OPTIONS FOR ABB DRIVES

Prevention of unexpected start-up (option +Q957) for ACS880-07/17/17LC/37/37LC drives
User's manual
Prevention of unexpected start-up (option +Q957) for ACS880-07/17/17LC/37/37LC drives

User's manual

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Safety instructions

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

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

The manual uses these warning symbols:

---

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

---

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

---

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

---

Instructions for functional safety circuits
This manual does not repeat the complete safety instructions of the drive but only includes the instructions related to the scope of this manual.
8 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. All user-made changes are on the user’s responsibility.

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

**WARNING!** (With permanent magnet or synchronous reluctance [SynRM] motors only)

In case of a multiple IGBT power semiconductor failure, the drive system can produce an alignment torque which maximally rotates the motor shaft by 180/p (with permanent magnet motors) or 180/2p (with synchronous reluctance [SynRM] motors) degrees regardless of the activation of the Safe torque off function. p denotes the number of pole pairs.

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

**WARNING!**

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

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

**Electrical safety precautions**

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

**WARNING!**

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

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

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

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

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

Applicability
The manual applies to ACS880-07/17/17LC/37/37LC drives which have the option: Prevention of unexpected start-up (option +Q957).

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

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

The system integrator (or other responsible party) must make sure that the entire implementation complies with the instructions in this manual, all relevant standards, directives and local electrical code, and that the system is tested, verified and validated correctly.
## Quick reference guide for taking a safety function into use

### Task

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

### Related manuals

<table>
<thead>
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<th>Code</th>
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<td>Drive hardware</td>
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<tr>
<td>ACS880-07 drives (560 to 2800 kW) hardware manual</td>
<td>3AUA0000143261</td>
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<td>ACS880-07 drives (45 to 710 kW, 50 to 700 hp) hardware manual</td>
<td>3AUA0000105718</td>
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<td>ACS880-17 drives (160 to 3200 kW) hardware manual</td>
<td>3AXD5000020436</td>
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<td>ACS880-17LC hardware manual</td>
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<td>ACS880-37 drives (160 to 3200 kW) hardware manual</td>
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<td>Drive firmware</td>
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<td>ACS880 primary control program firmware manual</td>
<td>3AUA0000085967</td>
</tr>
<tr>
<td>ACS880 primary control program quick start-up guide</td>
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</tr>
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<td>ACS880 diode supply control program firmware manual</td>
<td>3AUA0000103295</td>
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<tr>
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<td>3AUA0000131562</td>
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<td>PC tools</td>
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<tr>
<td>Drive composer start-up and maintenance PC tool user's manual</td>
<td>3AUA0000094606</td>
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<tr>
<td>Functional safety design tool user's manual</td>
<td>3AXD1000102417</td>
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<td>Safety</td>
<td></td>
</tr>
<tr>
<td>Functional safety; Technical guide No. 10</td>
<td>3AUA0000048753</td>
</tr>
<tr>
<td>Safety and functional safety; A general guide</td>
<td>1SFC001008B0201</td>
</tr>
<tr>
<td>ABB Safety information and solutions</td>
<td><a href="http://www.abb.com/safety">www.abb.com/safety</a></td>
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<tr>
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<td></td>
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<tr>
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<td>3AUA0000085685</td>
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<tr>
<td>Manuals and quick guides for I/O extension modules, fieldbus adapters, etc.</td>
<td></td>
</tr>
<tr>
<td>Other documents</td>
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</tr>
<tr>
<td>Circuit diagrams</td>
<td>Delivered with the drive</td>
</tr>
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<td>Part lists</td>
<td>Delivered with the drive</td>
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<td>Manual</td>
<td>Code</td>
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<tr>
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<td>-------------------------------------------</td>
</tr>
<tr>
<td>Safety data report (if the safety circuit is application-engineered)</td>
<td></td>
</tr>
</tbody>
</table>

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


<table>
<thead>
<tr>
<th>ACS880-07 (45 to 710 kW) manuals</th>
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<td>ACS880-37 (45 to 400 kW) manuals</td>
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<td>ACS880-37 (160 to 3200 kW) manuals</td>
<td>ACS880-37LC manuals</td>
<td></td>
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## Terms and abbreviations

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<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat.</td>
<td>Classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behavior in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability. The categories are: B, 1, 2, 3 and 4. (EN ISO 13849-1)</td>
</tr>
<tr>
<td>CCF</td>
<td>Common cause failure (%) (EN ISO 13849-1)</td>
</tr>
<tr>
<td>D8T</td>
<td>Frame size designation of the diode supply module</td>
</tr>
<tr>
<td>DC</td>
<td>Diagnostic coverage (EN ISO 13849-1)</td>
</tr>
<tr>
<td>FIT</td>
<td>Failure in time: 1E-9 hours (IEC 61508)</td>
</tr>
<tr>
<td>Frame, frame size</td>
<td>Physical size of the drive or power module</td>
</tr>
<tr>
<td>HFT</td>
<td>Hardware fault tolerance (IEC 61508)</td>
</tr>
<tr>
<td>IGBT</td>
<td>Insulated gate bipolar transistor</td>
</tr>
<tr>
<td>PFD&lt;sub&gt;avg&lt;/sub&gt;</td>
<td>Average probability of dangerous failure on demand (IEC 61508)</td>
</tr>
<tr>
<td>PFH</td>
<td>Average frequency of dangerous failures per hour (IEC 61508)</td>
</tr>
<tr>
<td>PL</td>
<td>Performance level. Levels a...e correspond to SIL (EN ISO 13849-1)</td>
</tr>
<tr>
<td>POUS</td>
<td>Prevention of unexpected start-up</td>
</tr>
<tr>
<td>SC</td>
<td>Systematic capability (IEC 61508)</td>
</tr>
<tr>
<td>SIL</td>
<td>Safety integrity level (1...3) (IEC 61508)</td>
</tr>
<tr>
<td>SILCL</td>
<td>Maximum SIL (level 1...3) that can be claimed for a safety function or subsystem (IEC/EN 62061)</td>
</tr>
<tr>
<td>STO</td>
<td>Safe torque off (IEC/EN 61800-5-2)</td>
</tr>
<tr>
<td>T1</td>
<td>Proof test interval. Defines the probabilistic failure rate (PFH or PFD) for the safety function or subsystem. Performing a proof test at a maximum interval of T1 is required to keep the SIL capability valid. The same interval must be followed to keep the PL capability (EN ISO 13849) valid. Note that any T1 values given cannot be regarded as a guarantee or warranty.</td>
</tr>
</tbody>
</table>
Option description

Contents of this chapter
This chapter describes the option +Q957, prevention of unexpected start-up, and its settings.

Overview
The Prevention of unexpected start-up (POUS) function disables the control voltage of the power semiconductors of the drive (inverter) output stage. This prevents the drive from generating the torque required to rotate the motor. The POUS function activates the Safe torque off (STO) function of the drive. By using this function, short-time operations (like cleaning) and/or maintenance work on the non-electrical parts of the machinery can be performed without switching off and disconnecting the drive.

The user activates the Prevention of unexpected start-up function using a switch mounted on a control desk. When the switch is open (off), the POUS function is active and the POUS indicator lamp is on.

The customer is responsible for installing and connecting the operating switch and the indicator lamp on site. They are not included in the delivery. See the machine-specific C-type standards whether the indication lamp is required.

For a detailed description of the Safe torque off function, see the appropriate hardware manual.
**Note:** Drives with the Emergency stop, stop category 1 function (option +Q952 or +Q964):
If the user activates the POUSS function during the emergency stop deceleration ramp, it overrides the emergency stop function. This activates the STO function of the drive immediately and the motor coasts to a stop. For more information on the emergency stop function, see the appropriate user’s manual.

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

The design principles of the option +Q957 comply with EN 1037. The STO function complies with EN/IEC 61800-5-2:2007. For a complete list of related standards and European directives, see section Related standards and directives.

**Operation principle**

The figure shows a simplified operation principle. For a more detailed description, see the circuit diagrams delivered with the drive.

---

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

A41 Inverter control unit
A65 POUSS safety relay
S POUSS switch (user-defined)
P POUSS indicator lamp (user-defined)
T11.x Inverter module(s) under inverter unit T11 (only for R8i)
X969 STO terminal block

1) Reset (automatic)
2) To parallel inverter modules (if any)
3) Drive module
OperationStep

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

1. The user activates the Prevention of unexpected start-up function by switching off the POUS switch [S].
2. The POUS safety relay [A65] switches off the XSTO inputs IN1 and IN2 of the inverter control unit [A41]. The STO is now activated.
   The drive indicates the status. See section Activating the safety function.
3. The POUS indication lamp [P] switches on.
4. The motor coasts to zero speed (if running) and the drive cannot start the motor while STO is active.
5. Normal operation resumes after the user:
   - switches on the POUS switch [S]
   - resets the drive (if the drive tripped on a fault)
   - makes sure that the drive has received the start signal (depends on the configuration, see the firmware manual).

Fault reaction function

Definition: A safety function requires a “fault reaction function” that attempts to initiate a safe state if the safety function’s diagnostics detect a fault within the hardware/software that performs the safety function.

The fault reaction function of the POUS safety relay trips the system if it detects a failure (short circuit between signals, open circuits, redundancy fault when the POUS switch is pressed) in the safety circuit consisting of, for example, POUS activation button and the contacts wired to it.

The fault reaction function shifts the system immediately into safe state by switching on the POUS command, activating the STO function, and keeping safe state activated and the POUS indication lamp on until the detected fault has been fixed and safety function has been reset.

The STO function has its own internal fault diagnostics and fault reaction function.

Parameter settings

Drive parameter settings

The parameter setting in ACS800 primary control program:

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

Additional parameter settings for ACS880-07 drives, frames nxDXT + nxR8i and ACS880-17/17LC/37/37LC drives, frames nxR8i + nxR8i

Note: ACS880 primary control program controls the inverter unit by default. There are dedicated control units for the supply and inverter units.

The supply unit parameter settings in the ACS880 supply control programs:
18 Option description

• parameter **121.05 Emergency stop source** is set to value *Inactive*.
  For more information, see the firmware manuals.

**Hardware settings**

Appropriate hardware settings have been preset at the factory for the safety function. The settings in the POUS safety relay [A65] are:

• cross fault detection is set to value *On*,
• reset is set to value *Automatic*.

**Note:** If the cross fault detection is not *On*, it decreases the fault diagnostics of the wiring.

For more information, see the circuit diagrams delivered with the drive.
Electrical installation

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

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

There are double contacts in the POUS switch [S] and double wiring (redundant two-channel connection) between the button and the POUS safety relay [A65]. The safety relay detects cross faults and faults across one contact from the POUS switch.

Wire the POUS switch to the appropriate terminals inside the drive cabinet. For the POUS indication lamp [P], we recommend an LED indication lamp. See the circuit diagrams delivered with the drive. Obey the rules below:

1. Use only double-contact switches. We recommend approved and lockable switches.
2. Connect the switch with two conductors (two-channel connection).
   
   Note: Keep the channels separate. Otherwise the cross-fault detection of the POUS safety relay trips.

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

4. Make sure that the sum resistance for one channel (loop resistance) does not exceed 70 ohms.

5. Obey the general control cable installation instructions given in the drive hardware manual.
Use of the safety function

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

Activating the safety function
1. Switch off the POUS switch.
   When the POUS is activated, the following indications are shown:
   • the drive control program has the warning *Safe torque off active*,
   • the POUS indication lamp is on.

   **Note:** The POUS indication is not SIL/PL-rated.

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

Resetting the safety function
No manual reset is necessary after you have deactivated the POUS function. The reset input of the POUS safety relay [A65] is set to autoreset mode at the factory. However, you must reset the drive if it has tripped on a fault at the activation of the POUS function. The drive reaction depends on the parameter settings. See section Parameter settings.
Start-up and acceptance test

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

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

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

■ Validation procedure
You must do the acceptance test using the checklist given in section Start-up and acceptance test:

• at initial start-up of the safety function
• after any changes related to the safety function (wiring, components, safety-function-related parameter settings, etc.)
• after any maintenance work related to the safety function.

The acceptance test must include at least the following steps:

• you must have an acceptance test plan
• you must test all commissioned functions for proper operation, from each operation location
• you must document all acceptance tests
you must sign and store the acceptance test report for further reference.

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

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

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

Start-up and acceptance test
You need the Drive composer PC tool or a control panel to perform the start-up and acceptance test.

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

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

Checks and settings with no voltage connected
Stop the drive and do the steps in section *Electrical safety precautions (page 8)* before you start the work.

After you have done the wiring to the POUS switch and to the indication lamp, check the connections against the appropriate circuit diagrams.

**Inverter units with parallel R8i inverter modules:**
Check that the XSTO.OUT output on the inverter control unit [A41] is chained to the STO inputs of all inverter modules.

Check that the hardware settings relevant to the safety function are set as defined in section Hardware settings.

**Settings with voltage connected**
Close the cabinet doors and power up the drive. See the hardware manual.

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

Acceptance test
Action

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

- 01.01 Motor speed used (rpm)
- 01.02 Motor speed estimated (rpm)
- 01.07 Motor current (A)
- 01.10 Motor torque (%)
- 23.01 Speed ref ramp input (rpm)
- 23.02 Speed ref ramp output (rpm)
- 90.01 Motor speed for control (rpm)
- **When using an encoder, also:** 90.10 Encoder 1 speed (rpm)

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

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

Activate the POUS function by switching off the POUS switch.

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

Make sure that the POUS indication lamp switches on.

Make sure that you cannot start the drive from any control location: Switch the external start signal off and on (in the external control mode) or press the start key of the control panel (in the local control mode).

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

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

Make sure that "STO hardware failure" (5090) is not generated. If the failure occurs, see section Fault tracing.

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

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

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

Contents of this chapter
This chapter provides general diagnostics and troubleshooting tips.

Fault tracing
This table describes the status LEDs of the POUS safety relay [A65].

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<thead>
<tr>
<th>LED</th>
<th>LED is lit and steady</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Power supply is connected.</td>
</tr>
<tr>
<td>K1</td>
<td>Relay K1 is energized.</td>
</tr>
<tr>
<td>K2</td>
<td>Relay K2 is energized.</td>
</tr>
</tbody>
</table>

If STO hardware failure (5090) is generated, check STO wiring against the circuit diagrams. See drive hardware manual for more information.

For more fault tracing possibilities, see the hardware and firmware manuals of the drive.

Reporting problems and failures related to safety functions
Contact ABB.
Maintenance

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

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

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

If you change any wiring or component after the start-up or restore parameters to their factory default values:
- Use only ABB-approved spare parts.
- Register the change to the change log for the safety circuit.
- Test the safety function again after the change. Do the start-up and acceptance test of the safety function.
- Document the tests and store the report into the logbook of the machine.

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

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

This is a recommendation and depends on the required (not achieved) SIL/PL. For example, safety relays, contactor relays, emergency stop buttons, switches, etc. are typically safety devices which contain electromechanical outputs. The STO circuit of the drive does not contain any electromechanical components.

**Competence**

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

**Residual risk**

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

**Intentional misuse**

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

**Decommissioning**

When you decommission a POUS group or a drive, make sure that the safety of the machine is maintained until the decommissioning is complete.
Technical data

Contents of this chapter

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

Safety data

■ Safety data values

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

The POUS switch is not included in the calculation since it is not included in the delivery.

Note: The POUS indication is SIL/PL-rated. For more information, see the FSO module user's manual.

<table>
<thead>
<tr>
<th>Drive module frame size</th>
<th>SIL / SILCL</th>
<th>SC</th>
<th>PL</th>
<th>PFFH</th>
<th>PFFDavg (T1=2a)</th>
<th>PFFDavg (T1=5a)</th>
<th>DC</th>
<th>Cat.</th>
<th>HFT</th>
<th>CCF</th>
<th>Mission time [a]</th>
<th>T1</th>
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<tbody>
<tr>
<td>R6, R7</td>
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<td>3</td>
<td>e</td>
<td>3.3E-09</td>
<td>1.1E-04</td>
<td>1.5E-04</td>
<td>&gt;90</td>
<td>3</td>
<td>1</td>
<td>80</td>
<td>20</td>
<td>20/5/2</td>
</tr>
<tr>
<td>R8, R9</td>
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<td>3</td>
<td>e</td>
<td>3.3E-09</td>
<td>1.1E-04</td>
<td>1.5E-04</td>
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<td>20/5/2</td>
</tr>
<tr>
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<td>3</td>
<td>e</td>
<td>3.8E-09</td>
<td>1.1E-04</td>
<td>1.6E-04</td>
<td>&gt;90</td>
<td>3</td>
<td>1</td>
<td>80</td>
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<td>20/5/2</td>
</tr>
<tr>
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<td>e</td>
<td>1.6E-10</td>
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<td>8.3E-05</td>
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</tr>
<tr>
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<td>20/5/2</td>
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<tr>
<td>3×R8i</td>
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<td>3</td>
<td>e</td>
<td>1.8E-10</td>
<td>8.3E-05</td>
<td>8.4E-05</td>
<td>&gt;90</td>
<td>3</td>
<td>1</td>
<td>80</td>
<td>20</td>
<td>20/5/2</td>
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</table>
### Technical data

<table>
<thead>
<tr>
<th>Drive module frame size</th>
<th>SIL / SilCL</th>
<th>SC</th>
<th>PL</th>
<th>PFH 1) [1/h]</th>
<th>PFD_{avg}(T_1=2a)</th>
<th>PFD_{avg}(T_1=5a)</th>
<th>DC 2) [%]</th>
<th>Cat.</th>
<th>HFT</th>
<th>CCF</th>
<th>Mission time a</th>
<th>T_1 3) 4)</th>
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<td>&gt;90</td>
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<td>80</td>
<td>20</td>
<td>20/5/2</td>
</tr>
<tr>
<td>6-8×R8i</td>
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<td>3</td>
<td>e</td>
<td>2.4E-10</td>
<td>8.3E-05</td>
<td>8.4E-05</td>
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<td>3</td>
<td>1</td>
<td>80</td>
<td>20</td>
<td>20/5/2</td>
</tr>
</tbody>
</table>

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

#### Safety component types

Safety component types as defined in IEC 61508-2:
- POUS safety relay: type A
- drive STO circuit:
  - frame sizes R1...R9 and drives with R1i...R7i inverter modules: type A
  - frame sizes R10 and R11 and drives with R8i inverter modules: type B.

#### Safety block diagrams

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

![Safety block diagram]

#### Relevant failure modes

Relevant failure modes are:
- internal failures of safety relays and STO. These failures are included in the PFH value of the function.

#### Fault exclusions

Fault exclusions (not considered in the calculations):
- any short and open circuits in the cables of the safety circuit
- any short and open circuits in the cabinet terminal blocks of the safety circuits.

#### Operation delays

Total delay for the POUS function: (less than) 100 ms.
Ambient conditions

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

- **ACS880-07 drives, frames R6 to R11**

The maximum ambient temperature for the drive with safety relays is 45 °C (113 °F). In the temperature range +40…45 °C (+104…113 °F), the rated output current must be derated by 2% for every added 1 °C (1.8 °F). The output current can be calculated by multiplying the current given in the rating table by the derating factor ($k$):

![Graph showing the derating factor $k$ for temperature range +40 °C to +45 °C.]

<table>
<thead>
<tr>
<th>Standard</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN ISO 13849-1:2015</td>
<td>Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design</td>
</tr>
<tr>
<td>IEC 61326-3-1:2017</td>
<td>Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - General industrial applications</td>
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<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>
</tbody>
</table>
### Compliance with the European Machinery Directive

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

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

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

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

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