OPTIONS FOR ABB DRIVES

Emergency stop, stop category 0 (option +Q951) for ACS880-07/07LC/17/17LC/37/37LC drives

User's manual

Emergency stop, stop category 0 (option +Q951) for ACS880-07/07LC/17/17LC/37/37LC drives

User's manual

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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 8)*.

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 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.
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

The manual is applicable to ACS880-07/07LC/17/17LC/37/37LC drives which have the option: Emergency stop, stop category 0 with main contactor/breaker, with safety relays (option +Q951).

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 make sure that the implemented system meets the safety requirements. You can find the instructions for the acceptance test in this manual.	☐
Document the acceptance test procedure. You can find the guidelines for the acceptance test report in this manual.	☐

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
Safety and functional safety; A general guide	1SFC001008B0201
ABB Safety information and solutions	www.abb.com/safety
Options	
ACX-AP-x assistant control panels user’s manual	3AUA0000085685
Manuals and quick guides for I/O extension modules, fieldbus adapters, etc.	
Other documents	
Circuit diagrams	Delivered with the drive
Part lists	Delivered with the drive

Manual	Code
Safety data report (if the safety circuit is order-based engineered)	

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

ACS880-17 (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

Term	Description
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
Inverter unit	Inverter module(s) under control of one control unit, and related components. One inverter unit typically controls one motor.
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	There are three categories of stop functions defined by IEC/EN 60204-1: • 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).
Supply unit	Supply module(s) under control of one control unit, and related components.
T_1	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 T_1 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 T_1 values given cannot be regarded as a guarantee or warranty.

3

Option description

Contents of this chapter

This chapter describes the +Q951 emergency stop option and its settings.

Overview

Option +Q951 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 opens the main contactor/breaker, which disconnects the input power from the drive. The motor coasts to a stop.

The drive main circuit is de-energized while the emergency stop is active and the main contactor/breaker is open, but the auxiliary circuit stays energized. Note that activating the emergency stop function does not isolate the drive or motor from dangerous voltages.

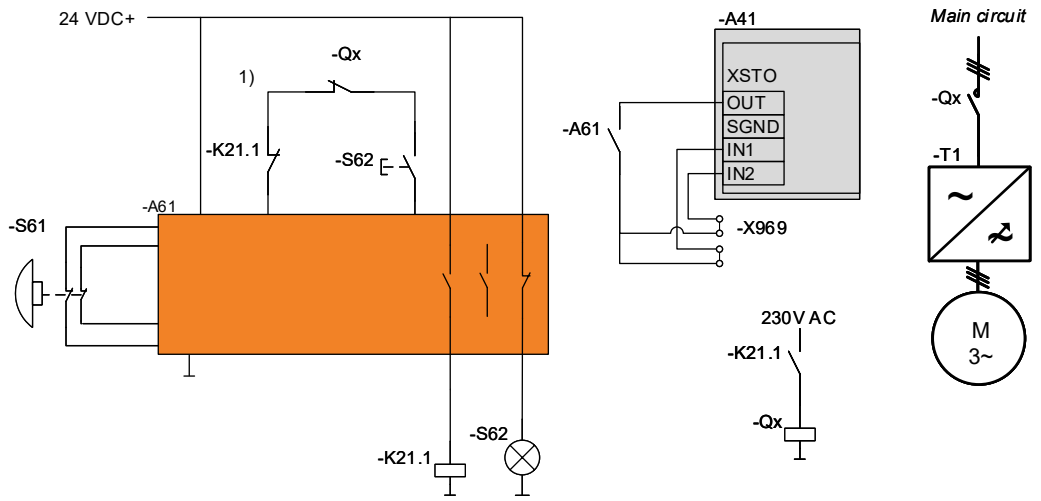
The design principles of the option +Q951 comply with EN ISO 13850.

For a list of related standards and European directives, see section *Related standards and directives (page 49)*.

Operation principle

The figures show a simplified operation principle. Implementation of main contactor/breaker and charging circuit can vary depending on the product. For a more detailed description, see the circuit diagrams delivered with the drive.

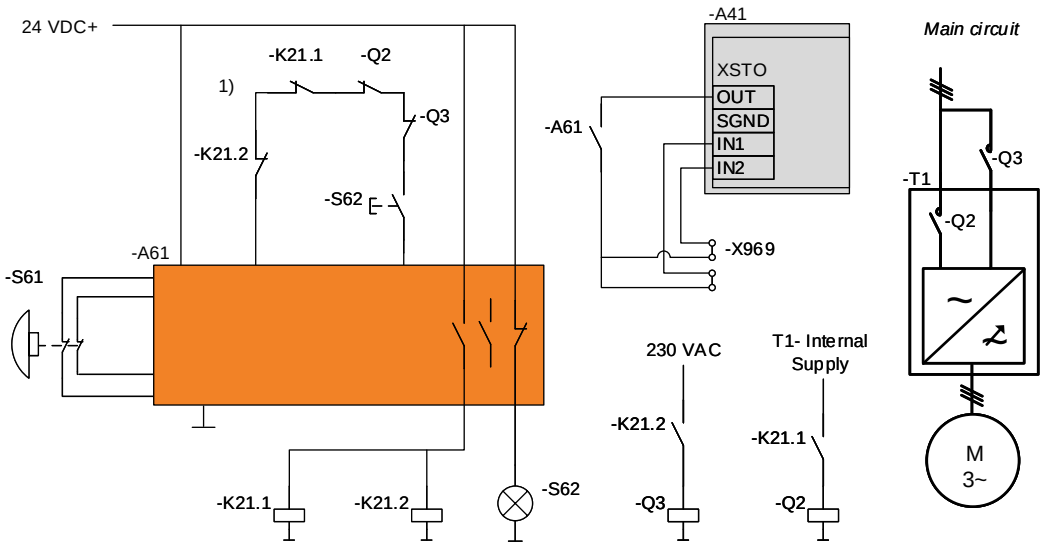
ACS880-07 drives, frames R6 to R11 and ACS880-17/-37 drives, frame R8



A41	Inverter control unit
A61	Emergency stop safety relay
S61	Emergency stop button
S62	Emergency stop reset button with indicator light
K21.1	Safety relay
X969	STO terminal block
T1	Drive module
Qx	Main contactor/breaker (Q2 or Q1)
1)	Reset circuit

Step	Operation
	Initial status: The drive is in operation and the motor is running.
1.	The user activates 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], which activates the Safe torque off function. The emergency stop safety relay [A61] de-energizes the safety relay [K21.1], which opens the main contactor/breaker [Qx]. The main contactor/breaker [Qx] disconnects the power supply from the drive module [T1].
3.	The emergency stop reset button indicator light [S62] comes on.
4.	The drive stops the motor by coasting. The motor stays stopped while the emergency stop is active.
5.	Normal operation resumes after the user: • 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).

ACS880-17/37 drives, frame R11

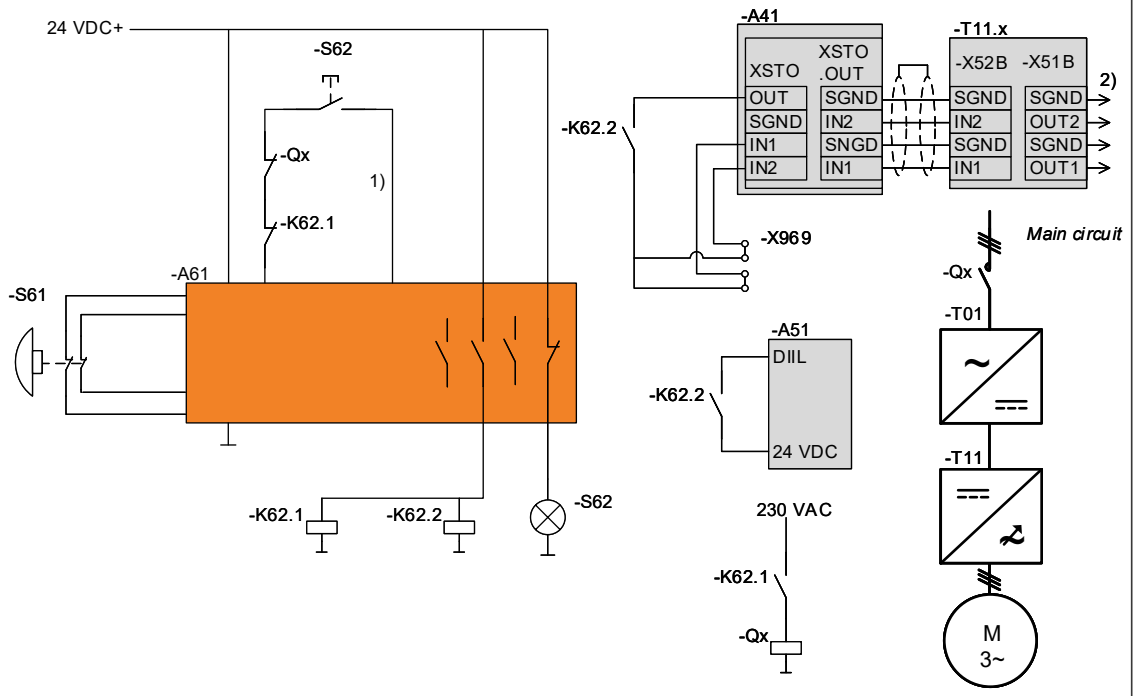


A41	Inverter control unit
A61	Emergency stop safety relay
S61	Emergency stop button
S62	Emergency stop reset button with indicator light
K21.1	Safety relay
K21.2	Safety relay
X969	STO terminal block
Q2	Main contactor
Q3	Charging contactor
T1	Drive module
1)	Reset circuit

Step	Operation
	Initial status: The drive is in operation and the motor is running.
1.	The user activates 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], which activates the Safe torque off function. The emergency stop safety relay [A61] de-energizes the safety relays [K21.1] and [K21.2], which opens the main contactor [Q2] and the charging supply contactor [Q3]. The main contactor [Q2] disconnects the power supply from the drive module [T1].
3.	The emergency stop reset button indicator light [S62] comes on.
4.	The drive stops the motor by coasting. The motor stays stopped while the emergency stop is active.

Step	Operation
5.	Normal operation resumes after the user: • 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).

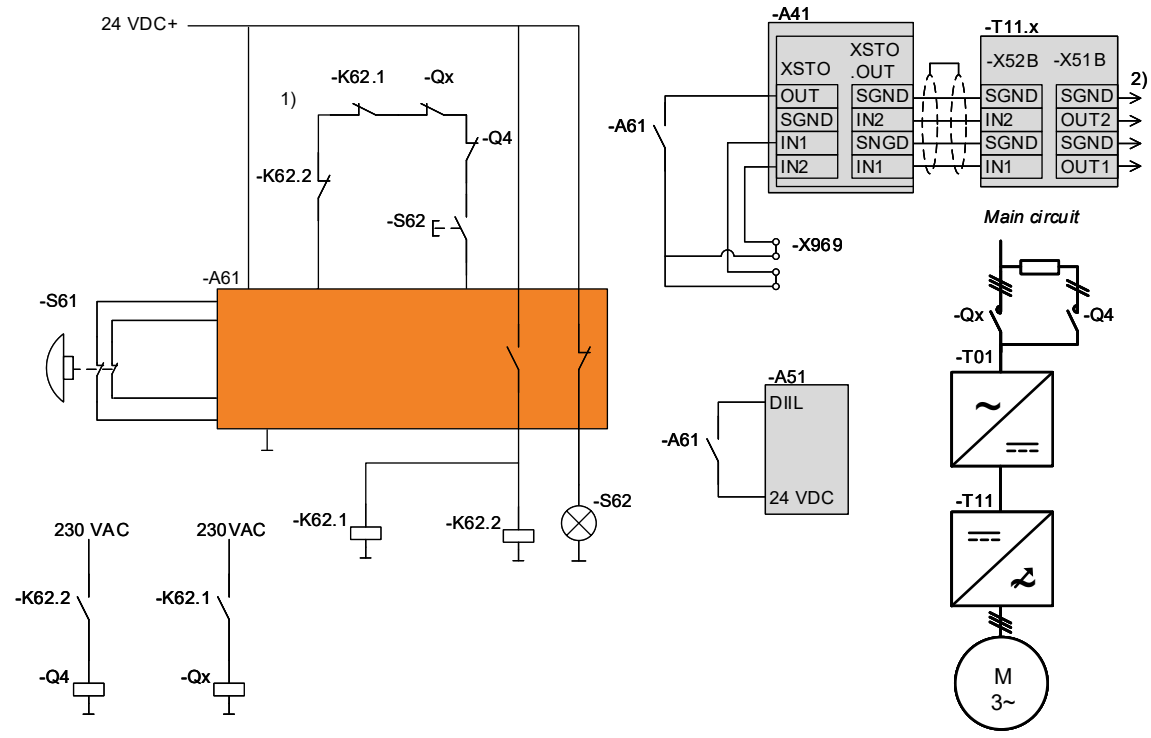
ACS880-07/07LC drives, frames n×DXT + n×R8i



A41	Inverter control unit
A51	Supply control unit
A61	Emergency stop safety relay
S61	Emergency stop button
S62	Emergency stop reset button with indicator light
K62.1	Safety relay
K62.2	Safety relay
X969	STO terminal block
Qx	Main contactor/breaker (Q2 or Q1)
T01	Supply unit
T11	Inverter unit
T11.x	Inverter module(s) under inverter unit T11
1)	Reset circuit
2)	To parallel inverter modules (if any)

Step	Operation
	Initial status: The drive is in operation and the motor is running.
1.	The user activates emergency stop with the emergency stop button [S61].
2.	The emergency stop safety relay [A61] de-energizes safety relays [K62.1] and [K62.2]. The safety relay [K62.1] opens the main contactor/breaker [Qx]. The main contactor/breaker [Qx] disconnects the power supply from the supply unit [T01]. The safety relay [K62.2] de-energizes the DIIL input of the supply control unit [A51] and the XSTO inputs IN1 and IN2 of the inverter control unit [A41], which activates the Safe torque off function.
3.	The emergency stop reset button indicator light [S62] comes on.
4.	The drive stops the motor by coasting. The motor stays stopped while the emergency stop is active.
5.	Normal operation resumes after the user: • 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).

ACS880-17/37 and -17LC/37LC drives, frames n×R8i + n×R8i



A41	Inverter control unit
A51	Supply control unit
A61	Emergency stop safety relay
S61	Emergency stop button
S62	Emergency stop reset button with indicator light
K62.1	Safety relay

K62.2	Safety relay
X969	STO terminal block
Qx	Main contactor/breaker (Q2 or Q1) (Component can also be installed by the customer.)
Q4	Charging contactor
T01	Supply unit
T11	Inverter unit
T11.x	Inverter module(s) under inverter unit T11
1)	Reset circuit
2)	To parallel inverter modules (if any)

Step	Operation
	Initial status: The drive is in operation and the motor is running.
1.	The user activates emergency stop with the emergency stop button [S61].
2.	The emergency stop safety relay [A61] de-energizes safety relays [K62.1] and [K62.2]. The safety relay [K62.1] opens the main contactor/breaker [Qx]. The main contactor/breaker [Qx] disconnects the power supply from the supply unit [T01]. The safety relay [K62.2] de-energizes the DIIL input of the supply control unit [A51] and the XSTO inputs IN1 and IN2 of the inverter control unit [A41], which activates the Safe torque off function. The charging contactor [Q4] is opened, if the emergency stop is activated during charging.
3.	The emergency stop reset button indicator light [S62] comes on.
4.	The drive stops the motor by coasting. The motor stays stopped while the emergency stop is active.
5.	Normal operation resumes after the user: • 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).

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 STO function
- opens the main contactor/breaker
- keeps the safe state activated and the emergency stop reset button indication lamp 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.

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 value *On*,
- manual reset is set to value *On*.

Note: If the cross fault detection is not set to value *On*, 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 (if any).

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

Customer-installed main breaker in ACS880-07LC/17LC/37LC drives

ACS880-07LC/17LC/37LC drives can be delivered without a factory-installed main breaker. In these cases, the customer must install and connect the main breaker to the safety circuit as described in the circuit diagrams.

5

Parameter settings

Contents of this chapter

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

Drive parameter settings

The parameter setting in ACS880 primary control program:

No.	Name	Default value	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. *Warning/Warning* is the recommended setting.

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 *121.04 Emergency stop mode* is set to value *Stop and warning*
- parameter *121.05 Emergency stop source* is set to value *DIIL*.

For more information, see the firmware manuals.

Additional parameter settings for ACS880-17/37, frames R8 and R11

The parameters are set at the factory.

The inverter unit parameter settings in the ACS880 primary control program:

- parameter *06.40 LSU CW user bit 0 selection* is set to Bit 7 (STO) of *06.18 Start inhibit status word*

The supply unit parameter settings in the ACS880 supply control programs:

- parameter *121.05 Emergency stop source* is set to Bit12- (user bit 0, inverted value) of *106.01 Main control word*

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

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!
If the drive start signal is on, and the operating switch is set to ON (1), the drive starts automatically after the reset.

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 indication lamp of the emergency stop reset button [S62] goes off, the emergency stop safety relay [A61] resets and the emergency stop deactivates.
3. Reset faults from the drive, if necessary.

You can now close the main contactor/breaker and start the drive.

Note: You must also reset the emergency stop safety relay [A61] with the emergency stop reset button [S62] every time after you energize the relay. If you do not reset the relay, you cannot close the main contactor.

7

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 person who does the acceptance 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 acceptance 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 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 must use the Drive composer PC tool or a control panel to do the start-up and acceptance test.

Action	☑
WARNING! Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.	☐
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.	☐
Make sure that the STO function has been configured and validated.	☐
Checks and settings with no voltage connected	
Stop the drive and do the steps in section *Electrical safety precautions (page 8)* before you start the work.	☐
If you have done any connections for the emergency stop circuit on site (such as wiring of additional emergency stop buttons, connection of shipping splits of large drives, etc.), check the connections against the applicable circuit diagrams.	☐
Inverter units with parallel R8i inverter modules: Make sure that the XSTO.OUT output on the inverter control unit [A41] is chained to the STO inputs of all inverter modules.	☐
Make sure that the hardware settings of the safety function are set as defined in section *Hardware settings (page 21)*.	☐
Settings with voltage connected	
Close the cabinet doors and power up the drive. See the hardware manual.	☐
Make sure that the parameter settings related to the safety functions are correct. See chapter *Parameter settings (page 25)*.	☐

Action	☑
Acceptance test	
ABB recommends 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. If possible, use a motor speed close to the maximum speed of the application.	☐
Push the emergency stop button [S61].	☐
Make sure that the drive stops the motor by coasting and the control panel displays a related warning.	☐
Make sure that the emergency stop reset button indicator light [S62] comes on.	☐
Make sure that the main contactor/breaker opens as described in this manual.	☐
Make sure that the drive generates none of these faults: • STO hardware failure (5090) • Safe torque off 1 loss (FA81) • Safe torque off 2 loss (FA82) If the drive generates one or more of these faults, see section *Fault tracing (page 33)*.	☐
Make sure that you cannot close the main contactor/breaker with the operating switch or by other means.	☐
Make sure that you cannot start the drive and motor from any control location. Make sure that the 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.	☐
Switch off the drive start signal.	☐
Turn the emergency stop button [S61] until it releases and returns to the up position.	☐
Push the emergency stop reset button [S62] to reset the emergency stop circuit.	☐
Make sure that the emergency stop reset button indicator light [S62] goes off.	☐
Power up the drive: • 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. For more information, see the hardware manual.	☐
Restart the drive and make sure that the drive and the motor operate normally.	☐
Repeat the test from each operating location (for every emergency stop button and reset button).	☐
Fill in and sign the acceptance test report which verifies that the safety function is safe and accepted for operation.	☐

8

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

This table describes the status LEDs of the emergency stop safety relay [A61].

LED	LED is on	LED is off
Netz	Power supply is connected.	Power supply is not connected, or during external errors.
K1	Relay K1 is energized.	During external errors.
K2	Relay K2 is energized.	During external errors.

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 safety relay with the emergency stop reset button [S62], check the reset circuit connections. See the circuit diagrams delivered with the drive.

Check the safety circuit connections against the circuit diagrams, 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)

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

Reporting problems and failures related to safety functions

Contact ABB.

9

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 function is tested at start-up, the safety function must be maintained by:

- periodic proof testing
- replacing main contactor or breaker before the end of its specified lifetime.

See the contactor/breaker data sheet or manual.

It is also 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.
- If parameters were restored to the factory default values: Set the parameters related to the safety function.
- 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 1 year (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 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 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 safety of the machine is maintained until the decommissioning is complete.

10

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 following assumptions on the operation of the main contactor [Q2]:

- It is switched at low load current (normal use, ~0%, AC-1).
- It is used for the emergency stop once a month.
- It is used for the ordinary on and off once a day.

The safety data calculations are based on the following assumptions on the operation of the main breaker [Q1]:

- It is switched at low load current (normal use, ~0%, AC-1).
- It is used for the emergency stop once a month.
- It is used for the ordinary on and off once a week.

ACS880-07 drives with a main contactor (option +F250)

ACS880-07 type	Contactor	SIL / SIL-CL	SC	PL	PFH [1/h] [1)]	PFD_{avg}	DC [%] [2)]	Cat.	HFT	CCF	Mission time [a]	T_1 [a] [3) 4)]
-0105A-3 to -0293A-3 -0096A-5 to -0260A-5 -0061A-7 to -0271A-7	AF145, AF146 or AF260	2	3	d	5.0E-7	6.8E-4	>90	2	0	65	20	20/1
-0363A-3 -0430A-3 -0302A-5 to -0414A-5 -0330A-7 to -0430A-7	AF400	2	3	d	5.0E-7	6.8E-4	>90	2	0	65	20	20/1
-0505A-3 to -0725A-3 -0460A-5 to -0715A-5 -0470A-7 to -0721A-7	AF750	2	3	d	5.0E-7	6.8E-4	>90	2	0	65	20	20/1

ACS880-07 type	Contactor	SIL / SIL-CL	SC	PL	PFH [1/h] [1)]	PFD_{avg}	DC [%] [2)]	Cat.	HFT	CCF	Mission time [a]	T_1 [a] [3) 4)]
With frame R11: -0820A-3 -0880A-3 -0820A-5 -0880A-5 With frame R8i: -0990A-3 -1140A-3 -1250A-3 -1480A-3 -1760A-3 -2210A-3 -2610A-3 -0990A-5 -1070A-5 -1320A-5 -1450A-5 -1580A-5 -1800A-5 -1980A-5 -0800A-7 -0900A-7 -0950A-7 -1160A-7 -1450A-7 -1650A-7 -1950A-7 -2300A-7 -2600A-7 -2860A-7	AF1250 or AF2050	2	3	d	5.0E-7	6.8E-4	>90	2	0	65	20	20/1

ACS880-07 type	Contactor	SIL / SIL-CL	SC	PL	PFH [1/h] [1]	PFD_{avg}	DC [%] [2]	Cat.	HFT	CCF	Mission time [a]	T_1 [a] [3] [4]
-1250A-3 -1480A-3 -1760A-3 -2210A-3 -2610A-3 -0990A-3 [5] -1140A-3 [5] -1250A-3 [5] -1480A-3 [5] -1760A-3 [5] -2210A-3 [5] -2610A-3 [5] -1070A-5 -1320A-5 -1450A-5 -1580A-5 -1800A-5 -1980A-5 -0990A-5 [5] -1320A-5 [5] -1450A-5 [5] -1580A-5 [5] -1800A-5 [5] -1980A-5 [5] -1160A-7 -1450A-7 -1650A-7 -1950A-7 -2300A-7 -2600A-7 -2860A-7 -0800A-7 [5] -0950A-7 [5] -1160A-7 [5] -1450A-7 [5] -1650A-7 [5] -1950A-7 [5] -2300A-7 [5] -2600A-7 [5] -2860A-7 [5]	2× AF1250 or 2× AF2050	2	3	d	7.3E-7	8.3E-4	>90	2	0	65	20	20/1
												3AXD10000097591 H

1) PFH values are according to EN ISO 13849.

2) In low demand mode, DC of electromechanical devices is considered as 0%, and therefore no overall DC value is claimed in low demand mode.

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 = 1a is used with low demand mode of operation.

5) 12-pulse variant

Note: If T_1 > 1a is needed in low demand mode of operation, SIL 1 / PL c levels are used and PFD is calculated separately.

ACS880-17/37 drives with a main contactor (option +F250)

ACS880-17/37 type	Contactor	SIL / SIL-CL	SC	PL	PFH 1) [1/h]	PFD_{avg}	DC 2) [%]	Cat.	HFT	CCF	Mission time [a]	T_1 3) 4) [a]
-0105A-3 -0145A-3 -0169A-3 -0206A-3 -0101A-5 -0124A-5 -0156A-5 -0180A-5	AF145, AF146 or AF260	2	3	d	5.0E-7	6.8E-4	>90	2	0	65	20	20/1
-0293A-3 -0363A-3 -0442A-3 -0505A-3 -0585A-3 -0650A-3 -0260A-5 -0302A-5 -0361A-5 -0414A-5 -0460A-5 -0503A-5 -0174A-7 -0210A-7 -0271A-7 -0330A-7 -0370A-7 -0430A-7	AF370 and AF16 charging contactor	2	3	d	9.6E-7	1.0E-3	>90	2	0	65	20	20/1

ACS880-17/37 type	Contactor	SIL / SIL-CL	SC	PL	PFH [1] [1/h]	PFD_{avg}	DC [2] [%]	Cat.	HFT	CCF	Mission time [a]	T_1 [3] [4] [a]
-0450A-3 -0620A-3 -0870A-3 -1110A-3 -1210A-3 -1430A-3 -1700A-3 -2060A-3 -2530A-3 -0420A-5 -0570A-5 -0780A-5 -1010A-5 -1110A-5 -1530A-5 -1980A-5 -2270A-5 -0320A-7 -0390A-7 -0580A-7 -0660A-7 -0770A-7 -0950A-7 -1130A-7 -1450A-7 -1680A-7 -1950A-7 -2230A-7 -2770A-7 -3310A-7	AF400 / AF580 / AF750 / AF1250 / AF1650 or AF2050 and AF110-A185 charging contactor	2	3	d	9.6E-7	1.0E-3	>90	2	0	65	20	20/1
												3AXD10000097591 H

1) PFH values are according to EN ISO 13849.

2) In low demand mode, DC of electromechanical devices is considered as 0%, and therefore no overall DC value is claimed in low demand mode.

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 = 1a is used with low demand mode of operation.

Note: If T_1 > 1a is needed in low demand mode of operation, SIL 1 / PL c levels are used and PFD is calculated separately.

ACS880-07/07LC/17/17LC/37/37LC drives with a main breaker (option +F255)

ACS880-07/17/37 type	Circuit breaker	SIL / SIL-CL	SC	PL	PFH [1] [1/h]	PFD_{avg}	DC [2] [%]	Cat.	HFT	CCF	Mission time [a]	T_1 [3] [4] [a]
-07-1250A-3	E3S1250	2	3	d	5.0E-7	1.8E-3	>90	2	0	65	20	20/1
-07-1480A-3	-											
-07-1760A-3	E3S3200											
-07-2210A-3	or											
-07-2160A-3	E2.2S-A800											
-07-1320A-5	-											
-07-1450A-5	E4.2V-A4000											
-07-1580A-5												
-07-1800A-5												
-07-1980A-5												
-07-1450A-7												
-07-1650A-7												
-07-1950A-7												
-07-2300A-7												
-07-2600A-7												
-07-2860A-7												
-07LC-0390A-7												
-07LC-0430A-7												
-07LC-0480A-7												
-07LC-0530A-7												
-07LC-0600A-7												
-07LC-0670A-7												
-07LC-0750A-7												
-07LC-0850A-7												
-07LC-1030A-7												
-07LC-1170A-7												
-07LC-1310A-7												
-07LC-1170A-7												
-07LC-1310A-7												
-07LC-1470A-7												
-07LC-1660A-7												
-07LC-1940A-7												
-07LC-2180A-7												
-07LC-2470A-7												
-07LC-2880A-7												
-07LC-3260A-7												

ACS880-07/17/37 type	Circuit breaker	SIL / SIL-CL	SC	PL	PFH [1/h] [1)]	PFD_{avg}	DC [%] [2)]	Cat.	HFT	CCF	Mission time [a]	T_1 [a] [3) 4)]
-07LC-3580A-7 -07LC-4050A-7 -07LC-4840A-7 -07LC-5650A-7 -07LC-6460A-7 -07LC-0530A-7 [5)] -07LC-0600A-7 [5)] -07LC-0670A-7 [5)] -07LC-0750A-7 [5)] -07LC-0850A-7 [5)] -07LC-1030A-7 [5)] -07LC-1170A-7 [5)] -07LC-1310A-7 [5)] -07LC-1470A-7 [5)] -07LC-1660A-7 [5)] -07LC-1940A-7 [5)] -07LC-2180A-7 [5)] -07LC-2470A-7 [5)] -07LC-2880A-7 [5)] -07LC-3260A-7 [5)] -07LC-3580A-7 [5)] -07LC-4050A-7 [5)] -07LC-4840A-7 [5)] -07LC-5650A-7 [5)] -07LC-6460A-7 [5)]	2× E2.2S-A 800 - 2× E4.2V 4000	2	3	d	7.3E-7	3.1E-3	>90	2	0	65	20	20/1

ACS880-07/17/37 type	Circuit breaker	SIL / SIL-CL	SC	PL	PFH [1] [1/h]	PFD_{avg}	DC [2] [%]	Cat.	HFT	CCF	Mission time [a]	T_1 [3] [4] [a]
-17/37-1210A-3 -17/37-1430A-3 -17/37-1700A-3 -17/37-2060A-3 -17/37-2530A-3 -17/37-1530A-5 -17/37-1980A-5 -17/37-2270A-5 -17/37-1450A-7 -17/37-1680A-7 -17/37-1950A-7 -17/37-2230A-7 -17/37-2770A-7 -17/37-3310A-7 -17LC/37LC-0390A-7 to -17LC/37LC-3580A-7	E3S1250 - E3S3200 or E2.2S-A1200 - E4.2V-A4000 with charging contactor	2	3	d	9.6E-7	2.2E-3	>90	2	0	65	20	20/1
												3AXD10000097591 H

1) PFH values are according to EN ISO 13849.
2) In low demand mode, DC of electromechanical devices is considered as 0%, and therefore no overall DC value is claimed in low demand mode.
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 = 1a is used with low demand mode of operation.
5) 12-pulse variant (option +A004)

Note: If T_1 > 1a is needed in low demand mode of operation, SIL 1 / PL c levels are used and PFD is calculated separately.

ACS880-17LC/37LC drives with two main breakers (option +F255)

ACS880-17LC/37LC type	Circuit breaker	SIL / SIL-CL	SC	PL	PFH [1] [1/h]	PFH [2] [1/h]	PFD_{avg}	DC [3] [%]	Cat.	HFT	CCF	Mission time [a]	T_1 [4] [5] [a]
-4050A-7 to -6260A-7	2× E4.2S-A3200 or 2× E4.2V-A4000 with charging contactor	2	3	c	1.0E-7	1.2E-6	3.5E-3	>90	2	0	65	20	20/1
													3AXD10000097591 H

1) PFH values according to IEC 62061.
2) PFH values according to EN ISO 13849.
3) In low demand mode, DC of electromechanical devices is considered as 0%, and therefore no overall DC value is claimed in low demand mode.
4) See the recommendation of use CNB/M/11.050 published by the European co-ordination of notified bodies for lower T_1 requirement.
5) T_1 = 20a is used with high demand mode of operation. T_1 = 1a is used with low demand mode of operation.

Note: If T_1 > 1a is needed in low demand mode of operation, SIL 1 / PL c levels are used and PFD is calculated separately.

ACS880-07LC/17LC/37LC drives without a main breaker

Note: ACS880-07LC/17LC/37LC drives can be delivered without a factory-installed main breaker. Customer-installed components are not included in the safety data calculations. These values must be added to the calculations by the customer.

ACS880-07LC/17LC/37LC type	Circuit breaker	SIL / SIL-CL	SC	PL	PFH [1] [1/h]	PFD_{avg}	DC [2] [%]	Cat.	HFT	CCF	Mission time [a]	T_1 [3] [4] [a]
-07LC without air circuit breaker delivery	-	2	3	d	2.8E-7	5.3E-4	>90	2	0	65	20	20/1
-17LC/37LC without air circuit breaker delivery	-	2	3	d	7.3E-7	8.6E-4	>90	2	0	65	20	20/1
												3AXD10000097591 H

1) PFH values are according to EN ISO 13849.
2) In low demand mode, DC of electromechanical devices is considered as 0%, and therefore no overall DC value is claimed in low demand mode.
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 = 1a is used with low demand mode of operation.

Note: If T_1 > 1a is needed in low demand mode of operation, SIL 1 / PL c levels are used and PFD is calculated separately.

Safety component types

Safety component types as defined in IEC 61508-2:

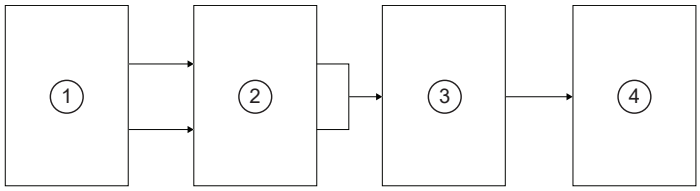
- emergency stop button: type A
- safety relay(s): type A
- main contactor(s): type A
- main breaker: type A.

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.

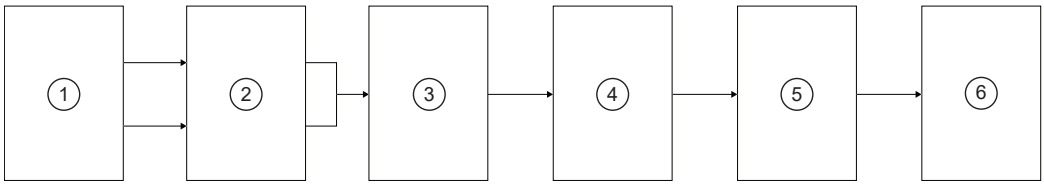
The components that are included in the safety circuit are shown in the safety block diagrams for different drive types.

Diagram 1: ACS880-07 drives, frames R6 to R11 and ACS880-17/37 drives, frame R8, 6-pulse variants with main contactor or main breaker



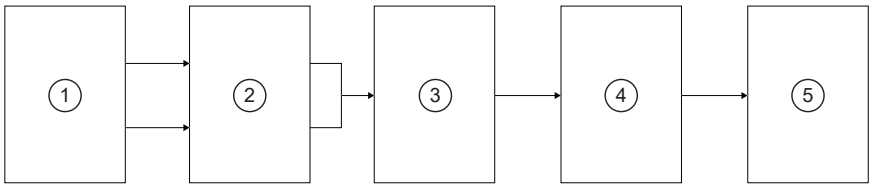
1	Emergency stop button
2	Emergency stop safety relay
3	Auxiliary safety relay
4	Main contactor or main breaker

Diagram 2: ACS880-17/37 drives, frame R11



1	Emergency stop button
2	Emergency stop safety relay
3	Auxiliary safety relay
4	Charging supply contactor
5	Auxiliary safety relay
6	Main contactor

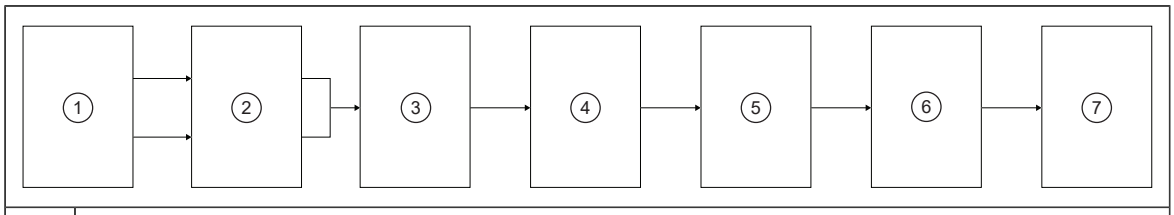
Diagram 3: ACS880-07/07LC drives, frames n×DXT + n×R8i



1	Emergency stop button
2	Emergency stop safety relay
3	Auxiliary safety relay
4	Main contactor or main breaker
5	Main contactor or main breaker

Note: Only some variants have two main contactors or main breakers.

Diagram 4: ACS880-17/17LC/37/37LC drives, frames n×R8i + n×R8i



1	Emergency stop button
2	Emergency stop safety relay
3	Auxiliary safety relay
4	Charging contactor
5	Auxiliary safety relay
6	Main contactor or main breaker
7	Main contactor or main breaker

Note: Only some variants have two main contactors or main breakers.

Relevant failure modes

Relevant failure modes are:

- the main contactor/breaker does not open when requested. (All contactor/breaker failures are considered dangerous.)
- internal failures of safety relays 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):

- 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

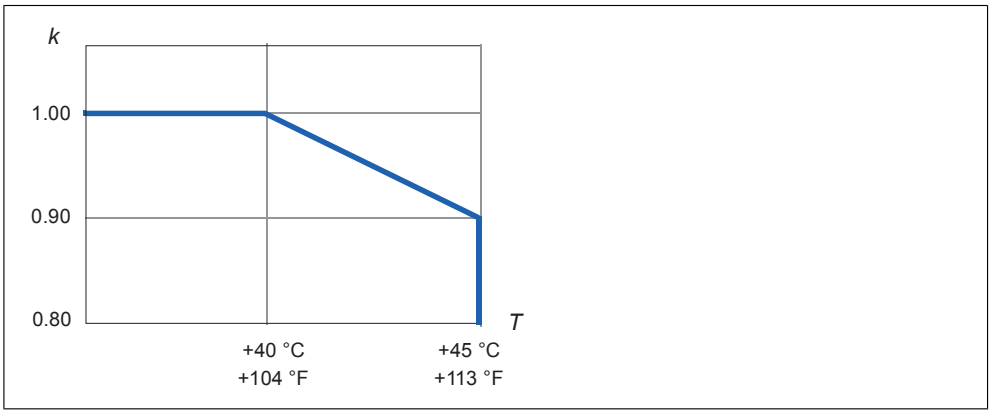
Emergency stop total delay: less than 500 ms.

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*):



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
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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