Options for ABB drives

User’s manual
Safely-limited speed with the encoder interface (option +Q965) for ACS880 multidrives
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<td>Functional safety design tool user’s manual</td>
<td>3AXD10000102417</td>
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<td>3UAA0000048753</td>
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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.
User’s manual

Safely-limited speed with the encoder interface (option +Q965) for ACS880 multidrives

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    - Acceptance test procedure
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    - Checks and settings with no voltage connected
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  - Safety performance with different safety pulse encoders
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Introduction to the manual

Contents of this chapter
This chapter contains information on the manual and some other general information for the reader. The chapter also contains a quick reference for implementing a safety system.

Applicability
The manual applies to ACS880 multidrives which have the option +Q965: Safely-limited speed with the encoder interface. For the option +Q965, ABB installs the FSO-21 safety functions modules (option +Q972) and the FSE-31 pulse encoder interface modules (option +L521) to the inverter units.

Required versions:
• 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
• 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!** Read and obey all safety instructions in *ACS880 multidrive cabinets and modules safety instructions* (3AUA0000102301 [English]). 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.

**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
### Abbreviations

Abbreviations used in this manual are listed below.

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<th>Abbreviation</th>
<th>Description</th>
<th>Reference</th>
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<tr>
<td>Cat.</td>
<td>Category. 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.</td>
<td>EN ISO 13849-1</td>
</tr>
<tr>
<td>DI</td>
<td>Digital input</td>
<td></td>
</tr>
<tr>
<td>DO</td>
<td>Digital output</td>
<td></td>
</tr>
<tr>
<td>GND</td>
<td>Ground</td>
<td></td>
</tr>
<tr>
<td>FSE-31</td>
<td>Pulse encoder interface module</td>
<td></td>
</tr>
<tr>
<td>FSO-21</td>
<td>Safety functions module which supports the SSM function and the use of safety encoders</td>
<td></td>
</tr>
<tr>
<td>HFT</td>
<td>Hardware fault tolerance</td>
<td>IEC 61508, EN/IEC 62061</td>
</tr>
<tr>
<td>IGBT</td>
<td>Insulated gate bipolar transistor</td>
<td></td>
</tr>
<tr>
<td>PL</td>
<td>Performance level (levels are: a, b, c, d and e). Corresponds to SIL.</td>
<td>EN ISO 13849-1</td>
</tr>
<tr>
<td>PLC</td>
<td>Programmable logic controller</td>
<td></td>
</tr>
<tr>
<td>POUS</td>
<td>Prevention of unexpected start-up</td>
<td>EN 1037</td>
</tr>
<tr>
<td>SAR</td>
<td>Safe acceleration range. In the FSO module, there are two sets of SAR parameters (SAR0 and SAR1) that are used to decelerate the motor(s) and to define the ramp monitoring limits. SAR1 parameters are used in the Safely-limited speed safety function described in this manual.</td>
<td>EN/IEC 61800-5-2</td>
</tr>
<tr>
<td>SBC</td>
<td>Safe brake control</td>
<td></td>
</tr>
<tr>
<td>SIL</td>
<td>Safety integrity level (levels are: 1, 2, 3 and 4)</td>
<td>IEC 61508, IEC 61511, EN/IEC 62061, EN/IEC 61800-5-2</td>
</tr>
<tr>
<td>SLS</td>
<td>Safely-limited speed</td>
<td>EN/IEC 61800-5-2</td>
</tr>
<tr>
<td>SMS</td>
<td>Safe maximum speed</td>
<td></td>
</tr>
<tr>
<td>SS1</td>
<td>Safe stop 1</td>
<td>EN/IEC 61800-5-2</td>
</tr>
<tr>
<td>SSE</td>
<td>Safe stop emergency</td>
<td></td>
</tr>
<tr>
<td>SSM</td>
<td>Safe speed monitor</td>
<td>EN/IEC 61800-5-2</td>
</tr>
<tr>
<td>STO</td>
<td>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.</td>
<td>EN/IEC 61800-5-2</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Task</th>
<th>Option description and instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select the appropriate functional safety standard for the implementation: EN ISO 13849-1, EN/IEC 62061, IEC 61511 or other.</td>
<td></td>
</tr>
<tr>
<td>If you select EN/IEC 62061 or IEC 61511, make a safety plan. See EN/IEC 62061 or IEC 61511.</td>
<td></td>
</tr>
<tr>
<td>Assess safety: analyze and evaluate risks (estimate SIL/PL) and define risk reduction strategies. Define the safety requirements.</td>
<td></td>
</tr>
<tr>
<td>Design the safety system. The part of the design made by ABB is described in section Option description and instructions on page 13.</td>
<td></td>
</tr>
<tr>
<td>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]).</td>
<td></td>
</tr>
<tr>
<td>Connect the wiring. See section Wiring on page 25.</td>
<td></td>
</tr>
<tr>
<td>Set the necessary parameters. See section Parameter settings on page 31.</td>
<td></td>
</tr>
</tbody>
</table>
| Validate that the implemented system meets the safety requirements:  
  • Do the acceptance test, see section Start-up and acceptance test on page 43. |                                     |
| Write the necessary documentation. |                                     |
Option description and instructions

Contents of this chapter
This chapter describes the operation of the option +Q965: Safely-limited speed with the encoder interface and instructs how to wire and use it.

Overview
The Safely-limited speed (SLS) function prevents the motor from exceeding the user-defined speed limits. The option +Q965 also includes the Safe maximum speed (SMS) and Safe speed monitor (SSM) functions. The SMS function is used to protect the machine from exceeding the dimensioned maximum speed of the machine/process. The SSM function provides a safe output signal to indicate whether the motor speed is between user-defined limits.

The option +Q965 requires that the FSO-21 safety functions modules (option +Q972) and the FSE-31 pulse encoder interface modules (option +L521) are installed in the inverter units. ABB installs the FSO and FSE modules to the inverter units and sets the delivery configuration for the cabinet safety option at the factory. The user tunes the operation of the SLS, SMS and SSM functions with the FSO module parameters at the start-up, for example, sets the appropriate speed limits.

The motors must be equipped with safety pulse encoders.

For more information on the safety functions of the FSO module, see 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 SLS and SSM functions comply with EN/IEC 61800-5-2. The SMS function is a special implementation of the SLS function. For a complete list of related standards and European directives, see section Related standards and directives on page 56.

Summary of wirings and settings

The wirings and settings of the SLS function are:

- The inverter units are equipped with the FSO-21 safety functions modules (option +Q972). ABB installs the modules at the factory.
- The inverter units are equipped with the FSE-31 pulse encoder interface modules (option +L521). ABB installs the modules at the factory.
- The motors must be equipped with safety pulse encoders. The user installs the safety pulse encoders and wires them to the FSE modules. The user must make sure that the required safety integrity (SIL/PL) can be achieved with the used safety encoders.
- The user wires the SLS activation signal (for example, a switch) to the FSO module.
- The user wires the SLS indication signal (for example, an indication lamp or a gate opening signal) to the FSO module.
- The digital input of the FSO module to which the SLS activation signal is connected, is selected as the input for the SLS request. This is an FSO module parameter that ABB sets at the factory by default and the user must check at the start-up.
- The digital output of the FSO module to which the SLS indication signal is connected, is selected as the output for the SLS output. This is an FSO module parameter that ABB sets at the factory by default and the user must check at the start-up.
- The speed limits (SLS and trip limits) must be set according to application needs. These are FSO module parameters that the user must set at the start-up.
- The SLS function is set to use either the time monitoring or ramp monitoring method to monitor the deceleration of the motors to the desired speed (before SLS monitoring is started). This is an FSO module parameter that the user must set at the start-up.
- The deceleration ramp that is used to decelerate the motors to the desired speed (before SLS monitoring is started) is set according to application needs. This is an FSO module or inverter unit parameter that the user must set at the start-up.
- The monitoring limits for the deceleration ramp (a time limit or ramp monitoring limits) are set according to application needs. These are FSO module parameters that the user must set at the start-up.

The wirings and settings of the SMS function are:

- The inverter units are equipped with the FSO-21 safety functions modules (option +Q972). ABB installs the modules at the factory.
- The inverter units are equipped with the FSE-31 pulse encoder interface modules (option +L521). ABB installs the modules at the factory.
- The motors must be equipped with safety pulse encoders. The user installs the safety pulse encoders and wires them to the FSE modules. The user must make sure that the required safety integrity (SIL/PL) can be achieved with the used safety encoders.
- There are two different versions of the SMS function. Version 1 monitors the motor speed and trips the drive if the user-defined trip limit is exceeded. Version 2 of the SMS function is similar to the SLS function except that it can only be configured to be continuously on or off. ABB activates the SMS function (Version 1) at the factory. This is an FSO module parameter that the user must set or check at the start-up.
- The SMS positive and negative speed limits are set. These are FSO module parameters that the user must set at the start-up.
The wirings and settings of the SSM function are:

- The inverter units are equipped with the FSO-21 safety functions modules (option +Q972). ABB installs the modules at the factory.
- The inverter units are equipped with the FSE-31 pulse encoder interface modules (option +L521). ABB installs the modules at the factory.
- The motors must be equipped with safety pulse encoders. The user installs the safety pulse encoders and wires them to the FSE modules. The user must make sure that the required safety integrity (SIL/PL) can be achieved with the used safety encoders.
- ABB activates the SSM function at the factory (Always on). This is done with FSO module parameters that the user must set or check at the start-up.
- The user wires the SSM indication signal (for example, an indication lamp) to the FSO module.
- The digital output of the FSO module to which the SSM indication signal is connected, is selected as the output for the SSM output. This is an FSO module parameter that ABB sets at the factory by default and the user must check at the start-up.
- The SSM positive and negative speed limits are set. These are FSO module parameters that the user must set at the start-up.

For a detailed description of wirings, see sections Wiring on page 25. For a detailed description of parameter settings, see chapter Parameter settings on page 31.
Operation principle

SLS function

The SLS function makes sure that the motor speed does not exceed the user-defined speed limits when the function is active. The user defines the SLS limits and SLS trip limits at the start-up. When the user activates the SLS function, the FSO module sends the SLS request to the inverter unit. The inverter unit takes the SLS parameters into use and controls the motor speed accordingly until the user deactivates the SLS request.

If the motor speed is above/below the user-defined SLS limit positive/negative when the SLS function is activated, the motor speed is first decelerated to the required speed. The SLS function monitors the deceleration to the required speed either with the time or ramp monitoring method.

When the SLS function is active, the inverter unit limits the motor speed reference so that it stays between the SLS limits.

Note: It is a good practice to define the motor speed reference so that it stays between the SLS limits in the operating situations when the SLS function is active.

If the motor speed reaches the user-defined SLS trip limit, the FSO module activates the Safe stop emergency (SSE) function of the FSO module. Depending on parameter settings, the SSE function activates the inverter unit Safe torque off (STO) function either immediately or after a deceleration ramp. The motor coasts to a stop or decelerates to zero speed.

There are four separate SLS functions in the FSO module with different parameter settings. The SLS1 function is used as an example and in the delivered default settings of the +Q965 option.

For more information, see chapter Parameter settings on page 31 and FSO-21 safety functions module user’s manual (3AXD50000015614 [English]).
SLS with speed below the monitored speed

This time scheme diagram illustrates the operation of the SLS function. The motor speed is below the monitored speed when the user activates the SLS function.

![Diagram of SLS function](image)

A Safety function response time  
B SLS1 limit positive (parameter 200.23)  
C SLS1 trip limit positive (parameter SLSx.14)  
D Zero speed with encoder (parameter FSOGEN.52): Speed limit at which the motor has stopped, the safety function is completed and acknowledgement of the SSE function is possible. Relevant only if 2b occurs.

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1    | The user or a PLC activates the SLS request of the FSO module, that is, switches the digital inputs of the FSO module from 1 to 0.  
*Note:* The safety function request to the FSO module must be active for at least 20 ms. |
| 2    | After the safety function response time (A), the FSO module starts to monitor the motor speed. The FSO module energizes the digital output that indicates the SLS status. |
| 2 - 3| The inverter unit limits the motor speed reference so that the motor speed stays below the SLS1 limit positive. The FSO module monitors the actual motor speed against the SLS1 limit positive. |
| 2b   | If the motor speed still goes above the SLS1 trip limit positive (C), the FSO module activates the SSE function and the motor coasts to a stop (in this case, the SSE function has been configured as “Immediate STO”, see section Parameters for the SSE function on page 34).  
*Note:* If the SBC function (brake) is in use, it is also activated according to the configuration (either before or after the drive STO is activated, or at a specified speed limit). In this case, make sure that you have dimensioned the brake correctly for these situations. For more information, see the FSO module user’s manual.  
*Note:* In this case, the FSO activates the SLS indication when the motor speed goes below the SLS1 limit positive (B). |
| 3    | The user or a PLC deactivates the SLS request of the FSO module, that is, switches the digital input of the FSO module from 0 to 1. The FSO module acknowledges the SLS1 function automatically. This is set to be automatic by an FSO parameter (SLSx.02), and no external acknowledgement input is in use. The FSO module stops SLS monitoring and de-energizes the SLS indication signal. |
| 3b   | The motor speed goes below the zero speed limit (D). If the FSO module activated the SSE function at 2b, the STO acknowledgement becomes allowed now. The user must reset the inverter unit if the STO indication parameter (FSOGEN.62 or 31.22) has been set so that a fault is generated. See chapter General parameters on page 32. |
SLS with time monitoring and speed above the monitored speed

This time scheme diagram illustrates the operation of the SLS function with time monitoring. The motor speed is above the monitored speed when the SLS function is activated.

**A** Safety function response time

**B** SLS time delay (parameter `SLSx.04`): When time B has elapsed from the start of the counter (step 1 below), the FSO module starts SLS monitoring (if not already started).

**C** SLS1 limit positive (parameter `200.23`)

**D** SLS1 trip limit positive (parameter `SLSx.14`)

### Step | Description
--- | ---
1 | The user or a PLC activates the SLS request of the FSO module, that is, switches the digital inputs of the FSO module from 1 to 0. The FSO module starts a counter for time (B).  
*Note:* The safety function request to the FSO module must be active for at least 20 ms.

2 - 3 | After the safety function response time (A), the inverter unit starts to ramp down the motor speed.  
The inverter unit decelerates the motor speed using the inverter unit ramp parameters (see [Ramp parameters](#) on page 41).  
The FSO module starts SLS monitoring and energizes the digital output that indicates the SLS status when the motor speed is in the middle of the SLS1 trip limit and the SLS1 limit.

3 | The actual motor speed reaches the SLS1 limit positive.

3 - 4 | The inverter unit limits the motor speed reference so that the motor speed stays below the SLS1 limit positive.  
The FSO module monitors the actual motor speed against the SLS1 limit positive.  
If the motor speed still goes above the SLS1 trip limit positive (D), the FSO module activates the SSE function (see section [SLS with speed below the monitored speed](#) on page 17).

3b | Time B has elapsed. The FSO module starts SLS monitoring (if not already started).  
*Note:* If the motor speed is above the SLS trip limit after time B has elapsed, the FSO module activates the SSE function. Depending on SSE function parameter settings, the motor either coasts to a stop (“Immediate STO”) or ramps down to zero speed (“Emergency ramp”). For more information, see section [Parameters for the SSE function](#) on page 34 and the FSO user’s manual.  
*Note:* If the SBC function (brake) is in use, it is also activated according to the configuration (either before or after the drive STO is activated, or at a specified speed limit). In this case, make sure that you have dimensioned the brake correctly for these situations. For more information, see the FSO module user’s manual.  
*Note:* In this case, the FSO activates the SLS indication when the motor speed goes below the SLS limit positive (C).
Option description and instructions

SLS with ramp monitoring and speed above the monitored speed

This time scheme diagram illustrates the operation of the SLS function with ramp monitoring. The motor speed is above the monitored speed when the SLS function is activated.

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>The user or a PLC deactivates the SLS request of the FSO module, that is, switches the digital input of the FSO module from 0 to 1. The FSO module acknowledges the SLS function automatically. This is set to be automatic by an FSO parameter (SLSx.02), and no external acknowledgement input is in use. The FSO module stops SLS monitoring and de-energizes the digital output that indicates the SLS status. The inverter unit returns to normal operation and starts to follow its ordinary speed reference. The inverter unit accelerates the motor to the desired speed along its acceleration ramp (inverter unit parameter).</td>
</tr>
<tr>
<td>5</td>
<td>Normal operation.</td>
</tr>
</tbody>
</table>

SLS request

Motor speed

A Safety function response time
B SLS1 limit positive (parameter 200.23)
C SLS1 trip limit positive (parameter SLSx.14)
D Zero speed with encoder (parameter FSOGEN.52): Speed limit at which the motor has stopped, the safety function is completed and acknowledgement of the SSE function is possible. Relevant only if 2b occurs.

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The user or a PLC activates the SLS request of the FSO module, that is, switches the digital inputs of the FSO module from 1 to 0. <strong>Note:</strong> The safety function request to the FSO module must be active for at least 20 ms.</td>
</tr>
<tr>
<td>2 - 3</td>
<td>After the safety function response time (A), the inverter unit starts to ramp down the motor speed. The ramp is defined and monitored using the SAR1 parameters of the FSO module (see SAR1 parameters 200.112 - SARx.22 and SARx.02 on page 37). The FSO module monitors the actual deceleration rate of the motor against the ramp monitoring settings. The FSO module starts SLS monitoring and energizes the digital output that indicates the SLS status when the motor speed is in the middle of the SLS1 trip limit and the SLS1 limit.</td>
</tr>
</tbody>
</table>
For more information, see FSO-21 safety functions module user’s manual (3AXD50000015614 [English]).
### SMS function

The FSO module includes two versions of the SMS function. This manual describes version 1. Version 2 of the SMS function is similar to the SLS function except that it can only be configured to be continuously on or off.

The user activates the desired version of the SMS function and sets the SMS maximum and minimum speed limits at the start-up. For more information, see chapter Parameter settings on page 31 and FSO-21 safety functions module user’s manual (3AXD50000015614 [English]).

If the motor speed reaches the SMS trip limit positive or negative, the FSO module activates the Safe stop emergency (SSE) function. Depending on parameter settings, the FSO module activates the inverter unit STO function either immediately or after a deceleration ramp. The motor coasts to a stop or decelerates to zero speed.

This time scheme diagram illustrates the operation of the SMS function (version 1).

![Time scheme diagram](image)

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The motor speed reaches the SMS trip limit positive.</td>
</tr>
</tbody>
</table>
| 2    | After the safety function response time (A), the FSO module activates the SSE function which in turn activates the inverter unit STO function. The motor coasts to a stop. In this case, the SSE function is configured as “Immediate STO” (parameter SSE.13).  
**Note:** If the SBC function (brake) is in use, it is also activated according to the configuration (either before or after the drive STO is activated, or at a specified speed limit). In this case, make sure that you have dimensioned the brake correctly for these situations. For more information, see the FSO module user’s manual. |
| 3    | When the motor speed reaches the zero speed limit (D), the FSO module acknowledges the SSE function (in this case automatic acknowledgement is used and no external acknowledgement input is in use, see parameter STO.02) and deactivates the inverter unit STO function. The user must reset the inverter unit if the STO indication parameter (FSOGEN.62 or 31.22) has been set so that a fault is generated. See chapter General parameters on page 32. |
SSM function

When the motor speed is between the SSM limits, the SSM indication signal in the FSO module is on.

There are four separate SSM functions in the FSO module with different parameter settings. The SSM1 function is used as an example and in the delivered default settings of the +Q965 option. ABB activates the SSM1 function at the factory. The user sets the SSM positive and negative SSM speed limits at the start-up. For more information, see chapter Parameter settings on page 31 and FSO-21 safety functions module user’s manual (3AXD50000015614 [English]).

This time scheme diagram illustrates the operation of the SSM1 function.

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The motor speed goes above the SSM limit positive. The SSM indication goes off.</td>
</tr>
<tr>
<td>2</td>
<td>The motor speed goes below the SSM limit positive. The SSM indication goes on.</td>
</tr>
<tr>
<td>3</td>
<td>The motor speed goes below the SSM limit negative. The SSM indication goes off.</td>
</tr>
<tr>
<td>4</td>
<td>The motor speed goes above the SSM limit negative. The SSM indication goes on.</td>
</tr>
</tbody>
</table>

For more information, see FSO-21 safety functions module user’s manual (3AXD50000015614 [English]).
Operation principle diagram

You can use a switch or a PLC to connect the SLS activation signal to the FSO module. SLS networks are created by connecting the SLS activation signal to the FSO modules with external wirings outside the cabinet. For more information, see the circuit diagrams delivered with the inverter unit.

This example diagram shows two FSO modules in a network. The SLS function is activated from an SLS switch. This is common to both FSO modules. The SLS and SSM indications are separate.

Note: In different trip limit situations (for example, when the motor speed reaches an SLS or SMS trip limit), the FSO module trips only the inverter unit in which it is installed.

Sxx SLS switch for external 24 V input (user-defined)
System User-defined indication system
FSO Safety functions module (FSO-21)
DI Digital input
DO Digital output
1) SSM function available only with FSO-21

The dash-dot line (—-—-) indicates a user-defined installation.
The dash line (—-—-) indicates an additional.
Initial status: The drive is in operation and the motor is running. This procedure describes the SLS function.

<table>
<thead>
<tr>
<th>Step</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>In this example, the SLS function is requested from a switch [Sxx]. This activates the safety function in both FSO modules.</td>
</tr>
</tbody>
</table>
| 2.   | In both inverter units:  
• If the motor speed is above the user-defined SLS limit, the inverter unit decelerates the motor speed to the SLS limit. The SLS indications go on.  
• The inverter unit limits the motor speed reference so that it stays below the SLS limit.  
• The FSO module monitors the actual motor speed against the SLS trip limits.  
**Note:** If the motor speed goes above the SLS trip limit, the FSO module activates the SSE function. The motor coasts to a stop or decelerates to zero speed according to FSO parameter settings. The FSO module activates the inverter unit STO (only in the inverter unit in which the FSO is installed, not in the other inverter unit). |
| 3.   | Normal operation resumes after the SLS request is removed.  
The SLS indications go off.  
If the motor speed reached the SLS trip limit during the SLS monitoring and if the STO indication parameter (*FSOGEN.62* or *31.22*) has been set so that a fault is generated, the user must reset the inverter unit. See chapter *Parameter settings* on page 31. |
Wiring

There is an extension terminal block [X68] for the connections to the FSO module inside the inverter unit cabinet. This terminal block is the user interface. 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.

<table>
<thead>
<tr>
<th>FSO X113:</th>
<th>X68</th>
<th>FSO X114:</th>
<th>X68</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>5</td>
<td>21</td>
</tr>
<tr>
<td>6</td>
<td>8,9</td>
<td>6</td>
<td>22, 23</td>
</tr>
<tr>
<td>7</td>
<td>10</td>
<td>7</td>
<td>24</td>
</tr>
<tr>
<td>8</td>
<td>11</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>9</td>
<td>12</td>
<td>9</td>
<td>26</td>
</tr>
<tr>
<td>10</td>
<td>13, 14, 15, 16</td>
<td>10</td>
<td>27, 28, 29, 30</td>
</tr>
</tbody>
</table>

ABB installs the FSO and FSE modules and the wirings between the FSO modules and the inverter units at the factory.

The user must wire the safety pulse encoders to the FSE modules 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).
SLS function

The user must wire the SLS request signal to the FSO module on site. The user can also wire the SLS indication signal of the FSO module to the control system on site. See the table above and circuit diagrams delivered with the inverter unit for the terminal designations. If you use a switch for SLS activation, obey these general rules:

1. Connect the SLS request 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 inverter unit 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.

2. Use a shielded, twisted pair cable. We recommend a double-shielded cable.

3. Make sure that the sum resistance for one channel (loop resistance) from the field to the FSO module does not exceed 1000 Ohm.

4. The maximum allowed cable length between the inverter unit and the activation switch (for the whole loop) is 250 m (820 ft).

5. Obey the general control cable installation instructions given in the inverter unit hardware manual.

6. Do not use test pulses in the FSO inputs (see section I/O settings on page 38).

If the SLS activation request comes from a PLC digital transistor output (as shown in section Operation principle diagram on page 23), obey these rules:

1. Do not use test pulses in the FSO inputs (see section I/O settings on page 38).

2. The PLC must monitor the request signals. For more information, see the documentation of your PLC.

SMS function

The user does not need to make any additional wirings.

SSM function

The user must wire the SSM indication signal of the FSO module according to the application on site. See the table above and circuit diagrams delivered with the inverter unit for the terminal designations.
Use of the SLS function

- **Activating**
  De-energize (1 -> 0) the appropriate digital input of the FSO module to activate the SLS function. See the circuit diagram delivered with the inverter unit.

- **Deactivating**
  Energize (0 -> 1) the appropriate digital input of the FSO module to deactivate the SLS function. See the circuit diagram delivered with the inverter unit.

Use of the SMS function

- **Activating and deactivating**
  If the SMS function is activated at the start-up, it monitors the motor speed continuously. The SMS function is activated and deactivated with an FSO module parameter (200.71). To change this parameter value, a password is needed (see chapter Parameter settings on page 31).

Use of the SSM function

- **Activating and deactivating**
  If the SSM function is activated at the start-up, it monitors the motor speed continuously. The SSM function is activated and deactivated with FSO module parameters (for example, SSMx.01 and SSMx.11 for the SSM1 function). To change these parameter values, a password is needed (see chapter Parameter settings on page 31).

**Note**: This manual describes the SSM function when it is set to be “Always on” at the start-up. You can also configure the SSM function so that is activated with an external request signal (from the FSO I/O or a PLC). Obey the wiring instructions given for the SLS function on page 26. For more information, see FSO-21 safety functions module user’s manual (3AXD50000015614 [English]).
Indications of the SLS function

When the SLS monitoring is on and the motor speed is below the SLS limit:
• the FSO module energizes a digital output and the indication connected to this output (for example, a lamp) is on. For the terminals designation, see the circuit diagram delivered with the inverter unit.

When the inverter unit trips after an SLS trip limit hit:
• the FSO module generates a fault (see parameter \textit{FSOGEN.62} on page \textit{32})
• the inverter unit generates an event according to parameter \textit{31.22 STO indication run/stop} (see page \textit{41}).

The indications that the FSO module generates are configurable. For more information, see chapter \textit{Parameter settings} on page \textit{31} and chapter \textit{Fault tracing} in FSO-21 safety functions module user’s manual (3AXD50000015614 [English]).

Indications of the SMS function

When the inverter unit trips after an SMS trip limit hit:
• the FSO module generates a fault (see parameter \textit{FSOGEN.62} on page \textit{32})
• the inverter unit generates an event according to parameter \textit{31.22 STO indication run/stop} (see page \textit{41}).

The indications that the FSO module generates are configurable. For more information, see chapter \textit{Parameter settings} on page \textit{31} and chapter \textit{Fault tracing} in FSO-21 safety functions module user’s manual (3AXD50000015614 [English]).

Indications of the SSM function

When the motor speed is between the SSM speed limits:
• the FSO module energizes a digital output and the indication signal connected to this output is on. For the terminals designation, see the circuit diagram delivered with the inverter unit.
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 SLS activation switch wiring chain, or
- any internal failure within the FSO or FSE modules, the safety encoder or the inverter unit STO.

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

- **FSO module**

  The fault reaction function of the FSO module trips the inverter unit if it detects a failure. The FSO module activates the STO or Safe stop emergency (SSE) function. This activates on the inverter unit STO function. The inverter unit 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 inverter unit parameter 96.09 FSO reboot. For more information, see the inverter unit firmware manual and FSO-21 safety functions module user’s manual (3AXD50000015614 [English]).

- **FSE module**

  When a safety function is active, the fault reaction function of the FSO module trips the inverter unit if it detects a failure in the FSE module. The FSO module activates the STO function. This activates the inverter unit STO function. The inverter unit 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.01 FSE diagnostic failure reaction (see section General parameters on page 32).

  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 inverter unit 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 inverter unit parameter 96.09 FSO reboot.

  For more information, see the inverter unit 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 inverter unit 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 inverter unit 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 inverter unit 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 inverter units

The STO function in the inverter units 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 inverter unit.
Parameter settings

Contents of this chapter
This chapter lists the parameters that you have to set in the FSO modules and the inverter units.

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 the delivered default values for the example SLS, SMS and SSM safety functions presented in this manual (+Q965). We assume that the FSO module is only used in either of the example safety functions 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 parameter 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 FSO-21 safety functions module user’s manual (3AXD50000015614 [English]). For more information on the Drive composer pro PC tool, see Start-up and maintenance PC tool Drive composer user’s manual (3UA0000094606 [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 *FSO-21 safety functions module user’s manual (3AXD5000015614 [English]), 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 +Q965. The example values apply only to the option +Q965.

### General parameters

These parameters are common to all safety functions.

<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSOGEN.21</td>
<td>Motor nominal speed</td>
<td>1500 rpm</td>
<td>Sets the nominal motor speed. Adjust the default value to meet the ratings of the motor in use.</td>
</tr>
<tr>
<td>FSOGEN.22</td>
<td>Motor nominal frequency</td>
<td>50 Hz</td>
<td>Sets the nominal motor frequency. Adjust the default value to meet the ratings of the motor in use.</td>
</tr>
<tr>
<td>FSOGEN.41</td>
<td>Power-up acknowledgement</td>
<td>Automatic</td>
<td>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.</td>
</tr>
<tr>
<td>FSOGEN.42</td>
<td>Acknowledgement button input</td>
<td>None</td>
<td>Selects the interface for the acknowledgement signal when parameter FSOGEN.41 Power-up acknowledgement or STO.02 STO acknowledgement has value Manual. In the safety functions 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 functions are configured not to require a reset/acknowledgment of the safety function after power-up or the removal of the safety function request.</td>
</tr>
<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 in the safety functions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>This parameter is relevant when the SSE function is activated and if parameter SSE.13 SSE function is set to Emergency ramp. See section Parameters for the SSE function. Note: You cannot set trip limits below this value.</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 for the limit hits of the SLS1, ..., SLS4 and SMS functions and for limit hits during ramp and time monitoring of safety ramps SAR0 and SAR1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SLS: When the motor speed does not follow the deceleration ramp, the FSO module activates the STO function and generates this user-defined indication. When the motor speed goes above the SLS trip limit, the FSO module activates the SSE function and generates this user-defined indication.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SMS: When the motor speed goes above the SMS trip limit positive or below the SMS trip limit negative, the FSO module activates the SSE function and generates this user-defined indication.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SSM: This value has no effect in the operation. Check the default setting and adjust if necessary. If you select Fault, you must reset the inverter unit 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 SLS function activates the STO function if a ramp monitoring limit is reached during deceleration. In addition, the FSO module can activate the STO function in internal fault situations.

<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
</table>
| STO.02 | STO acknowledgement          | Automatic     | Sets the acknowledgement method used in the STO, SSE and SS1 functions.  
Automatic: The FSO module generates the STO acknowledgment 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. |
| STO.14 | Time to zero speed with STO or modoff | 2000 ms     | Sets the time after which the acknowledgment is allowed after coast stop in the STO and SSE functions. Set this value always at the start-up. Use the estimated time in which the motor coasts to a stop from the maximum speed.  
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.  
**Note:** The default value after factory reset is 3,600,000 ms. Always check this parameter after factory reset. |

### SBC usage

<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
</table>
| SBC.11  | STO SBC usage                 | None          | Activates/deactivates the control of a mechanical brake of the motor.  
None: This feature is not in use.  
In this manual, we assume that you do not use a mechanical 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 SSE function of the FSO module. The SLS and SMS functions activate the SSE function if the motor speed hits a trip limit during monitoring. In addition, the FSO module can activate the SSE function in internal fault situations.

<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
</table>
| SSE.13 | SSE function                | Immediate STO or Emergency ramp | Sets the function that the SSE function activates.  
Immediate STO: The FSO module activates the inverter unit 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 (parameter `FSOGEN.52`) it activates the drive STO function. SAR0 parameters define the deceleration ramp (see `SAR0 ramp settings`).  
For the +Q965 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. |
| SSE.14 | SSE monitoring method       | Ramp or Time   | Sets the method used for the SSE emergency ramp monitoring. This parameter is relevant only if parameter `SSE.13 SSE function` is set to Emergency ramp.  
Ramp: SAR0 parameters define the emergency ramp and monitoring limits (see `SAR0 ramp settings`).  
Time: Parameter `200.102 SAR0 ramp time to zero` defines the emergency ramp and it is monitored with parameter `SSE.15 SSE delay for STO`.  
For the +Q965 option, ABB has set this parameter to value Ramp at the factory. Adjust the default value when necessary. |
| SSE.15 | SSE delay for STO           | 20000 ms      | Sets the security delay after which the FSO module activates the inverter unit STO function after the SSE request.  
This parameter is relevant only if parameter `SSE.13 SSE function` is set to Emergency ramp, time monitoring is used (`SSE.14 SSE monitoring method = Time`) and the motor speed does not follow the ramp.  
**Note:** This delay must be considered when the total response time for the safety function is defined. |
| SSE.16 | SSE ramp zero speed delay for STO | 0 ms          | Sets an extra delay time for the inverter unit STO activation at the zero speed in the SSE function.  
With this parameter, the FSO module delays the STO activation so that the inverter unit is able to reach the axle zero speed before the FSO module activates the STO function.  
The delay counter starts when the motor speed reaches the zero speed limit (parameter `FSOGEN.52`). After this delay has elapsed, the FSO module activates the inverter unit STO function. You can use this parameter when the motor rotates a heavy load (high inertia).  
**Note:** The FSO module activates the inverter unit STO immediately if the inverter unit stops modulating before this delay has passed (that is, the motor actual speed reaches 0 rpm).  
This parameter is relevant only if parameter `SSE.13 SSE function` is set to Emergency ramp. |
Parameters for the SLS function

There are four separate SLS functions (SLS1...4) in the FSO module. The SLS functions are identical and the configuration is done similarly, only the parameter numbers differ. The SLS1 function is shown as an example. ABB has activated the SLS1 function at the factory. For more information, see FSO-21 safety functions module user’s manual (3AXD50000015614 [English]).

Note: The FSO module activates the STO function if the motor speed hits a ramp monitoring limit during the deceleration ramp. The FSO module activates the SSE function if the motor speed hits a trip limit during SLS monitoring. Remember to configure the STO and SSE functions (see sections Parameters for the STO function and Parameters for the SSE function).
Set these parameters for all FSO modules. Each FSO module can have different SLS1 limits, SLS1 trip limits and SAR1 ramp settings.

<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
</table>
| 200.21  | SLS1 activity and version                 | Version 1     | Activates or deactivates the SLS1 function and shows the version of the SLS1 function.  
  
  *Disabled:* Deactivates the SLS1 function.  
  
  *Version 1:* Activates the SLS1 function. |
| 200.22  | SLS1 limit negative                       | -200 rpm      | Sets the SLS1 negative speed limit for the inverter unit.  
  
  Adjust the default value to meet the motor in use.  
  
  **Note:** The difference between the SLS limit and the corresponding SLS trip limit (*SLSx.13*) must be at least 0.1 rpm.  
  
  **Note:** The default value after factory reset is 0 rpm.  
  
  Always check this parameter after factory reset. |
| 200.23  | SLS1 limit positive                       | 200 rpm       | Sets the SLS1 positive speed limit for the inverter unit.  
  
  Adjust the default value to meet the motor in use.  
  
  **Note:** The difference between the SLS limit and the corresponding SLS trip limit (*SLSx.14*) must be at least 0.1 rpm.  
  
  **Note:** The default value after factory reset is 0 rpm.  
  
  Always check this parameter after factory reset. |
| SLSx.02 | SLS acknowledgement                       | Automatic     | Sets the acknowledgement method used in the SLS1…4 functions.  
  
  *Automatic:* The FSO module generates the SLS acknowledgment signal automatically after the SLS request has been removed and the SLS limit has been achieved. 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. |
| SLSx.03 | SLS activation monitoring method          | Time or Ramp  | Sets the monitoring method that is used in SLS activation.  
  
  *Time monitoring:* The inverter unit (parameter 23.13 *Deceleration time 1* or 23.15 *Deceleration time 2*) defines the deceleration ramp and it is monitored with parameter *SLSx.04 SLS time delay*.  
  
  *Ramp monitoring:* SAR1 parameters define the deceleration ramp and monitoring limits. See parameters *200.112, SARx.21, SARx.22* and *SARx.02*.  
  
  For the option +Q965, ABB has set this parameter to value *Ramp* at the factory. Adjust the default value when necessary. |
| SLSx.04 | SLS time delay                            | 4000 ms       | Sets the security delay after which the FSO module activates the SLS monitoring after the SLS request.  
  
  *Time monitoring:* This parameter is relevant only if time monitoring (parameter *SLSx.03 = Time*) is used and the motor speed does not follow the ramp.  
  
  *Ramp monitoring:* This value has no effect in the operation. |
| SLSx.11 | SLS1 input A                              | DI X113:2 & X114:2 | Sets the digital input that is connected to the primary input of the SLS function with limits 1.  
  
  For the option +Q965, ABB has configured the SLS request signal to these digital inputs at the factory.  
  
  **Note:** The default value after factory reset is *None*.  
  
  Always check this parameter after factory reset. |
<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
</table>
| SLSx.13| SLS1 trip limit negative                | -250 rpm      | Sets the SLS1 negative speed limit that trips the inverter unit. Adjust the default value to meet the motor in use.  
**Note:** The difference between the SLS trip limit and the corresponding SLS limit (200.22) must be at least 0.1 rpm.  
**Note:** The default value after factory reset is 0 rpm. Always check this parameter after factory reset. |
| SLSx.14| SLS1 trip limit positive                | 250 rpm       | Sets the SLS1 positive speed limit that trips the inverter unit. Adjust the default value to meet the motor in use.  
**Note:** The difference between the SLS trip limit and the corresponding SLS limit (200.23) must be at least 0.1 rpm.  
**Note:** The default value after factory reset is 0 rpm. Always check this parameter after factory reset. |
| SLSx.15| SLS1 output A                           | DO X114:7     | Sets the digital output that is connected to the primary output of the SLS1 function. Active when the SLS monitoring is on.  
For the option +Q965, ABB has configured the SLS indication signal to this digital output at the factory.  
**Note:** The default value after factory reset is None. Always check this parameter after factory reset. |

**SAR1 ramp settings**

| 200.112| SAR1 ramp time to zero                  | 2000 ms       | Sets the target time for the stop ramp SAR1 that is used in the SLS function. Adjust the default value when necessary.  
Target time = The time in which the inverter unit decelerates the motor(s) from speed 200.202 SAR speed scaling to zero.  
**Note:** With value 0 ms, the inverter unit uses the emergency stop ramp set by inverter unit parameter 23.23 (see section Ramp parameters on page 41). Also in this case, the FSO module monitors the actual ramp (ramp monitoring or time monitoring).  
*Ramp monitoring:* Adjust the default value when necessary.  
*Ramp monitoring:* This value has no effect in the operation. The inverter unit (parameter 23.13 Deceleration time 1 or 23.15 Deceleration time 2) defines the deceleration ramp (see section Ramp parameters on page 41).  
****Time monitoring:** This value has no effect in the operation. The inverter unit (parameter 23.13 Deceleration time 1 or 23.15 Deceleration time 2) defines the deceleration ramp (see section Ramp parameters on page 41). |
| 200.202| SAR speed scaling                       | 1500 rpm      | The same value is used for SAR0 and SAR1 ramps. See section SAR0 ramp settings on page 35.                                                                                                                                                                                                                                                     |
| SARx.02| SAR initial allowed range               | 100 ms        | The same value is used for SAR0 and SAR1 ramps. See section SAR0 ramp settings on page 35.                                                                                                                                                                                                                                                     |
| SARx.21| SAR1 min ramp time to zero              | 1000 ms       | Sets the minimum ramp time for the SAR1 ramp monitoring.  
**Time monitoring:** This value has no effect in the operation.  
**Ramp monitoring:** Sets the minimum stop ramp time for the emergency stop. Adjust the default value when necessary.  
**Note:** With value 0 ms, the ramp is not monitored. |
### Parameters for the SMS function

These parameters are related to the SMS function (version 1) of the FSO module.

**Note:** The FSO module activates the SSE function if the motor speed hits a trip limit during SMS monitoring. Remember to configure the SSE function (see section *Parameters for the SSE function*).

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
</table>
| 200.71 | SMS activity and version          | Version 1     | Activates or deactivates the SMS function and shows the version of the SMS function.  
*Disabled*: Deactivates the SMS function (default).  
*Version 1*: Activates version 1 of the SMS function.  
*Version 2*: Activates version 2 of the SMS function (for more information, see the FSO module user’s manual).  
For the option +Q965, ABB has configured the SMS function (Version 1) at the factory. Adjust the value if necessary.  
**Note:** The default value after factory reset is *Disabled*.  
Always check this parameter after factory reset. |
| SMS.13 | SMS trip limit negative           | -2000 rpm     | Sets the negative speed limit that trips the inverter unit for the SMS function.  
**Note:** You cannot set this limit above the general zero speed limit (parameter *FSOGEN.52*).  
**Note:** The default value after factory reset is 0 rpm.  
Always check this parameter after factory reset. |
| SMS.14 | SMS trip limit positive           | 2000 rpm      | Sets the positive speed limit that trips the inverter unit for the SMS function.  
**Note:** You cannot set this limit below the general zero speed limit (parameter *FSOGEN.52*).  
**Note:** The default value after factory reset is 0 rpm.  
Always check this parameter after factory reset. |
Parameters for the SSM function

There are four separate SSM functions (SSM1...4) in the FSO module. The SSM functions are identical and the configuration is done similarly, only the parameter numbers differ. The SSM1 function is shown as an example. ABB has activated the SSM1 function at the factory. For more information, see FSO-21 safety functions module user's manual (3AXD50000015614 [English]).

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSMx.01</td>
<td>SSM1 activity and version</td>
<td>Version 1</td>
<td>Activates or deactivates the SSM1 function and shows the version of the SSM1 function. Disabled: Deactivates the SSM1 function. Version 1: Activates the SSM1 function. For the option +Q965, ABB has activated the SSM1 function at the factory. Adjust the value if necessary.</td>
</tr>
<tr>
<td>SSMx.11</td>
<td>SSM1 input</td>
<td>Always on</td>
<td>Sets the digital input connected to the SSM1 function. Always on: The SSM1 function is always on. No external request signal is needed to activate the SSM1 function. For the option +Q965, ABB has configured the SSM1 function to be “Always on” at the factory.</td>
</tr>
<tr>
<td>SSMx.12</td>
<td>SSM1 limit negative</td>
<td>-100 rpm</td>
<td>Sets the negative speed limit for the SSM1 function.</td>
</tr>
<tr>
<td>SSMx.13</td>
<td>SSM1 limit positive</td>
<td>100 rpm</td>
<td>Sets the positive speed limit for the SSM1 function.</td>
</tr>
<tr>
<td>SSMx.14</td>
<td>SSM1 output</td>
<td>DO X113:8</td>
<td>Sets the digital output connected to the SSM1 function. Active when the motor speed is within the SSM1 speed limits. For the option +Q965, ABB has configured the SSM1 indication signal to this digital output at the factory.</td>
</tr>
<tr>
<td>SAFEIO.55</td>
<td>DO X113:8 diag pulse on/ off</td>
<td>On</td>
<td>Sets the diagnostic pulse of digital output X113:8 on or off. On: The output monitors that it receives test pulses.</td>
</tr>
<tr>
<td>SAFEIO.72</td>
<td>DO X113:8 logic state</td>
<td>Active high</td>
<td>Sets the logic state of digital output X113:8. Active high: The digital output is on when the indicated signal is active. For the option +Q965, ABB has configured the SSM1 indication signal to this digital output at the factory. Make sure that this value corresponds to the actual wiring. See the circuit diagrams of the delivery.</td>
</tr>
</tbody>
</table>

FSE module and safety pulse encoder 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 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 module. STO: The FSO module goes into the Fail-safe mode and activates the drive STO function.</td>
</tr>
<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>
</tbody>
</table>
### Parameter settings

<table>
<thead>
<tr>
<th>Index</th>
<th>Name</th>
<th>Example value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S_ENCGEN.41 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>
<td></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). |
Inverter units

- **Parameter 31.22 STO indication run/stop**

The inverter unit 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 inverter units from making a fault every time the FSO module activates the inverter units STO function.

For more information, see the firmware manual of your inverter unit.

- **Ramp parameters**

  **Note:** You must set these parameters only for the SLS function.

  When the SLS function is activated and the motor speed is above the SLS limit positive, the inverter unit ramps down the motor speed to the SLS limit.

  In SLS with time monitoring, inverter unit (parameter 23.13 Deceleration time 1 or 23.15 Deceleration time 2) always defines the deceleration ramp.

  In SLS with ramp monitoring, the inverter unit uses either the ramp settings in the FSO module or the inverter unit. If FSO parameter 200.112 SAR1 ramp time to zero is set to 0, inverter unit (parameter 23.23 Emergency stop time) defines the deceleration ramp. In this case, the FSO module monitors the actual deceleration ramp using SAR1 parameters.

  After the SLS function has been deactivated, the inverter unit returns to normal operation and starts to follow its ordinary speed reference. The inverter unit accelerates the motor to the desired speed along its acceleration ramp. Inverter unit parameters define the acceleration ramp and it is not monitored.

  For the parameter settings in the inverter unit, see the firmware manual.

  **Note:** ACS880 primary control program controls the inverter unit by default. There is a dedicated control board with a control program of its own for each inverter unit.

- **Safety pulse encoder parameters**

  The inverter unit 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 inverter units trip 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+, A1, B+, B-, Z+, Z-. 

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Parameter settings 41
42 Parameter settings
Start-up and acceptance test

Contents of this chapter
This chapter describes the start-up and acceptance procedure of the safety functions.

Before you start
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.

Note: When you perform the motor ID run, the SLS and SMS functions must be deactivated:
- **SLS function**: Make sure that the SLS request is not active (e.g., from a switch).
- **SMS function**: Adjust the delivered default value of the FSO module:
  - 200.71 SMS activity and version = Disabled.

After the motor ID run, activate the SLS and SMS functions.

Safety encoder interface
Validate the safety encoder interface as described in *FSO-21 safety functions module user’s manual* (3AXD50000015614 [English]), chapter Verification and validation.

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

Repeat this test for every inverter unit which uses the SLS function. Repeat the test in both operation directions of the motor.
**Note:** The SLS acceptance test procedure described in this chapter does not test the trip limits, because the SLS function limits the motor reference speed to the SLS limit. ABB has validated the functionality of trip limits in the verification tests.

<table>
<thead>
<tr>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WARNING!</strong> Obey the <em>Safety instructions</em>, page 9. If you ignore them, injury or death, or damage to the equipment can occur.</td>
</tr>
</tbody>
</table>

### Checks and settings with no voltage connected

1. Check the connections done on site against the circuit diagrams of the delivery.
2. **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

1. Check and set the parameters that are relevant to the safety function according to your application needs (see section *Parameters for the SLS function* on page 35).
2. Create a backup file of the drive (button **Backup/restore** in the Drive composer pro PC tool).
3. 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

1. Make sure that you can run and stop the motor freely during the test.
2. We recommend that you monitor these signals with the Drive composer pro PC tool:
   - 01.01 *Motor speed used* (rpm)
   - 01.02 *Motor speed estimated* (rpm)
   - 01.07 *Motor current* (A)
   - 01.10 *Motor torque* (%)
   - 23.01 *Speed ref ramp input* (rpm)
   - 23.02 *Speed ref ramp output* (rpm)
   - 90.01 *Motor speed for control* (rpm)
   - 90.10 *Encoder 1 speed* (rpm)
   - 200.01 *FSO speed ch1* (rpm)
   - 200.02 *FSO speed ch2* (rpm)
   - 200.03 *FSO DI status*
   - 200.04 *FSO DO status*
   - 200.05 *FSO control word 1*
   - 200.06 *FSO control word 2*
   - 200.07 *FSO status word 1*
   - 200.08 *FSO status word 2*
   - 200.09 *Drive status word 1*
   - 200.10 *Drive status word 2*

Start the inverter unit and make sure that the motor is running. Increase the motor speed close to the maximum speed of the application (above the SLS limit).

Activate the SLS request of the FSO module.

Make sure that the inverter unit decelerates the motor speed to the SLS limit, stays under the SLS limit and indicates the SLS function as describes in section *Indications of the SLS function* on page 28.
When the SLS request signal is on, make sure that you cannot increase the reference speed above the SLS limit:
  • with the panel in the local control mode
  • with an external speed reference signal in the external control mode.
The LOC and REM buttons of the control panel or the Drive composer PC tool switch between the local and external controls.

Deactivate the SLS request of the FSO module. Make sure that the inverter unit continues normal operation.

Stop and restart the inverter unit and motor and check that they operate normally.

Repeat the test in the reverse direction.

Repeat the test from each operating location.

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

Fill in and sign the acceptance test report which verifies that the safety function is safe and accepted to operation.
Start-up and acceptance test

SMS function

You need the Drive composer pro PC tool to perform the start-up and acceptance test. Repeat this test for every inverter unit which uses the SMS function (version 1). Repeat the test in both operation directions of the motor.

Note: If you use SMS function, version 2, do the acceptance test as described in FSO-21 safety functions module user’s manual (3AXD50000015614 [English]).

<table>
<thead>
<tr>
<th>Action</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WARNING! Obey the Safety instructions, page 9. If you ignore them, injury or death, or damage to the equipment can occur.</td>
<td>✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Checks and settings with no voltage connected</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Check the connections done on site against the circuit diagrams of the delivery.</td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Settings with voltage connected</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Check and set the parameters that are relevant to the safety function according to your application needs:</td>
<td></td>
</tr>
<tr>
<td>• Make sure the SMS function is active (parameter SMS activity and version = Version 1).</td>
<td></td>
</tr>
<tr>
<td>• Set parameter SMS trip limit positive to half of the value to be used in the application and parameter SMS trip limit negative to zero.</td>
<td></td>
</tr>
<tr>
<td>For more information, see section Parameters for the SMS function on page 38.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acceptance test procedure</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Create a backup file of the drive (button Backup/restore in the Drive composer pro PC tool).</td>
<td></td>
</tr>
<tr>
<td>Save the FSO safety file (button Save safety file in the Drive composer pro PC tool).</td>
<td></td>
</tr>
<tr>
<td>Note: The FSO safety file is not included in the drive backup process.</td>
<td></td>
</tr>
</tbody>
</table>

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

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

Start the inverter unit and make sure that the motor is running. Increase the motor speed above the speed defined in parameter *SMS trip limit positive*.  

Make sure that the inverter unit trips.  

Reset the inverter unit if the STO indication parameter (*FSOGEN.62* or 31.22) has been set so that a fault is generated. See section *Parameter settings* on page 31.  

Restart the inverter unit. Make sure that the inverter unit continues normal operation.  

Stop and restart the inverter unit and motor and check that they operate normally.  

Repeat the test in the reverse direction.  

Repeat the test from each operating location.  

Set the SMS parameters to suitable values to be used in the application (see section *Parameters for the SMS function* on page 38).  

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

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

<table>
<thead>
<tr>
<th>Action</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Start the inverter unit and make sure that the motor is running.</td>
<td>✓</td>
</tr>
<tr>
<td>Increase the motor speed above the speed defined in parameter *SMS</td>
<td></td>
</tr>
<tr>
<td>trip limit positive*.</td>
<td></td>
</tr>
<tr>
<td>Make sure that the inverter unit trips.</td>
<td></td>
</tr>
<tr>
<td>Reset the inverter unit if the STO indication parameter (<em>FSOGEN.62</em></td>
<td></td>
</tr>
<tr>
<td>or 31.22) has been set so that a fault is generated. See section</td>
<td></td>
</tr>
<tr>
<td><em>Parameter settings</em> on page 31.</td>
<td></td>
</tr>
<tr>
<td>Restart the inverter unit. Make sure that the inverter unit continues</td>
<td></td>
</tr>
<tr>
<td>normal operation.</td>
<td></td>
</tr>
<tr>
<td>Stop and restart the inverter unit and motor and check that they</td>
<td></td>
</tr>
<tr>
<td>operate normally.</td>
<td></td>
</tr>
<tr>
<td>Repeat the test in the reverse direction.</td>
<td></td>
</tr>
<tr>
<td>Repeat the test from each operating location.</td>
<td></td>
</tr>
<tr>
<td>Set the SMS parameters to suitable values to be used in the</td>
<td></td>
</tr>
<tr>
<td>application (see section <em>Parameters for the SMS function</em> on page</td>
<td></td>
</tr>
<tr>
<td>38).</td>
<td></td>
</tr>
<tr>
<td>Save the FSO safety file (button <em>Save safety file</em> in the Drive</td>
<td></td>
</tr>
<tr>
<td>composer pro PC tool).</td>
<td></td>
</tr>
<tr>
<td>Fill in and sign the acceptance test report which verifies that the</td>
<td></td>
</tr>
<tr>
<td>safety function is safe and accepted to operation.</td>
<td></td>
</tr>
</tbody>
</table>
SSM function

You need the Drive composer pro PC tool to perform the start-up and acceptance test. Repeat this test for every inverter unit which uses the SSM function. Repeat the test in both operation directions of the motor.

Action

- **WARNING!** Obey the Safety instructions, page 9. If you ignore them, injury or death, or damage to the equipment can occur.

Checks and settings with no voltage connected

- Check the connections done on site against the circuit diagrams of the delivery.
- 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

- Check and set the parameters that are relevant to the safety function according to your application needs (see section Parameters for the SSM function on page 39).
- 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.
- Start the inverter unit and make sure that the motor is running.

We recommend that you monitor these signals with the Drive composer pro PC tool:
- 01.01 Motor speed used (rpm)
- 01.02 Motor speed estimated (rpm)
- 01.07 Motor current (A)
- 01.10 Motor torque (%)
- 23.01 Speed ref ramp input (rpm)
- 23.02 Speed ref ramp output (rpm)
- 90.01 Motor speed for control (rpm)
- 90.10 Encoder 1 speed (rpm)
- 200.01 FSO speed ch1 (rpm)
- 200.02 FSO speed ch2 (rpm)
- 200.03 FSO DI status
- 200.04 FSO DO status
- 200.05 FSO control word 1
- 200.06 FSO control word 2
- 200.07 FSO status word 1
- 200.08 FSO status word 2
- 200.09 Drive status word 1
- 200.10 Drive status word 2

- Make sure that the SSM1 indication is on.
- Increase the motor speed above the speed defined in parameter SSM1 limit positive.
- Make sure that the SSM1 indication goes off.
### Start-up and acceptance test

#### Action

<table>
<thead>
<tr>
<th>Action</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease the motor speed below the speed defined in parameter <strong>SSM1 limit positive</strong>.</td>
<td>✓</td>
</tr>
<tr>
<td>Make sure that the SSM1 indication goes on.</td>
<td></td>
</tr>
<tr>
<td>Repeat the test in the reverse direction.</td>
<td></td>
</tr>
<tr>
<td>Repeat the test from each operating location.</td>
<td></td>
</tr>
<tr>
<td>If you made any changes in the FSO parameters, save the FSO safety file (button <strong>Save safety file</strong> in the Drive composer pro PC tool).</td>
<td></td>
</tr>
<tr>
<td>Fill in and sign the acceptance test report which verifies that the safety function is safe and accepted to operation.</td>
<td></td>
</tr>
</tbody>
</table>
Start-up and acceptance test
Contents of this chapter

This chapter gives maintenance instructions for the safety function.

Maintenance

After the operation of the safety circuit of the option +Q965 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 43.

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 43.
- 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 two or five 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 43.

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 inverter unit STO 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 operator.

Intentional misuse

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

Decommissioning

When you decommission a safety function network or a part of it or an inverter unit, make sure that the safety of the machine is maintained until the decommissioning is complete.
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.

Safety data

- **Safety performance with different safety pulse encoders**
  See *[FSE-31 pulse encoder interface module user’s manual](3AXD50000016597 [English]).*

- **Safety data values**
  Each multidrives delivery is unique. If included in the customer order, ABB calculates the safety data for each multidrives delivery, and delivers the data separately to the customer.
  For the safety data of the FSO-21 and FSE-31 modules, see *[FSO-21 safety functions module user’s manual](3AXD50000015614 [English]).*

- **Safety component types**
  Safety component types as defined in IEC 61508-2:
  - FSO module: type B
  - FSE module: type B
  - emergency stop safety relay: type A
  - inverter unit 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

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

Relevant failure modes

Relevant failure modes are internal failures of:
- the FSO and FSE modules and
- the STO function in the inverter unit.

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: less than 100 ms (includes the response time of the inverter unit STO).

Note: When you define the total response time for the safety function and the fault reaction function, you must add the delays of the safety pulse encoder.
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 section *Start-up and acceptance test* on page 43:

- 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:

- 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.

**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

<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 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>IEC 61326-3-1:2008</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>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 functions of this manual (option +Q965) 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
You can find manuals and other product documents in PDF format on the Internet at www.abb.com/drives/documents.
Contact us

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www.abb.com/drivespartners