

Safety encoder module XS-322-2INC



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Original Operating Instructions

is the German-language edition of this document

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Subject to alteration.



DANGER!

Hazardous electrical voltage!

Before starting with the installation

- Installation requires qualified electrician
 - Disconnect the power supply of the device.
 - Secure against retriggering
 - Verify isolation from the supply
 - Ground and short-circuit
 - Cover or enclose any neighboring live parts.
 - Follow the engineering instructions (IL) of the device concerned.
 - Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 part 100) may work on this device/system.
 - Before installation and before touching the device ensure that you are free of electrostatic charge.
 - The functional earth (FE) must be connected to the protective earth (PE) or to the equipotential bonding. The system installer is responsible for implementing this connection.
 - Connecting cables and signal lines should be installed so that inductive or capacitive interference does not impair the automation functions.
 - Install automation devices and related operating elements in such a way that they are well protected against unintentional operation.
 - Suitable safety hardware and software measures should be implemented for the I/O interface so that a line or wire breakage on the signal side does not result in undefined states in the automation devices.
 - Deviations of the mains voltage from the nominal value must not exceed the tolerance limits given in the specifications, otherwise this may result in malfunction and hazardous states.
 - Emergency-Stop devices complying with IEC/EN 60204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency switching off devices must not result in an automatic restart.
 - Built-in devices for enclosures or cabinets must only be run and operated in an installed state;
- desktop devices and portable devices only when the housing is closed.
- Measures should be taken to ensure the proper restarting of programs interrupted after a voltage dip or outage. This should not result in dangerous operating states even for a short time. If necessary, emergency switching off devices should be implemented.
 - Wherever faults in the automation system may cause damage to persons or property, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (for example, by means of separate limit switches, mechanical interlocks, etc.).

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0.1 About this manual

This operating manual contains all the information you will need in order to use the XN Safety modular safety PLC safely and correctly.

This Manual is considered an integral part of the XN Safety module and must always be readily available in the device's close proximity so that users have access to it. The XN Safety Designer programming software program is an integrated part of the XN Safety modular safety PLC system. This software is used to program the corresponding Safety projects.

This hardware manual describes all of Safety encoder modules lifecycle stages: transportation, installation, commissioning, operation, maintenance, storage, and disposal.

It assumes you have electrical engineering knowledge and skills.

Make sure to always use the latest documentation for your device.



Manual Safety encoder module

MN050024EN

The latest version of this documentation, as well as additional references, is available for download on the Internet.



Eaton.com/documentation

Please send any comments, recommendations, or suggestions regarding this document to: DocumentationEGBonn@eaton.com

0.1.1 List of revisions

The following significant amendments have been introduced since previous issues:

Publication date	Page(s)	Keyword	New	Modification	Deleted
2025-01-31	ff	Issue for certification	✓		
2025-06-01	ff	Product launch edition	✓		

0.1 About this manual

0.1.2 Target group

This operating manual contains all the information you will need in order to operate the Safety modules.

This operating manual is intended for electricians and electrical engineers, as well as for the people who will be in charge of performing the electrical installation and people who will be using the Safety encoder module:

- Project planners, automation technicians, and automation engineers
- Installers, commissioning technicians
- Machine operators
- Maintenance personnel / testing technicians

This manual assumes that the reader has extensive knowledge of automation and the specifics behind it.

For additional help, information, and compatible accessories, please visit our website: Eaton.com.

If you have any questions, our Support Team will of course be happy to assist you. For our emergency phone number and office hours, please visit our website.



CAUTION

Installation requires qualified electrician

XN Safety module must be installed and connected exclusively by electricians and people who are familiar with electrical installation work.



Follow the safety instructions for the XN Safety module!

The section on safety instructions must be read and understood by everyone who will be working with the Safety encoder module before the actual work is performed Safety modules.

0.1.3 Legal disclaimer

All the information in this manual has been prepared to the best of our knowledge and in conformity with the state of the art. However, this does not exclude the possibility of there being errors or inaccuracies. Accordingly, this manual is subject to change without notice, with potential changes including technical changes intended to improve devices.

We hereby disclaim any and all liability for the correctness and completeness of this information. Please note that this operating manual purely provides a product description. In particular, the information in it does not guarantee any specific properties in terms of warranty laws and similar regulations.

The machine manufacturer will be responsible for proper installation and product configuration. Meanwhile, the machine operator will be responsible for the product's safe use and proper operation.

Do not use the XN Safety before reading and understanding this manual.

It is assumed that the user of this manual is thoroughly familiar with the information found in the manuals for incorporating the safety controller into automation processes.

Hazards posed by the safety PLC cannot be ruled out if the safety instructions are not observed – especially if the safety PLC is installed and commissioned by inadequately qualified personnel or if it is used improperly. Eaton hereby disclaims any and all liability for damages arising from failure to observe these instructions or comply with all applicable standards and regulations.

The use of sample programs and of the program part screenshots used in the documentation are subject to the following safety instructions and operating guidelines:

1. The program examples provided were created to the best of our knowledge and belief and in accordance with the current state-of-the-art. The program examples provided were created to the best of our knowledge and belief and in accordance with the current state-of-the-art. However, errors cannot be totally excluded, and the example programs do not cover all function blocks and applications that are available for the safety controller.
2. Electrical engineering skills and know-how are required in order to be able to program and commission the safety controller. An incorrectly wired or incorrectly configured safety controller will pose a property damage risk and an injury hazard when active components such as motors and pressure cylinders are being driven.
3. When using the provided sample programs and generating a program with XN Safety Designer Configuration tool, the user has the sole responsibility to observe the following:
 - All relevant rules and practices for preparing circuit diagrams for the safety controller as specified in the latest documents for these XN Safety.

0.1 About this manual

- All occupational health and safety and accident prevention directives, standards, and regulations applicable to the commissioning, circuit diagram creation for, and use of the safety controller for your planned application, in particular those imposed by employers' liability insurance associations (Berufsgenossenschaften).
 - Acknowledged rule of technology and state of science.
 - All other general due diligence regarding the prevention of damages to life and physical condition of persons as well as material damage.
4. The manufacturer cannot accept any liability for any damages that are caused by customers not using the program examples provided in accordance with the conditions of use specified here under points 1 to 3.



The latest version of this manual can be found on our Download Center by using the following search term: MN050024.



Eaton.com/documentation

0.1.4 Short designations

The following general terms are used throughout this manual:

Short designation	Explanation
XN Safety	Entire series, used to refer to all the modules in the product family
Safety CPU	XN Safety CPU module
XN Safety module	Safety encoder module XS-322-2INC
XN Safety designer	XN Safety Designer Configuration tool



For the exact designation for your Safety encoder module, please refer to the inscription on the XS-322-2INC.

0.1.5 Writing conventions

0.1.5.1 Warning labels

Risk of personal injury warning.



DANGER

"Danger" means that death or serious injury will occur if the specified measures are not taken.

- Follow all instructions in order to prevent death and serious injury.

WARNING



"Warning" means that death or serious injury may occur if the specified measures are not taken.

- Follow all instructions in order to prevent death and serious injury.



CAUTION

"Caution" means that moderate or minor injury may occur if the specified measures are not taken.

- Follow all instructions in order to prevent moderate to minor injury.

Property damage warning



ATTENTION

Warns about the possibility of material damage.

Prohibited use



Prohibited uses, actions, etc.

Prohibition signs interdict actions or the use of certain objects

Requirements



Requirement

Mandatory signs require a certain behavior

Notes



Additional information, information worth knowing, useful additional information

Provides important information regarding the product, handling, use, or relevant parts of the documentation that require special attention.



► Indicates instructions to be followed

0.1 About this manual

0.1.5.2 Additional information for use

Documents (such as manuals) are listed after the  icon together with the corresponding name and Eaton number.



Publication title

For identifying the Eaton publication code

Links to external Internet addresses are shown after the  symbol.



Destination address without http(s)://www.

Links to external content are shown in [blue](#).

1. Description Safety encoder module XS-322-2INC

The Safety encoder module XS-322-2INC makes the values of two incremental encoders available to the safe CPU (XN Safety CPU module).

The dual-channel safety function is realized by "eavesdropping" on the increments on the incremental encoder interfaces and processing in two microcontrollers, the so-called "safety core", with cross-communication.

The incremental encoder function is ensured by a dual-channel evaluation of the encoder signals with dual-channel error detection of each data line and by the measurements of the encoder supply voltages and -currents.

Safe monitoring of speed, position, direction, and acceleration is performed in the safe application in the XN Safety CPU module.

The module detects various types of faults such as cable breakage, cross circuit and swapping of input signals.



XS-322-2INC

Fullfill the safety functions of the module

- **for dual-channel use**

the requirements of SIL 3, HFT 1 in accordance with EN IEC 62061 and PL e / Cat. 4 in accordance with EN ISO 13849.

as well as

- **for single-channel use**

the requirements of SIL 3, HFT 1 in accordance with EN IEC 62061 and PL d, Cat. 2 in accordance with EN ISO 13849.

Equipment supplied

1x XS-322-2INC

One (2) PLUG-FMC-8S (1.5/8-ST-3.5) plug connector

One (1) PLUG-FMC-4S (1.5/4-ST-3.5) plug connector

2. Basic safety instructions

2.1 General safety instructions

2. Basic safety instructions

2.1 General safety instructions

Follow the safety instructions in all of this manual's sections without fail. These instructions will be highlighted visually with appropriate symbols.

Pursuant to EU Directives, this operating manual is an integral part of a product. Accordingly, make sure to always keep this manual in the machine's vicinity, as it contains important instructions.

If you sell, transfer, or rent out the product, make sure to pass this documentation on and point out that it is available online.

In regard to all occupational health and safety requirements associated with the machine's use, the manufacturer must conduct a risk assessment in accordance with Machinery Directive 2006/42/EC before a machine is placed on the market.

Operate the XN Safety module product exclusively with devices and accessories approved by Eaton for this purpose.

CAUTION



Handle the XN Safety module carefully and do not drop it.

Do not, under any circumstance, let any foreign objects or liquids get into the module.

Do not open the XN Safety module!

If the XN Safety module is not working as intended or if it sustains any damage that could result in a hazard being posed, replace it without fail!

The XN Safety module conforms to EN 61131-2.

When used in combination with a system, the system integrator must meet the requirements in standard EN 60204-1.

Make sure to observe all environmental conditions for your own safety and the safety of others.

2.2 Use as intended

The safety functions implemented with the Safety encoder module are intended for use in safety applications within the context of a PLC and meet all necessary requirements for safe operation in conformity with SIL 3 as defined in EN IEC 62061 and PL e / Cat. 4 as defined in EN ISO 13849-1.

CAUTION



Always observe the instructions and information in this operation manual. Properly transporting and storing the device are essential for proper operation.

The device must be installed, mounted, programmed, commissioned, operated, maintained, and removed from service exclusively by trained qualified personnel.

Within this context, "trained qualified personnel" refers to individuals who have received the required vocational training as skilled workers or who have been trained by a skilled worker and accordingly are authorized to operate and take care of safety devices and systems in compliance with all applicable safety (functional safety) guidelines, standards, and Directives.

For your safety and the safety of others, make sure to only use the Safety encoder module as intended.

This intended use also includes installing the device properly in terms of EMC.

Within this context, the following are instances of unintended use:

- Any alterations of any type made to the device, as well as the use of damaged devices.
- Using the device outside of the technical limits and scope described in this operating manual or outside of the specified technical data.

2. Basic safety instructions

2.3 Software

2.3 Software

The XN Safety Designer Configuration tool is used to program the Safety project. The application compiled from this project can then be transferred to the XN Safety CPU module.

For basic information regarding functional safety, please refer to the XN Safety system manual.

3. IT security

XN Safety modules have been developed for integration into networks that are secure against third-party access.

The network being used could be exposed to the following risks, for example:

- Unauthorized access
- Data tampering
- And many other IT security risks

The integrator, or the company operating the device, is responsible for conducting a risk assessment for the connections between XN Safety and the corresponding integration into the general infrastructure. This assessment can result in a variety of measures, including, but not limited to (if necessary):

- IT/OT network segmentation (VLANs or physical)
- Firewalls
- Password-protected user accounts
- Data encryption
- and much more.

When it comes to functional safety, the various functions and their integrity are completely invulnerable to direct manipulation in this regard, since these functions cannot be affected through communication-based interfaces.

However, the availability of the overall system (as is the case with all safety functions) can be negatively affected as a result of third-party attacks, which is why the aforementioned measures are required.

4. Directives and standards
4.1 Residual risks

4. Directives and standards

4.1 Residual risks



CAUTION

The following residual risks for the Safety encoder module must be taken into account in the risk assessment conducted by the system integrator:

- Release of environmentally harmful substances, emissions, and unusual temperatures
- Dangerous touch voltages
- Effects of operational electric, magnetic, and electromagnetic fields
- Possible effects of IT devices

4.2 Machine or system safety



Observe all accident prevention and occupational health and safety standards and regulations that apply at the location of use.

4.3 Directives

The Safety encoder module has been designed in compliance with all applicable European Union Directives and tested for conformity accordingly.

4.3.1 Functional safety standards

EN IEC 62061	Safety of machinery - Functional safety of safety-related control systems
EN ISO 13849-1	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
EN ISO 13849-2	Safety of machinery - Safety-related parts of control systems - Part 2: Validation

4.3.2 EC Declaration of Conformity



EU Declaration of Conformity

The Safety encoder module XS-322-2INC conforms to all applicable European standards for programmable logic controllers and complies with the following European Directives:

- **2006/42/EG** directive 2006/42/EG of the European Parliament and Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (Machinery Safety Directive)
- **2014/30/EU** electromagnetic compatibility (EMC Directive)
- **2011/65/EU** Restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS Directive)

EU Declarations of Conformity are available on the EATON homepage. In addition, this one is included as a resource in the data sheet for the XS-322-2INC.

5. Safety-relevant characteristics

5.1 Horizontal mounting position, ambient temperature of 0–55 °C

5. Safety-relevant characteristics

5.1 Horizontal mounting position, ambient temperature of 0–55 °C

Module	Safety characteristic values	Safety level
XS-322-2INC including XN Safety CPU module XS-102-C00-000	Single-channel use:	
	PFH = 3.90E-09 (1/h) SFF = 99 %	SIL 3 as per EN IEC 62061
	MTTF _D = 704 years DC = 97 %	PL d/Kat. 2 as per EN ISO 13849
	Dual-channel use:	
	PFH = 4.00E-09 (1/h) SFF = 99 %	SIL 3 as per EN IEC 62061
	MTTF _D = 511 years DC = 99 %	PL e/Cat. 4 as per EN ISO 13849



The system integrator must perform separate verification in accordance with EN ISO 13849-1 for the entire system consisting of XS-322-2INC and the encoder. The safety ratings of the encoder must be obtained from the manufacturer. The safety ratings specified refer only to product XS-322-2INC.

5. Safety-relevant characteristics

5.2 Horizontal mounting position, ambient temperature of 55–60 °C

5.2 Horizontal mounting position, ambient temperature of 55–60 °C

Module	Safety characteristic values	Safety level
XS-322-2INC including XN Safety CPU module XS-102-C00-000	Single-channel use:	
	PFH = 5.10E-09 (1/h) SFF = 99 %	SIL 3 as per EN IEC 62061
	MTTF _D = 545 years DC = 97 %	PL d/Cat. 2 as per EN ISO 13849
	Dual-channel use:	
	PFH = 5.10E-09 (1/h) SFF = 99 %	SIL 3 as per EN IEC 62061
	MTTF D = 395 years DC = 99 %	PL e/Cat. 4 as per EN ISO 13849



The system integrator must perform separate verification in accordance with EN ISO 13849-1 for the entire system consisting of XS-322-2INC and the encoder.

The safety ratings of the encoder must be obtained from the manufacturer.

The safety ratings specified refer only to product XS-322-2INC.

Single and dual-channel use

The application for a specific PL, category or SIL requires correct installation.

Please observe any normative requirements of the end application (machine) for the installation and selection of encoders.

The use of the specified parameters requires a risk analysis of the end application to determine whether two incremental encoders are sufficient.

In the case of dual-channel use, the two incremental encoders must be monitored against each other in the application (XS-102-C00-000).

5. Safety-relevant characteristics

5.3 Compatibility

5.3 Compatibility



Compatibility

For more information on the compatibility of the XN Safety modules, please refer to the "Compatibility of XN Safety modules" section in the XN Safety system manual.

6. Nameplate

The nameplate can be found on the Safety encoder module.



7. Technical specifications

7.1 Incremental encoder specification

7. Technical specifications

7.1 Incremental encoder specification

Number of channels	2
Sensor	Incremental encoder with RS422 interface with zero position trace
Input frequency	0.75 MHz
Counter frequency	3 MHz
Signal analysis	4-way
Transfer rate	125 kHz, 250 kHz, 500 kHz, 1 MHz (parameterizable)
Encoder resolution	28 bits
Encoder power supply	+5 V supply short-circuit-proof with monitoring function and current measurement (+5 V is generated from +24 V on X3)
Status LED	Yes
Incremental encoder current consumption	Maximum 300 mA per encoder when the XS-322-2INC is installed in an ambient temperature of up to 50 °C, maximum 200 mA per encoder at an ambient temperature of 60 °C



The supply voltage must have an upstream fuse with appropriate voltage and current limiting characteristics!

7.2 Electrical requirements

Supply voltage for encoder supply	+18-30 V ¹⁾ (+5 V is generated from +24 V on X3)
-----------------------------------	---

7. Technical specifications

7.2 Electrical requirements

Current consumption (supply voltage for encoder supply)	Normally 162 mA/24 V	Maximum 200 mA/30 V
Voltage supply from safety bus	+12 V	
Current consumption on the safety bus (+12 V supply)	Normally 75 mA	Maximum 90 mA
Supply from XN Safety bus	+24 V	
Current consumption on XN Safety bus (+24 V supply)	Normally 33 mA	Maximum 40 mA



¹⁾ At an increased ambient temperature > 50 °C or in a horizontal installation position, the maximum permissible supply voltage for the encoder supply is reduced from +30 V to +28.8 V.

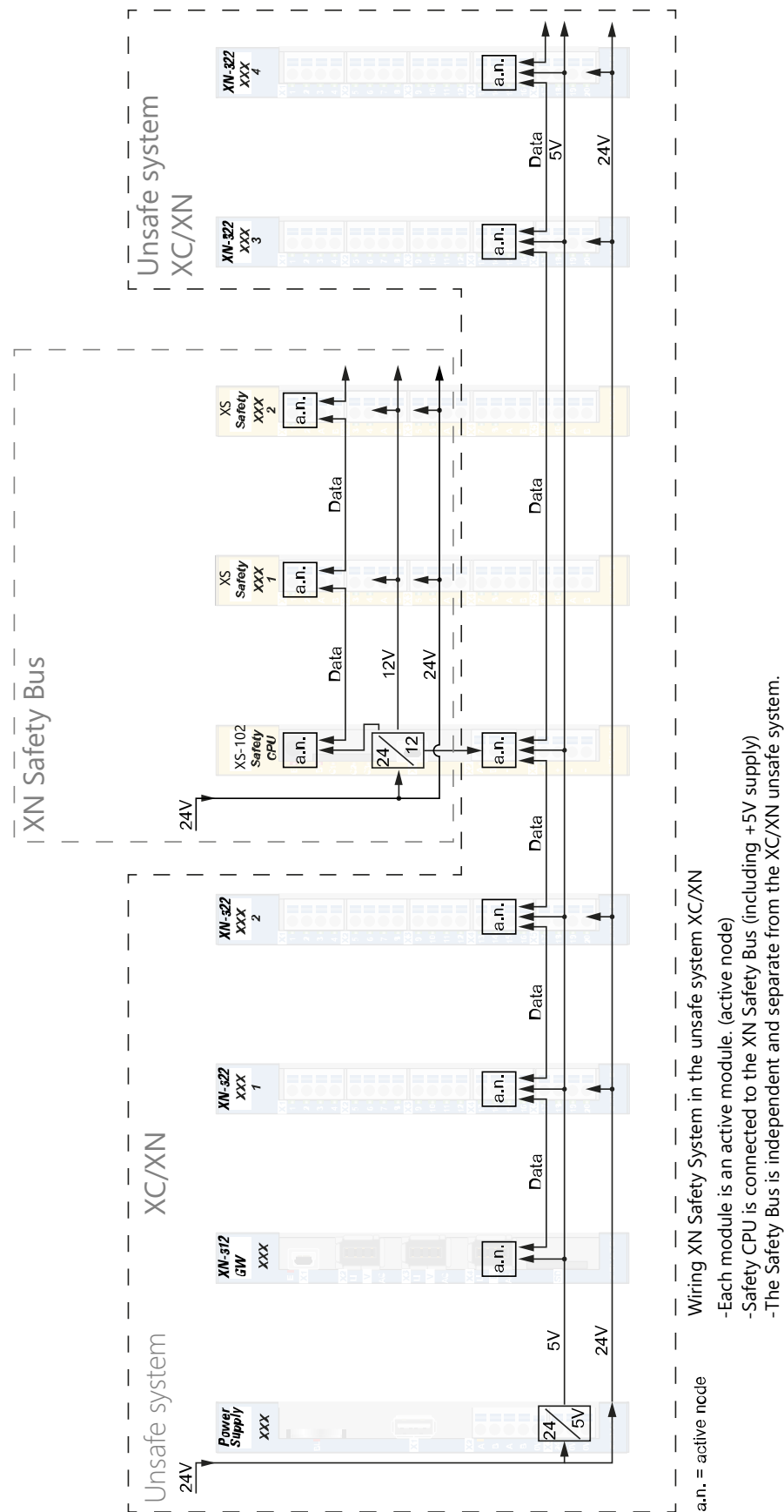
If this XN Safety module is operated on a Safety CPU with several modules, the total currents of the XN Safety module used must be determined and checked!

The total current of the +24 V supply must not exceed 800 mA and the total current of the +12 V supply must not exceed 800 mA.

Module XS-322-2INC can only be used in conjunction with a XN Safety CPU module that has been configured as the master CPU.

7. Technical specifications

7.2 Electrical requirements



7.3 Additional information

Article number	EP-401357
Circuit card coating	no
Standardization	Designed according to UL508 (E247993)
Approvals	cULus, CE, TÜV-Austria EC type-tested
Lifetime	20 years
Time of reaction	Please refer to the "Response time and shutdown time" section in the XN Safety system manual

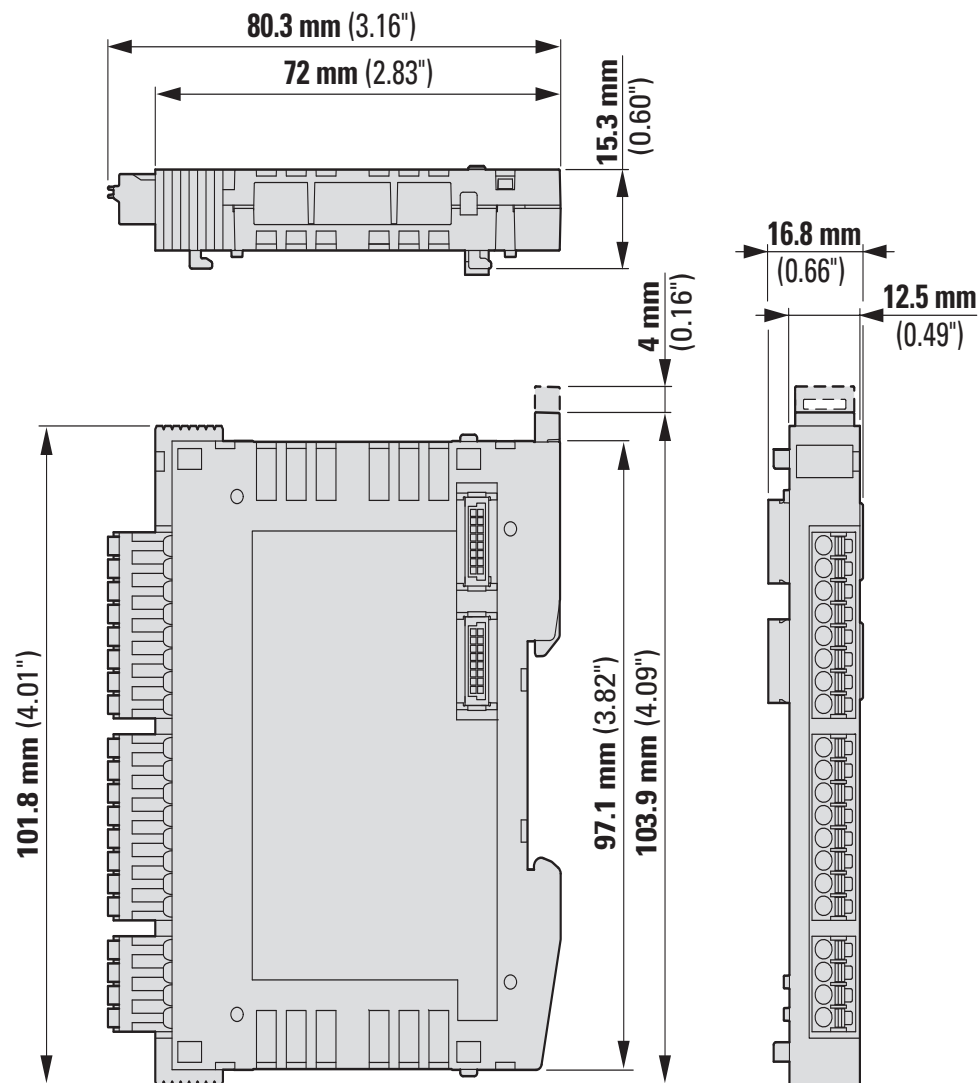
7. Technical specifications

7.4 Ambient conditions

7.4 Ambient conditions

Storage temperature	-20 – + 85 °C (-4 – +185 °F)	
Ambient temperature	± 0 – +55 °C (+32 – +131 °F) [UL] ± 0 – +60 °C (+32 – +140 °F) [CE]	
Humidity	0 - 95%, non-condensing	
Installation altitude	max. 2000 m above sea level without derating > 2000 m to max. 5000 m with derating of the maximum ambient temperature by 0.5 °C per 100 m	
Operating conditions	Pollution Degree 2	
Noise emissions	≤ 70 dB	
EMC interference immunity	EN 61000-6-2 (industrial environments) EN 61000-6-7 (interference immunity for functional safety in industrial applications) (stricter requirements in conformity with EN IEC 62061)	
EMC emitted interference	EN 61000-6-4 (industrial environment)	
Vibration resistance	EN 60068-2-6	3.5 mm of 5-8.4 Hz 1 g of 8.4-150 Hz
Mechanical shock resistance	EN 60068-2-27	15 g (147.15 m/s ²)
Protection Style	EN 60529/NEMA 250	IP20/type1

8. Mechanical dimensions

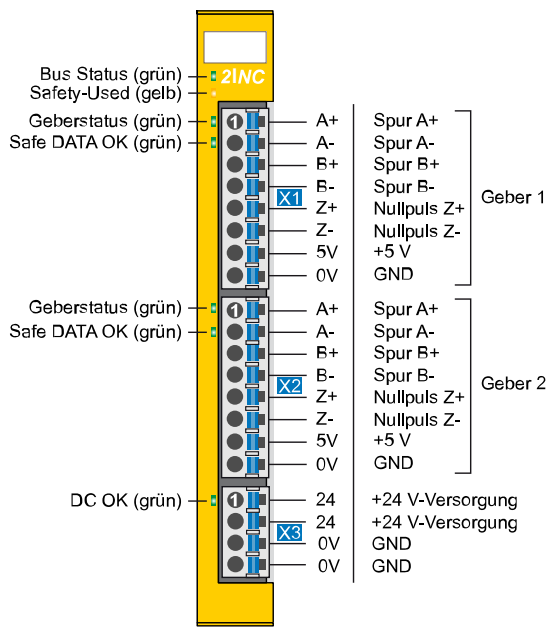


Dimensions (W x H x D)	16.8 mm x 104.2 mm x 80.3 mm (0.661" x 4.102" x 3.161") +/- 0.2 mm
Weight	68 gr

8. Mechanical dimensions

8.1 Pin assignment

8.1 Pin assignment



The terminals for +24 V power (X3: pin 1 and pin 2) and GND (X3: pin 3 and pin 4) are internally connected. This means that only one +24 V pin (pin 1 or pin 2) and one GND pin (pin 3 or pin 4) needs to be connected in order to power the module. The internally connected terminals can be used to extend the +24 V and GND connections. However, it is necessary to make sure that this does not result in a total current of 6 A being exceeded per terminal!

8.2 Status LEDs

Bus status	Green	ON	Bus communication OK
		OFF	No power supply available
		FLASHES (5 Hz)	No communications

8. Mechanical dimensions

8.2 Status LEDs

Safety-Used	Yellow	ON	Adjustable by application (For example, the visualization interface can be used to set the module's LED to flash so that it is easier to find the module inside the control panel OFF.)
		OFF	
		FLASHES (2 Hz)	
		FLASHES (4 Hz)	
Encoder status	Green	ON	Encoder signals OK
		OFF	Encoder is not in use
		Flashes	Signal error was detected
Safe status	Green	ON	Safety of the Safety CPU provides valid encoder values
		OFF	Encoder is not in use or Safety of the Safety CPU does not provide valid encoder values
DC OK	Green	ON	+24 V input voltage for encoder supply OK

8. Mechanical dimensions

8.3 Plug connectors that should be used

8.3 Plug connectors that should be used

X1-X3: Connector with push-in spring-cage terminal (included in the scope of supply)

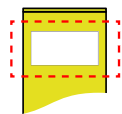
The spring-cage terminals can be used to connect ultrasonically spliced (ultrasonically welded) wires.

Connection specifications :

Stripping length / ferrule length	10 mm
Angle of plug	Parallel to conductor axis or circuit card
Conductor cross-section, rigid	0.2-1.5 mm ²
Conductor cross-section, flexible	0.2-1.5 mm ²
Conductor cross-section, ultrasonically spliced wires	0.2-1.5 mm ²
Conductor cross section, AWG/kcmil	24-16
Conductor cross-section, flexible with ferrule (uninsulated)	0.2-1.5 mm ²
Conductor cross-section, flexible with ferrule (insulated)	0.25-0.75 mm ² (reduction reason: d2 of ferrule)



8.4 Labeling area



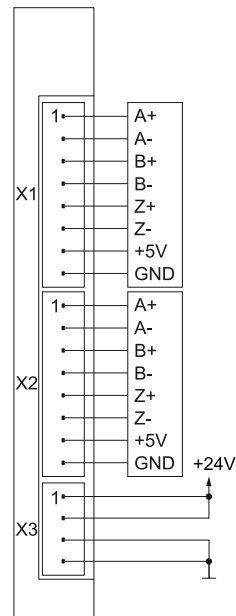
Manufacturer	Weidmüller
Type	MF 10/5 CABUR MC NE WS
Article number Weidmüller	1854510000
Compatible printers	Weidmüller
Type	Printjet Advanced 230V
Article number Weidmüller	1324380000

9. Wiring topic

9.1 Connection example

9. Wiring topic

9.1 Connection example



9.2 Notes

The input filters that suppress noise pulses make it possible to use the device in harsh environmental conditions. In addition, it is recommended to exercise particular care during wiring in order to ensure proper operation.

Observe the following installation instructions:

- Do not route the input cables parallel to load circuits.
- Suppressor circuit for all contactor coils (RC suppressors or flyback diodes)
- Correct grounding



If possible, connect the earth bus to the control panel earth bus!
De-energize the system before carrying out any wiring or installation work!

Do NOT, under any circumstance, connect or disconnect the XN Safety module while energized!

10.1 RS422 interface

The RS422 interface is terminated internally in the module.

10.2 Encoder configuration

The maximum permissible encoder frequency is set at 750 kHz (with single edge evaluation). This corresponds to a maximum counting frequency of 1.5 MHz (with X4 evaluation).

This must be taken into account when selecting the encoder to be used.

The table below shows the permissible speed for encoders for the respective encoder resolution based on the maximum encoder frequency.

Encoder resolution (increments/revolution)	Speed scaling	
	Revolutions/second	Revolutions/minute
60	12,500	750,000
80	9,375	562,500
100	7,500	450,000
128	5,859	351,563
150	5,000	300,000
200	3,750	225,000
256	2,930	175,781
512	1,465	87,891
1024	732	43,945
2048	366	21,973
4096	183	10,986

This is only an excerpt of possible encoder resolutions. The following formulas can be used to determine the maximum permissible speed (rpm) for an encoder with a resolution that is not included in the above table.

Revolutions/s:

$$n_{max} = \frac{f_{max}}{res}$$

Revolutions/min:

$$n_{max} = \frac{f_{max} \cdot 60}{res}$$

10.3 Installing the encoders

Legend:

n_{max}	...	Maximum permissible speed in revolutions/s or revolutions/min
f_{max}	...	Maximum encoder frequency of 750 kHz
res	...	Encoder resolution as per manufacturer's data sheet (specification for simple edge evaluation)

If linear encoders are used or, for example, a transmission ratio must be taken into account: In this case, the scaling parameters, which must be specified in XN Safety Designer Configuration tool for each encoder, must also be taken into account when calculating the maximum permissible speeds.

This results in the following formula:

$$v_{max} = (f_{max} * mul_{position} / div_{position}) * (mul_{speed} / div_{speed})$$

Legend:

v_{max}	...	Maximum possible, scaled speed
f_{max}	...	Maximum encoder frequency of 750 kHz
$mul_{position}$	...	Factor for converting the position or length (parameter units)
$div_{position}$	...	Divisor for converting the position or length (Parameter Increments)
mul_{speed}	...	Factor for converting the speed or time base (Parameter Speed Multiplier)
div_{speed}	...	Divisor for converting the speed or time base (Parameter Speed Divisor)

Due to the data width of 32 bits, the upper limit for the speed is a maximum value of 2,147,483,647 (the highest bit is used as the sign).

This results in the following conditions:

$$n_{max} \leq 2.147.483.647 \text{ and } f \leq f_{max}$$

$$v_{max} \leq 2.147.483.647 \text{ and } f \leq f_{max}$$

Legend:

f	...	Encoder frequency (with simple edge evaluation)
-----	-----	---

Note on position monitoring

If the encoders are used for position monitoring (linear encoders, rotary encoders), it must be taken into account that the minimum and maximum position values must be monitored in the application. The maximum value depends on the scaling parameters for converting the position and is limited to 32 bits.

10.3 Installing the encoders

Line and encoder faults are diagnosed by measuring the encoder currents, among other things.

To do this, it is necessary to define the setpoint values for the current measurement in the system. The current limits are defined automatically during the verification of

10.3 Installing the encoders

the system, so that no further parameters need to be specified or configured by the user.

If the system is not verified, the encoder currents are measured when the system is started and used as temporary reference values. The current limits are temporarily defined at $\pm 25\%$ on the basis of the reference values determined. If a corresponding fluctuation in the encoder currents due to a wiring fault is detected during movement, the system switches to the safe state and the corresponding diagnostic codes are made available.



ATTENTION

Before the safety system is marked as verified, the wiring of the connected encoders must be checked manually and it must be ensured that the system is working correctly (the encoders are working correctly).

During the verification process, which is carried out either via the "Set Verified" button in XN Safety designer or via the validation button on XN Safety CPU module, the permitted limit values for the encoder currents are determined based on the current current measurements and stored permanently in the XN Safety CPU module. These limit values are based on the measured value $\pm 25\%$.

After verification, the encoder currents are monitored using the current values stored in the XN Safety CPU module. If the limit values are exceeded or not reached in the verified state, the system switches to the safe state, just as in the non-verified state of the system, and the corresponding diagnostic codes are made available for fault analysis.

In the standard application, the current actual and target current measured values are made available via the hardware classes.



The Safety encoder module detects when an encoder is disconnected by actively monitoring the current values. If the current falls below the specified limit, the XS-322-2INC recognizes this as an error. The XN Safety CPU module receives this error and stops. The error code (ERRVAL) 10002 is output (for further measures, see help in XN Safety designer). This error cannot be acknowledged. The error remains on restart.

10.3 Installing the encoders



ATTENTION

Encoder replacement

In principle, the safety system cannot detect if an encoder is replaced when the system is de-energized. The characteristic values of the new encoder with regard to the currents may differ from those of the replaced encoder, which means that it is no longer possible guarantee the appropriate monitoring of the newly installed encoder. In such a case, the system **must** be reverified. This means that the Safe CPU must be reconfigured and verified using the XN Safety designer or microSD card (see XN Safety system manual).

10.4 Special instructions for dual-channel use

When using the Safety encoder module modules in accordance with the requirements of SIL 3 according to EN IEC 62061 and PL e/Cat. 4 according to EN ISO 13849, it must be taken into account that, in the case of dual-channel use, some of the possible wiring errors can only be detected by comparing the measurement results of both encoders in the safety application of the Safety CPU.

This affects the swapping of the signal lines A+ with A- and B+ with B-. Mechanical faults, such as a clutch coming loose, can also only be detected in the Safety CPU safety application.

In order to meet the requirements of the diagnostic coverage ratio, both encoders **must** be synchronously monitored in the Safety application of the Safety CPU.

For synchronous monitoring, the Functional Safety Block SF_SkewMonitor (see chapter "Numerical function blocks" in the XN Safety Designer Configuration tools user help) must be placed in the safety project and used in accordance with the documentation.

The inputs S_ChnValue1 and S_ChnValue2 of the Functional safety block must be wired with the input information S_Chn1Value and S_Chn2Value (synchronization monitoring of the position) or alternatively with the input information S_Chn1Speed and S_Chn2Speed (synchronization monitoring of the speed) of the XS-322-2INC module.

The tolerance required for this must be defined by the user. When monitoring synchronization via the position, it must be taken into account that position jumps can occur due to the scaling parameters if there is a possibility of position overflow. In this case, either the scaling parameters for converting the position should be left at the default settings (factor and divisor are 1) or the synchronization monitoring should be implemented using the speed.



If the system is not in the safe state, synchronization monitoring must be carried out in accordance with the above criteria!

In the event that all mechanical sources of error can be ruled out due to the type of coupling and the type of encoder used (including, for example, a defect in the mechanics in the encoder), monitoring the direction of rotation of both encoders is sufficient.

This can be done in the safety application using the Functional Safety Block SF_DirectionMonitor (see chapter "Numerical function blocks" in the help of the XN Safety Designer Configuration tool) and must be carried out for both encoders in this case.



If the synchronization monitoring is not implemented in the safety application as described here, the machine manufacturer must prove that the requirements according to SIL 3 in accordance with EN IEC 62061 and PL e/Cat. 4 in accordance with EN ISO 13849 are

10.4 Special instructions for dual-channel use

met if this is required for the machine or system.

11. Mounting/Installation

11.1 Checking the included equipment

Make sure to check the included equipment to make sure everything is included and in perfect condition,

→ Section "Equipment supplied", page 13.



Check the XN Safety module for damage both when first receiving it and before using it for the first time. If the Safety encoder module is damaged, please contact our Customer Service Team and do not install the XN Safety module in your system.

Damaged components can disrupt or damage your system!

11.2 Mounting

XN Safety modules are intended for installation in control cabinets. An EN/IEC 60715 DIN-rail is required in order to mount the modules. The DIN-rail must establish a conductive connection to the control panel's back plate. The individual XN Safety modules need to be mounted side by side on the DIN-rail and then secured in place by closing the locking elements. The grounding tab at the back of the XN Safety modules is used to establishing the functional earth connection between the module and the DIN-rail.

The device must always, without exception, be installed in a horizontal mounting position (module designation on top) with sufficient clearance between the XN Safety module block's vents and surrounding components / the control cabinet wall. This is necessary in order to achieve optimal cooling and air circulation so that the device's proper functionality will be guaranteed all the way up to the maximum operating temperature.

11. Mounting/Installation

11.2 Mounting

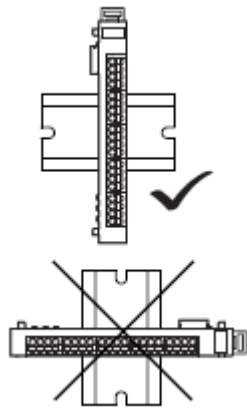
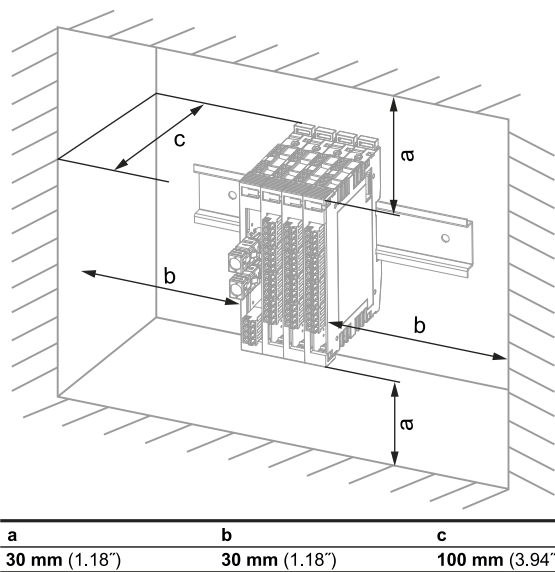


Fig. 1: Installation position - horizontal installation

Recommended minimum clearances between XN Safety modulees and surrounding components / the control cabinet wall:



Clearances in mm (inch)

$a, b \geq 30 \text{ mm (1.18")}$, $c \geq 100 \text{ mm (3.94")}$

Operating temperature

$\theta: 0^{\circ}\text{C (32}^{\circ}\text{F)} \leq T \leq 55^{\circ}\text{C (131}^{\circ}\text{F)}$ [UL] or $\pm 0 - +60^{\circ}\text{C (+32 - +140}^{\circ}\text{F)}$ [CE]

12. Transport/storage



This XN Safety module contains sensitive electronics. This means that you should make sure that it is not subjected to any large mechanical loads during transportation and storage.

The humidity, shock, and vibration conditions that apply during operation apply to storage and transportation as well!

Temperature and humidity fluctuations may occur during transportation. Accordingly, make sure that no moisture condenses inside the XN Safety module by turning off the XN Safety module and letting it acclimate to room temperature first.

If possible, ship / transport the XN Safety module in its original packaging. Otherwise, select packaging that will adequately protect the XN Safety module from external mechanical factors (a cardboard box filled with air pillows, for instance).

12.1 Storage



If you are not using the XN Safety module, store it in conformity with the corresponding storage conditions. For more information, please refer to → Section "Transport/storage", page 43.

Make sure that when the XN Safety module is stored, all protective caps (if any) are in place so that the device will not become soiled and foreign objects and liquids will be unable to get into it.

13. Maintenance

13.1 Maintenance

13. Maintenance



Follow all safety instructions during servicing and maintenance → Section "Basic safety instructions", page 14.

13.1 Maintenance

The XN Safety module has been specifically designed for low-maintenance operation.

13.2 Repairs



If the XN Safety module is defective or needs repairs, please send it to Eaton together with a detailed description of the problem.
Shipping conditions, → Chapter "13 Transport/storage", page 43.

14. Disposal



If you want to dispose of the XN Safety module, make sure to comply with all applicable national disposal regulations without fail.

Do not dispose of the XN Safety module with household waste.



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Appendix

A.1 Further usage information

A.1 Further usage information

Hardware

For more information and information on additional XN Safety module, please refer to the following documentation:

	XN Safety system manual	MN050020
	Installation instructions XS-102-C00-000, XS-322-...	IL050036ZU
	Operation manualXN Safety CPU module XS-102-C00-000	MN050019
	Operation manualXN Safety module XS-322-10DI-PF	MN050021
	Operation manualXN Safety module XS-322-8DO-P20	MN050022
	Operation manualXN Safety module XS-322-8DIO-PF20	MN050023
	Operation manualXN Safety module XS-322-2INC	MN050024
	Operation manualXN Safety module XS-322-4AI-I2	MN050025
	Operation manualXN Safety module XS-322-2DO-RNOAC	MN050026
	Operation manualXN Safety module XS-322-2DO-RNODC	MN050027

Software

For information on XN Safety designer, open the XN Safety Designer Configuration tool software and then the user help ( MN050028).

Download Center,Eaton Online Catalog

Enter "xnsafety" into the search box and the catalog will take you directly to the corresponding product group in the Automation, Control and visualization section.

 [Eaton.com/documentation](https://eaton.com/documentation)

 [Eaton.com/ecat](https://eaton.com/ecat)

Product information

For up-to-date information, please consult the product page on the Internet.

 [Eaton.com/xnsafety](https://eaton.com/xnsafety)

A.2 Data sheets

For the latest information on available XN Safety modules, please refer to the data sheet for the module in the Eaton online catalog.

 Eaton.com/ecat

XN Safety CPU module

EP-401352 XS-102-C00-000	Safety CPU module, SIL3/PLe, Cat. 4
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XS-Safety modules as expansions

with relay outputs	
EP-401359 XS-322-2DO-RNODC	Safety Digital, 30 VDC 2 outputs, relay ,NO, 6 A
EP-401360 XS-322-2DO-RNOAC	Safety Digital, 230 VAC 2 outputs, relay, NO, 6 A
With digital inputs	
EP-401353 XS-322-10DI-PF	Safety Digital, 10 inputs, 24 VDC, 0.5ms
with digital output	
EP-401354 XS-322-8DO-P20	Safety Digital, 8 outputs, 24 VDC, 2 A
With digital inputs/outputs	
EP-401355 XS-322-8DIO-PF20	Safety Digital, 6 inputs / 2 outputs, 24 VDC, 0.5 ms, 2 A
Rotary encoder	
EP-401357 XS-322-2INC	Safety rotary encoder, 2 inputs, incremental, 12-bit
with analog inputs	
EP-401356 XS-322-4AI-I2	Safety Analog current input, 4 inputs, 4-20 mA, 16-bit

Appendix

A.2 Data sheets

Accessory devices

Cat No. and type	Description
191080 XC-303-C32-002	XC modular PLC XC303, Small PLC, CODESYS 3 programmable, SD Slot, USB, 3x Ethernet, 2x CAN, RS485, four digital inputs/outputs
191081 XC-303-C32-001	XC modular PLC XC303, Small PLC, CODESYS 3 programmable, SD Slot, USB, 2x Ethernet, CAN, RS485
191082 XC-303-C32-000	XC modular PLC XC303, Small PLC, CODESYS 3 programmable, SD Slot, Ethernet, CAN
199973 XC-204-C10-000	Modular PLC XC204, Micro PLC, programmable CODESYS 3, USB, Ethernet
199975 XC-204-C21-001	Modular PLC XC204, Micro PLC, programmable CODESYS 3, USB, 2x Ethernet, CAN, 2DIO
199977 XC-204-C20-002	Modular PLC XC204, Micro PLC, programmable CODESYS 3, USB, 2x Ethernet, RS485, 2DIO
199971 XC-104-C10-000	Modular PLC XC104, Micro PLC, programmable CODESYS 3, USB, Ethernet
178782 XN-312-GW-CAN	XN-312 gateway to bus system CANopen
178785 XN-312-GW-EC	XN-322 digital input module, 20 digital inputs with 24 VDC each, pulse-switching, 5.0 ms
191087 MEMORY-SDU-A1	microSD card
206903 TS-CI-K3	DIN-rail that fit to 4RU
206904 TS-CI-K4	DIN-rail that fit to 6RU

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Eaton is an intelligent power management company dedicated to improving the quality of life and protecting the environment for people everywhere. We are guided by our commitment to do business right, to operate sustainably and to help our customers manage power – today and well into the future. By capitalizing on the global growth trends of electrification and digitalization, we're accelerating the planet's transition to renewable energy, helping to solve the world's most urgent power management challenges, and doing what's best for our stakeholders and all of society.

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