OPTIONS FOR ABB DRIVES

Emergency stop, stop category 1 (option +Q964) for ACS880 multidrives

User's manual

Emergency stop, stop category 1 (option +Q964) for ACS880 multidrives

User's manual

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1

Safety instructions

Contents of this chapter

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

Use of warnings and notes

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

The manual uses these warning symbols:

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

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

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

Instructions for functional safety circuits

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

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

WARNING!
The safety function described in this manual does not isolate the main 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 9)*.

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

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

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

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

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

Electrical safety precautions

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

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

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

Do these steps before you begin any installation or maintenance work.

1. Clearly identify the work location and equipment.
2. Disconnect all possible voltage sources. Make sure that re-connection is not possible. Lock out and tag out.
   - Open the main disconnecting device of the drive.
   - Open the charging switch if present.
   - Open the disconnector 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.)
   - If the drive is equipped with a DC/DC converter unit (optional) or a DC feeder unit (optional): Open the DC switch-disconnector ([Q11], option +F286 or +F290) of the unit. Open the disconnecting device of the energy storage connected to the unit (outside the drive cabinet).
   - Open the auxiliary voltage switch-disconnector (if 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 you have a permanent magnet motor connected to the drive, disconnect the motor from the drive with a safety switch or by other means.
   - Disconnect all dangerous external voltages from the control circuits.
   - After you disconnect power from the drive, always wait 5 minutes to let the intermediate circuit capacitors discharge before you continue.
3. Protect any other energized parts in the work location against contact.
4. Take special precautions when close to bare conductors.
5. Measure that the installation is de-energized. Use a quality voltage tester. If the measurement requires removal or disassembly of shrouding or other cabinet structures, obey the local laws and regulations applicable to live working (including – but not limited to – electric shock and arc protection).
   - Before and after measuring the installation, verify the operation of the voltage tester on a known voltage source.
   - Make sure that the voltage between the drive input power terminals (L1, L2, L3) and the grounding (PE) busbar is zero.
   - Make sure that the voltage between the drive output terminals (T1/U, T2/V, T3/W) and the grounding (PE) busbar is zero.

Important! Repeat the measurement also with the DC voltage setting of the 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 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 terminals (UDC+ and UDC-) and the grounding (PE) terminal is zero. In cabinet-built drives, measure between the drive DC busbars (+ and -) and the grounding (PE) busbar.

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 in control of the electrical installation work.

2

Introduction to the manual

Contents of this chapter

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

Applicability

This manual is applicable to ACS880 air-cooled and liquid-cooled multidrives which have the option: Emergency stop, stop category 1 with STO, with safety relays (option +Q964).

This manual shows the default design of the safety circuit ordered with option code +Q964. 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	☑
Connect the user-defined wiring (if any). Refer to the wiring instructions in this manual and the circuit diagrams delivered with the drive.	☐
Check and/or set the safety function related parameters (as listed in this manual).	☐
Do the 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.	☐
Document the validation test procedure. You can find the guidelines for the validation test report in this manual.	☐

Related manuals

Manual	Code
Drive hardware	
ACS880 multidrive cabinets mechanical installation instructions	3AUA0000101764
ACS880 liquid-cooled multidrive cabinets mechanical installation instructions	3AXD50000048635
ACS880 multidrive cabinets and modules electrical planning instructions	3AUA0000102324
ACS880 liquid-cooled multidrive cabinets and modules electrical planning	3AXD50000048634
Supply units	
ACS880-207 IGBT supply units hardware manual	3AUA0000130644
ACS880-207LC IGBT supply units hardware manual	3AXD50000174782
ACS880-307…+A003 diode supply units hardware manual	3AUA0000102453
ACS880-307…+A018 diode supply units hardware manual	3AXD50000011408
ACS880-307LC…+A018 diode supply units hardware manual	3AXD50000579662
ACS880-907 regenerative rectifier units hardware manual	3AXD50000020546
Inverter hardware	
ACS880-107 inverter units hardware manual	3AUA0000102519
ACS880-107LC inverter units hardware manual	3AXD50000196111
Drive firmware	
ACS880 primary control program firmware manual	3AUA0000085967
ACS880 primary control program quick start-up guide	3AUA0000098062
ACS880 diode supply control program firmware manual	3AUA0000103295
ACS880 IGBT supply control program firmware manual	3AUA0000131562
ACS880 regenerative rectifier control program firmware manual	3AXD50000020827
PC tools	
Drive Composer start-up and maintenance PC tool user's manual	3AUA0000094606
Functional safety design tool user’s manual	3AXD10000102417
Safety	
ACS880 multidrive cabinets and modules safety instructions	3AUA0000102301
ACS880 liquid-cooled multidrive cabinets and modules safety instructions	3AXD50000048633
Functional safety; Technical guide No. 10	3AUA0000048753
ABB Safety information and solutions	www.abb.com/safety

Manual	Code
Options	
ACX-AP-x assistant control panels user's manual	3AUA0000085685
Other documents	
Circuit diagrams	Delivered with the drive
Part lists	Delivered with the drive
Safety data report (if ordered with option code +P947)	

You can find manuals and other product documents in PDF format on the Internet at www.abb.com/drives/documents.

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)
DI	Digital input
DIIL	Digital input interlock
E-stop	Emergency stop
Frame, frame size	Physical size of the drive or power module
HFT	Hardware fault tolerance (IEC 61508)
IGBT	Insulated gate bipolar transistor
Inverter unit	Inverter module(s) under control of one control unit, and related components. One inverter unit typically controls one motor.
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 mission time values given cannot be regarded as a guarantee or warranty. (EN ISO 13849-1)
PL	Performance level. Levels a...e correspond to SIL (EN ISO 13849-1)
POUS	Prevention of unexpected start-up
RO	Relay output
SIL	Safety integrity level (1…3) (IEC 61508, IEC 62061, IEC 61800-5-2)
SS1	Safe stop 1 (IEC/EN 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: • 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.
Validation	Confirmation by, for example, analysis that the safety system meets the functional safety requirements of the specific application.
Verification	Confirmation by, for example, testing that the safety system meets the requirements set by the specification.
Zero speed	For safety functions, the zero speed limit indicates the completion of the safe stopping function.

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Option description

Contents of this chapter

This chapter describes the +Q964 emergency stop option and its settings.

Overview

Option +Q964 corresponds to a controlled stop in accordance with stop category 1 (IEC/EN 60204-1) and to the Safe Stop 1 time controlled function (SS1-t). When the user gives the emergency stop command, the drive decelerates the motors to zero speed according to a user-defined ramp time. Then, the Safe torque off (STO) function is activated, which prevents the inverter units from generating the torque required to rotate the motors. The main contactor/breaker of the drive is not opened.

For a detailed description of the Safe torque off function, refer to the inverter unit hardware manual.

Note: Drives with the 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 multidrives user's manual* (3AUA0000119894 [English]).

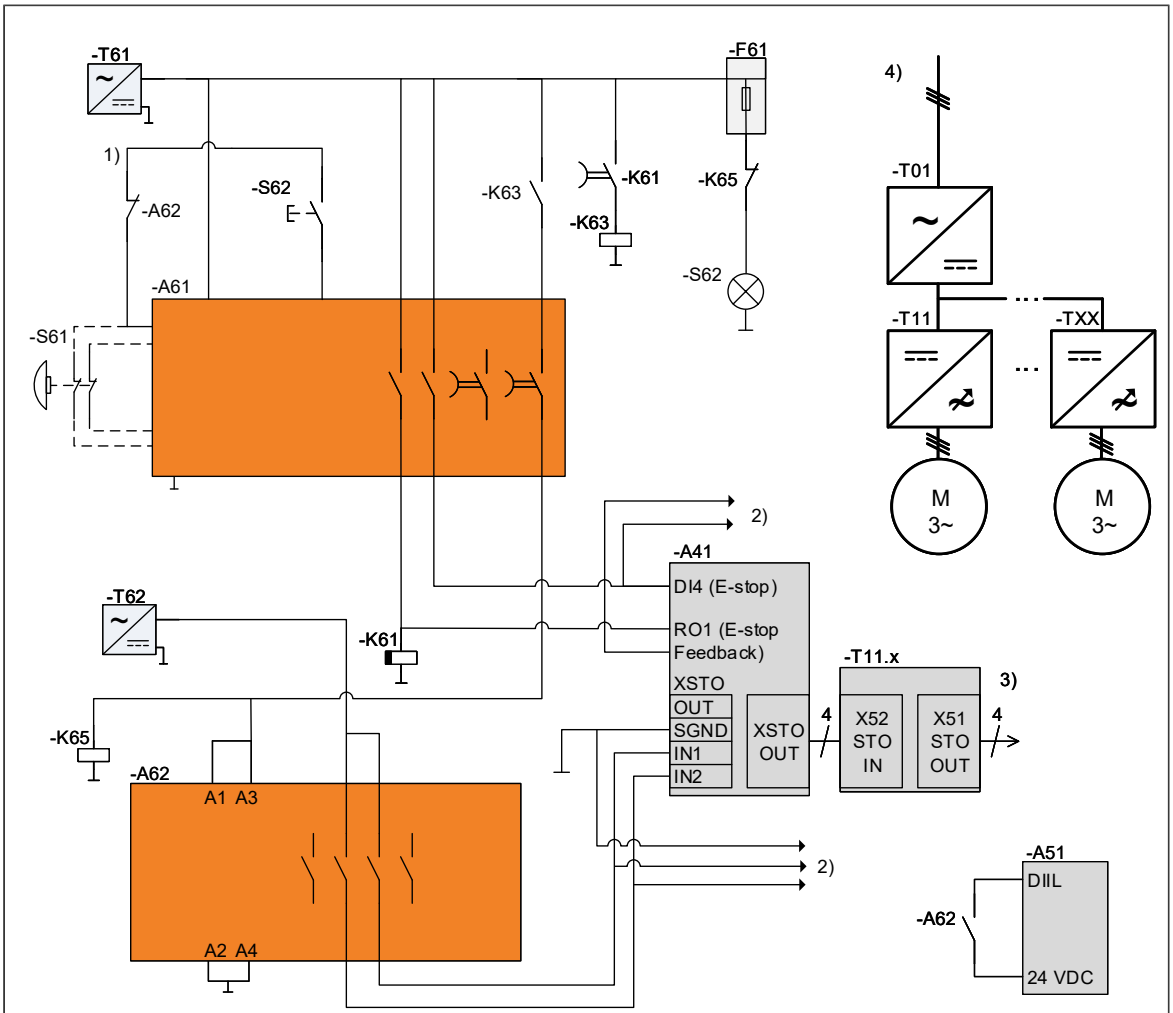
The SS1 and STO functions comply with IEC/EN 61800-5-2.

The design principles of the option +Q964 comply with EN ISO 13850.

For a complete list of related standards and European directives, refer to section *Related standards and directives (page 36)*.

Operation principle

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



- - -	The dashed line in the figure shows a user-defined installation.
A41	Inverter control unit
A51	Supply control unit
A61	Emergency stop safety relay with delay contacts
A62	Emergency stop extension relay
F61	Circuit protection switch
K61	Timer relay
K63	Safety relay
K65	Safety relay
S61	Emergency stop button (user-defined)
S62	Emergency stop reset button with indicator light
T01	Supply unit

T11 … Txx	Inverter unit(s)
T11.x	Inverter module(s) under inverter unit T11
T61	24 V power supply
T62	24 V power supply for Safe torque off (STO)
1)	Reset circuit
2)	To other inverter control units
3)	To parallel inverter modules (if any)
4)	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 inverter control units [A41]. This gives an emergency stop command to the inverter units. 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 units acknowledge the reception of the emergency stop command by energizing the relay outputs (RO1) on the inverter control units [A41]. The relay output energizes the timer relay [K61], resetting its break delay counter. The relay keeps its delayed break contact closed. **Note:** If an inverter unit does not acknowledge the reception of the emergency stop command in 2 seconds, the STO function is activated.
4	The inverter units decelerate the motors to zero speed in the emergency stop deceleration time (user-defined parameter setting).
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 STO function. The extension safety relay [A62] de-energizes the DIIL input on the supply control unit [A51]. This gives an emergency stop command to the supply unit.
6	The contact of the safety relay [K65] energizes the emergency stop reset button indicator light [S62].
7	Normal operation continues after the user: • releases the emergency stop button [S61] to normal (up) position • pushes the emergency stop reset button [S62] for 0.1 … 3 seconds to reset the emergency stop circuit • resets the inverter units, if they are configured to generate a fault when STO is activated • makes sure that the drive has received the start signal (depends on the configuration, see the firmware manual).

Fault reaction function

Definition: A safety function requires a “fault reaction function” that tries to initiate a safe state if it detects a failure in the safety system.

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

If a fault is detected, the fault reaction function:

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

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

The user must reset the safety relay. Refer to section *Fault tracing (page 29)*.

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

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 21)*.

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 s, t = 1 (30 s · 1 = 30 s), or
- t_{max} = 300 s, t = 0.1 (300 s · 0.1 = 30 s).

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Electrical installation

Contents of this chapter

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

Wiring

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.

If option +G331 has been selected, one emergency stop button is 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.

There is an emergency stop reset button on the cabinet door. The reset button is connected to the drive at the factory.

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 inverter unit hardware manual.

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

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

5

Parameter settings

Contents of this chapter

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

Inverter unit 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
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	DI4 [2]	Selects the source of the emergency stop signal.
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.
[2] Delivery-specific. Refer to the circuit diagrams.

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 18)*.

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.

No.	Name	Value	Description
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.

Supply unit parameter settings

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	Warning	Selects the way the supply unit is stopped when an emergency stop command is received.
121.05	Emergency stop source	DIIL	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 inverter unit 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 inverter unit STO is activated.

Resetting the safety function

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

1. Turn the emergency stop button [S61] until it releases.
2. Push the emergency stop reset button [S62] on the cabinet door for 0.1 … 3 seconds. The emergency stop reset button indicator light [S62] goes off, and the emergency stop is deactivated.
3. If necessary, reset faults from the inverter units and the supply unit.
4. Make sure that the inverter units receive the start signal.
5. You can now restart the inverter units.

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

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

7

Start-up and validation test

Contents of this chapter

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

Validation of the safety functions

You must do a validation test to 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
- after maintenance work related to the safety function
- at the proof test of 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	☑
WARNING! Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.	☐
Initial status	
Make sure that the drive is ready for use, that is, you have done the tasks of the drive start-up procedure. Refer to the hardware manuals.	☐
Make sure that the STO function is configured and validated. Refer to the inverter unit hardware manual.	☐
Checks and settings with no voltage connected	
Stop the drive and do the steps in section *Electrical safety precautions (page 9)* before you start the work.	☐
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.	☐
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.	☐

Action	☑
Make sure that the hardware settings of the safety function are set as defined in this manual.	☐
Settings with voltage connected	
Close the cabinet doors and power up the drive. Refer to the hardware manual.	☐
Make sure that the parameter settings related to the safety functions are correct. Refer to chapter *Parameter settings*.	☐
Validation test	
ABB recommends that you monitor at least these signals with the Drive Composer PC tool: • 01.01 Motor speed used (rpm) • 01.02 Motor speed estimated (rpm) • 01.07 Motor current (A) • 01.10 Motor torque (%) • 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) • When using an encoder, also: 90.10 Encoder 1 speed (rpm)	☐
Make sure that it is safe to start, run and stop the motors during the test.	☐
Start the inverter units and make sure that the motors are running. If possible, use a motor speed close to the maximum speed of the application.	☐
Push the emergency stop button [S61].	☐
Make sure that the inverter units stop the motors by decelerating and display a related warning.	☐
Make sure that the emergency stop reset button indicator light [S62] comes on.	☐
Make sure that the inverter unit generates none of these faults: • STO hardware failure (5090) • Safe torque off 1 loss (FA81) • Safe torque off 2 loss (FA82) If the inverter unit generates these faults, refer to the fault tracing instructions in this manual.	☐
Make sure that you cannot start the inverter units or motors from any control location. Make sure that the inverter units or motors do not start when you switch the start signal off and on, or push the start key of the panel when the panel is in local control mode.	☐
Switch off the start signals of the inverter units.	☐
Turn the emergency stop button [S61] until it releases and returns to the up position.	☐
Push the emergency stop reset button [S62] to reset the emergency stop circuit. Make sure that the emergency stop reset button indicator light [S62] goes off.	☐
Restart the inverter units and motors. Make sure that they operate normally.	☐
Do the test again from each operating location (for each emergency stop button and reset button).	☐
Create a backup file of the drive parameters with the Drive Composer PC tool or control panel.	☐
Fill in and sign the validation test report. Store the report in the logbook of the machine.	☐

8

Fault tracing

Contents of this chapter

This chapter provides general diagnostics and troubleshooting tips.

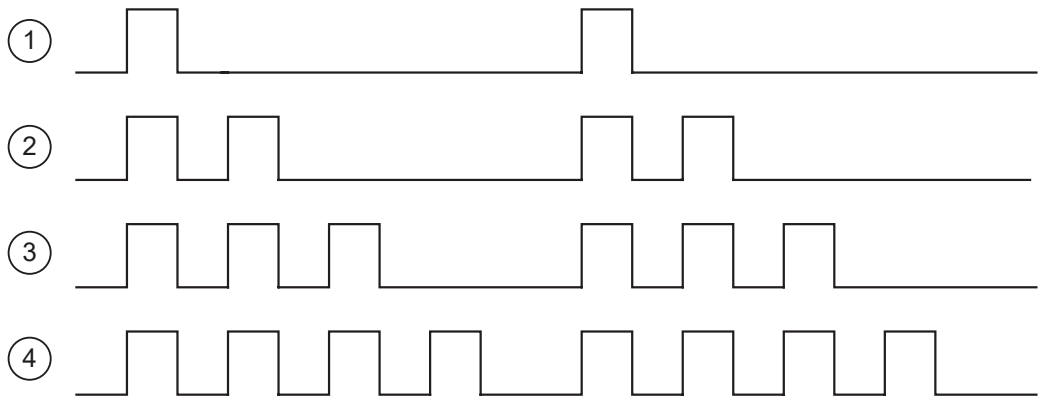
Fault tracing

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

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



1	Potentiometer or adjustment failure
2	Line fault across start button
3	Cross fault or wiring fault
4	Simultaneity error

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

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

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

Use a multimeter to measure the STO circuit connections, if the inverter unit 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.

This table describes the status LEDs of the extension safety relay [A62].

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

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.

9

Maintenance

Contents of this chapter

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

Safety circuit maintenance

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

If you change the wiring or a component after the start-up, 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 2 or 5 years (high or low demand as defined in IEC 61508, IEC/EN 62061 and EN ISO 13849-1). Regardless of the mode of operation, it is a good practice to do the proof test for the safety function at least

once a year. It is also a good practice to include the proof test for the safety function in the routine maintenance program of the machinery.

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

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

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

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 an inverter unit, 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

Each multidrives delivery is unique. If the customer has ordered safety data calculations (option +P947), ABB calculates the safety data and delivers it separately to the customer.

Safety component types

Safety component types as defined in IEC 61508-2:

- emergency stop button: type A
- safety relay(s): type A
- inverter unit STO circuit:
  - air-cooled R1i…R7i inverter modules: type A
  - air-cooled R8i inverter modules: type B
  - liquid-cooled R7i…R8i inverter modules: type B.

Safety block diagrams

Each multidrives delivery is unique. If included in the customer order, ABB defines the safety block diagram for the safety function and delivers the diagram separately to the customer.

Relevant failure modes

Relevant failure modes are:

- internal failures of safety relays, STO 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 inverter unit hardware manual.

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 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 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 + A1:2017	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

Standard	Name
	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. The declaration of conformity is delivered with the drive.

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. The declaration of conformity is delivered with the drive.

Further information

Product and service inquiries

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

Product training

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

Providing feedback on ABB manuals

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

Document library on the Internet

You can find manuals and other product documents in PDF format on the Internet at www.abb.com/drives/documents.

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