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OPTIONS FOR ABB DRIVES

Emergency stop, stop category 1 (option +Q952) for ACS880-07, -07LC, -17, -17LC, -37, and -37LC drives

User's manual



Emergency stop, stop category 1 (option +Q952) for ACS880-07, -07LC, -17, -17LC, -37, and -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	9
Safety messages	9
Instructions for functional safety circuits	10
Electrical safety precautions	11

2 Introduction to the manual

Contents of this chapter	13
Applicability	13
Target audience	13
Exclusion of liability	14
Quick reference guide for taking a safety function into use	14
Related manuals	14
Terms and abbreviations	15

3 Option description

Contents of this chapter	17
Overview	17
Operation principle	18
ACS880-07 drives with frame size R6...R11, ACS880-17 and -37 drives with frame size R8	18
ACS880-07 and -07LC drives with frame size nxDxT + n×R8i	20
ACS880-17 and -37 drives with frame size R11	22
ACS880-17 and -37 drives with frame size R6i + R6i or R7i + R7i	24
ACS880-17, -17LC, -37, and 37LC drives with frame size n×R8i + n×R8i	26
Fault reaction function	28

4 Electrical installation

Contents of this chapter	29
Wiring	29
Customer-installed main breaker in ACS880-07LC, -17LC, and -37LC drives	30
Hardware settings	30

5 Parameter settings

Contents of this chapter	31
Drive parameter settings	31
Additional parameter settings for ACS880-17 and -37 drives with frame size R8 or R11	32
Supply unit parameter settings	32

6 Use of the safety function

Contents of this chapter	35
Activating the safety function	35
Resetting the safety function	35



7 Start-up and validation test

Contents of this chapter	37
Validation of the safety functions	37
Competence	37
Validation procedure	37
Validation test reports	38
Start-up and validation test	38

8 Fault tracing

Contents of this chapter	41
Fault tracing	41
Emergency stop safety relay	41
Extension safety relay	42
STO circuit connections	42
Other	43
Reporting problems and failures related to safety functions	43

9 Maintenance

Contents of this chapter	45
Safety circuit maintenance	45
Proof test interval	45
Functional safety components	46
Competence	46
Residual risk	47
Intentional misuse	47
Decommissioning	47

10 Technical data

Contents of this chapter	49
Safety data	49
Safety data values	49
ACS880-07 drives with a main contactor (option +F250)	50
ACS880-17 and -37 drives with a main contactor (option +F250)	50
ACS880-07 drives with a main breaker (option +F255)	51
ACS880-17 and -37 drives with a main breaker (option +F255)	51
ACS880-07LC drives with a main breaker (option +F255)	52
ACS880-17LC and -37LC drives with a main breaker (option +F255)	53
ACS880-07LC, -17LC, and -37LC drives without a main breaker	54
Safety component types	55
Safety block diagrams	55
Diagram 1: ACS880-07 drives with frame size R6...R11	55
Diagram 2: ACS880-07 and -07LC drives with frame size nxDxT + n×R8i	55
Diagram 3: ACS880-17, -17LC, -37, and -37LC drives	56
Relevant failure modes	56
Fault exclusions	56
Operation delays	56
Ambient conditions	56
ACS880-07 drives with frame size R6...R11	56
Related standards and directives	57
Compliance with the European Machinery Directive	58



Compliance with the Supply of Machinery (Safety) Regulations (UK) 58

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.

Safety messages

These safety messages help to prevent personal injury and damage to the equipment. The hazard levels comply with standard ANSI Z535.6.

The manual uses these warning symbols:



▲DANGER Indicates a hazardous situation which, if not avoided, will result in death or serious injury.



▲WARNING Indicates a hazardous situation which, if not avoided, could result in death or serious injury.



▲CAUTION Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE Is used to address practices not related to physical injury, but which can result in equipment damage.



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.



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

- 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.
- The safety function described in this manual does isolate the main or auxiliary circuits from the power supply. Before you do work on the drive, or its main or auxiliary circuits, do the steps in section [Electrical safety precautions \(page 11\)](#).
- Do the validation test of the safety function at the start-up and also after you make changes to the safety circuit.
- 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.



Electrical safety precautions

These electrical safety precautions are for all persons 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 electrical installation or maintenance work. Do these steps before you do installation or maintenance work.

1. Prepare for the work.
 - Make sure that you have a work order.
 - Do an on-site risk assessment or job hazard analysis.
 - Make sure that you have the correct tools available.
 - Make sure that the workers are qualified.
 - Select the correct personal protective equipment (PPE).
 - Stop the drive and motor(s).
2. Clearly identify the work location and equipment.
3. Disconnect all possible voltage sources. Make sure that connection is not possible. Lock out and tag out.
 - Open the main disconnecting device of the drive.
 - Open the charging switch if it is present.
 - Open the disconnecter of the supply transformer. (The main disconnecting device in the drive cabinet does not disconnect the voltage from the AC input power busbars of the drive cabinet.)
 - Open the auxiliary voltage switch-disconnector (if it is present), and all other possible disconnecting devices that isolate the drive from dangerous voltage sources.
 - In the liquid cooling unit (if present), open the switch-disconnector of the cooling pumps.
 - If there is a permanent magnet motor connected to the drive, disconnect the motor from the drive with a safety switch or by other means.
 - Open the main isolating device of the drive.
 - Disconnect all dangerous external voltages from the control circuits.
 - After you disconnect power from the drive, wait 5 minutes to let the intermediate circuit capacitors discharge before you continue.
4. Protect other energized parts in the work location against contact and take special precautions when close to bare conductors.
5. Measure that the installation is de-energized. Use a high-quality voltage tester. If the measurement requires that you remove shrouding or other cabinet structures, obey the local laws and regulations applicable to live electrical work. This includes, but is not limited to, electric shock and arc protection.
 - Before and after you measure the installation, verify the operation of the voltage tester on a known voltage source.
 - Make sure that the voltage between the input power terminals of the drive (L1, L2, L3) and the grounding (PE) busbar is zero.
 - Make sure that the voltage between the output power terminals of the drive (U, V, W) and the grounding (PE) busbar is zero.

Important! Repeat the measurement with the DC voltage setting of the voltage tester. Measure between each phase and ground. There is a risk of dangerous DC voltage charging due to leakage capacitances of the motor circuit. This



12 Safety instructions

voltage can remain charged for a long time after the drive power-off. The measurement discharges the voltage.

- Make sure that the voltage between the drive DC busbars and the grounding (PE) busbar is zero.



▲WARNING The busbars inside the cabinet of liquid-cooled drives are partially coated. Measurements made through the coating are potentially unreliable, so only measure at uncoated portions. Note that the coating does not constitute a safe or touch-proof insulation.

6. Install temporary grounding as required by the local regulations.
7. Ask for a permit to work from the person that is responsible for the electrical installation work.





Introduction to the manual

Contents of this chapter

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

Applicability

This manual is applicable to ACS880-07, -07LC, -17, -17LC, -37, and -37LC drives which have the option: Emergency stop, stop category 1 with main contactor/breaker, with safety relays (option +Q952).

This manual shows the default design of the safety circuit ordered with option code +Q952. 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 customer-defined wiring (if any). Refer to 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 (AINLX)	3AUA0000085967
ACS880 primary control program firmware manual (YINLX)	3AXD50001000998
ACS880 diode supply control program firmware manual	3AUA0000103295
ACS880 diode supply control program (YDILX) firmware manual	3AXD50001096489
ACS880 IGBT supply control program firmware manual	3AUA0000131562
ACS880 IGBT supply control program (YISLX and YLHLX) firmware manual	3AXD50001019464
PC tools	
Drive Composer start-up and maintenance PC tool user's manual	3AUA0000094606
Functional safety design tool user's manual	3AXD10000102417

Manual	Code
Safety	
Functional safety; Technical guide No. 10	3AUA0000048753
ABB Safety information and solutions	www.abb.com/safety
Options	
ACS-AP-I, -S, -W and ACH-AP-H, -W 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 ordered with option code +P947)	

You can find manuals on the Internet. See below for the relevant code/link. For more documentation, go to www.abb.com/drives/documents.



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

16 Introduction to the manual

Term	Description
DIIL	Digital input interlock
E-stop	Emergency stop
FIO-01	Optional digital I/O extension module
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)
RO	Relay output
SC	Systematic capability (IEC 61508)
SIL	Safety integrity level (1...3) (IEC 61508, IEC 62061, IEC 61800-5-2)
STO	Safe torque off (IEC/EN 61800-5-2)
Stop category	There are three categories of stop functions defined by IEC/EN 60204-1: <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).
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.
T_M	Mission time: the period of time covering the intended use of the safety function/device. After the mission time elapses, the safety device must be replaced. Note that any T_M values given cannot be regarded as a guarantee or warranty. (EN ISO 13849-1)

3

Option description

Contents of this chapter

This chapter describes the +Q952 emergency stop option and its settings.

Overview

The option +Q952 corresponds to a controlled stop in accordance with stop category 1 (IEC/EN 60204-1). When the user gives the emergency stop command, the drive decelerates the motor(s) to zero speed according to a user-defined ramp time. Then, the drive opens the main contactor/breaker, which disconnects the input power from the drive.

For the option +Q952, ABB installs the FIO-01 digital I/O extension module (option +L501) to the drive control unit (Slot 1).

Note: Drives with Prevention of unexpected start-up (POUS) (option +Q957): If the user activates the POUS function during the emergency stop deceleration ramp, it overrides the emergency stop function. This activates the Safe torque off (STO) function of the drive immediately and the motor coasts to a stop. For more information on the POUS safety function, see [Prevention of unexpected start-up \(option +Q957\) for ACS880-07, -07LC, -17, -17LC, -37, and -37LC drives \(3AUA0000119910 \[English\]\)](#).

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

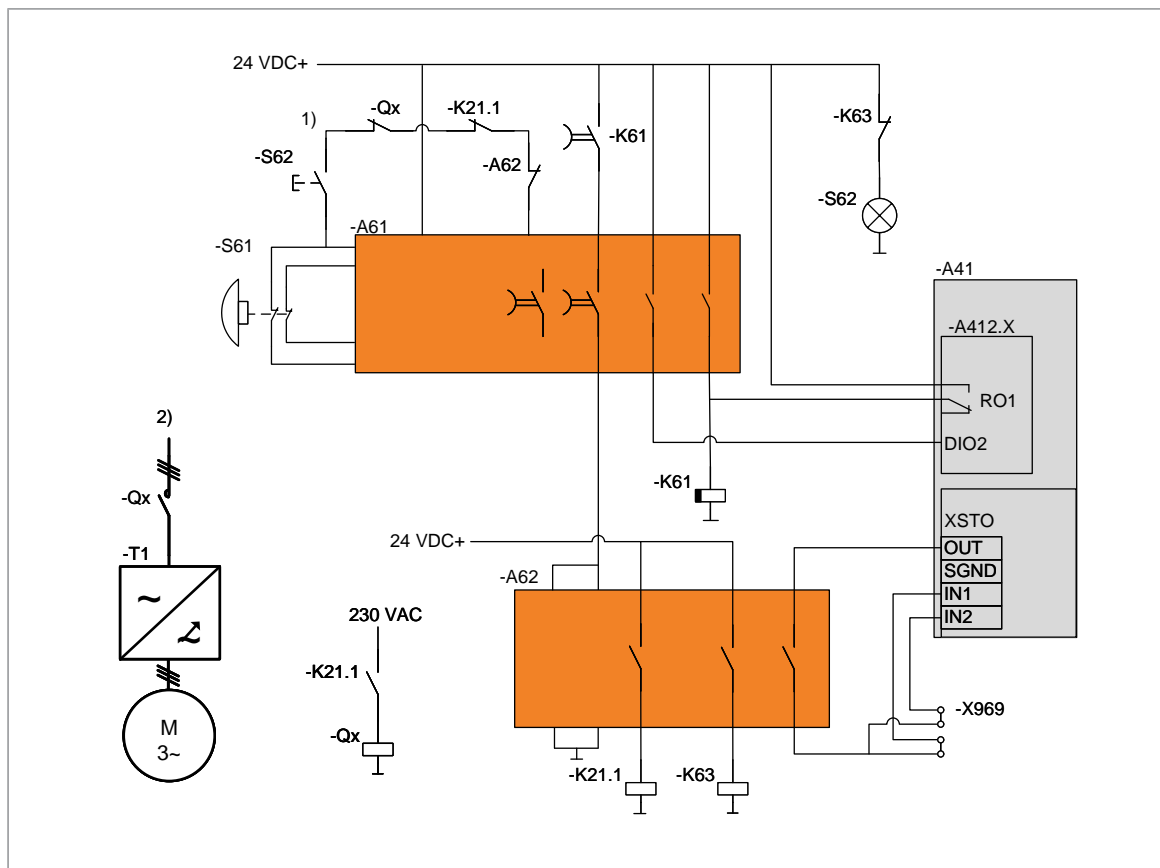
The design principles of the option +Q952 comply with EN ISO 13850.

For a list of related standards and European directives, refer to section [Related standards and directives \(page 57\)](#).

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, refer to the circuit diagrams delivered with the drive.

■ **ACS880-07 drives with frame size R6...R11, ACS880-17 and -37 drives with frame size R8**

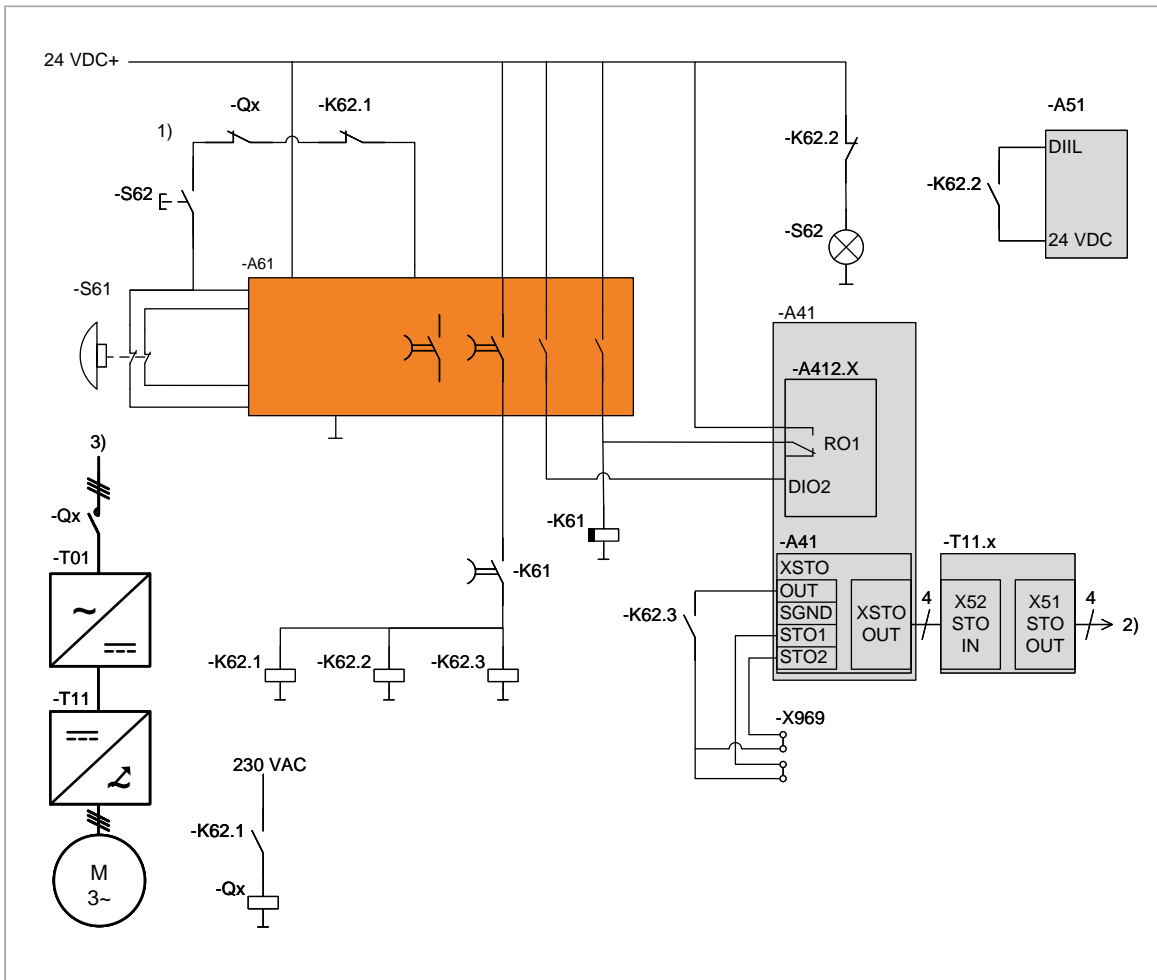


A41	Inverter control unit
A412.X	Digital I/O extension module FIO-01
A61	Emergency stop safety relay with delay contacts
A62	Extension safety relay
S61	Emergency stop button
S62	Emergency reset button with indicator light
K21.1	Safety relay
K61	Timer relay
K63	Safety relay
T1	Drive module
Qx	Main contactor/breaker (Q2 or Q1)
X969	STO terminal block
1)	Reset circuit

2)	Main circuit
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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 digital input on the digital I/O extension module [A412.X] of the drive. This gives the emergency stop command to the drive. The emergency stop safety relay [A61] de-energizes the timer relay [K61]. The break delay counter of the emergency stop safety relay [A61] starts (user-adjustable delay). The break delay counter of the timer relay [K61] starts (non-user-adjustable delay).
3	The drive acknowledges the reception of the emergency stop command by energizing the relay output (RO1) of the digital I/O extension module [A412.X]. The relay output of the extension module [A412.X] energizes the timer relay [K61], resetting its break delay counter. The relay keeps its delayed break contact closed. Note: If the drive does not acknowledge the reception of the emergency stop command in 2 seconds, the main contactor and STO circuit are opened and the system trips.
4	The drive decelerates the motor to zero speed in emergency stop deceleration time (user-defined parameter).
5	The break delay counter of the emergency stop safety relay [A61] trips and the delay contact de-energizes the extension safety relay [A62]. The extension safety relay [A62] de-energizes XSTO inputs IN1 and IN2 of the inverter control unit [A41], which activates the Safe torque off function. The extension safety relay [A62] de-energizes safety relays [K21.1] and [K63]. The safety relay [K21.1] opens the main contactor/breaker [Qx]. The main contactor/breaker [Qx] disconnects the power supply from the drive module [T1].
6	The contact of the safety relay [K63] energizes the emergency stop reset button indicator light [S62].
7	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 receives the start signal (depends on the configuration, refer to the firmware manual).

■ ACS880-07 and -07LC drives with frame size nxDxT + nXR8i

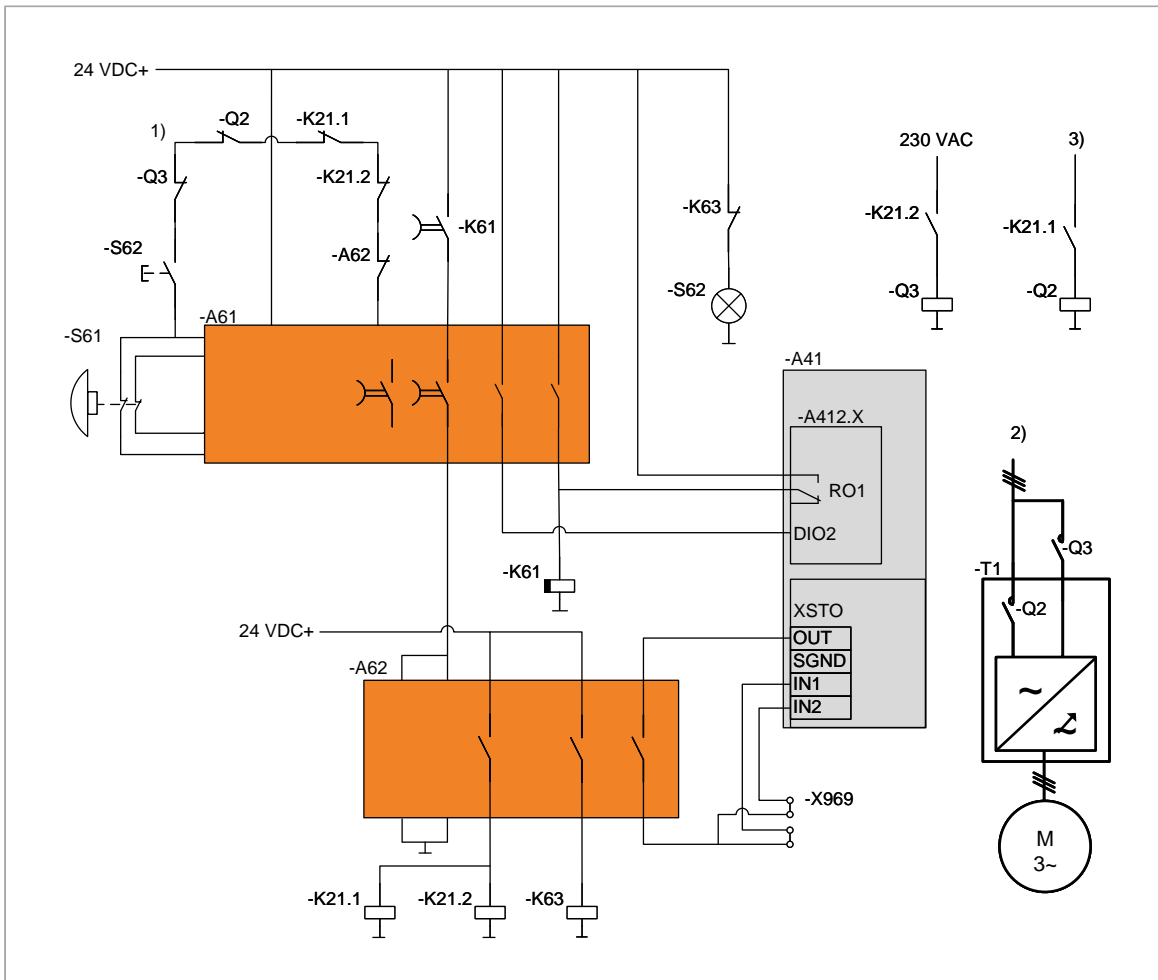


A41	Inverter control unit
A51	Supply control unit
A412.X	Digital I/O extension module
A61	Emergency stop safety relay with delay contacts
S61	Emergency stop button
S62	Emergency reset button with indicator light
K62.1	Safety relay
K62.2	Safety relay
K62.3	Safety relay
K61	Timer relay
Qx	Main contactor/breaker (Q2 or Q1)
T01	Supply unit
T11	Inverter unit
T11.x	Inverter module(s) under inverter unit T11
X969	STO terminal block

1)	Reset circuit
2)	To parallel R8i modules (if any)
3)	Main 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	<p>The emergency stop safety relay [A61] de-energizes the digital input on the digital I/O extension module [A412.X] of the inverter unit. This gives the emergency stop command to the inverter unit.</p> <p>The emergency stop safety relay [A61] de-energizes the timer relay [K61].</p> <p>The break delay counter of the emergency stop safety relay [A61] starts (user-adjustable delay).</p> <p>The break delay counter of the timer relay [K61] starts (non-user-adjustable delay).</p>
3	<p>The inverter unit acknowledges the reception of the emergency stop command by energizing the relay output (RO1) of the digital I/O extension module [A412.X].</p> <p>The relay output of the extension module [A412.X] energizes the timer relay [K61], resetting its break delay counter. The relay keeps its delayed break contact closed.</p> <p>Note: If the drive does not acknowledge the reception of the emergency stop command in 2 seconds, the main contactor and STO circuit are opened and the system trips.</p>
4	The drive decelerates the motor to zero speed in emergency stop deceleration time (user-defined parameter).
5	<p>The break delay counter of the emergency stop safety relay [A61] trips and the delay contact de-energizes safety relays [K62.1], [K62.2] and [K62.3].</p> <p>Safety relay [K62.3] de-energizes the XSTO inputs STO1 and STO2 of the inverter control unit [A41], which activates the Safe torque off function.</p> <p>Safety relay [K62.2] de-energizes the DIIL input of the supply control unit [A51]. This gives the emergency stop command to the supply unit.</p> <p>Safety relay [K62.1] opens the main contactor/breaker [Qx].</p> <p>The main contactor/breaker [Qx] disconnects the power supply from the supply unit [T01].</p>
6	The contact of the safety relay [K62.2] energizes the emergency stop reset button indicator light [S62].
7	<p>Normal operation resumes after the user:</p> <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 receives the start signal (depends on the configuration, refer to the firmware manual).

■ ACS880-17 and -37 drives with frame size R11



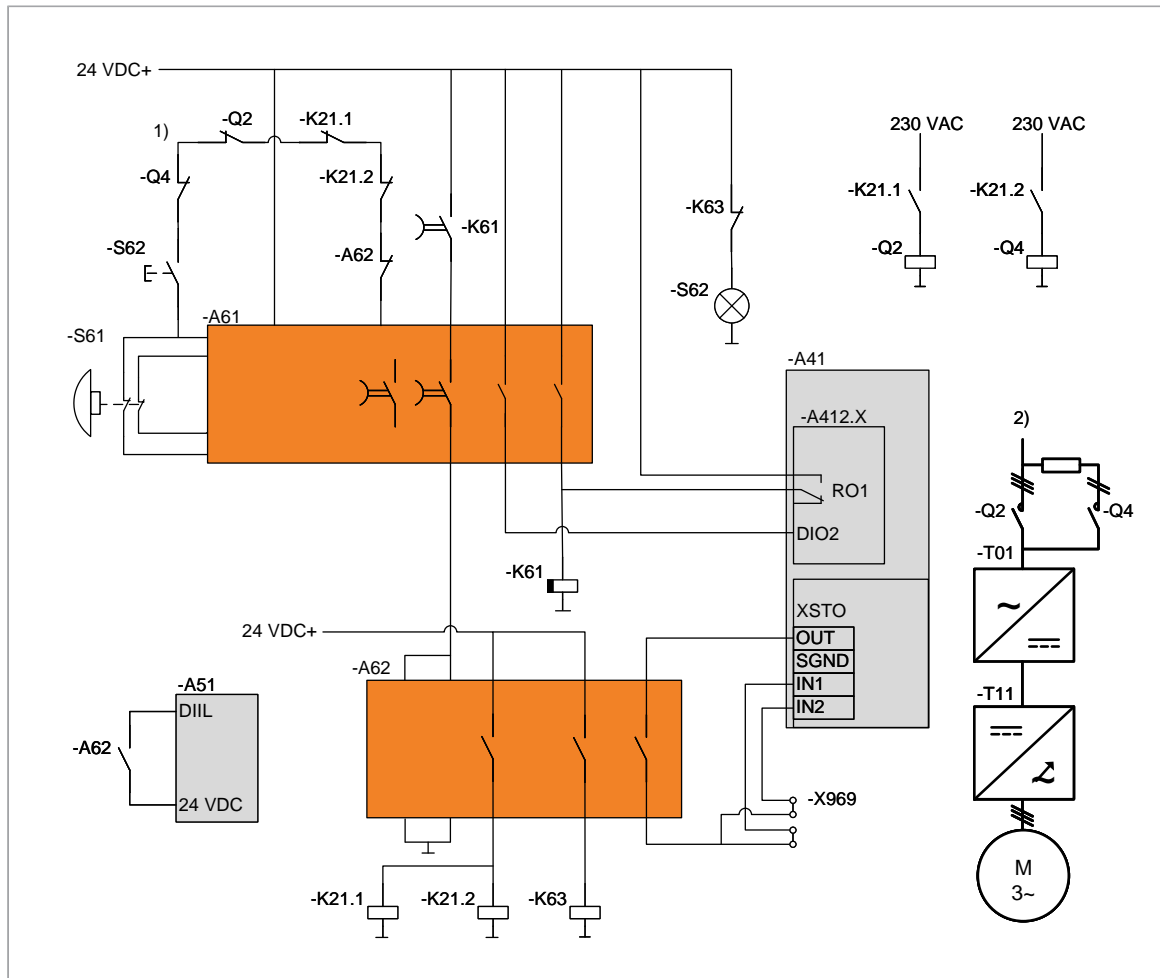
A41	Inverter control unit
A412.X	Digital I/O extension module
A61	Emergency stop safety relay with delay contacts
A62	Extension safety relay
S61	Emergency stop button
S62	Emergency reset button with indicator light
K21.1	Safety relay
K21.2	Safety relay
K61	Timer relay
K63	Safety relay
T1	Drive module
Q2	Main contactor
Q3	Charging contactor
X969	STO terminal block
1)	Reset circuit

2)	Main circuit
3)	Drive module internal supply

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 digital input on the digital I/O extension module [A412.X] of the drive. This gives the emergency stop command to the drive. The emergency stop safety relay [A61] de-energizes the timer relay [K61]. The break delay counter of the emergency stop safety relay [A61] starts (user-adjustable delay). The break delay counter of the timer relay [K61] starts (non-user-adjustable delay).
3	The drive acknowledges the reception of the emergency stop command by energizing the relay output (RO1) of the digital I/O extension module [A412.X]. The relay output of the extension module [A412.X] energizes the timer relay [K61], resetting its break delay counter. The relay keeps its delayed break contact closed. Note: If the drive does not acknowledge the reception of the emergency stop command in 2 seconds, the main contactor and STO circuit are opened and the system trips.
4	The drive decelerates the motor to zero speed in emergency stop deceleration time (user-defined parameter).
5	The break delay counter of the emergency stop safety relay [A61] trips and the delay contact de-energizes the extension safety relay [A62]. The extension safety relay [A62] de-energizes XSTO inputs IN1 and IN2 of the inverter control unit [A41], which activates the Safe torque off function. The extension safety relay [A62] de-energizes safety relays [K21.1], [K21.2], and [K63]. The safety relay [K21.1] opens the main contactor [Q2], and safety relay [K21.2] opens the charging supply contactor [Q3]. The main contactor [Q2] and charging supply contactor [Q3] disconnect the power supply from the drive module [T1].
6	The contact of the safety relay [K63] energizes the emergency stop reset button indicator light [S62].
7	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 receives the start signal (depends on the configuration, refer to the firmware manual).

24 Option description

■ ACS880-17 and -37 drives with frame size R6i + R6i or R7i + R7i

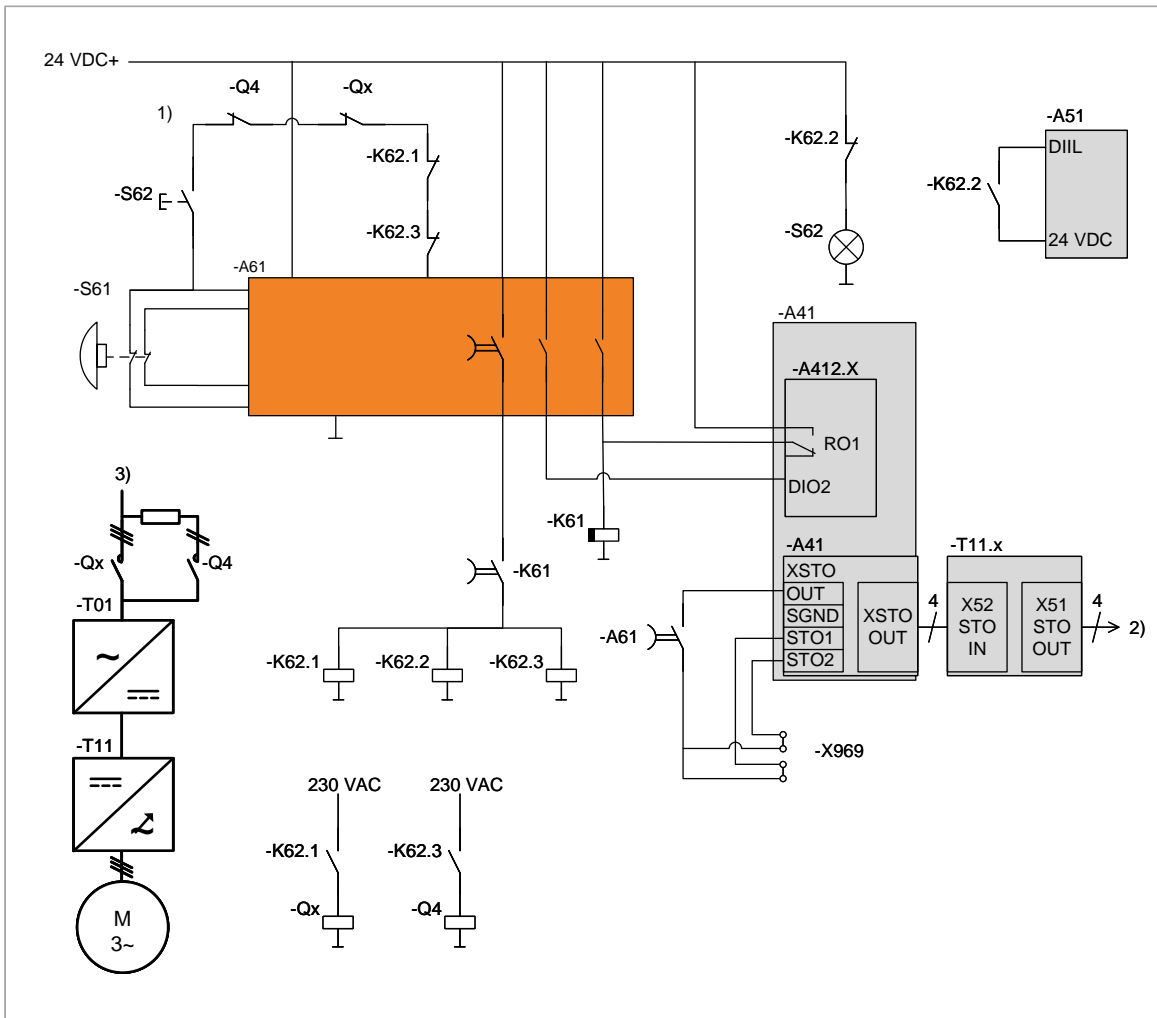


A41	Inverter control unit
A412.X	Digital I/O extension module
A51	Supply control unit
A61	Emergency stop safety relay with delay contacts
A62	Extension safety relay
S61	Emergency stop button
S62	Emergency stop reset button with indicator light
K21.1	Safety relay
K21.2	Safety relay
K61	Timer relay
K63	Auxiliary relay
Q2	Main contactor
Q4	Charging contactor
X969	STO terminal block
T01	Supply unit

T11	Inverter unit
1)	Reset circuit
2)	Main 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 digital input on the digital I/O extension module [A412.X]. This gives the emergency stop command to the drive. The emergency stop safety relay [A61] de-energizes the timer relay [K61]. The break delay counter of the emergency stop safety relay [A61] starts (user-adjustable delay). The break delay counter of the timer relay [K61] starts (non-user-adjustable delay).
3	The drive acknowledges the reception of the emergency stop command by energizing the relay output (RO1) of the digital I/O extension module [A412.X]. The relay output of the extension module [A412.X] energizes the timer relay [K61], which resets its break delay counter. The relay keeps its delayed break contact closed. Note: If the drive does not acknowledge the reception of the emergency stop command in 2 seconds, the main contactor and STO circuit are opened and the system trips.
4	The drive decelerates the motor to zero speed in emergency stop deceleration time (user-defined parameter).
5	The break delay counter of the emergency stop safety relay [A61] trips and the delay contact de-energizes the extension safety relay [A62]. The extension safety relay [A62] de-energizes XSTO inputs IN1 and IN2 of the inverter control unit [A41], which activates the Safe torque off function. The extension safety relay [A62] de-energizes safety relays [K21.1], [K21.2], and [K63]. The safety relay [K21.1] opens the main contactor [Q2], and safety relay [K21.2] opens the charging contactor [Q4]. The main contactor [Q2] and charging supply contactor [Q4] disconnect the power supply from the supply unit [T01].
6	The contact of the safety relay [K63] energizes the emergency stop reset button indicator light [S62].
7	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 receives the start signal (depends on the configuration, refer to the firmware manual).

■ ACS880-17, -17LC, -37, and 37LC drives with frame size n×R8i + n×R8i



A41	Inverter control unit
A51	Supply control unit
A412.X	Digital I/O extension module
A61	Emergency stop safety relay with delay contacts
S61	Emergency stop button
S62	Emergency reset button with indicator light
K62.1	Safety relay
K62.2	Safety relay
K62.3	Safety relay
K61	Timer relay
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
X969	STO terminal block
1)	Reset circuit
2)	To parallel R8i modules (if any)
3)	Main 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 digital input on the digital I/O extension module [A412.X] of the inverter unit. This gives the emergency stop command to the inverter unit. The emergency stop safety relay [A61] de-energizes the timer relay [K61]. The break delay counter of the emergency stop safety relay [A61] starts (user-adjustable delay). The break delay counter of the timer relay [K61] starts (non-user-adjustable delay).
3	The inverter unit acknowledges the reception of the emergency stop command by energizing the relay output (RO1) of the digital I/O extension module [A412.X]. The relay output of the extension module [A412.X] energizes the timer relay [K61], resetting its break delay counter. The relay keeps its delayed break contact closed. Note: If the drive does not acknowledge the reception of the emergency stop command in 2 seconds, the main contactor and STO circuit are opened and the system trips.
4	The drive decelerates the motor to zero speed in emergency stop deceleration time (user-defined parameter).
5	The break delay counter of the emergency stop safety relay [A61] trips and the delay contact de-energizes safety relays [K62.1], [K62.2] and [K62.3]. The emergency stop safety relay [A61] de-energizes XSTO inputs STO1 and STO2 of the inverter control unit [A41]. This activates the Safe torque off function. Safety relay [K62.2] de-energizes the DIIL input of the supply control unit [A51]. This gives the emergency stop command to the supply unit. Safety relay [K62.3] opens the charging contactor [Q4]. Safety relay [K62.1] opens the main contactor/breaker [Qx]. The main contactor/breaker [Qx] and charging contactor [Q4] disconnect the power supply from the supply unit [T01].
6	The contact of the safety relay [K62.2] energizes the emergency stop reset button indicator light [S62].
7	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 receives the start signal (depends on the configuration, refer to 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
- opens the main contactor/breaker
- 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.

If the reset button [S62] is pressed for more than 10 seconds, the emergency stop safety relay [A61] goes into a fault state. If this occurs, the user must reset the safety relay. Refer to section [Fault tracing \(page 41\)](#).

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

4

Electrical installation

Contents of this chapter

This chapter gives information on the electrical installation of the safety option.

Wiring



▲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, commissioning or maintenance work.

One emergency stop button and one reset button are installed on the cabinet door and connected 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.
4. Make sure that the sum resistance for one channel (loop resistance) is not more than 1 kohm.
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 these rules:

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

■ Customer-installed main breaker in ACS880-07LC, -17LC, and -37LC drives

ACS880-07LC, -17LC, and -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.

Hardware settings

The time delay on the emergency stop safety relay [A61] is adjustable. Set the delay according to the application requirements. Make sure that the delay is slightly longer than the emergency stop deceleration time defined by drive parameter 23.23 Emergency stop time. Refer to chapter [Parameter settings \(page 31\)](#).

Use the rotary switches on the relay to set the time delay. Refer to the table that follows:

Switch	Value	Description
t_{Fkt}	1	Selects the delay mode. Must be 1.
t_{max}	User-defined	Selects the time range (in seconds) for the delayed contacts. Value range: 1 ... 300 s.
t	User-defined	Adjusts the time within the selected range in 10% steps. Value range: 0.1...1.

Multiply the values of t_{max} and t to get the time delay ($t_v = t_{max} \cdot t$). For example, if the required time is 30 s, you can set the switches as follows:

- $t_{max} = 30 \text{ s}$, $t = 1$ ($30 \text{ s} \cdot 1 = 30 \text{ s}$), or
- $t_{max} = 300 \text{ s}$, $t = 0.1$ ($300 \text{ s} \cdot 0.1 = 30 \text{ s}$).



Parameter settings

Contents of this chapter

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

Drive parameter settings

The table that follows gives the parameters related to the safety function in the ACS880 primary control program. The parameters are set at the factory.

No.	Name	Default value ¹⁾	Description
14.01	Module 1 type	FIO-01	Activates (and specifies the type of) I/O extension module 1.
14.02	Module 1 location	Slot 1	Specifies the slot (1...3) on the control unit of the drive into which the I/O extension module is installed.
14.09	DIO 1 function	Input	Selects whether DIO1 of the extension module is used as a digital input or output.
14.14	DIO 2 function	Input	Selects whether DIO2 of the extension module is used as a digital input or output.
14.34	RO1 source	P.14.5.1-	Selects a drive signal to be connected to relay output RO1. In this case, the RO1 is energized by the status of DIO2 of the FIO module (inverted value).
21.04	Emergency stop mode	Eme ramp stop (Off3)	Selects the way the motor is stopped when an emergency stop command is received.
21.05	Emergency stop source	P.14.5.1	Selects the source of the emergency stop signal. In this case, the source is DIO2 of the FIO module.
31.03	External event 2 source	P.14.5.0	Selects the source of external event 1. In this case, the source is DIO1 of the FIO module.
31.04	External event 2 type	Warning/Fault	Selects the type of external event 2.

32 Parameter settings

No.	Name	Default value ¹⁾	Description
31.22	STO indication run/stop	Warning/Warning	Selects which indications are given when the Safe torque off (STO) function is activated. Warning/Warning is the recommended setting.

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

The table that follows gives the parameters that you must set according to application requirements. Make sure that the selected values agree with the time delay settings of the emergency stop safety relay. See section [Hardware settings \(page 30\)](#).

No.	Name	Value	Description
21.06	Zero speed limit	User-defined	Defines the zero speed limit. The motor is stopped along a speed ramp until this limit is reached. After the zero speed delay (parameter 21.07, default value 0 ms), the motor coasts to a stop.
23.23	Emergency stop time	User-defined	Defines the deceleration time for emergency stop Off3. The deceleration time is the time it takes to decelerate the motor from the maximum process speed defined by parameter 46.01 or 46.02 to the zero speed limit defined by parameter 21.06.
46.01	Speed scaling	User-defined	Defines the maximum motor speed used in the application. Set this parameter if you use the speed control mode or torque control mode.
46.02	Frequency scaling	User-defined	Defines the maximum motor frequency used in the application. Set this parameter if you use the frequency control mode.

Additional parameter settings for ACS880-17 and -37 drives with frame size R8 or 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

Supply unit parameter settings

This section is applicable to:

- ACS880-07 and -07LC drives with frame size $n \times D \times T + n \times R8i$
- ACS880-17 and -37 drives with frame size $R6i + R6i$ or $R7i + R7i$
- ACS880-17, -17LC, -37, and -37LC drives with frame size $n \times R8i + n \times R8i$

The table that follows gives the parameters related to the safety function in the ACS880 supply control programs. The parameters are set at the factory.

No.	Name	Default value ¹⁾	Description
121.04	Emergency stop mode	Stop and warning	Selects the way the supply unit is stopped when an emergency stop command is received.
121.05	Emergency stop source	D1IL	Selects the source of the emergency stop signal. This parameter cannot be changed while the supply unit is running.

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

For more information, refer to the applicable firmware manual.

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, these indications are shown:

- the drive control program has the indication Safe torque off and warning Emergency stop (off1 or off3) active
- the emergency stop reset button indicator light [S62] on the cabinet door is on after the emergency stop deceleration ramp time has elapsed
- the green ON LED of the emergency stop safety relay [A61] 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.
-

36 Use of the safety function

3. If necessary, reset faults from the drive.
4. If necessary, close the main contactor/breaker.
5. Make sure that the drive receives the start signal.
6. You can now restart the drive.

For more information, refer to the hardware and firmware manuals.

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

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 make sure that the safety function operates correctly and according to the safety requirements.

■ 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 and the validation test plan of the complete safety system:

- 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 changes related to the power unit or its circuit boards
 - at the proof test of the safety function
 - 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 correct 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 of the drive. 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. Refer to the hardware manual.	<input type="checkbox"/>
Make sure that the STO function is configured and validated. Refer to the drive hardware manual.	<input type="checkbox"/>
Checks and settings with no voltage connected	
Stop the drive and do the steps in section Electrical safety precautions (page 11) before you start the work.	<input type="checkbox"/>
If you made connections to the emergency stop circuit on site (for example, added emergency stop buttons or connected shipping splits of large drives), do a check of the connections against the applicable circuit diagrams.	<input type="checkbox"/>
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.	<input type="checkbox"/>
Make sure that the hardware settings of the safety function are set as defined in this manual.	<input type="checkbox"/>
Settings with voltage connected	
Close the cabinet doors and power up the drive. Refer to the hardware manual.	<input type="checkbox"/>

Action	<input checked="" type="checkbox"/>
Make sure that the parameter settings related to the safety functions are correct. Refer to chapter Parameter settings .	<input type="checkbox"/>
Validation test	
ABB recommends that you monitor at least these signals with the Drive Composer PC tool: <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 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 decelerating. Make sure that the correct warnings and indications are shown.	<input type="checkbox"/>
Make sure that the emergency stop reset button indicator light [S62] comes on.	<input type="checkbox"/>
Make sure that the main contactor/breaker opens as described in this manual.	<input type="checkbox"/>
Make sure that the STO function is activated.	<input type="checkbox"/>
Make sure that the correct indications for STO activation are shown (as defined by parameter 31.22).	<input type="checkbox"/>
Make sure that the drive generates none of these faults: <ul style="list-style-type: none"> • STO hardware failure (5090) • Safe torque off 1 loss (FA81) • Safe torque off 2 loss (FA82) If the drive generates these faults, refer to the fault tracing instructions in this manual.	<input type="checkbox"/>
Make sure that you cannot close the main contactor/breaker with the operating switch or by other means.	<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. Make sure that the emergency stop reset button indicator light [S62] goes off.	<input type="checkbox"/>
Power up the drive: <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. For more information, see the hardware manual.	<input type="checkbox"/>
Restart the drive and motor. Make sure that they operate normally.	<input type="checkbox"/>
Do the test again from each operating location (for each emergency stop button and reset button).	<input type="checkbox"/>
Create a backup file of the drive parameters with the Drive Composer PC tool or control panel.	<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

- **Emergency stop safety relay**

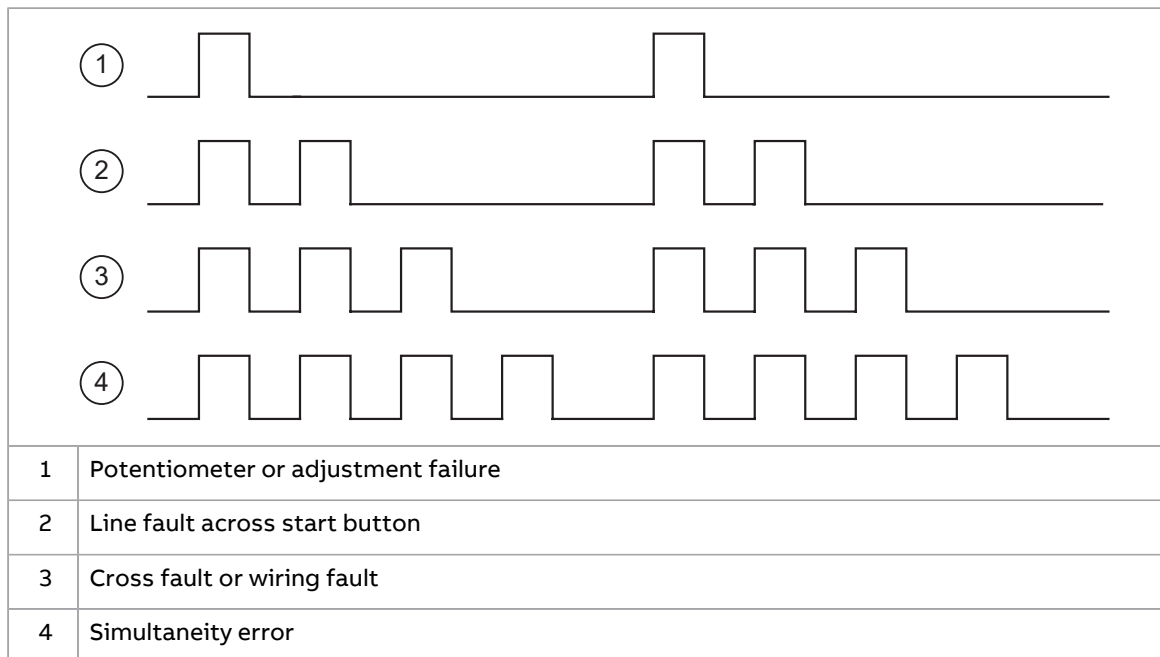
The emergency stop safety relay [A61] type is DOLD UG 6960.

This table gives the indications of the DOLD UG 6960 relay:

LED	Color	LED is on	LED is flashing	LED is off
ON	Green	Power supply is connected.	-	Power supply is not connected.
ERR	Red	System error. Replace the unit if the error is not removed after restart.	When flashing in 1:1 relation: Power supply undervoltage or overvoltage. When flashing in 4:1 relation: There is an external error.	-
K1/K2	Green	Relays K1 and K2 are energized (instantaneous contact).	There is an external error. See the figure below for the indications of the LED.	-
K3/K4	Green	Relays K3 and K4 are energized (delayed contacts).	During the time delay.	-

42 Fault tracing

If there are external errors, the K1/K2 LED shows an error code by flashing. This figure describes the K1/K2 LED indications.



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], examine the reset circuit connections. Refer to the circuit diagrams delivered with the drive.

■ Extension safety relay

This table gives information on the status LEDs of the extension safety relay [A62]. The extension safety relay [A62] is used in ACS880-07 drives with frame size R6...R11, and ACS880-17 and -37 drives with frame size R8, R11, R6i + R6i, or R7i + R7i.

LED	LED is on
K1	Power supply is connected. Relay K1 energized.
K2	Power supply is connected. Relay K2 energized.

■ STO circuit connections

Use a voltage tester or multimeter to measure the continuity of 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)

Refer to the circuit diagrams delivered with the drive.

Stop the drive and do the steps in section [Electrical safety precautions \(page 11\)](#) before you start the work.

■ **Other**

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

Reporting problems and failures related to safety functions

Contact ABB.



Maintenance

Contents of this chapter

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

Safety circuit maintenance

After the safety function is validated, it must be maintained by:

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

See the contactor/breaker data sheet or manual.

If you change the wiring or a component after the start-up, replace a power unit or its circuit boards, 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

Proof tests are used to detect failures in the safety function. To do a proof test, use the validation test procedure given in this manual.

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 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 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.

Functional safety components

The mission time of functional safety components is 20 years which equals the time during which failure rates of electronic components remain constant. This applies to the components of the standard Safe torque off circuit as well as any modules, relays and, typically, any other components that are part of functional safety circuits.

The expiry of mission time terminates the certification and SIL/PL classification of the safety function. The following options exist:

- Renewal of the whole drive and all optional functional safety module(s) and components.
- Renewal of the components in the safety function circuit. In practice, this is economical only with larger drives that have replaceable circuit boards and other components such as relays.

Note that some of the components may already have been renewed earlier, restarting their mission time. The remaining mission time of the whole circuit is however determined by its oldest component. Also note that some components connected to the functional safety system such as main and charging contactors or breakers may have a shorter lifespan than 20 years, depending on their usage. These components must be replaced before the end of their lifetime.

Contact your local ABB service representative for more information.

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.

10

Technical data

Contents of this chapter

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

Safety data

■ Safety data values

The safety data is valid for the default design of the safety circuit shown in this manual. If the final design is different from the default design, and the customer has ordered safety data calculations (option +P947), ABB calculates the new safety data and delivers it separately to the customer.

The safety data calculations are based on these assumptions on the operation of the main contactor [Q2] and charging contactor [Q4]:

- 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.

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)

Frame size	Contactors	SIL	SC	PL	PFH ¹⁾ [1/h]	PFD _{avg}	DC ²⁾ [%]	Cat.	HFT	CCF	T _M [a]	T ₁ ^{3) 4)} [a]
R6...R10	AF116 ... AF370	2	3	d	5.0E-07	5.0E-04	>90	2	0	65	20	20/1
R10...R11	AF400 ... AF750	2	3	d	5.0E-07	5.0E-04	>90	2	0	65	20	20/1
R11, R8i	AF1250 or AF2050	2	3	d	5.0E-07	5.0E-04	>90	2	0	65	20	20/1
nxDxT + n×R8i	2× AF1250 or AF2050	2	3	d	7.3E-07	6.6E-04	>90	2	0	65	20	20/1
3AXD10000097591 M												

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 T₁ requirement.

⁴⁾ T₁ = 20a is used with high demand mode of operation. T₁ = 1a is used with low demand mode of operation.

Note: If T₁ > 1 a is needed in low demand mode of operation, SIL 1 / PL c levels must be used and PFD is calculated separately.

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

Frame size	Contactors	SIL	SC	PL	PFH ¹⁾ [1/h]	PFD _{avg}	DC ²⁾ [%]	Cat.	HFT	CCF	T _M [a]	T ₁ ^{3) 4)} [a]
R8	AF116 ... AF370	2	3	d	5.0E-07	5.0E-04	>90	2	0	65	20	20/1
R11, R6i...R7i	AF116 ... AF370 and AF09 ... A110 charging con- tactor	2	3	d	9.6E-07	7.4E-04	>90	2	0	65	20	20/1
R11, R8i	AF400 ... AF750 and AF09 ... A110 charging con- tactor	2	3	d	9.6E-07	7.4E-04	>90	2	0	65	20	20/1
n×R8i	AF1250 ... AF2050 and AF116 ... AF370 char- ging contact- or	2	3	d	9.6E-07	7.4E-04	>90	2	0	65	20	20/1
3AXD10000097591 M												

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 T₁ 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 must be used and PFD is calculated separately.

ACS880-07 drives with a main breaker (option +F255)

Frame size	Circuit breaker type	SIL	SC	PL	PFH ¹⁾ [1/h]	PFD _{avg}	DC ²⁾ [%]	Cat.	HFT	CCF	T _M [a]	T ₁ ^{3) 4)} [a]
2...4xD8T + 2...4xR8i, 6-pulse	E2.2S-A 800 ... E2.2S 2500 or E2.2V-A 1200 ... E2.2V-A 2000	2	3	d	5.0E-07	2.1E-03	>90	2	0	65	20	20/1
3...4xD8T + 3...5xR8i, 6-pulse	E4.2S-A 2500 ... E4.2S 3200 or E4.2V-A 800 ... E4.2V-A 2500	2	3	d	5.0E-07	2.1E-03	>90	2	0	65	20	20/1
4xD8T + 5xR8i, 6-pulse	E4.2V 4000 ... E6.2V 6300	2	3	d	5.0E-07	2.1E-03	>90	2	0	65	20	20/1
3...4xD8T + 3...5xR8i, 12-pulse	2x E2.2S-A 800 ... E2.2S 2000 or 2x E2.2V-A 1200 ... E2.2V 2000	2	3	d	7.3E-07	3.8E-03	>90	2	0	65	20	20/1
3AXD10000097591 M												

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 must be used and PFD is calculated separately.

ACS880-17 and -37 drives with a main breaker (option +F255)

Frame size	Circuit breaker type	SIL	SC	PL	PFH ¹⁾ [1/h]	PFD _{avg}	DC ²⁾ [%]	Cat.	HFT	CCF	T _M [a]	T ₁ ^{3) 4)} [a]
1...2xR8i	E2.2S-A 800 ... E2.2S-A 2500 or E2.2V-A 1200 ... E2.2V-A 2000 with charging con- tactor	2	3	d	9.6E-07	2.3E-03	>90	2	0	65	20	20/1

52 Technical data

Frame size	Circuit breaker type	SIL	SC	PL	PFH ¹⁾ [1/h]	PFD _{avg}	DC ²⁾ [%]	Cat.	HFT	CCF	T _M [a]	T ₁ ^{3) 4)} [a]
3...6×R8i	E4.2S-A 2500 ... E4.2S 3200 or E4.2V-A 800 ... E4.2V-A 2500 with charging contactor	2	3	d	9.6E-07	2.3E-03	>90	2	0	65	20	20/1
5...6×R8i	E4.2V 4000 ... E6.2V 6300 with charging contactor	2	3	d	9.6E-07	2.3E-03	>90	2	0	65	20	20/1
3AXD10000097591 M												

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 T₁ requirement.

⁴⁾ T₁ = 20a is used with high demand mode of operation. T₁ = 1a is used with low demand mode of operation.

Note: If T₁ > 1 a is needed in low demand mode of operation, SIL 1 / PL c levels must be used and PFD is calculated separately.

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

Frame size	Circuit breaker type	SIL	SC	PL	PFH ¹⁾ [1/h]	PFH ²⁾ [1/h]	PFD _{avg}	DC ³⁾ [%]	Cat.	HFT	CCF	T _M [a]	T ₁ ^{4) 5)} [a]
1×D8T + 1×R8i, 6-pulse	E2.2S-A 800 ... E2.2S 2500 or E2.2V-A 1200 ... E2.2V-A 2000	2	3	d	5.0E-07	-	2.1E-03	>90	2	0	65	20	20/1
1...2×D8T + 1...3×R8i, 6-pulse	E4.2S-A 2500 ... E4.2S 3200 or E4.2V-A 800 ... E4.2V-A 2500	2	3	d	5.0E-07	-	2.1E-03	>90	2	0	65	20	20/1
3×D8T + 3...4×R8i, 6-pulse	E4.2V 4000 ... E6.2V 6300	2	3	d	5.0E-07	-	2.1E-03	>90	2	0	65	20	20/1
2...4×D8T + 1...4×R8i, 12-pulse	2× E2.2S-A 800 ... E2.2S 2000 or 2× E2.2V-A 1200 ... E2.2V 2000	2	3	d	7.3E-07	-	3.8E-03	>90	2	0	65	20	20/1

Frame size	Circuit breaker type	SIL	SC	PL	PFH ¹⁾ [1/h]	PFH ²⁾ [1/h]	PFD _{avg}	DC ³⁾ [%]	Cat.	HFT	CCF	T _M [a]	T ₁ ^{4) 5)} [a]
5...6×D8T + 6...7×R8i, 6-pulse 6×D8T + 6...8×R8i, 12-pulse	2× E4.2V 4000 ... E6.2V 6300	2	3	d	7.3E-07	-	3.8E-03	>90	2	0	65	20	20/1
5...6×D8T + 6...7×R8i, 6-pulse	3× E4.2S-A 2500 ... E4.2A 3200 or 3× E4.2V-A 800 ... E4.2V-A 2500	2	3	d	9.6E-07	-	5.6E-03	>90	2	0	65	20	20/1
6×D8T + 6...8×R8i, 12-pulse	4× E4.2S-A 2500 ... E4.2A 3200 or 4× E4.2V-A 800 ... E4.2V-A 2500	2	3	d	1.2E-06	1.2E-07	7.3E-03	>90	2	0	65	20	20/1

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1) PFH values according to EN ISO 13849.

2) PFH values according to IEC 62061. This value is given in cases where the PFH value according to EN ISO 13849 would result in SIL 1.

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 T₁ requirement.

5) T₁ = 20a is used with high demand mode of operation. T₁ = 1a is used with low demand mode of operation.

Note: If T₁ > 1 a is needed in low demand mode of operation, SIL 1 / PL c levels must be used and PFD is calculated separately.

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

Frame size	Circuit breaker type	SIL	SC	PL	PFH ¹⁾ [1/h]	PFH ²⁾ [1/h]	PFD _{avg}	DC ³⁾ [%]	Cat.	HFT	CCF	T _M [a]	T ₁ ^{4) 5)} [a]
R8i	E2.2S-A 800 ... E2.2S-A 2500 or E2.2V-A 1200 ... E2.2V-A 2000 with charging con- tactor	2	3	d	9.6E-07	-	2.3E-03	>90	2	0	65	20	20/1
1...3×R8i	E4.2S-A 2500 ... E4.2S 3200 or E4.2V-A 800 ... E4.2V-A 2500 with charging con- tactor	2	3	d	9.6E-07	-	2.3E-03	>90	2	0	65	20	20/1

54 Technical data

Frame size	Circuit breaker type	SIL	SC	PL	PFH ¹⁾ [1/h]	PFH ²⁾ [1/h]	PFD _{avg}	DC ³⁾ [%]	Cat.	HFT	CCF	T _M [a]	T ₁ ^{4) 5)} [a]
4...6×R8i	E4.2V 4000 ... E6.2V 6300 with charging contactor	2	3	d	9.6E-07	-	2.3E-03	>90	2	0	65	20	20/1
4...5×R8i	2× E4.2V- A 800 ... E4.2V-A 2500 with charging contactor	2	3	d	1.2E-06	6.5E-08	4.1E-03	>90	2	0	65	20	20/1
6...7×R8i	2× E4.2V 4000 ... E6.2V 6300 with charging contactor	2	3	d	1.2E-06	1.1E-07	4.1E-03	>90	2	0	65	20	20/1
7...8×R8i	4× E4.2V- A 800 ... E4.2V-A 2500 with charging contactor	2	3	d	1.7E-06	1.2E-07	7.6E-03	>90	2	0	65	20	20/1
3AXD10000097591 M													

1) PFH values according to EN ISO 13849.

2) PFH values according to IEC 62061. This value is given in cases where the PFH value according to EN ISO 13849 would result in SIL 1.

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 T₁ requirement.

5) T₁ = 20a is used with high demand mode of operation. T₁ = 1a is used with low demand mode of operation.

Note: If T₁ > 1 a is needed in low demand mode of operation, SIL 1 / PL c levels must be used and PFD is calculated separately.

ACS880-07LC, -17LC, and -37LC drives without a main breaker

Note: ACS880-07LC, -17LC, and -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.

Drive type	Circuit breaker	SIL	SC	PL	PFH ¹⁾ [1/h]	PFD _{avg}	DC ²⁾ [%]	Cat.	HFT	CCF	T _M [a]	T ₁ ^{3) 4)} [a]
ACS880-07LC without air cir- cuit breaker delivery	-	2	3	d	2.7E-07	2.9E-04	>90	2	0	65	20	20/1
ACS880-17LC and -37LC without air cir- cuit breaker delivery	-	2	3	d	7.3E-07	5.3E-04	>90	2	0	65	20	20/1
3AXD10000097591 M												

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 T₁ 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 $T_1 > 1 a$ is needed in low demand mode of operation, SIL 1 / PL c levels must be 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 drive 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 with frame size R6...R11

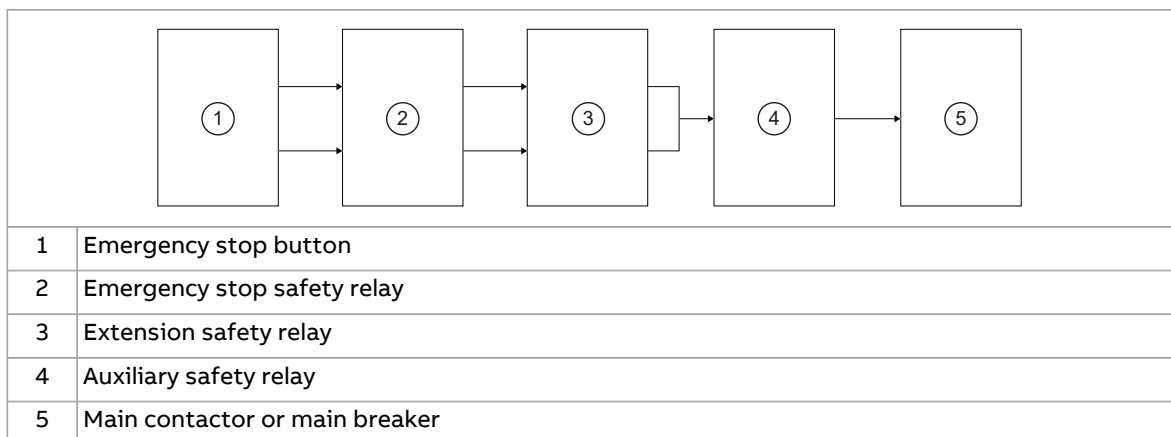
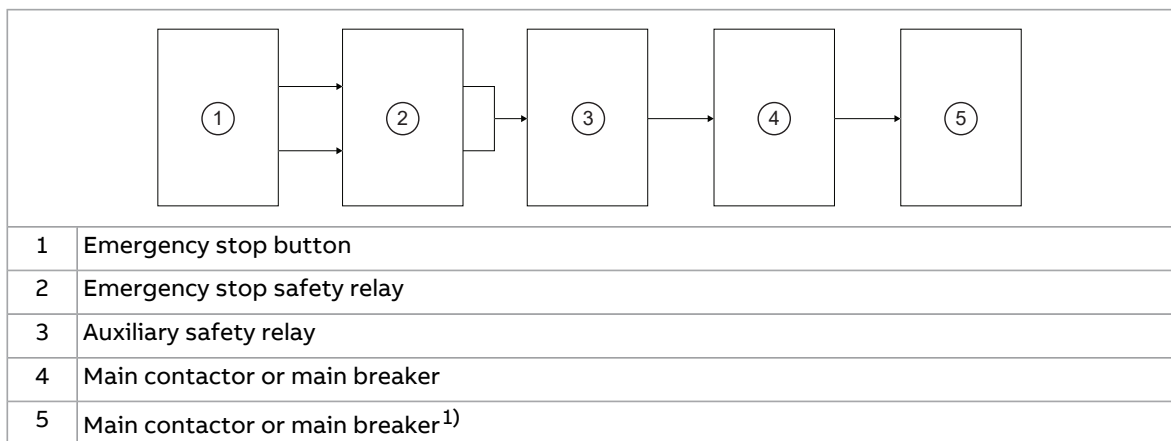
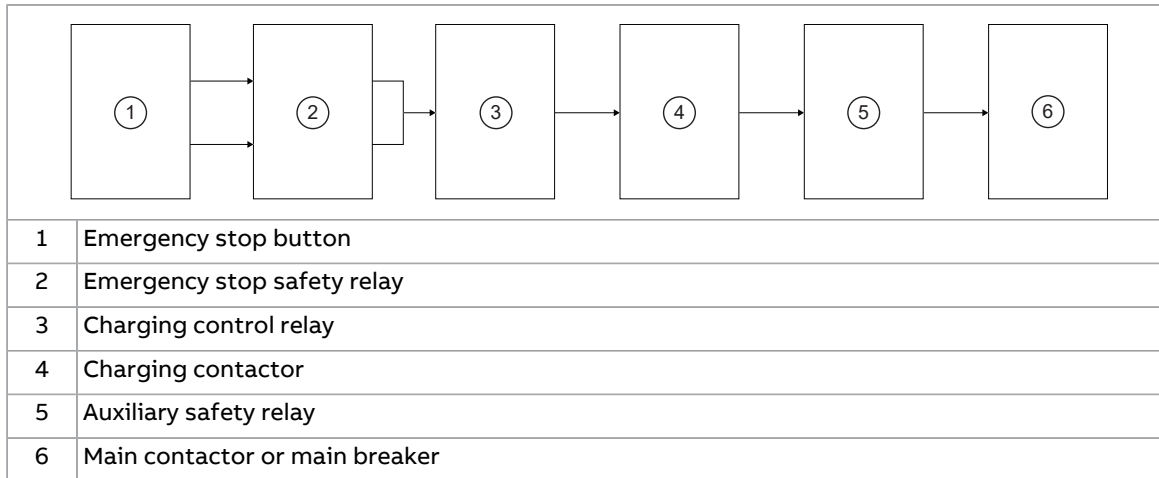


Diagram 2: ACS880-07 and -07LC drives with frame size nxDxT + n×R8i



¹⁾ Applicable to drive variants with two main contactors or main breakers.

Diagram 3: ACS880-17, -17LC, -37, and -37LC drives

■ 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 failure rate 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: emergency stop deceleration ramp time + 500 ms.

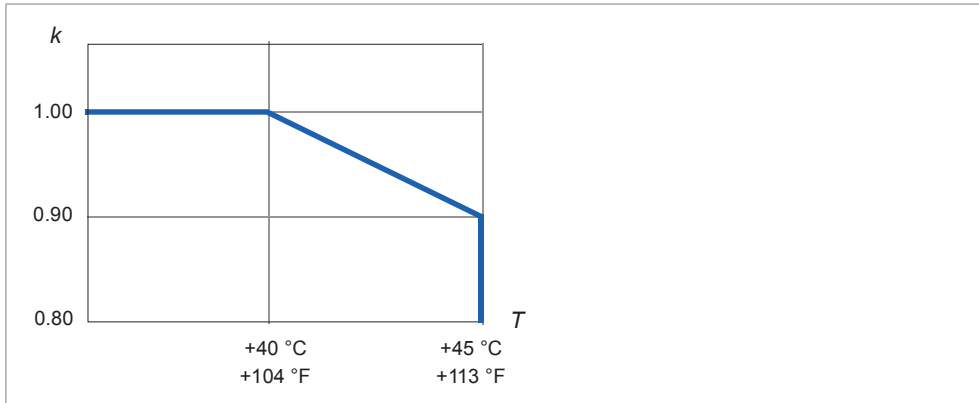
Ambient conditions

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

■ ACS880-07 drives with frame size 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
IEC 61800-5-2:2016 EN 61800-5-2:2007	Adjustable speed electrical power drive systems - Part 5-2: Safety requirements – Functional
IEC 62061:2021 + AMD1:2024 EN IEC 62061:2021	Safety of machinery – Functional safety of safety-related control systems
EN ISO 13849-1:2023	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
IEC 61508-1:2010	Functional safety of electrical/electronic/programmable electronics safety related systems – Part 1: General requirements
IEC 61508-2:2010	Functional safety of electrical/electronic/programmable electronics safety related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
IEC 61511-1:2016 + AMD1:2017	Functional safety – Safety instrumented systems for the process industry sector – Part 1: Framework, definitions, system, hardware and application programming requirements
IEC 61000-6-7:2014	Electromagnetic compatibility (EMC) – Part 6-7: Generic standards – Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations
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
EN ISO 13850:2015	Safety of machinery – Emergency stop – Principles for design
2006/42/EC	European Machinery Directive
	Supply of Machinery (Safety) Regulations 2008 (UK)
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.



Declaration of conformity according to EU Machinery Directive 2006/42/EU (3AXD10000105027)

Compliance with the Supply of Machinery (Safety) Regulations (UK)

The drive is an electronic product which is covered by the Electrical Equipment (Safety) Regulations. However, the drive internal safety function of this manual is in the scope of the Supply of Machinery (Safety) Regulations as a safety component. This function complies with designated standards such as EN 61800-5-2.



Declaration of conformity according to UK Supply of Machinery (Safety) Regulations 2008 (3AXD10001326695)

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/contact-centers.

Product training

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

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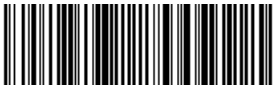
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