AXL F BK ETH XC



Axioline F, bus coupler, Modbus/TCP (UDP), Extreme conditions version

Data sheet
106229_en_14

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1 Description

The bus coupler is intended for use within a Modbus/TCP (UDP) network.
The bus coupler creates the link to the Axioline F I/O system and the industrial I/O signals connected to it.
Up to 63 Axioline F devices can be connected to the bus coupler.

Features

- 2 Ethernet ports (with integrated switch)
- Transmission speed of 10 Mbps and 100 Mbps
- Rotary coding switches for setting the IP address assignment and other functions
- Firmware can be updated
- Runtime in the bus coupler is negligible (almost 0 µs) (for Modbus/UDP)
- Typical cycle time of the Axioline F local bus is around 10 µs
- Web-based management
- Security in the network: Port disconnection possible via web-based management (firmware version 1.31 or later)
- Supports the operation of Axioline Smart Elements
- Supports passive Smart Elements (firmware version 1.30 or later)
- Supports IOL-CONF (firmware version 1.30 and later)
- Supports Diag+
- Can be used under extreme ambient conditions
- Extended temperature range of -40 °C … +70 °C (see “Tested successfully: use under extreme ambient conditions” in the data sheet)
- Partially coated PCBs

WARNING: Explosion hazard when used in potentially explosive areas
When using the module in potentially explosive areas, observe the corresponding notes.

Observe these notes

NOTE: Deactivated process data watchdog:
In the event of a connection abort, outputs retain their last state
By default upon delivery, the process data watchdog is deactivated.
Observe the specifications in “Monitoring”.

This data sheet is only valid in association with the UM EN AXL F SYS INST user manual.

Make sure you always use the latest documentation.
It can be downloaded at: phoenixcontact.com/product/2701949

2 Table of contents

1 Description 1
2 Table of contents 2
3 Ordering data 3
4 Technical data 4
5 Internal circuit diagram 9
6 Tested successfully: Use under extreme ambient conditions 9
7 For your safety 10
8 Installation in potentially explosive area 12
9 UL notes 13
10 Connections and operating elements 14
11 Configuring the bus coupler 17
12 Local diagnostic and status indicators 21
13 Startup behavior of the bus coupler 24
14 Monitoring of Ethernet communication 26
15 Monitoring of communications power UL (UL-Monitor) 27
16 Substitute value behavior 27
17 Modbus protocols and registers 27
18 Access to PDI objects 39
19 SNMP: Simple Network Management Protocol 51
20 WBM: Web-based management 51
21 Security: Port disconnection 52
22 Example: Modbus register table in the web-based management 53
23 Firmware update 55
24 Software drivers 55

3 Ordering data

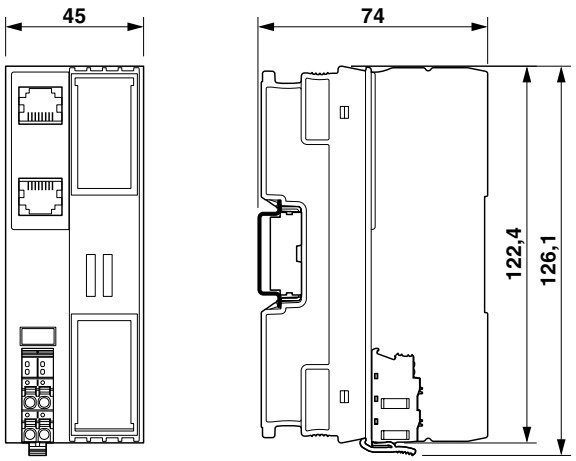
Description	Type	Item no.	Pcs./Pkt.
Axioline F, Bus coupler, Modbus/TCP (UDP), RJ45 jack, Extreme conditions version, transmission speed in the local bus: 100 Mbps, degree of protection: IP20, including bus base module and Axioline F connector	AXL F BK ETH XC	2701949	1

Documentation	Type	Item no.	Pcs./Pkt.
Application note, English, starting up the AXL F BK ETH ... bus coupler	AH EN AXL F BK ETH ...	-	-
User manual, English, Axioline F: System and installation	UM EN AXL F SYS INST	-	-
User manual, English, Axioline F: Diagnostic registers and error messages	UM EN AXL F SYS DIAG	-	-
Quick start guide, English, Handling an Axioline F station under Startup+	UM QS EN STARTUP+	-	-
Application note, English, protection of the FTP access on bus couplers	AH EN AXL F BK - SECURITY ADVISORY	-	-
Application note, English, Measures to protect network-capable devices with Ethernet connection against unauthorized access	AH EN INDUSTRIAL SECURITY	-	-
User manual, English, Installation and operation of the PC Worx Firmware Updater software	UM EN PC WORX FIRMWARE UPDATER	-	-
Application note, English, PC WORX FIRMWARE UPDATER – Change notes at a glance	AH EN PC WORX FIRMWARE UPDATER - CHANGE NOTES	-	-
Quick start guide, English, Startup of IO-Link masters and IO-Link devices with the IOL-CONF software	UM QS DE AXL F IOL CONF	-	-

Additional ordering data	
For additional ordering data (accessories), go to:	www.phoenixcontact.com/product/2701949

4 Technical data

Dimensions (nominal sizes in mm)	



Width	45 mm
Height	126.1 mm
Depth	74 mm
Note on dimensions	The depth applies when a TH 35-7.5 DIN rail is used (in accordance with EN 60715).

General data	
Color	Housing: traffic gray A (RAL 7042)
Weight	177 g (with connector and bus base module)
Ambient temperature (operation)	-25 °C ... 60 °C (Standard, applications with UL approval, use in zone 2 potentially explosive area; mounting position: panel mounting on horizontal DIN rail) -25 °C ... 55 °C (Standard, applications with UL approval, use in zone 2 potentially explosive area; mounting position: any) -40 °C ... 70 °C (Extended, see section “Tested successfully: use under extreme ambient conditions” in the data sheet.)
Ambient temperature (storage/transport)	-40 °C ... 85 °C
Permissible humidity (operation)	5 % ... 95 % (non-condensing)
Permissible humidity (storage/transport)	5 % ... 95 % (non-condensing)
Air pressure (operation)	70 kPa ... 106 kPa (up to 3000 m above sea level)
Air pressure (storage/transport)	70 kPa ... 106 kPa (up to 3000 m above sea level)
Degree of protection	IP20
Protection class	III (IEC 61140, EN 61140, VDE 0140-1)
Overvoltage category	II (IEC 60664-1, EN 60664-1)
Degree of pollution	2 (IEC 60664-1, EN 60664-1)
Mounting type	DIN rail mounting
Mounting position	any (observe temperature derating)

Connection data: Axioline F connector	
Connection method	Push-in connection
Conductor cross-section, rigid	0.2 mm² … 1.5 mm²
Conductor cross-section, flexible	0.2 mm² … 1.5 mm²
Conductor cross-section [AWG]	24 … 16
Stripping length	8 mm

Please observe the information provided on conductor cross-sections in the “Axioline F: system and installation” user manual.

Interface: Modbus/TCP (UDP)	
Number of interfaces	2
Connection method	RJ45 jack (Auto negotiation and autocrossing)
Transmission speed	10/100 Mbps (Half or full duplex mode (automatic detection, can be adjusted manually))
Transmission physics	Ethernet in RJ45 twisted pair
Transmission length	max. 100 m

Interface: Axioline F local bus	
Number of interfaces	1
Connection method	Bus base module
Transmission speed	100 Mbps

Interface: Service	
Number of interfaces	1
Connection method	USB type C (from HW 02) Micro USB type B (up to HW 01)

System limits of the bus coupler

Use the Project+ configuration software to calculate the individual process or parameter data and the corresponding number of devices that can be connected.

For the Project+ configuration software, go to: www.phoenixcontact.com/product/2701949

Number of local bus devices that can be connected	max. 63

NOTE: Electronics may be damaged when overloaded

Observe the logic current consumption of each device when configuring an Axioline F station. It is specified in every module-specific data sheet. The current consumption can differ depending on the individual module. The permissible number of devices that can be connected therefore depends on the specific station structure.

Supported protocols	
Supported protocols	Modbus/TCP (UDP), SNMP, HTTP, TFTP, FTP, BootP, DHCP, DCP

Communications power U_L feed-in (the supply of the Axioline F local bus U_{Bus} is generated from U_L)	
Supply voltage	24 V DC
Supply voltage range	19.2 V DC ... 30 V DC (including all tolerances, including ripple)
Current consumption	typ. 105 mA (without I/O modules, U_L = 24 V, up to HW 01) typ. 85 mA (without I/O modules, U_L = 24 V, from HW 02) max. 583 mA (2 A at U_{Bus}, U_L = 24 V, up to HW 01) max. 670 mA (2.5 A at U_{Bus}, U_L = 24 V, HW 02 or later) max. 583 mA (2.0 A at U_{Bus}, U_L = 24 V, applications with UL approval, use in zone 2 potentially explosive area)
Surge protection	electronic
Reverse polarity protection	electronic

NOTE: Electronics may be damaged when overloaded

Provide external fuses for the 24 V U_L area. If you are using an external fuse, the power supply unit must be able to supply four times the nominal current of the fuse. This ensures that it trips in the event of an error.

Axioline F local bus supply (U_{Bus})	
Supply voltage	5 V DC (via bus base module)
Power supply unit	max. 2 A (up to HW 01) max. 2.5 A (from HW 02) max. 2 A (Applications with UL approval, use in zone 2 potentially explosive area)

Power dissipation	
Maximum power dissipation for nominal condition	3.6 W

Electrical isolation/isolation of the voltage areas	
Test section	**Test voltage**
Ethernet interface 1 / Ethernet interface 2	1500 V AC, 50 Hz, 1 min
Ethernet interface 1 / 24 V communications voltage (U_L) feed-in	1500 V AC, 50 Hz, 1 min
Ethernet interface 2 / 24 V communications voltage (U_L) feed-in	1500 V AC, 50 Hz, 1 min
Ethernet interface 1 / functional ground	1500 V AC, 50 Hz, 1 min
Ethernet interface 2 / functional ground	1500 V AC, 50 Hz, 1 min
24 V communications voltage (U_L) feed-in / functional ground	500 V AC, 50 Hz, 1 min

Test (noxious gas)	
Test standard	ISA-71.04-2013 G3 Harsh Group A IEC 60068-2-60:2015 Method 4
Temperature	25 °C ±1 K
Humidity (relative)	75 % ±3 %
Test duration	21 Days
Volume concentration H_2S (Hydrogen sulfide)	50 ppb
Volume concentration NO_2 (Nitrogen dioxide)	1250 ppb
Volume concentration Cl_2 (Chlorine)	10 ppb
Volume concentration SO_2 (Sulfur dioxide)	300 ppb

Mechanical tests	
Vibration resistance in accordance with EN 60068-2-6/IEC 60068-2-6	5g
Shock in accordance with EN 60068-2-27/IEC 60068-2-27	30g
Continuous shock in accordance with EN 60068-2-27/IEC 60068-2-27	10g

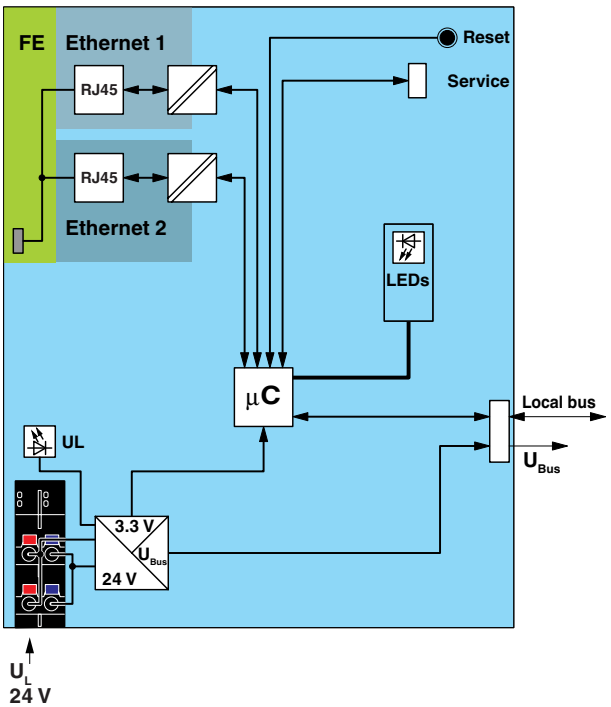
Conformance with EMC Directive 2014/30/EU	
Immunity test in accordance with EN IEC 61000-6-2	
Electrostatic discharge (ESD) IEC 61000-4-2	Criterion B, ±6 kV contact discharge, ±8 kV air discharge
Electromagnetic fields IEC 61000-4-3	Criterion A, Field intensity: 10 V/m
Fast transients (burst) IEC 61000-4-4	Criterion B, ±2 kV
Transient overvoltage (surge) IEC 61000-4-5	Criterion B; DC supply lines: ±0.5 kV/±1.0 kV (symmetrical/ asymmetrical), fieldbus cable shielding: ±1.0 kV
Conducted interference IEC 61000-4-6	Criterion A, Test voltage 10 V
Noise emission test in accordance with EN IEC 61000-6-3	Class B

Approvals	
For the current approvals, go to:	www.phoenixcontact.com/product/2701949
ATEX (UL 20 ATEX 2441X)	Ⓔx II 3 G Ex ec IIC T4 Gc EN IEC 60079-0, EN IEC 60079-7
IECEx (IECEx ULD 20.0026X)	Ex ec IIC T4 Gc IEC 60079-0 Ed. 7, IEC 60079-7 Ed. 5.1
UL, USA/Canada (E238705)	cULus
UL Ex, USA / Canada (E366272)	Class I, Zone 2, AEx ec IIC T4 Class I, Division 2, Groups A, B, C, D, T4 Ex ec IIC T4 Gc X UL 60079-0, Ed. 7 / CSA C22.2 NO. 60079-0, Ed. 4 UL 60079-7, Ed. 5 / CSA C22.2 NO. 60079-7, Ed. 2
CCC / China-Ex (㊿, 2021122309114456)	Ex ec IIC T4 Gc GB/T 3836.1-2021, GB/T 3836.3-2021

Manufacturer's declarations	
For the current manufacturer’s declarations, go to:	www.phoenixcontact.com/product/2701949

5 Internal circuit diagram

Figure 1 Internal wiring of connections



Key:

FE	Functional ground
Ethernet 1/2	Ethernet 1/2
Reset	Reset button
Service	Service interface
Local bus	Axioline F local bus (hereinafter referred to as local bus)
RJ45	RJ45 interface
	Electrical isolation for data or power supply
	Power supply unit
µC	Microcontroller
	LED
	Electrically isolated areas

6 Tested successfully: Use under extreme ambient conditions

WARNING:

In the following applications, the module is only approved for use in the temperature range from -25°C to 60°C:

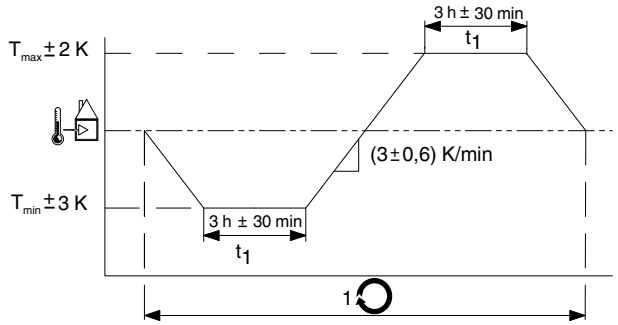
- Applications with UL approval
- Use in zone 2 potentially explosive areas

XC modules have been tested successfully over 250 temperature change cycles according to IEC 61131-2 in the range from -40°C to +70°C.

The following conditions were observed:

- The Axioline F devices for all connecting cables were connected with a minimum conductor cross-section of 0.5 mm²
- The Axioline F station was installed on a wall-mounted horizontal DIN rail
- Fans were used to ensure continuous movement of air in the control cabinet
- The Axioline F station was not exposed to vibration or shock
- The Axioline F station was operated with a maximum of 24.5 V (ensured by using electronically regulated power supply units)

Figure 2 Temperature change cycle



Temperature in the control cabinet/ambient temperature

Cycle

7 For your safety

7.1 Intended use

Use the Axioline F modules exclusively in accordance with the specifications in the accompanying data sheet and the “Axioline F: System and Installation” user manual.

If the equipment is used in a manner not specified, the protection provided by the equipment may be impaired.

7.2 Qualification of users

The use of products described in this data sheet is oriented exclusively to electrically skilled persons or persons instructed by them. The users must be familiar with the relevant safety concepts of automation technology as well as applicable standards and other regulations.

7.3 Electrical safety

WARNING: Loss of electrical safety

If used incorrectly, device safety may be impaired.

The instructions given in this data sheet as well as the UM EN AXL F SYS INST user manual must be observed during installation, startup, and operation.

7.4 Installation

Only install the Axioline F modules in a control cabinet or junction box.

CAUTION: Fire hazard

– The device must be installed in the final protective housing, which provides sufficient resistance to mechanical strain and protection against the spreading of fire in accordance with the standards UL/IEC/EN 61010-1 and UL/IEC/EN 61010-2-201.
– The supply and external circuits intended to be connected to this device shall be galvanically separated from the mains supply or hazardous live voltage by reinforced or double insulation and meet the requirements of SELV/PELV (Class III) circuits of UL/CSA/IEC/EN 61010-1, UL/CSA/IEC/EN 61010-2-201.

NOTE: Damage to the contacts

Physical overloads can result in damage to the terminal points.

- Relieve strain in the connected cables.

7.5 Security in the network

NOTE: Network security jeopardized by unauthorized access

Connecting devices to a network entails the danger of unauthorized access to the network.

Observe the following safety notes:

- If possible, deactivate unused communication channels.
- Use secure passwords reflecting the complexity and service life recommended in the latest guidelines.
- To ensure IT and OT security, operate the device only in areas that are exclusively accessible to authorized persons.
- Only allow authorized persons to access the device. Limit the number of authorized persons to the necessary minimum.
- Always install the latest firmware version. The firmware can be downloaded via the item (www.phoenixcontact.com/products).
- Observe the IT and OT security requirements and the standards applicable to your application. Take the necessary protective measures. These may include, for example, virtual networks for remote maintenance access or a firewall.
- In security-critical applications, always use the device with an additional security appliance.
  Phoenix Contact offers security appliances in the mGuard product range. The mGuard routers connect various networks for the remote maintenance and protection of the local network and protect these networks against cyberattacks.
- You must take defense-in-depth strategies into consideration when planning networks.

Additional measures for protection against unauthorized network access can be found in the “INDUSTRIAL SECURITY” application note. The application note can be downloaded via the item (www.phoenixcontact.com/products).
German: AH DE INDUSTRIAL SECURITY, 107913
English: AH EN INDUSTRIAL SECURITY, 107913

If a security vulnerability exists for products, solutions, or services from Phoenix Contact, it will be published on the PSIRT (Product Security Incident Response Team) website:
www.phoenixcontact.com/psirt

8 Installation in potentially explosive area

WARNING: Explosion hazard

Before using the device in a potentially explosive area, make sure that your device has the required approval.

The approvals are printed on the device.

WARNING: Explosion hazard

Please make sure that the following notes and instructions are observed.

- The category 3 device is designed for installation in zone 2 potentially explosive areas.
- The device satisfies the requirements of the following standards:

  EN/IEC 60079-0, EN/IEC 60079-7

  For detailed information, refer to the declarations of conformity that accompany the product. For the latest version, go to the item page at www.phoenixcontact.com/products.
- Installation, operation, and maintenance may only be carried out by qualified electricians. Follow the installation instructions as described. When installing and operating the device, the applicable regulations and safety directives (including national safety directives), as well as general technical regulations, must be observed. The safety data is listed in this document and in the certificates.
- Observe the specified conditions for use in potentially explosive areas. Also observe the requirements of IEC/EN 60079-14.
- The device must not be opened or modified. Do not repair the device yourself, replace it with an equivalent device. Repairs may only be carried out by the manufacturer. The manufacturer is not liable for damage resulting from violation.
- Do not subject the product to mechanical and/or thermal stress that exceeds the specified limits.
- The device must be stopped and immediately removed from the Ex area if it is damaged, was subject to an impermissible load, stored incorrectly or if it malfunctions.
- Electrical isolation, rated insulation voltage: 85 V DC in accordance with EN/IEC 600079-7 Annex H.

Specific conditions of use

- Install the device in such a way that a degree of protection of at least IP54 is achieved in accordance with EN/IEC 60529. To this end, a suitable, approved housing that meets the requirements of EN/IEC 60079-0, GB/T 3836.1 must be used.
- Only devices that are designed for operation in Ex Zone 2 and the conditions at the installation location may be connected to the circuits in Zone 2.
- The service interface may only be used if there is no potentially explosive atmosphere.
- In potentially explosive areas, only connect and disconnect cables and plug-in connections (e.g., connector, bus base module, SD card, etc.) when the power is disconnected.
- For safe operation, lockable plug-in connections must be fully inserted and have a functional interlock (e.g., locking clips, screw connection, etc.). Insert the interlock. Repair any damaged plug-in connections immediately.
- Only connect one cable per terminal point.
- Use only cables that are suitable for a temperature of at least 80°C.
- The air pressure during operation is limited to 106 kPa.
- Use the device in an environment that does not exceed pollution degree 2 in accordance with EN/IEC 60664-1, GB/T 16935.1.
- Use transient protection so that short-term surge voltages do not exceed 119 V.
- The switches of the device that can be accessed may only be actuated when the power supply to the device is disconnected or when it has been ensured that there is no potentially explosive atmosphere present.

Areas with a danger of dust explosions

- The device is not designed for use in atmospheres with a danger of dust explosions.

9 UL notes

- Use copper conductors only.

9.1 UL Ordinary Location

CAUTION!

– The external circuits intended to be connected to this device shall be galvanically separated from the mains supply or hazardous live voltage by reinforced or double insulation and meet the requirements of SELV/ PELV (Class III) circuits of UL/CSA/ IEC 61010-1, UL/CSA/IEC 61010-2-201.

– The device has to be installed in the final safety enclosure, which has adequate rigidity according to UL 61010-1, UL 61010-2-201 and meets the requirements with respect to spread of fire.

Information:

To install the device in accordance with UL/CSA/ IEC standard, the following notes must be observed.

– Minimum temperature rating of the cables to be connected to the field wiring terminals:

  80 °C, AWG 24 ... 16

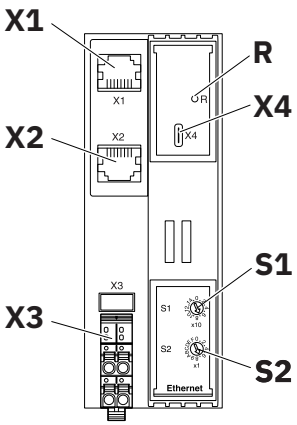
– The device is designed to be maintenance-free. Repairs are not permitted to be carried out.

9.2 UL Hazardous Location

- This device must be mounted in an enclosure certified for use in Class I, Zone 2, minimum, and rated IP54, minimum, in accordance with UL/CSA 60079-0 when used in a Class I, Zone 2 environment.
- This device is to be installed within an area of not more than pollution degree 2, as defined in IEC 60664-1.
- Only connect one cable per terminal point.
- Use only cables that are suitable for a temperature of at least 80°C.
- WARNING - Do not separate terminal blocks when energized!

10 Connections and operating elements

Figure 3 Connections and operating elements



Designation	Meaning	Note
X1	Ethernet port 1	See “Connecting Ethernet” section
X2	Ethernet port 2	
X3	Connector for connecting the supply voltage	See “Connecting the supply voltage” section
X4	Service interface	See “Service interface” section
R	Reset button	See “Reset button” section
S1, S2	Rotary encoding switch	See “Configuring the bus coupler” section

10.1 Connecting Ethernet

Connect Ethernet to the bus coupler via an 8-pos. RJ45 connector.

The Ethernet connections are set to “Auto crossover” by default.

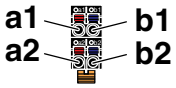
Auto crossover is only supported in auto negotiation mode.
Without auto negotiation, you can activate crossover manually in the web-based management, if necessary, using the “Manual crossover” checkbox.

Shielding
The shield of the connected twisted pair cables is electrically connected to the RJ45 socket. When connecting network segments, avoid ground loops, potential transfers, and equipotential bonding currents via the braided shield.

Observe bending radii
The housing dimensions specified under "Dimensions" refer to the bus coupler with I/O connectors without Ethernet connection. When installing the bus coupler in a control box, observe the bending radii of the Ethernet cables and the connectors used (e.g., FL CAT5 FLEX: 30 mm for fixed installation and FL CAT5 HEAVY: 30 mm without outer sheath and 45 mm with outer sheath). If required, use angled RJ45 connectors to maintain these bending radii.

10.2 Connecting the supply voltage

Figure 4 Terminal point assignment

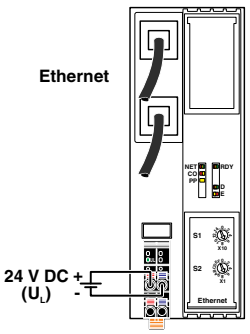


Terminal point	Color	Assignment	
Supply voltage input			
a1, a2	Red	24 V DC (U_L)	Communications power feed-in (bridged internally)
b1, b2	Blue	GND	Reference potential of the supply voltage (bridged internally)

Note the information on the power supplies in the UM DE AXL F SYS INST user manual.

Connection example

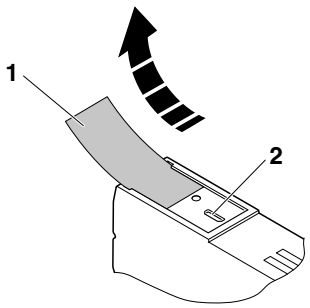
Figure 5 Connection of the cables



10.3 Service interface

The service interface is located beneath the top marking field on the bus coupler.

Figure 6 Service interface



1 Marking field

2 Service interface

Using the service interface via USB, you can connect the bus coupler to a PC on which Startup+, the startup and diagnostic tool, is running.

NOTE: Damage to the USB interface

In PCs, the USB ports are usually not electrically isolated from the rest of the hardware. This does not cause any problems for USB devices that do not have their own reference ground. However, if you connect grounded devices (e.g., the bus coupler), ground loops with undesired compensating currents may occur. These compensating currents can impair data transmission and, in extreme cases, destroy the interfaces.

Recommendation:

Connect the USB interface of the bus coupler to your PC in such a way that it is electrically isolated.
To do this, use a USB isolator.

Startup+

Startup+ offers the following functions:

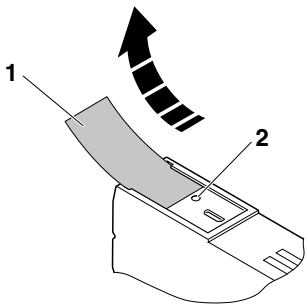
– Parameterization of the station I/O modules
– I/O check
– Diagnostics

For detailed information on Startup+, please refer to the UM QS EN STARTUP+ user manual.

10.4 Reset button

The reset button is located beneath the top marking label on the bus coupler.

Figure 7 Reset button



1 Marking field

2 Reset button

The reset button has two functions:

– Restarting the bus coupler

– Resetting of the default settings

10.4.1 Restart bus coupler

Restart the bus coupler by pressing the reset button during ongoing operation.

The outputs of the station are set to the parameterized substitute values.

The inputs are not updated during the restart.

10.4.2 Resetting to the default settings

If you wish to restore the default settings, proceed as follows:

- Disconnect the power to the module.
- Press and hold the reset button.
- Switch on the power.

The LEDs indicate the initialization phase:

LED	State	Meaning
RDY	Off	Starting firmware
RDY	Yellow on	Initializing firmware
RDY	Green	Initialization complete

- When the RDY LED lights up green, release the button.

↪ The default settings are restored.

10.4.3 Default settings

The bus coupler is supplied with the following default settings:

Password	private
IP settings	
IP address	0.0.0.0
Subnet mask	0.0.0.0
Default gateway	0.0.0.0
BootP	activated
Firmware update	
Firmware update on next restart	deactivated
TFTP server IP address	172.16.40.201
Name of firmware update file	c2701949.fw
System identification	
Name of device	AXL F BK ETH XC
Description	Ethernet bus terminal
Location	unknown
Contact	unknown
Process data monitoring	
Process data watchdog timeout	0 (deactivated)
Plug-and-play mode	activated
Behavior in case of a fault in the local bus (firmware version 1.30 or later)	Output substitute values
Access right IOL-CONF (firmware version 1.30 or later)	Full access
Hardware acceleration for Modbus/UDP	activated
Web-based management	activated

11 Configuring the bus coupler

You can configure the bus coupler in two ways:

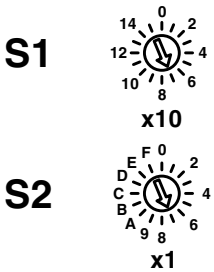
– From a higher-level PC (remote access) via a tool.
– Directly on the bus coupler using the rotary coding switches.

To configure the bus coupler via remote access, set rotary coding switches S1 and S2 to code 00. This code is preset by default in the delivery state.

If you do not want to configure the bus coupler via remote access, use rotary coding switches S1 and S2 with the codes listed in the table below to set the address and other functions.

Every time you change the switch position, restart the bus coupler. A change of the switch position during operation has no effect.

Figure 8 Rotary coding switch



The code results from the sum of S1 x 10 plus S2 x 1. The image shows code 77 (7 x 10 + 7).

S1	S2	Code	Function
0	0	00	Remote access (default)
0 ... 5	0 ... 9	01 ... 50	Manual IP address assignment
5 ... 15	0 ... 9	51 ... 159	DHCP name assignment
0	A	0A	Static IP address
0	E	0E	Resetting IP parameters
1	A	1A	Enable plug-and-play mode
1	B	1B	Disable plug-and-play mode
12	C	12C	Resetting to the default settings
14	E	14E	Extended manual IP address assignment (firmware version 1.34 or later)
Other			Reserved

11.1 Reserved/invalid switch position

The device starts with the previous settings, e.g., with the settings that were valid before the device was restarted.

An invalid switch position is indicated by the RDY LED (red on).

11.2 Remote access

Switch position 00

With this switch position, you can configure the device remotely using appropriate tools (e.g., Startup+, web-based management (WBM)).

Behavior during initial startup, after resetting the IP parameters or after resetting to default settings

Default: BootP activated, DHCP deactivated

A valid IP address is not assigned (0.0.0.0) and communication is therefore not possible.

The device transmits continuous BootP requests (2 s, 4 s, 8 s, 2 s ...), until a valid IP address has been received.

Valid IP parameters are then automatically saved as configuration data on the device.

Behavior during each additional start-up

BootP activated
Three BootP requests are transmitted even in the case of a valid configuration. If the device receives a BootP reply, the new IP parameters are applied. Otherwise the device starts with the last valid configuration.

DHCP activated
For behavior, see switch position 51 … 159. The station name can be selected in WBM. The default station name is the MAC address with “-” used as the separator.

Static (BootP and DHCP deactivated)
The device starts with the last valid assigned IP configuration.

11.3 Manual IP address assignment

Switch position 01 ... 50

BootP deactivated, DHCP deactivated

The first three octets in the IP address are preset as **192.168.0.**x.
The subnet mask is 255.255.255.0.

Specify the last byte with the switch position.

As such, you can select IP addresses between 192.168.0.**1** and 192.168.0.**50**.

Before transferring the IP address, a test is performed to check for potential IP address conflicts. If a conflict is detected, the bus coupler temporarily switches the IP address to 0.0.0.0 (no IP communication). In this case, the NET LED flashes red. Resolve the conflict and restart the bus coupler.

11.4 DHCP name assignment

Switch position 51 ... 159

This switch position is used to easily specify the DHCP host name for the device.

The host name is provided to the DHCP server via DHCP options. This is therefore able to send a DNS update to the DNS server.

The DNS name consists of a set part and a variable part. The set part is based on the order designation. You specify the variable part via the switch position.

The first part of the station name is AXL-F-BK-ETH-XC-.

The set number is added.

This results in the following station names: AXL-F-BK-ETH-XC-**051** ... AXL-F-BK-ETH-XC-**159**.

Behavior during initial startup, after resetting the IP parameters or after resetting to default settings

A valid IP address is not assigned (0.0.0.0) and communication is therefore not possible.

The device transmits continuous DHCP discover messages until a valid IP address has been received.

Behavior during each additional start-up

Within the first minute, DHCP requests are transmitted with the last valid IP address.

Three cases are possible:

1. The DHCP server accepts the desired address.
   ⇒ The device starts with this IP address.
2. The DHCP server assigns a new IP address.
   ⇒ The device applies the new IP parameters.
3. The DHCP server does not respond.
   ⇒ The device transmits continuous DHCP Discover messages until new IP parameters have been received.

11.5 Static IP address

Switch position 0A

Behavior during initial startup, after resetting the IP parameters or after resetting to default settings

A valid IP address is not assigned (0.0.0.0) and communication is therefore not possible.

Assign an address initially with another switch position.

Behavior during each additional start-up

After a voltage reset, the device maintains the IP address which was assigned last.

With this switch position, modifying the IP address via tools or web-based management is not possible.

11.6 Resetting IP parameters

Switch position 0E

The IP parameters stored on the device are reset.

All other settings made on the device are retained.

– BootP is activated for switch position 00.
– IP address, subnet mask: 0.0.0.0

As long as the switch position 0E remains selected, no connection to the device can be established.

IP communication is deactivated (LED NET static yellow).

11.7 Plug and Play mode

Switch position 1A: activate Plug and Play mode
Switch position 1B: deactivate Plug and Play mode

In Plug and Play mode, you can use the bus coupler to start up the connected local bus modules in the field without a higher-level PC (engineering system).

If plug and play mode is enabled, then the writing of process data is rejected. Read access to the process data is possible.

If Plug and Play mode is disabled, then the bus will only be commissioned if the configuration of the connected bus matches the saved configuration.

See section “Startup behavior of the bus coupler”.

11.8 Resetting to the default settings

Switch position 12C

All settings are reset to default settings, including IP parameters.

The device is ready for operation after powering up, as soon as the RDY LED lights up green.
A connection to the device however cannot be established in this switch position.
As soon as the RDY LED lights up green, a new switch position can be selected on the rotary encoding switch and the device can be restarted.

Alternatively, the default setting can also be restored via the reset button (see “Reset button”).

11.9 Extended manual IP address assignment (firmware 1.34 or later)

Switch position 14E

This switch position allows you to set a static IP address in the range 192.168.1.1 to 192.168.1.254.

BootP deactivated, DHCP deactivated

Activate "Extended manual IP address assignment"

- Set the rotary coding switches to S1 = 14, S2 = E.
- Switch on the bus coupler or carry out a voltage reset.

↪ The NET LED briefly flashes yellow/red after power-up.

↪ The extended manual IP address assignment is activated.

The first three octets in the IP address are preset as **192.168.1**.x.
The subnet mask is 255.255.255.0.

Specify the last byte with the switch position.

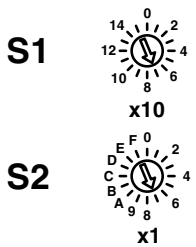
- Use the rotary coding switches to set the last octet of the desired IP address (see tables below).
- Restart the bus coupler by pressing the reset button or performing a voltage reset.

↪ The IP address has been applied.

Before transferring the IP address, a test is performed to check for potential IP address conflicts. If a conflict is detected, the bus coupler temporarily switches the IP address to 0.0.0.0 (no IP communication). In this case, the NET LED flashes red. Resolve the conflict and restart the bus coupler.

Rotary coding switches in "Extended manual IP address assignment" mode

Figure 9 Rotary coding switch



The code results from the sum of S1 x 16 plus S2 x 1. The figure shows the code 119 (7 x 16 + 7).

S1	S2	Code	Meaning
0	0	00	Remote access (default)
0 ... 15	0 ... F	1 ... 254	Last octet in the IP address
15	F	15F	Reserved

Possible IP addresses			
S1	**S2**	**IP address**	
0	1	192.168.1.	1
0	2	192.168.1.	2
...	...	...	...
0	F (15_{dez})	192.168.1.	15
1	0	192.168.1.	16
...	...	...	...
1	F (15_{dez})	192.168.1.	31
2	0	192.168.1.	32
...	...	...	...
2	F (15_{dez})	192.168.1.	47
3	0	192.168.1.	48
...	...	...	...
3	F (15_{dez})	192.168.1.	63
...	...	...	...
14	0	192.168.1.	224
...	...	...	...
14	15	192.168.1.	239
15	0	192.168.1.	240
...	...	...	...
15	E (14_{dez})	192.168.1.	254

In "Extended manual IP address assignment" mode, the rotary coding switches are only available for assigning IP addresses. All other functions that you can otherwise select using the rotary coding switches are deactivated.

To switch plug-and-play mode on or off, use the WBM or the Modbus commands.

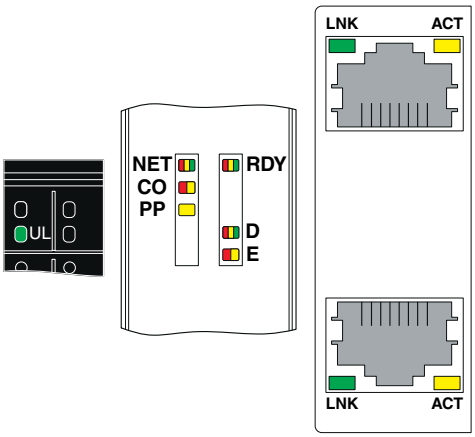
In switch position 00, all settings are retained but can be changed remotely (e.g., via the WBM).

Deactivate "Extended manual IP address assignment"

- Set the rotary coding switches to S1 ≠ 14, S2 ≠ E.
- Use the reset button to reset the device to its default settings (see Section "Reset button").

12 Local diagnostic and status indicators

Figure 10 Local diagnostic and status indicators



Designation	Color	Meaning	State	Description
UL	Green	U_{Logic}	On	Communications power supply present.
			Off	Communications power supply not present.
NET	Green/ yellow/ red	Network status	Green on	At least one connection has been established to the device.
			Flashing green	A connection can be established to the device.
			Yellow on	IP configuration (IP address) is invalid (0.0.0.0).
			Flashing yellow	BootP requests or DHCP requests/discover messages are being transmitted.
			Flashing yellow/red	Brief flashing after power-up: Extended manual IP address assignment (firmware version 1.34 or later)
			Red on	Network error; the process data watchdog was activated, the substitute value behavior of the outputs is performed.
			Red flashing	An IP address conflict has occurred during static configuration via rotary coding switches (IP address assigned twice).
			Off	Device is not ready for operation.
CO	Yellow/ red	Configuration	Yellow on	Parameterization of the I/O modules failed.
			Red on	The active configuration of the local bus differs from the saved configuration.
			Off	The active configuration of the local bus matches the saved configuration.
PP	Yellow	Plug-and-play mode	On	Plug-and-play mode is enabled.
			Off	Plug-and-play mode is disabled.

Designation	Color	Meaning	State	Description
RDY	Green/ yellow/ red	Ready	Green on	Device is ready for operation.
			Flashing green/ yellow	Communications power undervoltage or surge voltage
				Overtemperature
			Yellow on	Firmware/bus coupler is booting.
			Flashing yellow	Firmware update is being performed.
			Flashing yellow/red	Firmware update has failed. Check the firmware file and the settings.
			Red flashing	Faulty firmware. Carry out a firmware recovery update.
			Red on	Rotary encoding switches are set to an invalid/reserved position.
			Off	Device is not ready to operate. Check the supply voltage.
D	Red/ yellow/ green	Diagnostics of local bus communication		
		Run	Green on	The station is ready for operation; communication within the station is OK. All data is valid. An error has not occurred.
		Active	Flashing green	The station is ready for operation. Communication within the station is ok. The data are **not** valid. The controller or higher-level network is not providing valid data. There is no fault in the module.
			Flashing green/ red	A rest system will be operated; at least one device of the configuration is not available.
		Ready	Yellow on	The station is ready for operation. No data are being exchanged.
		Connected	Flashing yellow	Access from Startup+ in I/O check mode
			Flashing yellow/red	Local bus error during active I/O check (with connected Startup+)
		Not connected	Red flashing	Local bus error on startup
				Possible causes:
				The configuration cannot be generated. Information from at least one device is missing.
				Chip version of a device is <V1.1
				The desired and actual configuration are different
				No local bus device connected
				The maximum number of local bus devices is exceeded.
		Reset	Red on	The station is ready for operation but has lost connection to at least one device.
				Possible causes:
				Communication error
				Local bus device has been removed or configured device is missing.
				Reset at a local bus device
				Serious device error at a local bus device (local bus device can no longer be reached)
		Power down	Off	Device is in (power) reset or in energy-saving mode.

Designation	Color	Meaning	State	Description
E	Yellow/ red	Error	Yellow on	I/O warning at a local bus device
			Red on	I/O error at a local bus device
			Off	No I/O messages present.
LNK 1/2	Green	Link port 1/2	On	Connection via Ethernet to a module via port 1/2 established
			Off	No connection established via port 1/2
ACT 1/2	Yellow	Activity port 1/2	Flashing	Transmission or reception of Ethernet telegrams at port 1/2
			Off	No transmission or reception of Ethernet telegrams at port 1/2

If your station only contains input modules,
write “0” to register 9000 at least once after each restart of the bus coupler in order to ensure that the process data is valid. The D LEDs on the bus coupler and the local bus devices will switch from flashing green to steady green. As an alternative, write “0” to register 9000 periodically.

13 Startup behavior of the bus coupler

13.1 Plug and Play mode

Plug-and-play mode enabled

The bus coupler supports Plug and Play mode.

In Plug and Play mode, you can use the bus coupler to start up the connected local bus modules in the field without a higher-level PC (engineering system).

The plug-and-play mode status (enabled or disabled) is stored retentively on the bus coupler. The current status is displayed via the PP LED.

In plug-and-play mode, the connected local bus modules are detected (type and installation sequence).

If this physical configuration is ready to operate, it is started; however, writing outputs is not enabled.

To enable writing outputs, Plug and Play mode must be deactivated. The deactivation is to be saved at the same time as saving the signal, active configuration, and reference configuration.

Plug-and-play mode disabled

When plug and play mode is deactivated, the reference configuration is compared to the physical configuration. If the configurations are identical, the bus coupler is set to the RUN state on the first write access.

If the reference configuration and the physical configuration differ, the LED CO lights up red. In this case, process data exchange is not possible for safety reasons.

In order to operate the bus despite this, you have the following two options:

1. Restore the original configuration so that the reference configuration and the physical configuration are the same again.
2. Activate plug-and-play mode and restart the bus coupler so that the active physical configuration is accepted as the reference configuration.

13.2 Behavior in case of a fault in the local bus

Firmware version 1.30 or later.

In case a fault occurs in the local bus, you can parameterize the behavior of the outputs of the I/O modules that can be reached. You have the following options:

– The outputs remain in operation.
– The outputs output the parameterized substitute values.

A fault in the local bus can be caused by a bus interruption or a missing I/O module.

The inputs of all I/O modules that can be reached can always be read in.

Parameterize the behavior via web-based management or Modbus register 2011.

13.3 Startup parameterization

Some Axioline F modules can be parameterized (e.g., measuring ranges, substitute value behavior in the event of a bus error).

There are two ways to parameterize these modules:

– Parameterization via the Startup+ software.
– Parameterization via the PDI channel from a user program of a higher-level controller.

13.3.1 Parameterization via the Startup+ software

On power up, the bus coupler can take care of the startup parameterization of the local bus modules. To do this, a configuration file must be loaded in the bus coupler.

You can generate the file with Startup+ and store it on the bus coupler via Modbus/TCP or FTP. See UM QS EN STARTUP+.

The bus coupler transmits the parameters from the configuration file to the connected local bus modules during startup.

As the config.svc configuration file overwrites the parameters stored in the file on the module each time it is powered up, the parameters are always up-to-date.

This makes it easy for you to replace the local bus modules.

If you replace the bus coupler: download the configuration file to the bus coupler before replacing it.

Note that when starting up using a configuration file, any parameters saved on the module will be overwritten.

13.3.2 Parameterization via the PDI channel

Access to the parameters of the I/O modules and the parameters of lower-level subsystems (IO-Link) is explained in the section “Access to PDI objects”.

The parameterization is stored retentively on the I/O modules. This means that this information only has to be written once upon system startup.

When Plug and Play mode is deactivated, the bus coupler checks the parameterization of the I/O modules and the bus configuration. After the bus configuration has been changed (for example, a module has been replaced), the bus coupler will prevent process data from being written; bit 3 is set in the status register (7996), and the CO LED lights up yellow. Adapt the parameterization if necessary. Acknowledge the parameterization with code 0008_{hex} in the command register (2006). The bus coupler will now allow process data to be output.

14 Monitoring of Ethernet communication

Ethernet communication is monitored by a process data watchdog.

The following actions are monitored:

– Client application
– Ethernet connection
– Process data exchange

If the timeout period for the activated process data watchdog has expired, OUT process data is blocked. The parameterized substitute value behavior of I/O modules is executed. The LED NET (red on) signals the error.

In this state (Net Fail), the application can continue to update OUT process data. After a Net Fail reset, the substitute values are replaced by the latest process data.

NOTE: Deactivated process data watchdog: In the event of a connection abort, outputs retain their last state

The process data watchdog is deactivated by default.

Activate the process data watchdog before starting up an application.

Function of the process data watchdog

If station outputs are set, the controlling process must be able to access the station.
In the event of an error, e. g. a network cable is interrupted or there is a function error in the controlling process, the bus coupler can respond appropriately via the process data watchdog.

When you activate the process data watchdog, it is started by the first write process. It expects the next write process within the timeout period. In error-free operation, the write process is performed during the timeout period. The watchdog is then restarted (triggered).

Read requests do not trigger the process data watchdog.

Net Fail

If there is no triggering during the timeout period, an error has occurred. Two responses follow:

– All outputs are set to the configured substitute value.
– The Net Fail signal is set (NET LED red on and bit 1 is set in status register 7996).

For safety reasons, users cannot stop the watchdog once it has been activated.
If a user terminates the controlling application, the watchdog is not triggered. As soon as the timeout period has elapsed, the Net Fail signal is set. In addition, the parameterized substitute value behavior is executed. After the watchdog has been triggered, the outputs will not be enabled again until it is acknowledged.

Acknowledge error message

To reset the error, it must be acknowledged.

The following options are available:

– Web-based management
– Modbus command register 2006

When the error is acknowledged, the watchdog is restarted. This means that it must be triggered during the timeout period, otherwise an error is detected again.

Configuring the process data watchdog

- To activate the watchdog, specify the desired timeout value in the range between 200 ms and 65000 ms.
- To deactivate the watchdog, specify the value 0.

The following options are available for changing the timeout value:

– Web-based management
– Modbus register 2000

15 Monitoring of communications power U_L (UL-Monitor)

A monitoring function monitors the supply of communications power U_L. If the value is outside the specified voltage range, this is indicated in status register 7996.

Undervoltage	
Bit 12	Set as long as the communications power is too low.
Bit 14	Still set after a brief undervoltage.

Surge voltage	
Bit 13	Set as long as the communications power is too high.
Bit 15	Still set after a brief surge voltage.

Very brief voltage disturbances are also registered with bits 14 and 15. Both bits remain set until the UL monitor has been acknowledged with code 0080_{hex} via command register 2006.

16 Substitute value behavior

If Ethernet communication fails or an error occurs in the local bus, all outputs of the station are set to the substitute values previously parameterized on the module.

In order to do this, plug-and-play mode must be disabled and the process data watchdog must be activated.

For the possible substitute values of a module, please refer to the relevant module-specific data sheet.

17 Modbus protocols and registers

The bus coupler supports a Modbus/TCP server and a Modbus/UDP server.

The Modbus protocol can be used in both in a connection-related (TCP) and wireless (UDP) manner.

17.1 Modbus connections

Modbus/TCP

The bus coupler supports up to eight Modbus/TCP connections simultaneously.

The connection can access different addresses simultaneously.

Since eight connections are supported, a connection can quickly be restored. This means that the client can successfully restore an interrupted Modbus connection.

Modbus/UDP

The UDP server is wireless.

In applications with high demands on the response time, it is recommended that Modbus/UDP is used to access the process data. In this case, the runtime in the bus coupler is negligible (just a few µs).

Modbus/TCP and Modbus/UDP

The procedures for interlocking or priority switching of the client are not implemented.

17.2 Modbus interface

The Modbus interface of the bus coupler supports Modbus communication in accordance with standard port 502.

17.3 Modbus conformance classes

The bus coupler supports Modbus conformance class 0.

17.4 Modbus function codes

The following function codes are supported:

Function code	Function	Description
FC3	Read holding registers	Read words from outputs and inputs
FC4	Read input registers	Read words from inputs
FC6	Write single registers	Write word for output data
FC16	Write multiple registers	Write several output words
FC23	Read/write multiple registers	Read and write several process data for inputs and outputs

17.5 Modbus register

Modbus register table (16-bit word)	Access	Function	Access with function code
Local bus configuration			
1400	R	Number of local bus devices/entries	FC3, FC4
1401 ... 1652	R	Device type of local bus devices (4 registers per device)	
1700	R	Number of local bus devices/entries	
1701 ... 1763	R	Number of process data registers (8xxx or 9xxx) for local bus devices (one register per device)	
1800	R	Number of local bus devices/entries	
1801 ... 1989	R	Peripheral diagnostics of the local bus device (three registers per device)	
Special register			
2000	R/W	Timeout for process data watchdog	FC3, FC4, FC6, FC16
2006	W	Command register	FC6, FC16
2011	R/W	Behavior in case of a fault in the local bus (firmware version 1.30 or later)	FC3, FC4, FC6, FC16
2012	R/W	Access right IOL-CONF (firmware version 1.30 or later)	FC3, FC4, FC6, FC16
2013	R/W	Hardware acceleration for Modbus/UDP (firmware version 1.32 or later)	FC3, FC4, FC6, FC16
2014	R/W	Web-based management (firmware version 1.32 or later)	FC3, FC4, FC6, FC16
2050	R	Ethernet port status (firmware version 1.35 or later)	FC3, FC4
2075 ... 2089	R	Electronic rating plate	FC3, FC4
PDI			
6010 ... 6089	R/W	Tunnel register for PDI requests (channel 1 ... 8)	FC3, FC4, FC6, FC16, FC23
6210 ... 6289	R	Tunnel register for PDI confirmations (channel 1 ... 8)	FC3, FC4, FC23
Diagnostics			
7996	R	Status register	FC3, FC4, FC23
7997	R	Diagnostic status register	
7998	R	Diagnostic parameter register 1	
7999	R	Diagnostic parameter register 2	
Process data			
8000 ... 8999	R	Input process data	
9000 ... 9999	R/W	Output process data	FC3, FC4, FC6, FC16, FC23

R Read
W Write

In write access to the Modbus/TCP clients on the “Read only” register, the data is not transferred. The answer is exception code 02.

17.6 Figure showing process data on Modbus registers (8000 ... 8999, 9000 ... 9999)

The process data of the modules connected to the bus coupler are mapped to a register area. Registers are assigned the same way for all function codes. They are not differentiated according to the data types implied in the function codes (e.g., Modbus register and Modbus input register).

For address assignment, all input process data of the connected modules is mapped according to the physical bus configuration from Modbus register 8000 (up to 8999, maximum).
All output process data is mapped according to the physical bus configuration from Modbus register 9000 (up to 9999, maximum).

A number of registers is assigned to each module according to the data width. Each register comprises 16 bits. A module with a data width of 8 bits is mapped on one register, a module with 32 bits is mapped on two registers.

No distinction is made between digital and analog modules.

The current mapping of process data to the Modbus register for the I/O modules connected to the bus coupler can be viewed via the web-based management for the bus coupler under “Modbus/TCP (UDP), Modbus I/O table”.

Example: figure of process data on the Modbus register

Example of a station						
AXL F BK ETH XC	AXL F DI16/4 XC 2F	AXL F AO8 XC 1F	AXL F DI32/1 XC 1F	AXL F DI8/1 DO8/1 XC 1H	AXL F AI8 XC 1F	AXL F CNT2 INC2 XC 1F

	Input process data			Output process data		
AXL F DI16/4 XC 2F	8000	Byte 0	Byte 1	9000	-	-
		Channel 8 ... 1	Channel 16 ... 9			
AXL F AO8 XC 1F	8001	IN1		9001	OUT1	
	8002	IN2		9002	OUT2	
	...	...		...	...	
	8008	IN8		9008	OUT8	
AXL F DI32/1 XC 1F	8009	Byte 0	Byte 1	9009	-	-
		Channel 8 ... 1	Channel 16 ... 9			
	8010	Byte 2	Byte 3	9010	-	-
		Channel 24 ... 17	Channel 32 ... 25			
AXL F DI8/1 DO8/1 XC 1H	8011	-	Byte 0	9011	-	Byte 0
			Channel 8 ... 1			Channel 8 ... 1
AXL F AI8 XC 1F	8012	IN1		9012	-	-
	...	...		...	...	
	8019	IN8		9019	-	-
AXL F CNT2 INC2 XC 1F	8020	Word 0		9020	Word 0	
	...	...		...	...	
	8033	Word 13		9033	Word 13	
	...	Reserved		...	Reserved	
	8999	Reserved		9999	Reserved	

For further information on the assignment of bytes and words, please refer to the module-specific documentation (data sheet, user manual).

Unused registers, such as if there are dedicated input or output modules, are marked with “-” in the table. Write access to this register has no effect. Read access always returns the value 0.

17.7 Register tables for the local bus configuration (1400 ... 1652 / 1700 ... 1763)

Both register tables map the currently loaded bus configuration frame of the connected devices.
When plug-and-play mode is enabled, the bus configuration frame that is physically present is sent.
When plug-and-play mode is disabled, the stored reference configuration is sent.
Any differences between the stored reference configuration and the bus configuration that is physically present are indicated by diagnostic registers 7997 to 7999. The register tables can be used to monitor the bus configuration in the user application. The entire table can always be read. The “Number of entries” register indicates how many entries there actually are.

Register table for DeviceType (1400 ... 1652)

DeviceType is a manufacturer-specific module identification. It can be used to replace and operate modules of the same type within a bus configuration. For example, you can replace a 16-channel output module with screw connection technology by a module with spring-cage connection technology even though it does not have the same order number. On the other hand, a different functionality (such as 32 channels instead of 16) is indicated by a different DeviceType.
In this case the DeviceType acts as a uniquely assigned ID, but the module functionality cannot be directly derived from it (such as by evaluating a specific bit). If this is necessary, use the relevant PDI objects for this (see the module-specific data sheet).

Register table layout

Index	Contents	
1400	Number of entries	1 ... 63
1401	DeviceType	1st device
1402		
1403		
1404		
...	...	...
1649	DeviceType	63rd device
1650		
1651		
1652		

Register table for the number of process data registers (1700 ... 1763)

This register table indicates the number of registers occupied by each device in the process data register tables (8000...8999, 9000...9999). This information can be used to dynamically adapt the user application to changes in the bus configuration. The offset for the relevant device in the process data register table can therefore be calculated in the user application.

Register table layout

Index	Contents	
1700	Number of entries	1 ... 63
1701	Number of process data registers	1st device
...	...	...
1763	Number of process data registers	63rd device



The device type of a module can be found in the module-specific data sheet or in the application note “AXL F/AXL SE DEVICE TYPE - OBJECT 0x0037”.

17.8 Register table for I/O diagnostics (1800 ... 1989)

The register table maps the error number, priority, channel/group/module, and error code information contained in diagnostic object 0018_{hex} for every device.

For every device, the first message is displayed with the highest priority.

You can view the entire table at any time.

This table should not be read cyclically. Bits 0 and 1 in diagnostic status register 7997 indicate that an error message is present. This register can be read cyclically together with the process data. If either of these bits is set, read the registers for peripheral diagnostics acyclically.

Modbus register	Device	High byte	Low byte
1800	1 ... 63	Number of valid entries (number of devices)	
1801	1.	Error number	
1802		Priority	Channel/ group/ module
1803		Error code	
...	...	...	...
1987	63rd	Error number	
1988		Priority	Channel/ group/ module
1989		Error code	

For details of the contents of the fields for error number, priority, channel/group/module, and error code from PDI object 0018_{hex}, please refer to the module-specific documentation (data sheet, user manual).

17.9 Command register (2006)

You can control the bus coupler behavior using the command register. Only write access is enabled for the register.
If the requests are invalid (codes that are not supported), then an error message will be returned.

Code (hex)	Meaning
0000	No action
0001	Enable plug-and-play mode
	applied only following restart
0002	Disable plug-and-play mode
	Applied immediately
0008	Acknowledge startup parameterization
	Applied immediately; parameterization is permanently acknowledged; in other words, a subsequent restart does not result in another message
	For startup parameterization, see “Startup behavior of the bus coupler, startup parameterization”.
0010	Set Net Fail
0020	Acknowledge Net Fail
0080	Reset UL-Monitor (see “Monitoring of communications power U_L”)
8F00	Restart bus coupler
8F01	Read parameter file again (config.svc)
The following codes are no longer supported as of firmware 1.32. Use tabs 2013 (hardware acceleration) and 2014 (web-based management) instead.	
0400	Activate hardware acceleration for Modbus/UDP
	applied only following restart
0800	Deactivate hardware acceleration for Modbus/ UDP
	applied only following restart
8100	Deactivate web-based management
8101	Activate web-based management

When commands $8F00_{hex}$ and $8F01_{hex}$ are being executed, the substitute value behavior of the outputs is active.

The hardware acceleration for Modbus/UDP shortens the processing time for Modbus/UDP requests. It is enabled by default.
In the event of compatibility problems, deactivate the hardware acceleration using code 0800_{hex} in the command register and perform a restart. This setting is stored retentively.

17.10 Behavior in the event of a fault in the local bus (2011)

Firmware version 1.30 or later.

In case a fault occurs in the local bus, you can parameterize the behavior of the outputs of the I/O modules that can be reached. You have the following options:

Code (hex)	Meaning
0000	Output substitute values (default)
0001	Continue to operate the residual system

You have read and write access to the register.

17.11 Access right IOL-CONF (2012)

Firmware version 1.30 or later.

Using this register, you can parameterize how the IOL-CONF software can access the bus coupler.

Code (hex)	Meaning
0000	Full access (default)
0001	Read only
0002	Disabled

You have read and write access to the register.

17.12 Hardware acceleration for Modbus/UDP (2013)

Firmware version 1.32 or later.

The hardware acceleration for Modbus/UDP shortens the processing time for Modbus/UDP requests. It is enabled in the delivery state.

In the event of compatibility problems, you can use this object to disable hardware acceleration.

The parameter is stored retentively.

The parameter is reset to the default value by resetting to the default settings.

The selected setting will not take effect until the bus coupler has been restarted.

Code (hex)	Meaning
0000	Disabled
0001	Enabled (default)

17.13 Web-based management (2014)

Firmware version 1.32 or later.

Web-based management (port 80) can be parameterized via this tab. WBM is enabled in the delivery state.

The parameter is stored retentively.

The parameter is reset to the default value by resetting to the default settings.

The selected setting will not take effect until the bus coupler has been restarted.

Code (hex)	Meaning
0000	Disabled
0001	Enabled (default)

17.14 Ethernet port status (2050)

Firmware version 1.35 or later.

The register indicates the status of the Ethernet ports. Each bit has a meaning. Multiple bits can be set simultaneously.

Bit	Code (hex)	Meaning	
0	0001	Port X1 admin status	
		1	Port activated
1	0002	Port X1 link status	
		1	Link up
		0	Link down
2, 3	ENUM	Port X1 speed	
		0	Down
		1	10 Mbps
		2	100 Mbps
4 ... 7		Reserved	
8	0100	Port X2 admin status	
		1	Port activated
9	0200	Port X2 link status	
		1	Link up
		0	Link down
10, 11	ENUM	Port X2 speed	
		0	Down
		1	10 Mbps
		2	100 Mbps
12 ... 15		Reserved	

17.15 Electronic rating plate (2075 ... 2089)

The electronic rating plate contains the basic information on the module.

Only read access is enabled to the registers.

These registers should be seen as an object index and can be longer than 2 bytes. Therefore only access the registers one after another.

Modbus register	Function	Maximum length of the register in bytes
2075	Name of device	250
2076	Description	250
2077	Location	250
2078	Contact	250
2079	Boot loader version	4
2080	Firmware version	6
2081	Firmware status	8
2082	Hardware version	8
2083	Firmware date	8
2084	Hardware date	8
2085	Serial number	20
2086	MAC address	18
2087	Item No.	20
2088	Order designation	32
2089	Vendor name	20

17.16 Status register (7996)

The status register indicates the status of the bus coupler. Each bit has a different meaning. Several bits can be set simultaneously. No bit is set in normal operation without errors.

Bit	Code (hex)	Meaning	
0	0001	1	An error occurred (e.g., a bit is set in the diagnostic status register (7997))
		0	No errors have occurred.
1	0002	1	A Net Fail occurred; substitute values active
		0	No Net Fail occurred.
2	0004	1	Active bus configuration does not match the reference configuration
		0	No error
3	0008	1	Startup parameterization is faulty
		0	No error
4	0010	1	Plug-and-play mode is enabled.
		0	Plug-and-play mode is disabled.
5	0020	1	Startup not completed
		0	Startup completed
6	0040		Reserved
7	0080		Reserved
8	0100	1	Overtemperature of the device
		0	Normal temperature
9	0200		Reserved
10	0400		Reserved
11	0800		Reserved
12	1000	1	U_L-Monitor: communications power too low
		0	Voltage OK
13	2000	1	U_L-Monitor: communications power too high
		0	Voltage OK
14	4000	1	U_L-Monitor: communications power too low (acknowledge code 0080_{hex} via register 2006)
		0	No error stored
15	8000	1	UL-Monitor: communications power too high (acknowledge code 0080_{hex} via register 2006)
		0	No error stored

17.17 Diagnostic status register (7997)

Information on the operating and error states of the Axioline F local bus is stored in the diagnostic status register of the bus coupler. A state of the Axioline F local bus is assigned to each bit in the diagnostic status register.

The states in the error bits are described in greater detail using the two diagnostic parameter registers.

The following bits are error bits:

F_PW_BIT, F_PF_BIT, F_BUS_BIT, F_CTRL_BIT

Structure of the diagnostic status register

Bit	Designation	Meaning	
0	F_PW_BIT	I/O warning	At least one device indicates an I/O warning.
1	F_PF_BIT	I/O error	At least one device indicates a peripheral fault.
2	F_BUS_BIT	Bus error	A bus error has occurred.
3	-	Reserved	
4	-	Reserved	
5	F_RUN_BIT	Run	Data cycles are being exchanged, the output data is enabled.
6	F_ACTIVE_BIT	Active	Configuration is active, PDI to the devices is possible, data exchange with invalid/non-enabled process data.
7	F_READY_BIT	Ready	The local bus master is ready for operation, no data exchange over the bus.
8	F_BD_BIT	Bus different	A device which does not belong to the current configuration has been detected at the last interface.
9	F_BASP_BIT	SYS_FAIL	The controller is in the STOP state or no application program has been loaded. The output data is blocked (substitute value behavior is active).
10	F_FORCE_BIT	Force Mode	Force mode (startup tool/I/O check is active).
11	F_SYNC_BIT	Synchronization	Synchronization between higher-level system and local bus master has failed.
12	F_PARA_REQ	Module parameter	At least one device is requesting parameters.
13 ... 15	-	Reserved	

READY, ACTIVE, RUN status displays

The READY, ACTIVE, and RUN status displays show the current state of the local bus system.
The diagnostic parameter register is not used.

After the self-test, the local bus master is ready for operation.
The READY indicator bit is set (F_READY_BIT = 1).

If the local bus master is configured and the configuration frame has been activated without errors, the system indicates that it is active.
The READY and ACTIVE indicator bits are set (R_READY_BIT = 1, R_ACTIVE_BIT = 1).

In addition, the RUN indicator bit is set (F_READY_BIT = 1, F_ACTIVE_BIT = 1 and F_RUN_BIT = 1) when the data exchange is started.



I/O errors are displayed until the fault has been removed.



For further information on the error codes in the registers, refer to the UM EN AXL F SYS DIAG user manual.

Error indicators

The PF, BUS, CTRL, and SYNC error indicators report an error, while PW reports a warning.

17.18 Diagnostic parameter register (7998, 7999)

The diagnostic parameter registers are always written to when a malfunction occurs and whenever one of the error bits is set. Otherwise, the diagnostic parameter registers have the value 0000_{hex}.

When the error bits are set, the diagnostic parameter registers provide additional information on the status indicated in the diagnostic status register.

Error code

This register contains additional information in the form of an error code.

Further information on the error codes can be found in the UM EN AXL F SYS DIAG user manual.

Error location

In the case of localized local bus errors, the register provides the error location.

18 Access to PDI objects

18.1 General access to PDI objects

Within an Axioline F station, i.e., between Modbus/TCP and the I/O modules, the Axioline F local bus handles the data transmission. First and foremost, process data is transmitted in real time. Along with the process data, parameters, diagnostics, and information are all transmitted acyclically on demand in the form of objects in the so-called PDI channel.
Each Axioline F device displays its parameters, diagnostic values, and information in objects (the PDI objects).

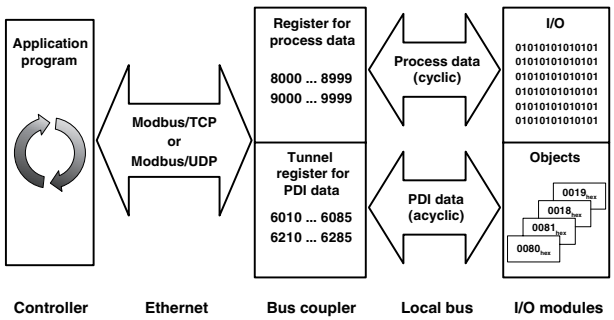
The objects are addressed via an object index (e.g., 0018_{hex}: DiagState). For detailed information on the objects present on a module, please refer to the module-specific documentation.

The PDI objects are transmitted in the PDI channel in a structure consisting of the header and data.
The header consists of the command code, device address (slot, subslot), object index, and length of the data. The structure and examples can be found in the following sections.

Objects created in the Axioline F device can be accessed via the PDI channel using services. These objects can be used, for example, to set measuring ranges, to specify the substitute value behavior of outputs in the event of a bus error or to read diagnostic details.

For Axioline F stations that can be operated with a bus coupler for Ethernet, you can access the PDI channel via both Modbus/TCP and Modbus/UDP. Register sets (6010 … 6085 and 6210 … 6285) are used for this, with which a tunnel method can be implemented. This method is explained below.

Figure 11 Access to PDI objects



18.2 Access to acyclic objects of lower-level subsystems (e.g., IO-Link)

You can also use sub-bus masters in Axioline F stations, which support lower-level sub-bus devices.

Sub-bus devices are, for example, IO-Link devices on a lower level than an IO-Link master (e.g., AXL F IOL8, AXL SE IOL4).

You can access objects of lower-level subsystems in the same way as PDI objects. See section below.

Use the “Subslot” field to address a sub-bus device.

For access with a subslot not equal to 0, the data is automatically forwarded by the sub-bus master to the lower-level device via the lower-level acyclic channel (e.g., ISDU for IO-Link).
For IO-Link, ISDU access requires the port number (1 ... n).

For a description of the objects, please refer to the specification of the relevant lower-level system or to the data sheet of the connected device.

18.3 Function description

For access to PDI objects, the bus coupler supports eight Modbus PDI communication channels. In the application, assign them to Modbus clients without causing a conflict.

Modbus PDI channels and associated Modbus registers:

Modbus PDI communication channel			
1	**2**	**...**	**8**
PDI request			
6010 ... 6015	6020 ... 6025	...	6080 ... 6085
PDI confirmation			
6210 ... 6215	6220 ... 6225	...	6280 ... 6285

NOTE: Data loss

Use an appropriate channel assignment to ensure that one channel is only used by one client at all times.

Each Modbus PDI channel features a request table and confirmation table.

The data necessary for a PDI request (PDI read or PDI write) is written to the request table by means of Modbus write access (FC16/FC23).

Subsequently, the PDI confirmation is read out of the confirmation table via Modbus read access (FC3, FC4, FC23).

You can conveniently use the PDI service with Modbus function code FC23. Using FC23, you can access the request table (write, e.g., to 6010) and the confirmation table (read, e.g., from 6210).

The confirmation table can only be accessed as read-only, whereas both read and write access are enabled for the request table. In the case of read-only access to the request table, the most recently written data is output (not the PDI confirmation).

The 6xx5 data registers (e.g., 6015, 6215) have a “virtual length”. This means that data can be transmitted, as long as the maximum length of the Modbus telegram is not exceeded. The data is mapped internally, but not directly, to the following registers, thereby ensuring a higher packing density for the PDI channels. Modbus function codes that allow access to multiple registers in one request (FC3, FC16 or FC23) must be used for access.
For example, register 6215 functions as a start address. Always use the maximum length of 125 words as the register number for read access to a PDI object (PDI read). For write access to a PDI object (PDI write), use the corresponding length. See the following examples.

Read access to the confirmation table is granted with a specified length. The specified number of registers is always returned. If the actual data length is lower (such as if the PDI object is smaller or contains a negative confirmation), then all remaining registers are filled with “0000”. The “Number of PDI data bytes” field contains the actual length of the PDI object. If the actual length is longer, only the requested data is returned.

18.4 Structure of the Modbus PDI communication channels

Modbus PDI communication channel 1							
PDI request				PDI confirmation			
Modbus register	Byte	Meaning		Modbus register	Byte	Positive response	Negative response
6010	0	Command code		6210	0	Message code	Message code
	1				1		
6011	2	Slot		6211	2	Slot	Slot
	3				3		
6012	4	Subslot		6212	4	Subslot	Subslot
	5	Reserved			5	Reserved	Reserved
6013	6	PDI object index		6213	6	PDI object index	PDI object index
	7				7		
6014	8	Subindex		6214	8	Subindex	Subindex
	9	Number of PDI data bytes			9	Number of PDI data bytes	0
6015	10	Data byte 0		6215	10	Error class	Error class
	11	Data byte 1			11	Error code	Error code
6016*	12	Data byte 2		6216*	12	Data byte 0	Additional error code
	13	Data byte 3			13	Data byte 1	
6017*	14	Data byte 4		6217*	14	Data byte 2	
	15	Data byte 5			15	Data byte 3	
...	...	...		...	...	...	

Command code

0041_{hex}	Read PDI object	(PDI read request)
0042_{hex}	Write PDI object	(PDI write request)

Message code

8041_{hex}	Response to “Read PDI object” (PDI read confirmation)
8042_{hex}	Response to “Write PDI object” (PDI write confirmation)

Slot

Position of the module in the local bus

Subslot

Specify a subslot if you wish to access a submodule (such as IO-Link).

PDI object index

See module-specific data sheet.

PDI object subindex

See module-specific data sheet.

Number of PDI data bytes

For command code

0041_{hex}	0
0042_{hex}	Amount of data to be written in bytes

For message code

8041_{hex}	Amount of data read in bytes
8042_{hex}	0

Error class, error code

0000_{hex}:	No error
$\neq 0000_{hex}$:	An error has occurred; negative response ID of error message

Additional code

More detailed information about the error cause.

Should an error occur, the error message details the error class, error code, and additional code.

For the meaning of the error codes for the Axioline F bus errors and Axioline F I/O errors, please refer to the AXL F SYS DIAG user manual.

Note that the data range for requests begins in a different register than that for confirmations.

– Request: data word 0 to register 60x5
– Confirmation: data word 0 to register 60x6

18.5 Example: read PDI object

The PDI read service can be conveniently used with the Modbus function code FC23 (read/write).

Alternatively, you can use FC16 (write) and FC3 (read).

The content of the VendorID object (manufacturer identification) of the first module after the bus coupler must be read.

To this end, PDI channel 1 (6010/6210) should be used.

Read request

Write the following values via FC16 or FC23 to register 6010 and onwards.

Modbus register	Byte	Contents (hex)	Meaning	
6010	0	00	Command code	Read PDI object
	1	41		
6011	2	00	Slot	1st local bus device
	3	01		
6012	4	00	Subslot	No subslot
	5	00	Reserved	Reserved
6013	6	00	PDI object index	0002_{hex}: VendorID (manufacturer identification)
	7	02		
6014	8	00	Subindex	No subindex
	9	00	Number of PDI data bytes	Read, therefore = 00

Response

The result is provided in the tunnel registers for conformations from 6210 onwards.

As described before, register 6215 has an internal “virtual length”. A Modbus function code is used to access the registers marked with *, which allows access to multiple registers in one request. Register 6210 is the start address. Always use the maximum length of 125 words as the register number for read access.

- Positive response

Modbus register	Byte	Contents (hex)	Meaning	
6210	0	80	Message code	Response to “Read PDI object”
	1	41		
6211	2	00	Slot	Copy of request
	3	01		
6212	4	00	Subslot	Copy of request
	5	00	Reserved	
6213	6	00	PDI object index	Copy of request
	7	02		
6214	8	00	Subindex	Copy of request
	9	07	Number of PDI data bytes	7 bytes of data read
6215	10	00	Error class	No error
	11	00	Error code	
6216*	12	30	Read data	00A045 (7 bytes, including zero terminator; ASCII coded)
	13	30		
6217*	14	41		
	15	30		
6218*	16	34		
	17	35		
6219*	18	00		
	19	00	Top up to an even number of bytes	

– Negative response

Modbus register	Byte	Contents (hex)	Meaning	
6210	0	80	Message code	Response to “Read PDI object”
	1	41		
6211	2	00	Slot	Copy of request
	3	01		
6212	4	00	Subslot	Copy of request
	5	00	Reserved	
6213	6	00	PDI object index	Copy of request
	7	02		
6214	8	00	Subindex	Copy of request
	9	00	Number of PDI data bytes	Error message, therefore = 0
6215	10	xx	Error class	Error message
	11	xx	Error code	
6216*	12	xx	Additional error code	
	13	xx		

18.6 Example: write to PDI object

The PDI write service can be conveniently used with the Modbus function code FC23 (read/write).

Alternatively, you can use FC16 (write) and FC3 (read).

All process data channels of the AXL F AI4 I XC 1H module should be parameterized.

In the physical bus configuration, the module is the second module.

The parameterization is performed via the ParaTable object (0080_{hex}).

PDI channel 3 (6030/6230) must be used.

Write requirement

Write the following values via FC16 or FC23 to register 6030 onwards.

As described before, register 6035 has an internal “virtual length”. A Modbus function code is used to access the registers marked with *, which allows access to multiple registers in one request. Register 6030 is the start address. Enter the total length as the register number. In the example, the total length is 11 (register 6030 to 6040).

Modbus register	Byte	Contents (hex)	Meaning	
6030	0	00	Command code	Write PDI object
	1	42		
6031	2	00	Slot	2nd local bus device
	3	02		
6032	4	00	Subslot	No subslot
	5	00	Reserved	Reserved
6033	6	00	PDI object index	0080_{hex}: ParaTable (parameter table)
	7	80		
6034	8	00	Subindex	No subindex
	9	0C	Number of PDI data bytes	12 bytes (length of the parameter table)
6035	10	00	Data byte 0	According to the module-specific data sheet: For each of the four channels: Filter 30 Hz, 16-sample average value, Measuring range 0 mA ... 20 mA
	11	04	Data byte 1	
6036*	12	00	Data byte 2	
	13	04	Data byte 3	
6037*	14	00	Data byte 4	
	15	04	Data byte 5	
6038*	16	00	Data byte 6	
	17	04	Data byte 7	
6039*	18	00	Data byte 8	According to the module-specific data sheet: Data format IB IL
	19	00	Data byte 9	
6040*	20	00	Data byte 10	According to the module-specific data sheet: Reserved
	21	00	Data byte 11	

Response

The result is provided in the tunnel registers for conformations from 6230 onwards.

As described before, register 6235 has an internal “virtual length”. A Modbus function code is used to access the registers marked with *, which allows access to multiple registers in one request. Register 6230 is the start address. Always use the maximum length of 125 words as the register number for read access.

- Positive response

Modbus register	Byte	Contents (hex)	Meaning	
6230	0	80	Message code	Response to “Write PDI object”
	1	42		
6231	2	00	Slot	Copy of request
	3	02		
6232	4	00	Subslot	Copy of request
	5	00	Reserved	
6233	6	00	PDI object index	Copy of request
	7	80		
6234	8	00	Subindex	Copy of request
	9	00	Number of PDI data bytes	For write access = 0
6235	10	00	Error class	No error
	11	00	Error code	
6236*	12	00	PDI data	Not available for write access to the confirmation, for this reason = 0
	13	00		
...	...	00		

– Negative response

Modbus register	Byte	Contents (hex)	Meaning	
6230	0	80	Message code	Response to “Write PDI object”
	1	42		
6231	2	00	Slot	Copy of request
	3	02		
6232	4	00	Subslot	Copy of request
	5	00	Reserved	
6233	6	00	PDI object index	Copy of request
	7	80		
6234	8	00	Subindex	Copy of request
	9	00	Number of PDI data bytes	Error message, therefore = 0
6235	10	xx	Error class	Error message
	11	xx	Error code	
6236*	12	xx	Additional error code	
	13	xx		

18.7 Example: Read object of a lower-level subsystem (IO-Link)

The PDI read service can be conveniently used with the Modbus function code FC23 (read/write).

Alternatively, you can use FC16 (write) and FC3 (read).

The content of the ISDU object ProductID (item no.) of the AXL E IOL DIO8 M12 3M IO-Link device connected to the AXL F IOL8 2H should be read.

In the physical bus configuration, the AXL F IOL8 2H module is the second module.
The AXL E IOL DIO8 M12 3M IO-Link device is connected to IO-Link master port 3.

To this end, PDI channel 1 (6010/6210) should be used.

Read request

Write the following values via FC16 or FC23 to register 6010 and onwards.

Modbus register	Byte	Contents (hex)	Meaning	
6010	0	00	Command code	Read PDI object
	1	41		
6011	2	00	Slot	2nd local bus device
	3	02		
6012	4	03	Subslot	3. IO-Link master port
	5	00	Reserved	Reserved
6013	6	00	Index PDI object (ISDU object)	ProductID
	7	13		
6014	8	00	Subindex	No subindex
	9	00	Number of PDI data bytes	Read, therefore = 00

Response

The result is provided in the tunnel registers for conformations from 6210 onwards.

As described before, register 6215 has an internal “virtual length”. A Modbus function code is used to access the registers marked with *, which allows access to multiple registers in one request. Register 6210 is the start address. Always use the maximum length of 125 words as the register number for read access.

- Positive response

Modbus register	Byte	Contents (hex)	Meaning	
6210	0	80	Message code	Response to “Read PDI object”
	1	41		
6211	2	00	Slot	Copy of request
	3	02		
6212	4	03	Subslot	Copy of request
	5	00	Reserved	
6213	6	00	Index PDI object (ISDU object)	Copy of request
	7	13		
6214	8	00	Subindex	Copy of request
	9	08	Number of PDI data bytes	8 bytes of data read
6215	10	00	Error class	No error
	11	00	Error code	
6216*	12	31	Read data	1480995
	13	34		
6217*	14	38		
	15	30		
6218*	16	39		
	17	39		
6219*	18	35		
	19	00		

– Negative response

Modbus register	Byte	Contents (hex)	Meaning	
6210	0	80	Message code	Response to “Read PDI object”
	1	41		
6211	2	00	Slot	Copy of request
	3	02		
6212	4	03	Subslot	Copy of request
	5	00	Reserved	
6213	6	00	Index PDI object (ISDU object)	Copy of request
	7	13		
6214	8	00	Subindex	Copy of request
	9	00	Number of PDI data bytes	Error message, therefore = 0
6215	10	xx	Error class	Error message
	11	xx	Error code	
6216*	12	xx	Additional error code	
	13	xx		

18.8 Example: Write to object of a lower-level subsystem (IO-Link)

The PDI write service can be conveniently used with the Modbus function code FC23 (read/write).

Alternatively, you can use FC16 (write) and FC3 (read).

The output substitute value behavior at output OUT02 of the AXL E IOL DIO8 M12 3M IO-Link device connected to the AXL F IOL8 2H should be parameterized.

In the physical bus configuration, the AXL F IOL8 2H module is the second module.
The AXL E IOL DIO8 M12 3M IO-Link device is connected to IO-Link master port 3.

The output substitute value behavior is parameterized via the ISDU object OutputSubstituteValueBehavior ($01D0_{hex}$) of the IO-Link device.

PDI channel 3 (6030/6230) must be used.

Write requirement

Write the following values via FC16 or FC23 to register 6030 onwards.

As described before, register 6035 has an internal “virtual length”. A Modbus function code is used to access the registers marked with *, which allows access to multiple registers in one request. Register 6030 is the start address. Enter the total length as the register number. In the example, the total length is 6 (registers 6030 to 6035).

Modbus register	Byte	Contents (hex)	Meaning	
6030	0	00	Command code	Write PDI object
	1	42		
6031	2	00	Slot	2nd local bus device
	3	02		
6032	4	03	Subslot	3. IO-Link master port
	5	00	Reserved	Reserved
6033	6	01	Index PDI object (ISDU object)	OutputSubstituteValueBehavior
	7	D0		
6034	8	02	Subindex	2
	9	01	Number of PDI data bytes	1 byte
6035	10	02	Data byte 0	According to the module-specific data sheet: Output substitute value behavior set to “Hold last value”
	11	00	Data byte 1	

Response

The result is provided in the tunnel registers for conformations from 6230 onwards.

As described before, register 6235 has an internal “virtual length”. A Modbus function code is used to access the registers marked with *, which allows access to multiple registers in one request. Register 6230 is the start address. Always use the maximum length of 125 words as the register number for read access.

- Positive response

Modbus register	Byte	Contents (hex)	Meaning	
6230	0	80	Message code	Response to “Write PDI object”
	1	42		
6231	2	00	Slot	Copy of request
	3	02		
6232	4	03	Subslot	Copy of request
	5	00	Reserved	
6233	6	01	Index PDI object (ISDU object)	Copy of request
	7	D0		
6234	8	02	Subindex	Copy of request
	9	00	Number of PDI data bytes	For write access = 0
6235	10	00	Error class	No error
	11	00	Error code	
6236*	12	00	PDI data	Not available for write access to the confirmation, for this reason = 0
	13	00		
...	...	00		

– Negative response

Modbus register	Byte	Contents (hex)	Meaning	
6230	0	80	Message code	Response to “Write PDI object”
	1	42		
6231	2	00	Slot	Copy of request
	3	02		
6232	4	03	Subslot	Copy of request
	5	00	Reserved	
6233	6	01	Index PDI object (ISDU object)	Copy of request
	7	D0		
6234	8	02	Subindex	Copy of request
	9	00	Number of PDI data bytes	Error message, therefore = 0
6235	10	xx	Error class	Error message
	11	xx	Error code	
6236*	12	xx	Additional error code	
	13	xx		

18.9 Exception Codes

In order to increase user comfort, the main problems that can occur when accessing the PDI channel are indicated directly via a Modbus exception. In addition to the standard exception codes (01 ... 04; see Modbus specification), some user-defined exception codes have been defined specifically for PDI channel handling.

Designation	Exception Code		Meaning/cause
	dec	hex	
ILLEGAL_FUNCTION	1	1	General (see Modbus/TCP specification)
ILLEGAL_DATA_ADDRESS	2	2	General (see Modbus/TCP specification)
ILLEGAL_DATA_VALUE	3	3	General (see Modbus/TCP specification)
			Write to PDI tunnel register 60x5, even though command 0041_{hex} (read PDI object) was selected in register 60x0.
			PDI length (register 60x4; length of the data to be written in bytes) does not match the actual length.
DEVICE_FAILURE	4	4	General (see Modbus/TCP specification)
			Internal failure (e.g., maximum number of connections exceeded)
			Device cannot be reached (timeout)
MBUS_PDI_ERR_DOUBLE_USE_CH	16	10	An attempt was made to use the same communication channel with multiple TCP connections.
			An attempt was made to use a communication channel used with a TCP connection via UDP.
MBUS_PDI_ERR_ILLEGAL_SVC_CODE	17	11	The “Command code” field (register 60x0) does not contain a valid command code. 0041_{hex} is valid for PDI_Read and 0042_{hex} for PDI_Write.
MBUS_PDI_ERR_USER_PROBLEM	18	12	An error occurred on a PDI_Write request (triggered by writing to register 60x5). For further information, refer to the confirmation (register 62xx).
MBUS_PDI_ERR_INVALID_DATA	19	13	No valid confirmation that can be read via the confirmation table (register 62xx). In this case, an access attempt returns the specified exception.

19 SNMP: Simple Network Management Protocol

The bus coupler supports SNMP v1 and v2c.

Management Information Base (MIB)

The corresponding latest MIBs are available on the Internet at www.phoenixcontact.com/products.

For the object descriptions, please refer to the ASN1 descriptions for this product.

The password for read access is “public”. This password cannot be changed.
By default, the password for write and read access is “private” in the delivery state. This password can be changed at any time.

You can use SNMP via port 161 for Ethernet management tools.

20 WBM: Web-based management

The device has a web server, which generates the required pages for web-based management and, depending on the requirements of the user, sends them to a standard web browser.

You can use web-based management to access static or dynamic information. Examples of static information include technical data or the MAC address. Examples of dynamic information include IP addresses, status information, local bus structure and diagnostics.

You can use web-based management via port 80.

Accessing web-based management

You can address the device’s web server using the IP address if it is configured accordingly. The device’s homepage (web page) is accessed by entering the URL http://<IP address>.
Example: http://172.16.113.38

The default password is “private”.

Recommendation: Assign your own password during startup (max. 16 characters).

If you cannot access the WBM pages, check the connection settings in your browser. Deactivate the proxy if set.

Controlling access to web-based management

There are two ways to block or approve access to web-based management:

– Via a higher-level controller.

  Up to firmware version 1.31

Block access:	Write command 8100 to command register 2006.
Approve access:	Write command 8101 to command register 2006.

  Firmware version 1.32 or later

Block access:	Write code 0000_{hex} to the tab 2014.
Approve access:	Write code 0001_{hex} to the tab 2014.

– Via SNMP, see section “SNMP: Simple Network Management Protocol”.

21 Security: Port disconnection

Firmware version 1.31 or later.

To increase network security in your application, block unused ports.

Adjust the port settings via the web-based management, “Configuration, Security: Port disconnection” menu item.

NOTE: Limited functionality when ports are blocked

Please note that blocked ports limit the functionality of the software.

Default setting for “Configuration, Security: Port disconnection”

IP layer				
Protocol	**Port**	**Comment**	**Software/function**	**Action**
TCP	21	FTP	FW update, parameterization	Accept
TCP	80	HTTP	Web-based management (WBM)	Accept
TCP	502	Modbus/TCP	Fieldbus	Accept
TCP	1962	DDI	Diag+	Accept
TCP	2001	IOL SMI	IOL-CONF	Accept
UDP	7	Echo	Test	Reject
UDP	161	SNMP	PC Worx Firmware Updater, network management	Accept
UDP	502	Modbus/UDP	Fieldbus	Accept
Ethernet layer				
Protocol	**Port**	**Comment**	**Software/function**	**Action**
DCP	0x8892	Network scan and IP address assignment	PC Worx Firmware Updater, NetNames+	Accept

22 Example: Modbus register table in the web-based management

The following example illustrates a Modbus register table in the web browser for an Axioline F station with IO-Link.

Special features in the bus configuration

The Axioline F station consists of the bus coupler and eight connected devices.

Device 5	AXL F IOL8 2H	IO-Link master, where four ports are configured as digital outputs and four ports are configured as digital inputs.
Device 8	AXL F IOL8 2H	IO-Link master, to which differently configured IO-Link devices are connected.

The Axioline F IO-Link master is not available as an XC version. Only use it in the approved ambient temperature range (-25°C ... +60°C).

Modbus I/O table

The current assignment of the Modbus registers can be found in the web-based management under this path: “Modbus/TCP (UDP), Modbus I/O table”.

No.	Product name	Description	Location	Equipment identifier	Modbus register	
					Input	Output
0	AXL F BK ETH XC	Ethernet bus terminal	...	-	-	-
1	AXL F DI16/4 XC 2F	16 digital inputs, adjustable filter	...	...	8000	-
2	AXL F AO8 XC 1F	8 analog output channels	...	...	8001 ... 8008	9001 ... 9008
3	AXL F AI8 XC 1F	8 analog input channels	...	...	8009 ... 8016	-
4	AXL F DO16/3 XC 2F	16 digital outputs	...	...	-	9017
5	AXL F IOL8 2H	IO-Link master, 8 ports	...	...	8018 ... 8049	9018 ... 9049
5.1	DO	-	-	-	-	9019
5.2	DO	-	-	-	-	9019
5.3	DO	-	-	-	-	9019
5.4	DO	-	-	-	-	9019
5.5	DI	-	-	-	8019	-
5.6	DI	-	-	-	8019	-
5.7	DI	-	-	-	8019	-
5.8	DI	-	-	-	8019	-
6	AXL F DI32/1 XC 1F	32 digital inputs, adjustable filter	...	...	8050 ... 8051	-
7	AXL F DO32/1 XC 1F	32 digital outputs	...	...	-	9052 ... 9053
8	AXL F IOL8 2H	IO-Link master, 8 ports	...	...	8054 ... 8085	9054 ... 9085
8.1	IOL device	IN 7 bytes, OUT 7 bytes	-	-	8057 ... 8060	9057 ... 9060
8.2	IOL device	IN 2 bytes, OUT 2 bytes	-	-	8060 ... 8061	9060 ... 9061
8.3	DO	-	-	-	-	9055
8.4	IOL device	IN 1 byte, OUT 1 byte	-	-	8061	9061
8.5	IOL device	IN 2 bytes, OUT 2 bytes	-	-	8062	9062
8.6	IOL device	IN 8 bytes, OUT 8 bytes	-	-	8063 ... 8066	9063 ... 9066
8.7	DI	-	-	-	8055	-
8.8	IOL device	IN 32 bytes, OUT 32 bytes	-	-	8067 ... 8082	9067 ... 9082

Mapping of the IO-Link master and the IO-Link devices

For detailed information on the process data of the IO-Link master, please refer to the module-specific data sheet.

Input process data register																					
8054		8055		8056		8057		8058		8059		8060		8061		8062		8063 ... 8066	8067 ... 8082	8083 ... 8085
H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L			
COM	PD_VALID	DI 8.7		Res.		8.1							8.2		8.4		8.5	8.6	8.8	-
						7 bytes							2 bytes		1 byte		2 bytes	8 bytes	32 bytes	

Output process data register																					
9054		9055		9056		9057		9058		9059		9060		9061		9062		9063 ... 9066	9067 ... 9082	9083 ... 9085
H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L			
Res.		DO 8.3		Res.		8.1							8.2		8.4		8.5	8.6	8.8	-
						7 bytes							2 bytes		1 byte		2 bytes	8 bytes	32 bytes	

Key:

H	High byte
L	Low byte
COM	Status of the IO-Link connection for each IO-Link port
PD_VALID	Status of the IO-Link input process data for each port
DI	Status (level) of the C/Q cable for each IO-Link port
Res.	Reserved
DO	DO state

Port	Operating mode	PD IN	PD OUT	Note
8.1	IO-Link	7 bytes	7 bytes	As the device has an odd amount of input and output data, it only occupies the high byte in 8060/9060.
8.2	IO-Link	2 bytes	2 bytes	As the preceding device occupies the high byte of 8060/9060, this device with its even amount of process data occupies the free low byte of 8060/9060 and the high byte of the subsequent register.
8.3	DO	-	1 bit	The output bit is mapped to bit 2 in the high byte of register 9055.
8.4	IO-Link	1 byte	1 byte	As the preceding device occupies the high byte of 8061/9061, this device occupies the free low byte of 8061/9061.
				The following devices, which all have an even amount of process data, occupy entire register addresses again.
8.6	IO-Link	8 bytes	8 bytes	If the connected IO-Link devices do not occupy the same quantity of input and output bytes in the process data, the missing bytes will be set to the value 00_{hex}.
8.7	DI	1 bit	-	The input bit is mapped to bit 6 in the high byte of register 8055.
8.8	IO-Link	32 bytes	32 bytes	
				If the data width used for the input and output process data of the IO-Link ports is less than 58 bytes, the excess bytes will be set to 00_{hex}.

To ensure that the process data of the IO-Link devices occupies entire Modbus register addresses, you can configure fill bytes.
To do this, add one byte to the process data width in the port configuration of the IO-Link master. The additional byte is reserved at the end.

There are two ways to specify the PD IN length and PD OUT length process data lengths of a device:

– Specification via object 0041_{hex},desired subbus configuration.
– Specification via Startup+.

23 Firmware update

To update the bus coupler firmware, provide the bus coupler with a firmware container via a TFTP server or load it onto the bus coupler via FTP. You can use any FTP client or TFTP server for this, such as the PC Worx Firmware Updater.
If you do not use the PC Worx Firmware Updater, start the firmware update using the web-based management. When the firmware is being updated, the RDY LED flashes yellow.

For more detailed information regarding the firmware update, refer to the “Installation and operation of the PC Worx Firmware Updater software” user manual.

24 Software drivers

You can address the bus coupler from your own application program using Modbus/TCP and Modbus/UDP. Various drivers are available on the market for this, some of which are also available as freeware. For the lowest possible response times, we recommend using Modbus/UDP.