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OPTIONS FOR ABB DRIVES

Emergency stop, stop category 0 (option +Q963) for ACS880-07/07LC/17/17LC/37/37LC drives

User's manual



Emergency stop, stop category 0 (option +Q963) for ACS880-07/07LC/17/17LC/37/37LC drives

User's manual

Table of contents



1. Safety instructions



4. Electrical installation



7. Start-up and validation test



Table of contents

1 Safety instructions

Contents of this chapter	7
Use of warnings and notes	7
Instructions for functional safety circuits	8
Electrical safety precautions	9

2 Introduction to the manual

Contents of this chapter	11
Applicability	11
Target audience	11
Exclusion of liability	11
Quick reference guide for taking a safety function into use	12
Related manuals	12
Terms and abbreviations	13

3 Option description

Contents of this chapter	15
Overview	15
Operation principle	16
Fault reaction function	17
Hardware settings	17

4 Electrical installation

Contents of this chapter	19
Wiring	19

5 Parameter settings

Contents of this chapter	21
Drive parameter settings	21
Additional parameter settings for ACS880-07/07LC drives, frames n×DXT + n×R8i and ACS880-17/17LC/37/37LC drives, frames n×R8i + n×R8i	21

6 Use of the safety function

Contents of this chapter	23
Activating the safety function	23
Resetting the safety function	23

7 Start-up and validation test

Contents of this chapter	25
Validation of the safety functions	25
Competence	25
Validation procedure	25
Validation test reports	26
Start-up and validation test	26



8 Fault tracing

Contents of this chapter 29
Fault tracing 29
Reporting problems and failures related to safety functions 30

9 Maintenance

Contents of this chapter 31
Safety circuit maintenance 31
Proof test interval 31
Competence 32
Residual risk 32
Intentional misuse 32
Decommissioning 32

10 Technical data

Contents of this chapter 33
Safety data 33
 Safety data values 33
 Safety component types 34
 Safety block diagrams 34
 Relevant failure modes 34
 Fault exclusions 34
 Operation delays 35
Ambient conditions 35
 ACS880-07 drives, frames R6...R11 35
Related standards and directives 35
Compliance with the European Machinery Directive 36

Further information



1

Safety instructions



Contents of this chapter

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

Use of warnings and notes

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

The manual uses these warning symbols:

**WARNING!**

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

**WARNING!**

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

**WARNING!**

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

Instructions for functional safety circuits

This manual does not contain the complete safety instructions of the drive. It only includes the instructions related to the scope of this manual.

Only a qualified electrical professional who has sufficient knowledge about functional, machine, and process safety is permitted to install, start up and maintain the safety circuit. All user-made changes are on the user's responsibility.



WARNING!

The safety function described in this manual does not isolate the main circuit or auxiliary circuit from the power supply. Do not do work on the drive, motor cable or motor before you have isolated the drive system from all power supplies and measured that there are no dangerous voltages. Before you start the work, do the steps in section *Electrical safety precautions (page 9)*.



WARNING!

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

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



WARNING!

Do the validation test of the safety function at the start-up and also after you make changes to the safety circuit.



WARNING!

Make sure that the functional safety of the machine is maintained in situations where the safety option does not provide protection, for example, during commissioning, system maintenance, fault tracing, or decommissioning.



WARNING!

Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do installation or maintenance work.



Electrical safety precautions

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



WARNING!

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

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

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 all dangerous external voltages from the control circuits.
 - After you disconnect power from the drive, always wait 5 minutes to let the intermediate circuit capacitors discharge before you continue.
3. Protect any other energized parts in the work location against contact.
4. Take special precautions when close to bare conductors.
5. Measure that the installation is de-energized.
 - Before and after measuring the installation, verify the operation of the voltage tester on a known voltage source.
 - Make sure that the voltage between the drive input power terminals (L1, L2, L3) and the grounding (PE) busbar is zero.
 - Make sure that the voltage between the drive output terminals (T1/U, T2/V, T3/W) and the grounding (PE) busbar is zero.
 - Make sure that the voltage between the drive DC terminals (UDC+ and UDC-) and the grounding (PE) terminal is zero. In cabinet-built drives, measure between the drive DC busbars (+ and -) and the grounding (PE) busbar.
6. Install temporary grounding as required by the local regulations.
7. Ask the person in control of the electrical installation work for a permit to work.



2

Introduction to the manual

Contents of this chapter

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

Applicability

This manual is applicable to ACS880-07/07LC/17/17LC/37/37LC drives which have the option: Emergency stop, stop category 0 with STO, with safety relays (option +Q963).

This manual shows the default design of the safety circuit ordered with option code +Q963. The actual design can be different from the default design because of customer-defined modifications. Always refer to the documentation delivered with the drive.

Target audience

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

Exclusion of liability

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

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

Quick reference guide for taking a safety function into use

Task	<input checked="" type="checkbox"/>
Connect the user-defined wiring (if any). See the wiring instructions in this manual and the circuit diagrams delivered with the drive.	<input type="checkbox"/>
Check and/or set the safety function related parameters (as listed in this manual).	<input type="checkbox"/>
Do the validation test to make sure that the implemented system meets the safety requirements. You can find the instructions for the validation test in this manual.	<input type="checkbox"/>
Document the validation test procedure. You can find the guidelines for the validation test report in this manual.	<input type="checkbox"/>

Related manuals

Manual	Code
Drive hardware	
ACS880-07 drives (560 to 2800 kW) hardware manual	3AUA0000143261
ACS880-07 drives (45 to 710 kW, 50 to 700 hp) hardware manual	3AUA0000105718
ACS880-07LC drives hardware manual	3AXD50000569786
ACS880-17 drives (160 to 3200 kW) hardware manual	3AXD50000020436
ACS880-17 drives (45 to 400 kW) hardware manual	3AXD50000035158
ACS880-17LC drives hardware manual	3AXD50000250295
ACS880-37 drives (160 to 3200 kW) hardware manual	3AXD50000020437
ACS880-37 drives (45 to 400 kW) hardware manual	3AXD50000035159
ACS880-37LC drives hardware manual	3AXD50000251407
Drive firmware	
ACS880 primary control program firmware manual	3AUA0000085967
ACS880 primary control program quick start-up guide	3AUA0000098062
ACS880 diode supply control program firmware manual	3AUA0000103295
ACS880 IGBT supply control program firmware manual	3AUA0000131562
PC tools	
Drive composer start-up and maintenance PC tool user's manual	3AUA0000094606
Functional safety design tool user's manual	TT201312111015
Safety	
Functional safety; Technical guide No. 10	3AUA0000048753
ABB Safety information and solutions	www.abb.com/safety
Options	
ACX-AP-x assistant control panels user's manual	3AUA0000085685
Other documents	
Circuit diagrams	Delivered with the drive
Part lists	Delivered with the drive
Safety data report (if the safety circuit is different from the default design)	

See www.abb.com/drives/documents for all manuals on the Internet.



[ACS880-07 \(45 to 710 kW\) manuals](#)



[ACS880-07 \(560 to 2800 kW\) manuals](#)



[ACS880-07LC manuals](#)



[ACS880-17 \(45 to 400 kW\) manuals](#)



[ACS880-17 \(160 to 3200 kW\) manuals](#)



[ACS880-17LC manuals](#)



[ACS880-37 \(45 to 400 kW\) manuals](#)



[ACS880-37 \(160 to 3200 kW\) manuals](#)



[ACS880-37LC manuals](#)

Terms and abbreviations

Term	Description
Cat.	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)
CCF	Common cause failure (%) (EN ISO 13849-1)
D8T	Frame size designation of the diode supply module
DC	Diagnostic coverage (EN ISO 13849-1)
DI	Digital input
DIIL	Digital input interlock
E-stop	Emergency stop
Frame, frame size	Physical size of the drive or power module
HFT	Hardware fault tolerance (IEC 61508)
IGBT	Insulated gate bipolar transistor

14 Introduction to the manual

Term	Description
PFD _{avg}	Average probability of dangerous failure on demand (IEC 61508)
PFH	Average frequency of dangerous failures per hour (IEC 61508)
PL	Performance level. Levels a...e correspond to SIL (EN ISO 13849-1)
SC	Systematic capability (IEC 61508)
SIL	Safety integrity level (1...3) (IEC 61508)
SILCL	Maximum SIL (level 1...3) that can be claimed for a safety function or subsystem (IEC/EN 62061)
STO	Safe torque off (IEC/EN 61800-5-2)
Stop category	<p>There are three categories of stop functions defined by IEC/EN 60204-1:</p> <ul style="list-style-type: none"> • stop category 0: an uncontrolled stop where power to the machine actuators is removed immediately (for example, STO) • stop category 1: a controlled stop where the machine actuators have power for stopping, after which the power is removed (SS1) • stop category 2: a controlled stop where the machine actuators continue to have power (SS2).
T ₁	<p>Proof test interval. Defines the probabilistic failure rate (PFH or PFD_{avg}) 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.</p>



Option description

Contents of this chapter

This chapter describes the +Q963 emergency stop option and its settings.

Overview

Option +Q963 corresponds to an uncontrolled stop in accordance with stop category 0 (IEC/EN 60204-1). When the user gives the emergency stop command, the drive activates the Safe torque off (STO) function. The Safe torque off function disables the control voltage of the power semiconductors of the drive output stage. This prevents the drive from generating the torque required to rotate the motor. The motor coasts to a stop. The main contactor/breaker of the drive is not opened.

Note: ACS880-07/07LC drives, frames n×DXT + n×R8i with a main contactor/breaker (option +F250/+F255), ACS880-17/17LC/37/37LC drives, frames n×R8i + n×R8i, and ACS880-17/37 drives, frames R8 and R11: When the inverter unit STO is activated, the main contactor/breaker is opened after a user-defined delay (defined with parameter 94.11, the default value is 600 s). See the hardware and firmware manuals for more information.

For a detailed description of the Safe torque off function, see the hardware manual.

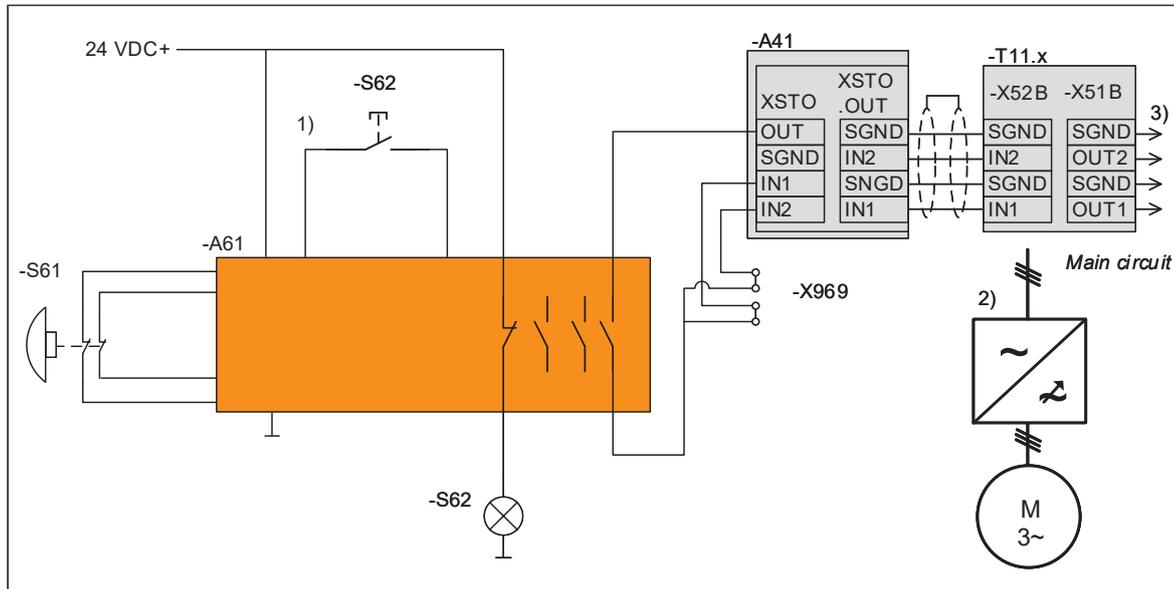
The STO function complies with IEC/EN 61800-5-2.

The design principles of the option +Q963 comply with EN ISO 13850.

For a complete list of related standards and European directives, see section [Related standards and directives \(page 35\)](#).

Operation principle

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



A41	Inverter control unit
A61	Emergency stop safety relay
S61	Emergency stop button
S62	Emergency stop reset button with indicator light
X969	STO terminal block
T11.x	Inverter module(s) under inverter unit T11 (only for R8i)
1)	Reset circuit
2)	Drive module
3)	To parallel R8i modules (if any)

Step	Operation
	Initial status: The drive is in operation and the motor is running.
1	The user activates the emergency stop with the emergency stop button [S61].
2	The emergency stop safety relay [A61] de-energizes the XSTO inputs IN1 and IN2 of the inverter control unit [A41]. This activates the Safe torque off function.
3	The emergency stop reset button indicator light [S62] comes on.
4	The motor coasts to a stop. The motor cannot be started while the emergency stop is active.
5	Normal operation resumes after the user: <ul style="list-style-type: none"> releases the emergency stop button [S61] to normal (up) position pushes the emergency stop reset button [S62] for 0.1 ... 3 seconds to reset the emergency stop circuit 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 tries to initiate a safe state if it detects a failure in the safety system.

The fault reaction function of the emergency stop safety relay trips the system, if it detects a failure in the safety circuit (for example, short circuit between signals, open circuit, or redundancy fault).

If a fault is detected, the fault reaction function:

- activates the emergency stop command
- activates the drive STO function
- keeps the safe state activated and the emergency stop reset button indicator light on until the fault is repaired and the safety function is reset.

Note: Resetting the safety function is not possible, if the reset circuit in the emergency stop safety relay is open.

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

Hardware settings

The hardware settings for the safety function are set at the factory.

The settings in the emergency stop safety relay [A61] are:

- Cross fault detection is set to *With*
- Start mode is set to *Manual*.

Note: If the cross fault detection is set to *Without*, the fault diagnostics of the wiring decreases.

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

4

Electrical installation

Contents of this chapter

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

Wiring

One emergency stop button and one reset button are installed on the cabinet door and wired to the drive at the factory. There are double contacts in the emergency stop button and double wiring (redundant two-channel connection) between the button and the emergency stop safety relay [A61]. The safety relay detects cross faults and faults across one contact from the emergency stop button.

If necessary, install additional emergency stop buttons on site and connect them to the applicable terminal block inside the drive cabinet. Refer to the circuit diagrams delivered with the drive. Obey these general rules:

1. Use only double-contact buttons approved for emergency stop circuits.
2. Connect the emergency stop buttons with two conductors (two-channel connection). Keep the channels separate.

Note: If you use only one channel in a two-channel implementation, or if the channels are connected together, the cross fault detection of the emergency stop relay detects a redundancy fault and activates the fault reaction function.

Note: The safety circuit design can be different when modified according to the customer's safety requirements. Refer to the circuit diagrams delivered with the drive.

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



20 Electrical installation

4. Make sure that the sum resistance for one channel (loop resistance) is not more than 70 ohms.
5. Obey the general control cable installation instructions given in the drive hardware manual.

You can also install additional reset buttons and indication lamps for the emergency stop circuit on site. ABB recommends gold-plated contacts in the reset button. Connect the buttons to the applicable terminal block inside the drive cabinet. Refer to the circuit diagrams delivered with the drive. Obey the rules below:

1. Sum resistance of the external reset circuit must not be more than 70 ohms.
2. Obey the general control cable installation instructions given in the drive hardware manual.





5

Parameter settings

Contents of this chapter

This chapter contains the parameter settings related to the safety function.

Drive parameter settings

This section shows the drive parameter settings related to the safety function in the ACS880 primary control program.

The table that follows shows the parameters that are set at the factory.

No.	Name	Default value ¹⁾	Description
31.22	STO indication run/stop	Warning/Warning	Selects which indications are given when one or both Safe torque off (STO) signals are switched off or lost. <i>Warning/Warning</i> is the recommended setting.

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

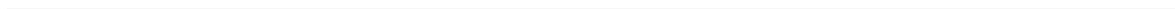
Additional parameter settings for ACS880-07/07LC drives, frames n×DXT + n×R8i and ACS880-17/17LC/37/37LC drives, frames n×R8i + n×R8i

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

The parameters are set at the factory. The supply unit parameter settings in the ACS880 supply control programs:

- parameter *121.05 Emergency stop source* is set to value *Inactive*.

For more information, see the firmware manuals.



6

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

Activation procedure:

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

When the emergency stop is active, the following indications are shown:

- the drive control program has the indication *Safe torque off* active
- the emergency stop reset button indicator light [S62] on the cabinet door is on.

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

Resetting the safety function

**WARNING!**

Make sure that the drive does not start accidentally. This can occur after the reset of the safety function, if a level-triggered start command and the start enable signal are on at the same time.

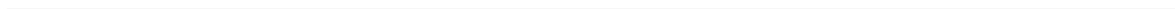
1. Turn the emergency stop button [S61] until it releases.
 2. Push the emergency stop reset button [S62] on the cabinet door for 0.1 ... 3 seconds. The emergency stop reset button indicator light [S62] goes off, and the emergency stop is deactivated.
 3. If necessary, reset faults from the drive.
-

24 Use of the safety function

4. Make sure that the drive receives the start signal. See the firmware manual.

5. You can now restart the drive.

You must also reset the emergency stop safety relay [A61] with the emergency stop reset button [S62] each time after you energize the relay.



7

Start-up and validation test

Contents of this chapter

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

Validation of the safety functions

You must do a validation test to validate the correct operation of safety functions.

■ Competence

The person who does the validation test of the safety function must be a competent person with expertise and knowledge of the safety function and functional safety, as required by IEC 61508-1 clause 6. This person must document and sign the test procedures and report.

■ Validation procedure

You must do the validation test using the checklist given in this manual:

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

The validation test must include at least the following steps:

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



■ Validation test reports

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

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

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

Start-up and validation test

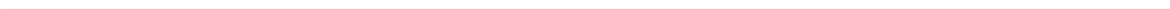
You must use the Drive composer PC tool or a control panel to do the start-up and validation test.

Action	<input checked="" type="checkbox"/>
 WARNING! Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.	<input type="checkbox"/>
Initial status	
Make sure that the drive is ready for use, that is, you have done the tasks of the drive start-up procedure. See the hardware manual.	<input type="checkbox"/>
Make sure that the STO function is configured and validated.	<input type="checkbox"/>
Checks and settings with no voltage connected	
Stop the drive and do the steps in section <i>Electrical safety precautions (page 9)</i> before you start the work.	<input type="checkbox"/>
If you have done any connections for the emergency stop circuit on site (such as wiring of additional emergency stop buttons, connection of shipping splits of large drives, etc.), check the connections against the applicable circuit diagrams.	<input type="checkbox"/>
<u>Inverter units with parallel R8i inverter modules:</u> Make sure that the XSTO.OUT output on the inverter control unit [A41] is chained to the STO inputs of all inverter modules.	<input type="checkbox"/>
Make sure that the hardware settings of the safety function are set as defined in section <i>Hardware settings (page 17)</i> .	<input type="checkbox"/>
Settings with voltage connected	
Close the cabinet doors and power up the drive. See the hardware manual.	<input type="checkbox"/>
Make sure that the parameter settings related to the safety functions are correct. See chapter <i>Parameter settings</i> .	<input type="checkbox"/>



Action	<input checked="" type="checkbox"/>
Validation test	
<p>ABB recommends that you monitor these signals with the Drive composer PC tool:</p> <ul style="list-style-type: none"> • 01.01 Motor speed used (rpm) • 01.02 Motor speed estimated (rpm) • 01.07 Motor current (A) • 01.10 Motor torque (%) • 06.18 Start inhibit status word • 23.01 Speed ref ramp input (rpm) • 23.02 Speed ref ramp output (rpm) • 90.01 Motor speed for control (rpm) • <u>When using an encoder, also:</u> 90.10 Encoder 1 speed (rpm) 	<input type="checkbox"/>
Make sure that it is safe to start, run and stop the motor(s) during the test.	<input type="checkbox"/>
Start the drive and make sure that the motor is running. If possible, use a motor speed close to the maximum speed of the application.	<input type="checkbox"/>
Push the emergency stop button [S61].	<input type="checkbox"/>
Make sure that the drive stops the motor by coasting and the control panel displays a related warning.	<input type="checkbox"/>
Make sure that the emergency stop reset button indicator light [S62] comes on.	<input type="checkbox"/>
<p>Make sure that the drive generates none of these faults:</p> <ul style="list-style-type: none"> • STO hardware failure (5090) • Safe torque off 1 loss (FA81) • Safe torque off 2 loss (FA82) <p>If the drive generates one or more of these faults, see section Fault tracing (page 29).</p>	<input type="checkbox"/>
Make sure that you cannot start the drive or motor from any control location. Make sure that the drive or motor does not start when you switch the start signal off and on, or push the start key of the panel when the panel is in local control mode.	<input type="checkbox"/>
Switch off the drive start signal.	<input type="checkbox"/>
Turn the emergency stop button [S61] until it releases and returns to the up position.	<input type="checkbox"/>
Push the emergency stop reset button [S62] to reset the emergency stop circuit.	<input type="checkbox"/>
Make sure that the emergency stop reset button indicator light [S62] goes off.	<input type="checkbox"/>
<p>Power up the drive:</p> <ul style="list-style-type: none"> • If the drive tripped on a fault, reset the faults from the drive • Make sure that the operating switch is set to ON (1) • Switch on the drive start signal. <p>For more information, see the hardware manual.</p>	<input type="checkbox"/>
Restart the drive and make sure that the drive and the motor operate normally.	<input type="checkbox"/>
Do the test again from each operating location (for every emergency stop button and reset button).	<input type="checkbox"/>
Fill in and sign the validation test report. Store the report in the logbook of the machine.	<input type="checkbox"/>







Fault tracing

Contents of this chapter

This chapter provides general diagnostics and troubleshooting tips.

Fault tracing

The emergency stop safety relay [A61] type is DOLD LG 5925.

This table gives the indications of the DOLD LG 5925 relay:

LED	LED is on	LED is off
Netz	Power supply is connected.	Power supply is not connected, or there is an external error.
K1	Relay K1 is energized.	There is an external error.
K2	Relay K2 is energized.	There is an external error.

For more information, see the data sheet of the relay (www.dold.com).

If there is a fault, the emergency stop safety relay [A61] can go into a fault mode. If this occurs, you must restart the relay. Switch off the external power supply of the relay and then switch it back on.

If you cannot reset the emergency stop function with the emergency stop reset button [S62], check the reset circuit connections. Refer to the circuit diagrams delivered with the drive.

Use a multimeter to measure the STO circuit connections, if the drive generates one or more of these faults:

- STO hardware failure (5090)
 - Safe torque off 1 loss (FA81)
 - Safe torque off 2 loss (FA82)
-

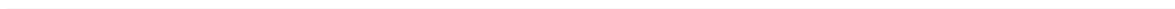
30 Fault tracing

Refer to the circuit diagrams delivered with the drive.

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

Reporting problems and failures related to safety functions

Contact ABB.



A large, bold, black number '9' is centered within a light grey square with rounded corners.

Maintenance

Contents of this chapter

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

Safety circuit maintenance

After the safety function is validated, it must be maintained by periodic proof testing.

If you change the wiring or a component after the start-up, or restore parameters to their factory default values:

- Use only ABB-approved spare parts.
- Register the change to the change log for the safety circuit.
- If parameters were restored to the factory default values: Set the parameters related to the safety function.
- Do the validation test of the safety function.
- Document the tests and store the report into the logbook of the machine.

Proof test interval

Periodic proof testing of the safety function is necessary to maintain the required SIL/PL-level. In high demand mode of operation, the maximum proof test interval is 20 years. In low demand mode of operation, the maximum proof test interval is 2 or 5 years (high or low demand as defined in IEC 61508, IEC/EN 62061 and EN ISO 13849-1). Regardless of the mode of operation, it is a good practice to do the proof test for the safety function at least once a year. It is also a good practice to include the proof test for the safety function in the routine maintenance program of the machinery.

The person responsible for the design of the complete safety system should also note the Recommendation of Use CNB/M/11.050 published by the European co-ordination of Notified Bodies for Machinery concerning dual-channel safety-related systems with electromechanical outputs:

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

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

Competence

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

Residual risk

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

Intentional misuse

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

Decommissioning

When you decommission an emergency stop circuit or a drive, make sure that the functional safety of the machine is maintained by other means until the decommissioning is completed.



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. If the final design is different from the default, ABB calculates new safety data and delivers it separately to the customer.

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

Drive module frame size	SIL / SIL-CL	SC	PL	PFH ¹⁾ [1/h]	PFD _{avg} (T ₁ =2a)	PFD _{avg} (T ₁ =5a)	DC ²⁾ [%]	Cat.	HFT	CCF	Mission time [a]	T ₁ ^{3) 4)} [a]
R6, R7	3	3	e	4.6E-8	3.7E-04	4.1E-04	≥90	3	1	80	20	20/5/2
R8, R9	3	3	e	4.6E-8	3.7E-04	4.1E-04	≥90	3	1	80	20	20/5/2
R10, R11	3	3	e	4.7E-8	3.8E-04	4.3E-04	≥90	3	1	80	20	20/5/2
1×R8i	3	3	e	4.3E-8	3.5E-04	3.5E-04	≥90	3	1	80	20	20/5/2
2×R8i	3	3	e	4.3E-8	3.5E-04	3.5E-04	≥90	3	1	80	20	20/5/2
3×R8i	3	3	e	4.3E-8	3.5E-04	3.5E-04	≥90	3	1	80	20	20/5/2
4×R8i	3	3	e	4.3E-8	3.5E-04	3.5E-04	≥90	3	1	80	20	20/5/2
5×R8i	3	3	e	4.3E-8	3.5E-04	3.5E-04	≥90	3	1	80	20	20/5/2

Drive module frame size	SIL / SIL-CL	SC	PL	PFH ¹⁾ [1/h]	PFD _{avg} (T ₁ =2a)	PFD _{avg} (T ₁ =5a)	DC ²⁾ [%]	Cat.	HFT	CCF	Mission time [a]	T ₁ ^{3) 4)} [a]
6...8×R8i	3	3	e	4.3E-8	3.5E-04	3.5E-04	≥90	3	1	80	20	20/5/2
3AXD10000097591 J												

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 coordination of notified bodies for lower T₁ requirement.

4) T₁ = 20a is used with high demand mode of operation. T₁ = 2a/5a is used with low demand mode of operation.

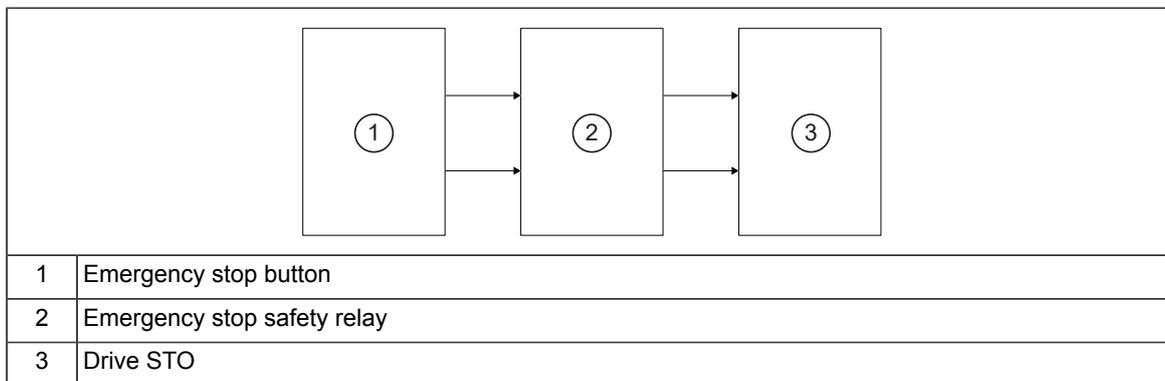
■ Safety component types

Safety component types as defined in IEC 61508-2:

- emergency stop button: type A
- safety relay(s): 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). The components not included in the delivery are not included in the safety data calculations.



■ Relevant failure modes

Relevant failure modes are:

- internal failures of safety relays, STO and the emergency stop button. These failures are included in the PFH value of the function.

■ Fault exclusions

Fault exclusions (not considered in the calculations):

- short and open circuits in the cables of the safety circuit
- short and open circuits in the cabinet terminal blocks of the safety circuits.

■ **Operation delays**

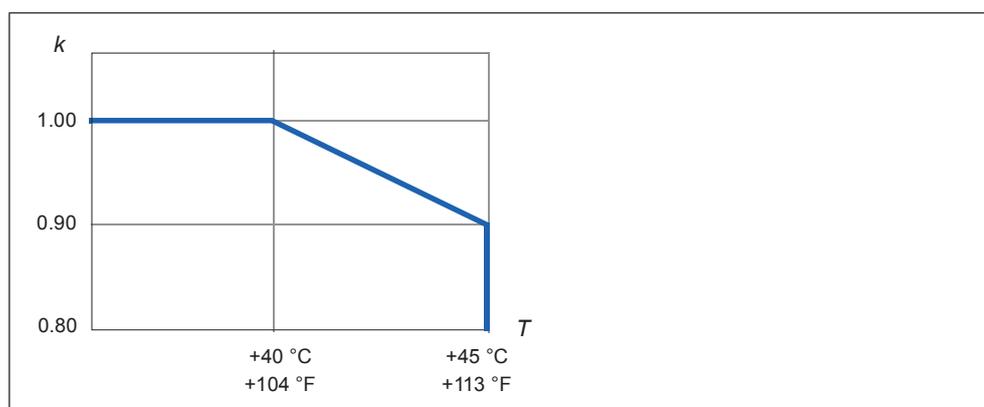
Emergency stop total delay: less than 500 ms.

Ambient conditions

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

■ **ACS880-07 drives, frames R6...R11**

The maximum surrounding air 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*):



Related standards and directives

Standard	Name
EN ISO 12100:2010	Safety of machinery – General principles for design – Risk assessment and risk reduction
EN ISO 13849-1:2015	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design
EN ISO 13849-2:2012	Safety of machinery – Safety-related parts of control systems – Part 2: Validation
EN ISO 13850:2015	Safety of machinery. Emergency stop. Principles for design.
EN 60204-1:2018 IEC 60204-1:2016	Safety of machinery – Electrical equipment of machines – Part 1: General requirements
IEC 61326-3-1:2017	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) - General industrial applications
IEC 61508-1:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements
IEC 61508-2:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
IEC 61511-1:2016	Functional safety – Safety instrumented systems for the process industry sector – Part 1: Framework, definitions, system, hardware and application programming requirements

Standard	Name
EN 61800-5-2:2007 IEC 61800-5-2:2016	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional
EN 62061:2005 + AC:2010 + A1:2013 + A2:2015 IEC 62061:2015 Ed. 1.2	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
2006/42/EC	European Machinery Directive
Other	Machine-specific C-type standards

Compliance with the European Machinery Directive

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

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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