

AXL F SAFE

Use of Axioline F modules in applications which meet functional safety requirements

Application note
8021_en_03

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1 Description

This application note describes the measures that must be observed when using Axioline F modules in an application which should meet the functional safety requirements (hereinafter referred to as safety application).

The principle of the safety circuit is that the supply voltage for the output modules is safely disconnected using a safety relay module (e.g., PSR safety relay from Phoenix Contact). This means that the outputs are switched off independently of the bus signal.

Only Axioline F modules that are specifically approved for safety applications should be used in the safety circuit. They are listed under “Ordering data” on page 3.

The Axioline F modules are approved for safety applications as of a specific hardware/firmware (HW/FW) version. The version is printed on the side of the housing of each module (1 in Figure 1).

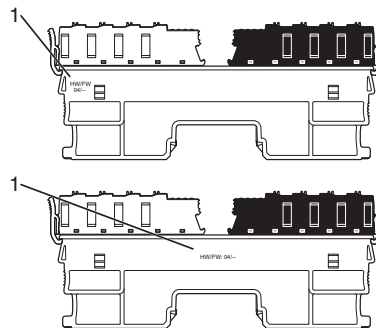


Figure 1 Example of the hardware/firmware version of an Axioline F module

The position of the printing differs for modules with an old and a new type designation.



Make sure you always use the latest documentation. It can be downloaded at [phoenixcontact.net/products](https://www.phoenixcontact.net/products).

In addition to this application note, please also refer to the following documentation:

- Data sheet or user manual for the module used
- “Axioline F: system and installation” user manual

(see “Ordering data” on page 3)



This document is valid for the products listed in Section “Ordering data” on page 3.

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2 Ordering data

2.1 Axioline F modules approved for safety applications

Description	Type	Order No.	As of hardware/firmware (HW/FW) version
Axioline F, digital output module, digital outputs: 16, 24 V DC, 500 mA, connection technology: 3-wire, transmission speed in the local bus: 100 Mbps, degree of protection: IP20, including bus base module and Axioline F connectors	AXL F DO16/3 2F	2688048	04/--
Axioline F, digital output module, digital outputs: 16, 24 V DC, 500 mA, connection technology: 3-wire, transmission speed in the local bus: 100 Mbps, degree of protection: IP20, including bus base module and Axioline F connectors	AXL F DO16/3 2F	2688048	05/100
Axioline F, digital output module, digital outputs: 16, 24 V DC, 500 mA, connection technology: 2-wire, transmission speed in the local bus: 100 Mbps, degree of protection: IP20, including bus base module and Axioline F connectors	AXL F DO16/2 2H	1027904	00/100

2.2 Documentation

Description	Type
User manual, German Axioline F: system and installation	UM EN AXL F SYS INST



For more detailed information on the modules, please refer to the corresponding documentation. It can be downloaded at www.phoenixcontact.net/catalog.

3 Explanation of symbols and abbreviations used

Symbols used:



This symbol indicates hazards that could lead to personal injury.

There are three signal words indicating the severity of a potential injury.

DANGER

Indicates a hazard with a high risk level. If this hazardous situation is not avoided, it will result in death or serious injury.

WARNING

Indicates a hazard with a medium risk level. If this hazardous situation is not avoided, it could result in death or serious injury.

CAUTION

Indicates a hazard with a low risk level. If this hazardous situation is not avoided, it could result in minor or moderate injury.



This symbol together with the **NOTE** signal word warns the reader of actions that might cause property damage or a malfunction.



Here you will find additional information or detailed sources of information.

Abbreviations used:

Cat.	Category
PL	Performance level
MTTFd	Mean time to dangerous failure

4 Safety notes

The machine/system manufacturer and the operator are solely responsible for validating the safety of the machine or system and the implemented application in which the machine or system is used. The Machinery Directive must be observed.



WARNING: Loss of the safety function

Use the devices in safety applications as intended.

In the event of noncompliance, the safety of personnel and equipment can no longer be assured.

The following organizational points must be observed:

- When working on devices in safety applications and/or the system, the latest version of the data sheets for the devices and other product documentation must always be at hand and referred to.
 - It is prohibited for unqualified personnel to work on the devices in the safety application, in the system, or in its vicinity.
 - Only qualified personnel who are familiar with the applicable regulations governing occupational safety and accident prevention are permitted to install and start up the devices in safety applications while observing the information provided in the data sheets for the devices used. Electrical work may only be carried out by electrically skilled persons.
 - Observe all applicable regulations, especially those regarding safeguarding.
 - Repairs to Axioline F modules, especially if the housing must be opened, may only be carried out by the manufacturer or persons authorized by the manufacturer.
 - The manufacturers and users of machines or systems in which the aforementioned devices are used are solely responsible for agreeing on and observing all applicable safety directives and regulations and all applicable standards with the appropriate authorities.
- Observe the following additional points during installation:**
- Please observe the safety notes in the “Axioline F: system and installation” user manual.
 - The instructions given in this document must be followed during installation and startup.
 - Mount the Axioline F modules in a housing protected from dust and humidity (IP54 or higher); dust and humidity can lead to malfunctions.
 - Take measures to prevent mismatching, polarity reversal, and manipulation of connections.
 - Disconnecting an output via the bus system does not guarantee the safety-related function of the system (e.g., emergency stop, safety door). This is only achieved if the supply voltage of the output groups is disconnected via the safety relay module.
 - The process notes and circuit details presented in this document should be understood in a general sense and the relevant application should be examined to see if they apply. Phoenix Contact cannot guarantee the suitability of the procedures described or the circuit suggestions for the relevant application made in this document.

5 Requirements for the wiring of devices to be used in safety applications



WARNING: Loss of the safety function in the event of feedback

When wiring Axioline F modules in safety applications, ensure that errors are prevented in terms of feedback for:

- All connected cables that supply the device with actuator voltage
- The connecting cables of the actuators

Please also take all connected loads into consideration. This means, for example, that the cabling must be implemented using separate sheath cables.

Observe the respective applicable DIN and VDE regulations that are required for error prevention.

Feedback is when voltages are fed into a cable (caused, for example, by generator effects of the connected load, by an insulation fault or by feed-in from a connected load due to an internal insulation fault).

5.1 Power supply requirements for the logic and actuators



WARNING: Loss of the safety function when using unsuitable power supplies for the logic and actuators

The Axioline F modules are designed exclusively for protective extra-low voltage (PELV) operation in accordance with EN 60204-1. Only protective extra-low voltage in accordance with the defined standard may be used for supply purposes.

Only use power supply units that meet EN 61204 and feature safe isolation and PELV in accordance with EN 50178 / VDE 0160 (PELV). These prevent short circuits between primary and secondary sides.

Also make sure that the output voltage of the power supplies do not exceed 32 V even in the event of an error.

Make sure that the GND connection to PE on the power supply unit complies with the applicable VDE regulations and is executed in such a way that errors are prevented if the connection is lost (interrupted).

If you cannot ensure that errors will be prevented, the application can be used to a maximum of PL c (Cat. 2), depending on the safe switching device connected upstream.

5.2 Requirements for cable installation from the safety relay module to the Axioline F module

Install the cable between the safety relay module and the terminal block for supplying the supply voltage U_O of the Axioline F output module in a protected environment. The type of cable installation must ensure that errors are prevented in cross circuits with external signals.

Install the cable between the safety relay module and terminal block GND of the Axioline F output module in a protected environment. The type of cable installation must ensure that errors are prevented in cross circuits with external signals.

5.3 Requirements for the connection between DIN rail and PE



WARNING: Loss of the safety function when the connection from the DIN rail to PE is interrupted

When connecting the DIN rail to PE, make sure that errors are prevented if the connection is lost (interrupted).

If you cannot ensure that errors will be prevented, establish an additional, separate connection from the DIN rail to PE.

Observe the respective applicable DIN and VDE regulations that are required for error prevention.

5.4 Requirements for DO modules

In safety applications, only use the modules listed in Section "Axioline F modules approved for safety applications" on page 3.



WARNING: Loss of the safety function due to parasitic voltages

The ground contact of the connected load should only be connected to the ground contact of the Axioline F module. This means, for example, that 1-wire termination is not permitted.

5.5 Requirements for controlled devices/actuators

- Dimension the controlled device used such that a leakage current of 2 mA does not cause a hazardous system state.
This also means that the controlled device must switch from the operating state to the idle state at a current of 2 mA.
- Only use controlled devices that definitely maintain the idle state at a voltage of 5 V.
This also means that the controlled device must switch from the operating state to the idle state at a voltage of 5 V.
- Only use loads that have an insulated structure. This means:
 - Make sure there is no electrically conductive connection between the control connections and the equipotential bonding.
 - Make sure there is no electrically conductive connection between GND and PE/FE at the load.
 - Make sure that, even in the event of an error, no external voltage is led to the device outputs via the load (no feedback).
- Only use appropriately qualified actuators.
- Use components proven in use. This includes, for example:
 - Control contactors according to EN 60947-4-1
 - Power contactors
 - Relays with force-guided contacts according to DIN EN 50205
- Use relays or contactors with force-guided N/C contacts to safely monitor the state (pickup, dropout).

6 Use of the Axioline F modules in systems according to EN ISO 13849-1

In accordance with the installation guidelines, these Axioline F modules may be used in systems up to Cat. 4/PL e (see Section 8 “Connection examples”). The category and PL that can be achieved are specified for each connection example. To achieve the required Cat./PL, implement the measures described in Section 4, 5, and 7.

The Axioline F modules are PL-neutral. This means that they do not perform any safety functions and do not have any influence on the safety function.

An infinite MTTFd may be assumed for Axioline F modules.

Please note that these Axioline F modules do not have diagnostic coverage (DC = 0). Make sure that the application (e.g., safety relay modules) provides the diagnostic coverage required for the safety function.

The Axioline F modules have an unlimited mission time.

7 Measures required to achieve a specific category



Please also observe the information in EN ISO 13849.

Cat. 2

- Use proven and basic safety principles in accordance with EN ISO 13849.
- Use appropriately qualified actuators (see “Requirements for controlled devices/actuators” on page 7).
- Please note that mechanical failure of the switching device can result in the loss of the safety function.
- Prevent the welding of contacts on the connected contactors or safety relays with appropriate protection against overcurrent and overvoltage.
- Please note that a **single** error between the tests can result in the loss of the safety function.
- Make sure that the external wiring is tested by the machine control system on machine startup and at suitable intervals. This test has to detect the loss of the safety function.
- Make sure that, in the event of an error, the application shuts down the machine or system safely or generates a warning (optical and/or audible).

Cat. 3

- Use proven and basic safety principles in accordance with EN ISO 13849.
- Use appropriately qualified actuators (see “Requirements for controlled devices/actuators” on page 7).
- Please note that mechanical failure of the switching device can result in the loss of the safety function.
- Prevent the welding of contacts on the connected contactors or safety relays with appropriate protection against overcurrent and overvoltage.
- All errors that cannot be detected can result in the loss of the safety function. Take appropriate measures to prevent these errors. Suitable measures include, for example, protected cable installation or double insulation.
- Please take into consideration errors with a common cause.
- Ensure that **a single** error does not result in the loss of the safety function.
- Test the shutdown capability of the actuators at regular intervals.

Cat. 4

- Use proven and basic safety principles in accordance with EN ISO 13849.
- Use appropriately qualified actuators (see “Requirements for controlled devices/actuators” on page 7).
- Please note that mechanical failure of the switching device can result in the loss of the safety function.
- Prevent the welding of contacts on the connected contactors or safety relays with appropriate protection against overcurrent and overvoltage.
- Accumulation of errors must not result in the loss of the safety function. Following the third error, evaluation can be aborted if the probability of further errors occurring is low.
- All errors that cannot be detected can result in the loss of the safety function. Take appropriate measures to prevent these errors. Suitable measures include, for example, protected cable installation or double insulation.
- Please take into consideration errors with a common cause.
- Test the shutdown capability of the actuators at regular intervals.

8 Connection examples



For greater clarity, the Axioline F module is illustrated separately in the following connection examples. However, it can only perform its function if it is integrated in an Axioline F station.

8.1 Example: single-channel controlled device; achievable: Cat. 1/PL c

Independent of the Cat./PL achieved using the safety relay module (PSR safety relay in the example), the controlled device is designed for single-channel operation only.

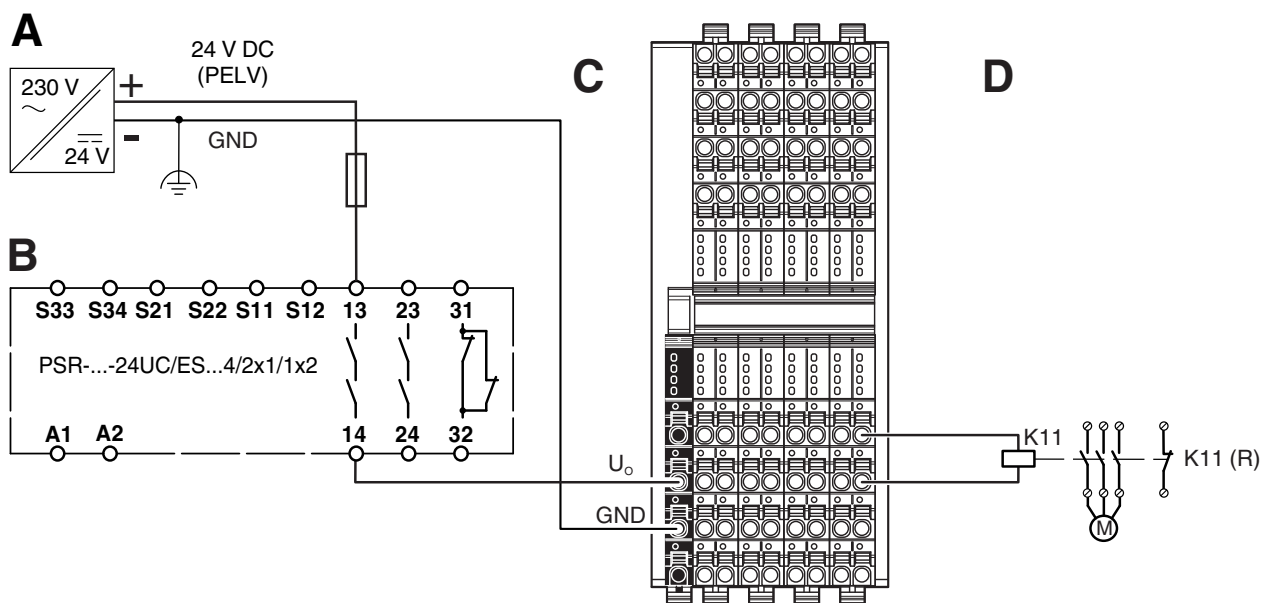


Figure 2 Single-channel controlled device

- A** Power supply unit to supply the Axioline F module
- B** PSR safety relay
- C** Axioline F module (within an Axioline F station)
- D** Controlled device



The system or machine operator bears sole responsibility for testing the safety function.

- Monitor the switching state of the controlled device in your application by reading back N/C contact K11 (R).
- Test the safety function at regular intervals. The interval at which testing is to take place depends on the applicable standard and the application.
- Observe the requirements of the safety relay module (PSR safety relay in the example) to achieve the required Cat./PL.

8.2 Example: two-channel controlled device; achievable: Cat. 3/PL d

Independent of the Cat./PL achieved using the safety relay module (PSR safety relay in the example), the controlled device is designed for two-channel operation.

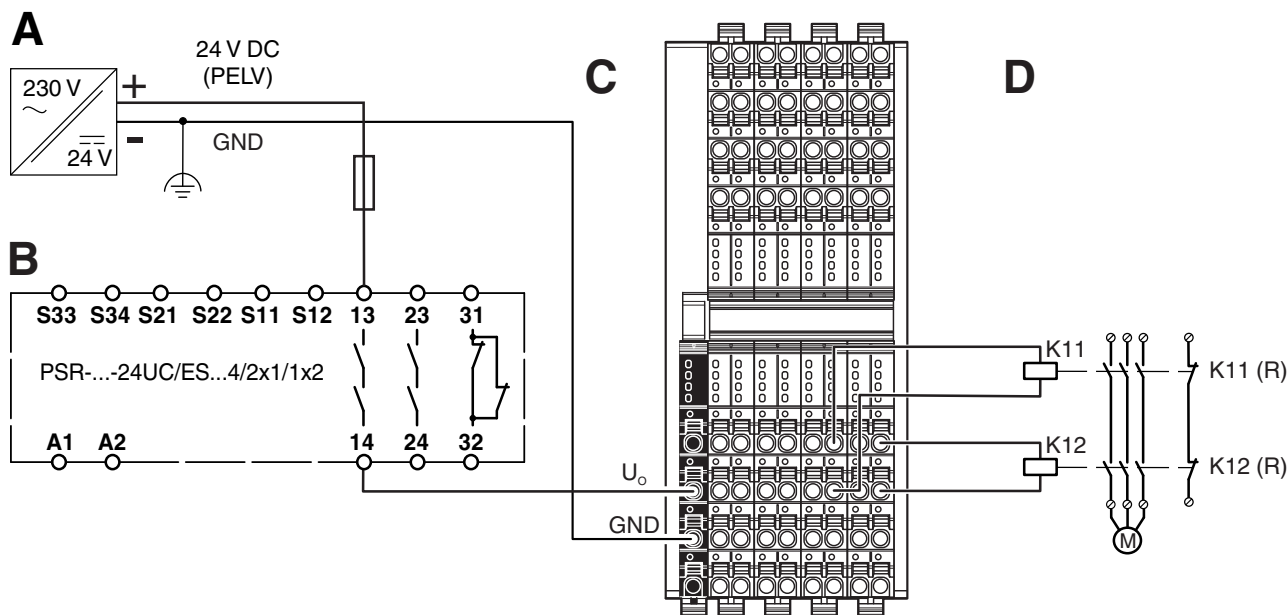


Figure 3 Two-channel controlled device

- A** Power supply unit to supply the Axioline F module
- B** PSR safety relay
- C** Axioline F module (within an Axioline F station)
- D** Controlled device

i The system or machine operator bears sole responsibility for testing the safety function.

- **Protected cable installation is required between terminal point 14 of the PSR and the U_o terminal. This prevents external signal input.**
- The controlled device must not compromise category or performance level. Usually, a two-channel controlled device is required for this purpose.
- Monitor the switching state of the controlled device in your application by reading back N/C contacts K11 (R) and K12 (R).
- Test the safety function at regular intervals. The interval at which testing is to take place depends on the applicable standard and the application.
- Observe the requirements of the safety relay module (PSR safety relay in the example) to achieve the required Cat./PL.

8.3 Example: two-channel controlled device; achievable: Cat. 4/PL e

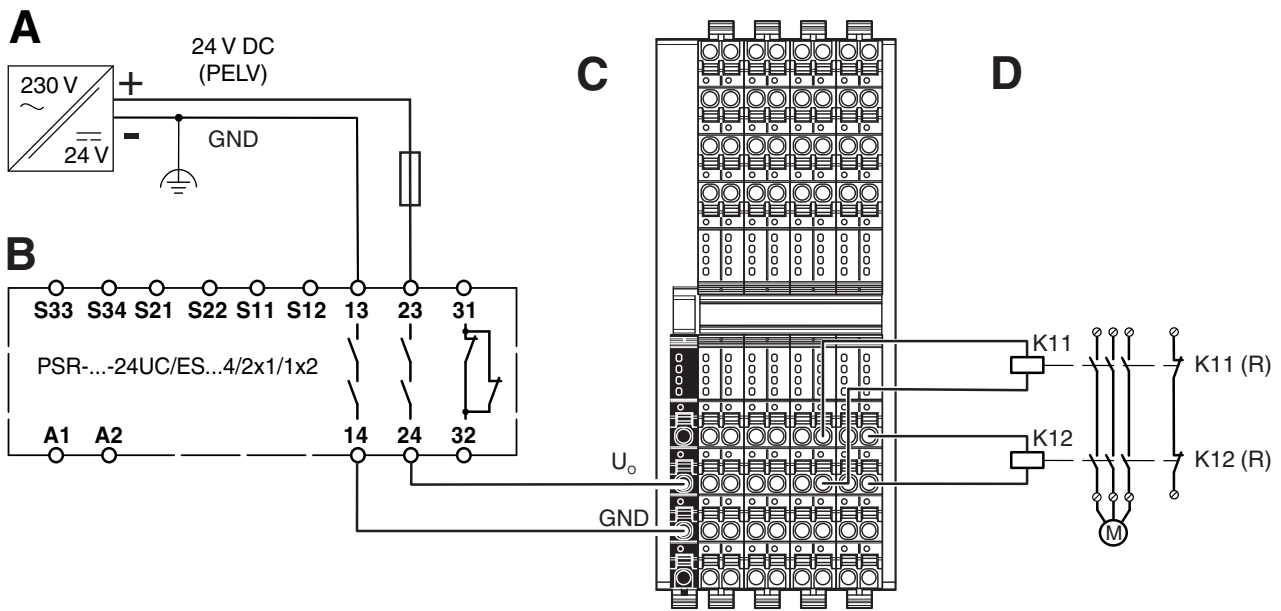


Figure 4 Two-channel controlled device

- A** Power supply unit to supply the Axioline F module
- B** PSR safety relay
- C** Axioline F module (within an Axioline F station)
- D** Controlled device

i The system or machine operator bears sole responsibility for testing the safety function.

- Monitor the switching state of the controlled devices in your application by reading back N/C contacts K11 (R) and K12 (R).
- Test the safety function at regular intervals. The interval at which testing is to take place depends on the applicable standard and the application.
- Observe the requirements of the safety relay module (PSR safety relay in the example) to achieve the required Cat./PL.



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