

OPTIONS FOR ABB DRIVES

# FPTC-01 thermistor protection module (option +L536) for ACS880 drives

User's manual





# FPTC-01 thermistor protection module (option +L536) for ACS880 drives

User's manual

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## Further information





## 1

# Safety instructions

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## 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

---



**WARNING!**

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

---



This manual does not contain the complete safety instructions of the drive. It only includes the instructions related to the scope of this manual. The general instructions are given in this section and the option-specific instructions in the applicable chapter.

If the motor thermal protection function is used with an Ex motor, obey all safety regulations required with application of Ex motors in Zone 1/21 (equipment category 2) or Zone 2/22 (equipment category 2 or 3) and the requirements of IEC/EN 60079-14.

In addition to this manual:

- for ACS880 single drives, see the drive hardware manual
  - for ACS880 air-cooled multidrives, multidrive modules and single drive modules, see *ACS880 multidrive cabinets and modules safety instructions* (3AUA0000102301 [English])
-

- for ACS880 liquid-cooled multidrives, multidrive modules and single drive modules, see *ACS880 liquid-cooled multidrive cabinets and modules safety instructions* (3AXD50000048633 [English]).

**WARNING!**

The safety function described in this manual does not isolate the main circuit or auxiliary circuit from the power supply. Do not do work on the drive, motor cable or motor before you have isolated the drive system from all power supplies and measured that there are no dangerous voltages. Before you start the work, do the steps in section *Electrical safety precautions* (page 12).

---

**WARNING!**

If a short-circuit occurs in the output stage of the drive, the STO function does not prevent the intermediate DC current from flowing through and heating up the motor. The system integrator must take this into account when planning the protection of the installation.

---



## Electrical safety precautions

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

---



### **WARNING!**

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

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

Go through these steps before you begin any installation or maintenance work.

---

1. Clearly identify the work location and equipment.
  2. Disconnect all possible voltage sources. Make sure that re-connection is not possible. Lock out and tag out.
    - Open the main disconnecting device of the drive.
    - If you have a permanent magnet motor connected to the drive, disconnect the motor from the drive with a safety switch or by other means.
    - Disconnect all dangerous external voltages from the control circuits.
    - After you disconnect power from the drive, always wait 5 minutes to let the intermediate circuit capacitors discharge before you continue.
  3. Protect any other energized parts in the work location against contact.
  4. Take special precautions when close to bare conductors.
- 



5. Measure that the installation is de-energized.
  - Before and after measuring the installation, verify the operation of the voltage tester on a known voltage source.
  - Make sure that the voltage between the drive input power terminals (L1, L2, L3) and the grounding (PE) busbar is zero.
  - Make sure that the voltage between the drive output terminals (T1/U, T2/V, T3/W) and the grounding (PE) busbar is zero.
  - Make sure that the voltage between the drive DC terminals (UDC+ and UDC-) and the grounding (PE) terminal is zero. In cabinet-built drives, measure between the drive DC busbars (+ and -) and the grounding (PE) busbar.
6. Install temporary grounding as required by the local regulations.
7. Ask the person in control of the electrical installation work for a permit to work.





# 2

## Introduction to the manual

---

### Contents of this chapter

This chapter gives basic information on the manual.

### Applicability

This manual is applicable to the FPTC-01 module and to the Safe motor temperature safety (SMT) function which uses the FPTC-01 module (option +L536).

### Compatibility

The FPTC-01 module is compatible with:

- ACS880-01/11/31 drives
  - ACS880-04/04XT/04F/04FXT/M04/14/34 drive modules
  - ACS880-104/104LC inverter modules
  - ACS880-07/07LC/17/17LC/37/37LC cabinet-built drives
-

- ACS880-107/107LC inverter units
- FSO-12 and FSO-21 safety functions modules
- ACS880 primary control program version 2.10 or later. For the compatibility of other control programs, contact your local ABB representative.

## Target audience

This manual is intended for people who plan the installation, install, start up, use and service the module. Before you do work on the module, read this manual and the applicable drive manual that contains the hardware and safety information for the product in question. You are expected to know the fundamentals of electricity, wiring, electrical components, electrical schematic symbols, functional safety, and Ex regulations.

## 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.

## Related manuals

Name	Code
<b>Drive hardware</b>	
ACS880-01 hardware manual	3AUA0000078093
ACS880-11 hardware manual	3AXD50000045932
ACS880-31 hardware manual	3AXD50000045933



<b>Name</b>	<b>Code</b>
ACS880-04 drive modules (200 to 710 kW, 300 to 700 hp) hardware manual	3AUA0000128301
ACS880-04 single drive module packages (560 to 2200 kW) hardware manual	3AUA0000138495
ACS880-04F drive modules hardware manual	3AXD50000034664
ACS880-04XT drive module packages (500 to 1200 kW) hardware manual	3AXD50000025169
ACS880-04FXT drive module packages hardware manual	3AXD50000274444
ACS880-M04 drive hardware manual	3AXD50000028613
ACS880-14 drive modules (132 to 400 kW) hardware manual	3AXD50000035160
ACS880-34 drive modules (132 to 400 kW) hardware manual	3AXD50000035191
ACS880-14 and -34 single drive module packages hardware manual	3AXD50000022021
ACS880-07 drives (45 to 710 kW) hardware manual	3AUA0000105718
ACS880-07 drives (560 to 2800 kW) hardware manual	3AUA0000143261
ACS880-07LC drives hardware manual	3AXD50000569786
ACS880-17 drives (160 to 3200 kW) hardware manual	3AXD50000020436
ACS880-17 drives (45 to 400 kW, 60 to 450 hp) hardware manual	3AXD50000035158
ACS880-17LC drives hardware manual	3AXD50000250295
ACS880-37 drives (160 to 3200 kW) hardware manual	3AXD50000020437
ACS880-37 drives (45...400 kW, 60...450 hp) hardware manual	3AXD50000035159
ACS880-37LC drives hardware manual	3AXD50000251407
<b>Inverter hardware</b>	
ACS880-104 inverter modules hardware manual	3AUA0000104271
ACS880-104LC inverter modules hardware manual	3AXD50000045610
ACS880-107 inverter units hardware manual	3AUA0000102519
ACS880-107LC inverter units hardware manual	3AXD50000196111
<b>Drive firmware</b>	
ACS880 primary control program firmware manual	3AUA0000085967

Name	Code
<b>PC tools</b>	
Drive composer start-up and maintenance PC tool user's manual	3AUA0000094606
<b>Safety</b>	
Functional safety; Technical guide No. 10	3AUA0000048753
ABB Safety information and solutions	<a href="http://www.abb.com/safety">www.abb.com/safety</a>
Motors and drives in potentially explosive atmospheres - What you need to know	3AUA0000037223
<b>Option manuals</b>	
ACS-AP-x assistant control panels user's manual	3AUA0000085685
FSO-12 safety functions module user's manual	3AXD50000015612
FSO-21 safety functions module user's manual	3AXD50000015614
FSE-31 pulse encoder interface module user's manual	3AXD50000016597
FPTC-01 thermistor protection module (option +L536) user's manual	3AXD50000027750
Manuals and quick guides for I/O extension modules, fieldbus adapters, etc.	

See [www.abb.com/drives/documents](http://www.abb.com/drives/documents) for all manuals on the Internet.

## 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)
DI	Digital input
Drive	Frequency converter for controlling AC motors
Drive module	Frequency converter enclosed in a metal frame or enclosure. Intended for cabinet installation.
EMC	Electromagnetic compatibility

Term	Description
Ex	An IEC term used in the context of explosive atmospheres (IEC 60079)
Ex d	Type of protection, flameproof enclosures (IEC/EN 60079-1)
Ex eb, Ex ec	Types of protection, increased safety (IEC/EN 60079-7)
Ex motors	Motors used in explosive atmospheres
FEA-03	Optional I/O extension adapter
FPTC-01	Optional thermistor protection module
FSE-31	Optional pulse encoder interface module for safety encoder
FSO-21	Safety functions module which supports the FSE-31 module and the use of safety encoders
FSO-12	Safety functions module which does not support the use of encoders
HFT	Hardware fault tolerance (IEC 61508)
Inverter module	Inverter bridge, related components and drive DC link capacitors enclosed in a metal frame or enclosure. Intended for cabinet installation.
Inverter unit	Inverter module(s) under control of one control unit, and related components. One inverter unit typically controls one motor.
MTTF <sub>D</sub>	Mean time to dangerous failure: (Total number of life units) / (Number of dangerous, undetected failures) during a particular measurement interval under stated conditions (EN ISO 13849-1)
PFD <sub>avg</sub>	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)
Proof test	Periodic test performed to detect failures in the safety function. The target of the proof test is to ensure that the safety function still operates correctly and is able to achieve the safe state. (IEC 61508, IEC 62061)
SAR	Safe acceleration range
SBC	Safe brake control
SC	Systematic capability (IEC 61508)
SFF	Safe failure fraction (%) (IEC 61508)

Term	Description
SIL	Safety integrity level (1...3) (IEC 61508)
SILCL	Maximum SIL (level 1...3) that can be claimed for a safety function or subsystem (IEC/EN 62061)
SMT	Safe motor temperature (IEC/EN 61800-5-2)
SS1	Safe stop 1 (IEC/EN 61800-5-2)
SSE	Safe stop emergency
STO	Safe torque off (IEC/EN 61800-5-2)
Stop category	<p>There are three categories of stop functions defined by IEC/EN 60204-1:</p> <ul style="list-style-type: none"> <li>• stop category 0: an uncontrolled stop where power to the machine actuators is removed immediately (for example, STO)</li> <li>• stop category 1: a controlled stop where the machine actuators have power for stopping, after which the power is removed (SS1)</li> <li>• stop category 2: a controlled stop where the machine actuators continue to have power (SS2).</li> </ul>
$T_1$	Proof test interval. Defines the probabilistic failure rate (PFH or PFD <sub>avg</sub> ) 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, IEC 61800-5-2)
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.
Zone	Potentially explosive atmosphere. Hazardous areas are divided into zones, based on the frequency and duration of the occurrence of an explosive atmosphere. (IEC/EN 60079)

# 3

## Hardware description

---

### Contents of this chapter

This chapter gives a short description of the module.

### Product overview

The FPTC-01 module together with the drive/inverter STO implements the Safe motor temperature (SMT) safety function as defined in IEC/EN 61800-5-2.

Inside the module, there is reinforced insulation between the motor thermistor connection and the other terminals of the module. The insulation forms a reliable protective separation between the motor main circuit and the drive control circuits. Thus, the drive control unit is Protective Extra Low Voltage (PELV) compatible also when the FPTC-01 module and a thermistor protection circuit are installed.

---

## ■ Operation basics

The module includes two PTC sensor inputs:

- **XFLT** activates the SIL/PL capable SMT safety function by activating the drive Safe torque off (STO) function. This input is a safety-related input and can be used for protection function purposes.
- **XWRN** generates a warning to the drive. This is not a safety-related input and can only be used for indication purposes.

### **XFLT input (Fault)**

When the motor temperature rises above the PTC sensor temperature limit, the sensor resistance increases sharply. This indicates overtemperature to the FPTC-01 module. The FPTC-01 module then activates the SMT function by opening the drive Safe torque off (STO) circuit. This activates the drive STO function.

The STO function disables the control voltage of the power semiconductors of the drive output stage. This prevents the drive from generating the torque required to rotate the motor. If the motor is running when the STO function is activated, it coasts to a stop.

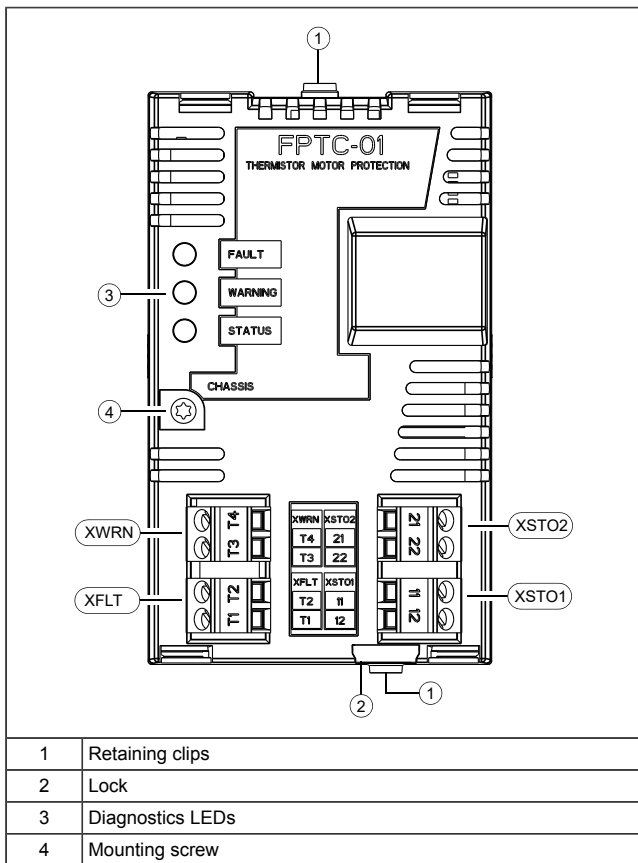
### **XWRN input (Warning)**

When the motor temperature increases above the PTC sensor temperature limit, the sensor resistance increases sharply. The FPTC-01 module sends a warning indication to the drive. The XWRN input is not safety-related and does not activate the drive STO function.

For the resistance limits and other technical details of the FPTC-01 module, see the technical data.

---


## Layout



XWRN	2-pin detachable terminal block for PTC warning (non-safety related)
XFLT	2-pin detachable terminal block for PTC fault (safety related)
XSTO1	2-pin detachable terminal block for STO output 1
XSTO2	2-pin detachable terminal block for STO output 2

## Markings

The type designation label is attached to the back of the FPTC-01 module. An example label and description of the label contents are shown below.

<div style="text-align: center;"> <span style="margin: 0 20px;">①</span> <span style="margin: 0 20px;">②</span> <span>③</span> </div> <div style="text-align: center;"> <b>ABB OY FPTC-01 SN:A52900012 CODE:3AXD50000024933</b>    <b>3AXD50000024933A5290013WS</b> <span style="float: right;"><b>ROHS</b></span> </div> <div style="text-align: center;"> <span style="margin: 0 20px;">④</span> <span>⑤</span> </div>	
1	Type
2	Serial number in format RYWWSSSS, where: R: Component revision Y: Last digit of the manufacturing year (for example, 5 = 2015) WW: Manufacturing week (for example, 01 = week 1) SSSS: Number that starts every week from 0001
3	ABB MRP code of the module
4	Combined ABB MRP code, serial number and manufacturing location
5	RoHS mark



# 4

## Option description and instructions

---

### Contents of this chapter

This chapter describes the Safe motor temperature function implemented with the FPTC-01 module and the drive Safe torque off function and gives instructions for the user.

### Overview

To implement the Safe motor temperature (SMT) function, you can connect the FPTC-01 module directly to the drive Safe torque off (STO) circuit, or you can use it together with an FSO module.

The FSO safety functions module (FSO-12 or FSO-21) is an optional device used with ACS880 drives to implement safety functions. When installed, it reserves the standard STO connection of the drive. Safety functions in the FSO module can open the drive STO circuit, which activates the STO function of the drive.

---

**Note:** The Safe motor temperature function is motor-specific. This is the case also in ACS880 multidrives where multiple motors are connected to the drive.

## ■ **Wall-mounted drives, drive modules and inverter modules**

The option module is available as a factory-installed option (+L536) or as an add-on kit for ACS880 wall-mounted drives, drive modules and inverter modules.

To install the kit, the user:

- installs the option module to an option slot of the drive control unit and sets the applicable drive parameters
- connects the PTC temperature sensors of the motor to the PTC inputs of the option module
- connects the drive STO terminals to the STO output of the option module (or to the FSO module and then configures the FSO module to do the STO function).

## ■ **Cabinet-built drives**

For cabinet-built ACS880 single drives and ACS880 multidrives, the module is available as factory-installed options:

- +L536
- +L536+Q973 (with the FSO-12 module)
- +L536+Q972 (with the FSO-21 module)
- +L536+Q972+L521 (with the FSO-21 and FSE-31 modules).

The user connects the PTC temperature sensors of the motor to the PTC inputs of the module.

---

## Commissioning the drive for a motor in a hazardous area

Commission the drive according to the requirements and limitations set by the application, the motor manufacturer's instructions, drive firmware manual, local laws and regulations and this manual.

The certificate of the Ex motor typically requires that you set a minimum limit for the output switching frequency of the drive. Make sure that the Ex motor is operated above the minimum output switching frequency specified by the motor manufacturer.

## Resetting the safety function

The Ex regulations require that the safety function must be reset manually. When the XFLT input detects a motor overtemperature situation, the FPTC-01 module generates a fault to the drive. You must reset the drive before it is possible to restart the drive.

When the XWRN input detects a motor overtemperature situation, the FPTC-01 module generates a warning to the drive. This is not a safety-related function, and does not need a reset.

If an FSO module is used together with the FPTC-01 module, it is possible that you must reset the safety function also with a reset button connected to the FSO module. This depends on parameter settings and other safety functions in the FSO module. For more information, see section [FSO module \(page 48\)](#).

**Note:** The reset function of the safety function is not SIL classified.

## Indications of the safety function

The possible indications of the safety function are:

1. LED indications on the FPTC-01 module:
    - The FAULT LED is on when the motor temperature is outside the permitted (safe) temperature range (XFLT input).
-

- The WARNING LED is on when the motor temperature is outside the temperature warning range (XWRN input).
2. Motor temperature indication in the drive:
    - Safe motor temperature fault (XFLT input)
    - Motor temperature warning (XWRN input)
  3. STO indication in the drive: The drive STO indication is active when the SMT safety function has activated the drive STO function. The type of the indication is set with parameter *31.22 STO indication run/stop*.
  4. STO indication in the FSO module: The STO LED (green) is on when the safety function has activated the drive STO function.
  5. STO indication from the FSO module to the drive: The FSO module sends an indication to the drive when the FSO module activates the drive STO function. The type of the indication is set with parameter *FSOGEN.61 STO indication ext request*.

If you use an FSO module, the activation of the SMT function can generate two STO indications in the drive. To prevent this, you can set one of the two STO indication parameters (*31.22 STO indication run/stop* or *FSOGEN.61 STO indication ext request*) to value *None/No indication* or *Event*. See chapter [Parameter settings \(page 45\)](#).

**Note:** The indications of the safety function are not SIL classified.

## Fault reaction function

### ■ FPTC-01 module

The FPTC-01 module has a fault reaction function. When the module detects an internal fault or a fault in the temperature sensor circuit, it sends a request to the drive control unit to stop modulation, and activates the drive STO function.

---

## ■ STO function in the drive/inverter

The STO function in the drive/inverter has internal fault diagnostics and a fault reaction function. The fault reaction function causes a fault trip if it detects a redundancy fault of STO control signals or an internal failure. For more information, see the hardware and firmware manuals of the drive/inverter.

## ■ FSO module

The fault reaction function of the FSO module trips the drive if it detects a failure. The FSO module activates the STO or Safe stop emergency (SSE) function. This activates the drive STO function. The drive STO function is active until the fault is repaired.

**Note:** With the FPTC module, the recommended type of the SSE function is *Immediate STO*, but other safety functions in the FSO module can require that the type is *Emergency ramp*. With both settings, the FSO module always activates the drive STO function immediately in motor overtemperature situations (the drive trips on a SMT fault).

The FSO module goes into the Fail-safe mode. The FSO module LED STATUS/FAULT is red until the fault is repaired. To exit the Fail-safe mode, remove the cause of the fault and reset the FSO module. To reset the FSO module:

- switch the power off and on, or
- click the *Reboot FSO* button on the *Safety view* of the Drive composer pro PC tool, or
- use drive parameter 96.09 *FSO reboot*.

For more information, see the drive firmware manual and the FSO module user's manual.

---



## 5

# Mechanical installation

---

## Contents of this chapter

This chapter contains a delivery checklist and instructions on installing the module.



## Necessary tools and instructions

- Torx screwdriver (T10)

For a complete list of tools, see the applicable drive hardware manual.

## Unpacking and examining the delivery

1. Open the option package.
  2. Make sure that the package contains:
    - FPTC-01 module
    - STO cable
    - this manual.
-

3. Make sure that there are no signs of damage to the items.

## Installing the module

---



### WARNING!

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

---

Install the option module to the drive control unit as follows:

1. Stop the drive and do the steps in section *Electrical safety precautions (page 12)* before you start the work.
2. Pull out the lock.
3. Put the module carefully into its position on the control unit until the retaining clips lock it into position.
4. Push in the lock.
5. Torque the screw to 0.8 N·m (7.1 lbf·in).

**Note:** The screw tightens the connections and grounds the module, which is necessary for fulfilling the EMC requirements and for correct operation of the module.

---



### WARNING!

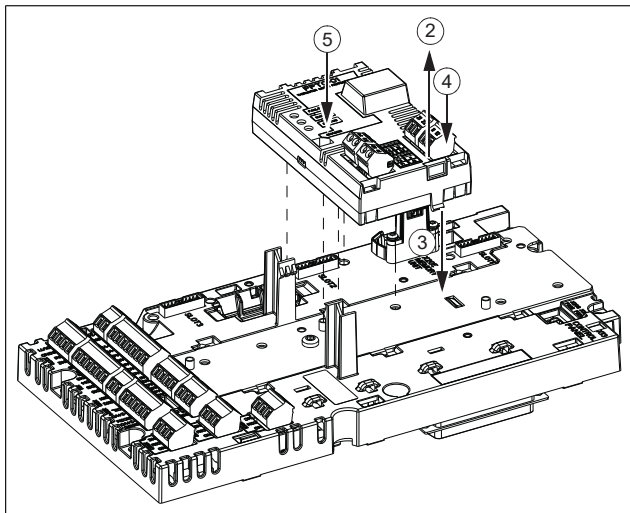
Do not tighten the screw too much. If you tighten it too much, you can cause damage to the threads.

---

For more information, refer to the drive hardware manual.

---





Do not install the FPTC-01 module on an FEA-03 F-series extension adapter. The diagnostics of the module requires that you install it directly on the control unit.





## 6

# Electrical installation

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## Contents of this chapter

This chapter contains instructions on wiring the module.

## Warnings

---

**WARNING!**

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

---

**WARNING!**

Cabinet-built drives: Do not connect, test or measure a drive based on the diagrams in this manual. Each delivery is unique. Before starting the work on the electric circuits of a drive, always refer to the delivery-specific circuit diagrams.

---



**WARNING!**

Make sure that the drive is disconnected from the input power during installation. Before you start the work, stop the drive and do the steps in section *Electrical safety precautions (page 12)*.

---

## Necessary tools and instructions

- Screwdriver with a set of suitable bits
- Cabling tools

## General wiring instructions

1. For the STO circuit wiring, use the type of cable specified in the applicable drive or inverter unit hardware manual. With an FSO module, use the STO cable that is included in the FSO module delivery.

2. Install only the sensor circuit into the potentially explosive atmosphere.

The sensor circuit in the Ex Zone must comply with the requirements for the applicable type of protection, such as:

- Ex d (IEC/EN 60079-1)
- Ex eb (IEC/EN 60079-7, Ex e in EN 60079-7:2007 and IEC 60079-7:2006)
- Ex ec (IEC/EN 60079-7, Ex nA in IEC/EN 60079-15:2010).

3. Install the drive or inverter unit, including the components of the motor thermal protection function, outside the potentially explosive atmosphere.
  4. For the sensor connection, ABB recommends to use shielded twisted-pair cable. This type of cable decreases electromagnetic interference in the sensor circuit.
-

5. Route the sensor cables away from the motor cable. Power cables can cause electromagnetic interference in the sensor circuit.
6. Ground all sensor cable shields to a single grounding point outside the potentially explosive atmosphere. 360-degree grounding of the cable shields at the cable entry of the drive is recommended. Do not connect the cable shields to ground at the sensor end of the cable.

## Terminal designations

The table that follows shows the terminal designations of the module.

Terminal	Description
XSTO1	STO channel 1
11	In, +24 V DC in for STO
12	Out, +24 V DC out for STO
XSTO2	STO channel 2
21	In, +24 V DC in for STO
22	Out, +24 V DC out for STO
XFLT	PTC FAULT (SMT function)
T1	In, 0 ... +5 V DC
T2	Out
XWRN	PTC WARNING (non-safety related)
T3	In, 0 ... +5 V DC
T4	Out

## PTC sensor inputs

For the recommended cable type and correct tightening torque, see the technical data.

### ■ XFLT input

To enable the SMT function, connect the PTC sensor to the XFLT input.

To disable the SMT function, connect a resistor (100 ohm ... 1 kohm ¼ W wire-wound) to the XFLT input.

**Note:** If you do not connect a PTC sensor or resistor to the XFLT input, the STO function stays active. You cannot start the motor while the STO function is active.

## ■ XWRN input

To enable motor temperature warnings, connect the PTC sensor to the XWRN input.

If you do not use the XWRN input, you can:

- connect a resistor (100 ohm ... 1 kohm ¼ W wire-wound) to the XWRN input, or
- suppress the motor temperature warnings with parameter 35.30.

**Note:** If you do not connect a PTC sensor or resistor to the XWRN input, the WARNING LED of the module stays on.

## Wiring examples

This section shows five methods to connect the FPTC-01 module to the drive.

If you use a one-channel connection, make sure that you can reach the required safety integrity level (SIL).

*Wiring example 1 (page 40):* The STO outputs of the FPTC-01 module are connected directly to the STO terminals of the drive.

- ACS880 wall-mounted drives and drive modules: In the factory-installed option (+L536), the wiring is done at the factory according to this example.
- ACS880 cabinet-built drives: In option +L536, terminal block [X969] is located between the module and the drive control unit (not shown in the figure). See the circuit diagrams delivered with the drive for the actual wiring.

*Wiring example 2 (page 41):* The STO outputs of the FPTC-01 module are connected to an FSO module, and the STO outputs of the FSO module to the STO terminals of the drive with a two-channel connection. In this case, the FSO module controls the drive STO function.

- ACS880 cabinet-built drives: In option +L536+Q973/Q972 (+L521), terminal block [X68] is located between the module and the FSO module (not shown in the figure). See the circuit diagrams delivered with the drive for the actual wiring.

*Wiring example 3 (page 42):* An external safety relay is connected between the FPTC-01 module and the drive STO inputs with a two-channel connection.

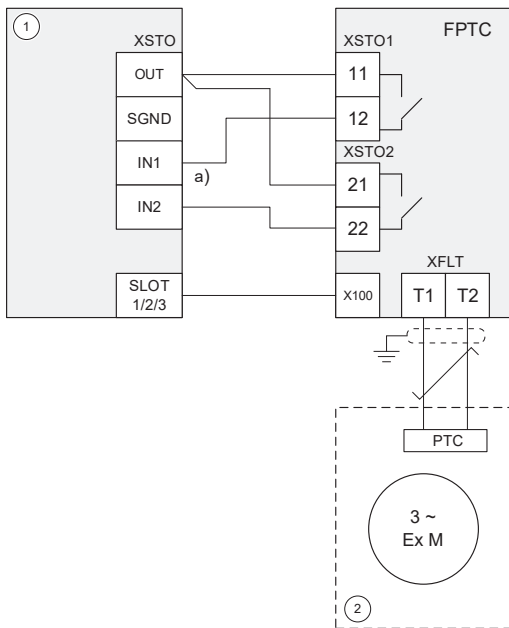
*Wiring example 4 (page 43):* The STO outputs of the FPTC-01 module are connected directly to the STO terminals of the drive with a one-channel connection.

*Wiring example 5 (page 44):* The STO outputs of the FPTC-01 module are connected to an FSO module, and the STO outputs of the FSO module to the STO terminals of the drive with a one-channel connection.



## ■ Wiring example 1

This connection is SIL2 capable (redundancy between STO channels).

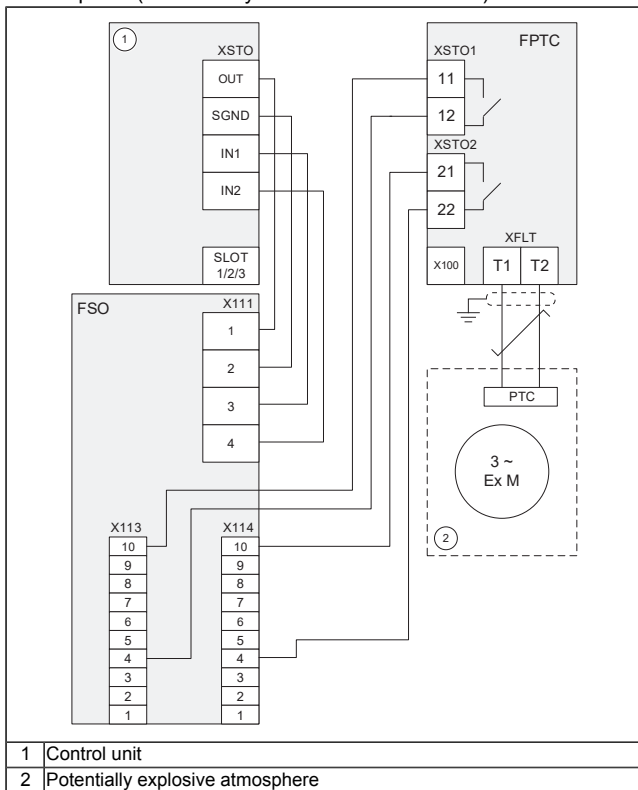


- a) If necessary, you can also connect an external device (for example, an emergency stop button) between the XSTO input of the control unit and the XSTO1 and XSTO2 outputs of the FPTC module. See [Wiring example 3 \(page 42\)](#).



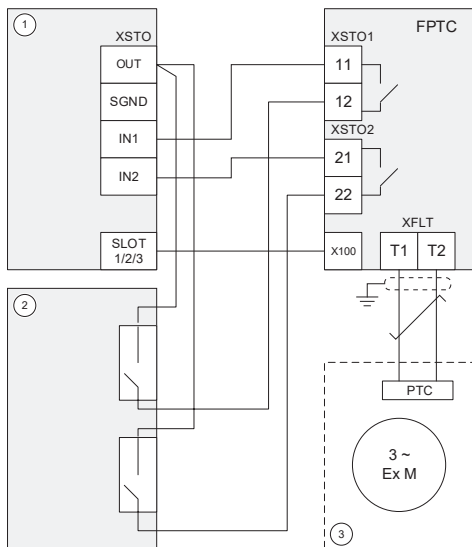
## ■ Wiring example 2

With an FSO module, two-channel connection. This connection is SIL2 capable (redundancy between STO channels).



### ■ Wiring example 3

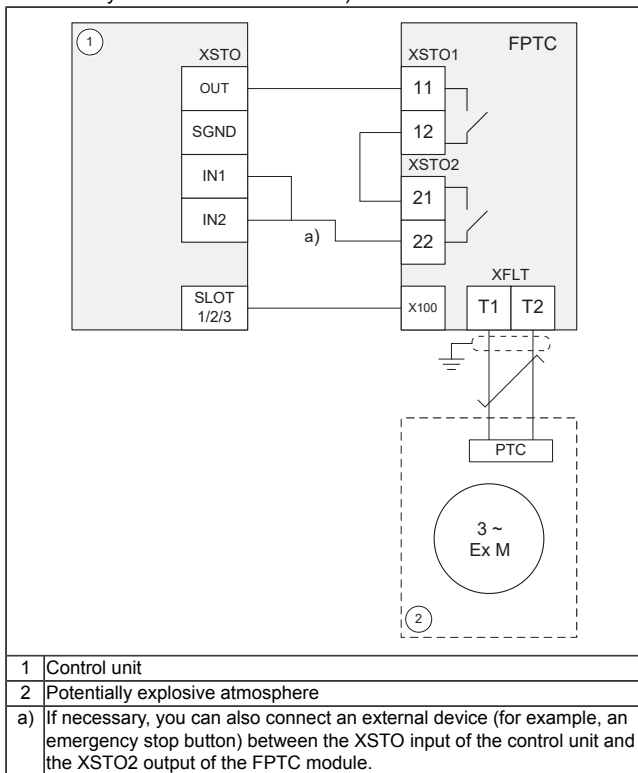
With an external safety relay, two-channel connection. This connection is SIL2 capable (redundancy between STO channels).



1	Control unit
2	External safety relay
3	Potentially explosive atmosphere

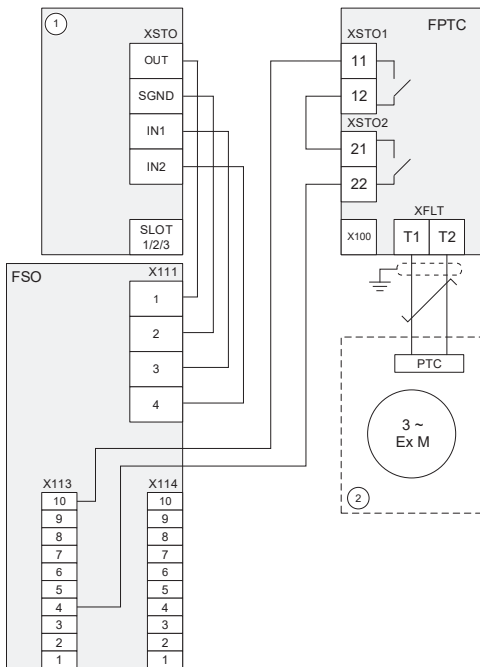
## ■ Wiring example 4

One-channel connection. This connection is SIL1 capable (no redundancy between STO channels).



## ■ Wiring example 5

With an FSO module, one-channel connection. This connection is SIL1 capable (no redundancy between STO channels).



1	Control unit
2	Potentially explosive atmosphere

# 7

## Parameter settings

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### Contents of this chapter

This chapter contains the drive and FSO module parameter settings.

### Drive / inverter

Use the Drive composer PC tool or the control panel to set the parameter values.

This table lists the parameters related to the safety function in ACS880 primary control program. For more information, see the drive firmware manual.

Index	Name		Description
31.22	STO indication run/stop		Selects the indications that the drive gives when the STO function is activated.
	Value	Description	
	Warning/Warning		The drive generates a warning both when the drive is running and when it is stopped. This parameter value does not have an effect on the SMT function, but this is the recommended setting. For cabinet-built drives, ABB sets this value at the factory.
35.30	FPTC configuration word		Activates FPTC modules installed on the control unit of the drive. With this word, it is also possible to suppress the motor temperature warnings from the XWRN input. It is not possible to suppress the SMT faults from the XFLT input.
	Bit	Name	Description
	0	Module in slot 1	1 = Yes: Module installed in slot 1.
	1	Disable slot 1 warning	0 = No (default): Warnings from the module in slot 1 not suppressed. 1 = Yes: Warnings from the module in slot 1 suppressed.
	2	Module in slot 2	1 = Yes: Module installed in slot 2.
	3	Disable slot 2 warning	0 = No (default): Warnings from the module in slot 2 not suppressed. 1 = Yes: Warnings from the module in slot 2 suppressed.
	4	Module in slot 3	1 = Yes: Module installed in slot 3.
	5	Disable slot 3 warning	0 = No (default): Warnings from the module in slot 3 not suppressed. 1 = Yes: Warnings from the module in slot 3 suppressed.
	6...15	Reserved	

Index	Name		Description
35.04	FPTC status word		Displays the status of FPTC modules. The word can be used as the source of eg. external events. This parameter is read-only.
	<b>Bit</b>	<b>Name</b>	<b>Description</b>
	0	Module found in slot 1	1 = Yes: An FPTC module has been detected in slot 1.
	1	Fault active in slot 1	1 = Yes: The module in slot 1 has an active SMT fault.
	2	Warning active in slot 1	1 = Yes: The module in slot 1 has an active motor temperature warning.
	3	Module found in slot 2	1 = Yes: An FPTC module has been detected in slot 2.
	4	Fault active in slot 2	1 = Yes: The module in slot 2 has an active SMT fault.
	5	Warning active in slot 2	1 = Yes: The module in slot 2 has an active motor temperature warning.
	6	Module found in slot 3	1 = Yes: An FPTC module has been detected in slot 3.
	7	Fault active in slot 3	1 = Yes: The module in slot 3 has an active SMT fault.
	8	Warning active in slot 3	1 = Yes: The module in slot 3 has an active motor temperature warning.
	9...15	Reserved	
95.15	Special HW settings		Contains hardware-related settings that can be enabled and disabled by toggling the specific bits.
	<b>Bit</b>	<b>Name</b>	<b>Description</b>
	0	EX motor	1 = The driven motor is an Ex motor provided by ABB for potentially explosive atmospheres. This sets the required minimum switching frequency for ABB Ex motors. For non-ABB Ex motors, contact your local ABB representative.

## ■ Switching frequency limitation

The certificate of the Ex motor typically requires that you set a minimum limit for the switching frequency of the drive.

For ABB Ex motors, use parameter **95.15** to set the required minimum switching frequency. For more information, see the drive firmware manual.

For Ex motors supplied by other motor manufacturers, contact the motor manufacturer for the correct value and your local ABB representative for instructions on how to make the parameter setting in the drive.

### ■ Other recommended settings

ABB recommends that you also set these parameters to improve the safety of the application:

- minimum and maximum speeds (parameter group 30)
- maximum current, power and torque (group 30)
- acceleration and deceleration times
- stall protection (parameters 31.24...31.28)
- motor load curve (parameters 35.50...35.55)
- motor cable protection (parameters 35.60...35.62)

For more information, see the drive firmware manual.

## FSO module

If you use an FSO module (option +Q972 or +Q973) in the safety system configuration, set the parameters according to the system requirements. Example values are shown in this section.

The person who configures the safety functions in the FSO module must be a competent person as required by IEC 61508-1 clause 6. In this context, the person must have expertise and knowledge of functional safety, the safety functions and the configuration of the FSO module. ABB has training courses on the FSO module.

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You must use the Drive composer pro PC tool to set the FSO module parameters. You also need a password to be able to download the configuration to the FSO module from Drive composer pro. For the default password of the FSO module, see the applicable FSO module user's manual. For more information on the Drive composer pro PC tool, see *Drive composer start-up and maintenance PC tool user's manual* (3AUA0000094606 [English]).

**Note:** When the motor is running, you cannot change the password, adjust parameter values, or upload or download the FSO configuration file.

Follow the configuration steps described in the applicable FSO module user's manual, chapter *Configuration*.

There are parameters that you must always set when you use the FSO module, and parameters that are related only to some safety functions. This section lists the parameters that are related to options +L536+Q973 (with FSO-12) and +L536+Q972 (with FSO-21).

If you use an FSO-21 module with a FSE-31 pulse encoder interface module and safety encoder, set the parameters listed in section [FSE module and safety encoder parameters \(page 55\)](#).

The example values are factory default values in ACS880 cabinet-built drives delivered with an FPTC module. You must set the parameter values as required by the application. Change the parameter default values when necessary. One FPTC module is connected to the FSO module with a two-channel connection (digital inputs X113:4 and X114:4).

Configure the FSO module so that it opens the drive STO circuit immediately after the safety function request from the FPTC module (stop category 0). With the FPTC module, you cannot use a stop function with a deceleration ramp (stop category 1). The FPTC module always generates a fault and activates the drive STO function immediately in overtemperature situations.

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**Note:** Setting parameters related to STO and SSE can also have an effect on other safety functions. You must take all safety functions into consideration when you configure the FSO module. See the applicable FSO module user's manual and safety option user's manual.

**Note:** The FSO module has a factory reset button. The factory reset button clears the configuration and sets the parameters to the factory default values. These values are not the same as the pre-set values in an FSO module that was ordered as an option (with a plus code). You cannot restart the drive with the factory default values. If you do a factory reset of the FSO module, you must reconfigure the FSO module and set all applicable parameters. Because of this, it is recommended to save the FSO safety file with the button *Save safety file* in the Drive composer pro PC tool. For more information, see the FSO module user's manual and the Drive composer PC tool user's manual.

## ■ General parameters

These parameters are common to all safety functions in the FSO module.

Index	Name	Example value	Description
FSO-GEN.11	Stop completed output	None <sup>1)</sup>	Sets the digital output that indicates the completion of any stop function. Active when the FSO module has completed the STO or SSE function.
FSO-GEN.21	Motor nominal speed	1500.0 rpm	Sets the nominal motor speed. Adjust the default value to meet the ratings of the motor in use.
FSO-GEN.22	Motor nominal frequency	50.00 Hz	Sets the nominal motor frequency. Adjust the default value to meet the ratings of the motor in use.

Index	Name	Example value	Description
FSO-GEN.41	Power-up acknowledgement	Automatic	Sets the power-up acknowledgement method of the FSO module. <i>Automatic:</i> You do not need to push a reset button after switching on the FSO module. The FSO module generates the acknowledgement signal automatically after the power-up. <i>Manual:</i> The FSO module reads the external acknowledgement signal through the digital input defined by parameter <i>FSOGEN.42</i> . Make sure that the value is <i>Automatic</i> .
FSO-GEN.42	Acknowledgement button input	None 1)	Sets the digital input for the acknowledgement signal when parameter <i>STO.02</i> has value <i>Manual</i> . In the safety function described in this manual, parameter <i>STO.02</i> has value <i>Automatic</i> and this parameter has value <i>None</i> (no acknowledgement signal connected to the input).
FSO-GEN.61	STO indication ext request	Warning 1)	Sets the type of the event that the FSO module generates and sends to the drive after external requests that end to a successful activation of the drive STO function (STO or SSE). <i>None, Warning, Event:</i> You do not have to reset the drive/inverter unit. <i>Fault:</i> You have to reset the drive/inverter unit.

- 1) The value does not have an effect on the SMT function, but other safety functions in the FSO module can require a certain value.

## ■ Parameters for the STO function

These parameters are related to the STO function of the FSO module. With stop category 0, the FSO module activates the STO function in

overtemperature situations. Also, the FSO module can activate the STO function in fault situations.

Index	Name	Example value	Description
STO.02	STO acknowledgement	Automatic 1)	<p>Sets the acknowledgement method used in the STO, SSE and SS1 functions.</p> <p><i>Automatic:</i> The FSO module resets the STO function automatically after the STO request is removed.</p> <p><i>Manual:</i> The FSO module reads the external acknowledgement signal through the digital input defined by parameter <a href="#">FSOGEN.42</a>.</p>
STO.11	STO input A	None	<p>Sets the digital input that is connected to the primary input of the STO function.</p> <p>In this example, this parameter has value <i>None</i>.</p>
STO.12	STO input B	DI X113:4 & X114:4	<p>Sets the digital input that is connected to the secondary input of the STO function.</p> <p><b>Note:</b> In a non-redundant system, you can use a one-channel input (for example, <i>DI X113:4</i>).</p>
STO.13	Restart delay after STO	2000 ms	<p>Sets the time after which the drive can restart when the FSO module has activated the STO function and opened the drive STO circuit. With this parameter, you can let the drive restart before the motor has stopped (fly-start). This parameter is relevant only if the STO function is requested from STO input A (<a href="#">STO.11</a>) or STO input B (<a href="#">STO.12</a>).</p> <p><u>STO function:</u> Adjust the value when necessary. If you do not use the fly-start feature, set this parameter to the same value as parameter <a href="#">STO.14</a>.</p>

Index	Name	Example value	Description
STO.14	Time to zero speed with STO and mod-off	2000 ms	<p>Sets the time that is needed to coast the motor to a standstill from maximum process speed. If this time is not known, it can be measured with Drive composer pro PC tool when an encoder is used for motor control (otherwise you have to make sure that the motor shaft has stopped rotating by other means, eg, visually).</p> <p>Acknowledgement is allowed after coast stop in the STO and SSE functions (when SBC is not used). If the drive STO is activated or modulation stopped while a monitoring safety function is indicating "unsafe", after this time acknowledgement is allowed. For example, if the drive modulation is lost during SLS deceleration ramp, SLS OK will be indicated after this time has elapsed.</p> <p><u>STO function:</u> This parameter sets the time after which the STO function is completed and the STO completed indication goes on. Parameter <a href="#">STO.13</a> defines the time after which the acknowledgement is allowed. Adjust the value according to application requirements.</p> <p><u>When an encoder is used:</u> This parameter is relevant only if there is an encoder failure and the FSO module activates the STO function.</p>
<b>SBC usage</b>			
SBC.11	STO SBC usage	None	<p>Sets how the mechanical brake is used together with the STO function.</p> <p>In the safety functions described in this manual, this feature is not used and this parameter has value <i>None</i>.</p>

Index	Name	Example value	Description
<b>I/O settings</b>			
SAFEIO.36	DI X113:4 diag pulse on/off	On 2)	<p>Sets the diagnostic pulse of digital input X113:4 on or off.</p> <p>On: The input monitors that it receives test pulses.</p> <p>Off: The input does not monitor for test pulses.</p>
SAFEIO.40	DI X114:4 diag pulse on/off	On 2)	<p>Sets the diagnostic pulse of digital input X114:4 on or off.</p> <p>On: The input monitors that it receives test pulses.</p> <p>Off: The input does not monitor for test pulses.</p> <p><b>Note:</b> In a non-redundant system, you can use a one-channel input (for example, DI X113:4). In this case, this parameter has no effect.</p>

- 1) The value does not have an effect on the SMT function, but other safety functions in the FSO module can require a certain value.
- 2) The safety data is based on the assumption that this diagnostic measure for the wiring is active (On). If pulsing is disabled, you must consider other measures to ensure sufficient diagnostic coverage of the wiring failures.

## ■ Parameters for the SSE function

These parameters are related to the Safe stop emergency (SSE) function of the FSO module. The safety functions described in this

manual do not use this function, but the FSO module can activate the SSE function in internal fault situations.

Index	Name	Example value	Description
SSE.13	SSE function	Immediate STO 1)	Sets the type of the SSE function. <i>Immediate STO</i> : The FSO module activates the drive STO function immediately after the SSE request (stop category 0). <i>Emergency ramp</i> : The FSO module first ramps down the motor speed and when the speed is below the zero speed limit it activates the STO function (stop category 1). SAR0 parameters define the deceleration ramp (for more information, see the FSO module user's manual).

#### SBC usage

SBC.15	SSE/SS1 SBC speed	0.0 rpm	Sets the absolute speed below which the FSO module activates the brake (SBC) while ramping. <i>0.0 rpm</i> : The feature is not in use. In the safety functions described in this manual, this feature is not used. Make sure that the value is <i>0.0 rpm</i> .
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- 1) With the FPTC module, the recommended value is *Immediate STO*, but other safety functions in the FSO module can require that the value is *Emergency ramp*. With both settings, the FSO module always activates the drive STO function immediately in motor overtemperature situations (SMT function activated).

## ■ FSE module and safety encoder parameters

Set these parameters only when you use a safety pulse encoder and the FSE-31 pulse encoder interface module with the FSO-21 module.

Index	Name	Example value	Description
200.231	FSE 3X act and par version	Version 1	Activates the FSE-31 encoder interface and shows the version of the encoder parameter groups (91 and 92).

Index	Name	Example value	Description
200.232	Number of encoders	Single encoder CH1	Shows the number of safety encoders connected to the FSE module.
S_ENC-GEN.01	Safe pulse encoder version	Version 1	Activates the safety encoder and shows the version parameter group <i>S_ENC-GEN</i> .
S_ENC-GEN.11	FSE diagnostic failure reaction	STO	Sets the action taken when there is a problem with the FSE module or the safety encoder. <i>STO</i> : The FSO module goes into the Fail-safe mode and activates the drive STO function.
S_ENC-GEN.14	Enc speed cross comp tolerance	1.0 rpm	Sets the encoder speed cross comparison tolerance. This defines how much the axle speed of the motor can change within 1 ms. Adjust the default value to meet the motor in use. This parameter is used for the encoder diagnostic. It defines the maximum difference between the speed information from channel A and B of the encoder. If the difference of these two values is more than defined by this parameter, FSO will safely stop the system (STO). The suitable value depends on the configuration (motor and load). Typically this value is between 2 ... 10 rpm. A value that is too small will cause an encoder fault (A7D8). A value that is too big will prevent the encoder diagnostic related to this parameter.
S_ENC-GEN.41	Gear numerator encoder 1	1	Sets the rotation direction for the safety encoder. With this parameter, you can change the rotation direction of the motor. Adjust the default value if necessary.
91.11	Module 1 type	FSE-31	Sets the type of the safety encoder interface module 1.



Index	Name	Example value	Description
91.12	Module 1 location	2	Sets the slot in which the safety encoder interface module 1 is located.
92.01	Encoder 1 type	HTL1	Activates or deactivates the communication with the safety encoder interface module 1 and sets the type for the safety encoder.
92.02	Encoder 1 source	Module 1	Sets the safety encoder interface module that the safety encoder 1 is connected to.
92.10	Pulses/revolution	2048	Sets the number of HTL pulses per revolution for safety encoder 1. Adjust the default value to meet the safety encoder in use. Make sure that the value is according to the encoder nameplate.
92.17	Accepted pulse freq of encoder 1	300 kHz	<p>Sets the maximum pulse frequency range of encoder 1. Adjust the default value to meet the motor and safety encoder in use. You can use this formula to define the value: <math>r\_max \cdot ppr\_enc + 10\%</math>, where</p> <ul style="list-style-type: none"> <li><b>r_max</b>: the maximum motor speed (rpm) used in the application (or the motor nominal speed)</li> <li><b>ppr_enc</b>: pulses/revolution of the safety encoder (parameter <a href="#">92.10</a>).</li> </ul>

## ■ Notes

ACS880-07/07LC/17/17LC/37/37LC drives with option +Q978: In motor overtemperature situations, the FSO module also opens the main contactor/breaker.

ACS880-07/07LC/17/17LC/37/37LC drives with option +Q978 or +Q979: The FSO module is configured so that after the safety function activation, the user must reset the FSO module manually with the

emergency stop reset button. The user must also reset the FSO module with the emergency stop reset button after motor overtemperature situations. The indication lamp on the reset button is on. Do not change this setting.

## **Mechanical brake control**

If you use a mechanical brake with the motor thermal protection circuit, pay special attention to the control of the mechanical brake.

If the motor deceleration by the mechanical brake causes extra heat generation in the Ex zone, make sure that the use of the brake does not increase the temperature too much.

In some cases you cannot use the brake for the motor deceleration when the motor thermal protection circuit has tripped and the motor temperature is too high.

For more information, see the drive firmware manual (or the FSO module user's manual if you use the Safe brake control (SBC) function of the FSO module).

# 8

## Start-up and validation test

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### Contents of this chapter

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

### Validation of the safety functions

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

#### ■ Competence

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



## ■ Validation procedure

If you use an FSO module in the safety system, you must validate the general settings of the FSO module and the safety encoder (if used) before you validate the safety function. See the FSO module user's manual, chapter *Verification and validation*.

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

- at the initial start-up of the safety function
- after changes related to the safety function (wiring, components, safety function -related parameter settings, etc.)
- after maintenance work related to the safety function
- 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 proper operation, from each operation location
- you must document all validation tests
- you must sign and store the validation test report for further reference.



## ■ Validation test reports

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


- a description of the safety application (including a figure)
  - a description and revisions of safety components that are used in the safety application
-

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

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

## Validation test

Use the Drive composer PC tool or a control panel to do the validation test. If you use an FSO module, you must use the Drive composer pro PC tool.

<b>Action</b>	<input checked="" type="checkbox"/>
 <b>WARNING!</b> Obey the safety instructions of the drive. If you ignore them, injury or death, or damage to the equipment can occur.	<input type="checkbox"/>
<b>Initial status</b>	
<u>With an FSO-21 and FSE-31 module:</u> If you use a safety encoder in the safety application, validate the safety encoder interface as described in <i>FSO-21 safety functions module user's manual</i> (3AXD50000015614 [English]), chapter <i>Verification and validation</i> .	<input type="checkbox"/>
Make sure that the drive is ready for use, that is, you have done the tasks of the drive start-up procedure. See the drive hardware manual.	<input type="checkbox"/>
Make sure that the drive STO function is configured and validated. See the hardware manual.	<input type="checkbox"/>



<b>Action</b>	<input checked="" type="checkbox"/>
<p><u>With an FSO module:</u> Make sure that the FSO STO function is configured and validated.</p> <p>Internal monitoring of the FSO module can trigger the STO function even if you have not defined an external request signal. The STO function must be validated before other safety functions.</p> <p><b>Note:</b> If you use a safety encoder, and parameter <i>S_ENCGEN.11</i> is set to <i>Est switch not active load</i>, both STO function with speed estimate and STO function with encoder feedback must be tested - most importantly, the value of parameter <i>STO.14</i> must be set according to the application requirements.</p>	<input type="checkbox"/>
<b>Checks and settings with no voltage connected</b>	
Stop the drive and do the steps in section <i>Electrical safety precautions (page 12)</i> before you start the work.	<input type="checkbox"/>
The motor manufacturer selects the PTC sensors for the motor temperature measurement according to the specified temperature class. Make sure that the temperature on-off resistances match those of the module.	<input type="checkbox"/>
If you have done any changes to the wiring, do a check of the connections against the applicable circuit diagrams.	<input type="checkbox"/>
Make sure that the installation of the motor temperature sensor complies with the requirements for the applicable type of protection.	<input type="checkbox"/>
Make sure that the SIL/PL of the safety function meets the target SIL/PL. If SIL2 is required, make sure that the STO connection between the FPTC-01 module and drive STO is kept redundant.	<input type="checkbox"/>
Make sure that the wires are connected to the correct terminals and that the terminal connections are tightened to the correct torque.	<input type="checkbox"/>
<b>Settings with voltage connected</b>	
Make sure that you have activated the FPTC-01 module in the correct slot (parameter 35.30).	<input type="checkbox"/>
Make sure that you have set all the necessary parameters for the safety function. See chapter <i>Parameter settings (page 45)</i> .	<input type="checkbox"/>
<b>Validation test procedure</b>	
Make sure that you can run and stop the motor freely during the test.	<input type="checkbox"/>

<b>Action</b>	<input checked="" type="checkbox"/>
Start the drive and make sure that the motor is running.	<input type="checkbox"/>
Do an overtemperature monitoring test: increase the resistance in the XFLT input to more than 4 kohm (for example, open the circuit by disconnecting the wires).	<input type="checkbox"/>
Make sure that the correct indications are activated: the SMT fault and other indications depending on the parameter settings and if an FSO module is installed.	<input type="checkbox"/>
Make sure that the STO is activated and that the motor coasts to a stop.	<input type="checkbox"/>
Make sure that you cannot start the drive before you reset the drive.	<input type="checkbox"/>
Reset the drive. Make sure that you cannot reset and restart the drive before the resistance in the XFLT input decreases to less than 1.6 kohm (that is, the thermistor wires are reconnected).	<input type="checkbox"/>
Restart the drive and the motor. Make sure that they operate normally.	<input type="checkbox"/>
Do a short-circuit detection test: decrease the resistance in the XFLT input to less than 50 ohm (for example, connect a jumper wire between the terminals of the XFLT input).	<input type="checkbox"/>
Make sure that the correct indications are activated: the SMT fault and other indications depending on the parameter settings and if an FSO module is installed.	<input type="checkbox"/>
Make sure that the STO is activated and that the motor coasts to a stop.	<input type="checkbox"/>
Make sure that you cannot start the drive before you reset the drive.	<input type="checkbox"/>
Reset the drive. Make sure that you cannot reset and restart the drive before the resistance in the XFLT input increases to more than 50 ohm (that is, the jumper wire connected earlier is removed).	<input type="checkbox"/>
Restart the drive and the motor. Make sure that they operate normally.	<input type="checkbox"/>
If used, do the overtemperature monitoring and short-circuit detection tests for the XWRN input. Make sure that the motor temperature warning indication is activated in both cases.	<input type="checkbox"/>
Create a backup file of the drive parameters with the Drive composer PC tool or control panel.	<input type="checkbox"/>



<b>Action</b>	<input checked="" type="checkbox"/>
If you use an FSO module, save the FSO safety file (button <b>Save safety file</b> in the Drive composer pro PC tool).	<input type="checkbox"/>
Fill in and sign the validation test report. Store the report in the logbook of the machine.	<input type="checkbox"/>





# 9

## Fault tracing

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### Contents of this chapter

This chapter shows how to trace faults with fault and warning messages of the drive and LEDs on the module.

### Reporting problems and failures related to safety functions

Contact ABB.

### FPTC-01 module replacement

If there is a failure in the FPTC-01 module, you must replace it with a new one. Do not try to repair the module.

---

## Fault and warning messages

Fault and warning messages in the ACS880 primary control program:

Code (hex)	Name	Cause	Action
<b>Faults</b>			
4990	FPTC not found	A thermistor protection module is activated by parameter 35.30 but cannot be detected. The last digit of the auxiliary code identifies the slot.	Power down the control unit and make sure that the module is correctly inserted in the option slot.
4991	Safe motor temperature 1 1)	The FPTC-01 module in option slot 1 indicates overtemperature in the XFLT input (safety related).  1. Motor temperature is too high, or  2. the thermistor is short-circuited or disconnected.	<ol style="list-style-type: none"> <li>1. Make sure that the motor has sufficient cooling.</li> <li>2. Make sure that the drive and the motor are compatible with each other.</li> <li>3. Make sure that the motor is not overloaded.</li> <li>4. Make sure that the drive parameter settings are correct.</li> <li>5. Examine the wiring of the temperature sensor. If necessary, repair the wiring.</li> <li>6. Measure the resistance of the sensor. If necessary, replace the sensor.</li> </ol>
4992	Safe motor temperature 2 1)	The FPTC module in option slot 2 indicates overtemperature in the XFLT input (safety related). See 4991.	
4993	Safe motor temperature 3 1)	The FPTC module in option slot 3 indicates overtemperature in the XFLT input (safety related). See 4991.	

Code (hex)	Name	Cause	Action
<b>Warnings</b>			
A497	Motor temperature 1 1)	<p>The FPTC module in option slot 1 has activated a motor temperature warning in the XWRN input (non-safety related).</p> <ol style="list-style-type: none"> <li>1. Motor temperature is too high, or</li> <li>2. the thermistor is short-circuited or disconnected.</li> </ol>	<ol style="list-style-type: none"> <li>1. Make sure that the motor has sufficient cooling.</li> <li>2. Make sure that the drive and the motor are compatible with each other.</li> <li>3. Make sure that the motor is not overloaded.</li> <li>4. Make sure that the drive parameter settings are correct.</li> <li>5. Examine the wiring of the temperature sensor. If necessary, repair the wiring.</li> <li>6. Measure the resistance of the sensor. If necessary, replace the sensor.</li> </ol>
A498	Motor temperature 2 1)	The FPTC module in option slot 2 has activated a motor temperature warning in the XWRN input (non-safety related). See A497.	
A499	Motor temperature 3 1)	The FPTC module in option slot 3 has activated a motor temperature warning in the XWRN input (non-safety related). See A497.	

1) Editable message text

For the fault and warning messages of the FSO module, see the FSO module user's manual.

## LEDs

The FPTC-01 module has three diagnostic LEDs.

Name	Color	Description
FAULT	Red	The motor temperature is outside the permitted temperature range and the drive STO is active, or there is no PTC sensor connected to the XFLT input (safety-related).
WARNING	Red	The motor temperature is outside the temperature warning range, or there is no PTC sensor connected to the XWRN input (non-safety-related). <sup>1)</sup>
STATUS	Green	The module is powered up.

- 1) If there is no sensor connected to XWRN input, the WARNING LED is always on while the module is powered up. To turn off the WARNING LED, you can connect a resistor to the XWRN input. See the electrical installation instructions.
-

## 10

# Maintenance

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## 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 the FPTC-01 module, modify parameters, 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

To do a proof test, activate the safety function to make sure that it operates correctly. For guidelines, refer to the validation test procedure.

### 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 2 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 check the operation of the safety function at least once a year.

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 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 FPTC-01 module,

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the FSO module and the STO circuit of the drive do not have electromechanical outputs.

## **Competence**

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

## **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 the module, make sure that the safety of the machine is maintained until the decommissioning is complete. Mark clearly on the module that it is decommissioned.

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# 11

## Technical data

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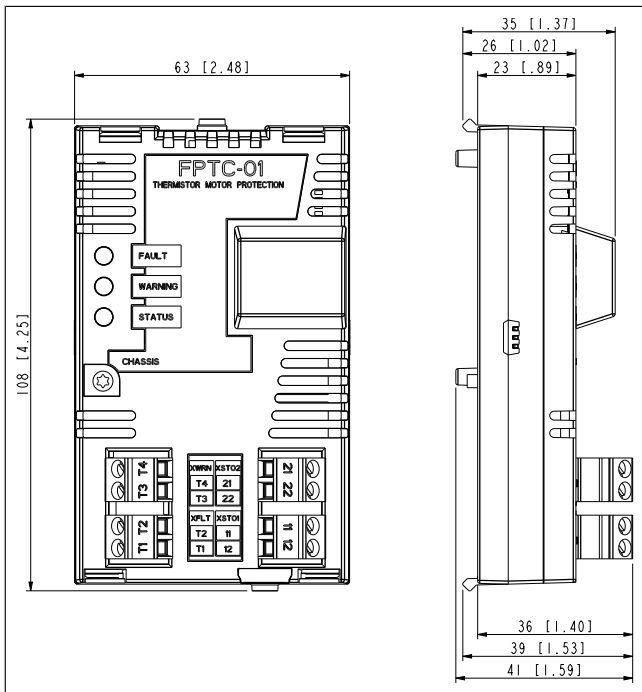
### Contents of this chapter

This chapter contains the technical data of the module, gives general rules, notes and definitions related to safety functions and lists the related standards and directives. The safety data, relevant certificates and Declarations of Conformity are also included.

---

## Dimension drawing

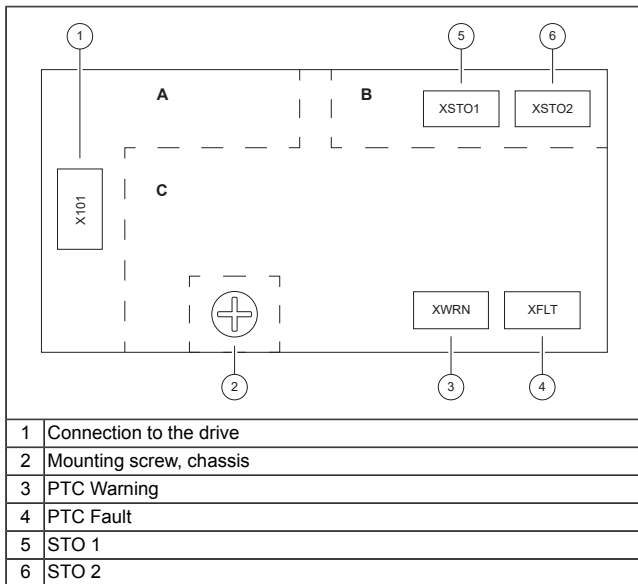
The dimensions are shown in millimeters and inches.



## Isolation areas

The following figure shows the different isolation areas of the module. Isolation areas A and B and the mounting screw are connected to

ground. Isolation area C is in the same potential as the PTC sensor element in the motor.



There is reinforced insulation between:

- isolation areas A and C
- isolation areas B and C.

## Connections

### ■ Motor thermistor connection

- Maximum wire size: 2.5 mm<sup>2</sup> (14 AWG)
- Maximum wire length: 700 m (2300 ft) (1400 m [4600 ft] for the whole loop)  
With the specified cable type, detection of a short-circuited PTC sensor or cable is not guaranteed after 100 m (328 ft).
- Type: Shielded, twisted-pair cable (Draka JAMAK 1×(2+1)×0.5 mm<sup>2</sup> or equivalent)
- Tightening torque: 0.5 N·m (4.4 lbf·in)
- Supported standards: DIN 44081 and DIN 44082
- Number of PTC thermistors: 1, 3 or 6 in series (in both inputs)
- Triggering threshold: 3.6 kohm ±10%
- Recovery threshold: 1.6 kohm ±10%
- PTC terminal voltage: < 5.0 V
- PTC terminal current: < 1 mA
- Short-circuit detection: < 50 ohm ±25 ohm (for the effect of the cable length, see above).

### ■ STO output connection

- Maximum wire size:
    - 2.5 mm<sup>2</sup> (14 AWG) without FSO module
    - 1.5 mm<sup>2</sup> (16 AWG) with FSO module
  - Maximum wire length: 30 m (98 ft) for the whole loop
  - Tightening torque: 0.5 N·m (4.4 lbf·in)
-

- Contact rating: 24 V DC (17 ... 30 V), 1 A / channel
- Maximum breaking capacity: 1000 VA

## Ambient conditions

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

## Safety data

The FPTC-01 module is a type A safety component as defined in IEC 61508-2. For the types of the drive/inverter STO and the FSO module, see the applicable hardware manual or FSO user's manual.

The table gives the safety data for the SMT function with different configurations. The calculations are based on the worst case data of the drive Safe torque off (STO) function. The PFH/PFD<sub>avg</sub> values can be different based on the internal configuration of the FSO module. The FSE-31 module is included in the calculations for the FSO module.

**Note:** The failure rate of the PTC sensor is not included in the calculations.

1. FPTC module + drive STO, two-channel configuration. See [Wiring example 1 \(page 40\)](#).
  2. FPTC module + drive STO + FSO module with STO function request, two-channel configuration. See [Wiring example 2 \(page 41\)](#).
  3. FPTC module + drive STO + external safety relay, two-channel configuration. See [Wiring example 3 \(page 42\)](#).
  4. FPTC module + drive STO, one-channel configuration. See [Wiring example 4 \(page 43\)](#).
-

5. FPTC module + drive STO + FSO module with STO function request, one-channel configuration. See *Wiring example 5 (page 44)*.

	Two-channel configurations			One-channel configurations	
Configuration	1	2	3	4	5
<b>SIL / SILCL</b>	2	2	2	1	1
<b>PL</b>	c	c	c	c	c
<b>SFF (%)</b>	>90	>90	>90	>60	>60
<b>PFH (1/h)</b> $T_1 = 20 \text{ a}$	5.48E-09	5.54E-09	5.48E-09	7.68E-09	8.25E-09
<b>PFD<sub>avg</sub></b> $T_1 = 2 \text{ a}$	4.81E-05	4.88E-05	4.81E-05	7.84E-05	8.39E-05
<b>PFD<sub>avg</sub></b> $T_1 = 5 \text{ a}$	1.20E-04	1.22E-04	1.20E-04	1.97E-04	2.10E-04
<b>DC (%)</b>	60	60	60	0	0
<b>SC</b>	2	2	2	2	2
<b>Cat.</b>	1	1	1	1	1
<b>HFT</b>	0	0	0	0	0
<b>CCF</b>	65	65	65	65	65
<b>T<sub>M</sub> (a)</b>	20	20	20	20	20
3AXD10000454332 F					

The MTTF<sub>D</sub> value (EN ISO 13849-1) of the FPTC-01 module:

- 1697 years (two-channel connection)
- 1703 years (one-channel connection)

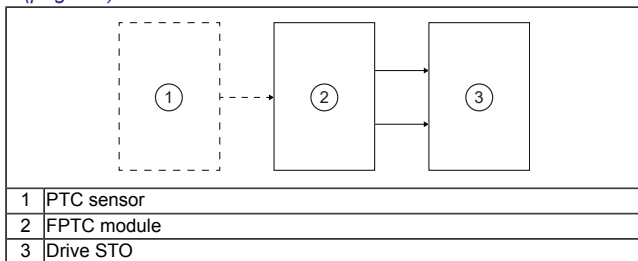
## Safety block diagrams

The components that are included in the safety data calculations are shown in the safety block diagrams below. The dashed line identifies a component that is not included in the safety data calculations shown in this manual.

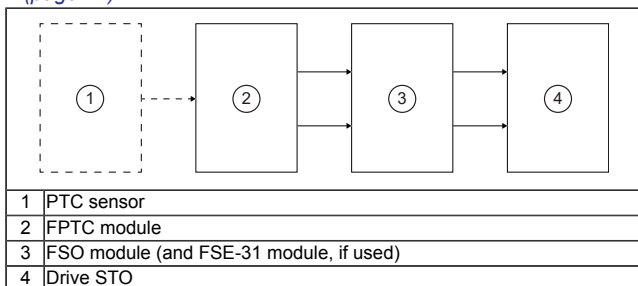
**Note:** The failure rate of the PTC sensor is not included in the calculations.

## ■ Two-channel configurations

This diagram is applicable to configuration 1. See [Wiring example 1 \(page 40\)](#).

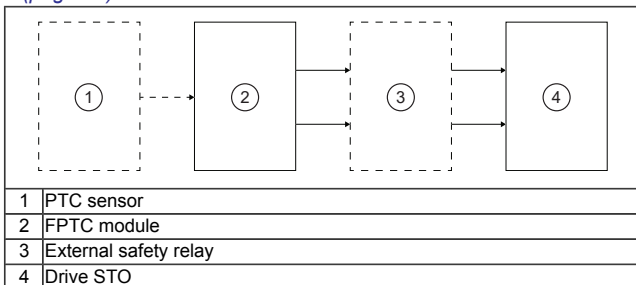


This diagram is applicable to configuration 2. See [Wiring example 2 \(page 41\)](#).



**Note:** The failure rate of the safety encoder is not included in the calculation.

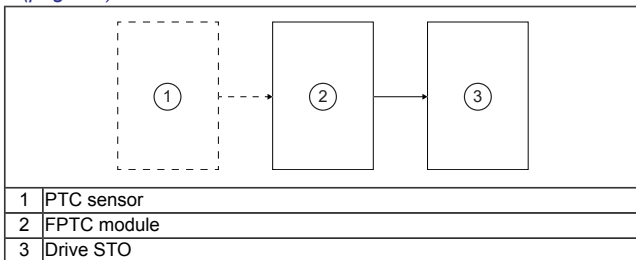
This diagram is applicable to configuration 3. See [Wiring example 3 \(page 42\)](#).



**Note:** The failure rate of the external safety relay is not included in the calculation.

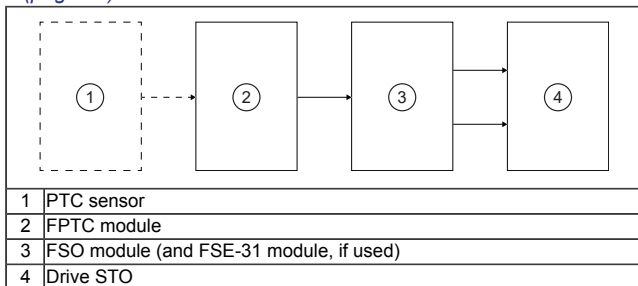
### ■ One-channel configurations

This diagram is applicable to configuration 4. See [Wiring example 4 \(page 43\)](#).





This diagram is applicable to configuration 5. See [Wiring example 5 \(page 44\)](#).



**Note:** The failure rate of the safety encoder is not included in the calculation.

## Response times

- FPTC-01 module: less than 10 ms
- SMT function: the response time of the PTC sensor + FPTC-01 module (<10 ms) + FSO module (<50 ms) + drive STO (<50 ms)

## Relevant failure modes

- The SMT function activates when not necessary (safe failure)
- The SMT function does not activate when requested

A fault exclusion on the failure mode “short-circuit on printed circuit board” has been made (EN 13849-2, table D.5). The analysis is based on the assumption that one failure occurs at one time. No accumulated failures have been analyzed.

The failures of the PTC sensor (thermistor) are not included in the failure analysis. The customer is responsible for the applicability of the PTC element.

## Related standards and directives

<b>IEC 61508:2010</b>	Functional safety of electrical/electronic/programmable electronic safety-related systems. Part 1 – General Requirements Part 2 – Requirements for electrical/electronic/programmable electronic safety-related systems
<b>EN 61800-5-2:2007</b> <b>IEC 61800-5-2:2016</b>	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional
<b>EN 62061:2005</b> <b>+AC:2010</b> <b>+A1:2013</b> <b>+A2:2015</b> <b>IEC 62061:2015</b> <b>Ed.1.2</b>	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
<b>EN ISO 13849-1:2015</b>	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design
<b>EN ISO 13849-2:2012</b>	Safety of machinery – Safety-related parts of control systems – Part 2: Validation
<b>EN 60204-1:2018</b> <b>IEC 60204-1:2016</b>	Safety of machinery – Electrical equipment of machines – Part 1: General requirements
<b>IEC 61326-3-1:2017</b>	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
<b>IEC 61511-1:2017</b> <b>Ed.2.1</b>	Functional safety – Safety instrumented systems for the process industry sector – Part 1: Framework, definitions, system, hardware and application programming requirements
<b>2006/42/EC</b>	European Machinery Directive

## 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 (option +L536) 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 included in the documentation delivered with the drive.

## TÜV Nord certificate

The TÜV Nord certificate for the FPTC-01 module and ACS880 drive series is shown below.





Deutsche  
Akkreditierungsstelle  
D-ZE-11074-01-00

# Certificate

No. SEBS-A.095524/15, V2.0

TÜV NORD Systems GmbH & Co. KG hereby certifies to

**ABB Oy**  
Hiomitie 13  
00381 Helsinki  
Finland

that the

**FPTC-01**

as a plug-in module for the ABB industrial drive ACS880 series

with the safety function Safe Motor Temperature (SMT) meets the requirements listed in the following standards

- IEC 61508-1 / -2: 2010, capable up to SIL 2
- IEC 61800-5-2: 2016, capable up to SIL 2
- IEC 62061: 2005 + A1:2012 + A2:2015 + CSV/COR1:2015, capable up to SIL<sub>CL</sub> 2
- ISO 13849-1 / -2: 2015 / 2012, capable up to PL c

Certificationprogram Leittechnik (SEB-ZE-SEECERT-VA-320-20, Rev. 5.1/4.19)

Base of certification is the report  
SEBS-A.095525/15TB in the valid  
version.

This certificate entitles the holder to  
use the pictured safety approved mark.

Valid until: 29-09-2025  
File reference: 8118123960

Hamburg, 28-09-2020

  
Bianca Pfuff



**FPTC-01**  
(SMT)  
IEC 61508-1-2:2010 SIL 2  
IEC 61800-5-2:2016 SIL 2  
ISO 13849-1:2015 PL c  
ISO 13849-2:2012 PL c  
IEC 60941:2015 Sil c 2  
SEBS-A.095524/15

Certification Body SEECERT  
TÜV NORD Systems GmbH & Co. KG  
Große Bahnstraße 31, 22525 Hamburg, Germany



## 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](http://www.abb.com/searchchannels).

### Product training

For information on ABB product training, navigate to [new.abb.com/service/training](http://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](http://new.abb.com/drives/manuals-feedback-form).

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[www.abb.com/drives](http://www.abb.com/drives)



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