zero speed limit (parameter FSOGEN.51 or FSOGEN.52), it activates the STO function. SAR0 parameters define the deceleration ramp (for more information, see the FSO module user's manual).

For the +Q979 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.

**SBC usage**

**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 has reached the zero speed limit (parameter FSOGEN.51 or FSOGEN.52), it activates the STO function. SAR0 parameters define the deceleration ramp (for more information, see the FSO module user's manual).

For the +Q979 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.

**I/O parameters**

For indication lamps, set the logic state of the corresponding digital output to *Active high*. For digital inputs, set the diagnostic pulse setting to *On*.

**Index** | **Name** | **Example value** | **Description**
---|---|---|---
SAFEIO.33 | DI X113:1 diag pulse on/off | On$^1$ | Sets the diagnostic pulse of digital input X113:1 on or off. *On*: The input monitors that it receives test pulses.
For the option +Q979, ABB has configured the emergency stop button to this digital input at the factory. Make sure that this value corresponds to the actual wiring. See the circuit diagrams of the delivery.

SAFEIO.37 | DI X114:1 diag pulse on/off | On$^1$ | Sets the diagnostic pulse of digital input X114:1 on or off. *On*: The input monitors that it receives test pulses.
For the option +Q979, ABB has configured the emergency stop button to this digital input at the factory. Make sure that this value corresponds to the actual wiring. See the circuit diagrams of the delivery.
The safety data given in this manual is based on the assumption that this diagnostic measure for the Emergency stop button wiring is active (On). If pulsing is disabled, other measures should be considered to ensure sufficient diagnostic coverage of the Emergency stop button wiring.

Parameters for Emergency stop, stop category 0

The Emergency stop, stop category 0 safety function uses the STO function of the FSO module, see section Parameters for the STO function above. There are no additional parameters related to this function.

Parameters for Emergency stop, stop category 1

The Emergency stop, stop category 1 safety function uses the SS1 function of the FSO module. Set these parameters only for this function.
<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS1.13</td>
<td>SS1 type</td>
<td>SS1-r or SS1-t</td>
<td>Sets the method used for the SS1 monitoring. Adjust the default value when necessary.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Time monitoring (SS1-t):</strong> The FSO module monitors that a user-defined deceleration time limit is not exceeded. (See parameter SS1.14.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Ramp monitoring (SS1-r):</strong> The FSO module monitors that the motor decelerates along a user-defined stop ramp. (See SAR1 ramp parameters 200.112, SARx.21, SARx.22 and SARx.02.)</td>
</tr>
<tr>
<td>SS1.14</td>
<td>SS1-t delay for STO</td>
<td>20000 ms</td>
<td>Sets the SS1-t monitoring time after which the FSO module activates the drive STO at the latest, if the motor speed has not reached the zero speed limit (parameter FSOGEN.51 or FSOGEN.52) yet. For more information, see the Operation time scheme.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Time monitoring:</strong> This value sets the security delay that the FSO module monitors. Adjust the default value when necessary.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Ramp monitoring:</strong> This value has no effect in the operation.</td>
</tr>
<tr>
<td>SS1.15</td>
<td>SS1-r ramp zero speed delay for STO</td>
<td>0 ms</td>
<td>Sets an extra delay time for the activation of the drive STO at the zero speed limit in the SS1 function.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>With this parameter, the FSO module delays the STO activation so that the drive is able to reach the axle zero speed before the FSO module activates the STO function.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The delay counter starts when the motor speed reaches the zero speed limit (parameter FSOGEN.51 or FSOGEN.52). After this delay has elapsed, the FSO module activates the drive STO function. You can use this parameter when the motor rotates a high inertia load.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Note:</strong> The FSO module activates the drive STO immediately if the drive stops modulating before the delay has passed (that is, the motor actual speed reaches 0 rpm). Adjust the default value when necessary.</td>
</tr>
</tbody>
</table>

**SAR1 ramp settings**
### Option description

<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>200.112</td>
<td>SAR1 ramp time to zero</td>
<td>2000 ms</td>
<td>Sets the target time for the stop ramp SAR1 that is used in the SS1 function. Adjust the default value when necessary. Target time = The time in which the drive decelerates the motor from speed 200.202 SAR speed scaling to zero. <strong>Note:</strong> With value 0 ms, the drive uses the emergency stop ramp set by drive parameter 23.23 (see section SS1 ramp parameters below). Also in this case, the FSO module only monitors the actual ramp (ramp monitoring or time monitoring).</td>
</tr>
<tr>
<td>200.202</td>
<td>SAR speed scaling</td>
<td>1500 rpm</td>
<td>Sets a speed value that the FSO module uses as a reference point in ramp parameter calculations (see SAR1 ramp parameters 200.112, SARx.21, SARx.22 and SARx.02). Adjust the default value when necessary.</td>
</tr>
<tr>
<td>SARx.02</td>
<td>SAR initial allowed range</td>
<td>100 ms</td>
<td>Sets the initial allowed range for the SAR0/SAR1 ramp. This parameter delays the start of the ramp monitoring. The slope of the ramp stays the same as defined with parameters 200.202 and SARx.22. For more information, see the FSO module user’s manual. <strong>Time monitoring:</strong> This value has no effect in the operation. <strong>Ramp monitoring:</strong> Adjust the default value according to application needs.</td>
</tr>
<tr>
<td>SARx.21</td>
<td>SAR1 min ramp time to zero</td>
<td>1000 ms</td>
<td>Sets the minimum ramp time for the SAR1 ramp monitoring. <strong>Time monitoring:</strong> This value has no effect in the operation. <strong>Ramp monitoring:</strong> Sets the minimum stop ramp time for the emergency stop. Adjust the default value according to application needs. <strong>Note:</strong> With value 0 ms, the minimum ramp is not monitored.</td>
</tr>
<tr>
<td>SARx.22</td>
<td>SAR1 max ramp time to zero</td>
<td>3000 ms</td>
<td>Sets the maximum ramp time for the SAR1 ramp monitoring. <strong>Time monitoring:</strong> This value has no effect in the operation. <strong>Ramp monitoring:</strong> Sets the maximum stop ramp time for the emergency stop. Adjust the default value according to application needs.</td>
</tr>
</tbody>
</table>

**SBC usage**
Changing the stop category from 0 to 1

Stop category 0 is the default setting. This category uses the STO function of the FSO module. Stop category 1 uses the SS1 function of the FSO module.

To change the stop category to 1, set the parameters listed in section Parameters for the Emergency stop, stop category 1, and those in this table. See also section SS1 ramp parameters.

<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Preset value (stop cat. 0)</th>
<th>Value in stop cat. 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>STO.11</td>
<td>STO input A</td>
<td>DI X113:1 &amp; X114:1</td>
<td>None</td>
</tr>
<tr>
<td>FSOGEN.51</td>
<td>Zero speed without encoder</td>
<td>90 rpm</td>
<td>If you do not use a safety encoder, adjust the default value to meet the motor in use.</td>
</tr>
<tr>
<td>FSOGEN.52</td>
<td>Zero speed with encoder</td>
<td>10 rpm</td>
<td>If you use a safety encoder, adjust the default value to meet the motor in use.</td>
</tr>
<tr>
<td>FSOGEN.62</td>
<td>STO indication safety limit</td>
<td>Fault</td>
<td>Adjust the default value when necessary.</td>
</tr>
</tbody>
</table>

**FSE-31 module and safety pulse encoder related parameters**

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

<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>200.231</td>
<td>FSE 3X act and par version</td>
<td>Version 1</td>
<td>Activates the FSE-31 encoder interface and shows the version of the encoder parameter groups (91 and 92).</td>
</tr>
<tr>
<td>200.232</td>
<td>Number of encoders</td>
<td>Single encoder CH1</td>
<td>Shows the number of safety pulse encoders connected to the FSE-31 module.</td>
</tr>
<tr>
<td>S_ENCGEN.01</td>
<td>Safe pulse encoder version</td>
<td>Version 1</td>
<td>Activates the safety pulse encoder and shows the version parameter group S_ENCGEN.</td>
</tr>
<tr>
<td>S_ENCGEN.11</td>
<td>FSE diagnostic failure reaction</td>
<td>STO</td>
<td>Sets the action taken when there is a problem with the FSE-31 module. STO: The FSO module goes into Fail-safe mode and activates the drive STO function.</td>
</tr>
</tbody>
</table>

**Note:** This parameter is relevant only when there are no active safety functions.
<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S_ENCGEN.14</td>
<td>Enc speed cross comp tolerance</td>
<td>1 rpm</td>
<td>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.</td>
</tr>
<tr>
<td>S_ENCGEN.41</td>
<td>Gear numerator encoder 1</td>
<td>1</td>
<td>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.</td>
</tr>
<tr>
<td>91.11</td>
<td>Module 1 type</td>
<td>FSE-31</td>
<td>Sets the type of the safety pulse encoder interface module 1.</td>
</tr>
<tr>
<td>91.12</td>
<td>Module 1 location</td>
<td>2</td>
<td>Sets the slot in which the safety pulse encoder interface module 1 is located.</td>
</tr>
<tr>
<td>92.01</td>
<td>Encoder 1 type</td>
<td>HTL1</td>
<td>Activates or deactivates the communication with the safety pulse encoder interface module 1 and sets the type for the safety pulse encoder.</td>
</tr>
<tr>
<td>92.02</td>
<td>Encoder 1 source</td>
<td>Module 1</td>
<td>Sets the safety pulse encoder interface module that the safety pulse encoder 1 is connected to.</td>
</tr>
<tr>
<td>92.10</td>
<td>Pulses/revolution</td>
<td>2048</td>
<td>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.</td>
</tr>
</tbody>
</table>
| 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: \( r_{\text{max}} \times \text{ppr}_{\text{enc}} + 10\% \), where  
  \( r_{\text{max}} \) = the maximum motor speed used in the application (or the motor nominal speed)  
  \( \text{ppr}_{\text{enc}} \) = Pulses/revolution of the safety pulse encoder (parameter 92.10). |

### Drive parameter settings

The parameter setting in ACS880 primary control program:

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Default value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.22</td>
<td>STO indication run/stop</td>
<td>Warning/Warning</td>
<td>Selects which indications are given when one or both Safe torque off (STO) signals are switched off or lost. ( \text{Warning/Warning} ) is the recommended setting.</td>
</tr>
</tbody>
</table>

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

The drive parameter settings in ACS880 primary control program when you use a 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.

SS1 ramp parameters

You must set these parameters only for the Emergency stop, stop category 1 option. If FSO parameter 200.112 SAR1 ramp time to zero is set to 0, drive parameters define the stop ramp that is used in the SS1 function (stop category 1):

- 21.04 Emergency stop mode is set to value Eme ramp stop (Off3)
- 23.23 Emergency stop time is set to a suitable value.

Also in this case, the FSO module monitors the actual stop ramp (ramp monitoring or time monitoring).

For more information, see the firmware manual.
Electrical installation

Contents of this chapter

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

Wiring

One emergency stop button and one reset button are installed on the cabinet door and wired to the FSO module at the factory. There are double contacts in the emergency stop button and double wiring (redundant two-channel connection) between the button and the FSO module.

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

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

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

If needed, install additional emergency stop buttons on site. See the tables above and the circuit diagrams delivered with the drive. Obey these general rules:

1. Use only double-contact buttons approved for the emergency stop circuits.
2. Connect the emergency stop buttons 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 fault reaction function as it detects a redundancy fault.

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

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

4. The maximum allowed cable length between the drive and the emergency stop button is 250 m (820 ft).

5. Obey the general control cable installation instructions given in the drive hardware manual and in the FSO module user’s manual.

If necessary, install additional reset buttons and indication lamps for the emergency stop circuit on site. We recommend gold-plated NC contacts in the reset button. The maximum allowed cable length between the drive and the reset button (for the whole loop) is 250 m (820 ft). See the circuit diagrams of the delivery. Obey the general control cable installation instructions given in the hardware manual and in the FSO module user's manual.

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-31 module on site. Obey the instructions of the encoder manufacturer as well as the following rules:

• Use a double-shielded, twisted pair cable.
• The maximum allowed cable length between the safety pulse encoder and the FSE-31 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

Contents of this chapter

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

Activating the safety function

1. Push the emergency stop button [S61]. The emergency stop is activated and the button locks in the “ON” (open) position.

   Depending on the stop category, either AAA1 FSO STO request (stop category 0) or AAA3 FSO SS1 request (stop category 1) is shown.

   When the emergency stop function has been completed, the following indications are shown:
   - the emergency stop reset button indicator light [S62] on cabinet door is lit, indicating that it is now possible to reset the Emergency stop function.
   - AA90 FSO stop completed is indicated.

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

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

Note: The indication lamp goes on also when the FSO module has activated the drive STO function after fault situations. In addition, the indication lamp goes on and off when the drive is started.

Resetting the safety function

1. Make sure that the external start signal of the drive is switched off (it may still be on if no pulse start is in use).
2. Turn the emergency stop button [S61] until it releases.
3. Push the emergency stop reset button [S62] on the cabinet door. The emergency stop reset button indicator light [S62] goes out, the emergency stop is deactivated.
4. Reset the drive if necessary.
5. Make sure that the drive has received the start signal (depends on the configuration, see the firmware manual).
6. You can now restart the drive.

**Note:** If you switch off the power after you have released the emergency stop button [S61] (step 2), the drive resets the safety function automatically. In this case, you do not have to push the reset button [S62].
Start-up and acceptance test

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

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

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

- Validation procedure
You must do the acceptance test using the checklist given in section Start-up and acceptance test:
  • at initial start-up of the safety function
  • after any changes related to the safety function (wiring, components, safety-function-related parameter settings, etc.)
  • after any maintenance work related to the safety function.
The acceptance test must include at least the following steps:
  • you must have an acceptance test plan
  • you must test all commissioned functions for proper operation, from each operation location
  • you must document all acceptance tests
you must sign and store the acceptance test report for further reference.

## Acceptance test reports

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

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

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

### Start-up and acceptance test

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

<table>
<thead>
<tr>
<th>Action</th>
<th>Initial status</th>
<th>Safety encoder interface:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make sure that the drive is ready for use, that is, you have done the tasks of the drive start-up procedure. See the hardware manual.</td>
<td>✔️</td>
<td></td>
</tr>
</tbody>
</table>

**WARNING!**

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

**Checks and settings with no voltage connected**

Stop the drive and do the steps in section *Electrical safety precautions (page 8)* before you start the work.

If you have done any connections for the emergency stop circuit on site (such as wiring of additional emergency stop buttons, connection of shipping splits of large drives, etc.), check the connections against the appropriate circuit diagrams.

Inverter units with parallel R8i inverter modules:

Check that the XSTO.OUT output on the inverter control unit [A41] is chained to the STO inputs of all inverter modules.

**Settings with voltage connected**

Close the cabinet doors and power up the drive. See the hardware manual.

Check the parameters that are relevant to the safety function. If necessary, set the parameters as defined in section Parameter settings.

Create a backup file of the drive (button *Backup/restore* in the Drive composer pro PC tool).
Action

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

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

Acceptance test

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

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

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

Start the drive and make sure that the motor is running. If possible, use a motor speed close to the maximum speed of the application.

Push the emergency stop button [S61].

Stop category 0: Make sure that the drive stops the motor by coasting and the appropriate warnings and indications are shown.

Stop category 1: Make sure that the drive stops the motor by decelerating and the appropriate warnings and indications are shown.

See section Activating the safety function and the FSO module user’s manual.

Make sure that the emergency stop reset button indicator light [S62] switches on.

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

Make sure that you cannot start the drive and motor from any control location: make sure that the motor does not start even if you switch the start signal off and on or push the start key of the panel.

Turn the emergency stop button [S61] until it releases and returns to the up position.

Push the emergency stop reset button [S62].

- Make sure that the emergency stop reset button indicator light [S62] switches off.
- Make sure that the drive does not restart automatically at this point.

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

Power up the drive (see the hardware manual).

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

Repeat the test from each operating location (for every emergency stop button and reset button).

Fill in and sign the acceptance test report which verifies that the safety function is safe and accepted for operation.
Contents of this chapter

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

Safety circuit maintenance

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

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

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

• Use only ABB-approved spare parts.
• Register the change to the change log for the safety circuit.
• Test the safety function again after the change. Do the start-up and acceptance test of the safety function.
• Document the tests and store the report into the logbook of the machine.

Proof test interval

After the operation of the safety function is validated at start-up, the operation of the safety function must be ensured by periodic proof testing. In high demand mode of operation, the maximum proof test interval is 20 years. In low demand mode of operation, the maximum proof test interval is 2 or 5 years (high or low demand as defined in IEC 61508, EN/IEC 62061 and EN ISO 13849-1). Regardless of the mode of operation, it is a good practice to check the operation of the safety function at least once a year by doing the start-up and acceptance test of the safety function.
The person responsible for the design of the complete safety system should also note the Recommendation of Use CNB/M/11.050 published by the European co-ordination of Notified Bodies for Machinery concerning dual-channel safety-related systems with electromechanical outputs:

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

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

**Competence**

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

**Residual risk**

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

**Intentional misuse**

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

**Decommissioning**

When you decommission an emergency stop circuit or a drive, make sure that the safety of the machine is maintained until the decommissioning is complete.
Technical data

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

Safety data

- Safety data values

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

The safety data calculations are based on the assumption that the emergency stop is used once a month.

The safety pulse encoder is not included in the calculations since it is not included in the delivery. Only the FSE module is included in the calculations (if used).

ACS880-07/17/17LC/37/37LC drives without an FSE-31 module

<table>
<thead>
<tr>
<th>Stop category and monitoring method</th>
<th>SIL / SILCL</th>
<th>SC</th>
<th>PL</th>
<th>PFH1) [1/h]</th>
<th>PF-Davg (T1=2a)</th>
<th>PF-Davg (T1=5a)</th>
<th>DC2) [%]</th>
<th>Cat.</th>
<th>HFT</th>
<th>CCF</th>
<th>Mission time [a]</th>
<th>T1 3) 4) [a]</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

1) PFH: Probability of Failure on Demand
2) DC: Duty Cycle
3) T1: Time Interval
4) a: Additional parameters
## 54 Technical data

<table>
<thead>
<tr>
<th>Stop category and monitoring method</th>
<th>SIL / SILCL</th>
<th>SC</th>
<th>PL</th>
<th>PFH$^1$ [1/h]</th>
<th>PF-Davg $^{(T_1=2a)}$ [1/h]</th>
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Frame sizes 1-8 x R8i

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ACS880-07/17/17LC/37/37LC drives with an FSE-31 module

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</table>

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

### Safety component types

Safety component types as defined in IEC 61508-2:

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

### Safety block diagrams

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

![Safety block diagram](image)

### Relevant failure modes

Relevant failure modes are:

- the FSO module detects any open circuits, short circuits and redundancy failures of the emergency stop input signal wirings. Similarly, it detects redundancy failures of the emergency stop button when the request is on.
- internal failures of the emergency stop button, 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 inside the cabinet
- any short and open circuits in the cabinet terminal blocks of the safety circuits.

### Operation delays

Emergency stop total delay and fault reaction response time (includes the response time of the drive STO):

- Stop category 0: (less than) 500 ms
- Stop category 1: Emergency stop ramp time + possible STO delay settings + (less than) 500 ms.
Note: If you use a safety pulse encoder, you must add the delays of the encoder when defining the total response time for the safety function and the fault reaction function.

Ambient conditions

For the environmental limits for the safety functions and the drive, refer to the hardware manual of your drive, and to FSO and FSE-31 module user's manuals.

Related standards and directives

<table>
<thead>
<tr>
<th>Standard</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN ISO 13849-1:2015</td>
<td>Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design</td>
</tr>
<tr>
<td>IEC 61326-3-1:2017</td>
<td>Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - General industrial applications</td>
</tr>
<tr>
<td>IEC 61511-1:2016</td>
<td>Functional safety – Safety instrumented systems for the process industry sector – Part 1: Framework, definitions, system, hardware and application programming requirements</td>
</tr>
<tr>
<td>2006/42/EC</td>
<td>European Machinery Directive</td>
</tr>
<tr>
<td>Other</td>
<td>Machine-specific C-type standards</td>
</tr>
</tbody>
</table>

Compliance with the European Machinery Directive

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

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

Product training
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.

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