ABB WIND TURBINE CONVERTERS

Emergency stop, stop category 0 (option +Q951) for ACS880-77LC/-77CC/-87LC/-87CC wind turbine converters

User's manual

Emergency stop, stop category 0 (option +Q951) for ACS880-77LC/-77CC/-87LC/-87CC wind turbine converters

User's manual

3AXD50000040787 Rev C
EN
Original instructions
EFFECTIVE: 2023-04-28

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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 the converter.

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.

Safety instructions

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

WARNING!
After you have made additions to the safety circuit or modified it (e.g. replaced a component), always test the operation of the safety circuit according to its acceptance test procedure.

WARNING!
Obey the safety instructions of the converter. 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.

This manual does not repeat the complete safety instructions of the converter but it only includes the instructions related to the scope of this manual.

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 for implementing a safety system.

Applicability

The manual applies to the ACS880-77LC, ACS880-77CC, ACS880-87LC and ACS880-87CC wind turbine converters which have the option: Emergency stop, stop category 0, with opening the main circuit breaker (option +Q951).

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 implementing a safety system

Task	☑
Do a risk assessment according to ISO 12100 and/or the relevant C-type standards of the application.	☐
Select the applicable functional safety standard for the implementation.	☐
If you select IEC/EN 62061 or IEC 61511, make a safety plan.	☐
Assess safety: analyze and evaluate risks (estimate SIL/PL) and define risk reduction strategies. Define the safety requirements.	☐
Design the safety system. The part of the design made by ABB is shown in this manual.	☐
If you make any changes to the delivered safety function, verify the achieved SIL/PL with, for example, FSDT-01 Functional safety design tool or similar. See Functional safety design tool user's manual (3AXD10000102417 [English]).	☐
Connect the wiring. See the wiring instructions in this manual and the circuit diagrams delivered with the drive.	☐
Set the parameters related to the safety function (as listed in this manual).	☐
Do the validation test. You can find instructions for the validation test in this manual.	☐
Document the validation test procedure. You can find the guidelines for the validation test report in this manual.	☐

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)
DC	Diagnostic coverage (EN ISO 13849-1)
EMC	Electromagnetic compatibility
HFT	Hardware fault tolerance (IEC 61508)
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, IEC 62061, IEC 61800-5-2)
SILCL	Maximum SIL (level 1...3) that can be claimed for a safety function or subsystem (IEC/EN 62061)
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 and instructions

Contents of this chapter

This chapter describes the safety function and instructs how to wire, start up, test, validate, use and maintain it. The safety data is also given.

Overview

This emergency stop function corresponds to an uncontrolled stop in accordance with stop category 0 (EN/IEC 60204-1). After the emergency stop request command has been given (eg, by pushing an emergency stop button), the main circuit breaker of the converter opens. This disconnects the converter from the grid. It is not possible to start the converter when the emergency stop function is active.

The customer is responsible for designing the overall safety system to stop the rotor of the wind turbine from rotating (GL-IV-1:2010 clause 2.3.2.15.2).

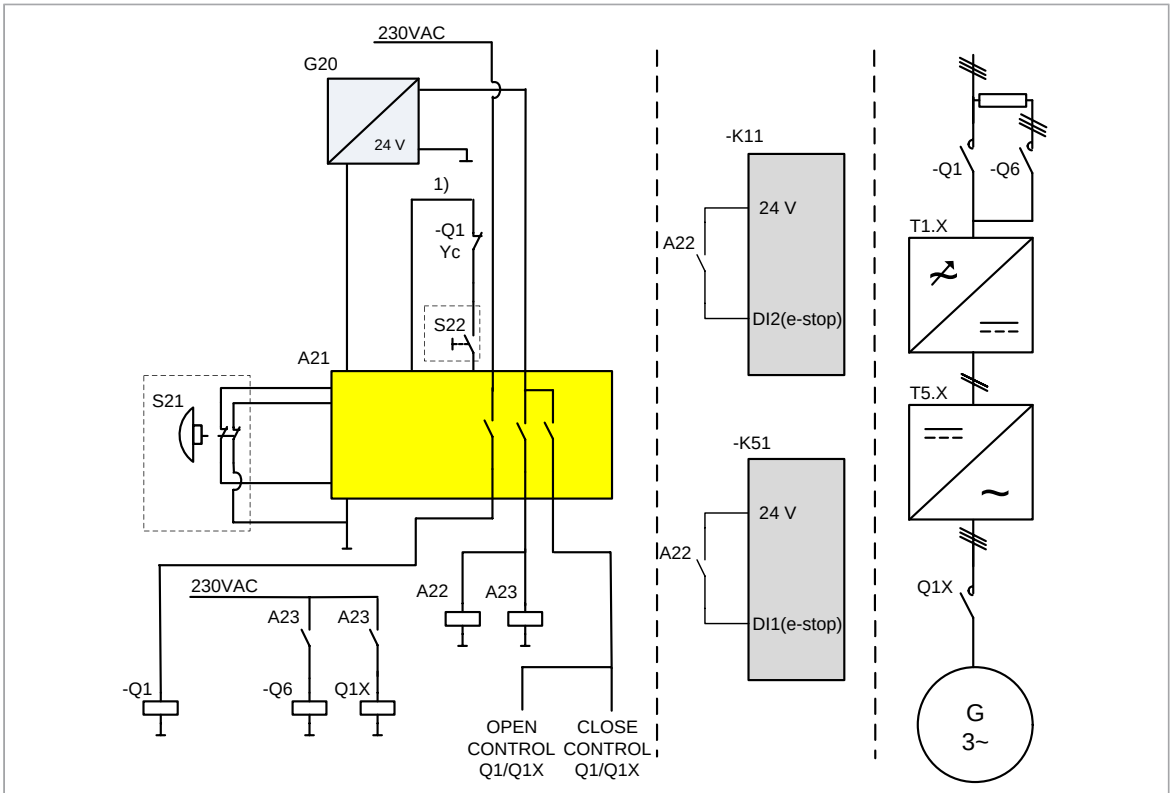
The design principles of the safety function comply with EN ISO 13850.

For a list of related standards and European directives, see section Related standards and directives (page 37).

Operation principle – ACS880-77LC/-87LC with single-step output contactor closing control

Operation principle described in this section applies to the safety circuits with single-step output contactor closing control. For more information, contact your local ABB representative.

Single converter



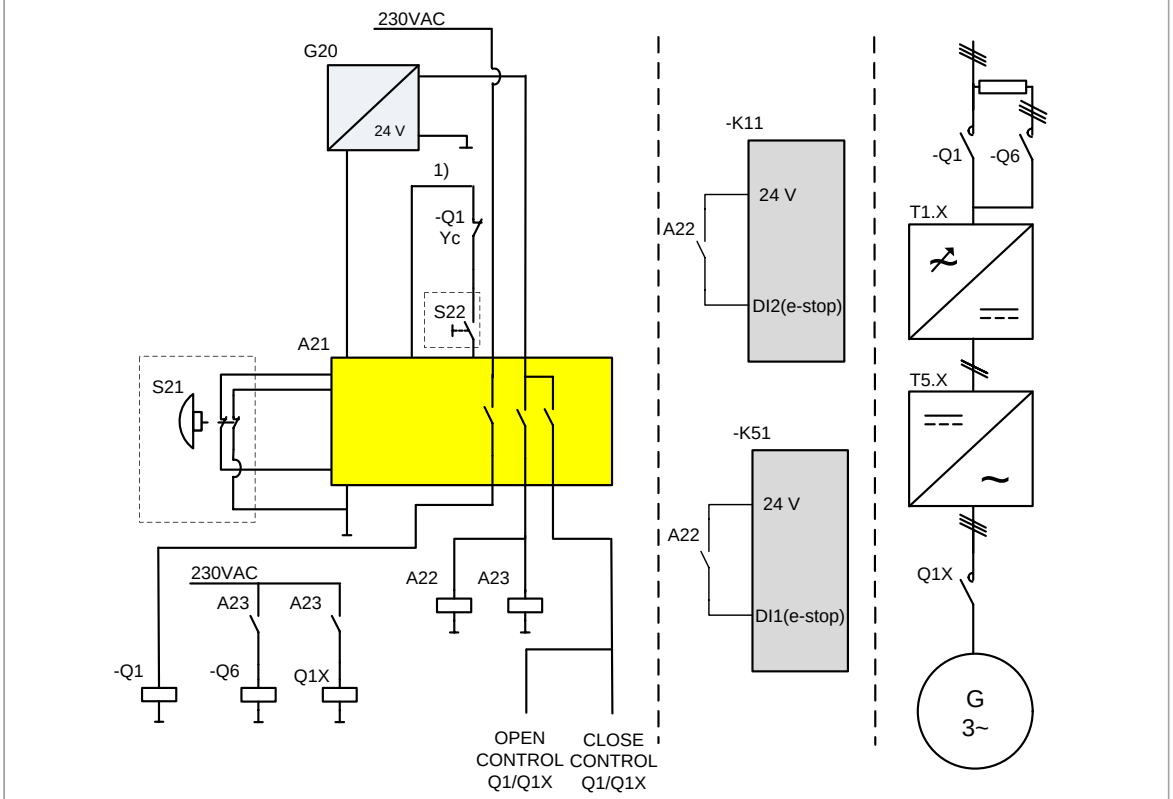
1)	Reset circuit	K11	Control unit (grid-side converter)
S21	Control contact, eg, a button (user-defined)	G20	24 V DC power supply
S22	Reset contact, eg, a button (user-defined)	Q1	Main circuit breaker
Q1Yc	Feedback contact from the main circuit breaker to the reset circuit	Q6	Charging contactor
A21	Emergency stop safety relay	Q1X	Output contactors (option +F269)
A22	Auxiliary safety relay	T1.X	Grid-side converter modules
A23	Auxiliary safety relay	T5.X	Generator-side converter modules
K51	Control unit (generator-side converter)		
The dash line indicates a customer-defined installation.			

Initial status: The converter is running and the wind turbine is rotating. In this example, the user gives the emergency stop command and resets the emergency circuit with buttons.

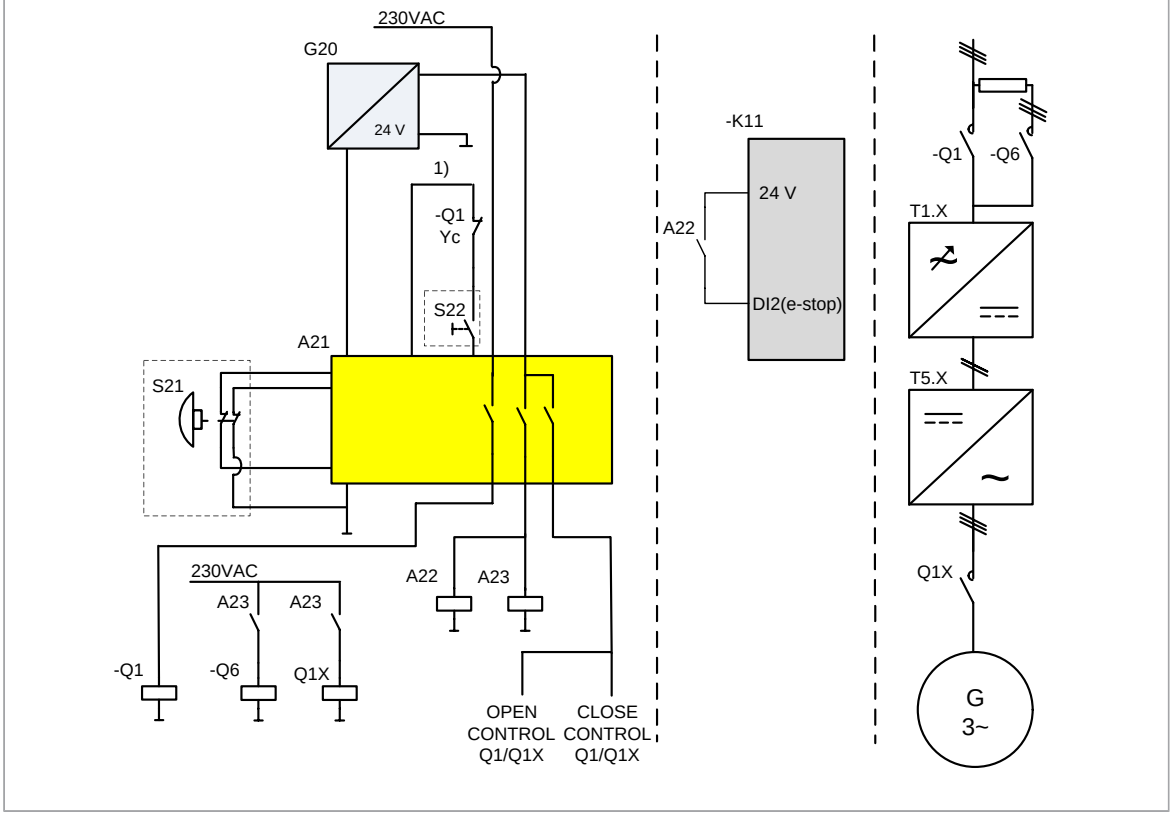
Step	Operation
1.	The user activates Emergency stop function with the emergency stop button [S21].
2.	The emergency stop safety relay [A21] de-energizes relays [A22] and [A23] and opens the main circuit breaker [Q1]. The main circuit breaker remains open while the emergency stop function is on. The auxiliary safety relay [A23] de-energizes the charging contactor [Q6] to prevent it from closing. The auxiliary safety relay [A23] opens the optional output contactors [Q1X] (this is not part of the safety circuit). The auxiliary safety relay [A22] switches off the DI2 input of the grid-side control unit [K11] and DI1 input of the generator-side control unit [K51]. The emergency stop indication is shown in the grid-side control program.
3.	Normal operation resumes after the user: • releases the emergency stop button [S21] to normal (up) position • resets the emergency stop circuit with the emergency stop reset button [S22] • resets the converter if a fault is generated (parameter 121.04 Emergency stop mode is set to Fault).

Parallel-connected converters

Master unit



Slave unit



1)	Reset circuit	K11	Control unit (grid-side converter in the slave unit)
S21	Control contact, eg, a button (user-defined)	G20	24 V DC power supply
S22	Reset contact, eg, a button (user-defined)	Q1	Main circuit breaker
Q1Yc	Feedback contact from the main circuit breaker to the reset circuit	Q6	Charging contactor
A21	Emergency stop safety relay	Q1X	Output contactors (option +F269)
A22	Auxiliary safety relay	T1.X	Grid-side converter modules
A23	Auxiliary safety relay	T5.X	Generator-side converter modules
K51	Control unit (generator-side converters)		
The dash line indicates a customer-defined installation.			

Initial status: The converter is running and the wind turbine is rotating.

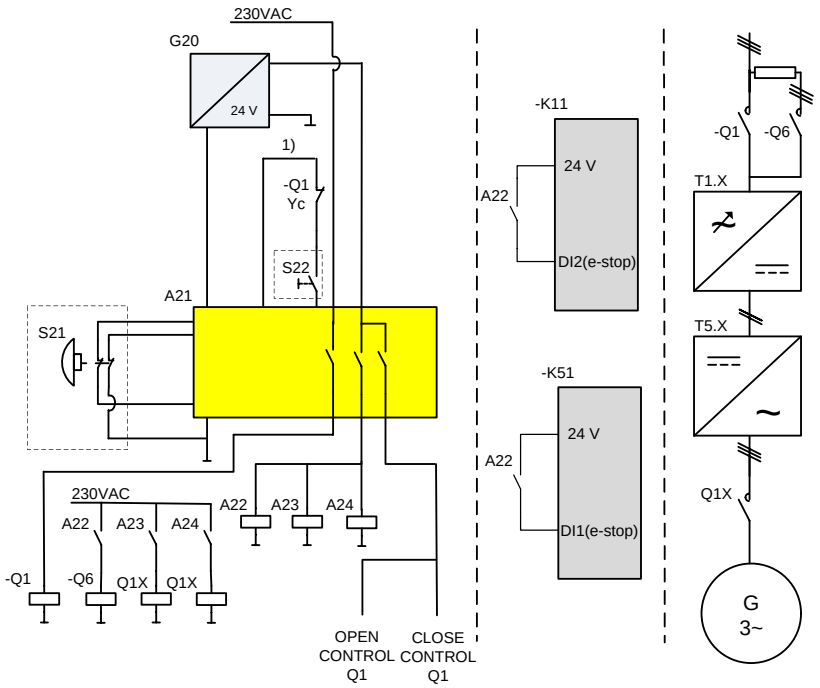
In this example, the user gives the emergency stop request command and resets the emergency circuit with buttons. The emergency stop request and reset commands are given to the master and slave units at the same time (the buttons are wired to both units).

Step	Operation
1.	The user activates Emergency stop function with the emergency stop button [S21].
2.	The emergency stop safety relay [A21] de-energizes relays [A22] and [A23] and opens the main circuit breaker [Q1] in both units. The main circuit breakers remain open while the emergency stop function is on. The auxiliary safety relay [A23] de-energizes the charging contactor [Q6] to prevent it from closing in both units. The auxiliary safety relay [A23] opens the optional output contactors [Q1X] in both units (this is not part of the safety circuit). The auxiliary relay [A22] switches off the DI2 input of the grid-side control units [K11] in the master and slave units and DI1 input of the generator-side control unit [K51] in the master unit. The emergency stop indication is shown in the grid-side control program.
3.	Normal operation resumes after the user: • releases the emergency stop button [S21] to normal (up) position • resets the emergency stop circuit with the emergency stop reset button [S22] • resets the converter if a fault is generated (parameter 121.04 Emergency stop mode is set to Fault).

Operation principle – ACS880-77LC/-87LC with multi-step output contactor closing control

Operation principle described in this section applies to the safety circuits with multi-step output contactor closing control. For more information, contact your local ABB representative.

Single converter



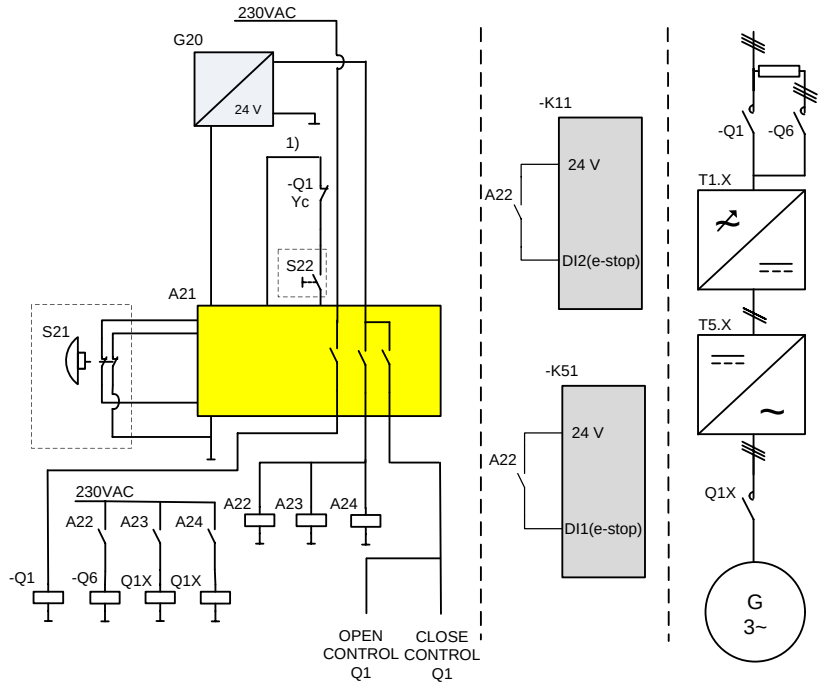
1)	Reset circuit	K51	Control unit (generator-side converter)
S21	Control contact, eg, a button (user-defined)	K11	Control unit (grid-side converter)
S22	Reset contact, eg, a button (user-defined)	G20	24 V DC power supply
Q1Yc	Feedback contact from the main circuit breaker to the reset circuit	Q1	Main circuit breaker
A21	Emergency stop safety relay	Q6	Charging contactor
A22	Auxiliary safety relay	Q1X	Output contactors (option +F269)
A23	Auxiliary safety relay	T1.X	Grid-side converter modules
A24	Auxiliary safety relay	T5.X	Generator-side converter modules
The dash line indicates a customer-defined installation.			

Initial status: The converter is running and the wind turbine is rotating. In this example, the user gives the emergency stop command and resets the emergency circuit with buttons.

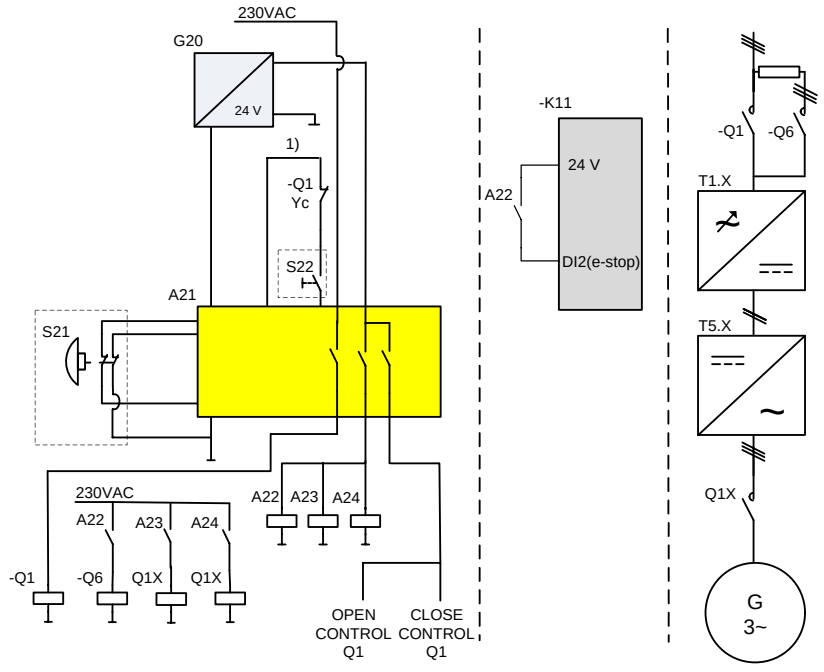
Step	Operation
1.	The user activates Emergency stop function with the emergency stop button [S21].
2.	The emergency stop safety relay [A21] de-energizes relays [A22], [A23] and [A24] and opens the main circuit breaker [Q1]. The main circuit breaker remains open while the emergency stop function is on. The auxiliary safety relay [A23] de-energizes the charging contactor [Q6] to prevent it from closing. The auxiliary safety relays [A23] and [A24] open the optional output contactors [Q1X] (this is not part of the safety circuit). The auxiliary safety relay [A22] switches off the DI2 input of the grid-side control unit [K11] and DI1 input of the generator-side control unit [K51]. The emergency stop indication is shown in the grid-side control program.
3.	Normal operation resumes after the user: • releases the emergency stop button [S21] to normal (up) position • resets the emergency stop circuit with the emergency stop reset button [S22] • resets the converter if a fault is generated (parameter 121.04 Emergency stop mode is set to Fault).

Parallel-connected converters

Master unit



Slave unit



1)	Reset circuit	K51	Control unit (generator-side converters)
S21	Control contact, eg, a button (user-defined)	K11	Control unit (grid-side converter in the slave unit)
S22	Reset contact, eg, a button (user-defined)	G20	24 V DC power supply
Q1Yc	Feedback contact from the main circuit breaker to the reset circuit	Q1	Main circuit breaker
A21	Emergency stop safety relay	Q6	Charging contactor
A22	Auxiliary safety relay	Q1X	Output contactors (option +F269)
A23	Auxiliary safety relay	T1.X	Grid-side converter modules
A24	Auxiliary safety relay	T5.X	Generator-side converter modules
The dash line indicates a customer-defined installation.			

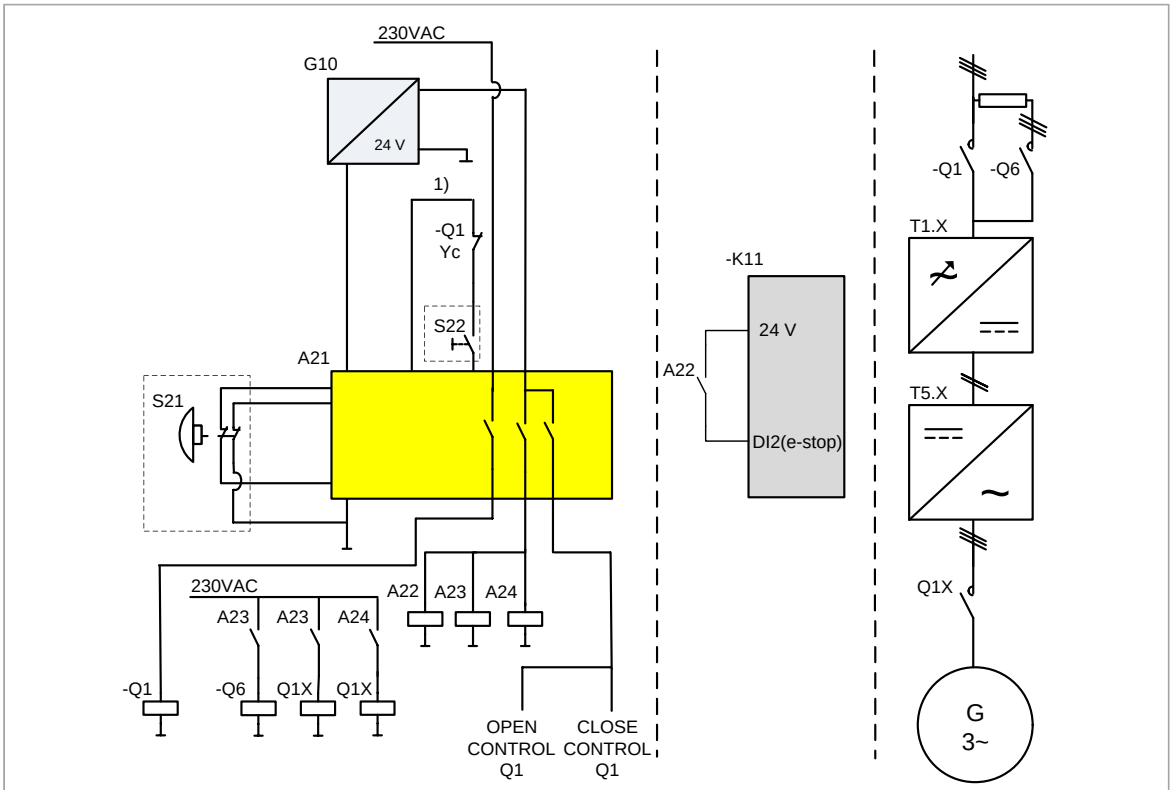
Initial status: The converter is running and the wind turbine is rotating.

In this example, the user gives the emergency stop request command and resets the emergency circuit with buttons. The emergency stop request and reset commands are given to the master and slave units at the same time (the buttons are wired to both units).

Step	Operation
1.	The user activates Emergency stop function with the emergency stop button [S21].
2.	The emergency stop safety relay [A21] de-energizes relays [A22], [A23] and [A24] and opens the main circuit breaker [Q1] in both units. The main circuit breakers remain open while the emergency stop function is on. The auxiliary safety relay [A23] de-energizes the charging contactor [Q6] to prevent it from closing in both units. The auxiliary safety relays [A23] and [A24] open the optional output contactors [Q1X] in both units (this is not part of the safety circuit). The auxiliary relay [A22] switches off the DI2 input of the grid-side control units [K11] in the master and slave units and DI1 input of the generator-side control unit [K51] in the master unit. The emergency stop indication is shown in the grid-side control program.
3.	Normal operation resumes after the user: • releases the emergency stop button [S21] to normal (up) position • resets the emergency stop circuit with the emergency stop reset button [S22] • resets the converter if a fault is generated (parameter 121.04 Emergency stop mode is set to Fault).

Operation principle – ACS880-77CC/-87CC

Single converter



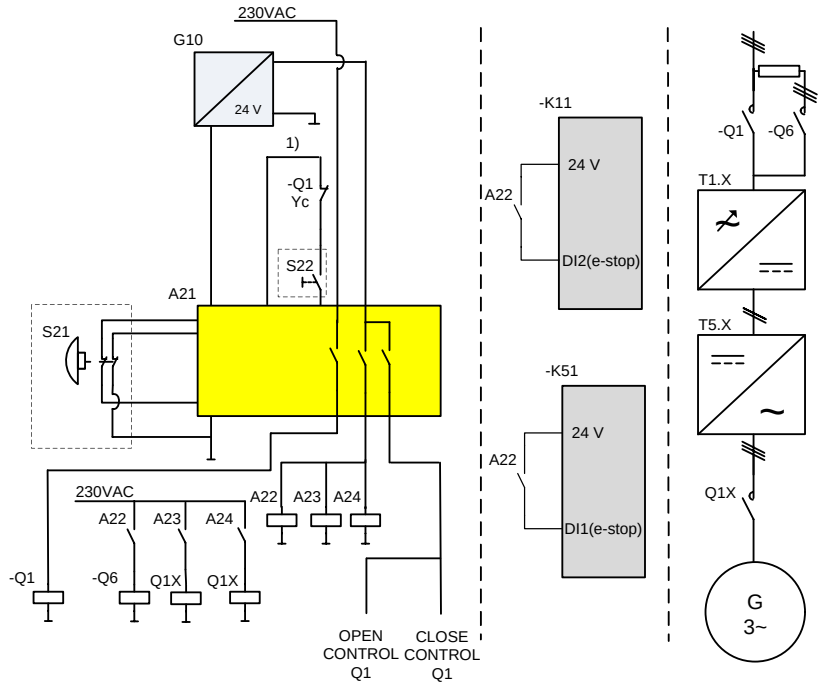
1)	Reset circuit	K11	Control unit (common for grid-side converter and generator-side converter)
S21	Control contact, eg, a button (user-defined)	G10	24 V DC power supply
S22	Reset contact, eg, a button (user-defined)	Q1	Main circuit breaker
Q1Yc	Feedback contact from the main circuit breaker to the reset circuit	Q6	Charging contactor
A21	Emergency stop safety relay	Q1X	Output contactors (option +F269)
A22	Auxiliary safety relay	T1.X	Grid-side converter modules
A23	Auxiliary safety relay	T5.X	Generator-side converter modules
A24	Auxiliary safety relay		
The dash line indicates a customer-defined installation.			

Initial status: The converter is running and the wind turbine is rotating. In this example, the user gives the emergency stop command and resets the emergency circuit with buttons.

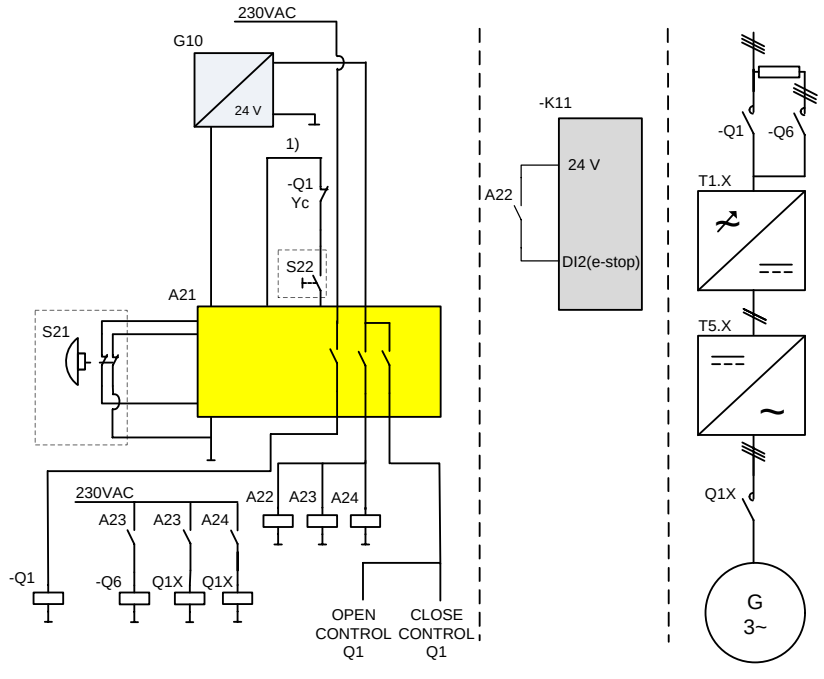
Step	Operation
1.	The user activates Emergency stop function with the emergency stop button [S21].
2.	The emergency stop safety relay [A21] de-energizes relays [A22], [A23] and [A24] and opens the main circuit breaker [Q1]. The main circuit breaker remains open while the emergency stop function is on. The auxiliary safety relay [A23] de-energizes the charging contactor [Q6] to prevent it from closing. The auxiliary safety relays [A23] and [A24] open the optional output contactors [Q1X] (this is not part of the safety circuit). The auxiliary safety relay [A22] switches off the DI2 input of the control unit [K11]. The emergency stop indication is shown in the grid-side control program.
3.	Normal operation resumes after the user: • releases the emergency stop button [S21] to normal (up) position • resets the emergency stop circuit with the emergency stop reset button [S22] • resets the converter if a fault is generated (parameter 121.04 Emergency stop mode is set to Fault).

Parallel-connected converters

Master unit



Slave unit



1)	Reset circuit	K51	Control unit (generator-side converters)
S21	Control contact, eg, a button (user-defined)	K11	Control unit (grid-side converter in the slave unit)
S22	Reset contact, eg, a button (user-defined)	G10	24 V DC power supply
Q1Yc	Feedback contact from the main circuit breaker to the reset circuit	Q1	Main circuit breaker
A21	Emergency stop safety relay	Q6	Charging contactor
A22	Auxiliary safety relay	Q1X	Output contactors (option +F269)
A23	Auxiliary safety relay	T1.X	Grid-side converter modules
A24	Auxiliary safety relay	T5.X	Generator-side converter modules
The dash line indicates a customer-defined installation.			

Initial status: The converter is running and the wind turbine is rotating.

In this example, the user gives the emergency stop request command and resets the emergency circuit with buttons. The emergency stop request and reset commands are given to the master and slave units at the same time (the buttons are wired to both units).

Step	Operation
1.	The user activates Emergency stop function with the emergency stop button [S21].
2.	The emergency stop safety relay [A21] de-energizes relays [A22], [A23] and [A24] and opens the main circuit breaker [Q1] in both units. The main circuit breakers remain open while the emergency stop function is on. The auxiliary safety relay [A23] de-energizes the charging contactor [Q6] to prevent it from closing in both units. The auxiliary safety relays [A23] and [A24] open the optional output contactors [Q1X] in both units (this is not part of the safety circuit). The auxiliary relay [A22] switches off the DI2 input of the grid-side control units [K11] in the master and slave units and DI1 input of the generator-side control unit [K51] in the master unit. The emergency stop indication is shown in the grid-side control program.
3.	Normal operation resumes after the user: • releases the emergency stop button [S21] to normal (up) position • resets the emergency stop circuit with the emergency stop reset button [S22] • resets the converter if a fault is generated (parameter 121.04 Emergency stop mode is set to 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 trips the system if it detects a failure (short circuit between signals, open circuits, redundancy fault when the emergency stop button is pressed) in the safety circuit consisting of, for example, emergency stop button and the contacts wired to it.

The fault reaction function forces the system immediately into safe state by switching on the emergency stop command, opening the main circuit breaker, and keeping them on until the detected fault has been repaired and the safety function has been reset.

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

Parameter settings

Parameters relevant to the safety function have been set at the factory.

Single converter

Generator-side control program:

- 21.04 Emergency stop mode = Coast stop (Off2)
- 21.05 Emergency stop source = DI1

Grid-side control program:

- 121.04 Emergency stop mode = Stop and warning
- 121.05 Emergency stop source = DI2

ACS880-87CC single converter:

- 21.04 Emergency stop mode = Coast stop (Off2)
- 21.05 Emergency stop source = DI1

Parallel-connected converters

Generator-side control program in the master unit :

- 21.04 Emergency stop mode = Coast stop (Off2)
- 21.05 Emergency stop source = 88.50.5 **(Combined EM stop Word, bit 5: Emergency stop active in any converter)**
- 88.51 Combined ISU EM STOP source = 88.11.12 **(Combined ISU Status Word: bit 12)**
- 88.52 INU EM stop source = 10.1.0 **(DI1)**

Note: Digital input from subconverter comes via Ethernet connections and is not SIL capable.

Grid-side control program in the master and slave units:

- 121.04 Emergency stop mode = Stop and warning **(or** Fault**)**
- 121.05 Emergency stop source = DI2.

Hardware settings

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

The emergency stop safety relay is set to the manual reset mode at the factory. Do not change this setting.

Wiring

Install an emergency stop request button (or similar) and wire it to terminal block [X5] inside the converter cabinet. See the circuit diagrams for the correct terminals. The request button is not included in the delivery.

There must be double contacts in the emergency stop button and double wiring (two-channel connection) between the button and the emergency stop safety relay. The safety relay detects cross faults and faults across one contact from the emergency stop button. This function must be used in a redundant manner, that is, the emergency stop button must be connected to both terminals with a separate contact.

For the emergency stop button, obey these rules:

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

   Note: Keep the channels separate. If you use only one channel, or if the first and second channels are connected together (for example, in a chain), the cross fault detection of the emergency stop safety relay trips and activates the emergency stop command of the converter as it detects a redundancy fault.
3. Use a shielded, twisted pair cable. We recommend a double-shielded cable and gold-plated contacts in the emergency stop button.
4. Ensure that the sum resistance for one channel (loop resistance) from the field to the safety relay does not exceed 70 ohm.
5. Obey the general control cable installation instructions given in the hardware manual.

Install an emergency stop reset button (or similar) and wire it to terminal block [X5] inside the converter cabinet. See the circuit diagrams for the correct terminals. The reset button is not included in the delivery.

We recommend gold-plated contacts in the reset button.

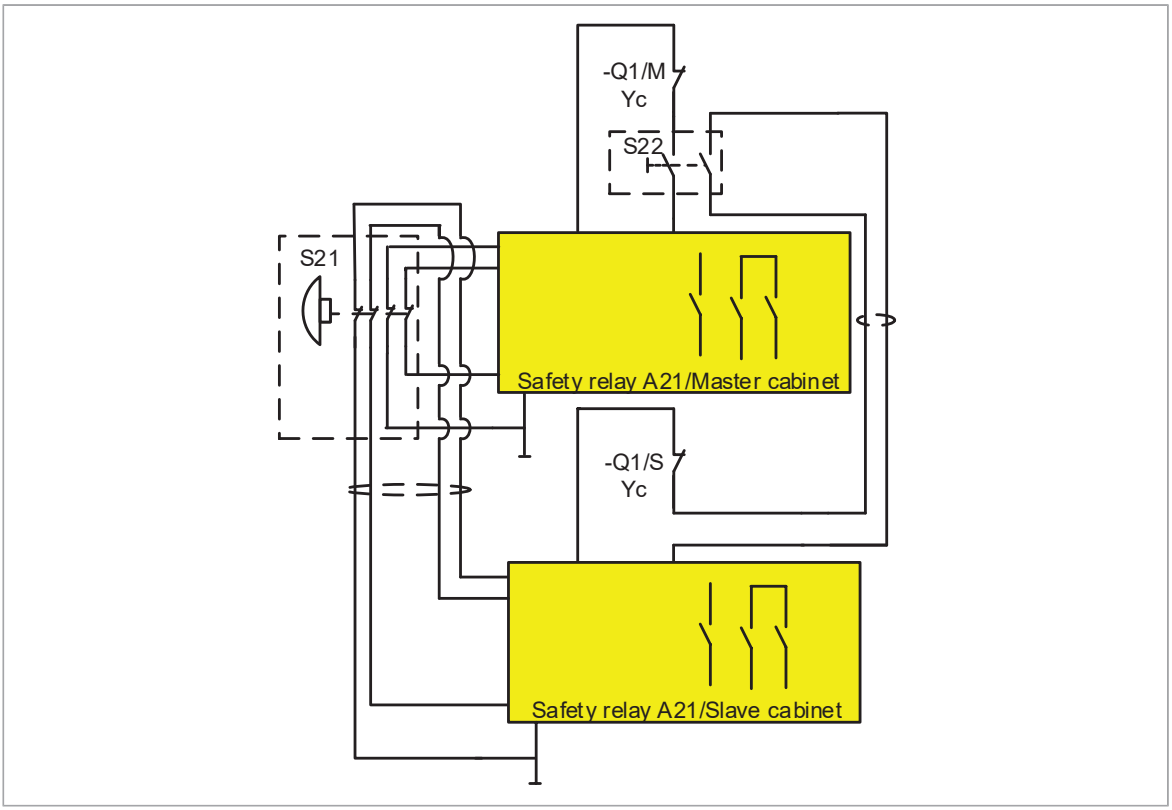
For the reset button, obey these rules:

1. Sum resistance of the external reset circuit must not exceed 70 ohm.
2. Obey the general control cable installation instructions given in the hardware manual.

Parallel-connected converters

The customer is responsible for connecting the master and slave units. This connection is not part of the safety circuit. See the hardware manual.

There are similar safety circuits in the master and slave units. The customer is responsible for connecting the emergency stop request and reset buttons (or similar) to the master and slave units. We recommend that you connect the same emergency stop request and reset buttons to the master and slave units. Common emergency stop request for master and slave can for example be implemented using emergency stop button with four NC contacts. Similarly common emergency stop reset button can be implemented with one button with two contacts. Obey the rules above. See the example diagram below.



WARNING!
If you connect separate emergency stop buttons to the master and slave units, pushing the emergency stop button stops safely only the unit to which it is connected to.

Note: The overall safety system and all customer-made wirings are on the customer's responsibility.

Start-up and acceptance test

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

Initial status: Make sure that the converter is ready for use, that is, you have done the tasks of the converter start-up procedure. See the start-up guide.

Single converter

Action	☑
WARNING! Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.	☐
Checks and settings with no voltage connected	
Check the connections against the appropriate circuit diagrams. Digital inputs that are used for the activation of the Emergency stop function in the control units: • DI1 in the generator-side converter • DI2 in the grid-side converters Note that ACS880-87CC single converter contains one control unit [K11] only. Make sure you have connected the emergency stop request and reset buttons (or similar) to the correct terminals in terminal block [X5]. See the wiring instructions.	☐
Check that the parameters relevant to the safety function are set as defined in section Parameter settings (page 25).	☐
Acceptance test	
Run the wind turbine and the converter with minor speed and load (torque). **WARNING!** A stop with full speed or torque stresses the wind turbine mechanically and can damage it.	☐
Activate the Emergency stop function with the request button.	☐
Monitor these signals with the Drive composer PC tool: • 01.01 Generator speed used • 01.07 Generator current • 01.10 Generator torque % • 10.01 DI status **of the generator-side converter:** DI1 - Emergency stop **(0: Request is active, 1: Request is not active)** • 26.02 Torq ref used • 101.02 Line current • 110.01 DI status **of the grid-side converter:** DI2 - Emergency stop **(0: Request is active, 1: Request is not active)** • 110.01 DI status **of the grid-side converter:** DI3 - Main circuit breaker **(0: MCB is open, 1: MCB is closed)** Check also warnings and faults in the event logger of the Drive composer PC tool.	☐
Make sure that the converter stops by coasting (as defined by parameter 21.04 Emergency stop mode). Signals 01.10 Generator torque % and 26.02 Torq ref used go to zero immediately.	☐
Make sure that the main circuit breaker opens (check parameter 110.01 DI Status: DI3 of the grid-side converter).	☐
Make sure that the correct indication is generated in the grid-side control program. See the Emergency stop indications.	☐

Action	☑
Make sure that you cannot start the converter from any control location.	☐
Turn the emergency stop request button until it releases and returns to the up position.	☐
Reset the emergency stop circuit with the reset button.	☐
Make sure that the converter does not start without a start command (safety requirement in EN ISO 13850).	☐
Reset the converter if a fault is generated (parameter 121.04 Emergency stop mode is set to Fault).	☐
Restart the converter with a start command and make sure that it operates normally.	☐
Repeat the test both when the Local control and Remote control is selected in the Drive composer PC tool.	☐
Fill in and sign the acceptance test report which verifies that the safety function is safe and accepted to operation.	☐

Parallel-connected converters

Action	☑
WARNING! Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.	☐
Checks and settings with no voltage connected	
Check the connections against the appropriate circuit diagrams. Digital inputs that are used for the activation of the Emergency stop function in the control units: • DI1 in the generator-side converter (master converter) • DI2 in the grid-side converters (master and slave converters) Make sure you have connected the emergency stop request and reset buttons (or similar) to the correct terminals in terminal blocks [X5]. See the wiring instructions.	☐
Check that the parameters relevant to the safety function are set as defined in section Parameter settings (page 25).	☐
Acceptance test	
Run the wind turbine and the converter with minor speed and load (torque). **WARNING!** A stop with full speed or torque stresses the wind turbine mechanically and can damage it.	☐
Activate the Emergency stop function with the request button.	☐

Action	☑
Monitor these signals with the Drive composer PC tool: **Generator-side converter:** • 01.01 Generator speed used • 01.07 Generator current • 01.10 Generator torque % • 10.01 DI status **of the generator-side converter:** DI1 - Emergency stop **(0: Request is active, 1: Request is not active)** • 26.02 Torq ref used **Master and slave grid-side converters:** • 101.02 Line current • 110.01 DI status **of the grid-side converter:** DI2 - Emergency stop **(0: Request is active, 1: Request is not active)** • 110.01 DI status **of the grid-side converter:** DI3 - Main circuit breaker **(0: MCB is open, 1: MCB is closed)** Check also warnings and faults in the event logger of the Drive composer PC tool.	☐
Make sure that the converter stops by coasting (as defined by parameter 21.04 Emergency stop mode). Signals 01.10 Generator torque % and 26.02 Torq ref used go to zero immediately.	☐
Make sure that the main circuit breaker opens in both subconverters (check parameter 110.01 DI Status DI3 of the grid-side converters).	☐
Make sure that the correct indications are generated in the grid-side control programs (in both subconverters). See the Emergency stop indications.	☐
Make sure that you cannot start the converter from any control location.	☐
Turn the emergency stop request button until it releases and returns to the up position.	☐
Reset the emergency stop circuit with the reset button.	☐
Make sure that the converter does not start without a start command (safety requirement in EN ISO 13850).	☐
Reset the converter if a fault is generated (parameter 121.04 Emergency stop mode is set to Fault).	☐
Restart the converter with a start command and make sure that it operates normally.	☐
Repeat the test both when the Local control and Remote control is selected in the Drive composer PC tool.	☐
Fill in and sign the acceptance test report which verifies that the safety function is safe and accepted to operation.	☐

Use of the safety function

Activating

1. Push the emergency stop button (customer-defined).
   The emergency stop activates and the button locks in “ON” (open) position.

Resetting

1. Turn the emergency stop button until it releases (customer-defined).
2. Reset the emergency stop circuit with the reset button (customer-defined).
   The emergency stop function deactivates.
3. Reset the converter if a fault is generated (parameter 121.04 Emergency stop mode is set to Fault).
4. Start the converter with a start command.

Emergency stop indications

When the emergency stop is activated:

- the grid-side control program has the Grid Emergency stop (off2) warning or fault active (according to parameter 121.04 Emergency stop mode).
- the generator-side control program has the Gen Emergency stop (circuit) warning active.
- **Parallel-connected converters**: the generator-side control program also indicates which subconverter activated the emergency stop.

For more information, see the firmware manual.

Fault tracing

The emergency stop safety relay type is Phoenix Contact PSR-MC34.

This table gives the indications of the Phoenix Contact PSR-MC34 relay:

PWR LED	IN1/2 LED	K1 LED	K2 LED	State
ON	OFF	OFF	OFF	All relays are not activated. The sensor circuit is off. Possible error, see the data sheet of the relay.
ON	ON	OFF	OFF	The sensor circuit is active. Relays K1 and K2 are ready to start and await reset/start command.
ON	ON	ON	ON	The sensor circuit is active. All relays are picked up.
Other LED combination				Possible error, see the data sheet of the relay.

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

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 component or wiring after the start-up, or restore parameters to their default values:

- Use only ABB-approved spare parts.
- Register the change to the change log for the safety circuit.
- Test the safety function again after the change. Obey the rules given in section Start-up and acceptance test.
- Document the tests and store the report into the logbook of the machine.

Proof test interval

After the operation of the safety function is validated at start-up, the safety function must be maintained by periodic proof testing. In high demand mode of operation, the maximum proof test interval is 20 years. In low demand mode of operation, the maximum proof test interval is 1 year (high or low demand as defined in IEC 61508, EN/IEC 62061 and EN ISO 13849-1). Regardless of the mode of operation, it is a good practice to check the operation of the safety function at least once a year. Do the acceptance test as described in section Start-up and acceptance test.

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

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

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

Competence

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

Residual risk

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

Intentional misuse

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

Decommissioning

When you decommission an emergency stop circuit or the whole unit, make sure that the safety of the machine is maintained until the decommissioning is complete.

Safety data

The safety data given below is valid for the default design of the safety circuit presented in this manual. If the design differs from the default, ABB calculates new safety data and delivers it separately to the customer.

Safety data values

Parallel-connected converters: Similar safety circuits are included in both subconverters (master and slave). This safety data is calculated per subconverter.

The safety data calculations are based on the following assumptions on the operation of the main circuit 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.

Converter type ACS880-	SIL / SILCL	PL	PFH [1/h] [1)]	PFD_{avg}	DC [%] [2)]	SC	Cat.	HFT	CCF	Mission time [a]	T1 [3) 4)] [a]
77LC/77CC/87LC/87CC	2	d	6.9E-7	3.0E-03	>90	3	2	0	80	20	20 / 1
											3AXD10000650820 Rev B

1) PFH values according to EN ISO 13849.
2) DC for low demand mode is 0% (determined by the DC of the worst component in the subsystem).
3) See also the Recommendation of Use CNB/M/11.050 published by the European coordination of Notified Bodies for lower T1 requirement.
4) T1 = 20 a stands for high demand use. T1 = 1 a 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 shall be used and PFD calculated separately.

Safety component types

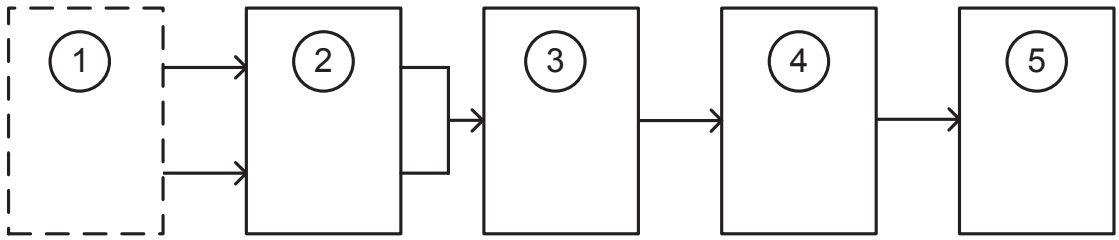
Safety component types as defined in IEC 61508-2:

- emergency stop safety relay: type A
- auxiliary safety relay: type A
- main circuit breaker: type A
- charging contactor: type A

Safety block diagram

The components that are included in the safety circuit are shown in this safety block diagram.

Parallel-connected converters: Similar safety circuits are included in both subconverters (master and slave).



No.	Description
1	Emergency stop request button (customer-defined, not included in the safety data calculations)
2	Emergency stop safety relay
3	Auxiliary safety relay
4	Charging contactor
5	Main circuit breaker

Relevant failure modes

- The main circuit breaker does not open when requested. (All main circuit breaker failures are considered dangerous.)
- Internal failures of safety relays. 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.

General rules, notes and definitions

Validation of the safety functions

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

Validation procedure

You must do the acceptance test using the checklist given in section Start-up and acceptance test.

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

The acceptance test must include at least the following steps:

- you must have an acceptance test plan
- you must test all commissioned functions for proper operation, from each operation location
- you must document all acceptance tests.

Acceptance test reports

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

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

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

Competence

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

Ambient conditions

For environmental limits, see the hardware manual.

Reporting problems and failures related to safety functions

Contact your local ABB representative.

Related standards and directives

Standard	Name
EN 60204-1:2006 + AC:2010 IEC 60204-1:2016	Safety of machinery – Electrical equipment of machines – Part 1: General requirements
IEC 61508 Parts 1-2, Ed. 2.0:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems
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 EN 62061:2005 +AC:2010+A1:2013+ A2:2015	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
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 61800-3:2004 + A1:2012	Adjustable Speed Electrical Power Drive Systems - Part 3: EMC requirements and specific test methods
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
Other	Sector-specific C-type standards

Compliance with the European Machinery Directive

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

Declaration of conformity

EU Declaration of Conformity

Machinery Directive 2006/42/EC

We
Manufacturer: ABB Oy
Address: Hiomotie 13, 00380 Helsinki, Finland.
Phone: +358 10 22 11

Declare under our sole responsibility that the following products:

Frequency converters

ACS880-77LC **ACS880-77CC**

ACS880-87LC **ACS880-87CC**

identified with serial numbers beginning with 1 or 8

with regard to the safety function

Emergency stop (option code +Q951)

is in conformity with all the relevant safety component requirements of the EU Machinery Directive 2006/42/EC, when the listed safety function is used for safety component functionality.

The following harmonized standards have been applied:

EN 61800-5-2:2007	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements - Functional
EN 62061:2005 + AC:2010 + A1:2013 + A2:2015	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
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 the control systems. Part 2: Validation
EN 60204-1:2018	Safety of machinery – Electrical equipment of machines – Part 1: General requirements

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IMS template code: 3AFE011906, Rev. E

The following other standard has been applied:

IEC 61508:2010, parts 1-2	Functional safety of electrical / electronic / programmable electronic safety-related systems

The products referred in this declaration of conformity fulfils the relevant provisions of other European Union directives which are notified in a single EU declaration of conformity 3AXD10000497308.

Authorized to compile the technical file: ABB Oy, Hiomotie 13, 00380 Helsinki, Finland

Helsinki, 18th of November 2022

Signed for and on behalf of:

Peter Lindgren
Vice President, ABB Oy

Vesa Tiihonen
Manager, Quality and Reliability, ABB Oy

3AXD10000659646 Rev. D
IMS template code: 3AFE011906, Rev. E

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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