

OPTIONS FOR ABB DRIVES

# FSE-31 pulse encoder interface module

## User's manual



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## List of related manuals

### Drive hardware manuals and guides

ACS880-01 hardware manual	<a href="#">3AUA0000078093</a>
ACS880-04 hardware manual	<a href="#">3AUA0000128301</a>
ACS880-04 single drive module packages hardware manual	<a href="#">3AUA0000138495</a>
ACS880-14 and -34 single drive module packages hardware manual	<a href="#">3AXD50000022021</a>
ACS880-04XT drive modules (500 to 1200 kW) hardware manual	<a href="#">3AXD50000025169</a>
ACS880-07 (45 to 630 kW) hardware manual	<a href="#">3AUA0000105718</a>
ACS880-07 (560 to 2800 kW) hardware manual	<a href="#">3AUA0000143261</a>
ACS880-17 (160 to 3200 kW) hardware manual	<a href="#">3AXD50000020436</a>
ACS880-37 (160 to 3200 kW) hardware manual	<a href="#">3AXD50000020437</a>
ACS880-17 (132 to 355 kW) hardware manual	<a href="#">3AXD50000035158</a>
ACS880-37 (132 to 355 kW) hardware manual	<a href="#">3AXD50000035159</a>
ACS880-104 hardware manual	<a href="#">3AUA0000104271</a>
ACS880-107 hardware manual	<a href="#">3AUA0000102519</a>

### Drive firmware manuals and guides

ACS880 primary control program firmware manual	<a href="#">3AUA0000102519</a>
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### Option manuals and guides

ACX-AP-x assistant control panels user's manual	<a href="#">3AUA0000085685</a>
FSE-31 pulse encoder interface module user's manual	<a href="#">3AXD50000016597</a>
FSO-21 safety functions module user's manual	<a href="#">3AXD50000015614</a>

### Drive PC tool manuals

Drive composer start-up and maintenance PC tool user's manual	<a href="#">3AUA0000094606</a>
Functional safety design tool user's manual	<a href="#">3AXD10000102417</a>

### General safety guides

Functional safety; Technical guide No. 10	<a href="#">3AUA0000048753</a>
Safety and functional safety; A general guide	<a href="#">1SFC001008B0201</a>
ABB Safety information and solutions	<a href="http://www.abb.com/safety">www.abb.com/safety</a>

You can find manuals and other product documents in PDF format on the Internet. See section Document library on the Internet on the inside of the back cover. For manuals not available in the Document library, contact your local ABB representative.

# User's manual

## FSE-31 pulse encoder interface module

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### **Further information**



## 1

# Safety instructions

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## 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* draw attention to a particular condition or fact, or give information on a subject.

The manual uses these warning symbols:



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

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

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## Electrical safety precautions

These instructions are for all who install or connect an option module to a drive and need to open its front cover or door to do the work.

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**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.

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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.
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5. Measure that the installation is de-energized.
  - Use a multimeter with an impedance greater than 1 Mohm.
  - Make sure that the voltage between the drive input power terminals (L1, L2, L3) and the grounding (PE) busbar is close to 0 V.
  - Make sure that the voltage between the drive output terminals (T1/U, T2/V, T3/W) and the grounding (PE) busbar is close to 0 V.
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.



## 10 Safety instructions



# 2

## Introduction to the manual

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### Contents of this chapter

This chapter introduces this manual.

### Applicability

This manual applies 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 version 2.21 or later  
It is recommended to always use the latest drive firmware.
- FSO-21 safety functions module, revision B or later
- Drive composer pro PC tool, version 1.8 or later.

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

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module, read this manual and the applicable drive manual that contains the information for the product in question.

You are expected to know the fundamentals of functional safety, electricity, wiring, electrical components and electrical schematic symbols. The manual is written for readers worldwide. Both SI and imperial units are shown.

## General safety system considerations

The FSE-31 module is part of a functional safety system. Any 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, see *FSO-21 safety functions module user's manual* (3AXD50000015614 [English]).



**WARNING!** User safety must be ensured by other means in all of the stages of the product's lifecycle when the safety option may not provide protection, especially during commissioning, system maintenance, fault tracing, and decommissioning.

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## Contents

The manual consists of these chapters:

- *Safety instructions* contains the electrical safety instructions which you must obey when you install the module.
  - *Hardware description* gives a short description of the module.
  - *Mechanical installation* contains a delivery checklist and instructions on installing the module.
  - *Electrical installation* contains instructions on wiring the module.
  - *Commissioning* contains instructions on taking the module into use as a part of a functional safety system.
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- **Diagnosics** shows how to trace faults with the status LED on the module.
- **Technical data** contains the technical data of the module.

## Terms and abbreviations

Term/abbreviation	Description
Fail-safe mode	The FSO module has activated the drive STO function as a result of an error. To exit this mode and continue normal operation, repair the possible fault and reboot the FSO module.
FEA-03	F-series extension adapter module
FSO-21	Safety functions adapter module which supports a safety encoder
hi-Z state	A digital signal is neither driven to a logical high nor low level. It is "floating".
HTF	Hardware fault tolerance. (EN/IEC 62061)
HTL	High-threshold logic
Safety system	Whole functional safety system including, for example, human-machine interface (HMI), safety encoder, FSE-31 module, FSO module, drive and sensors.
SIL	Safety integrity level (levels are: 1, 2, 3, and 4). Corresponds to PL. (EN 62061)
SILCL	Maximum SIL that can be claimed for a safety function or subsystem. (EN/IEC 62061)
STO	Safe torque off
PL	Performance level (levels are: a, b, c, d and e). Corresponds to SIL. (EN ISO 13849-1)

## 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 all relevant standards, directives and local electrical code, and that the system is tested, verified and validated correctly.

## 3

# Hardware description

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## Contents of this chapter

This chapter gives a short description of the module.

## Product overview

The FSE-31 safety pulse encoder interface module delivers speed, direction and position data from the safety encoder to:

- the functional safety system via the FSO-21 safety functions module, and
- to the ACS880 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.

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

- The need for a safety encoder. ABB recommends to 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, eg, process safety time
- the required encoder resolution

The operation environment of the FSE-31 module must comply with the specified conditions. See *FSO-21 safety functions module user's manual* (3AXD50000015614 [English]).

If the FSE-31 module fails to operate, replace it with a new one. Do not try to repair the module.

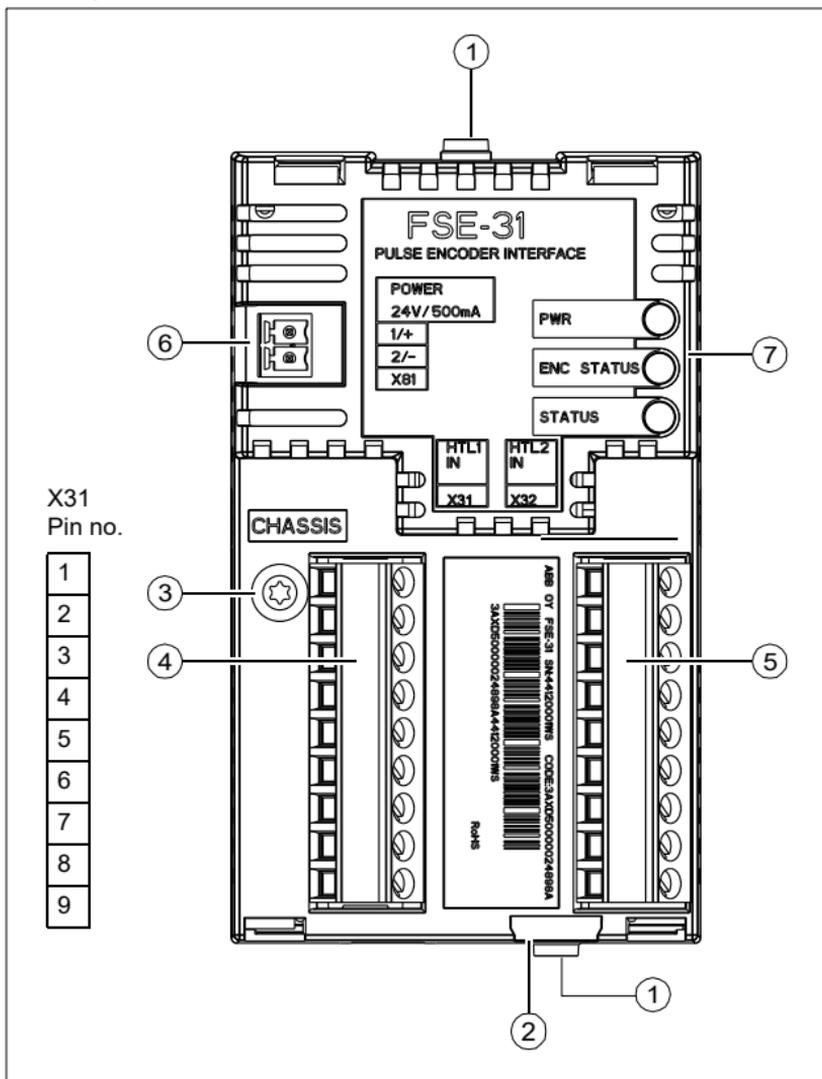
For instructions on decommissioning the module, see *FSO-21 safety functions module user's manual* (3AXD50000015614 [English]).



**WARNING!** Do not bypass the FSE-31 pulse encoder interface module or FSO safety functions module under any circumstances.

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## Layout





## 4

# Mechanical installation

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## 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 pulse encoder interface module
    - this manual (not included if the module is installed into the drive at the factory).
  3. Make sure that there are no signs of damage.
-

## Installing the module

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**WARNING!** Obey the safety instructions. See chapter [Safety instructions](#). If you ignore the safety instructions, injury or death can occur.

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Install the FSE-31 module onto an option module slot of the drive control unit. Do not install the FSE-31 module onto an FEA-03 F-series extension adapter.

1. Stop the drive and do the steps in section [Electrical safety precautions](#) on page 8 before you start the work.
2. Pull out the lock.
3. Put the module carefully into its position on the drive until the retaining clips lock it into position.
4. Push in the lock.
5. Tighten the mounting screw. The maximum tightening torque is 0.8 N·m (7.1 lbf·in).

**Note:** The mounting screw tightens the connections and grounds the module. It is necessary for fulfilling the EMC requirements and for proper operation of the module.

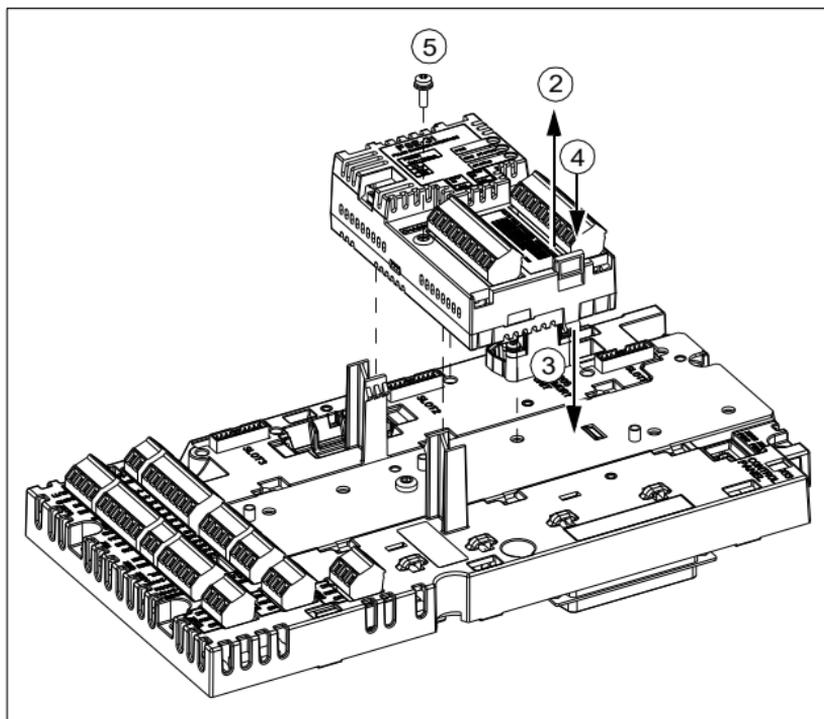


**WARNING!** Tightening the screw too much can cause damage to the threads.

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See the applicable drive manual for further instructions on how to install the module to the drive.

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## 5

# Electrical installation

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## Contents of this chapter

This chapter contains instructions on wiring the module.

## Warnings

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**WARNING!** Obey the safety instructions. See chapter [Safety instructions](#). If you ignore the safety instructions, injury or death can occur. If you are not a qualified electrical professional, do not do electrical 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.

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## 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

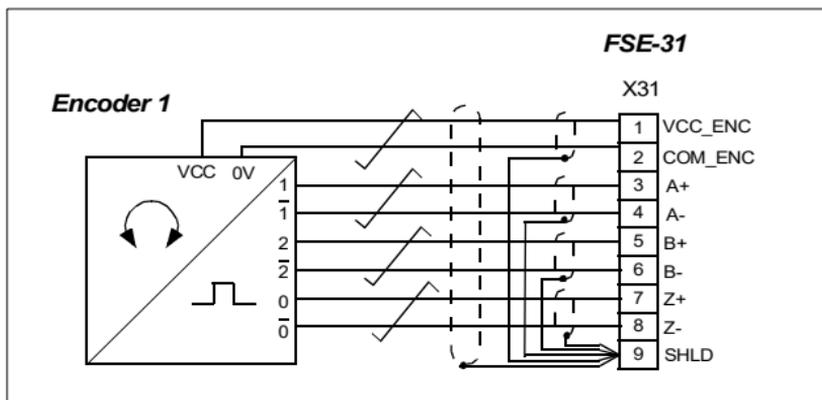
### ■ General guidelines

- For planning the FSE-31 wiring, see chapter *Planning for installation* in the *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.
- 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).
- 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.



## ■ Installation procedure

1. Stop the drive and do the steps in section [Electrical safety precautions](#) on page 8 before you start the work.
2. Connect the power supply cables to the X81 terminal.
3. Connect the safety encoder to the X31 terminal as follows:



**Note:** This diagram is applicable to all revisions of FSE-31. However, VCC is 15 V DC for revision F and later, and 24 V DC for the module revisions A to E. You can see the revision of the module on the type designation label. Refer to [Type designation label](#) on page 18.

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



**WARNING!** Use only the X31 connector of the FSE-31 module to supply power to the encoder. Do not use other power supplies, because they can cause damage to the module.

## 6

# Commissioning

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## Contents of this chapter

This chapter refers to instructions for taking the safety subsystem into use.

### Before you start

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

### Required tools

Drive composer pro PC tool, version 1.8 or later.

### Setting the parameters

The FSE-31 module is taken into use by setting the relevant safety parameters of the FSO module using the Drive composer pro PC tool.

### Validation of the safety system

See the validation instructions 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.
3. Make sure that the installed encoder type, pulse count, and safety rating match the system design specification.
4. Make sure that the installed encoder is suitable for the application and that the encoder is compatible with the FSE module. See section [Supported safety encoders](#) on page 34.
5. Make sure that the encoder is installed according to the instructions of the safety encoder manufacturer and according to the wiring instructions of this manual.
6. For the encoder interface configuration and validation instructions, see *FSO-21 safety functions module user's manual* (3AXD50000015614 [English]).



## 7

# Diagnostics

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## Contents of this chapter

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

## 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]).

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## LEDs

The FSE-31 module has three diagnostic LEDs.

Name	Color	Description
PWR	Green	The module is powered up.
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.

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

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

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# Technical data

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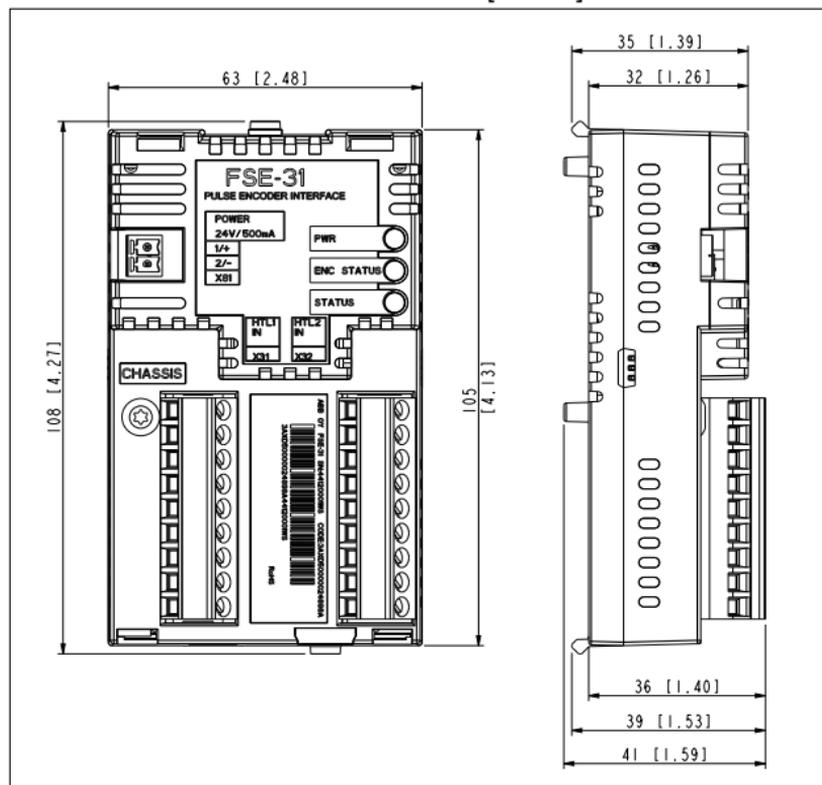
## Contents of this chapter

This chapter contains the technical data of the module.

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## Dimension drawing

The dimensions are in millimeters and [inches].



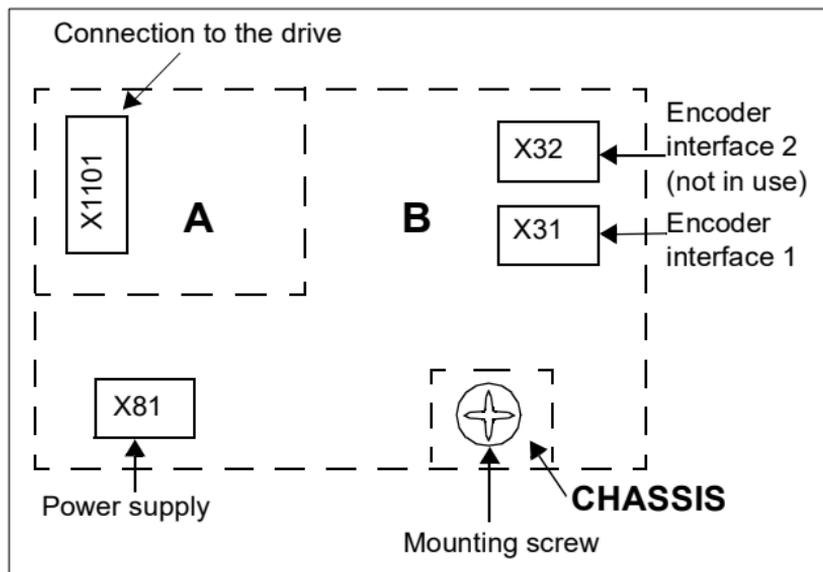
## General data

- Degree of protection: IP20
- Ambient conditions: Same as FSO-21. See *FSO-21 safety functions module user's manual* (3AXD50000015614 [English]).

## Isolation areas

The following figure describes 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.



### Encoder interface connector 1 (X31)

Connector pitch: 5.0 mm, wire size: max. 2.5 mm<sup>2</sup> (14 AWG)

### Power supply (X81)

- Connector pitch: 3.5 mm, wire size: max. 1.5 mm<sup>2</sup> (16 AWG)
- 24 V DC (tolerance  $\pm 20\%$ )
- Maximum current consumption: 500 mA
- SELV- or 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 installation and use must comply with the safety encoder manufacturer’s instructions related to, for example, installation, maximum cable lengths, etc.

## Supported encoder cables

- Double-shielded twisted-pair cable (Draka JAMAK 4×(2+1)×0.5 mm<sup>2</sup> 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, SILCL 3, PL e and the FSE-31 and FSO-21 modules:

- SIL 3, SILCL 3, PL e
-

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

- SIL 2, SILCL 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:

- IEC 61508 ed. 2.0: 2010
- IEC 62061:2015 Ed. 1.2
- EN 62061:2005 + AC:2010 + A1:2013 + A2:2015
- IEC 61800-5-2:2016
- EN 61800-5-2:2007
- EN ISO 13849-1:2015 Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design.
- EN ISO 13849-2:2012 Safety of machinery – Safety-related parts of control systems – Part 2: Validation

All components are RoHS compliant.

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

### Product training

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

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