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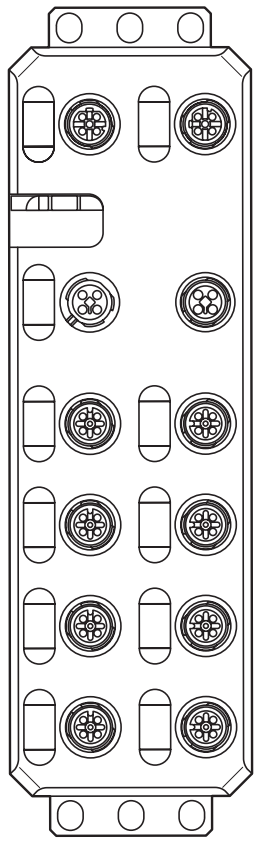
Device manual
IO-Link Master EtherNet/IP

AL1020



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1 Preliminary note

This document applies to devices of the type "IO-Link master" (art. no. AL1020).

This document is intended for specialists. These specialists are people who are qualified by their appropriate training and their experience to see risks and to avoid possible hazards that may be caused during operation or maintenance of the device. The document contains information about the correct handling of the device.

Read this document before use to familiarise yourself with operating conditions, installation and operation. Keep this document during the entire duration of use of the device.

Adhere to the safety instructions.

Symbols

► Instructions

> Reaction, result

[…] Designation of keys, buttons or indications

→ Cross-reference

Important note
Non-compliance may result in malfunction or interference.

Information
Supplementary note

Warnings used

⚠ WARNING
Warning of serious personal injury.
Death or serious irreversible injuries may result.

⚠ CAUTION
Warning of personal injury.
Slight reversible injuries may result.

NOTE
Warning of damage to property.

2 Safety instructions

These instructions contain texts and figures concerning the correct handling of the device and must be read before installation or use.

Observe the operating instructions. Non-observance of the instructions, operation which is not in accordance with use as prescribed below, wrong installation or incorrect handling can seriously affect the safety of operators and machinery.

- ► Prepare installation
- ► Disconnect the power supply of the device.
- ► Ensure that devices cannot be accidentally restarted.
- ► Verify safe isolation from the supply.
- ► Earth and short circuit.
- ► Cover or enclose adjacent units that are live.
- ► Follow the specific mounting instructions of the device.
- ► Only suitably qualified personnel in accordance with EN 50 110-1/-2 (VDC 0105 part 100) is permitted to work on this device/system.
- ► Before installation and before touching the device ensure that you are free of electrostatic charge.
- ► The functional earth (FE) must be connected to the protective earth (PE) or to the potential equalisation. The system installer is responsible for implementing this connection.
- ► Connection cables and signal lines must be installed in such a manner that inductive and capacitive interference do not impair the automation functions.
- ► Install automation equipment and related operating elements in such a way that they are protected against unintentional operation.
- ► Suitable safety hardware and software measures should be implemented for the I/O interface so that a line or wire breakage on the signal side does not result in undefined states in the automation device.
- ► Ensure a reliable electrical isolation of the low voltage for the 24 V supply. Only use power supplies compliant with IEC 60 364-4-41 or HD 384.4.41 S2 (VDE 0100 part 410).
- ► Fluctuations or deviations of the mains voltage from the rated value must not exceed the tolerance limits specified in the technical data; otherwise this may cause malfunction and dangerous operation.
- ► E-stop devices to IEC/EN 60 204-1 must be effective in all operating modes of the automation device. Unlatching the e-stop devices must not cause restart.

- ► Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been installed with the housing closed. Desktop or portable units must only be operated and controlled in enclosed housings.
- ► Measures should be taken to ensure the proper restart of programs interrupted after a voltage dip or failure. This should not cause dangerous operating states even for a short time. If necessary, an emergency stop must be carried out.
- ► Wherever faults in the automation system may cause personal injuries or damage to property, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (e.g. by means of separate limit switches, mechanical interlocks etc.)
- ► The electrical installation must be carried out in accordance with the relevant regulations (e.g. with regard to cable cross-sections, fuses, PE).
- ► All work relating to transport, installation, commissioning and maintenance must only be carried out by qualified personnel. (IEC 60 364 or HD 384 or DIN VDE 0100 and national work safety regulations have to be observed).
- ► All shrouds and doors must be kept closed during operation.

3 Documentation

This documentation relates to the hardware and firmware status at the time of editing this manual. The features of the devices are continuously developed further and improved.

4 Functions and features

The devices have been designed for use in applications described in this manual and the device-specific data sheets.

Adhere to the data indicated in the data sheets and in the manual. If the handling specifications and safety instructions for configuration, installation and operation indicated in the documentation are adhered to, the devices normally do not lead to a danger for persons and objects.

The input and output devices of the IO-Link master have been designed for automation tasks in harsh environmental conditions. The devices meet the requirements of IP65/67 protection rating. They enable direct connection of sensors and actuators in an environment close to the station.

The devices are available with M12 connection technology.

The devices cannot be extended and have a directly integrated fieldbus connection and I/O level. They are used for distribution in the field when only a few digital or analogue I/O points are required.

5 Product description

5.1 DI (digital input)

The digital inputs receive the digital control signals from the process level. These signals are transferred to the higher-level automation device via the network/bus. The signal status is indicated via LEDs. The sensors are connected via M12 screw connectors. The sensors are supplied from the sensor voltage U_S.

5.2 IOL (IO-Link port)

These devices have IO-Link ports for communication-capable sensors so that the automation device can make dynamic changes to the sensor parameters directly.

The IO-Link ports can be operated in the following operating modes:

- DI (behaves like a digital input supplied via U_S)
- DO (behaves like a digital output supplied via U_S)
- IO-Link (IOL sensor supplied via U_S / IOL actuator supplied via U_S and U_A)

5.3 Connections

The bus, I/O devices and supply are connected via M12 screw connections. Each device is connected directly to the network/bus system.

5.4 Protection rating

The devices have IP65/67 protection rating. To ensure IP65 / IP67 protection, cover unused sockets with protective caps.

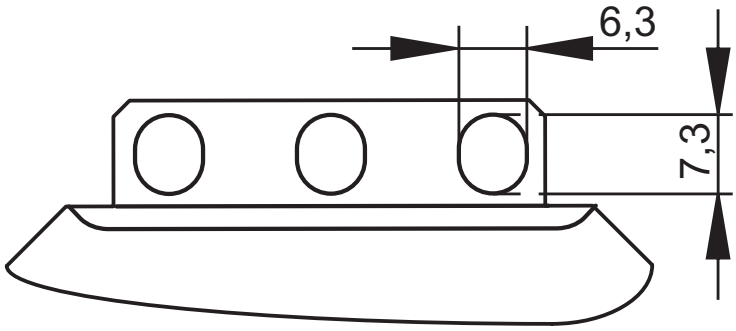
6 Features

The devices have been designed for use without a control cabinet in plant construction. The fixing clips are firmly mounted.

The housing dimensions of the Profibus devices differ from the housing dimensions of the Ethernet versions with regard to the depth at socket X21.

7 Scale drawings

7.1 Dimensions of the screw holes in the fixing clips



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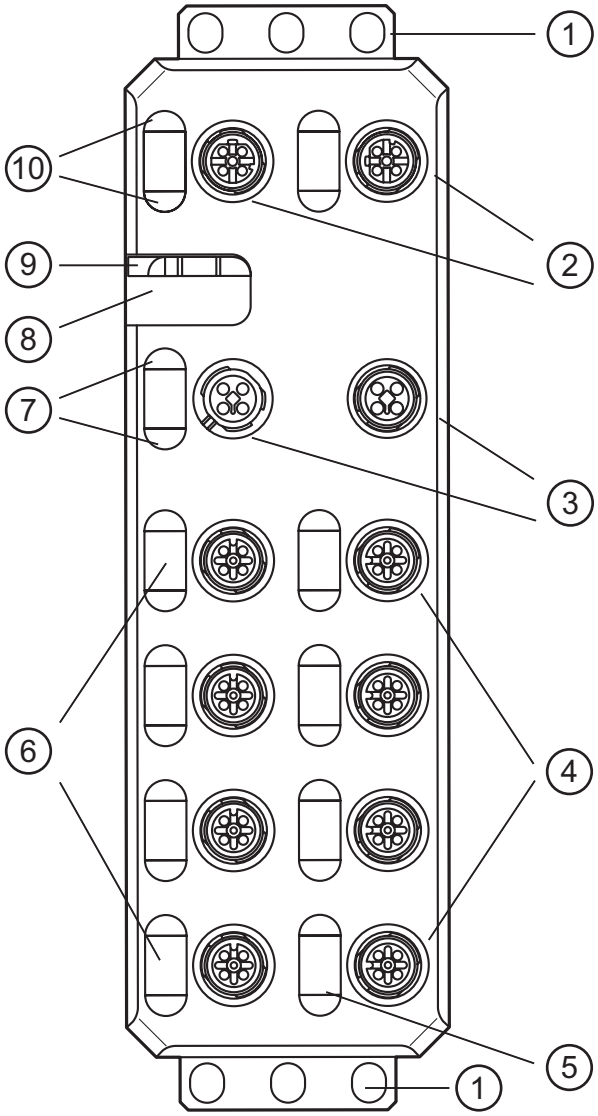
8 Structure of the device



1. Fixing clips (FE connection)
2. Network or bus connection (IN, OUT)
3. Connections for the supply voltages
4. Connections for inputs/outputs or IO-Link ports
5. Markers for labelling
6. Status indicators of the inputs/outputs or the IO-Link ports
7. Diagnostics and status indication for the supply voltages
8. Rotary coding switch (no function for ProfiNet)
9. Diagnostics and status indicators for the network / bus system
10. Diagnostics and status indicators for the network (not for Profibus)

8.1 Diagnostic and status indicators

8.1.1 Diagnostics

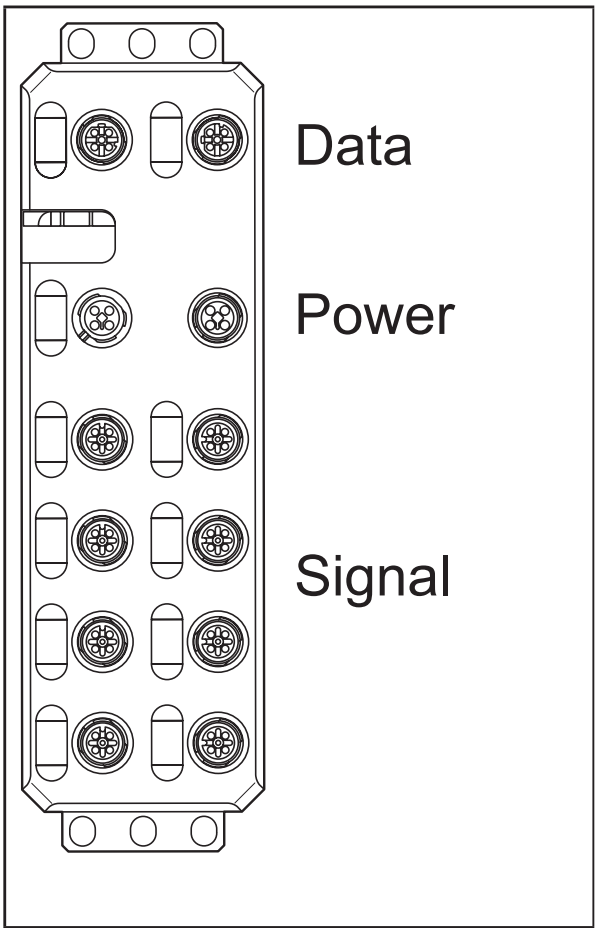
The diagnostic indicators (green/yellow/red) indicate whether an error is present or not. In case of an error, they indicate the error type and location. The device is operating correctly if all green indicators are on.

8.1.2 Status

The status indicators (yellow) indicate the signal state of the corresponding input/output or of the IO-Link port. If the yellow status indicators are on, this indicates signal state “1” of the input/output signal.

The devices have three main areas for diagnostics and status indicators.

- Indicators for the network/bus system (network/bus-specific) - Data
- Indicators for the power supplies - Power
- Indicators for the inputs and outputs and the IO-Link ports (device-specific) - Signal



9 Installation

When preparing for cable installation, the local conditions and the corresponding mounting regulations are very important. Cables can be installed, for example, in cable ducts or on cable bridges.

Data corruption and loss

A minimum distance between the cabling and possible sources of interference (e.g., machines, welding equipment, power lines) is defined in the applicable regulations and standards. During system planning and installation, these regulations and standards must be taken into account and observed.

Protect the bus cables from sources of electric/magnetic interference and mechanical strain.

Observe the following guidelines regarding “electromagnetic compatibility” (EMC) to keep mechanical risks and interference to a minimum.

9.1 Mechanical strain

- ► Choose the correct cable type for the respective application (e.g., indoor or outdoor installation, drag chains).
- ► Observe the minimum bending radius.
- ► Make sure that cables do not enter the shear area of moving machine parts.
- ► Do not install bus cables at right angles to driving routes and machine movements.
- ► Use cable ducts and cable bridges.

► Observe the specifications of the cables used.

9.2 Sources of interference

Signal cables and power supply lines should not be installed in parallel.

- ► If necessary, metal isolating segments should be placed between the power supply lines and signal cables.
- ► Only use connectors with metal housing and connect as much of the shielding as possible to the housing.
- ► For outdoor cables between buildings, make sure that grounding is carried out in accordance with “Installing network/bus cables between buildings”.
- ► During installation, all connector locking mechanisms (screws, union nuts) must be firmly tightened in order to ensure the best possible contact between shielding and ground. Before initial startup, the ground or shielding connection of cables must be checked for low-resistance continuity.

9.3 Cable routing in control cabinets

- ► Install network/bus cables in separate cable ducts or separate cable bundles.
- ► Where possible, do not install network/bus cables parallel to power supply lines.
- ► Install network/bus cables at least 10 cm away from power lines.

9.4 Cable routing in buildings

- ► Where possible, use metal cable hangers.

- ► Do not install network/bus cables together with or parallel to power supply lines.
- ► Separate network/bus cables on cable bridges or in cable ducts from power supply lines using isolating segments.
- ► Install network/bus cables as far away as possible from sources of interference, such as motors and welding equipment.
- ► For long cable connections, install an additional equipotential bonding line between the terminal points.

9.5 Cable routing outside buildings

- ► Install network/bus cables in metal pipes that are grounded on both sides or in concrete cable ducts with continuous reinforcement.
- ► For long cable connections, install an additional equipotential bonding line between the terminal points.

9.6 Installing network/bus cables between buildings

9.6.1 Causes of surge voltages

Surge voltages occur as a result of switching operations, electrostatic discharge, and lightning discharge. Surge voltages can be inductively, capacitively or galvanically coupled into electrical cables for mains supply, measured value transmission, and data transmission. In this way, surge voltages reach the power supply units and the interfaces of systems and devices.

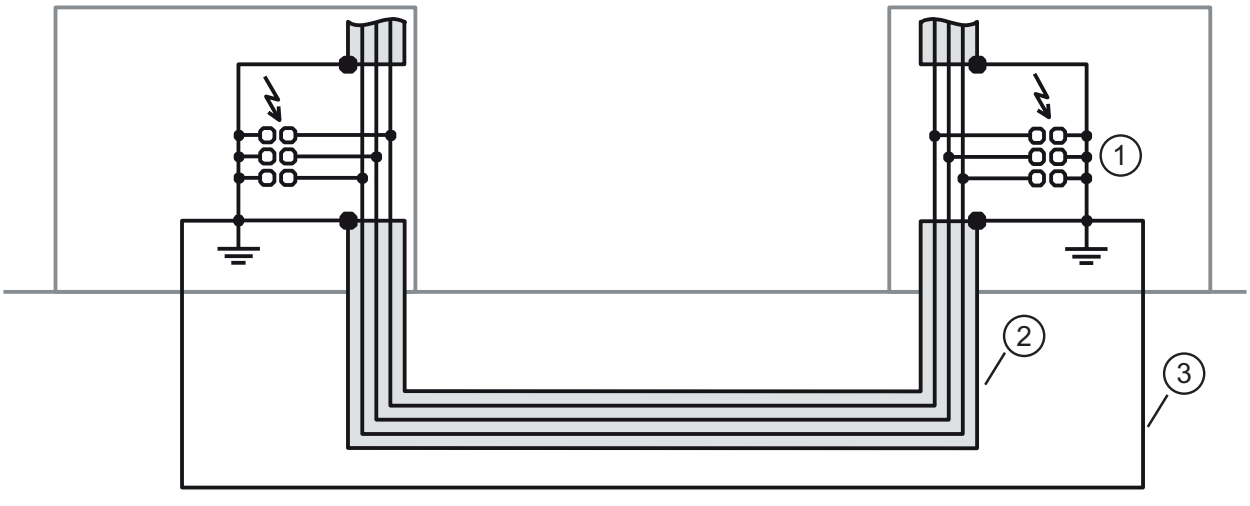
9.6.2 Equipotential bonding line

Install an additional equipotential bonding line between the grounding points of buildings, preferably in the form of

- – a metal-reinforced concrete channel,
- – an additional grounding cable or
- – a metal pipe.

9.6.3 Surge protective devices

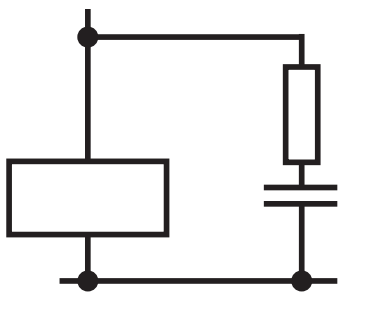
ifm recommends wiring all the wires of the cable to surge protective devices in order to protect the devices against surge voltages.
Observe all national and international regulations when installing surge protective devices.



1. Surge protective devices
2. Cable shielding
3. Equipotential bonding line

9.7 Surge protection measures

ifm recommends wiring relay coils or motor coils to an RC element in order to protect the devices against interference. Depending on the application, the delay time of the relay can be increased by approximately 1 ms.



Relay coil with RC element

For the dimensioning of the RC element, the following values are recommended:

R = 100...200 Ω /
C = 220...470 nF

9.8 Grounding concept

The devices operate in the low-level signal voltage range. In the case of low-level signal devices, interference is discharged via functional earth (FE). Functional earth (FE) is only used to discharge interference. It does not provide shock protection for people.

Functional grounding

The devices are designed to be screwed onto a flat mounting surface.

► Ground the devices by means of the mounting screws of the fixing clips.

9.9 Installation instructions

Electrostatic discharge

The device contains components that can be damaged or destroyed by electrostatic discharge. When handling the device, observe the necessary safety precautions against electrostatic discharge (ESD) according to EN 61340-5-1 and IEC 61340-5-1.

Damage to the electronics

- ► The device may only be installed and removed by qualified electricians in accordance with the ESD regulations.
- ► Implement the FE connection using mounting screws, in order to ensure immunity to interference.
- ► To ensure IP65/IP67 protection, cover unused connections with protective caps.
- ► Only supply the sensors with the voltage U_S which is provided at the terminal points.
- ► Avoid polarity reversal of supply voltages U_S and U_A.

Data corruption or loss

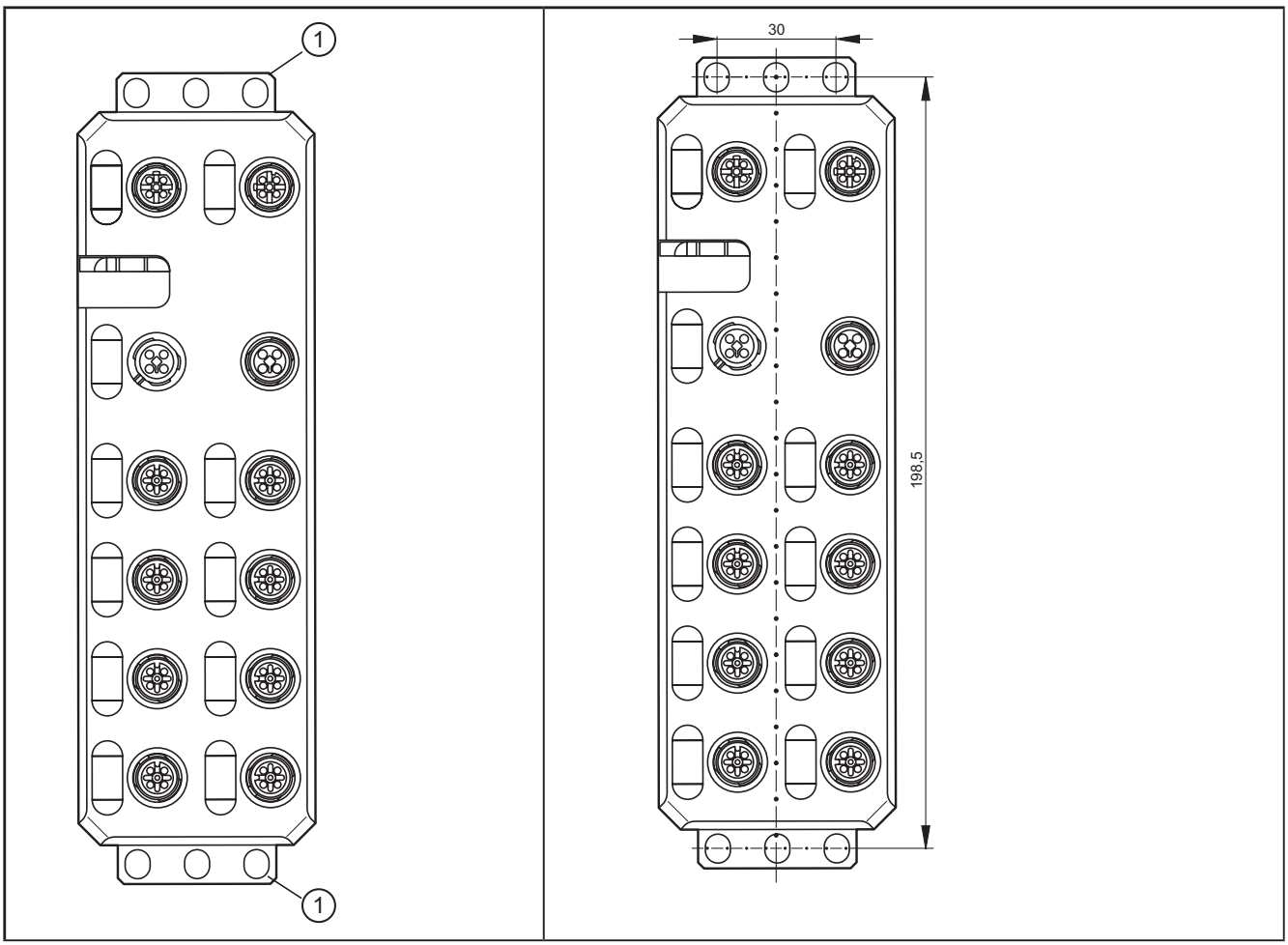
- ► Implement the FE connection using mounting screws, in order to ensure immunity to interference.

9.10 Mounting distances

No specific distances are required between devices or between a device and a cabinet door or cover. Mounting distances are determined solely by the plugs used and the bending radii of the cables.

9.11 Mounting dimensions

► Screw the device directly onto the flat mounting surface using the drill holes (1) of the fixing clips.

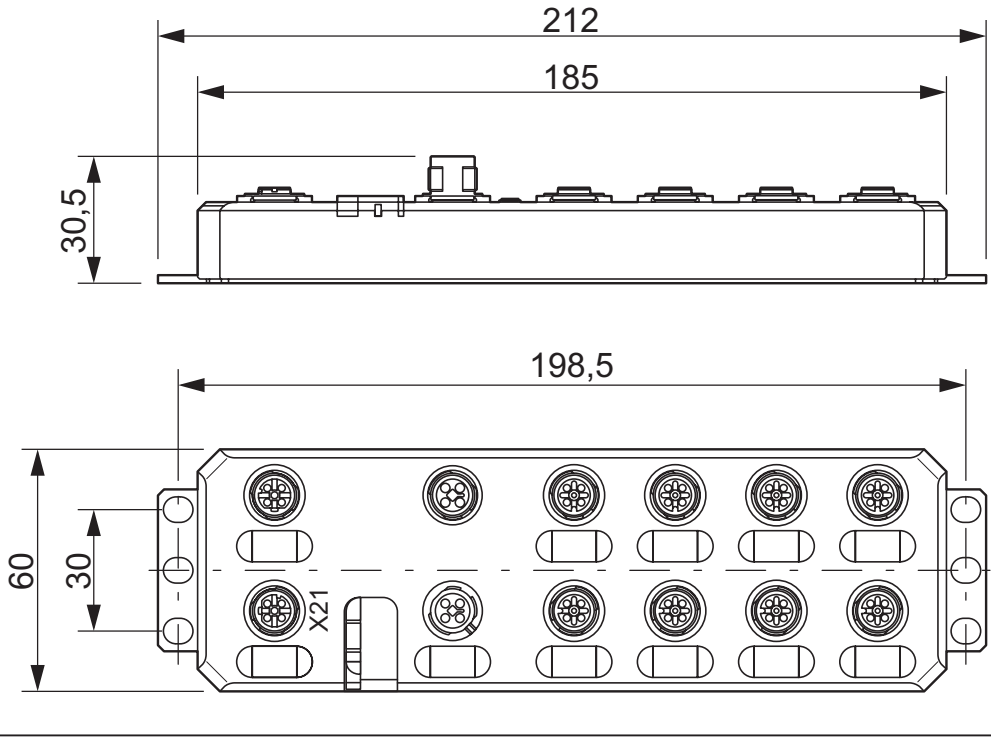


- ▶ Use standard M5 screws with toothed lock washer and self-locking nuts.
- ▶ Observe the maximum torque of the screws.

Functional grounding

- ▶ Functional grounding is crucial for interference-free operation. Ground the device by means of the mounting screws of the fixing clips.

10 Scale drawing



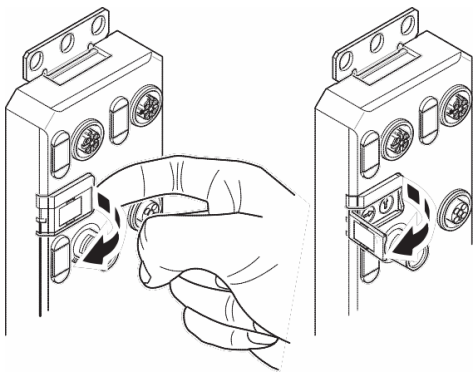
Scale drawing AL1020

11 Setting the address

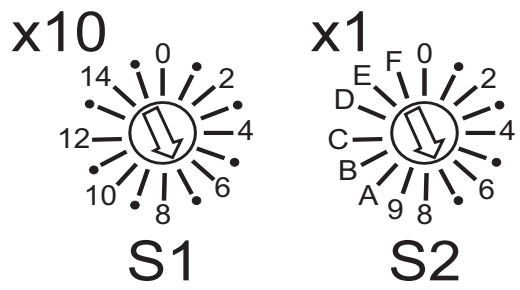
The device has rotary coding switches for setting the address and, if required, the transmission speed (see user manual for the respective network/bus system).

The rotary coding switches are located below a cover.

► Open the cover



► Rotary coding switch S1 is used to specify the tens (X10) of the device ID (module ID).
► Rotary coding switch S2 is used to specify the units (X1) of the device ID (module ID).



Example:

Ethernet IP
Setting address 77

Adjust the rotary coding switches using a suitable screwdriver (according to DIN 5264: blade width 3.0 mm or 2.5 mm). Using an unsuitable tool may damage the rotary coding switches.

12 Electrical connection

For the devices, a distinction is made between two voltages:

– U_S to supply the communications power and the sensors (always required),
– U_A for supplying the actuators, only required for devices with fixed outputs or for additional devices.

All supply voltages are connected via M12 connectors.

Damage to the electronics

► Connect both supply voltages completely (to +24 V and GND).
Do not connect several supply voltages via one GND, as this will exceed the current rating of the contacts.

12.1 Supply voltages U_S and U_A

The voltages U_S and U_A are fed in at connection X31.

Power supply U_S is required to supply the communications power of the device electronics and to supply the sensors. It must be connected to every device. If this supply voltage is disconnected, the device will not work.

► Install the power supply for the device electronics independently of the power supply for the actuators.

► Protect the power supplies independently.

> This means that the bus can continue running even if some I/O devices are switched off.

12.2 Power supply U_S

► Connect power supply Usfor the logic and sensors to socket X31.

► To supply additional devices, connect the cable for the outgoing supply voltage to socket X32.

Damage to the electronics

The current rating of the M12 connectors is 12 A per contact.
Make sure that this value is not exceeded. Please note that the connection for the outgoing supply voltage is not monitored for overload. If the permissible current rating is exceeded, this may result in damage to the connectors.

12.3 Power supply U_A

The voltage supply U_A is only required for the supply of the IO-Link actuators. IO-Link port in the operating mode DO is supplied via U_S.

Damage to the electronics

Power supplies U_S and U_A should only be supplied with SELV.

13 Features

The device has been designed for use within an EtherNet/IP™ nework.It enables the operation of up to eight IO-Link sensors/actuators and is also used to acquire digital signals.

13.1 Ethernet/IP™ features

- Connection to Ethernet/IP™ network using M12 connectors (D-coded)
- Transmission rate 10 MBits/s and 100 MBits/s
- Two Ethernet ports (with integrated switch)
- Min. cycle time of 1 ms (RPI)
- Ethernet/IP™ features:
  - ACD, DLR, IGMP v2, Quick Connect
- Supported protocols:

  - SNMP v1, HTTP, TFTP, FTP, BootP, DHCP
- Specification:
  - CIP edition 3.11; EIP adaption of CIP 1.12
- Device description using EDS file
- Firmware can be updated
- Integrated web server for web-based management

13.2 IO-Link features

- Connection of eight IO-Link devices
  - 4 type A ports with an additional digital input
  - 4 type B ports with an additional voltage supply
- Connection of IO-Link ports using M12 connectors (A-coded, 5-pos.)
- – Parameterisation of devices via CIP objects
- Parameter data on the master
- Parameterisable process data
- IO-Link specification V1.1

13.3 General features

- Diagnostic and status indicators
- Short-circuit and overload protection of the sensor supply
- Protection rating IP65/67

14 Technical data

General data	
Housing material	Pocan
Weight [kg]	0.48
Ambient temperature (operation) [°C]	-25 ...60
Ambient temperature (storage/transport) [°C]	-25...85
Permissible humidity (operation) [%]	5...95
Air pressure (operation) [kPa]	70...106 (up to 3000 m above sea level)
Air pressure (storage/transport) [kPa]	70...106 (up to 3000 m above sea level)
Protection rating	IP65 / IP67
Protection class	III, IEC 61140, EN 61140, VDE 0140-1
Connection data	

Connection method	M12 connector
EtherNet/IP™ interface	
Number	2
Connection method	M12 connectors, D-coded
Designation connection point	Copper cable
Number of positions	4
Transmission rate [MBits/s]	10/100 (with auto-negotiation)
Min. cycle time [ms]	1 (RPI)
EtherNet/IP™	
Equipment type	EtherNet/IP™ slave
EtherNet/IP™ protocols	ACD, DLR, IGMP v2
Additional protocols	SNMP v1, HTTP, TFTP, FTP, BootP, DHCP
Specification	CIP edition 3.11 EIP adaption of CIP 1.12
Supply of the module electronics and sensors	
Connection method	M12 connector (T-coded)
Number of positions	4
Designation	U_S
Supply voltage [V]	24 DC
Nominal supply voltage range [V]	19...31.2 DC (including all tolerances, including ripple)
Typical current consumption [mA]	180 ±15 % at 24 V DC
Maximum current consumption [A]	12
Supply of the actuators	
Connection method	M12 connector (T-coded)
Number of positions	4
Designation	U_A
Supply voltage [V]	24 DC
Nominal supply voltage range [V]	18...31.2 DC (including all tolerances, including ripple)
Typical current consumption [mA]	28 ±15 % at 24 V DC
Maximum current consumption [A]	12
Supply of the IO-Link ports	
I/O supply voltage [V]	24 DC
Nominal current for every IO-Link port [mA]	200 (short-term during start-up up to 1.6 A)
Nominal current for each device [A]	1.6

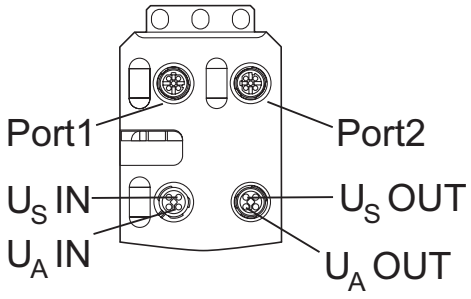
Overload protection	Electronic
Permissible conductor length to the sensor [m]	< 20
IO-Link ports in the mode digital input (DI)	
Number of inputs	Max. 8 (EN 61131-2 type 1)
Connection method	M12 connector, X01 ... X04 double occupancy
Connection method	2, 3-wire
Nominal input voltage [V]	24 DC
Nominal input current [mA]	Typ. 3
Sensor current [mA]	Max. 200 for each channel from L+/L-
Total current consumption [mA]	Max. 1.6 from L+/L-
Input voltage range "0" signal [V]	-3...5 DC
Input voltage range "1" signal [V]	15...30 DC
Input filter time [µs]	< 1000
Overload protection, short-circuit protection of sensor supply	Electronic
IO-Link ports in the digital output mode (DO)	
Maximum number of outputs	8
Connection method	M12 connector, X01 ... X04 double occupancy
Connection method	2, 3-wire
Nominal output voltage [V]	24 DC
Output current for each channel [mA]	200
Output current for each device [A]	1.6
Nominal load, ohmic [W]	12 (48 Ω; with nominal voltage)
Nominal load, inductive [VA]	12 (1,2 H; 12 Ω; with nominal voltage)
Signal delay [µs]	Max. 150 (at power on)
Signal delay [µs]	Max. 200 (at power off)
Switching frequency	Max. 5500 / s (with load current)
Switching frequency	Max. 1 / s (with inductive load
Limitation of the voltage induced on circuit interruption [V]	-15 DC
Max. output voltage when switched off [V]	1
Max. output current when switched off [µA]	300
Behaviour with overload	Switched off with auto restart
Overload protection, short-circuit protection of the outputs	Electronic
Digital inputs on pin 2 with type A ports	
Number of inputs	4 (EN 61131-2 type 1)

Connection method	M12 connector, X01 ... X04 double occupancy
Connection method	2, 3-wire
Nominal input voltage [V]	24 DC
Nominal input current [mA]	Typ. 3
Sensor current [mA]	Max. 200 for each channel from L+/L-
Total current consumption [mA]	Max. 1.6 from L+/L-
Input voltage range "0" signal [V]	-3...5 DC
Input voltage range "1" signal [V]	15...30 DC
Input filter time [µs]	< 1000
Overload protection, short-circuit protection of sensor supply	Electronic
Electrical isolation/isolation of the voltage areas **Test section**	**Test voltage**
24 V supply (communications power and sensor supply, IO-Link ports)/bus connection (Ethernet 1) [V]	500 AC, 50 Hz, 1 min
24 V supply (communications power and sensor supply, IO-Link ports)/bus connection (Ethernet 2) [V]	500 AC, 50 Hz, 1 min
24 V supply (communications power and sensor supply, IO-Link ports)/FE [V]	500 AC, 50 Hz, 1 min
Bus connection (Ethernet 1) / FE [V]	500 AC, 50 Hz, 1 min
Bus connection (Ethernet 2) / FE [V]	500 AC, 50 Hz, 1 min
Bus connection (Ethernet 1) / bus connection (Ethernet 2) [V]	500 AC, 50 Hz, 1 min
24 V supply (actuator supply)/ 24 V supply (communications power and sensor supply, IO-Link ports) [V]	500 AC, 50 Hz, 1 min
24 V supply (actuator supply)/bus connection (Ethernet 1) [V]	500 AC, 50 Hz, 1 min
24 V supply (actuator supply)/bus connection (Ethernet 2) [V]	500 AC, 50 Hz, 1 min
24 V supply (actuator supply)/FE [V]	500 AC, 50 Hz, 1 min
Mechanical tests	
Vibration resistance in accordance with EN 60068-2-6/IEC 60068-2-6 [g]	5
Shock in accordance with EN 60068-2-27/IEC 60068-2-27 [g]	30, 11 ms period, half-sine shock pulse
Continuous shock according to EN 60068-2-27/IEC 60068-2-27 [g]	10
Conformance with EMC Directive 2004/108/EC	
Noise immunity test in accordance with EN 61000-6-2	
Electrostatic discharge (ESD) EN 61000-4-2/IEC 61000-4-2	Criterion B; 6 kV contact discharge; 8 kV air discharge
Electromagnetic fields EN 61000-4-3/IEC 61000-4-3	Criterion A; field intensity: 10 V/m

Fast transients (burst) EN 61000-4-4/IEC 61000-4-4	Criterion B, 2 kV
Transient surge voltage (surge) EN 61000-4-5/IEC 61000-4-5	Criterion B; DC supply lines: ±0.5 kV/±0.5 kV (symmetrical/ asymmetrical)
Conducted interference EN 61000-4-6/IEC 61000-4-6	Criterion A; test voltage 10 V
Noise emission test according to EN 61000-6-4	
Radio interference properties EN 55022	Class A
Approvals	See www.ifm.com

15 Connections

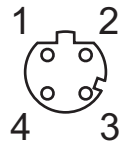
15.1 EtherNet/IP™ connection and voltage supply



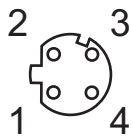
Port 1 (X21): Ethernet port 1
Port 2 (X22): Ethernet port 2
U_S IN (X31): Power supply IN (logic and sensors)
U_A IN (X31): Power supply IN ((IO-Link actuators))
U_S OUT (X32): Power supply OUT for additional devices
U_A OUT (X32): Power supply OUT for additional devices

► Implement the FE connection using mounting screws.

15.2 Pin connection EtherNet/IP™



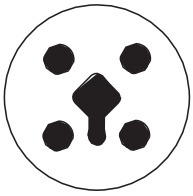
Ethernet port 1 X21
1: TX +
2: RX +
3: TX -
4: RX -



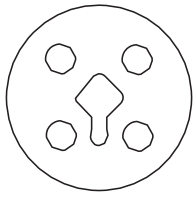
Ethernet port 2 X22
1: TX +
2: RX +
3: TX -
4: RX -

The shield is connected to FE in the device. The thread is used for additional shielding.

15.3 Pin connection voltage supply U_S/U_A



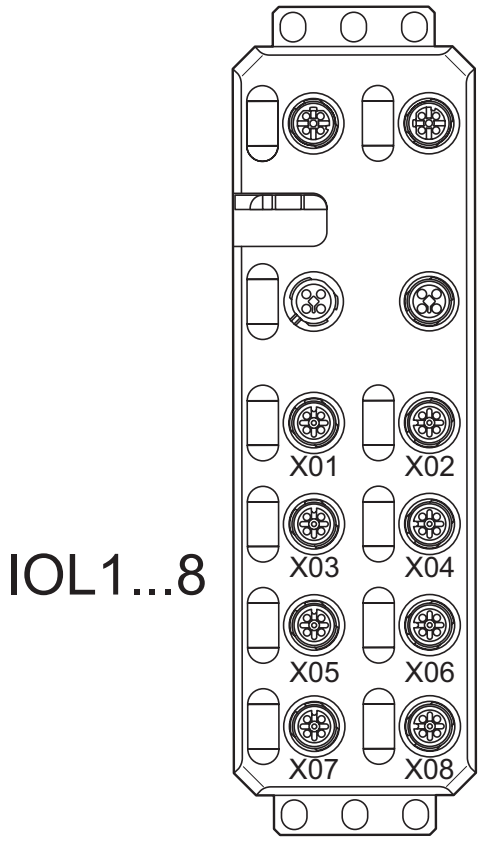
IN X31
1: + 24 V DC (U_S) brown
2: GND (U_A) white
3: GND (U_S) blue
4: + 24 V DC (U_A) black



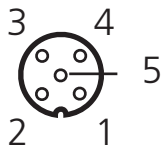
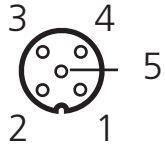
OUT X32
1: + 24 V DC (U_S) brown
2: GND (U_A) white
3: GND (U_S) blue
4: + 24 V DC (U_A) black

Pin assignment of the power supply, T-coded

15.4 Connecting IO Link ports and digital inputs



IO-Link 1...8 (X01...X08): IO-Link ports 1...8
DI1...DI4 (X01...X04): inputs 1...4

	IO-Link A ports (X01...X04) 1: 24 V DC (L+) 2: DI 3: GND (L-) 4: C/Q IO-Link data transfer channel 5: not connected		IO-Link B ports (X05...X08) 1: 24 V DC (L+) 2: 24 V DC (U_A) 3: GND (L-) 4: C/Q IO-Link data transfer channel 5: GND (U_A)

Port class A (type A)

The IO-Link port according to type A is assigned an additional hardwired DI (digital input) at pin 2.

Port class B (type B)

The IO-Link port according to type B has an additional supply voltage via pins 2 and 5. This port is suitable for connecting devices that have a higher current consumption.

Operating modes

The C/Q cable (pin 4) can be configured independently of the other pins. The IO-Link ports can be operated in the following operating modes:

– DI (behaves like a digital input supplied via U_S)
– DO (behaves like a digital output supplied via U_S)
– IO-Link (IOL sensor supplied via US / IOL actuator supplied via U_S and U_A)

15.5 Connection notes

Implement the FE connection using mounting screws, in order to ensure immunity to interference.

To ensure IP65 / IP67 protection, cover unused sockets with protective caps.

Only supply the IO-Link master and the IO-Link devices with the voltage provided at the terminal points (A ports, X03 and B ports, X06).Observe the correct polarity of the supply voltages U_S and U_A in order to prevent damage to the device.

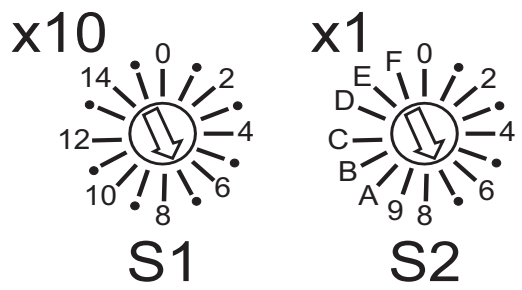
When connecting the sensors and actuators, observe the assignment of the connections.

Fix the device to a level surface or to a profile. Do not use this device to bridge gaps in order to prevent forces being transmitted via the device.

Use standard M5 screws with toothed lock washer and self-locking nuts. Observe the maximum torque of the screws.

16 Configuration via rotary encoding switch

You can configure the address assignment and other functions using rotary encoding switches.



Example:

Ethernet IP
Setting of address 77

► After modifying the switch position, restart the device. A modification to the switch position does not take effect during operation.

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

S1	S2	Code	Function
0	0	00	Remote access (default)
0...5	1...0	01...50	Manual address assignment
5...15	0...9	51...159	DHCP name assignment
0	A	0A	Fixed address
0	E	0E	Reset the IP parameters
0	F	0F	Reset to factory settings
Other			Reserved

16.1 Remote access

16.1.1 Switch position 00

At this switch position it is possible to remotely configure the device using corresponding tools (e.g. Startup+, web-based management (WBM)).

16.1.2 Behaviour 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 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.

16.1.3 Each additional start-up

If BootP is not explicitly deactivated, 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.

16.2 Manual address assignment

16.2.1 Switch positions 01...50

Default: 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 octet with the switch position. That means you can select IP addresses between 192.168.0.1 and 192.168.0.50.

Prior to transferring the IP address, a test is performed to check for any potential IP address conflicts. If a conflict is detected, the device temporarily switches the IP address to 0.0.0.0 (no IP communication). In this case, the NET LED flashes red.

► Eliminate the conflict and restart the device.

16.3 DHCP name assignment

16.3.1 Switch positions 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. It is therefore able to send a DNS update to the DNS server

The DNS name consists of one set part, which is based on the order designation, and a variable part, which is determined by the switch position.

Behaviour 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.

16.3.2 Each additional start-up

The device transmits continuous DHCP requests. There are two possible scenarios:

1. The DHCP server assigns a new IP address.

> The device applies the new IP parameters.

2. The DHCP server does not respond.

> The device transmits continuous DHCP discover messages until new IP parameters have been received.

16.4 Fixed address

16.4.1 Switch position 0A

16.4.2 Behaviour 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.

16.4.3 Each additional start-up

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

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

16.5 Reset the IP parameters

16.5.1 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).

16.6 Reset to factory settings

All settings are reset to the factory setting, including the IP parameters.

The device is ready for operation after the voltage has been applied, as soon as the RDY LED lights green. A connection to the device can, however, not be established in this switch position.

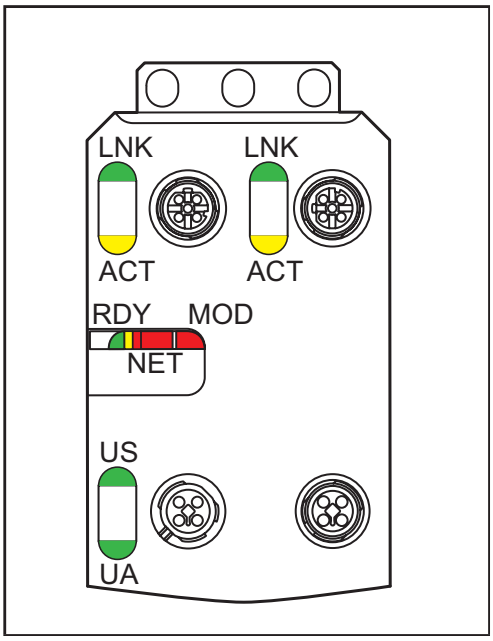
As soon as the RDY LED lights green, a new switch position can be selected on the rotary encoding switch and the device can be restarted.

16.7 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).

17 Local status and diagnostic indicators

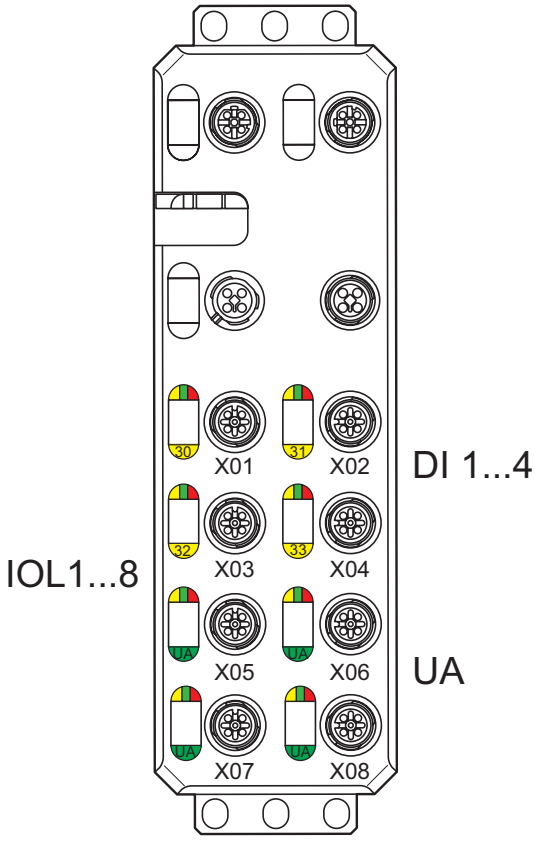
17.1 Indicators for Ethernet ports and power supply



Designation	Colour	Meaning	State	Description
LNK 1/2	Green	Link	Green ON	Connection present at port 1/2
			Green OFF	Connection not present at port 1/2
ACT 1/2	Yellow	Activity	Yellow flashing	Data transmission present at port 1/2
			Yellow OFF	Data transmission not present at port 1/2

Designation	Colour	Meaning	State	Description
RDY	Green/ yellow/ red	Ready	Green ON	Unit is ready for operation
			Yellow flashing	Firmware update is being performed
			Flashing green/ yellow	Overvoltage or undervoltage at U_S Temperature of the device is in the critical area Failure of the actuator supply U_A and red U_S LED: sensor supply overload
			Red ON	Rotary encoding switches are set to an invalid/reserved position
			OFF	Device is not ready for operation
NET	Green / red	Network status	Green ON	At least one CIP connection is in place and the exclusive owner connection has no timeout
			Green flashing	An IP address is configured, no CIP connection is yet in place, and the exclusive owner connection has no timeout.
			Red ON	Duplicate IP. ACD has determined an IP address conflict
			Red flashing	Connection timeout. A timeout of an exclusive owner connection has occurred
			Green / red flashing	Self-test
			OFF	Device is not ready for operation
MOD	Green / red	Module status	Green ON	Normal operation
			Green flashing	The device is not configured
			Red ON	A recoverable error has occurred
			Red flashing	An unrecoverable error has occurred
			Green / red flashing	Self-test
			OFF	Device is not ready for operation
US	Green / red	$U_{Sensors}$	Green ON	Communications power/sensor voltage present
			OFF	Communications power/sensor voltage not present or too low
			Red ON	Sensor voltage overload
UA	Green	$U_{Actuators}$	On	Actuator voltage present
			OFF	Actuator voltage not present

17.2 Displaying the IO-Link ports and inputs



Designation	Colour	Meaning	State	Description
IO-Link LED	Green/ yellow/ red	Status of the IO-Link ports (X01 ... X08)	Green ON	In IO-Link mode IO-Link communication present
			Green flashing	In IO-Link mode no IO-Link communication
			Yellow ON	In the DI or DO operating mode the digital input or output is set
			Red ON	In IO-Link mode IO-Link communication error
			Red ON	In IO-Link mode overload of the L+/L- cable
			Red ON	In DI or DO mode overload of the L+/L- cable
			Red ON	Overload of the C/Q cable
			OFF	In the DI or DO operating mode the digital input or output is not set
30 ... 33	Yellow	Status of the digital inputs	On	Input is set
			OFF	Input is not set.
UA	Green / red	Actuator supply for X05 ... X08	Green ON	Actuator voltage present

Designation	Colour	Meaning	State	Description
			Green OFF	Actuator voltage not present
			Red ON	Short circuit between pin 2 and pin 5

The numbering of the LEDs is as follows:
the first number specifies the byte, the second number specifies the bit.

18 EtherNet/IP™ object classes, messages and services

The device supports the Common Industrial Protocol (CIP) according to the ODVA specification.

EtherNet/IP™ uses the Common Industrial Protocol as the application layer. IP and TCP or UDP are used for the network and transport layers. CIP and EtherNet/IP™ are standardised by the ODVA on a manufacturer-neutral basis. The Common Industrial Protocol is an object-oriented protocol with two different types of communication between a controller and termination devices.

The following table describes the two communication types.

Connection type	Description
Explicit messaging	Explicit messaging is based on the request/response principle. This means that a controller or an engineering system sends a request and the termination device responds. For example, explicit messaging can be used for configuration and/or diagnostics.
Implicit messaging	Implicit messaging is used for the cyclic transmission of I/O data. That means, for example, that a termination device sends an analogue value which is present at a termination device input. The time for a transmission cycle can be set via the requested packet interval (RPI).

18.1 CIP-class services

The device supports the following class services and instance services:

Service code		Service name
dec	hex	
01	01	Get_Attribute_All
02	02	Set_Attribute_All
05	05	Reset
09	09	Delete
14	0E	Get_Attribute_Single
16	10	Set_Attribute_Single
75	4B	Read_ISDU
78	4C	Write_ISDU

18.2 CIP object classes

The device supports the following CIP object classes:

Service code		Object type
dec	hex	
01	01	Identity object
02	02	Message router object
04	04	Assembly object
06	06	Connection manager object
71	47	Device level ring object
72	48	Quality of service object
128	80	IO-Link device parameter (vendor specific)
245	F5	TCP/IP interface object
246	F6	Ethernet link object

18.3 Identity object (class code 01_{hex})

The identity object is required by all devices and provides the device ID and general information about the device.

Class attributes

Attribute	Name	Access	Data type	Value
1	Revision	Get	UINT	1
2	Max instance	Get	UINT	1
6	Max class attribute	Get	UINT	7
7	Max instance attribute	Get	UINT	9

Instance attributes

Attribute	Name	Access	Data type	Value	
1	Vendor ID	Get	UINT	322	
2	Product type	Get	UINT	12 ("Communications adapter")	
3	Product code	Get	UINT	1020	
4	Revision	Get	STRUCT of:	1	
	– Major revision		– USINT	1	
	– Minor revision		– USINT	1	

Attribute	Name	Access	Data type	Value	
5	Status	Get	WORD	Bit 0	Owned
				Bit 1	= reserved
				Bit 2	Configured
				Bit 3	= reserved
				Bit 4 ... bit 7	Extended device status
				Bit 8	Minor recoverable fault
				Bit 9	Minor unrecoverable fault
				Bit 10	Major recoverable fault
				Bit 11	Major unrecoverable fault
				Bit 12 ... bit 15	Extended device status 2
6	Serial number	Get	UDINT	Is fixed in production process	
7	Product name	Get	STRING	AL1020	
8	State	Get	USINT	0 = nonexistent	
				1 = device self testing	
				2 = standby	
				3 = operational	
				4 = major recoverable fault	
				5 = major unrecoverable fault	
				6 ... 254 = reserved	
				255 = default for Get_ Attribute_All service	
9	Configuration consistency value	Get	USINT	CRC checksum	

Common services

Service code		Class	Instance	Service name
dec	hex			
01	01	Yes	Yes	Get_Attribute_All
05	05	No	Yes	Reset
14	0E	Yes	Yes	Get_Attribute_Single
16	10	No	Yes	Set_Attribute_Single

18.4 Message router object (class code 02_{hex})

The message router object provides a messaging connection point through which an Ethernet/IP™ client may address a service to any object class or instance in the physical device. The device does not support any access to object attributes.

18.5 Assembly object (class code 04_{hex})

The assembly object combines attributes of several objects to allow data to be sent to or received from each object via a single connection.

Class attributes

Attribute	Name	Access	Data type	Value
1	Revision	Get	UINT	2
2	Max instance	Get	UINT	107

Instance attributes

Attribute	Name	Access	Data type	Value
3	Data	Get, Set	ARRAY of byte	Current process data of the corresponding assembly instance
4	Size	Get	UINT	Number of bytes in attribute 3

Common services

Service code		Class	Instance	Service name
dec	hex			
14	0E	Yes	Yes	Get_Attribute_Single
16	10	No	Yes	Set_Attribute_Single

18.6 Connection manager object (class code 06_{hex})

The connection manager object allocates and manages the internal resources that are used for I/Os and explicit messaging connections.

Class attributes

Attribute	Name	Access	Data type	Value
1	Revision	Get	UINT	1
2	Max instance	Get	UINT	1

Instance attributes

The device does not support any instance attributes.

Common services

Service code		Class	Instance	Service name
dec	hex			
14	0E	Yes	Yes	Get_Attribute_Single

18.7 Device level ring object (class code 47_{hex})

The device level ring object (DLR) is the interface for configuration and status information for the DLR protocol.

Class attributes

Attribute	Name	Access	Data type	Value
1	Revision	Get	UINT	3

Instance attributes

Attribute	Name	Access	Data type	Value / description
1	Network topology	Get	USINT	0 = linear
				1x55 = ring
2	Network status	Get	USINT	0 = normal
				1 = ring fault
				2 = unexpected loop detected
				3 = partial network fault
				4 = rapid fault/restore cycle

Attribute	Name	Access	Data type	Value / description
10	Active supervisor address	Get	STRUCT of:	IP and/or MAC address of the active ring supervisor
			– UDINT	Supervisor IP address
			– ARRAY of 6 USINTs	Supervisor MAC address
12	Capability flags	Get	DWORD	Bit 0 anounced-based ring node
				Bit 1 beacon-based ring note
				Bit 2...bit 4 reserved
				Bit 5 supervisor capable
				Bit 6...bit 31 reserved

Common services

Service code		Class	Instance	Service name
dec	hex			
1	01	Yes	Yes	Get_Attribute_All
14	0E	Yes	Yes	Set_Attribute_Single

18.8 Quality of service object (class code 48_{hex})

Quality of service (QoS) affects the forwarding and handling of data streams and results in individual data streams being given differential treatment (usually preferential). QoS can be used, e.g. to guarantee a transmission bandwidth for individual data streams. The device uses QoS in connection with prioritisation.

Class attributes

Attribute	Name	Access	Data type	Value
1	Revision	Get	UINT	1
2	Max instance	Get	UINT	1

Instance attributes

Attribute	Name	Access	Data type	Value / description
1	802.1Q tag enable	Get, Set	UINT	0 = off (default); 1 = on
4	DSCP urgent	Get, Set	USINT	DSCP value for CIP transport class 0/1 urgent priority message (default 55)
5	DSCP sche-duled	Get, Set	USINT	DSCP value for CIP transport class 0/1 scheduled priority message (default 47)
6	DSCP high	Get, Set	USINT	DSCP value for CIP transport class 0/1 high priority message (default 43)
7	DSCP low	Get, Set	USINT	DSCP value for CIP transport class 0/1 low priority message (default 31)
8	DSCP explicit	Get, Set	USINT	DSCP value for CIP explicit messages (transport class 2/3 and UCMM) and all other EtherNet/IP™ encapsulation messages (default 27)

Common services

Service code		Class	Instance	Service name
dec	hex			
14	0E	Yes	Yes	Get_Attribute_Single
16	10	No	Yes	Set_Attribute_Single

18.9 IO-Link parameter object (class code 80_{hex})

The IO-Link device parameter object allows access to the IO-Link device parameters. The object has the class instance 0 and the instance 1. The class instance 1 addresses the IO-Link master.

Class attributes

Attribute	Name	Access	Data type	Value
1	Revision	Get	UINT	1
2	Max instance	Get	UINT	1
6	Max class attribute	Get	UINT	8 (number of the IO-Link ports)

Instance attributes

The IO-Link master ports are addressed via the corresponding instance attributes number. For the exact addressing or use we refer you to the chapters "Read_ ISDU" or "Write _ISDU".

Common services

Service code		Class	Instance	Service name
dec	hex			
14	0E	Yes	No	Get_Attribute_Single
75	4B	No	Yes	Read_ISDU
78	4C	No	Yes	Write_ISDU

Read_ISDU

This service is used to read device parameters of the connected IO-Link device.

Request

	MSG Config	Description	
Class	80hex	IO-Link parameter object	
Instance	1	Addressing of the IO-Link master	
Instance attributes	1...8	IO-Link port number	
Service code	$4B_{hex}$	6	
Data	Read ISDU service request parameter		
	Name	Data type	Description
	Index	UINT	IO-Link ISDU object index
	Sub-index	USINT	IO-Link ISDU object sub-index

Ethernet/IP™ uses the little endian format (Intel), IO-Link the big endian format (Motorola). For the IO-Link process data, no byte swapping is performed.

Response

The response to the request can either be positive or negative.

- Positive response

If the request service was successful (general status of the CIP service response is = 0), the service response has the following structure:

Name	Data type	Description
ISDU Data	Array of byte	Maximal 232 Bytes

- Negative response

If the request service was not successful (general status of the CIP service response unequal 0), the service response has the following structure:

Name	Data type	Value/description	
IO-Link master error	UINT	1	Service not available
		2	Port blocked
		3	Timeout
		4	Invalid index
		5	Invalid sub-index
		6	Wrong port
		7	Wrong port function
		8	Invalid length
		9	ISDU not supported
IO-Link device error	USINT	Please refer to the specific device data sheet	
IO-Link device additional error	USINT	Please refer to the specific device data sheet	

Example: Reading an IO-Link device object

The following table shows the exemplary structure of a message (MSG) for reading the VendorName of an IO-Link device, which is connected to port 7.

Request

	MSG Config	Description
Class	80hex	IO-Link parameter object
Instance	1	Addressing of the IO-Link master
Instance attributes	7	IO-Link port 7
Service code	4Bhex	Read ISDU
Data	0010hex	IO-Link ISDU object index 0010hex (VendorName)
	00hex	IO-Link ISDU object sub-index 00hex (no sub-index)

Response

Depending on whether the response is positive or negative, the data structure contains either the VendorName of the device or additional error codes.

Write_ISDU

This service is used to write device parameters of a connected IO-Link device.

Request

	MSG Config	Description	
Class	80_{hex}	IO-Link parameter object	
Instance	1	Addressing of the IO-Link master	
Instance attributes	1 ... 8	IO-Link port number	
Service code	$4C_{hex}$	Write ISDU	
Data	Write ISDU Service request parameter		
	Name	Data type	Description
	Index	UINT	IO-Link ISDU object index
	Sub-index	USINT	IO-Link ISDU object sub-index
	Data	Array of byte	IO-Link ISDU data (max. 232 bytes)

Ethernet/IP™ uses the little endian format (Intel), IO-Link the big endian format (Motorola). For the IO-Link process data, no byte swapping is performed.

Response

The response to the request can either be positive or negative.

- Positive response

If the request service was successful (general status of the CIP service response is = 0), the service response does not contain any further data.

Negative response

If the request service was not successful (general status of the CIP service response unequal 0), the service response has the following structure:

Name	Data type	Value/description	
IO-Link master error	UINT	1	Service not available
		2	Port blocked
		3	Timeout
		4	Invalid index
		5	Invalid sub-index
		6	Wrong port
		7	Wrong port function
		8	Invalid length
		9	ISDU not supported

Name	Data type	Value/description
IO-Link device error	USINT	Please refer to the specific device data sheet
IO-Link device additional error		

Example: Writing to an IO-Link device object

The following table shows an example of the structure of a message (MSG) for writing the application-specific name object (18hex) of the ifm device AL1020 which is connected to port 5.

Request

	MSG Config	Description
Class	80_{hex}	IO-Link parameter object
Instance	1	Addressing of the IO-Link master
Instance attributes	7	IO-Link port 7
Service code	$4C_{hex}$	Write ISDU
Data	0018_{hex}	IO-Link ISDU object index: 0018hex (application-specific name)
	00_{hex}	IO-Link ISDU object sub-index: 00hex (no sub-index)
	[0] 4F [1] 75 ... [13] 5F [14] 31 [15] 00	IO-Link ISDU data: The above object has 16 bytes. – ASCII: Outside_Meter_1 (= 15 bytes) – Hex: 4f 75 74 73 69 64 65 5f 4d 65 74 65 72 5f 31 – The last byte is filled with zeros.

Response

If the service was successful, the general status of the CIP service response is = 0. In the event of an error the status is unequal 0.

18.10 TCP/IP object (class code F5hex)

The TCP/IP interface object makes it is possible to configure the physical network interface. This includes, for example, the IP address, subnet mask and gateway address.

Class attributes

Attribute	Name	Access	Data type	Value
1	Revision	Get	UINT	3
2	Max instance	Get	UINT	1

Instance attributes

Attribute	Name	Access	Data type	Description	
1	Status	Get	DWORD	Bit 0 ... bit 3	Interface configuration status
				Bit 4	Mcast pending (always 0)
				Bit 5	Interface configuration pending
				Bit 6	AcdStatus
				Bit 7	AcdFault
				Bit 8 ... bit 31	= reserved
2	Configuration capability	Get	DWORD	Bit 0	BOOTP client
				Bit 1	Not supported
				Bit 2	DHCP client
				Bit 3	Not supported
				Bit 4	TCP/IP config can be set via ETH/IP
				Bit 5	Not supported
				Bit 6	Not supported
				Bit 7	AcdCapable
				Bit 8 ... bit 31	= reserved
3	Configuration control	Get, Set	DWORD	Bit 0 ... bit 3	0 = the device uses static IP configuration.
					1 = the device uses BOOTP
					2 = the device uses DHCP
				Bit 4	Not supported
				Bit 5 ... bit 31	= reserved
4	Physical link object	Get	STRUCT of	Path to physical link object	
	– Path size		– UINT	4	
	– Path		– Padded EPATH	20_{hex}, $F6_{hex}$, 25_{hex}, 01_{hex}	

Attribute	Name	Access	Data type	Description
5	Interface configuration	Get, Set	STRUCT of:	TCP/IP network interface configuration
	– IP address		– UDINT	The device's IP address
	– Network mask		– UDINT	The device's network mask
	– Gateway address		– UDINT	Default gateway address
	– Name server		UDINT	Primary name server (always 0.0.0.0)
	– Name server 2		– UDINT	Secondary name server (always 0.0.0.0)
	– Domain name		– STRING	Default domain name (always empty)
6	– Host name	Get, Set	STRING	The device's host name
10	– SelectAcd	Get, Set	BOOL	0 = disable; 1 = enable (default)
11	Last conflict detected	Set	STRUCT of:	Structure containing information related to the last conflict detected
	– AcdActivity		– USINT	State of ACD activity when last conflict detected
				0 = noconflictdetected (default)
				1 = probeIpv4Address
				2 = ongoingDetection
				3 = semiActiveProbe
	– Remote MAC		– ARRAY of 6 USINTs	MAC address of remote node from the ARP PDU in which a conflict was detected
	– ArpPdu		– ARRAY of 28 USINTs	Copy of the raw ARP PDU in which a conflict was detected
12	Ethernet/IP quick connect	Get, Set	BOOL	0 = disable (default); 1 = enable

Common services

Service code		Class	Instance	Service name
dec	hex			
1	01	Yes	Yes	Get_Attribute_All
14	0E	Yes	Yes	Get_Attribute_Single
16	10	No	Yes	Set_Attribute_Single

18.11 Ethernet link object (class code $F6_{hex}$)

The Ethernet link object contains specific status information of the Ethernet interface (IEEE 802.3).

Class attributes

Attribute	Name	Access	Data type	Value
1	Revision	Get	UINT	3
2	Max instance			2
3	Number of instances			2

Instance attributes

Attribute	Name	Access	Data type	Description	
1	Interface speed	Get	UDINT	Interface speed currently in use. Speed in bps (e.g. 10, 100)	
2	Interface flags	Get	DWORD	Bit 0	Link status
				Bit 1	Half/full duplex status
					0 = half duplex
					1 = full duplex
				Bit 2 ... bit 4	Auto negotiation status
					0 = auto negotiation in progress
					1 = auto negotiation and speed detection failed
					2 = auto negotiation failed but detected speed
					3 = successfully negotiated
					4 = auto negotiation not attempted
				Bit 5	Not supported
				Bit 6	Not supported
				Bit 7 ... bit 31	= reserved
3	Physical address	Get	ARRAY of 6 USINTs	MAC layer address	

Attribute	Name	Access	Data type	Description	
6	Interface control	Get, Set	STRUC of:	Configuration for physical interface	
	– Control bits		– WORD	Interface control bits	
				Bit 0	Auto negotiate (set)
					0 = auto negotiation disabled
					1 = auto negotiation enabled
				Bit 1	Forced duplex mode (set)
					0 = half duplex
					1 = full duplex
					Set only if auto negotiation is disabled
				Bit 2 ... bit 15	Reserved, shall be set to 0
	– Forced interface speed		– UINT	The Forced interface speed bits indicate the speed at which the interface shall operate.	
				10 = 10 Mbps	
				100 = 100 Mbps	
				Set only if auto negotiation is disabled.	
7	Interface type	Get		Indicates the type of the physical interface.	
				0 = unknown interface type	
				1 = the interface is internal to the device	
				2 = twisted-pair	
				3 = optical fibre	
				4 … 255 = reserved	
8	Interface type	Get		Indicate the current operational state of the interface.	
				0 =unknown interface state	
				1 =the interface is enabled and is ready to send and receive data.	
				2 =the interface is disabled.	
				3 =the interface is testing.	
				4 … 255 =reserved	

Attribute	Name	Access	Data type	Description
9	Interface type	Get, Set		Allows administrative setting of the interface state
				0 = reserved
				1 = enable the interface
				2 = disable the interface
				3 … 255 = reserved
10	Interface label	Get	STRING	Interface name

Common services

Service code		Class	Instance	Service name
dec	hex			
14	0E	Yes	Yes	Get_Attribute_Single
16	10	No	Yes	Set_Attribute_Single

19 EtherNet/IP™ assembly instances

The IO-Link master has several assembly instances for input and output process data which differ mainly in the data length. The configuration assembly is always the same.

	Input assembly	Data length	Output assembly	Data length	Config assembly	Data length
Exclusive Owner						
Without IO-Link	101	4	100	4	106	214
With IO-Link input	103	260	100	4	106	214
With IO-Link output	101	4	102	260	106	214
With IO-Link I/O	103	260	102	260	106	214
With IO-Link I/O + status	105	316	102	260	106	214
With IO-Link I/O + status + events	107	388	102	260	106	214
Input Only						
Without IO-Link	101	4	193	0	106	214
With IO-Link	103	260	193	0	106	214
With IO-Link input + status	105	316	193	0	106	214
With IO-Link input + status + events	107	388	193	0	106	214
Listen Only						

	Input assembly	Data length	Output assembly	Data length	Config assembly	Data length
Without IO-Link	101	4	192	0	-	-
With IO-Link	103	260	192	0	-	-
With IO-Link input + status	105	316	192	0	-	-
With IO-Link input + status + events	107	388	192	0	-	-

19.1 Input process data

Assembly instance 101

Byte	Function	Description
0...3	Status bytes	IO-Link master status bytes

Assembly instance 103

Byte	Function	Description
0...3	Status bytes	IO-Link master status bytes
4...35	IO-Link port 1 IN	32 byte IO-Link input process data
36...67	IO-Link port 2 IN	32 byte IO-Link input process data
68...99	IO-Link port 3 IN	32 byte IO-Link input process data
100...131	IO-Link port 4 IN	32 byte IO-Link input process data
132...163	IO-Link port 5 IN	32 byte IO-Link input process data
164...295	IO-Link port 6 IN	32 byte IO-Link input process data
296...227	IO-Link port 7 IN	32 byte IO-Link input process data
228...259	IO-Link port 8 IN	32 byte IO-Link input process data

Assembly instance 107

Byte	Function	Description
0...3	Status bytes	IO-Link master status bytes
4...35	IO-Link port 1 IN	32 byte IO-Link input process data
36...42		Extended IO-Link port status
43...51		IO-Link event data
52...83	IO-Link port 2 IN	32 byte IO-Link input process data
84...90		Extended IO-Link port status
91...99		IO-Link event data

Byte	Function	Description
100...131	IO-Link port 3 IN	32 byte IO-Link input process data
132...138		Extended IO-Link status
139...147		IO-Link event data
148...179	IO-Link port 4 IN	32 byte IO-Link input process data
180...186		Extended IO-Link status
187...195		IO-Link event data
196...227	IO-Link port 5 IN	32 byte IO-Link input process data
228...234		Extended IO-Link status
235...243		IO-Link event data
244...275	IO-Link port 6 IN	32 byte IO-Link input process data
276...282		Extended IO-Link status
283...291		IO-Link event data
292..323	IO-Link port 7 IN	32 byte IO-Link input process data
324...330		Extended IO-Link status
331..339		IO-Link event data
340...371	IO-Link port 8 IN	32 byte IO-Link input process data
372...378		Extended IO-Link status
379...388		IO-Link event data

19.2 IO-Link master status bytes

The first two status bytes provide information if the respective port(s) has/have established a communication to the IO-Link device (COM State) and if the IO-Link process data of the port(s) is valid or not (PD valid status).

Byte	Byte 0								Byte 1							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Port	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
Function	COM state								PD valid state							
	0 = communication inactive								0 = invalid data							
	1 = communication active								1 = valid data							

Bytes 2 and 3 show the input status of the IO-Link ports in the configured digital input mode (DI) (byte 2) and the status of the hardwired inputs of the type A ports (byte 3).

Byte	Byte 2								Byte 3							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Port	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
Function	DI status of pin 4 (C/Q) (type A and type B ports)								Reserved				DI status of pin 2 (type A ports)			
	0 = iput is not active												0 = iput is not active			
	1 =input is active												1 =input is active			

19.3 32 byte IO-Link input process data

Ethernet/IP™ uses the little endian format (Intel), IO-Link the big endian format (Motorola). For the IO-Link process data, no byte swapping is performed.

Input data is directly copied to the input assembly as it was received from the connected IO-Link device (transparent).

Byte	Function	Description
4	IO-Link port 1 IN	IOLD input process data byte 0
5		IOLD input process data byte 1
...		...
34		IOLD input process data byte 30
35		IOLD input process data byte 31

The structure of the mappings of the other IO-Link ports is the same.

19.4 Extended IO-Link port status

Byte	Function	Description	
0	IO-Link status	Bit 0	IO-Link operating mode for ports is active
		Bit 1	IO-Link device connected and communication is active
		Bit 2 ... bit 7	Reserved

Byte	Function	Description	
1	IO-Link error	Bit 0	Incompatible device found (wrong Vendor ID and/or Device ID)
		Bit 1	Data storage error mechanism
		Bit 2	Device detected which has invalid parameters in the direct parameter page 2
		Bit 3 ... bit 7	Reserved
2	Vendor ID of the connected device	Vendor ID byte 1 (LSB)	
3		Vendor ID byte 2 (MSB)	
4	Device ID of the connected device	Device ID byte 1 (LSB)	
5		Device ID byte 2	
6		Device ID byte 3 (MSB)	

19.5 IO-Link event data

Byte	Function	Description	
0	Event Qualifier	Bit 0 ... bit 2	Event Instance
			0 = unknown
			1 ... 3 = reserved
			4 = application
			5 ... 7 = reserved
		Bit 3	Event Source
			0 = device application (remote)
			1 = master application (local)
		Bit 4 ... bit 5	Event type
			0 = reserved
			1 = notification
			2 = warning
			3 = error
		Bit 6 ... bit 7	Event mode 0 = reserved 1 = event single shot 2 = event disappears 3 = event appears
1	Event code 1 (LSB)	The event codes reported by the IO-Link device are mapped 1:1 to this register. Please refer to the specific IO-Link device data sheet for the definition of the event codes.	
2	Event code 2 (MSB)		

Byte	Function	Description	
3	Event qualifier	Data of the IO-Link events 2 (see byte 0 … byte 2)	
4	Event code 1 (LSB)		
5	Event code 2 (MSB)		
6	Event qualifier	Data of the IO-Link events 3 (see byte 0 … byte 2	
7	Event code 1 (LSB)		
8	Event code 2 (MSB)		

Assembly instance 100

Byte	Function	Description
0...3	Control bytes	IO-Link master control bytes

Assembly instance 102

Byte	Function	Description
0...3	Control bytes	IO-Link master control bytes
4...35	IO-Link port 1 OUT	32 byte IO-Link output process data
36...67	IO-Link port 2 OUT	32 byte IO-Link output process data
68...99	IO-Link port 3 OUT	32 byte IO-Link output process data
100...131	IO-Link port 4 OUT	32 byte IO-Link output process data
132...163	IO-Link port 5 OUT	32 byte IO-Link output process data
164...295	IO-Link port 6 OUT	32 byte IO-Link output process data
296...227	IO-Link port 7 OUT	32 byte IO-Link output process data
228...259	IO-Link port 8 OUT	32 byte IO-Link output process data

19.6 IO-Link master control bytes

With byte 0 of the IO-Link master control bytes it is possible to temporarily switch one or several IO-Link ports to IO-Link mode (as long as the COM control bit is set). They were previously configured in the operating mode digital input (DI). Cyclic and acyclic communication can therefore be established with the connected IO-Link device.

Byte	Byte 0								Byte 1							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Port	8	7	6	5	4	3	2	1	Whole device							

Byte	Byte 0	Byte 1
Function	COM control (port configuration)	PD valid state
	0 = use configuration of assembly instance 106	0 = invalid data
	1 = activate IO-Link mode for port Only possible for ports that are running in DI mode	Q

Byte 2 (DO state of pin 4 (C/Q) allows the control (set or reset) of IO-Link ports in digital output mode (DO).

Byte	Byte 2								Byte 3							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Port	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
Function	DO state on pin 4 (C/Q)								Reserved							
	0= Output not set								0 = no function							
	1 = output set								1 = not allowed							

19.7 32 byte IO-Link output process data

Ethernet/IP™ uses the little endian format (Intel), IO-Link the big endian format (Motorola). For the IO-Link process data, no byte swapping is performed.

Output data is directly written to the connected IO-Link device as received by the connected IO-Link device (transparent).

Byte	Function	Description
4	IO-Link port 1 OUT	IOLD output process data byte 0
5		IOLD output process data byte 1
...		...
34		IOLD output process data byte 30
35		IOLD output process data byte 31

The structure of the mappings of the other IO-Link ports is the same.

Assembly instance 106

Byte	Data type	Function
0	UINT8	= reserved
1	UINT8	= reserved
2	UINT8	Fail-safe mode
3	UINT8	Fail-safe pattern DO pin 4
4	UINT8	= reserved
5	UINT8	= reserved
6	UINT8	Port mode port 1
7...8	UINT16	Vendor ID port 1
9...12	UINT32	Device ID port 1
13	UINT8	Data storage port 1
14	UINT8	IO-Link fail- safe mode port 1
15	UINT8	Enable direct parameter port 1
16...31	Array of 16 x UINT8	Direct parameter page 2 port 1
32...213	...	26 parameter bytes per port

Fail-safe mode

This parameter is used for setting the substitute value behaviour of IO-Link ports in the digital output mode.

Adjustable values are:

Code (hex)	Description
00	Reset, DO ≥ 0
01	Set DO ≥ 1
02	Hold last value
03	Use substitute value pattern Fail-safe pattern DO pin 4 is active.

If the IO-Link port is working in IO-Link mode, the port-specific behaviour is active (see byte 14).

Fail-safe pattern DO pin 4

The substitute value pattern (high or low) can be adjusted individually for all digital outputs.

Example:
The outputs 1, 4, 5 and 8 are to be set to "0" and the outputs 2, 3, 6 and 7 are to be set to "1".

Bit	7	6	5	4	3	2	1	0
DO	8	7	6	5	4	3	2	1
Pattern	0	1	1	0	0	1	1	0
hex	=66							

The substitute value pattern is only active if this is selected in the parameter fail-safe mode. (= 03_{hex}).

Port Mode

With this parameter you can set the runtime performance of the individual IO-Link port.

Code (hex)	Description	
00	Deactivated	The IO-Link port (pin 4) is deactivated. In this operating mode the sensor supply voltage is also switched off.
01	Digital input (DI)	In this operating mode the IO-Link port (pin 4) functions like a digital input. The process data can be found in byte 2 of the IO-Link master status bytes.
02	Digital output (DO)	In this operating mode the IO-Link port (pin 4) functions like a digital output. The process data can be found in byte 2 of the IO-Link master control bytes.
03	DI with IO-Link	The operating mode is a quick digital input for IO-Link devices with SIO mode support (standard input output). If a device with SIO mode support is connected, the device parameters can be accessed in reading and writing. In this respect the master automatically changes from the operating mode DI to IO-Link. After the access the master switches automatically to the operating mode DI. The process data can be found in byte 2 of the IO-Link master status bytes.

Code (hex)	Description	
04	IO-Link (IOL)	Use this operating mode to communicate with IO-Link sensors and actuators (devices). You can set the process data length, vendor ID and device ID for each IO-Link port individually according to the connected IO-Link device. The process data can be found in the IO-Link input/ output process data area.

Vendor ID

The vendor ID of the connected IO-Link device can be parameterised for the respective port. The vendor ID can be found in the data sheet of the IO-Link device. If the Vendor ID is set, the Device ID must be set as well because both are always checked together.

As soon as the content of the vendor ID and/or device ID is not equal to “0”, the IO-Link “Type Compatible” inspection level is activated. Only if the parameterised vendor ID as well as the device ID correspond with the one read out (in the device), is communication to the device established (COM state bit of the corresponding port = 1), otherwise it is rejected (IO-Link LED is red).

Example
The vendor ID for port 1 is to be set.

– The vendor ID is a 16 bit value (2 bytes): Example 2211_{hex}
– The mapping is done according to the Intel format (common for CIP), i.e. LSB/MSB.

Byte	Data (hex)
7	11
8	12

Device ID

The device ID of the connected IO-Link device for the respective port can be set in this area. The device ID can be found in the data sheet of the IO-Link device. To check the device ID, a vendor ID check must be carried out beforehand.

Example:
The device ID for port 1 is to be set.

– The device ID is a 24 bit value (3 bytes): Example CCBBAAhex
– The mapping is done according to the Intel format (common for CIP), i.e. LSB/MSB.

Byte	Data (hex)
9	AA
10	BB
11	CC
12	00

Data storage

The data storage mechanism allows the exchange of parameters between the master and device. To use this function connected devices must at least support the IO-Link specification v1.1

Code (hex)	Description	
0000	Deactivated (default)	The data storage mechanism is deactivated.
0001	Download only	The parameter data is sent to the device from the IO-Link master. In the event of an inconsistency between the parameter data of the IO-Link device and the master, the data from the IO-Link master is taken as the default. That means that it is possible to exchange the IO-Link device.
0002	Upload only	The parameter data is sent from the IO-Link device to the IO-Link master. In the event of an inconsistency between the parameter data of the IO-Link device and the IO-Link master, the data from device is used as the default. That means that it is possible to exchange the IO-Link master.
0003	Download / upload allowed	The parameter data is saved both in the IO-Link master and the device. In the event of an inconsistency between the parameter data of the IO-Link device or the IO-Link master, the data from both is used as the default. That means that it is possible to exchange the IO-Link device or the IO-Link master.
0004	Cleared	The data storage mechanism is deactivated and the master deletes all stored parameters for the respective port.

IO-Link fail-safe mode

This parameter allows to define the substitute value behaviour for the respective IO-Link port in the IO-Link operating mode.

Adjustable values are:

Code (hex)	Description
00	Reset, DO ≥ 0
01	Set DO ≥ 1
02	Hold last value
03	Reserved
04	IO-Link master command (default)

The IO-Link master enables the substitute value behaviour with the first three options. The master informs the device with the last option "IO-Link master command" that the process data is invalid since the communication to the higher-level system has stopped. In this case the substitute value behaviour set in the device determines the behaviour in case of a fault.

Enable direct parameter

This parameter determines if the data of the direct parameter page 2 should be transferred to the IO-Link device or not.

Code (hex)	Description
00	Do not transfer data (default)
01	Transfer data

Direct parameter page 2 (DPP2)

The device parameter page 2 describes the area between the IO-Link objects 10hex…1Fhex. This relates to the manufacturer-specific area of the IO-Link device data.

The example for port 1 shows the mapping of the DPP2 objects to the parameter bytes.. The mapping is done transparently.

Byte	DPP2 object (hex)
16	10
17	11
...	...
30	1D
31	1F

20 Setup

20.1 Default upon delivery/default settings

By default upon delivery, the following functions and features are available:

IP settings

- IP parameters: 0.0.0.0
- Subnet mask: 0.0.0.0
- Default gateway: 0.0.0.0
- BootP: ativated

Firmware update

- Firmware update on next restart: deactivated
- TFTP server IP address: 192.168.210.211
- Firmware file name: FIRMWARE.NXF

System identification

- Device name: no name assigned
- Description: no description assigned
- Device location: no location assigned
- Contact: no contact assigned

Web-based management (WBM)

- User name: admin
- Password: private

20.2 Firmware started

Once you have connected the power, the firmware is started. After completion of the firmware boot process, the NET LED either lights or flashes green.

21 IO-Link master

IO-Link is an internationally standardised I/O technology (IEC 61131-9) for communicating with sensors and actuators. An IO-Link master is integrated in the device. The IO-Link master establishes the connection between the IO-Link devices and the automation system. The device supports IO-Link specification V1.1.

22 Connection monitoring/substitute value behaviour

The device executes connection monitoring which is configured for the device using a timeout multiplier configured by the scanner. In the event of a connection timeout, the device switches its outputs to the previously configured safe state.

For further information please refer to the following chapters:

- Fail-safe mode
- Fail-safe pattern DO pin 4
- IO-Link fail safe mode

23 Firmware update

In order to update the firmware of the device, the device must be provided with a firmware container via a TFTP server or it must be loaded onto the device via FTP. Any FTP client or TFTP server can be used for this. The update must always be initiated by the web-based management. When carrying out the firmware update, the RDY LED flashes yellow.

24 Restarting the device (reboot)

The device can be restarted (rebooted) via process data. You have to follow this sequence:

Output control bytes (hex)				Sequence steps	Input status bytes (hex)			
0	1	2	3		0	1	2	3
xx	xx	xx	xx	Normal data communication	xx	xx	xx	xx
xx	52	xx	xx	Sequence step 1 (write) – The reset sequence is initiated (ASCII: R) – Control bytes and status bytes go into the "Restart Mode"	xx	xx	xx	xx .....
xx	xx	xx	xx	Sequence step 2 (read) – When 52_{hex} in byte 1 of the control bytes is received, all four status bytes show 52 20 59 $3F_{hex}$ (ASCII: R Y?)	52	20	59	3F
00	59	00	00	Sequence step 3 (write) – Now the outputs can be put into a defined state. – – 00 59 00 00hex has to be written to all four control bytes (ASCII: Y). – – Then the IO-Link ports stop the IO-Link communication; connected devices (actuators) switch to their defined substitute behaviour. – – IO-Link ports in digital output operating mode switch their defined substitute behaviour.	xx	xx	xx	xx .....
xx	xx	xx	xx	Sequence step 4 (read) Status bytes show 00 00 00 00_{hex} that all outputs and IO-Link ports have transitioned into a defined state.	00	00	00	00
52	20	59	21	Sequence step 5 (write) – To restart the device write 52 20 59 21hex into all four control bytes (ASCII: R Y!). – – Device restarts immediately after receiving this sequence.	xx	xx	xx	xx

Any deviation from the above sequence will abort the reboot sequence. The codes must be transferred consistently with a write access.

25 Restoring the default settings

The following options are available to restore the factory default settings:

Rotary encoding switches
Switch position 0F, please refer to chapter "Configuration via rotary encoding switch".

Web-based management
Navigate to "Administration → Factory Defaults" and follow the instructions.

Identity object
Send a request service with the reset type 1 to the identity object.

26 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. Web-based management can be used to access static information (e.g. technical data, MAC address) or dynamic information (e.g., IP address, status information).

26.1 Calling web-based management

The device web server can be addressed using the IP address if configured accordingly. The homepage (web page) of the device is accessed by entering the URL “http://ip-address”.

Example
http://172.16.113.38

The default user name is “admin”, the default password is “private”.

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

27 SNMP - Simple Network Management Protocol

The device supports SNMP v1.

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

The password for read access is “public” and cannot be changed.

By default upon delivery, the password for write/read access is “private” and can be modified at any time.

28 DLR - Device Level Ring

The device supports DLR. DLR is a protocol that works on layer 2 for multi-port-EtherNet/IP™ devices.
The use of DLR is transparent for the protocols which work on higher levels such as TCP/IP. DLR increases the network availability, thanks to a redundant ring topology with a switch-over time of less than 3 ms for error detection and reconfiguration.
The DLR protocol supports the 1-ring topology; multiple rings or overlapping rings are not possible.

29 Quick Connect

The device supports the Quick Connect Class A. The device is ready to process a connection request after power on within 350 ms. Cyclic process data communication is possible within 500 ms.

When operating as an IO-Link master, the readiness for operation depends on the IO-Link configuration and the connected IO-Link devices.

30 Connection types

The device supports the connection types Exclusive Owner, Input Only and Listen Only.

- Exclusive Owner and Input Only can be configured via the scanner as multicast or point-to-point connections in "Target to Originator" direction.
- Listen Only connections can only be used as multicast.

AL1020 Ethernet/IP™ devices transmit the data always with only one connection to the scanner.

31 Device description file (EDS)

EtherNet/IP™ uses a device description file for various configuration tools. This file is called Electronic Data Sheet, short EDS.

For each AL1020 Ethernet/IP™ device one specific EDS file is provided.

32 Endianness

Ethernet/IP™ uses the little endian format (Intel), IO-Link the big endian format (Motorola). No byte swapping is performed for the IO-Link process data.

Input data from the IO-Link device is received as is and copied directly into the input assembly.

Output data is written to the IO-Link device as received in the output assembly.

33 Firmware Update EtherNet/IP

This document describes how you can make a firmware update for AL1020.

33.1 Firmware update

To upload the firmware file you will need either an FTP tool or you can use the Windows Explorer.

This document describes the firmware update using the Windows Explorer.

The default login details are as follows:

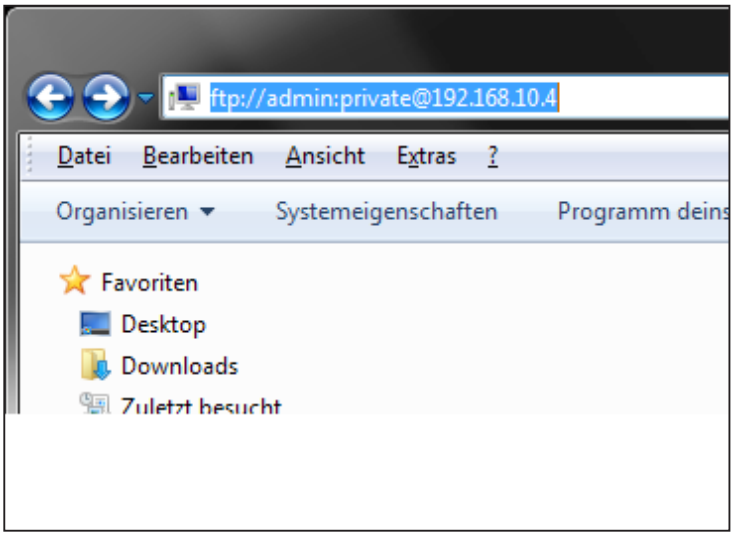
- User: admin
- Password: private

If you use the FTP tool, please follow the appropriate steps in your tool.

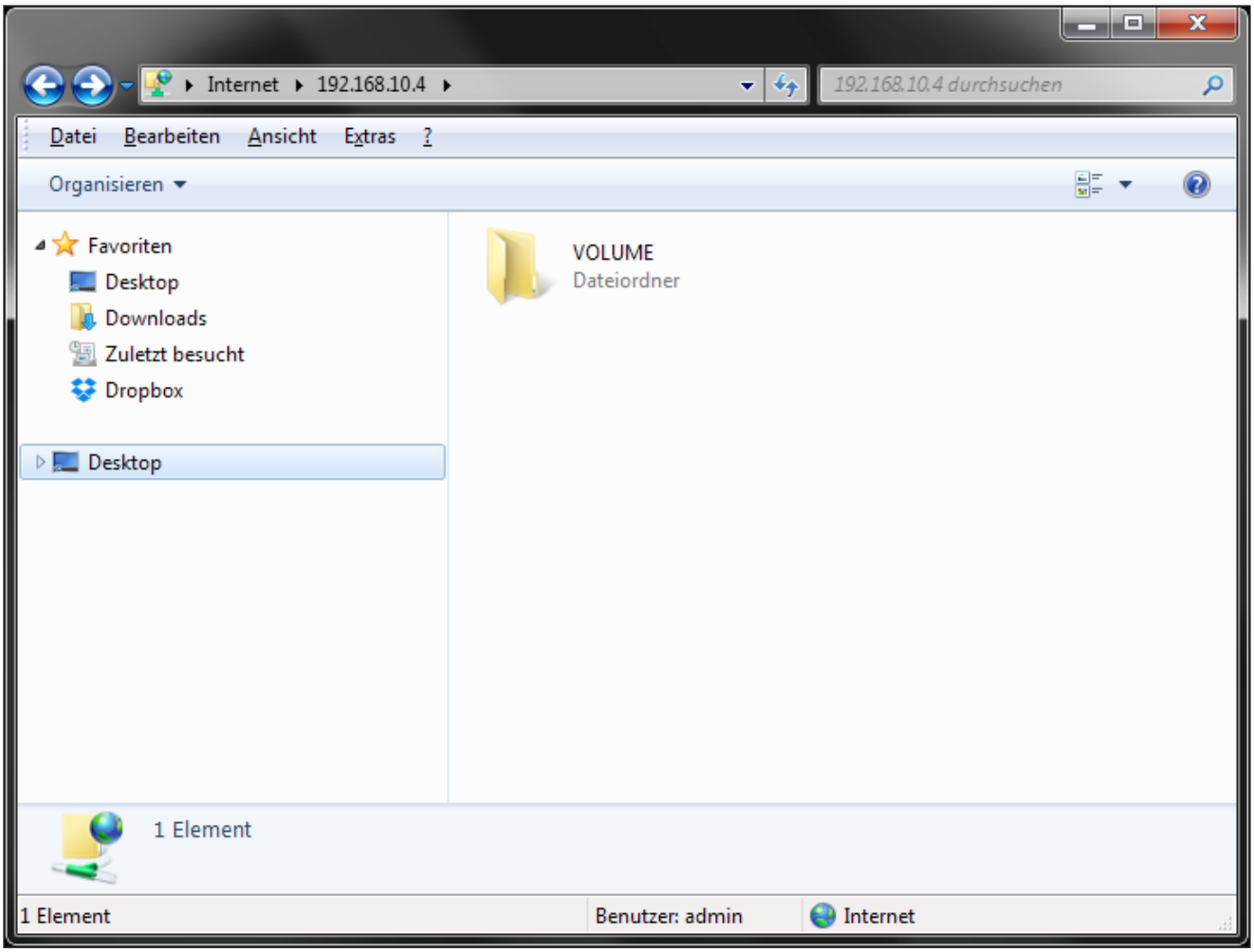
33.2 Access the FTP server

To access the FTP server on the device, please enter the address in the Windows Explorer in the following manner:
ftp://user:password@ip.address

Example
Here the default login details were used. The IP address is 172.16.49.10



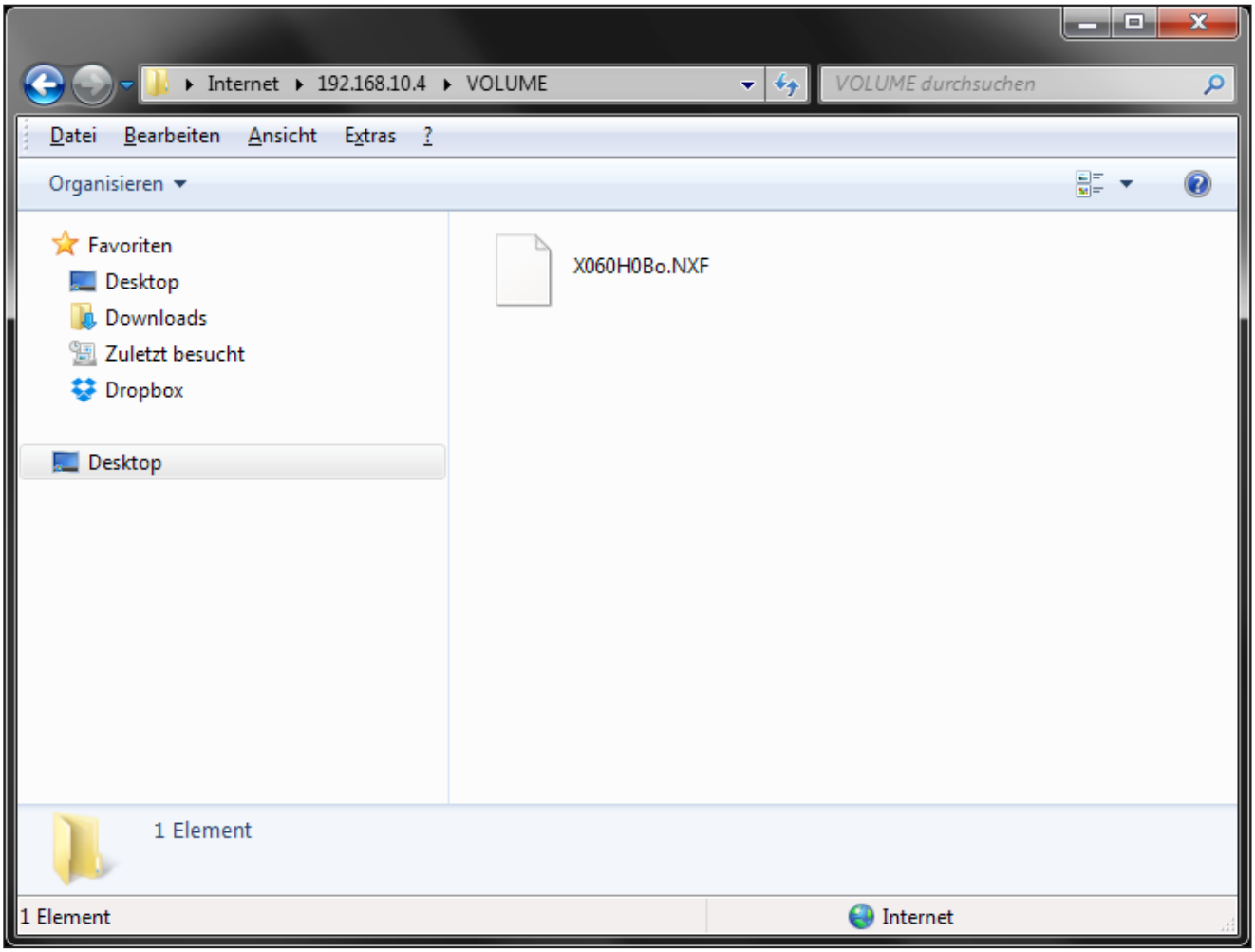
If the login is successful you will see the following window in the Windows Explorer: You see the following structure:



If you do not enter any login details or wrong details, you get a message. Please check your login details and try again.

33.3 Upload

► Open the [Volume] folder and copy the firmware file to the root of the [Volume] folder.



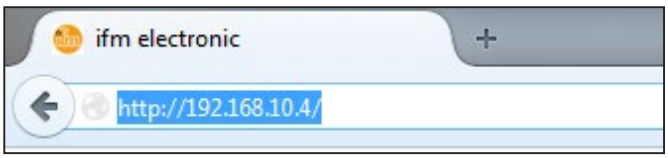
33.4 Firmware update

33.5 Access the web server

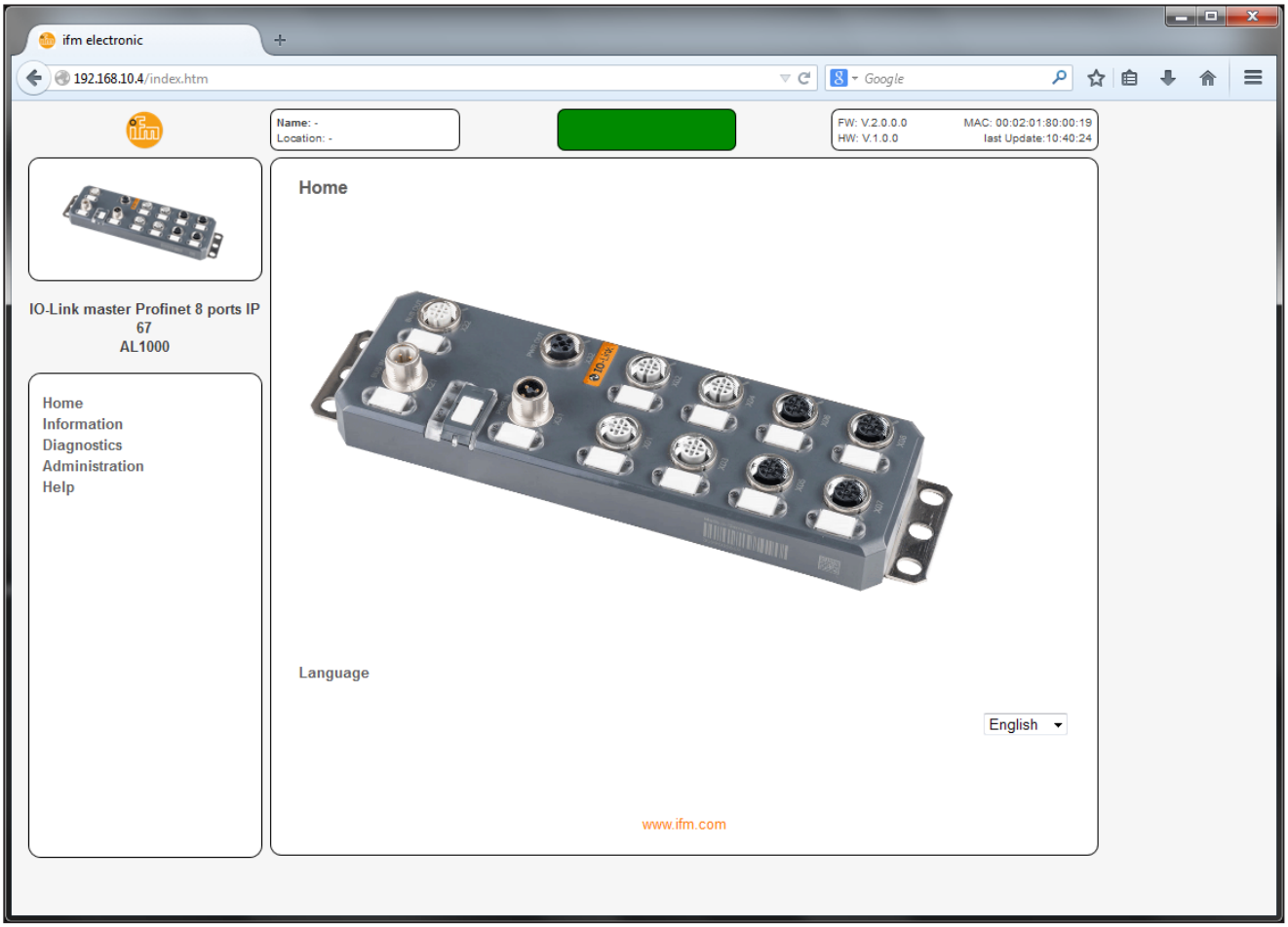
► Open the web browser.

► Enter the IP address of the device in the address line of the web browser.

Figure 4 shows the IP address in the address line of the Internet Explorer.



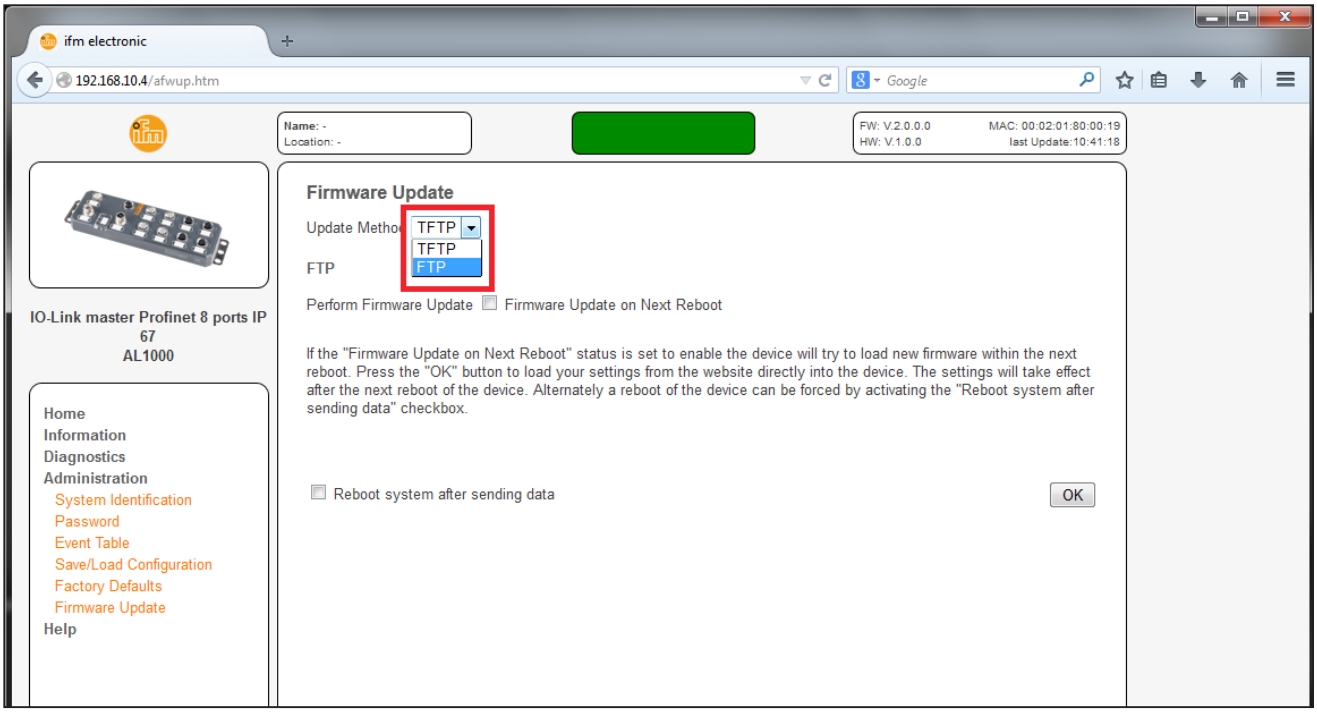
This takes you to the homepage of the respective device.



33.6 Setting the firmware update via FTP

Navigate to [Administration] (1) and then to the [Firmware Update] (2) page.

► In the next step select the setting FTP in the drop down menu.

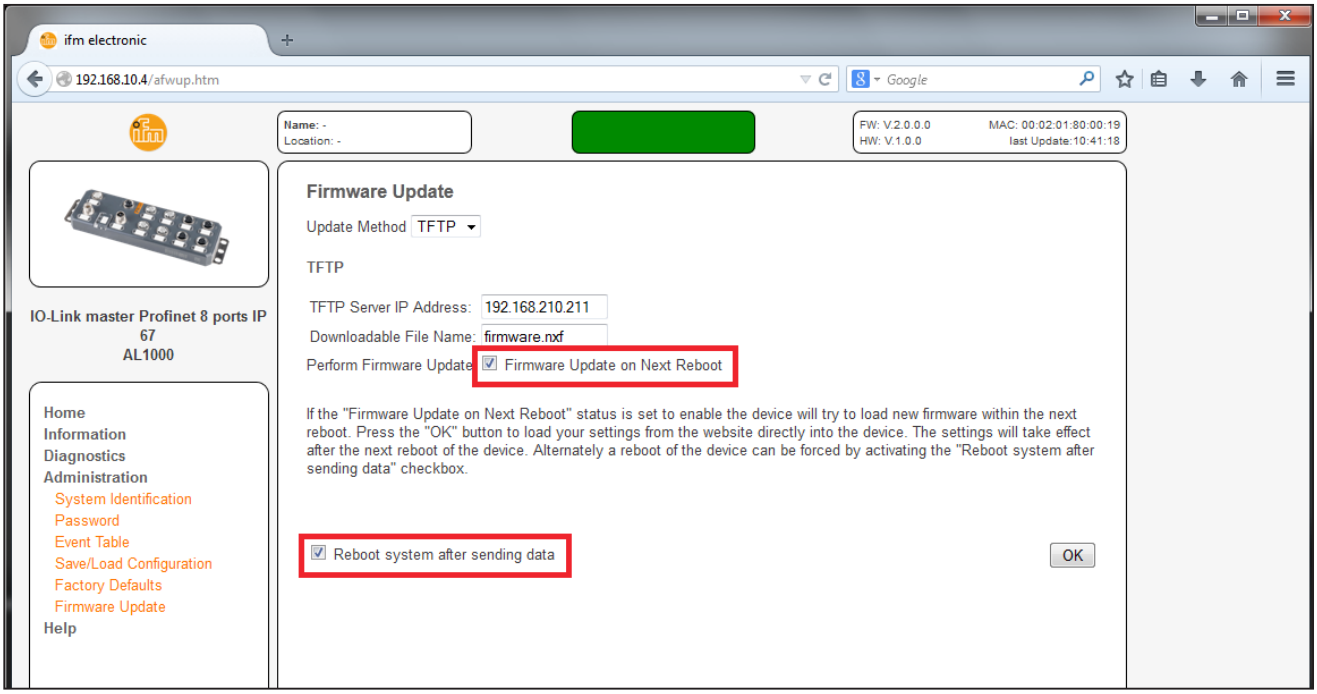


33.7 Perform the firmware update

To perform the firmware update, select the checkbox [Firmware Update on Next Reboot].

> The device then automatically updates the firmware upon the next reboot.

If you want to start the device immediately, also select the checkbox [Reboot system after sending data].

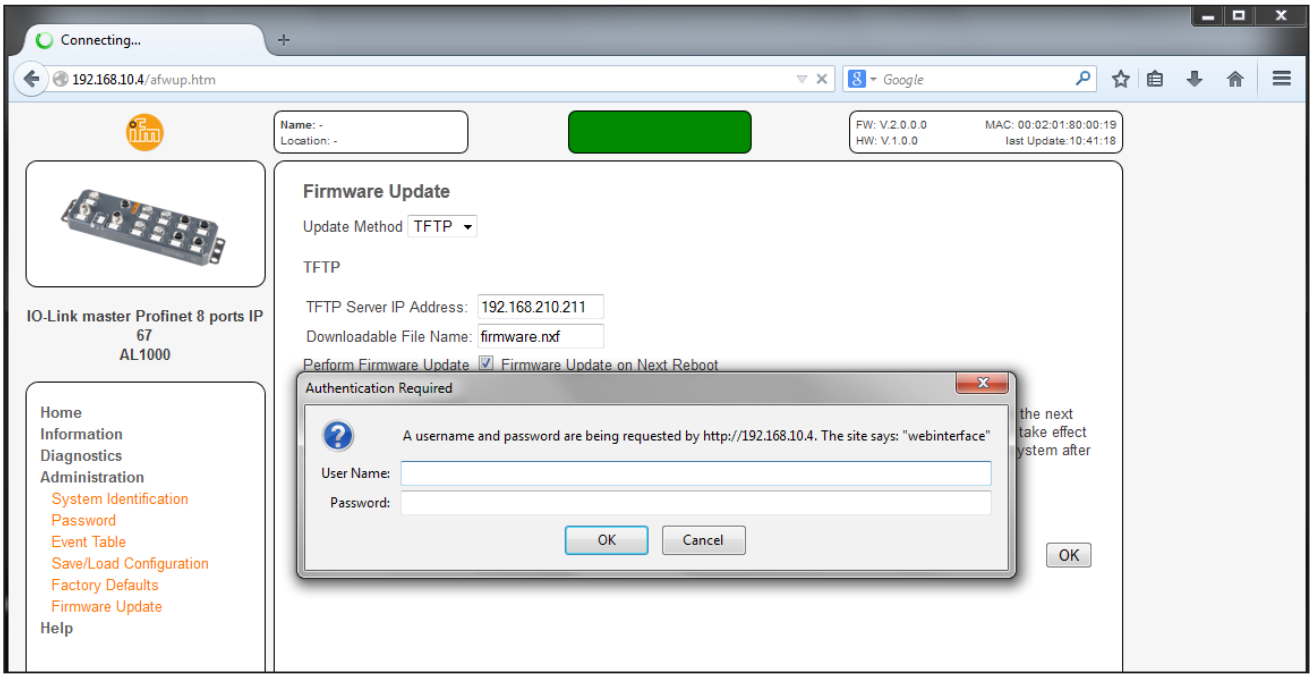


► Click on [OK].

Now you will need to authenticate:

► Enter your login details.

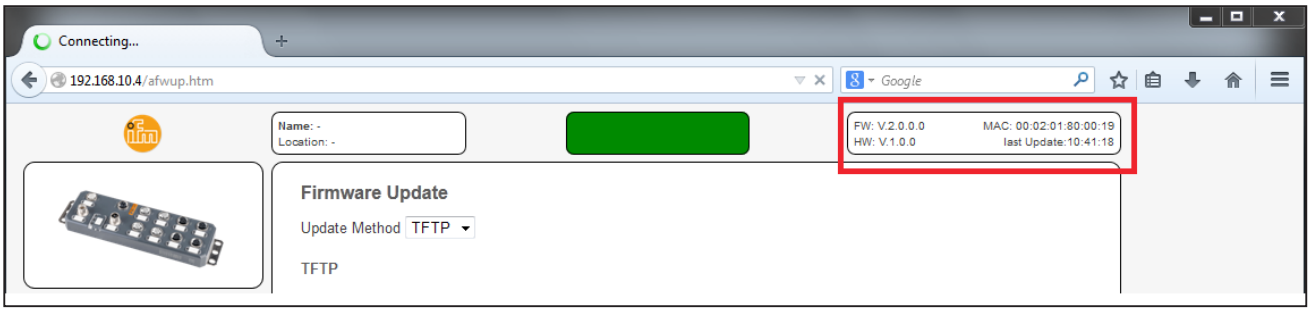
► Click on [OK].



► Please wait a certain period of time and then refresh the web page or click on the picture of the product to reach the homepage.

33.8 Read out the firmware revision

► The information bar on the top right corner provides you with important details of your device, like firmware and hardware revision. If the firmware update was successful the new revision appears in the bar.



► Close the web page and use your device with the new firmware.

► If the firmware revision is not updated, perform a reboot.