ABB INDUSTRIAL DRIVES

DCS880 drives

FSO-21 safety functions module supplement

DCS880 Drive Manuals

	Publication number	EN	DE	IT	ES	FR	PL	ZH	RU	JP
DCS880 Quick guide	3ADW000545	EN	DE	IT	ES	FR				
Safety instructions all languages	3ADW000481	EN	DE	IT	ES	FR	PL	ZH	RU	
DCS880 Manual set	-	EN								
DCS880 Units										
DCS880 Flyer	3ADW000475	EN	DE	IT	ES	FR		ZH	RU	
DCS880 Technical catalog	3ADW000465	EN	DE	IT	ES	FR	PL	ZH	RU	
DCS880 Hardware manual	3ADW000462	EN	DE	IT	ES	FR	PL		RU	JA
DCS880 Firmware manual	3ADW000474	EN	DE	IT	ES	FR	PL		RU	JA
DCS880 Service manual	3ADW000488	EN								
DCS880 Hardparallel manual (on request only)	3ADW000530	EN								
DCS880 12-pulse manual	3ADW000533	EN								
DCS880 Current measurement aid (SDCS-CMA-2) manual	3ADW000745	EN								
ACS-AP-x assistant control panels user's manual	3AUA0000085685	EN								
DCS Thyristor power converter – Technical guide	3ADW000163	EN								
DCS880 External DC voltage measurement H1 ... H5	3ADW000601	EN								
Functional safety										
Supplement for functional safety	3ADW000452	EN		IT	ES	FR	PL		RU	
FSPS-21 PROFIsafe safety functions module	3AXD50000158638	EN								
FSO-21 Safety functions module	3AXD50000015614	EN								
Functional safety for enclosed converter										
+Q957 Prevention of unexpected Start Up	3ADW000504	EN								
+Q951 Emergency stop, category 0 with MC opening	3ADW000505	EN								
+Q952 Emergency stop, category 1 with MC opening	3ADW000506	EN								
+Q963 Emergency stop, category 0 without MC opening	3ADW000507	EN								
+Q964 Emergency stop, category 1 without MC opening	3ADW000508	EN								
Enclosed converter										
DCS880-A Catalog	3ADW000531	EN								
DCS880-A Installation manual	3ADW000627	EN								
DCS880-A81 Hydrogen catalog	3ADW000824	EN								
DCS800-A +S880 Enclosed converters, flyer	3ADW000523	EN								
Rebuild and upgrade systems										
DCS880-R Rebuild manual	3ADW000599	EN								
DCS880-U Upgrade manual	3ADW000719	EN								
Door mounting kits										
DPMP-01 mounting platform for ACS-AP control panel	3AUA0000100140	EN								
DPMP-02 mounting platform for ACS-AP control panel	3AUA0000136205	EN								
Serial communication										
FCAN-01 CANopen adapter module	3AFE68615500	EN	DE							
FDNA-01 DeviceNet™ adapter module	3AFE68573360	EN								
FECA-01 EtherCAT adapter module	3AUA0000068940	EN	DE		ES					
FENA-11/-21 Ethernet adapter module	3AUA0000093568	EN						ZH		
FEPL-02 Ethernet POWERLINK adapter module	3AUA0000123527	EN	DE							
FPBA-01 PROFIBUS DP adapter module	3AFE68573271	EN	DE				PL	ZH		
FSCA-01 RS-485 adapter module	3AUA0000109533	EN						ZH		
FDCO-01/02 DDCS communication modules	3AUA0000114058	EN								
FPNO-21 PROFINET fieldbus adapter module	3AXD50000158614	EN								
Tool and maintenance manuals and guides										
Drive Composer PC tool	3AUA0000094606	EN								
Drive application programming (IEC61131-3) manual	3AUA0000127808	EN								
Adaptive programming, Application guide	3AXD50000028574	EN								
NETA-21 remote monitoring tool	3AUA0000096939	EN								
NETA-21 remote monitoring tool guide	3AUA0000096881	EN								
DDCS branching unit NDBU-95 user's manual	3BFE64285513	EN								
Extension modules										
FIO-11 Analog extension module	3AFE68784930	EN	DE	IT						
FIO-01 Digital extension module	3AFE68784921	EN	DE	IT						
FAIO-01 Analog extension module	3AUA0000124968	EN	DE							
FDIO-01 Digital extension module	3AUA0000124966	EN								
FEN-01 TTL encoder interface	3AFE68784603	EN	DE	IT				ZH		
FEN-31 HTL encoder interface	3AUA0000031044	EN						ZH		
FSE-31 pulse encoder interface module user's manual	3AXD50000016597	EN								
FEA-03 F series extension adapter	3AUA0000115811	EN								
Ethernet tool network for ACS880 drives appl. guide	3AUA0000125635	EN								

Table of contents

Safety instructions

What this chapter contains

This chapter contains the safety instructions you must follow when installing, operating, and servicing the drive.
If ignored, physical injury or death may follow, or damage may occur to the drive, the motor or driven equipment. Read the safety instructions before you work on the unit.

To which products this chapter applies

The information is valid for the whole range of the product DCS880, the converter modules DCS880-S0x size H1 … H8, field exciter units DCF80x, etc. like the Rebuild Kit DCS880-R00.

Usage of warnings and notes

There are two types of safety instructions throughout this manual: warnings and notes.
Warnings caution you about conditions which can result in serious injury or death and/or damage to the equipment, and advice on how to avoid the danger.
Notes draw attention to a particular condition or fact or give information on a subject.
The warning symbols are used as follows:

Dangerous voltage warning warns of high voltage which can cause physical injury or death and/or damage to the equipment.

General danger warning warns about conditions, other than those caused by electricity, which can result in physical injury or death and/or damage to the equipment.

Electrostatic sensitive devices warning warns of electrostatic discharge which can damage the equipment.

Installation and maintenance work

These warnings are intended for all who work on the drive, motor cable or motor. Ignoring the instructions can cause physical injury or death and/or damage to the equipment.

WARNING

- **Only qualified electricians are allowed to install and maintain the drive!**
- Never work on the drive, motor cable or motor when main power is applied.
- Always ensure by measuring with a multimeter (impedance at least 1 MΩ) that:
  - 1. Voltage between drive input phases U1, V1 and W1 and the frame is close to 0 V.
  - 2. Voltage between terminals C+ and D- and the frame is close to 0 V.
- Do not work on the control cables when power is applied to the drive or to the external control circuits. Externally supplied control circuits may cause dangerous voltages inside the drive even when the main power on the drive is switched off.
- Do not make any insulation resistance or voltage withstand tests on the drive or drive modules.
- Isolate the motor cables from the drive when testing the insulation resistance or voltage withstand of the cables or the motor.
- When reconnecting the motor cable, always check that the C+ and D- cables are connected with the proper terminal.

Notes:

- The motor cable terminals on the drive are at a dangerously high voltage when the main power is on, regardless of whether the motor is running or not.

- Depending on the external wiring, dangerous voltages (115 V, 220 V or 230 V) may be present on the relay outputs of the drive system (e.g., XRO1 … XRO3).
- DCS880 with enclosure extension: Before working on the drive, isolate the whole drive system from the supply.

Grounding

These instructions are intended for all who are responsible for the grounding of the drive. Incorrect grounding can cause physical injury, death and/or equipment malfunction and increase electromagnetic interference.

WARNING

- Ground the drive, motor, and adjoining equipment to ensure personnel safety in all circumstances, and to reduce electromagnetic emission and pick-up.
- Make sure that grounding conductors are adequately sized and marked as required by safety regulations.
- In a multiple-drive installation, connect each drive separately to protective earth (PE ⏚).
- Minimize EMC emission and make a 360° high frequency grounding (e.g., conductive sleeves) of screened cable entries at the cabinet lead-through plate.
- Do not install a drive equipped with an EMC filter to an ungrounded power system or a high resistance-grounded (> 30 Ω) power system.

Notes:

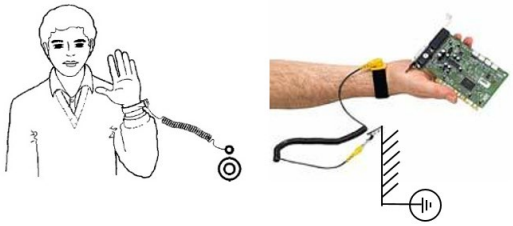
- Power cable shields are suitable as equipment grounding conductors only when adequately sized to meet safety regulations.
- As the normal leakage current of the drive is higher than 3.5 mA_{AC} or 10 mA_{DC} a fixed protective earth connection is required.
- This product can cause a DC current in the protective earthing conductor. Where a residual current-operated protective (RCD) or monitoring (RCM) device is used for protection in case of direct or indirect contact, only an RCD or RCM of Type B is allowed on the supply side of this product.

Printed circuit boards and fiber optic cables

These instructions are intended for all who handle the circuit boards and fiber optic cables. Ignoring the following instructions can cause damage to the equipment.

WARNING

- The printed circuit boards contain components sensitive to electrostatic discharge. Wear a grounding wrist band when handling the boards. Do not touch the boards unnecessarily.
- Use grounding strip:



- ABB order no.: 3ADV050035P0001

WARNING

- Handle the fiber optic cables with care.
- When unplugging optic cables, always grab the connector, not the cable itself.
- Do not touch the ends of the fibers with bare hands as the fiber is extremely sensitive to dirt.
- The minimum allowed bend radius is 35 mm (1.38 in.).

Mechanical installation

These notes are intended for all who install the drive. Handle the unit carefully to avoid damage and injury.

WARNING

- DCS880 sizes H4 ... H8:
  - The drive is heavy. Lift the drive by lifting lugs only.
  - The drive's center of gravity is high. Do not tilt the drive. The drive will overturn from a tilt of about 6 degrees. An overturning drive can cause physical injury.
  - Do not lift the drive by the front cover.
  - Place drives H4 … H6 only on their back.
- Make sure that dust from drilling does not enter the drive when installing. Electrically conductive dust inside the unit may cause damage or lead to malfunction.
- Ensure sufficient cooling.
- Do not fasten the drive by riveting or welding.

Operation

These warnings are intended for all who plan the operation of the drive or operate the drive. Ignoring the instructions can cause physical injury or death and/or damage to the equipment.

WARNING

- Before adjusting the drive and putting it into service, make sure that the motor and all driven equipment are suitable for operation throughout the speed range provided by the drive. The drive can be adjusted to operate the motor at speeds above and below the base speed.
- Do not control the motor with the disconnecting device (disconnecting mains); instead, use the control panel keys  and  , or commands via the I/O board of the drive.
- Mains connection:
  You can use a disconnect switch (with fuses) to disconnect the electrical components of the drive from the mains for installation and maintenance work. The type of disconnect switch used must be as per EN 60947-3, Class B, so as to comply with EU regulations, or a circuit-breaker type which switches off the load circuit by means of an auxiliary contact causing the breaker's main contacts to open. The mains disconnect must be locked in its "OPEN" position during any installation and maintenance work.
- EMERGENCY STOP buttons must be installed at each control desk and at all other control panels requiring an emergency stop function. Pressing the STOP button on the control panel of the drive will neither cause an emergency stop of the motor, nor will the drive be disconnected from any dangerous potential.
- To avoid unintentional operating states, or to shut the unit down in case of any imminent danger according to the standards in the safety instructions it is not sufficient to merely shut down the drive via signals "RUN", "drive OFF" or "Emergency Stop" respectively "control panel" or "PC tool".
- Intended use:
- The operating instructions cannot take into consideration every possible case of configuration, operation, or maintenance. Thus, they mainly give such advice only, which is required by qualified personnel for normal operation of the machines and devices in industrial installations.
- If in special cases the electrical machines and devices are intended for use in non-industrial installations - which may require stricter safety regulations (e.g., protection against contact by children or similar) - these additional safety measures for the installation must be provided by the customer during assembly.

Note:

– When the control location is not set to Local (Local not shown in the status row of the display), the stop key on the control panel will not stop the drive. To stop the drive using the control panel, press the Loc/Rem key and then the stop key  .

FSO-21 for DCS880

Purpose

The purpose of this manual is to give additional information about the usage of the FSO-21 in conjunction with the DCS880. This allows to use advanced safety functions such as safe stop 1 (SS1) with ramp supervision, safely limited speed (SLS), and many more. Note that for DCS880, FSO-21 must be always used together with FSE-31.
The information of this manual is not found in the DCS880 Hardware manual or in the FSO-21 Safety functions module User's manual.

Requirements

Safety functions with safe speed estimation (FSO-21)

Compared to the ACS880, the DCS880 does not provide a safe speed estimate together with the FSO-21. Therefore, an FSE-31 in combination with a safe HTL encoder (see FSE-31 pulse encoder interface module) is required in general.
For further information see also FSO-21 Safety functions module User's manual.

Safety functions with safety encoder (FSO-21+FSE-31)

Similar to the ACS880 the DCS880 works together with the combination of FSO-21+FSE-31.
The certificate for FSO-21+FSE-31 in conjunction with the DCS880 is valid with the control board SDCS-CON-H01 (Electronic Unit DCS880/DCT880 3ADT220166R0002) only.
Attention: The other control board SDCS-CON-H01**L** (Electronic Unit DCS880/DCT880 3ADT220166R0012) is not released for any safety function.

Plus codes

Plus code	Option	Description
+Q986	FSPS-21	PPROFINET IO, PROFISAFE fieldbus adapter.
+Q972	FSO-21	Safety functions module. The safety functions module provides an easy way to extend safety functions of the DCS880.
+L521	FSE-31	HTL pulse encoder interface module. The safety pulse encoder interface module provides an easy way to extend safety functions of the DCS880. **Note:** Requires an FSO-21. See +Q972.
+K492	FPNO-21	PROFINET IO (2-port) fieldbus adapter.
+Q982	PROFISAFE using FSO-21	PROFISAFE communication using an FSO-21. See DCS880-A enclosed converters Catalog chapter Functional safety modules. **Note:** Requires an FSO-21, see +Q972 and an FPNO-21, see +K492 or a FENA-21, see +K475.

FSE-31 and the field bus modules (if any) must be always mounted on an option slot. FSO-21 can be mounted on a free option slot (if it is not needed for DDCS communication or a second field bus module).

Documentation

All documentation can be found in chapter DCS880 Drive Manuals.
The most relevant manuals are the:

- DCS880 Hardware manual.
- Supplement for functional safety.
- FSO-21 Safety functions module User's manual.
- FSE-31 pulse encoder interface module.
- DCS880-A Catalog.
- FENA-11/-21 Ethernet adapter module.
- FPNO-21 PROFINET fieldbus adapter module.

See also the FSPS-21 manual as an alternative safety function module:

– FSPS-21 PROFIsafe safety functions module.

Certificates

List of all relevant certificates:

– DCS880 with FSO-21 and FSE-31, TÜV NORD.

TÜV NORD

DAkkS Deutsche Akkreditierungsstelle D-ZE-11074-01-00

Certificate

No. 1435.IM.161833/20 V1.0

TÜV NORD Systems GmbH & Co. KG hereby certifies

ABB AG
Wallstadter Straße 59
68526 Ladenburg

that the series

DCS880 with FSO-21 and FSE-31

safety module with various integrated safety functions meets the requirements listed in the following standards:

- **IEC 61508 part 1, part 2, part 3: 2010 SIL 3**
- **IEC 61800-5-2: 2016 SIL 3**
- **ISO 13849 part 1: 2015 PL e**
- **IEC 62061: 2005 + AMD1: 2012 + AMD2: 2015 SIL_{cl} 3**

Certification program Leittechnik (SEB-ZE-SEECERT-VA-320-20, Rev. 5.1 / 04.19)

Base of certification is the report 1435.IM.161833/20TB in the valid version.

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

Valid until: 2026-09-30
File reference: 8118789689

Hamburg, 2021-09-30

B Pfuff

Bianca Pfuff

TÜV NORD Safety Approved
TÜV NORD Systems GmbH & Co. KG
DCS880 with FSO-21 and FSO-31
IEC 61508:2010 SIL 3
IEC 61800-5-2:2016 SIL 3
ISO 13849-1:2015 PL e
IEC 62061:2015 SIL_{CL} 3
1435.IM.161833/20
Voluntary Certification

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

– FSO-12, FSO-21, and FSE-31 as plug-in modules for ACS880, TÜV NORD.

TÜV NORD

DAkkS Deutsche Akkreditierungsstelle D-ZE-11074-01-00

Certificate

No. 1435.IM.153902/19 V1.0

TÜV NORD Systems GmbH & Co. KG hereby certifies

ABB Oy
Hiomotie 13
00381 Helsinki
Finland

that the safety modules

FSO-12, FSO-21 and FSE-31

as plug-in modules for the industrial drive series ACS880 meets the requirements listed in the following standards:

- **IEC 61508 part 1, part 2, part 3: 2010 SIL 3**
- **IEC 61800-5-2: 2016 SIL 3**
- **ISO 13849 part 1: 2015 PL e, part 2: 2012**
- **IEC 62061: 2005 + AMD1: 2012 + AMD2: 2015 SIL_{CL} 3**

Certification program Leittechnik (SEB-ZE-SEECERT-VA-320-20, Rev. 5.1 / 04.19)

Beneath the integrated "Safe Torque Off (STO)" function within the industrial drive ACS880 series, the additional safety functions "(variable) Safely Limited Speed (SLS)", "Safe Maximum Speed (SMS)", "Safe Stop Emergency (SSE)", "Safe Stop 1 (SS1)", "Prevention Of Unexpected Start-up (POUS)", "Safe Direction (SDI)", "Safe Acceleration Range (SAR)", "Safe Speed Monitor (SSM)" and "Safe Brake Control (SBC)" can be realized with the plug-in safety functions modules FSO-12, FSO-21 and FSE-31.

The whole assembly can be used in safety applications up to SIL 3 according to IEC 61511.

Base of certification is the report 1435.IM.153902/19TB in the valid version.

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

Valid until: 2025-07-22
File reference: 8117456871

Hamburg, 2020-07-22

Bianca Pfuff

Voluntary Certification
TÜV NORD
TÜV NORD Systems GmbH & Co. KG
Safety Approved
FSO-12, FSO-21, FSE-31
IEC 61508:2010 SIL 3
IEC 61800-5-2:2016 SIL 3
ISO 13849-1:2015 PL e
ISO 13849-2:2012
IEC 62061:2015 SIL_{CL} 3
1435.IM.153902/19

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

– FSO-21 PROFIsafe.

PROFIBUS · PROFINET

Certificate

PROFIBUS Nutzerorganisation e.V. grants to

ABB Oy
Hiomotie 13, 00380 Helsinki, Finland

the Certificate No: **Z20147** for the PROFIsafe Module:

Model Name:	FSO-21
Order-Number:	3AXD50000012090
Revision:	SW: V4.3.0; HW: 1
Application CRC:	Channel A: 0x63F41365
	Channel B: 0xB630A569

This certificate confirms that the product has successfully passed the certification tests with the following PROFIsafe scope:

☑ PROFIsafe_V2 functionality on PROFINET IO

Test Report Number:	PS087-3
Authorized Test Laboratory:	SIEMENS AG, Fürth, Germany

The tests were executed in accordance with the following documents:
"PROFIsafe - Test Specification for F-Slaves, F-Devices, and F-Hosts, Version 2.1, March 2007".
This certificate is granted according to the document:
"Framework for testing and certification of PROFIBUS and PROFINET products".
For all products that are placed in circulation by **June 22, 2023** the certificate is valid for life.

Karlsruhe, August 06, 2020

(Official in Charge)

Board of PROFIBUS Nutzerorganisation e. V.

(Karsten Schneider)

(Dr. Jörg Hähniche)

PROFIsafe

eLearnings

Available eLearnings:

- G3852E - FSO SAFETY FUNCTIONS MODULE WITH FSE SAFETY ENCODER, INTERNET COURSE – EN.
- G3857E - FSDT-01 FUNCTIONAL SAFETY DESIGN TOOL, INTERNET COURSE – EN.

Note: The eLearnings are valid to be used in conjunction with the ACS880. For a DCS880 some details must be handled differently. For more information see the following manuals:

- DCS880 FSO-21 safety functions module supplement (this manual).
- DCS880-A Catalog chapter Safety functions offering.
- FSO-21 Safety functions module User's manual especially chapter Compatible products (section DCS880 drives and option modules).
- Product note DCS880 with FSO-21 (forthcoming).

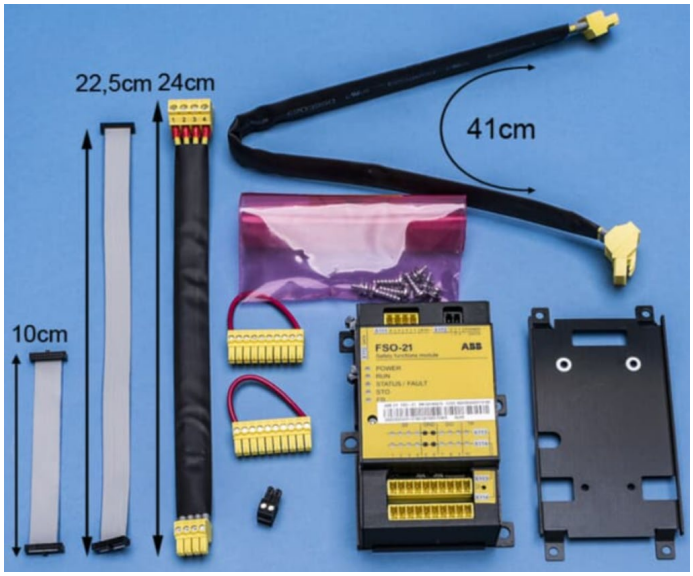
Mounting kit for DCS880 FSO-21 (+Q972)

The plus code +Q972 adds an FSO-21 module, including an additional mounting kit.
For drive modules (DCS880-S) the mounting kit is not pre-installed.
For enclosed converters (DCS880-A), it is installed using the mounting kit as a standard.

Content of the mounting kit

The mounting kit contains the following items:

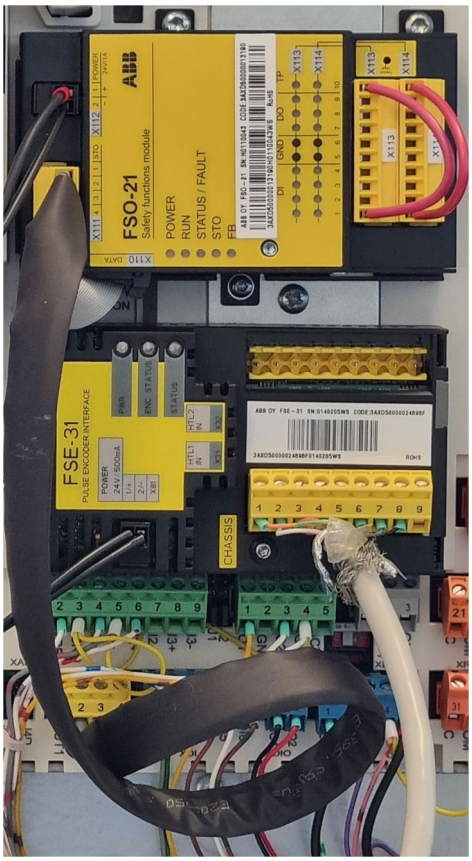
- Data cable long (460 mm): 3AXD50000001430.
- Connection Plate FSO H1-H4: 3ADT613062P0001.
- Connection Plate FSO H6: 3ADT614271P0001.
- Original ACS880 mounting Kit (see picture below): 3AXD50000023987.



Mounting options

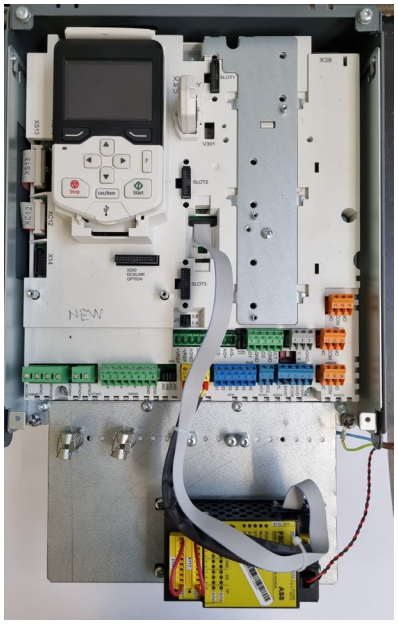
There are two mounting options available:

- Mount the FSO-21 using a free option slot directly onto the DCS880. However, in this case the front cover of the DCS880 cannot be used anymore.



– For tightening torques, refer to the FSO-21 Safety functions module User's manual chapter Tightening torques.

– Mount the FSO-21 using the mounting plates of the mounting kit. This solution does not require an empty option slot and the front cover of the DCS880 can still be used.



– Mounting kit option for units size H1 … H5 and H7/H8

– Mounting kit option for units size H6

– For tightening torques, refer to the FSO-21 Safety functions module User's manual chapter Tightening torques.

Functional safety concepts for DCS group drives

If more than one drive can become a danger at a specific place according to functional safety standards, all drives need to behave identical according to functional safety (E-Stop, SLS, etc.). This means, they must be in the same safety group and thus get the identical safety request.
This is particularly the case, when the motors are connected via shafts, belts, or work on the same mechanics. For such a configuration, all involved drives need to switch off safely to achieve STO. These configurations are often realized in a master-follower or 12-pulse configuration.
These systems are called a functional safety group drive, even if they should consist of two or more single cabinet drives.

In this chapter, three concepts are shown.

a. Single drives & simple group drives with FSO-21.
b. Master-follower/12-pulse solution using XSTO:1 supply
c. Master-follower/12-pulse full solution with emergency operation

They differ in the way, the STO signal/safety function request is given to the other drives and how many drives can be grouped.

Wired safety functions requests require plus code +S925 for each drive to take care of the cabling (custom safety option, not released). Further, an additional safety relay for stopping function such as SS1, SSE, etc. to prevent an automatic restart (plus codes not yet available).

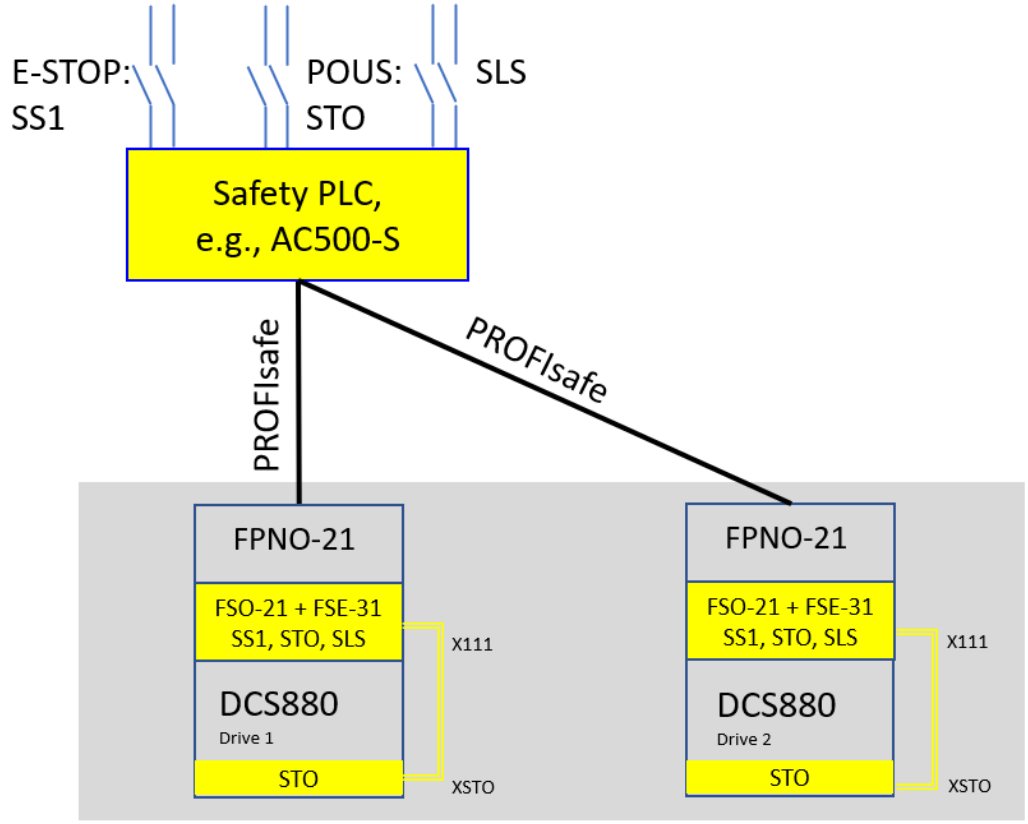
For all configurations, a maximum safety level of SIL 3/PL e is possible.

Note 1: Hard parallel drives are not considered to be a functional safety group drive, because only one STO terminal is used.

Note 2: At the writing of this documents, none of these concepts are released yet. They can be realized as custom functional safety circuit only.
Please contact the product management. For the release status of the FSO-21, see DCS880 Firmware release note.

Single drives & simple group drives with FSO-21

This concept is suitable for single drives and for group drives without master-follower or 12-pulse configuration.
In the schematic below, the safety request is given using a PROFIsafe connection. But also wired inputs to the FSO-21 module(s) can be used to activate safety functions instead.



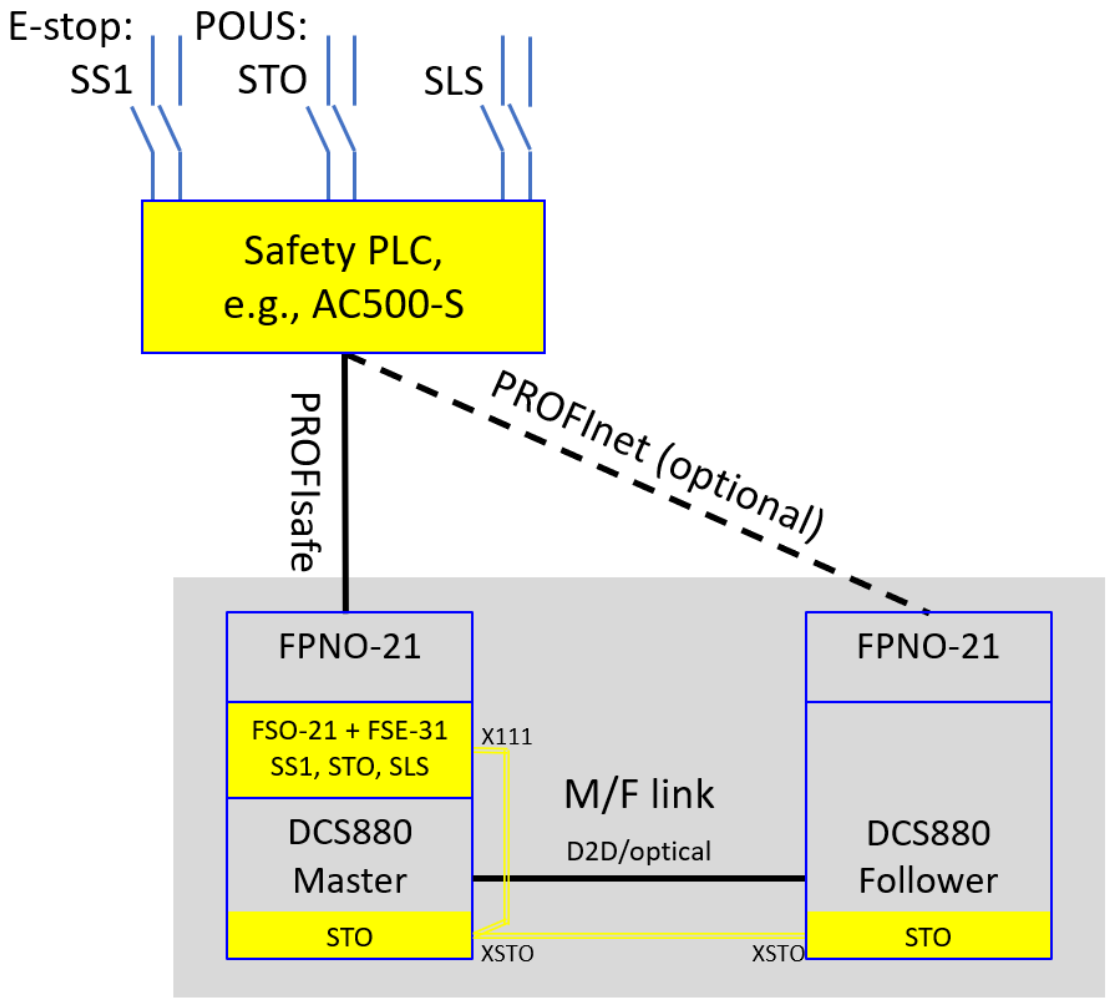
For each drive, the following is required:
- FSO-21.
- FSE-31 and a safe HTL encoder.
- FPNO-21 or FENA-21, if PROFIsafe/PROFInet is required.

Connect the terminals X111 with XSTO using the delivered cable according to the FSO-21 Safety functions module User's manual. It is not required to connect a Diagnostic circuit (31.98.b11 STO Reset indication).

To calculate the total probability of a dangerous random hardware failure per hour (PFH), follow the FSO-21 Safety functions module User's manual and then add up all resulting PFH_d values of all drives in the group.
This solution provides a max. safety level of SIL 3/PL e.

Master-follower/12-pulse solution using XSTO:1 supply

This concept is suitable for master-follower or 12-pulse drives, with up to 4 four follower drives/one 12-pulse slave drive. It assumes, that the safety functions are activated in in the master only. The STO signal is given by the master in parallel to all other drives.
In the schematic below, the safety request is given using a PROFIsafe connection. But also wired inputs to the FSO-21 module(s) can be used to activate safety functions instead.



For a master/12-pulse master, the following is required:
- FSO-21.
- FSE-31 and a safe HTL encoder.
- FPNO-21 or FENA-21, if PROFIsafe/PROFInet is required.

For followers or 12-pulse slaves, no extra modules are needed.

The STO output of the DCS880 master/12-pulse master is connected to the FSO-21 module which acts like a relay with two outputs. These outputs are connected to all DCS880 drives XSTO inputs in parallel.
The power capability of output XSTO:1 is 200 mA. This is sufficient for the master/12-pulse master and up to four follower drives/one 12-pulse slave drive. For this, the connectors in each line need to be connected to each other as below:

FSO-21		DCS880 Master		Follower/12-pulse slave	
X111:1	STO 24 V_{DC} (relay input)	XSTO:1	Out	-	-
X111:2	STO ground	XSTO:2	SGND	XSTO:2	SGND
X111:3	STO1LO drive internal signal	XSTO:3	IN1	XSTO:3	IN1
X111:4	STO2LO drive internal signal	XSTO:4	IN2	XSTO:4	IN2
Cable length	From FSO-21 to:	Master	Max. 1 m	Slave	Max. 100 m

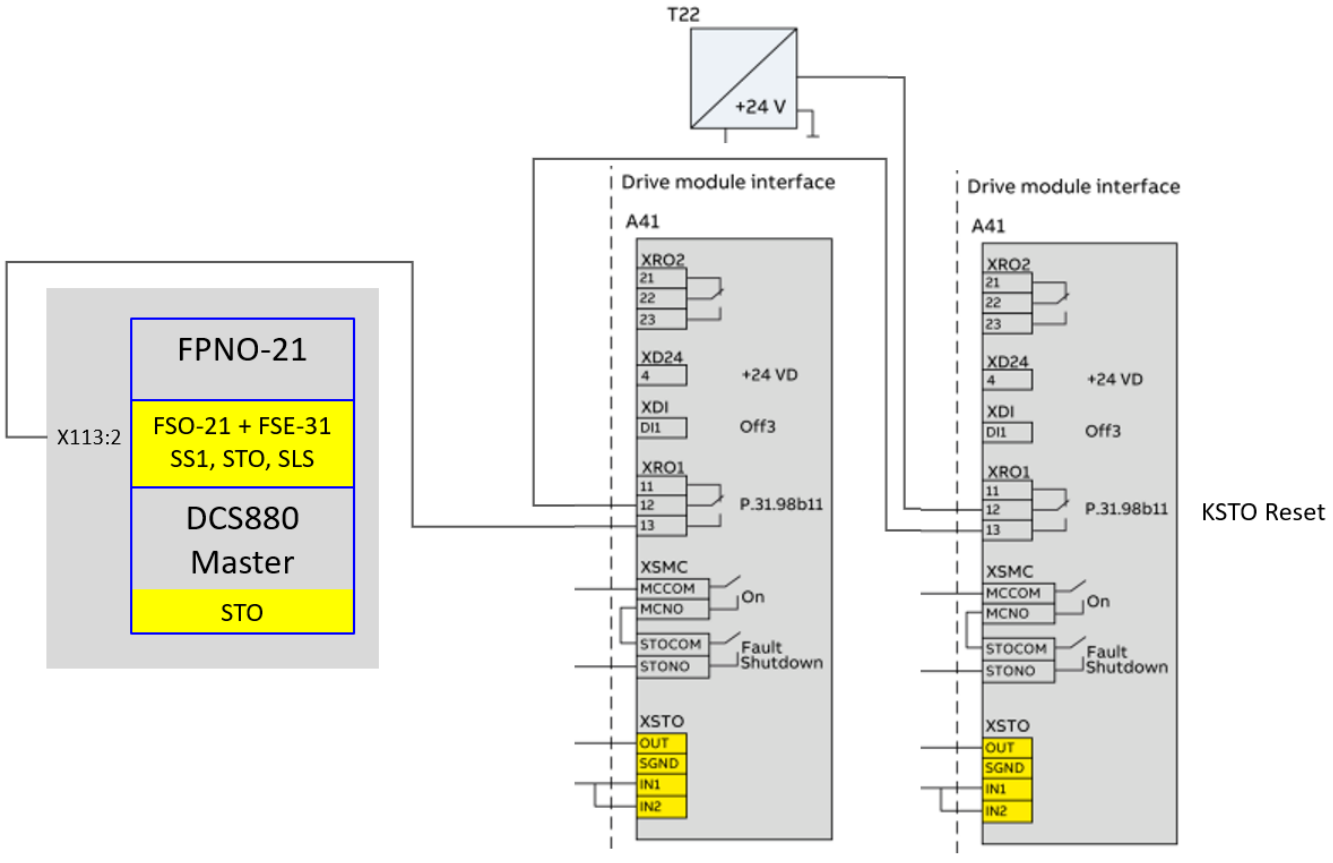
Note: This connects the GNDs of all DCS880 with each other. This can lead to problems, if the cabinets are separated and not next to each other. In this case, a reliable extra grounding between these line-ups is needed.

To calculate the total probability of a dangerous random hardware failure per hour (PFH), follow the FSO-21 Safety functions module User's manual and then add the PFH_d value(s) of the follower drives/12-pulse slave drive. See also manual Supplement for functional safety.
This solution provides a max. safety level of SIL 2/PL d.
Note 1: With diagnostics, SIL 3 is possible (see section Diagnostic circuit).
Note 2: The supervision of the follower speed via safe encoder and FSO-21 module can only be omitted if the mechanical link between the motors can be safely assumed to be robust. If this is not the case, the full solution is required (see chapter Master-follower/12-pulse full solution with emergency operation).

Diagnostic circuit

The following diagnostic circuit can be implemented to increases the safety level to up to SIL 3/PL e.

Via relay outputs the reset signals (STO Reset Indication) of all drives are connected in series and routed to a digital input of the FSO-21, e.g., X113:2. This input is used for the manual STO acknowledgement and must be configured accordingly.



The following table lists the additional drive and FSO-parameters settings for the diagnosis.

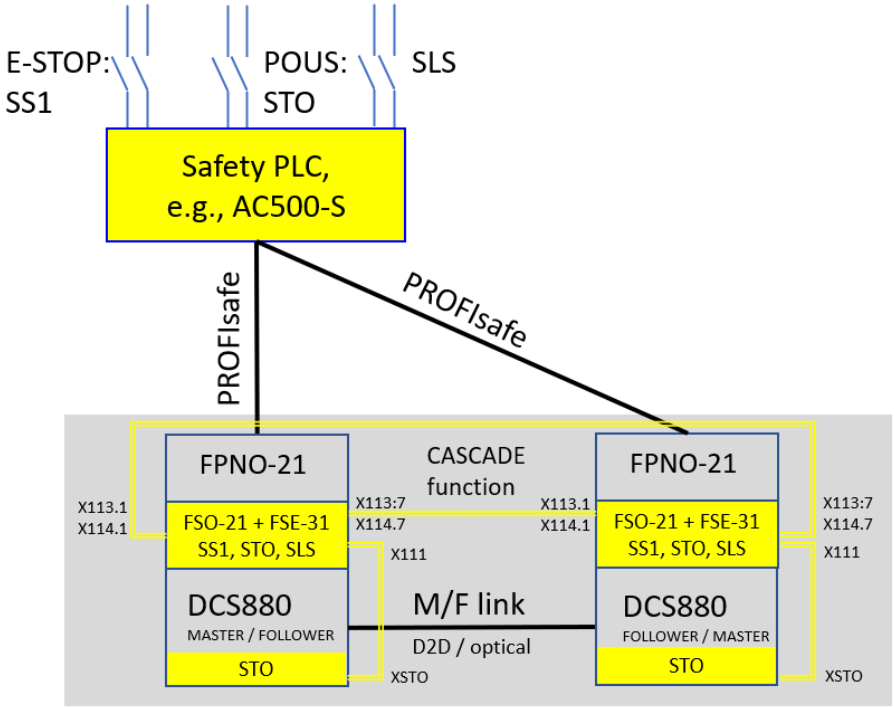
No.	Name	Value	Description
10.24	RO1 source	31.98.b11 STO Reset indication	Selects a drive signal to be connected to relay output RO1. In this case, the RO1 is energized if the drive is in STO state and no STO related fault is active.
31.22	STO indication run/stop	Warning/Warning	Selects which indications are given when one or both safe torque off (STO) signals are switched off or lost. The result depends on the state of the drive (e.g., stopped, running, …), when the signals are lost. Fault/Warning is the recommended setting. When a fault occurs in the drive, the mains contactor, AC-breaker, or DC-breaker is opened by the relay XSMC:1/2.
STO.02	STO acknowledgement	Manual	Sets the acknowledgement method used in the STO, SSE and SS1 functions.
FSOGEN.42	Acknowledgement button input	DI X113:2	Sets the digital input that is used for acknowledgement operations.

Master-follower/12-pulse full solution with emergency operation

The full solution is suitable for master-follower drives/12-pulse drives.
Only the STO function of the other drives is triggered using the cascade function. The STO signal is sent from the master/12-pulse master in a ring structure to all followers/12-pulse slave and back to the master for confirmation.

This solution also allows the so-called emergency operation. This means, that either master or follower can work alone if required for all FSO-21 safety functions.

In the schematic below, the safety request is given using a PROFIsafe connection. But also wired inputs to the FSO-21 module(s) can be used to activate safety functions instead.



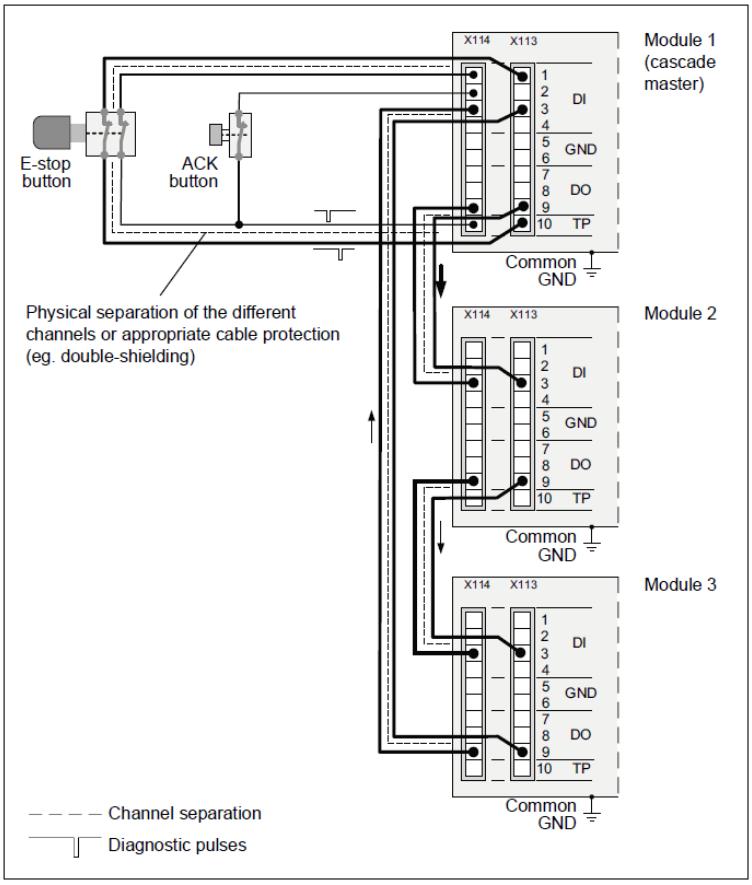
For the full solution for each drive, the following is required:
- FSO-21.
- FSE-31 and a safe HTL encoder.
- FPNO-21 or FENA-21, if PROFIsafe/PROFInet is required.
- Any number of drives can be connected via the cascade function.

Note 1: The emergency operation requires additional configuration in DCS880 and in the overriding control system to switch the drive from the follower to the master role. Also, the cascade outputs (X113.7 and X114.7) need to be bridged.
The FSO-21 module assumes the drive to be in speed control mode for the use of most safety functions. Followers are normally in either torque control, 19.01 Operation mode = **Torque**, or in window control, 24.41 Speed error window control enable = **Enable window control**. In 12-pulse slaves either the current reference or the firing angle is directly controlled by the 12-pulse master. Thus, the FSO-21 module of followers/12-pulse slaves has to be configured so that it does not contradict the master-follower function. This includes the master drive being responsible for the E-stop ramp, for instance.

Note 2: For most applications (without emergency operation), simpler solutions are recommended (see chapters Single drives & simple group drives with FSO-21 and Master-follower/12-pulse solution using XSTO:1 supply).

To calculate the total probability of a dangerous random hardware failure per hour (PFH), follow the FSO-21 Safety functions module User's manual for each drive and then add the resulting PFH_d value(s) as a worst case approximation.
This solution provides a max. safety level of SIL 3/PL e.

For more information on the cascade function and safety values, see the FSO-21 Safety functions module User's manual.
Here is an example how to connect a cascade function (no plus code available):



E-Stop button connection to FSO-21 module: cascade master follower

Annex

Known problems

- In contradiction to the FSO-21 Safety functions module User's manual, it is necessary to set FSOGEN.22 Motor nominal frequency = 50 Hz if the motor has a base speed higher than 1500 rpm. Otherwise, a configuration error check is falsely applied for the DCS880, even though DC motors do not have a nominal frequency. This setting is only used for the estimated speed of the ACS880 and thus, does not have any effect on the use of the FSO-21+FSE-31 together with a DCS880.
- **Note:** The safe speed estimate is not used for the DCS880.
- AUX codes for the DCS880 are not yet implemented in Drive Composer pro (current version is 2.8.0).

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The compact drive for machinery application

20 ... 1,000 A_{DC}
0 ... 610 V_{DC}
230 ... 525 V_{AC}
IP00

- Compact
- Robust design
- Adaptive and winder program
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For safe productivity

20 ... 5,200 A_{DC}
0 ... 1,500 V_{DC}
230 ... 1,200 V_{AC}
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- Safe torque off (STO) built in as standard
- Compact and robust
- Single drives, 20 A_{DC} to 5,200 A_{DC}, up to 1,500 V_{DC}
- IEC 61131 programmable
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