OPTIONS FOR ABB DRIVES

FSE-31 pulse encoder interface module

User's manual

FSE-31 pulse encoder interface module

User's manual

3AXD50000016597 Rev E
EN
Original instructions
EFFECTIVE: 2025-01-09

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Further information

1

Safety instructions

Contents of this chapter

The chapter contains the warning symbols used in this manual and the safety instructions which you must obey when you install or connect an option module to a drive. If you ignore the safety instructions, injury, death or damage can occur. Read this chapter before you start the installation.

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 show a particular condition or fact, or give information.

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

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

WARNING!
Do not bypass the FSE-31 pulse encoder interface module or FSO-21 safety functions module.

This manual does not contain the complete safety instructions of the drive. It does also not contain detailed information for disconnecting and isolating all drive types. It only includes the instructions related to the scope of this manual. Refer also to the drive or inverter unit hardware manual.

The FSE-31 module is part of a functional safety system. A functional safety system must be validated and verified according to the functional safety process. For general safety considerations and information to be taken into account when building a safety system, refer to FSO-21 safety functions module user's manual (3AXD50000015614 [English]).

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

Risk assessment of the application must determine at least these safety critical requirements:

- The need for a safety encoder. ABB recommends that you use a safety encoder if it is necessary to measure the safe speed close to the zero speed region, and in active load applications.
- the required SIL or PL level
- identifying the safety relevant application-specific parameters (for example, process safety time)
- the required encoder resolution.

The operating environment of the FSE-31 module must comply with the specified conditions. Refer to the technical data.

For instructions on decommissioning the module, refer to FSO-21 safety functions module user's manual (3AXD50000015614 [English]).

Electrical safety precautions

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

WARNING!
Obey these instructions. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrical professional, do not do electrical installation or maintenance work. Do these steps before you do installation or maintenance work.

1. Prepare for the work.
   - Make sure that you have a work order.
   - Do an on-site risk assessment or job hazard analysis.
   - Make sure that you have the correct tools available.
   - Make sure that the workers are qualified.
   - Select the correct personal protective equipment (PPE).
   - Stop the drive and motor(s).
2. Clearly identify the work location and equipment.
3. Disconnect all possible voltage sources. Make sure that connection is not possible. Lock out and tag out.
   - Open the main disconnecting device of the drive.

- If there is a permanent magnet motor connected to the drive, disconnect the motor from the drive with a safety switch or by other means.
- Open the main isolating device of the drive.
- Disconnect all dangerous external voltages from the control circuits.
- After you disconnect power from the drive, wait 5 minutes to let the intermediate circuit capacitors discharge before you continue.

4. Protect other energized parts in the work location against contact and take special precautions when close to bare conductors.
5. Measure that the installation is de-energized. Use a high-quality voltage tester.
   - Before and after you measure the installation, verify the operation of the voltage tester on a known voltage source.
   - Make sure that the voltage between the input power terminals of the drive (L1, L2, L3) and the grounding (PE) busbar is zero.
   - Make sure that the voltage between the output power terminals of the drive (U, V, W) and the grounding (PE) busbar is zero.

     Important! Repeat the measurement with the DC voltage setting of the voltage tester. Measure between each phase and ground. There is a risk of dangerous DC voltage charging due to leakage capacitances of the motor circuit. This voltage can remain charged for a long time after the drive power-off. The measurement discharges the voltage.

- Make sure that the voltage between the drive DC terminals (UDC+ and UDC-) and the grounding (PE) terminal is zero.

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

2

Introduction to the manual

Contents of this chapter

This chapter introduces this manual.

Applicability

This manual is applicable to the FSE-31 pulse encoder interface module, revision F.

Compatibility

The FSE-31 pulse encoder interface module is compatible with:

- ACS880 primary control program (AINLX): version 2.21 or later
- ACS880 primary control program (YINLX): version 1.30 or later
- DCS880 series with firmware version 2.07 or later
- FSO-21 safety functions module, revision B or later

- Drive Composer pro PC tool, version 1.8 or later.

ABB recommends that you always use the latest drive firmware.

The supported safety encoder type is:

- differential push-pull HTL encoder

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.

You are expected to know the fundamentals of functional safety, electricity, wiring, electrical components, and electrical schematic symbols.

Terms and abbreviations

Term	Description
BCU	Type of control unit
Drive	Frequency converter for controlling AC motors
Fail-safe mode	The functional safety module has activated the drive STO function as a result of an error (in some cases, after a delay). To exit this mode and continue normal operation, reboot the functional safety module.
FEA-03	Optional I/O extension adapter
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
HFT	Hardware fault tolerance (IEC 61508)
HTL	High-threshold logic
Inverter unit	Inverter module(s) under control of one control unit, and related components. One inverter unit typically controls one motor.

Term	Description
PL	Performance level. Levels a...e correspond to SIL (EN ISO 13849-1)
Safety system	Whole functional safety system including, for example, human-machine interface (HMI), safety encoder, FSE-31 module, FSO-21 module, drive and sensors.
SIL	Safety integrity level (1…3) (IEC 61508, IEC 62061, IEC 61800-5-2)
STO	Safe torque off (IEC/EN 61800-5-2)
UCU	Type of control unit
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.
ZCU	Type of control unit

List of related manuals

Manual	Code (English)
Drive hardware manuals and guides	
ACS880-01 hardware manual	3AUA0000078093
ACS880-11 hardware manual	3AXD50000045932
ACS880-31 hardware manual	3AXD50000045933
ACS880-04 hardware manual	3AUA0000128301
ACS880-04 single drive module packages hardware manual	3AUA0000138495
ACS880-14 and -34 single drive module packages hardware manual	3AXD50000022021
ACS880-04F drive modules hardware manual	3AXD50000034664
ACS880-04XT drive modules (500 to 1200 kW) hardware manual	3AXD50000025169
ACS880-04FXT drive module packages hardware manual	3AXD50000274444
ACS880-07 (45 to 710 kW) hardware manual	3AUA0000105718
ACS880-07 (560 to 2800 kW) hardware manual	3AUA0000143261

Manual	Code (English)
ACS880-37 (160 to 3200 kW) hardware manual	3AXD50000020437
ACS880-17 (45…400 kW) hardware manual	3AXD50000035158
ACS880-37 (45…400 kW) hardware manual	3AXD50000035159
ACS880-104 hardware manual	3AUA0000104271
ACS880-107 hardware manual	3AUA0000102519
DCS880 hardware manual	3ADW000462R
DCS880 FSO-21 safety functions module supplement	3ADW000821R
DCS880 supplement for functional safety	3ADW000452R
Drive firmware manuals and guides	
ACS880 primary control program (AINLX) firmware manual	3AUA0000085967
ACS880 primary control program (YINLX) firmware manual	3AXD50001000998
DCS880 firmware manual	3ADW000474R
Option manuals and guides	
ACS-AP-I, -S, -W and ACH-AP-H, -W Assistant control panels user's manual	3AUA0000085685
FSO-21 safety functions module user's manual	3AXD50000015614
Drive PC tool manuals	
Drive Composer start-up and maintenance PC tool user's manual	3AUA0000094606
Functional safety design tool user's manual	3AXD10000102417
General safety guides	
Functional safety; Technical guide No. 10	3AUA0000048753
ABB Safety information and solutions	www.abb.com/safety

See www.abb.com/drives/documents for all manuals on the Internet.

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.

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Hardware description

Contents of this chapter

This chapter gives a short description of the module.

Product overview

The FSE-31 pulse encoder interface module is an option module that lets you use a safety encoder in the safety system. It is used together with the FSO-21 safety functions module.

The FSE-31 module supplies data (speed, direction, and position) from the safety encoder to:

- the functional safety system through the FSO-21 safety functions module, and
- the ACS880 or DCS880 drive for motor control.

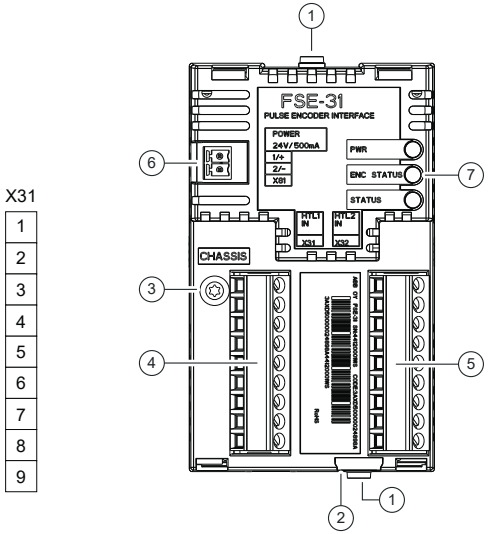
The FSE-31 module also monitors the operation of the encoder and indicates faults to the FSO-21 module.

The FSE-31 module supports one HTL safety encoder. The module has two built-in encoder interface connectors, X31 and X32. Only X31 can be used. Interface X32 is reserved for future use and must be left unconnected.

The FSE-31 module needs an external 24 V DC power supply which must be connected to connector X81. For the safety encoder, the module provides a 15 V DC power supply through connector X31. The safety encoder must be powered from this interface only.

Only one FSE-31 module can be installed to a drive/inverter unit.

Layout



1	Retaining clips
2	Lock
3	Mounting/grounding screw
4	Encoder interface connector X31
5	Encoder interface connector X32 (reserved for future use)
6	External power supply X81
7	Diagnostic LEDs

Type designation label

The type designation label is attached on the top of the FSE module. An example label and description of the label contents are shown below.

1	Type
2	Serial number of format RYWWSSSSWS, where R: component revision: A, B, … Y: Last digit of the manufacturing year: 4, 5, … for 2014, 2015 WW: Manufacturing week: 01, 02, … for week 1, week 2, … SSSS: Integer starting every week from 0001 WS: Manufacturing location
3	ABB MRP code of the FSE module
4	Combined ABB MRP code, component revision, serial number and manufacturing location
5	RoHS mark

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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:
   - FSE-31 module
   - 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, commissioning or maintenance work.

If you install the FSE-31 module onto an UCU-22, UCU-23, or UCU-24 control unit, you must use a USCA-02 slot adapter. For the installation instructions of the slot adapter, refer to UCU-22, UCU-23 and UCU-24 control units hardware manual (3AXD50000817726 [English]).

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

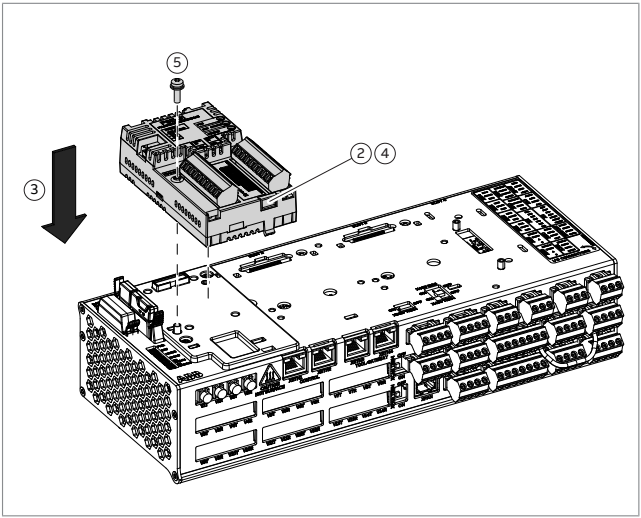
1. Stop the drive and do the steps in section Electrical safety precautions (page 12) before you start the work.
2. Pull out the lock.
3. Put the module carefully into its position on the control unit until the retaining clips lock it into position.
4. Push in the lock.
5. Torque the screw to 0.8 N·m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

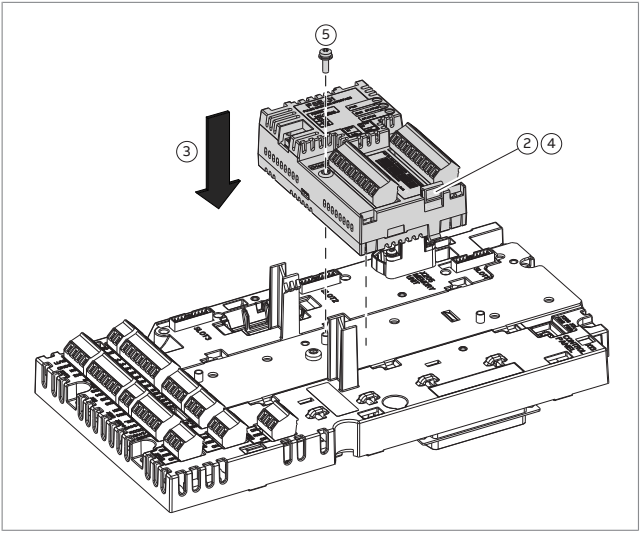
WARNING!
Do not tighten the screw too much. If you tighten it too much, you can cause damage to the threads.

For more information, refer to the drive hardware manual.

The figure that follows shows the installation of the FSE-31 module onto a UCU-22 control unit.



The figure that follows shows the installation of the FSE-31 module onto a ZCU-12 control unit.



WARNING!
Do not install the FSE-31 module on an FEA-03 F-series extension adapter. The diagnostics of the module requires that you install it directly on the control unit.

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Electrical installation

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, commissioning or maintenance work.

Necessary tools and instructions

- Slot-head screwdriver, 0.5 × 3.0 mm for encoder connectors
- Slot-head screwdriver, 0.4 × 2.0 mm for power connector
- Cabling tools.

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

Terminal designations

Pin allocation of the encoder interface connector 1 (X31)

X31	HTL		
No.	**Name**	**Specification**	**Description**
1	VCC_ENC_1	15 V DC	Encoder channel 1 power supply output
2	COM_ENC_1	0 V	Encoder channel 1 supply/signal common (ground)
3	A+_1	0…15 V DC	Encoder channel 1 signal A+ input
4	A-_1	0…15 V DC	Encoder channel 1 signal A- input
5	B+_1	0…15 V DC	Encoder channel 1 signal B+ input
6	B-_1	0…15 V DC	Encoder channel 1 signal B- input
7	Z+_1	0…15 V DC	Encoder channel 1 signal Z+ input
8	Z-_1	0…15 V DC	Encoder channel 1 signal Z- input
9	SHIELD_1	N/A	Encoder channel 1 cable shield

Pin allocation of the power supply connector (X81)

X81	Description
1/+	Supply voltage
2/-	Supply ground

Wiring

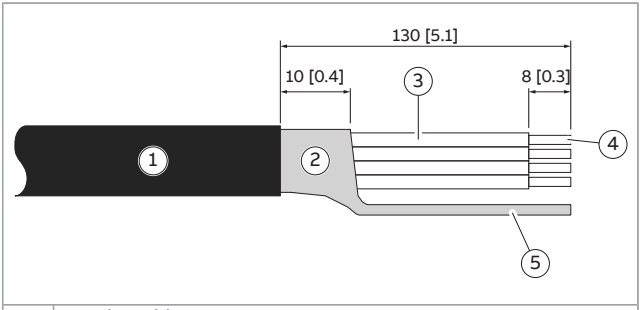
General guidelines

- For planning the FSE-31 wiring, refer to chapter **Planning for installation** in FSO-21 safety functions module user's manual (3AXD50000015614 [English]).
- Route the encoder cables separately from power cables (drive, motor, etc).
- Do not install more than one FSE-31 module to a drive or inverter unit.
- Use the same power supply for the FSE-31 module and the FSO-21 module. If there is no power, or if the power is not sufficient, FSE-31 remains in Safe state. If this occurs when FSO is in running mode, FSO will go into fail-safe mode.
- The safety encoder must be attached to the motor shaft according to the instructions of the encoder manufacturer. FSE-31 does not detect mechanical failures outside of the encoder (for example, motor shaft slipping).

WARNING!
Use only connector X31 of the FSE-31 module to supply power to the encoder. If you supply power to the encoder from a different source, you can cause damage to the module.

Stripping the encoder cable

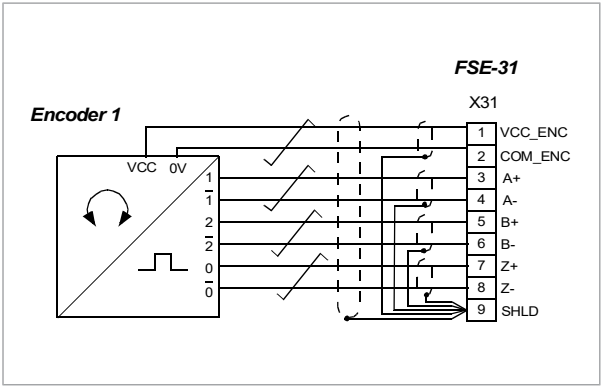
Strip the cable as shown in the figure below. The dimensions are in millimeters. Inches are shown in brackets.



1	Encoder cable
2	Encoder cable shield
3	Conductor
4	Stripped conductor
5	Cable shields twisted together

Installation procedure

1. Stop the drive and do the steps in section Electrical safety precautions (page 12) before you start the work.
2. Connect the power supply cables to terminal X81.
3. Connect the safety encoder to terminal X31 as shown in the diagram.



Note: This diagram is applicable to all revisions of FSE-31, but the voltage for VCC is:

- 24 V DC in revisions A…E
- 15 V DC in revisions F and later.

For the revision of the module, see the type designation label. Refer to section Type designation label (page 24).

4. Make sure that the electrical installation is completed. Refer to chapter **Installation checklists** in FSO-21 safety functions module user's manual (3AXD50000015614 [English]).

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Commissioning

Contents of this chapter

This chapter gives instructions for taking the safety subsystem into use.

Before you start

Make sure that the installation of the drive, the FSO-21 module, and the FSE-31 module is completed.

Required tools

Drive Composer pro PC tool, version 1.8 or later.

Setting the parameters

To take the FSE-31 module into use, set the related safety parameters of the FSO-21 module with the Drive Composer pro PC tool. Make sure that the parameter settings agree with the safety encoder used.

Validation of the safety system

Refer to chapter **Verification and validation** in FSO-21 safety functions module user's manual (3AXD50000015614 [English]).

Commissioning test for FSE-31

1. Make sure that only one safety encoder is connected to the FSE-31 module and that it is connected to connector X31.
2. Make sure that only one FSE-31 module is connected to the drive or inverter unit.
3. Make sure that the installed encoder type, pulse count, and safety rating agree with the system design specification.
4. Make sure that the installed encoder is correct for the application and that the encoder is compatible with the FSE-31 module. Refer to section Supported safety encoders (page 46).
5. Make sure that the encoder is installed according to the instructions of the safety encoder manufacturer and according to the wiring instructions in this manual.
6. For the encoder interface configuration and validation instructions, refer to FSO-21 safety functions module user's manual (3AXD50000015614 [English]).

7

Fault tracing

Contents of this chapter

This chapter shows how to trace faults with the status LEDs on the module.

Reporting problems and failures related to safety functions

Contact ABB.

Faults and warning messages

The FSE-31 module power input (X81) is protected against overvoltage, undervoltage and overcurrent, and it has reverse polarity protection. The FSE-31 module enters fail-safe mode if any of these protections trip. The module enters fail-safe mode also if output voltages of the internal power supply are outside the specified limits due to power input overvoltage.

The FSE-31 module detects short-circuits between the signal channels in the encoder cable.

For the fault and warning messages concerning the FSE-31 module and the safety encoder, see the drive firmware manual and FSO-21 safety functions module user's manual (3AXD50000015614 [English]).

LEDs

The FSE-31 module has three diagnostic LEDs.

Name	Color	Description
PWR	Green	The module is energized.
ENC STATUS	Green	The encoder is in normal operation.
	Off	An encoder fault is active.
STATUS	Green	The module is in normal operation.
	Green flashing	The module is initializing.
	Off	A module fault is active.

Safety encoder fault reaction

The FSE-31 module indicates the internal faults of the safety encoder as cabling faults.

If an internal safety encoder failure occurs, the safety encoder goes into Safe state. To recover from these situations, you must reboot the FSE-31 module by switching the power off and on.

The fault reaction depends on the FSO-21 module parameter settings. For more information, see FSO-21 safety functions module user's manual (3AXD50000015614 [English]).

FSE-31 module replacement

If there is a failure in the FSE-31 module, you must replace it with a new one. Do not try to repair the module.

For instructions about replacing the FSE-31 module, see FSO-21 safety functions module user's manual (3AXD50000015614 [English]).

8

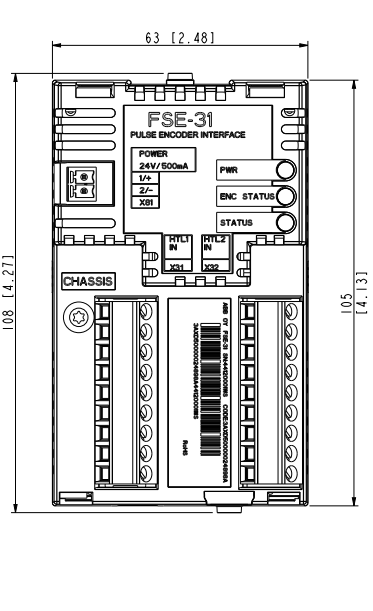
Technical data

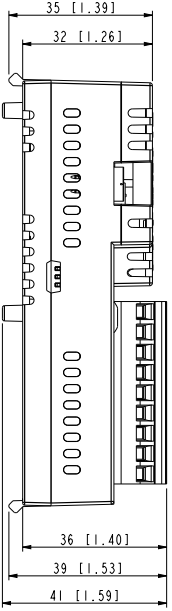
Contents of this chapter

This chapter contains the technical data of the module.

Dimension drawing

The dimensions are in millimeters. Inches are shown in brackets.





Ambient conditions

	Operation, installed for stationary use	Storage, in the protective package	Transportation, in the protective package
Altitude	At 0…1000 m (0…3281 ft) above sea level, no derating is necessary At 1000…2000 m (3281…6562 ft) above sea level, the air temperature outside the module is derated to -15…+49 °C (+5…+120 °F) At 2000…4000 m (6562…13124 ft) above sea level, the air temperature outside the module is derated to -15…+40 °C (+5…+104 °F)	-	-
Air temperature	-15…+65 °C (+5…+149 °F)	-40…+65 °C (-40…+149 °F)	-40…+65 °C (-40…+149 °F)
Relative humidity	5…95%. No condensation permitted. If corrosive gases are present, the maximum permitted humidity is 60%.		

	Operation, installed for stationary use	Storage, in the protective package	Transportation, in the protective package
Contamination	IEC 60721-3-3:2002 **Chemical gases:** Class 3C2 **Solid particles:** Class 3S2	IEC 60721-3-1:1997 **Chemical gases:** Class 1C2 **Solid particles:** Class 1S3	IEC 60721-3-2:1997 **Chemical gases:** Class 2C2 **Solid particles:** Class 2S2
	No contaminants, conductive dust or corrosive dust permitted. In an environment where conductive dust or corrosive dust exists, use an enclosure with a rating of IP54 or higher.		
Vibration IEC 60068-2-6, Test Fc (2007-12)	Frequency range: 2…9 Hz: Constant deflection = 7 mm 9…200 Hz: Constant acceleration = 20 m/s^2		
Shock IEC 60068-2-27, Test Ea (2008-02)	Peak acceleration 50 m/s^2. Pulse duration 30 ms, 3 pulses in each direction with STO and SS1 functions activated.		
Atmospheric pressure	70 … 106 kPa (0.7 … 1.05 atmospheres)		

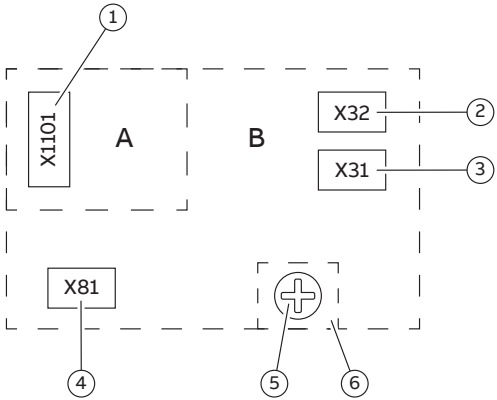
Degree of protection

IP20

Isolation areas

The figure below shows the different isolation areas of the module.

The shield pins of connectors X31 and X32 are connected to chassis. The mounting screw connects the chassis to ground.



1	Connection to the drive
2	Encoder interface 2 (not in use)
3	Encoder interface 1
4	Power supply
5	Mounting screw
6	Chassis

Encoder interface connector 1 (X31)

Connector pitch: 5.0 mm, wire size: max. 2.5 mm^2 (14 AWG)

Power supply (X81)

- Connector pitch: 3.5 mm, wire size: max. 1.5 mm^2 (16 AWG)
- 24 V DC (tolerance ±20%)
- Maximum current consumption: 500 mA

- PELV-type power supply

Supported safety encoders

- Differential push-pull HTL encoders
- Supply voltage: 15 V DC
- Only safety-certified encoders are supported.

The safety encoder must indicate its internal faults either by

- setting its outputs to the hi-Z state (“floating” the outputs) or
- setting its complement outputs to identical states.

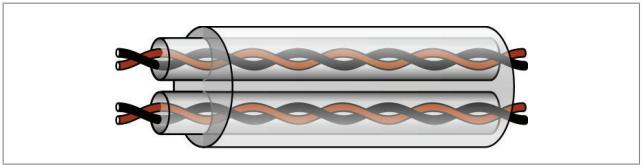
Note: The FSE-31 module does not support the use of a separate error indication signal from the safety encoder.

The HTL encoder input can detect signal frequencies up to 300 kHz.

The installation and use must comply with the safety encoder manufacturer’s instructions related to, for example, installation, maximum cable lengths, etc.

Supported encoder cables

Always use a double-shielded cable for the pulse encoder signals.



Example of supported encoder cable:

- Double-shielded twisted-pair cable (Draka JAMAK 4×(2+1)×0.5 mm^2 or equivalent)

The maximum cable length depends on the encoder type, cable type, and cable termination. For more information, see the encoder manufacturer's data.

Safety performance

When the FSE-31 module and a safety encoder are used in a safety function with a SIL/PL requirement, the safety encoder must be SIL/PL classified. The user must make sure that the SIL/PL capability of the safety encoder and the complete safety function meets the required SIL/PL. This includes the possible application of, for example, a signal splitter.

Examples of the SIL/PL capability of the safe speed measurement:

Safety performance with an HTL encoder classified to SIL 3, PL e and the FSE-31 and FSO-21 modules:

- SIL 3, PL e

Safety performance with an HTL encoder classified to SIL 2, PL d and the FSE-31 and FSO-21 modules:

- SIL 2, PL d

Safety data

The safety data of the FSE-31 module is given in FSO-21 safety functions module user's manual (3AXD50000015614 [English]).

Related standards

The FSE-31 and FSO-21 module combination complies with:

Standard	Name
IEC 61508 ed. 2.0: 2010	Functional safety of electrical/electronic/programmable electronic safety-related systems
IEC 61800-5-2:2016 EN 61800-5-2:2007	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional
IEC 62061:2021 + AMD1:2024 EN IEC 62061:2021	Safety of machinery – Functional safety of safety-related control systems
EN ISO 13849-1:2023	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design
EN ISO 13849-2:2012	Safety of machinery – Safety-related parts of control systems – Part 2: Validation

All components are RoHS compliant.

Further information

Product and service inquiries

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

Product training

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

Providing feedback on ABB manuals

Your comments on our manuals are welcome. Navigate to forms.abb.com/form-26567.

Document library on the Internet

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

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