Manual

Modbus TCP

LioN-X Digital-I/O Multiprotocol:
0980 XSL 3900-121-007D-01F (16 x Input/Output)
0980 XSL 3901-121-007D-01F (16 x Input)
0980 XSL 3903-121-007D-01F (8 x Input, 8 x Output isolated)
0980 XSL 3923-121-007D-01F (8 x Input, 8 x Output)

Manual Modbus TCP

Version 1.1 07/2023

Technical Support

lumberg-automation-support.belden.com

Contents

1 About this manual

1.1 General information

Please read the assembly and operating instructions in this manual carefully before starting up the devices. Keep the manual where it is accessible to all users.

The texts, figures, diagrams, and examples used in this manual are used exclusively to explain how to operate and apply the devices.

Please contact us if you have any detailed questions on installing and starting up the devices.

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Belden Deutschland GmbH – Lumberg Automation™ – reserves the right to make technical changes or changes to this manual at any time without notice.

1.2 Explanation of symbols

1.2.1 Use of danger information

Danger information is denoted as follows:

⚠ **Danger:** Means that death, serious physical injury or substantial damage to property will occur if the required safety measures are not taken.

⚠ **Warning:** Means that death, serious physical injury or substantial damage to property can occur if the required safety measures are not taken.

⚠ **Caution:** Means that minor physical injury or damage to property can occur if the required safety measures are not taken.

1.2.2 Use of general information

General information is denoted as follows:

ℹ **Attention:** Contains important information on the product, on how to manage the product, or on the respective section of the documentation to which your special attention is being drawn.

1.3 Version information

Version	Created	Changes
1.0	03/2023	
1.1	07/2023	Warning in ch. Setting the rotary encoding switches on page 36

Table 1: Overview of manual revisions

2 Safety instructions

2.1 Intended use

The products described in this manual are decentralized I/O Devices on an Industrial Ethernet Network.

We adhere to all safety standards when developing, producing, testing, and documenting our products. When you adhere to the handling specifications and safety instructions described for the configuration, assembly, and correct operation, there should not normally be any risks for people or equipment.

The modules fulfill the requirements of the EMC guidelines (89/336/EEC, 93/68/EEC and 93/44/EEC) and the low voltage guideline (73/23/EEC).

The devices are designed to be used in the industrial sector. The industrial environment is distinguished by the fact that the consumer is not connected directly to the public low voltage network. Additional measures are required for use in residential areas or in business and commercial sectors.

Attention: This equipment may cause radio interference in residential areas. In this case the operator may be requested to carry out appropriate measures.

The proper and safe operation of this product depends on proper transportation, storage, assembly, and installation, and careful operation.

During the configuration, installation, start-up, maintenance, and testing of the devices, adhere to the safety and accident-prevention guidelines for the specific application.

Only install cables and accessories that fulfill the requirements and regulations for safety, electromagnetic compatibility, and, where applicable, telecommunication end devices, as well as the specification information. Information on which cables and accessories are permitted for the installation can be obtained from Lumberg Automation™ or is contained in this manual.

2.2 Qualified personnel

The configuration, installation, start-up, maintenance, and testing of the devices may only be performed by a qualified electrician who is familiar with the safety standards of the automation technology.

The personnel requirements are based on the requirement profiles described by ZVEI, VDMA, or equivalent organizations.

Only electricians who are familiar with the content of this manual are authorized to install and maintain the devices described. These are persons who

- based on their technical training, knowledge, and experience, and their knowledge of the pertinent standards, can evaluate the work to be carried out and identify any potential risks or
- based on working for several years in a related sector, have the same level of knowledge as they would have from the relevant technical training.

Only Belden Deutschland GmbH – Lumberg Automation™ – is permitted to make changes to the hardware or software of the products that go beyond the scope of this manual.

⚠ **Warning:** Making unqualified changes to the hardware or software, or non-adherence to the warning information contained in this manual, can result in serious personal injury or damage to equipment.

ℹ **Attention:** Belden accepts no liability for any damage caused by unqualified personnel or improper use. This automatically voids the warranty.

3 Designations and synonyms

AOI	Add-On Instruction
API	Application Programming Interface
BF	Bus Fault LED
Big Endian	Data format with High-B on first place (PROFINET)
BUI	Back-Up Inconsistency (EIP diagnostics)
CC	CC-Link IE Field
Ch. A	Channel A (Pin 4) of I/O port
Ch. B	Channel B (Pin 2) of I/O port
CIP	Common Industrial Protocol (media independent protocol)
CoAP	Constrained Application Protocol
CSP+	Control & Communication System Profile Plus
DCP	Discovery and Configuration Protocol
DevCom	Device Comunicating (EIP diagnostics)
DevErr	Device Error (EIP diagnostics)
DI	Digital Input
DIA	Diagnostic LED
DO	Digital Output
DIO	Digital Input/Output
DTO	Device Temperature Overrun (EIP diagnostics)
DTU	Device Temperature Underrun (EIP diagnostics)
DUT	Device under test
EIP	EtherNet/IP
ERP	Enterprise Resource Planning system
ETH	ETHERNET
FE	Functional Earth
FME	Force Mode Enabled (EIP diagnostics)
FSU	Fast Start-Up

GSDML	General Station Description Markup Language
High-B	High-Byte
ICT	Invalid Cycle Time (EIP diagnostics)
IIoT	Industrial Internet of Things
ILE	Input process data Length Error (EIP diagnostics)
IME	Internal Module Error (EIP diagnostics)
I/O	Input / Output
I/O port	X1 .. X8
I/O port pin 2	Channel B of X1 .. X8
I/O port pin 4 (C/Q)	Channel A of X1 .. X8
IVE	IO-Link port Validation Error (EIP diagnostics)
I&M	Identification & Maintenance
JSON	JavaScript Object Notation (platform independent data format)
L+	I/O port pin 1, sensor power supply
LioN-X 60	LioN-X variants with a width of 60mm
Little Endian	Data format with Low-B on first place (EtherNet/IP)
LLDP	Link Layer Discovery Protocol
Low-B	Low-Byte
LSB	Least Significant Bit
LVA	Low Voltage Actuator Supply (EIP diagnostics)
LVS	Low Voltage System/Sensor Supply (EIP diagnostics)
MIB	Management Information Base
MP	Multiprotocol: PROFINET + EtherNet/IP + EtherCAT® + Modbus TCP (+ CC-Link IE Field Basic)
MQTT	Message Queuing Telemetry Transport (open networking protocol)
MSB	Most Significant Bit
M12	Metric thread according to DIN 13-1 with 12 mm diameter
NTP	Network Time Protocol
OLE	Output process data Length Error (EIP diagnostics)
OPC UA	Open Platform Communications Unified Architecture (platform independent, service-oriented architecture)

PLC	Programmable Logic Controller
PN	PROFINET
PWR	Power
REST	REpresentational State Transfer
RFC	Request for Comments
RPI	Requested Packet Interval
RWr	Word data input as seen from the master station (CC-Link)
RWw	Word data output as seen from the master station (CC-Link)
RX	Bit data input as seen from the master station (CC-Link)
RY	Bit data output as seen from the master station (CC-Link)
SCA	Short Circuit Actuator/U_L/U_{AUX} (EIP diagnostics)
SCS	Short Circuit Sensor (EIP diagnostics)
SLMP	Seamless Message Protocol
SNMP	Simple Network Management Protocol
SP	Single Protocol (PROFINET, EtherNet/IP, EtherCAT®, Modbus TCP or CC-Link IE Field Basic)
SPE	Startup Parameterization Error (EIP diagnostics)
U_{AUX}	$U_{Auxiliary}$, supply voltage for the load circuit (Actuator supply on Class B ports)
UDP	User Datagram Protocol
UDT	User-Defined Data Types
UINT8	Byte in PLC (IB, QB)
UINT16	Unsigned integer with 16 bits or word in PLC (IW, QW)
U_L	U_{Load}, supply voltage for the load circuit (Actuator supply on Class A)
UL	Underwriters Laboratories Inc. (certification company)
UTC	Coordinated Universal Time (Temps Universel Coordonné)

Table 2: Designations and synonyms

4 System description

The LioN modules (**L**umberg Automation™ **I**nput/**O**utput **N**etwork) function as the interface in an industrial Ethernet system: A central controller on the management level is able to communicate with the decentralized sensors and actuators on the field level. The line or ring topologies for which LioN modules can be used ensure not only reliable data communication but also significantly reduce the number of cables required and thus also the costs for installation and maintenance. They additionally enable easy and quick extension.

4.1 Device variants

The following Digital I/O device variants are available in the LioN-X family:

Article number	Product designation	Description	I/O port functionality
935705001	0980 XSL 3900-121-007D-01F	LioN-X M12-60 mm, I/O Device Multiprotocol (PN, EIP, EC, MB, CC) Security	16 x Input/Output universal
935706002	0980 XSL 3901-121-007D-01F	LioN-X M12-60 mm, I/O Device Multiprotocol (PN, EIP, EC, MB, CC) Security	16 x Input
935707001	0980 XSL 3903-121-007D-01F	LioN-X M12-60 mm, I/O Device Multiprotocol (PN, EIP, EC, MB, CC) Security	8 x Input, 8 x Output Mixmodule, galvanic isolated
935708001	0980 XSL 3923-121-007D-01F	LioN-X M12-60 mm, I/O Device Multiprotocol (PN, EIP, EC, MB, CC) Security	8 x Input, 8 x Output Mixmodule, without galvanic isolation of the outputs

Table 3: Overview of LioN-X Digital-I/O variants

4.2 I/O port overview

The following tables show the main I/O port differences of the LioN-X family. Pin 4 and Pin 2 of the I/O ports can be configured partly to Digital Input or Digital Output.

LioN-X 16DIO ports

Device variant	Port	Pin 1 U_S	Pin 4 / Ch. A (In/Out)		Pin 2 / Ch. B (In/Out)	
0980 XSL 3900...	**Info:**	–	Type 3	Supply by U_L	Type 3	Supply by U_L
	X8:	U_S (4 A)	DI	DO (2 A)	DI	DO (2 A)
	X7:	U_S (4 A)	DI	DO (2 A)	DI	DO (2 A)
	X6:	U_S (4 A)	DI	DO (2 A)	DI	DO (2 A)
	X5:	U_S (4 A)	DI	DO (2 A)	DI	DO (2 A)
	X4:	U_S (4 A)	DI	DO (2 A)	DI	DO (2 A)
	X3:	U_S (4 A)	DI	DO (2 A)	DI	DO (2 A)
	X2:	U_S (4 A)	DI	DO (2 A)	DI	DO (2 A)
	X1:	U_S (4 A)	DI	DO (2 A)	DI	DO (2 A)

Table 4: Port configuration of 0980 XSL 3900... variants

LioN-X 16DI ports

Device variant	Port	Pin 1 U_S	Pin 4 / Ch. A (Input)	Pin 2 / Ch. B (Input)
0980 XSL 3901...	**Info:**	–	Type 3	Type 3
	X8:	U_S (4 A)	DI	DI
	X7:	U_S (4 A)	DI	DI
	X6:	U_S (4 A)	DI	DI
	X5:	U_S (4 A)	DI	DI
	X4:	U_S (4 A)	DI	DI
	X3:	U_S (4 A)	DI	DI
	X2:	U_S (4 A)	DI	DI
	X1:	U_S (4 A)	DI	DI

Table 5: Port configuration of 0980 XSL 3901... variants

LioN-X 8DI8DO ports with galvanic isolation of the outputs

Device variant	Port	Pin 1 U_S	Pin 4 / Ch. A (In/Out)		Pin 2 / Ch. B (In/Out)	
0980 XSL 3903...	**Info:**	–	Type 3	Supply by U_L	Type 3	Supply by U_L
	X8:	–	–	DO (2 A)	–	DO (2 A)
	X7:	–	–	DO (2 A)	–	DO (2 A)
	X6:	–	–	DO (2 A)	–	DO (2 A)
	X5:	–	–	DO (2 A)	–	DO (2 A)
	X4:	U_S (4 A)	DI	–	DI	–
	X3:	U_S (4 A)	DI	–	DI	–
	X2:	U_S (4 A)	DI	–	DI	–
	X1:	U_S (4 A)	DI	–	DI	–

Table 6: Port configuration of 0980 XSL 3903... variants

LioN-X 8DI8DO ports without galvanic isolation of the outputs

Device variant	Port	Pin 1 U_S	Pin 4 / Ch. A (In/Out)		Pin 2 / Ch. B (In/Out)	
0980 XSL 3923...	**Info:**	–	Type 3	Supply by U_L	Type 3	Supply by U_L
	X8:	–	–	DO (2 A)	–	DO (2 A)
	X7:	–	–	DO (2 A)	–	DO (2 A)
	X6:	–	–	DO (2 A)	–	DO (2 A)
	X5:	–	–	DO (2 A)	–	DO (2 A)
	X4:	U_S (4 A)	DI	–	DI	–
	X3:	U_S (4 A)	DI	–	DI	–
	X2:	U_S (4 A)	DI	–	DI	–
	X1:	U_S (4 A)	DI	–	DI	–

Table 7: Port configuration of 0980 XSL 3923... variants

5 Overview of product features

5.1 Modbus TCP product features

Modbus Mode

Features MODBUS server via a standard TCP network. The number of allowed operations for holding registers is dependent on the device configuration. The device supports 4 up to 8 TCP sockets for communication.

Data connection

The connection option provided by LioN-X is the widely-used M12 connector with D-coding for the Modbus TCP network.

The connectors are also color-coded to prevent the ports from being mixed up.

Data transmission rates

Featuring a transmission rate of up to 100 MBit/s, the Modbus TCP devices can handle both fast transmission of I/O data and transmission of larger volumes of data.

Diagnostic data

The devices support diagnosis flags and extended diagnostic data that can be appended to the I/O data.

5.2 Integrated Web server

Network parameter display

Get an overview of network parameters such as the IP address, subnet mask and gateway.

Displaying diagnostics

View diagnostics via the integrated Web server.

User management

Use the integrated Web server for convenient management of all users.

5.3 Security features

Firmware signature

The official firmware update packages contain a signature which helps prevent the system against manipulated firmware updates.

Syslog

The LioN-X multiprotocol variants support the traceability of messages centrally managed and logged via Syslog.

User manager

The Web server provides a user manager to help protect the Web interface against unauthorized access. You can manage the users by groups with different access levels “Admin” or “Write”.

Default user settings:

User: admin

Password: private

Attention: Change the default settings to help protect the device against unauthorized access.

5.4 Other features

Interface protection

The devices have reverse polarity, short-circuit and overload protection for all interfaces.

For more details, see section Port assignments on page 29.

Failsafe

The devices support a failsafe function. This allows you to define the behavior of every single channel configured as an output in the case of a loss of the PLC communication.

Industrial Internet of Things

LioN-X is industry 4.0 ready and supports the integration in IIoT networks via REST API and the IIoT-relevant protocols MQTT, OPC UA and CoAP.

Color-coded connectors

The colored connectors help you avoid confusion in your cabling.

IP protection classes: IP65 / IP67 / IP69K

The IP protection class describes environmental influences that the devices can be exposed to without risk and without suffering damage or causing a risk for the user.

The whole LioN-X family offers IP65, IP67 and IP69K.

6 Assembly and wiring

6.1 General information

Mount the device on a flat surface using 2 screws (M4x 25/30). The torque required here is 1 Nm. Use washers for all fastening methods as per DIN 125.

Attention: The devices have a ground connection with an M4 thread for the conduction of interference currents and the EMC immunity. This is labeled with the symbol for the ground and the designation "FE"

Attention: Use a low-impedance connection to connect the device to the reference ground. When using a grounded mounting surface, you can make the connection directly via the fixing screws.

Attention: If the mounting surface is ground-free, use a ground strap or a suitable FE line (FE = Functional Earth). Use an M4 screw to connect the ground strap or the FE line to the ground point and if possible put a washer and a toothed washer below the fixing screw.

6.2 Outer dimensions

6.2.1 LioN-X Digital-I/O multiprotocol variants

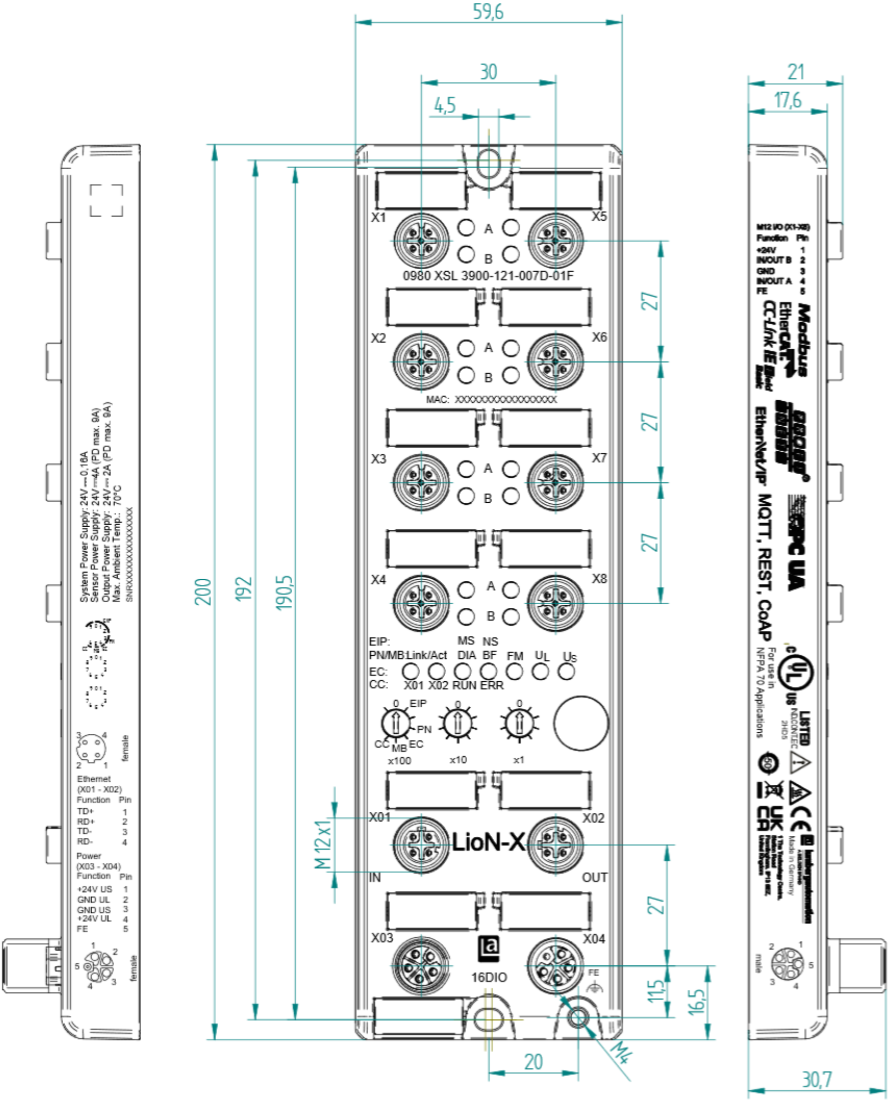


Figure 1: 0980 XSL 3900-121-007D-01F

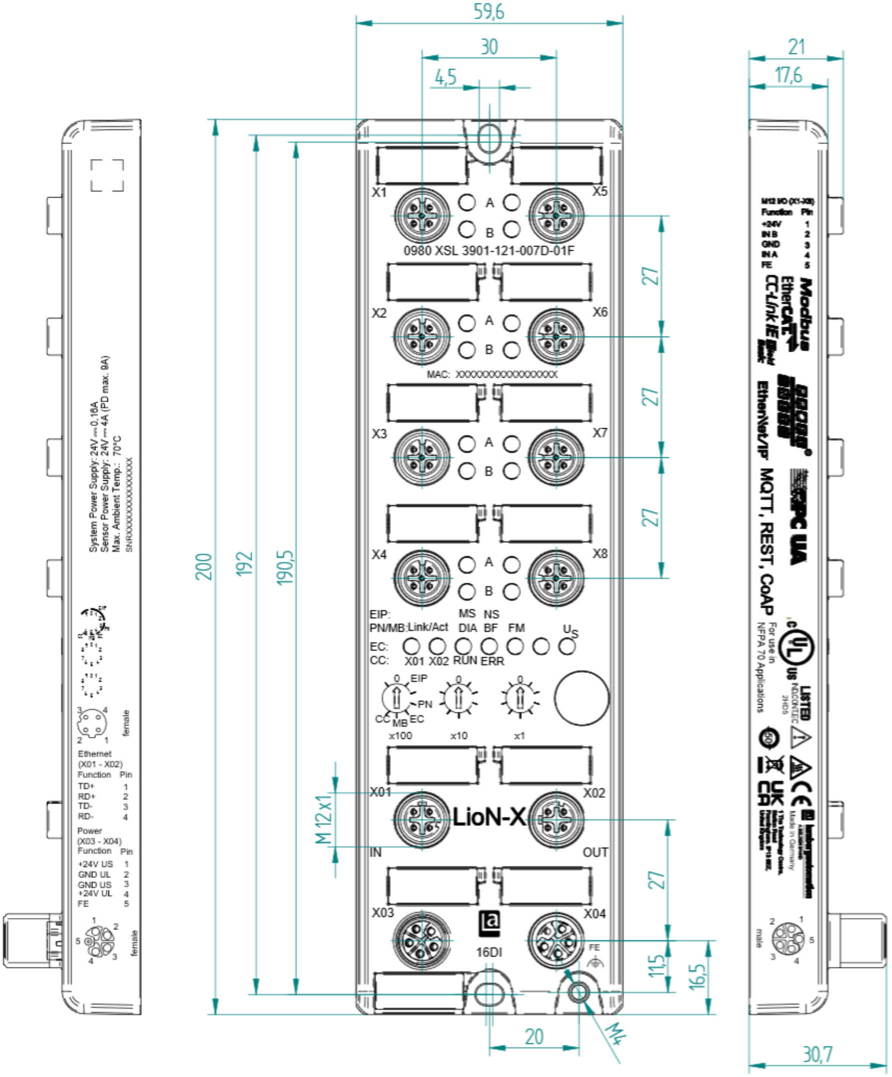


Figure 2: 0980 XSL 3901-121-007D-01F

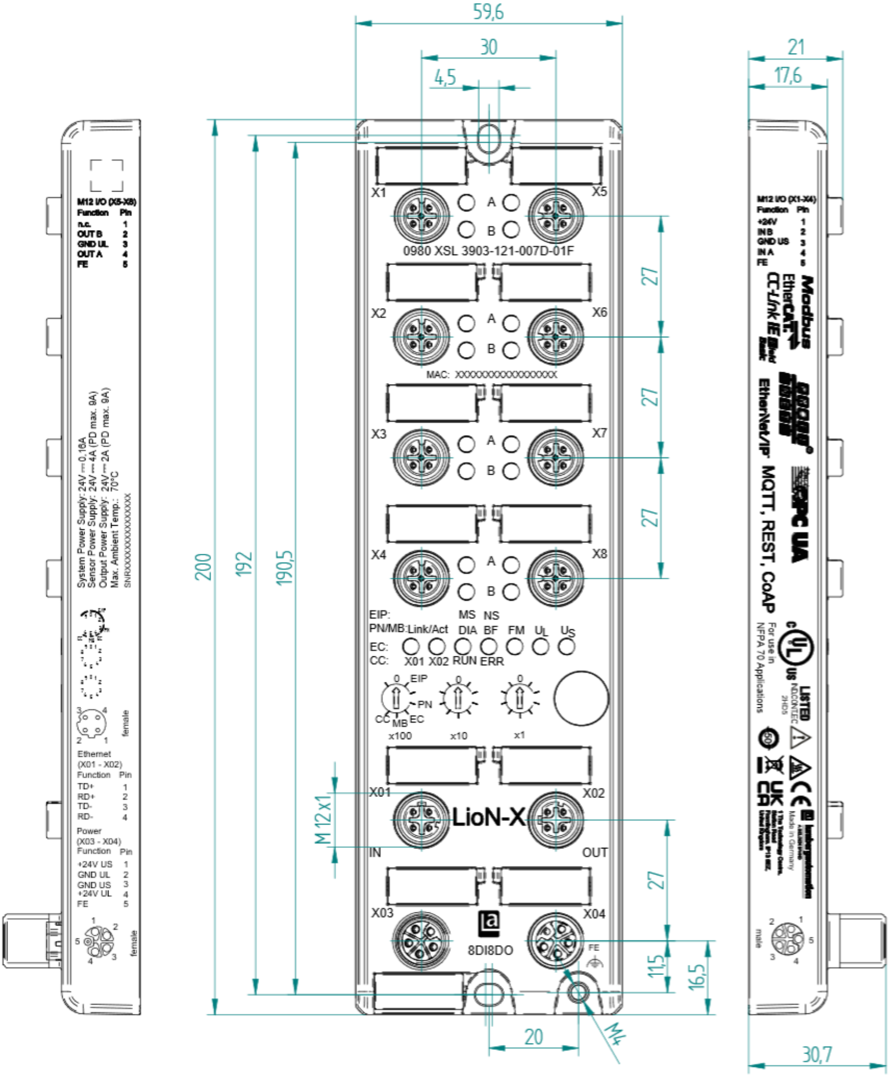


Figure 3: 0980 XSL 3903-121-007D-01F

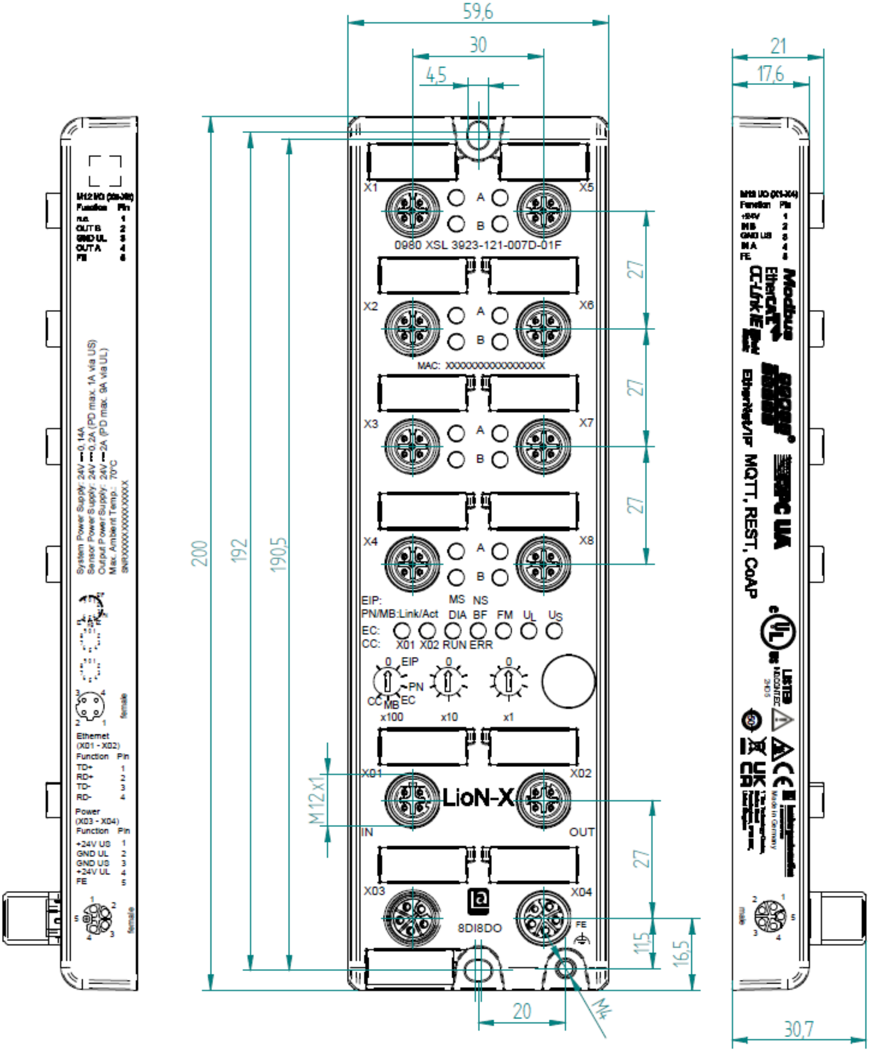


Figure 4: 0980 XSL 3923-121-007D-01F

6.2.2 Notifications

Attention:

For **UL applications**, be sure to use a UL-certified cable with a suitable evaluation to connect the devices (CYJV or PVVA). To program the control, please refer to the OEM information, and only use suitable accessories.

Only approved for interior use. Please note the maximum elevation of 2000 meters. Approved up to a maximum soiling level of 2.

Warning: Terminals, housings field-wired terminal boxes or components can exceed temperatures of +60 °C (140 °F).

Warning: For **UL applications** at a maximum ambient temperature of +70 °C (158 °F):

Use temperature-resistant cables with heat resistance up to at least +125 °C (257 °F) for all LioN-X and LioN-Xlight variants.

Warning: Observe the following maximum output power for the sensor supply of Class A devices:

Max. 4.0 A per port; for **UL applications** max. 5 A for every port pair X1/X2, X3/X4, X5/X6, X7/X8; max. 9.0 A in total (with derating) for the whole port group X1 .. X8.

Warning: Observe the following maximum output power for the sensor supply of Class A/B devices:

Max. 4.0 A per port; for **UL applications** max. 5.0 A from U_S power supply for every port pair X1/X2, X3/X4, X5/X6, X7/X8 and max. 5.0 A from U_{AUX} power supply in total for port group X5/X6/X7/X8; max. 9.0 A in total (with derating) for the whole port group X1 .. X8.

6.3 Port assignments

All the contact arrangements shown in this chapter show the frontal view of the connection area for the connectors.

6.3.1 Ethernet ports, M12 socket, 4-pin, D-coded

Color coding: green

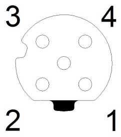


Figure 5: Schematic drawing, ports X01, X02

Port	Pin	Signal	Function
Ethernet Ports X01, X02	1	TD+	Transmit data plus
	2	RD+	Receive data plus
	3	TD-	Transmit data minus
	4	RD-	Receive data minus

Table 8: Assignment of ports X01, X02

⚠ **Caution: Risk of destruction!** Never connect the power supply to the data cables.

6.3.2 Power supply with M12 power L-coded

Color coding: gray

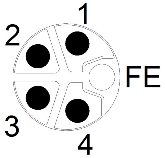


Figure 6: Schematic diagram of the M12 L-coding (connector X03 for Power In)

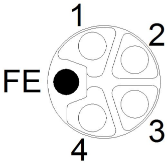


Figure 7: Schematic diagram of the M12 L-coding (socket X04 for Power Out)

Power supply	Pin	Signal	Function
	1	U_S (+24 V)	Sensor/system power supply
	2	GND_U_L	Ground/reference potential U_L
	3	GND_U_S	Ground/reference potential U_S
	4	U_L (+24 V)	Load supply Actuator supply
	5	FE	Functional ground

Table 9: Pin assignments ports X03 and X04

Attention: Only use power supply units for the system/sensor and actuator supply that correspond to PELV (Protective Extra Low Voltage) or SELV (Safety Extra Low Voltage). Power supplies according to EN 61558-2-6 (transformers) or EN 60950-1 (switching power supply units) fulfill these requirements.

Attention: For the input module 0980 XSL 3901-xxx, the two contacts 1 and 5 are not required for the voltage supply of the actuator. Nevertheless, these two contacts are bridged together on the plug and socket side to enable a 5-pole forwarding of the voltage supply to a subsequent module.

6.3.3 I/O ports as M12 sockets

Color coding: black

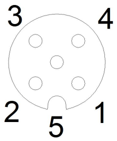


Figure 8: Schematic drawing I/O port as M12 socket

6.3.3.1 I/O ports

0980 XSL 3900-121...	Pin	Signal	Function
16DIO X1 .. X8	1	+24 V	power supply +24 V
	2	IN/OUT	Ch. B: Digital input or digital output
	3	GND	Ground/reference potential
	4	IN/OUT	Ch. A: Digital input or digital output
	5	FE	Functional ground

0980 XSL 3901-121...	Pin	Signal	Function
16DI X1 .. X8	1	+24 V	power supply +24 V
	2	IN	Ch. B: Digital input
	3	GND U_S	Ground/reference potential
	4	IN	Ch. A: Digital input
	5	FE	Functional ground

0980 XSL 39x3-121...	Pin	Signal	Function
8DI8DO X1 .. X4	1	+24 V	power supply +24 V
	2	IN	Ch. B: Digital input
	3	GND U_S	Ground/reference potential
	4	IN	Ch. A: Digital input
	5	FE	Functional ground
8DI8DO X5 .. X8	1	n.c.	–
	2	OUT	Ch. B: Digital output
	3	GND U_L	Ground/reference potential
	4	OUT	Ch. A: Digital output
	5	FE	Functional ground

Table 10: Pin assignments I/O ports

7 Starting operation

7.1 Device information

With any MODBUS client, the server running on LioN-X can be reached to get identification data including vendor name, product code and revision.

The following table represents the accessible device information via the register addresses 1024-1053.

Register address[1]	Name	Access	Register length	Size (bytes)	Description
1024	Firmware Version minor	RO (Read Only)	1	2	MBTCP Digital device Firmware Version minor
1025	Firmware Version major	RO	1	2	MBTCP Digital device Firmware Version major
1026-1041	Model Number/ Device name	RO	16	32	Name of device
1042	IP address Source	RO	1	2	0: DHCP 1: Static
1043-1046	IP address	RO	4	8	IP Address of Device
1047-1052	MAC address	RO	6	12	MAC Address of device
1053	Current TCP connections	RO	1	2	Active TCP connections

[1] **Given numbers are addresses starting from "0".**

7.2 MAC addresses

Every device has three unique assigned MAC addresses that cannot be changed by the user. The first assigned MAC address is printed onto the device.

7.3 Modbus function codes

LioN-X devices support the following Modbus function codes:

- Function code 03 (0x03)
- Function code 06 (0x06)
- Function code 16 (0x10)

Write access to holding registers is subject to the device feature set and the configuration of the holding register.

7.4 State on delivery

Modbus TCP parameters in state on delivery or after a factory reset:

Network mode:	DHCP
Static IP address:	192.168.1.XXX (XXX = rotary switch position or last stored data)
Subnet mask:	255.255.255.0
Gateway address	0.0.0.0
Device designations:	0980 XSL 3900-121-007D-01F 0980 XSL 3901-121-007D-01F 0980 XSL 3903-121-007D-01F 0980 XSL 3923-121-007D-01F
Product type:	Modbus TCP server

7.5 Setting the rotary encoding switches

The following LioN-X variants support multiprotocol application for the protocols EtherNet/IP (E/IP), PROFINET (P), EtherCAT® (EC), Modbus TCP (MB) and CC-Link IE Field Basic (CC):

- 0980 XSL 3900-121-007D-01F
- 0980 XSL 3901-121-007D-01F
- 0980 XSL 3903-121-007D-01F
- 0980 XSL 3923-121-007D-01F

Caution: Risk of device damage due to memory malfunction

Any interruption of the power supply to the device during and after protocol selection can lead to a corrupt device memory.

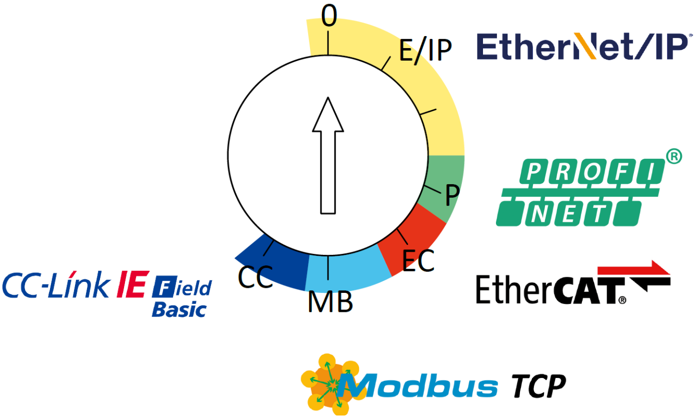
After selecting a protocol followed by a restart of the device, the new protocol is initialized. This can take up to 15 seconds. During this time the device is not usable and the LED indicators are out of function. When the protocol change is complete, the LED indicators return to normal operation and the device can be used again.

- Make sure that the power supply is maintained during the entire process.

The LioN-X multiprotocol variants allow you to select different protocols for communication within an industrial Ethernet system. In this way Digital I/O devices with multiprotocol function can be integrated into different networks without it being necessary to purchase products specific for each protocol. This technology also gives you the option to use the same I/O Device in different environments.

Using rotary encoding switches at the lower front of the devices, you can easily and conveniently set both the protocol and the address of the device, if the protocol to be used supports this. Once you have made a protocol selection and started the cyclical communication, the device stores this setting permanently and uses the selected protocol from this point on. To use another supported protocol with this device, perform a factory reset.

The multiprotocol devices have a total of three rotary encoding switches. With the first rotary encoding switch (x100) you set the protocol by using the corresponding switch position. Additionally, x100 is used to set the third last digit of the IP address for EIP.



With the other rotary encoding switches (x10 / x1), you set the last two digits of the IP address when you are using EtherNet/IP, Modbus TCP or CC-Link IE Field Basic.

Protocol	x100	x10	x1
EtherNet/IP	0-2	0-9	0-9
PROFINET	P	–	–
EtherCAT®	EC	–	–
Modbus TCP	MB	0-9	0-9
CC-Link IE Field	CC	0-9	0-9

Table 11: Assignment of the rotary encoding switches for each protocol

The setting you make to select a protocol is described detailed in the protocol-specific sections.

In delivery state no protocol settings are stored in the device. In this case only the desired protocol has to be chosen. To take over a changed rotary encoding switch setting (protocol setting), a power cycle or “Reset” from the Web interface is necessary.

Once you have set the protocol using the rotary encoding switches, the device stores this setting when it starts in cyclic communication. Changing the protocol using the rotary encoding switch is no longer possible after this point. The device will always start using the stored protocol from that point on. The IP address can be changed depending on the selected protocol.

To change the protocol, carry out a factory reset. In this way you restore the factory settings of the respective device. How you perform the factory reset for your device is described in chapter Factory reset on page 39.

If you position the rotary encoding switch in a manner that is invalid, the device signals this to you with a blink code (the BF/MS LED blinks in red three times).

7.5.1 Modbus TCP

If you decide to use Modbus TCP as a protocol, use the first rotary encoding switch to select the protocol. The second rotary encoding switch (x10) can be used to configure the 10 position of the last octet of the IP address, and the third rotary encoding switch (x1) allows you to configure the 1 position. Values between 0 and 9 can be selected for the second and third switches. The first three octets of the IP address are set by default to 192.168.1.

For example, the rotary encoding switch setting 5(x100), 1(x10) and 0(x1) gives you an IP address of 192.168.1.10 for Modbus TCP. It is only possible to assign IP addresses between 192.168.1.1 and 192.168.1.99 for Modbus TCP via the rotary switches.

Rotary switch setting	Function
500 (network parameters already saved)	The network parameters last saved are used (IP address, subnet mask, gateway address, DHCP on/off, BOOTP on/off).
501 ... 599	The last 2 digits of the saved or preset IP address are overwritten by the setting of the rotary switch.
979	The device performs a reset to the factory settings. The network parameters are also reset to the default values. Communication is not possible in this operation mode.

Table 12: Setting options of the rotary encoding switches for Modbus TCP

7.5.2 Factory reset

A factory reset restores the original factory settings and thus resets the changes and settings you have made up to that point. It also resets the protocol selection. To perform a factory reset, set the first rotary encoding switch (x100) to 9, the second (x10) to 7, and the third (x1) also to 9.

Afterwards perform a power cycle and wait 10 seconds due to internal memory write processes.

During the factory reset, the U_S LED is blinking red. After the internal memory write processes have finished, the U_S LED returns to display static green or red light, in dependency of the actual U_S voltage.

	x100	x10	x1
Factory Reset	9	7	9

Follow the steps from section Setting the rotary encoding switches on page 36 again to select a new protocol.

For performing a factory reset via software configuration, see chapter OPC UA configuration on page 79 and the configuration section.

7.6 Setting network parameters

Use the two right-hand rotary switches (x10 and x1) on the front of the device to set the last octet of the static IP address. Each rotary switch in the range of Modbus TCP is assigned to one decimal digit, so that you can configure a number between **0 – 99**. During startup, the position of the rotary switches is typically read within one time cycle.

The complete IP address, the subnet mask, the gateway address and the network mode (DHCP or BOOTP) can be configured and stored via the Web server or any other available configuration interfaces. New configuration interfaces can only be applied to after a restart of the device.

For additional information, see chapter Setting the rotary encoding switches on page 36.

8 Configuration Modbus TCP

The LioN-X devices support Modbus over a standard TCP network. It is possible to create 4 to 8 socket connections with devices.

Certain configuration parameters apply only to Digital Outputs or only to Digital Inputs. For these to be effective, the corresponding channel must have output or input functionality and must also be configured accordingly.

Configuration parameter	Applicable for channel configuration
Surveillance Timeout	DIO, Output
Failsafe	DIO, Output
Auto Restart	DIO, Output
Current Limit	DIO, Output
Input Filter Time	DIO, Input
Input Logic	DIO, Input

8.1 Outputs / Coils

Register address*	Coil No.*	Name	Access	Length (Boolean)	Size (bits)
0	1	Output X1.A	RW (Read/ Write)	1	1
1	2	Output X1.B	RW	1	1
2	3	Output X2.A	RW	1	1
3	4	Output X2.B	RW	1	1
4	5	Output X3.A	RW	1	1
5	6	Output X3.B	RW	1	1
6	7	Output X4.A	RW	1	1
7	8	Output X4.B	RW	1	1
8	9	Output X5.A	RW	1	1
9	10	Output X5.B	RW	1	1
10	11	Output X6.A	RW	1	1
11	12	Output X6.B	RW	1	1
12	13	Output X7.A	RW	1	1
13	14	Output X7.B	RW	1	1
14	15	Output X8.A	RW	1	1
15	16	Output X8.B	RW	1	1

* Depending on *Coils* or *Register* selection in Flashlabel. Default: *Coils*.

8.2 Inputs

Register address*	Input No.*	Name	Access	Length (Boolean)	Size (bits)
16	1	Input X1.A	RO (Read Only)	1	1
17	2	Input X1.B	RO	1	1
18	3	Input X2.A	RO	1	1
19	4	Input X2.B	RO	1	1
20	5	Input X3.A	RO	1	1
21	6	Input X3.B	RO	1	1
22	7	Input X4.A	RO	1	1
23	8	Input X4.B	RO	1	1
24	9	Input X5.A	RO	1	1
25	10	Input X5.B	RO	1	1
26	11	Input X6.A	RO	1	1
27	12	Input X6.B	RO	1	1
28	13	Input X7.A	RO	1	1
29	14	Input X7.B	RO	1	1
30	15	Input X8.A	RO	1	1
31	16	Input X8.B	RO	1	1

* Depending on *Inputs* or *Register* selection in Flashlabel. Default: *Inputs*.

8.3 Registers

Given numbers are addresses starting from "0".

8.3.1 Latch register

Register address	Name	Access	Register length	Size (bytes)	Description
511	Configuration Latch Register	RW (Read/ Write)	1	2	This is a latch register which acts as switch. If "1" is written, then and only then the configuration registers described below can be written. If "0" is written, the updated configuration will be taken by the device It detects transition: "0" to "1": Below described registers will be RW "1" to "0": Configuration apply

8.3.2 Global configuration

Register address	Name	Access	Register length	Size (bytes)	Description
+ 128 (640)					
640	Report U_L Voltage Fault	RW (Read/ Write)	1	2	A missing or out of range U_L supply voltage is ignored. Valid Values: "0" = Reporting disabled "1" = Reporting enabled "2" = Auto (Reporting active after U_L was present) Default Value: "1"
641	Report Actuator Fault without U_L	RW	1	2	An actuator diagnosis which is caused by a missing U_L voltage is suppressed. Valid Values: "0" = Reporting disabled "1" = Reporting enabled Default Value: "1"
642	Report U_S Voltage Fault	RW	1	2	An out of range U_S supply voltage is ignored. Valid Values: "0" = Reporting disabled "1" = Reporting enabled Default Value: "1"

Register address	Name	Access	Register length	Size (bytes)	Description
644	Web Interface Lock	RW	1	2	If enabled, the Web interface is not accessible. Valid Values: "0" = No lock "1" = Web interface locked Default Value: "0"
645	Forcing Lock	RW	1	2	If locked, outputs can not be forced from Web interface or any IIOT protocol. Additionally, there is no input simulation possible in this case. Valid Values: "0" = No Lock "1" = Forcing locked Default Value: "0"
646	Reserved	RW	1	2	
647	Reserved	RW	1	2	
648	External Configuration Lock	RW	1	2	If locked, no port / channel reconfiguration via Web interface or IIOT protocol is possible. Valid Values: "0" = No External Lock "1" = External config is locked Default Value: "0"

Register address	Name	Access	Register length	Size (bytes)	Description
649	Output Source	RW	1	2	Specifies the control source for the digital outputs. If "Coils" is selected, the outputs can be controlled via Coils 1-16. If "Holding Register" is selected, the outputs are controlled via Holding Register 00. The 16 Bit value in this single register directly maps to the max. 16 output channels. "0" = Coils "1" = Holding Register

8.3.3 Surveillance Timeout

Register address	Name	Access	Register length	Size (bytes)	Description
+0 (512)			16	32	
	Surv Timeout Port X1.A	RW (Read/ Write)	1	2	Surveillance timeout in ms 0 .. 255
	Surv Timeout Port X1.B	RW	1	2	
	Surv Timeout Port X2.A	RW	1	2	
	Surv Timeout Port X2.B	RW	1	2	
	Surv Timeout Port X3.A	RW	1	2	
	Surv Timeout Port X3.B	RW	1	2	
	Surv Timeout Port X4.A	RW	1	2	
	Surv Timeout Port X4.B	RW	1	2	
	Surv Timeout Port X5.A	RW	1	2	
	Surv Timeout Port X5.B	RW	1	2	
	Surv Timeout Port X6.A	RW	1	2	
	Surv Timeout Port X6.B	RW	1	2	
	Surv Timeout Port X7.A	RW	1	2	
	Surv Timeout Port X7.B	RW	1	2	
	Surv Timeout Port X8.A	RW	1	2	
	Surv Timeout Port X8.B	RW	1	2	

8.3.4 Failsafe

Register address	Name	Access	Register length	Size (bytes)	Description
+16 (528)			16	32	
	Failsafe mode Port X1.A	RW (Read/ Write)	1	2	Valid Values : "0" = Set Low "1" = Set High "2" = Hold Last Default Value : "0"
	Failsafe mode Port X1.B	RW	1	2	
	Failsafe mode Port X2.A	RW	1	2	
	Failsafe mode Port X2.B	RW	1	2	
	Failsafe mode Port X3.A	RW	1	2	
	Failsafe mode Port X3.B	RW	1	2	
	Failsafe mode Port X4.A	RW	1	2	
	Failsafe mode Port X4.B	RW	1	2	
	Failsafe mode Port X5.A	RW	1	2	
	Failsafe mode Port X5.B	RW	1	2	
	Failsafe mode Port X6.A	RW	1	2	
	Failsafe mode Port X6.B	RW	1	2	
	Failsafe mode Port X7.A	RW	1	2	
	Failsafe mode Port X7.B	RW	1	2	
	Failsafe mode Port X8.A	RW	1	2	
	Failsafe mode Port X8.B	RW	1	2	

8.3.5 Digital Input Filter

Register address	Name	Access	Register length	Size (bytes)	Description
+32 (544)			16	32	
	DI Filter Port X1.A	RW (Read/ Write)	1	2	Input Filter in 100µS (10 = 1 ms). Max. value "255" = 25.5 ms.
	DI Filter Port X1.B	RW	1	2	
	DI Filter Port X2.A	RW	1	2	
	DI Filter Port X2.B	RW	1	2	
	DI Filter Port X3.A	RW	1	2	
	DI Filter Port X3.B	RW	1	2	
	DI Filter Port X4.A	RW	1	2	
	DI Filter Port X4.B	RW	1	2	
	DI Filter Port X5.A	RW	1	2	
	DI Filter Port X5.B	RW	1	2	
	DI Filter Port X6.A	RW	1	2	
	DI Filter Port X6.B	RW	1	2	
	DI Filter Port X7.A	RW	1	2	
	DI Filter Port X7.B	RW	1	2	
	DI Filter Port X8.A	RW	1	2	
	DI Filter Port X8.B	RW	1	2	

8.3.6 Digital Input Logic

Register address	Name	Access	Register length	Size (bytes)	Description
+48 (560)			16	32	
	Digital input logic Port X1.A	RW (Read/ Write)	1	2	Valid Values : "0": Normally Open "1": Normally Close Default Value : "0"
	Digital input logic Port X1.B	RW	1	2	
	Digital input logic Port X2.A	RW	1	2	
	Digital input logic Port X2.B	RW	1	2	
	Digital input logic Port X3.A	RW	1	2	
	Digital input logic Port X3.B	RW	1	2	
	Digital input logic Port X4.A	RW	1	2	
	Digital input logic Port X4.B	RW	1	2	
	Digital input logic Port X5.A	RW	1	2	
	Digital input logic Port X5.B	RW	1	2	
	Digital input logic Port X6.A	RW	1	2	
	Digital input logic Port X6.B	RW	1	2	
	Digital input logic Port X7.A	RW	1	2	
	Digital input logic Port X7.B	RW	1	2	
	Digital input logic Port X8.A	RW	1	2	
	Digital input logic Port X8.B	RW	1	2	

8.3.7 Digital Output Auto Restart Mode

Register address	Name	Access	Register length	Size (bytes)	Description
+64 (576)			16	32	
	DO Restart Port X1.A	RW (Read/ Write)	1	2	Valid Values : "0": Disable "1": Enable Default Value : "1"
	DO Restart Port X1.B	RW	1	2	
	DO Restart Port X2.A	RW	1	2	
	DO Restart Port X2.B	RW	1	2	
	DO Restart Port X3.A	RW	1	2	
	DO Restart Port X3.B	RW	1	2	
	DO Restart Port X4.A	RW	1	2	
	DO Restart Port X4.B	RW	1	2	
	DO Restart Port X5.A	RW	1	2	
	DO Restart Port X5.B	RW	1	2	
	DO Restart Port X6.A	RW	1	2	
	DO Restart Port X6.B	RW	1	2	
	DO Restart Port X7.A	RW	1	2	
	DO Restart Port X7.B	RW	1	2	
	DO Restart Port X8.A	RW	1	2	
	DO Restart Port X8.B	RW	1	2	

8.3.8 Channel Direction

Register address	Name	Access	Register length	Size (bytes)	Description
+96 (608)			16	32	
	Channel_Direction Port X1.A	RW (Read/Write)	1	2	**Note:** The possible value options depend on the used device variant. Valid Values : "0": Input/Output "1": Output "2": Input "3": Inactive Default Value : "0"
	Channel_Direction Port X1.B	RW	1	2	
	Channel_Direction Port X2.A	RW	1	2	
	Channel_Direction Port X2.B	RW	1	2	
	Channel_Direction Port X3.A	RW	1	2	
	Channel_Direction Port X3.B	RW	1	2	
	Channel_Direction Port X4.A	RW	1	2	
	Channel_Direction Port X4.B	RW	1	2	
	Channel_Direction Port X5.A	RW	1	2	
	Channel_Direction Port X5.B	RW	1	2	
	Channel_Direction Port X6.A	RW	1	2	
	Channel_Direction Port X6.B	RW	1	2	
	Channel_Direction Port X7.A	RW	1	2	
	Channel_Direction Port X7.B	RW	1	2	
	Channel_Direction Port X8.A	RW	1	2	
	Channel_Direction Port X8.B	RW	1	2	

8.3.9 Digital Output Current Limit

Register address	Name	Access	Register length	Size (bytes)	Description
+112 (624)			16	32	
	DO Current Limit Port X1.A	RW (Read/ Write)	1	2	Current limit in mA. "0" = Current limit off Max. value = 4000 mA
	DO Current Limit Port X1.B	RW	1	2	
	DO Current Limit Port X2.A	RW	1	2	
	DO Current Limit Port X2.B	RW	1	2	
	DO Current Limit Port X3.A	RW	1	2	
	DO Current Limit Port X3.B	RW	1	2	
	DO Current Limit Port X4.A	RW	1	2	
	DO Current Limit Port X4.B	RW	1	2	
	DO Current Limit Port X5.A	RW	1	2	
	DO Current Limit Port X5.B	RW	1	2	
	DO Current Limit Port X6.A	RW	1	2	
	DO Current Limit Port X6.B	RW	1	2	
	DO Current Limit Port X7.A	RW	1	2	
	DO Current Limit Port X7.B	RW	1	2	
	DO Current Limit Port X8.A	RW	1	2	
	DO Current Limit Port X8.B	RW	1	2	

9 Diagnostics

Diagnostics base register: 400

Register address	Name	Access	Length	Size (bits)	Description
400	Sensor Diagnosis	RO (Read Only)		8	
	b0: Port X1	RO	1	1	
	b1: Port X2	RO	1	1	
	b2: Port X3	RO	1	1	
	b3: Port X4	RO	1	1	
	b4: Port X5	RO	1	1	
	b5: Port X6	RO	1	1	
	b6: Port X7	RO	1	1	
	b7: Port X8	RO	1	1	

Register address	Name	Access	Length	Size (bits)	Description
401	Actuator Diagnosis	RO (Read Only)		16	
	b0: Port X1.A	RO	1	1	
	b1: Port X1.B	RO	1	1	
	b2: Port X2.A	RO	1	1	
	b3: Port X2.B	RO	1	1	
	b4: Port X3.A	RO	1	1	
	b5: Port X3.B	RO	1	1	
	b6: Port X4.A	RO	1	1	
	b7: Port X4.B	RO	1	1	
	b8: Port X5.A	RO	1	1	
	b9: Port X5.B	RO	1	1	
	b10: Port X6.A	RO	1	1	
	b11: Port X6.B	RO	1	1	
	b12: Port X7.A	RO	1	1	
	b13: Port X7.B	RO	1	1	
	b14: Port X8.A	RO	1	1	
	b15: Port X8.B	RO	1	1	

Register address	Name	Access	Length	Size (byte)	Description
402	US Supply Present	RO (Read Only)	1	2	System Supply Voltage valid range
403	US Supply Diag	RO	1	2	System Supply Voltage diagnosis
404	UL Supply Present	RO	1	2	Actuator Supply valid range
405	UL Supply Diag	RO	1	2	Actuator Supply diagnosis
406	Internal Module Error	RO	1	2	I/O data not reliable due to internal error
407	Forcemode active	RO	1	2	Forcemode enabled. Outputs can differ from Modbus output values.
408	US Voltage	RO	16	2	System Supply Voltage in mV
409	UL Voltage	RO	16	2	Actuator Supply Voltage in mV
410 .. 425	Output Currents	RO	16	2	Output Currents in mA for X1 .. X8 Pin 4 + Pin 2
426 .. 433	Sensor Currents	RO	16	2	Sensor Currents in mA for X1 .. X8 Pin 1

10 IIoT functionality

The LioN-X variants offer a number of new interfaces and functions for the optimal integration into existing or future IIoT (Industrial Internet of Things) networks. The devices continue to work as field bus devices which communicate with and are controlled by a PLC (Programmable Logic Controller).

In addition, the devices offer common IIoT interfaces, which enable new communication channels besides the PLC. The communication is performed via IIoT-relevant protocols MQTT and OPC UA. With the help of these interfaces not only all information in a LioN-X device can be read. They also enable its configuration and control, if the user wishes. All interfaces can be configured extensively and offer read-only functionality.

All LioN-X variants provide user administration, which is also applicable for accessing and configuring the IIoT protocols. This allows you to manage all modification options for the device settings via personalized user authorizations.

All IIoT protocols can be used and configured independently of the field bus. It is also possible to use the devices completely without the help of a PLC and control them via IIoT protocols.

Attention: When using the IIoT functionality, a protected local network environment without direct access to the Internet is recommended.

10.1 MQTT

The MQTT (Message Queueing Telemetry Transport) protocol is an open network protocol for machine-to-machine communication, which provides the transmission of telemetric data messages between devices. The integrated MQTT client allows the device to publish a specific set of information to an MQTT broker.

The publishing of messages can either occur periodically or be triggered manually.

10.1.1 MQTT configuration

In **delivery state**, MQTT functions are **disabled**. The MQTT client can be configured either using the Web interface or directly via a JSON object sent in an HTTP request. For more information see chapter MQTT configuration - Quick start guide on page 77.

The configuration URL is:

```
http://[ip-address]/w/config/mqtt.json
```

The configuration can also read back as a JSON file:

```
http://[ip-address]/r/config/mqtt.json
```

The configuration is a JSON object. Each JSON member is a configuration element. The object must not contain all elements. Only the provided elements will be changed. The configuration changes apply only after a device restart.

The following configuration elements are available (default values in bold):

Element	Data type	Description	Example data
mqtt-enable	boolean	Master switch for the MQTT client.	true / **false**
broker	string	IP address of the MQTT Broker	**"192.168.1.1"**
login	string	Username for MQTT Broker	"admin" (Default: **null**)
password	string	Password for MQTT Broker	"private" (Default: **null**)
port	number	Broker port	**1883**
base-topic	string	Base topic	"iomodule_[mac]" (Default: "**lionx**")
will-enable	boolean	If true, the device provides a last will message to the broker	true / **false**
will-topic	string	The topic for the last will message.	(Default: **null**)
auto-publish	boolean	If true, all enabled domains will be published automatically in the specified interval.	**true** / false
publish-interval	number	The publish interval in ms if auto-publish is enabled. Minimum is 250 ms.	**2000**
publish-identity	boolean	If true, all identity domain data will be published	**true** / false
publish-config	boolean	If true, all config domain data will be published	**true** / false
publish-status	boolean	If true, all status domain data will be published	**true** / false
publish-process	boolean	If true, all process domain data will be published	**true** / false
commands-allowed	boolean	Master switch for MQTT commands. If false, the device will not subscribe to any command topic, even if specific command topics are activated below.	true / **false**
force-allowed	boolean	If true, the device accepts force commands via MQTT.	true / **false**
reset-allowed	boolean	If true, the device accepts restart and factory reset commands via MQTT.	true / **false**
config-allowed	boolean	If true, the device accepts configuration changes via MQTT.	true / **false**

Element	Data type	Description	Example data
qos	number	Selects the "Quality of Service" status for all published messages.	**0 = At most once** 1 = At least once 2 = Exactly once

Table 13: MQTT configuration

MQTT response:

The resulting response is a JSON object with a "status" field. Status should be "0" if no error occurred and "-1" if there is an error.

In case of an error, the response contains an error array.

The error array contains an error object for each error occurred. The object consists of a field "Element" which names the config element which caused the error, and a field "Message" for the error message.

- A malformed JSON object produces an error.
- Not existing parameters produce an error.
- Parameters with a wrong data type produce an error.

It is not allowed to write all available parameters at once. You may write only one or a limited number of parameters.

Examples:

```
{"status": -1, "error": [{"Element": "publish-interval", "Message": "Integer
 expected"}]}

{"status": 0}

{"status": -1, "error": [{"Element": "root", "Message": "Not a JSON
 object"}]}
```

For more information see chapter MQTT topics on page 62.

10.1.2 MQTT topics

MQTT mainly relates to topics. All messages are attached to a topic which adds context to the message itself. Topics may consist of a string and they are allowed to contain slashes (`/`). In topic filters, there also wildcard symbols like e.g. (#) allowed.

10.1.2.1 Base topic

For all LioN-X variants there is a configurable Base topic which is the prefix for all topics. The Base topic can be chosen freely by the user. The Base topic can also contain selected variables as shown in Table 14: Base topic variables on page 62.

Variables in the Base topic have to be written in brackets ("[ ]"). The following variables are possible:

Variable	Description
mac	The MAC address of the device
name	The name of the device
order	The ordering number of the device
serial	The serial number of the device
ip0 ip1 ip2 ip3	IP address octets

Table 14: Base topic variables

Example:

The Base topic `"io_[mac]"` translates to `"io_A3B6F3F0F2F1"`.

All data is organized in domains. The domain name is the first level in the topic after the Base topic. Note the following notation:

```
Base-Topic/domain/.….
```

There are the following domains:

Domain name	Definition	Example content
identity	All fixed data which is defined by the used hardware and which cannot be changed by configuration or at runtime.	Device name, ordering number, MAC address, port types, port capabilites and more.
config	Configuration data which is commonly loaded once at startup, mostly by a PLC.	IP address, port modes, input logic, failsafe values and more.
status	All (non-process) data which changes quite often in normal operation.	Bus state, diagnostic information, Device status and data.
process	All process data which is produced and consumed by the device itself or by attached devices.	Digital inputs, digital outputs, cyclic data.

Table 15: Data domains

There is often one topic used for all gateway related information and topics for each port. All identity topics are published just once at start-up, because this information should never change. All other topics are published either in a fixed interval or just triggered manually, according to the configuration.

Topic	Content examples	Total publish count	Publish interval
[base-topic]/identity/gateway	Name, ordering number, MAC, vendor, I&M etc.	1	Startup
[base-topic]/identity/port/n	Port name, port type	8	Startup
[base-topic]/config/gateway	Configuration parameters, ip address etc.	1	Interval
[base-topic]/config/port/n	Port mode, data storage, mapping, direction	8	Interval
[base-topic]/status/gateway	Bus state, device diagnosis, master events	1	Interval
[base-topic]/status/port/n	Port or channel diagnosis, state	8	Interval
[base-topic]/process/gateway	All Digital IN/OUT	1	Interval
[base-topic]/process/port/n	Digital IN/OUT per port, pdValid	8	Interval

Table 16: Data model

An MQTT client which wants to subscribe to one or more of these topics can also use wildcards.

Full topic	Description
[base-topic]/identity/gateway	Receive only indentity objects for the gateway
[base-topic]/identity/#	Receive all data related to the identity domain
[base-topic]/status/port/5	Receive only status information for port number 5
[base-topic]/+/port/2	Receive information of all domains for port number 2
[base-topic]/process/port/#	Receive only process data for all ports
[base-topic]/config/#	Receive config data for the gateway and all ports.

Table 17: Use case examples

10.1.2.2 Publish topic

Overview of all publish JSON data for the defined topics:

Identity/gateway	
Key	**Data type**
product_name	json_string
ordering_number	json_string
device_type	json_string
serial_number	json_string
mac_address	json_string
production_date	json_string
fw_name	json_string
fw_date	json_string
fw_version	json_string
hw_version	json_string
family	json_string
location	json_string
country	json_string
fax	json_string
vendor_name	json_string
vendor_address	json_string
vendor_phone	json_string
vendor_email	json_string
vendor_techn_support	json_string
vendor_url	json_string
vendor_id	json_integer
device_id	json_integer

Table 18: Identity/gateway

Config/gateway				
Key	**Data type**	**Range**	**Default value**	**Remarks**
fieldbus_protocol	json_string	PROFINET EtherNet/IP EtherCAT® Modbus TCP CC-Link IE Field Basic		
network_configuration	json_string	PROFINET: ▶ DCP ▶ Manual EtherNet/IP: ▶ Manual ▶ Rotary ▶ DHCP EtherCAT®: ▶ Manual Modbus TCP: ▶ Manual ▶ DHCP ▶ Rotary CC-Link IE Field Basic: ▶ Manual ▶ Rotary		
rotary_switches	json_integer	0 .. 999		
ip_address	json_string		192.168.1.1	
subnet_mask	json_string		255.255.255.0	
report_ul_alarm	json_boolean	true / false	true	
report_do_fault_without_ul	json_boolean	true / false	false	
force_mode_lock	json_boolean	true / false	false	
web_interface_lock	json_boolean	true / false	false	

Config/gateway				
Key	**Data type**	**Range**	**Default value**	**Remarks**
fast_startup	json_boolean	true / false	false	PROFINET and EIP only

Table 19: Config/gateway

Status/gateway				
Key	**Data type**	**Range**	**Default value**	**Remarks**
protocol	json_string	PROFINET: ▶ UNKNOWN ▶ OFFLINE ▶ STOP ▶ IDLE ▶ OPERATE EtherNet/IP: ▶ CONNECTED ▶ DISCONNECTED EtherCAT®: ▶ PREOP ▶ SAFEOP ▶ OP ▶ INIT ▶ UNKNOWN Modbus TCP: ▶ No Connections ▶ Connected CC-Link IE Feld Basic: ▶ ON ▶ STOP ▶ DISCONNECTED ▶ ERROR		
system_voltage_fault	json_boolean	true / false		
actuator_voltage_fault	json_boolean	true / false		
internal_module_error	json_boolean	true / false		
simulation_active_diag	json_boolean	true / false		
us_voltage	json_integer	0 .. 32		in Volts
ul_voltage	json_integer	0 .. 32		in Volts
forcemode_enabled	json_boolean	true / false		

Table 20: Status/gateway

Process/gateway				
Key	**Data type**	**Range**	**Default value**	**Remarks**
Input_data	json_integer[]			
output_data	json_integer[]			

Table 21: Process/gateway

Identity/port/1 .. 8				
Key	**Data type**	**Range**	**Default value**	**Remarks**
port	json_integer	1 .. 8		
type	json_string	Digital Input DIO Digital Output DIO Pin 4 Only DI Pin 4 Only DO Pin 4 Only Not available Unknown		
max_output_power_cha	json_string	2.0_mA 0.5_mA		
max_output_power_chb	json_string	2.0_mA 0.5_mA		
channel_cha	json_string	Digital Input Digital Output DIO Digital Input/Output Auxiliary Power Auxiliary with DO Not available Unknown		
channel_chb	json_string	Digital Input Digital Output DIO Digital Input/Output Auxiliary Power Auxiliary with DO Not available Unknown		

Table 22: Identity/port/1 .. 8

Config/port/1 .. 8				
Key	**Data type**	**Range**	**Default value**	**Remarks**
port	json_integer	1 .. 8		
direction_cha	json_string	Output Input Inactive Auxiliary Power DIO Unknown		
direction_chb	json_string	Output Input Inactive Auxiliary Power DIO Unknown		
restart_mode_cha	json_string	Manual Auto		
restart_mode_chb	json_string	Manual Auto		
input_polarity_cha	json_string	NO NC		
input_polarity_chb	json_string	NO NC		
input_filter_cha	json_integer			ms
input_filter_chb	json_integer			ms
do_auto_restart_cha	json_boolean	true / false		
do_auto_restart_chb	json_boolean	true / false		
failsafe_cha	json_string	set_low set_high hold_last	set_low	
failsafe_chb	json_string	set_low set_high hold_last	set_low	
surveillance_timeout_cha	json_integer	0 .. 255	80	

Config/port/1 .. 8				
Key	**Data type**	**Range**	**Default value**	**Remarks**
surveillance_timeout_chb	json_integer	0 .. 255	80	
io_mapping_cha	json_integer	0 .. 15	channel number	16DIO only
io_mapping_chb	json_integer	0 .. 15	channel number	16DIO only

Table 23: Config/port/1 .. 8

Status/port/1 .. 8				
Key	**Data type**	**Range**	**Default value**	**Remarks**
port	json_integer	1 .. 8		
physical_state_cha	json_integer	0 .. 1		
physical_state_chb	json_integer	0 .. 1		
actuator_short_circuit_cha	json_boolean	true / false		
actuator_short_circuit_chb	json_boolean	true / false		
sensor_short_circuit	json_boolean	true / false		
current_cha	json_integer			mA
current_chb	json_integer			mA
current_pin1	json_integer			mA

Table 24: Status/port/1 .. 8

10.1.2.3 Command topic (MQTT Subscribe)

The main purpose of MQTT is to publish data from the device to a broker. This data can then be received by any subscriber who is interested in this data. But also the other way round is possible. The device can subscribe to a topic on the broker and is then able to receive data. This data can contain configuration or forcing data. This allows the user to fully control a device via MQTT only, without using other ways of communication like Web or REST.

If the configuration allows commands in general, the device subscribes to special Command topics on which it can receive commands from other MQTT clients. The Command topic is based upon the Base topic. It always has the following form:

```
[base-topic]/command
```

After the Command topic, there are fixed topics for different writeable objects. The data format of the MQTT payload is always JSON. It is possible to set only a subset of the possible objects and fields.

[…]/forcing

Use the Command topic `[base-topic]/command/forcing` for *Force object* data. The *Force object* can contain any of the following properties:

Property	Data type	Example values	Remarks
forcemode	boolean	true / false	Forcing Authority: on/off
digital	array (Table 26: Force object: Digital on page 74)		

Table 25: Force object properties

For the *Force object* properties `digital` and `iol`, there are several value specifications arrayed:

Property	Data type	Example values	Remarks
port	integer	1, 2, 5	
channel	string	"a", "b"	
force_dir	string	"out", "in", "clear"	
force_value	integer	0, 1	

Table 26: Force object: Digital

[…]/config

Use the Command topic `[base-topic]/command/config` for *Config object* data. The *Config object* can contain any of the following properties:

Property	Data type	Example values	Remarks
portmode	array (Table 28: Config object: Portmode on page 75)		
ip_address	string	"192.168.1.5"	
subnet_mask	string	"255.255.255.0"	
gateway	string	"192.168.1.100"	

Table 27: Config object properties

For the *Conig object* property `portmode`, there are several value specifications arrayed:

Property	Data type	Example values	Remarks
port	integer	2	
channelA*	string	"dio", "di", "do", "iol", "off"	
channelB*	string	"dio", "di", "do", "iol", "off", "aux"	
inlogicA	string	"no", "nc"	
inlogicB	string	"no", "nc"	
filterA	integer	3	input filter in ms
filterB	integer	3	input filter in ms
autorestartA	boolean		
autorestartB	boolean		

Table 28: Config object: Portmode

*channelA = Pin 4, channelB = Pin 2

[…]/reset

Use the Command topic `[base-topic]/command/reset` for *Reset object* data about restart and factory reset issues. The *Reset object* can contain any of the following properties:

Property	Data type	Example values	Remarks
factory_reset	boolean	true / false	
system_reset	boolean	true / false	

Table 29: Reset object properties

[…]/publish

Use the Command topic `[base-topic]/command/publish` for *Publish object* data.

Trigger publish of all topics manually (can be used when auto publish is off or long interval is set).

10.1.3 MQTT configuration - Quick start guide

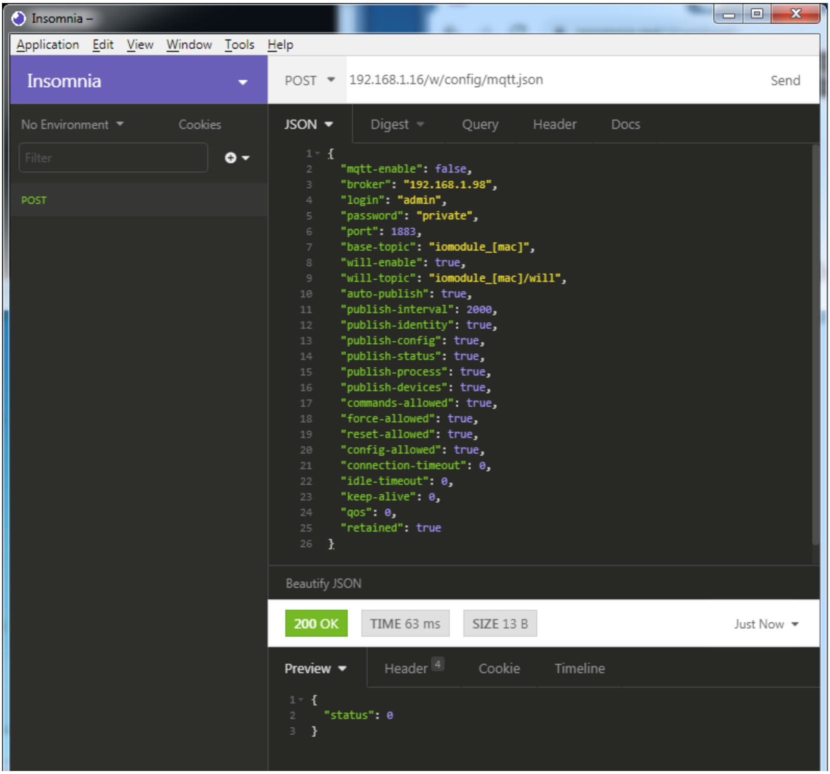
Attention: Lumberg Automation^{TM} is not responsible for any content of the referenced Web pages and provides no warranty for any functionality of the named third party software.

10.1.3.1 MQTT configuration via JSON

1. Depending on your application case, download and install *Insomnia* or a comparable application: https://insomnia.rest/download/

2. Configure MQTT:

POST: `[IP-address]/w/config/mqtt.json`



POST 192.168.1.16/w/config/mqtt.json

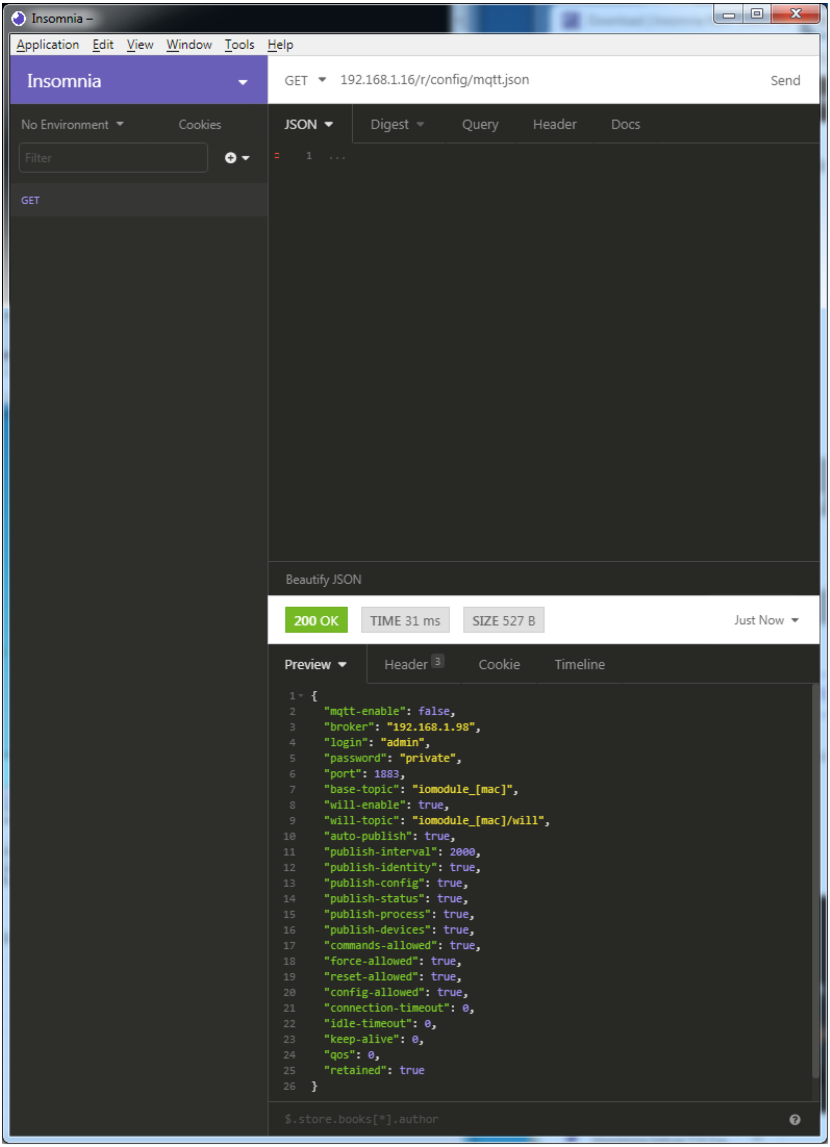
```json
{
  "mqtt-enable": false,
  "broker": "192.168.1.98",
  "login": "admin",
  "password": "private",
  "port": 1883,
  "base-topic": "iomodule_[mac]",
  "will-enable": true,
  "will-topic": "iomodule_[mac]/will",
  "auto-publish": true,
  "publish-interval": 2000,
  "publish-identity": true,
  "publish-config": true,
  "publish-status": true,
  "publish-process": true,
  "publish-devices": true,
  "commands-allowed": true,
  "force-allowed": true,
  "reset-allowed": true,
  "config-allowed": true,
  "connection-timeout": 0,
  "idle-timeout": 0,
  "keep-alive": 0,
  "qos": 0,
  "retained": true
}
```

200 OK TIME 63 ms SIZE 13 B

```json
{
  "status": 0
}
```

3. Read MQTT:

GET: `[IP-address]/r/config/mqtt.json`


Insomnia –
Application Edit View Window Tools Help
Insomnia
GET 192.168.1.16/r/config/mqtt.json Send
No Environment Cookies
Filter
GET
JSON Digest Query Header Docs
Beautify JSON
200 OK
TIME 31 ms
SIZE 527 B
Just Now
Preview Header 3 Cookie Timeline
$.store.books[*].author

```
{
  "mqtt-enable": false,
  "broker": "192.168.1.98",
  "login": "admin",
  "password": "private",
  "port": 1883,
  "base-topic": "iomodule_[mac]",
  "will-enable": true,
  "will-topic": "iomodule_[mac]/will",
  "auto-publish": true,
  "publish-interval": 2000,
  "publish-identity": true,
  "publish-config": true,
  "publish-status": true,
  "publish-process": true,
  "publish-devices": true,
  "commands-allowed": true,
  "force-allowed": true,
  "reset-allowed": true,
  "config-allowed": true,
  "connection-timeout": 0,
  "idle-timeout": 0,
  "keep-alive": 0,
  "qos": 0,
  "retained": true
}
```

10.2 OPC UA

OPC Unified Architecture (OPC UA) is a platform-independent standard with a service-oriented architecture for communication in and with industrial automation systems.

The OPC UA standard is based on the client-server principle and lets machines and devices, regardless of any preferred field bus, communicate horizontally among each other as well as vertically to the ERP system or the cloud. LioN-X provides an OPC UA server on field device level, with which an OPC UA client can connect for information exchange secure in transmission.

10.2.1 OPC UA configuration

In **delivery state**, OPC UA functions are **disabled**. The OPC UA Server can be configured either using the Web interface or directly via a JSON Object sent in an HTTP request.

The configuration URL is:

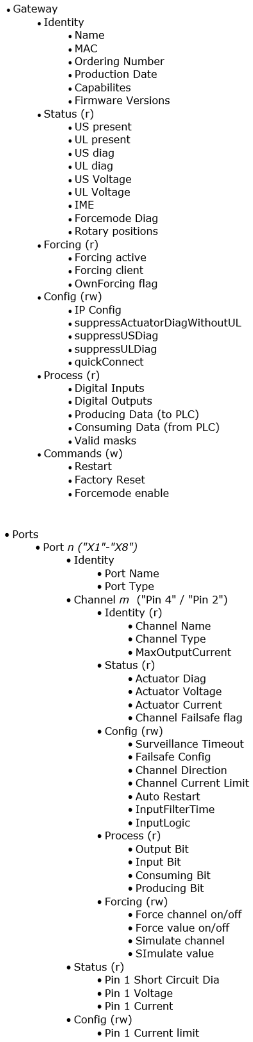
`http://[ip-address]/w/config/opcua.json`

The configuration can also read back as a JSON file:

`http://[ip-address]/r/config/opcua.json`

The configuration is a JSON object. Each JSON member is a configuration element. The object must not contain all elements. Only the provided elements will be changed. All configuration changed applies only after a device restart.

Tree overview of OPC UA objects:



- Gateway
    - Identity
        - Name
        - MAC
        - Ordering Number
        - Production Date
        - Capabilites
        - Firmware Versions
    - Status (r)
        - US present
        - UL present
        - US diag
        - UL diag
        - US Voltage
        - UL Voltage
        - IME
        - Forcemode Diag
        - Rotary positions
    - Forcing (r)
        - Forcing active
        - Forcing client
        - OwnForcing flag
    - Config (rw)
        - IP Config
        - suppressActuatorDiagWithoutUL
        - suppressUSDiag
        - suppressULDiag
        - quickConnect
    - Process (r)
        - Digital Inputs
        - Digital Outputs
        - Producing Data (to PLC)
        - Consuming Data (from PLC)
        - Valid masks
    - Commands (w)
        - Restart
        - Factory Reset
        - Forcemode enable

- Ports
    - Port *n ("X1"-"X8")*
        - Identity
            - Port Name
            - Port Type
        - Channel *m* ("Pin 4" / "Pin 2")
            - Identity (r)
                - Channel Name
                - Channel Type
                - MaxOutputCurrent
            - Status (r)
                - Actuator Diag
                - Actuator Voltage
                - Actuator Current
                - Channel Failsafe flag
            - Config (rw)
                - Surveillance Timeout
                - Failsafe Config
                - Channel Direction
                - Channel Current Limit
                - Auto Restart
                - InputFilterTime
                - InputLogic
            - Process (r)
                - Output Bit
                - Input Bit
                - Consuming Bit
                - Producing Bit
            - Forcing (rw)
                - Force channel on/off
                - Force value on/off
                - Simulate channel
                - SImulate value
        - Status (r)
            - Pin 1 Short Circuit Dia
            - Pin 1 Voltage
            - Pin 1 Current
        - Config (rw)
            - Pin 1 Current limit

All configuration elements are optional and do not need a specific order. Not every element is required to be sent. This means that only configuration changes will be taken over.

Optional: The configuration parameters of OPC UA can be set directly via the Web interface. It is possible to download the Web interface for sharing with other devices.

Response:

The resulting response is a JSON object with a status field. Status should be "0" if no error occurred and "-1" if there is an error.

In case of an error, the response contains an error array.

The error array contains an error object for each error occurred. The object consists of a field "Element" which names the config element which caused the error, and a field "Message" for the error message.

Examples:

```
{"status": -1, "error": [{"Element": "upcua-enable", "Message": "Boolean
 expected"}]}

{"status": 0}

{"status": -1, "error": [{"Element": "root", "Message": "Not a JSON
 object"}]}
```

10.2.1.1 Gateway objects

Identity

Name	Data type	Example
Device Name	UA_STRING	
Device ID	UA_STRING	
MAC address	UA_STRING	
Ordering Number	UA_STRING	
Serial Number	UA_STRING	
Production Date	UA_STRING	
Hardware Version	UA_STRING	
App Firmware Version	UA_STRING	
Fieldbus Firmware Version	UA_STRING	
IO Firmware Version	UA_STRING	
Running Fieldbus	UA_STRING	
Forcemode supported	UA_BOOLEAN	Forcing supported by module variant

Status (read)

Name	Data type	Unit	Example
US present	UA_BOOLEAN		
UL present	UA_BOOLEAN		
US diagnosis	UA_BOOLEAN		
UL diagnosis	UA_BOOLEAN		
Internal Module Error diag	UA_BOOLEAN		

Name	Data type	Unit	Example
Forcemode diag	UA_BOOLEAN		
US voltage	UA_DOUBLE	V	23.2
UL voltage	UA_DOUBLE	V	22.9
Rotary position	UA_UINT16		343

Forcing (read)

Name	Data type	Example
Forcing active	UA_BOOLEAN	
Forcing client	UA_STRING	if forcemode is not active, string is empty
Own Forcing	UA_BOOLEAN	Indicates if OPC UA is currently forcing
Forcing possible	UA_BOOLEAN	true if forcing by OPC UA is possible
Forcemode lock	UA_BOOLEAN	Forcing locked by PLC

Config (read + write)

Name	Data type	Example
IP address	UA_STRING	
Subnet Mask	UA_STRING	
Default Gateway IP	UA_STRING	
Suppress US diag	UA_BOOLEAN	
Suppress UL diag	UA_BOOLEAN	
Supppres Actuator Diag w/o UL	UA_BOOLEAN	
QuickConnect	UA_BOOLEAN	

Process (read)

Name	Data type	Example
Input Data	UA_UINT16	ioInput for all channels
Output Data	UA_UINT16	ioOutput for all channels
Consuming Data	UA_UINT16	Data from the PLC to the device
Producing Data	UA_UINT16	Data from the device to the PLC

Commands (write)

Name	Arguments	Return	Example
Restart	void	UA_INT32	
Factory reset	void	UA_INT32	
Forcemode enable	void	UA_INT32	
Forcemode disable	void	UA_INT32	

10.2.1.2 Ports objects

Identity

Name	Data type	Example
Name	UA_STRING	"X1"
Type	UA_STRING	"DIO"

Channel *m* ("Pin 4" / "Pin 2")

See details in Channel objects on page 86.

Status (read)

Name	Data type	Unit	Example
Sensor Diag	UA_BOOLEAN		
Pin 1 Voltage	UA_DOUBLE	V	22.5
Pin 1 Current	UA_INT16	mA	1900

Config (read + write)

Name	Data type	Unit	Example
Pin 1 Current Limit	UA_INT16	mA	1000

10.2.1.3 Channel objects

Identity (read)

Name	Data type	Unit	Example
Name	UA_STRING		"X1A"
Type	UA_STRING		"DIO"
MaxOutputCurrent	UA_INT16	mA	1300

Status (read)

Name	Data type	Unit	Example
Actuator Diag	UA_BOOL		
Actuator Voltage	UA_DOUBLE	V	23.5
Actuator Current	UA_INT16	mA	800
Channel Failsafe	UA_BOOL		

Config (read + write)

Name	Data type	Unit	Example / Remarks
Surveillance Timeout	UA_UINT8	ms	80 ms
Failsafe Config	UA_ENUMERATION		Low Hi Hold Last
Channel DIrection	UA_ENUMERATION		DIO Input Output Inactive
Channel Current Limit	UA_UINT16	mA	2000 mA
Auto Restart	UA_BOOL		

Name	Data type	Unit	Example / Remarks
InputFilterTime	UA_UINT8	ms	3ms
InputLogic	UA_ENUMERATION		NO NC

Process (read)

Name	Data type	Example / Remarks
Output	UA_BOOLEAN	Output type channels only.
Input	UA_BOOLEAN	Input type channels only.
Consuming	UA_BOOLEAN	
Producing	UA_BOOLEAN	

Forcing (read + write)

Name	Data type	Example / Remarks
Force channel	UA_BOOLEAN	Enable forcing with the current force value or disable forcing for this channel. Output type channels only.
Force value	UA_BOOLEAN	When changed by the user it will start forcing with the new value if forcing is enabled for opcua. Output type channels only.
Simulate channel	UA_BOOLEAN	Enable simulation with the current force value or disable simulation for this channel. Input type channels only.

Name	Data type	Example / Remarks
Simulate value	UA_BOOLEAN	When changed by the user it will start simulation with the new value if forcing is enabled for opcua. Input type channels only.

10.2.2 OPC UA address space

OPC UA provides different services on the LioN-X devices with which a client can navigate through the hierarchy of the address space and read or write variables. In addition, the client can monitor up to 10 attributes from the address space for value changes.

A connection to an OPC UA server is established via the endpoint URL:

```
opc.tcp://[ip-address]:[port]
```

Various device data such as MAC address, device settings, diagnostics or status information can be read via *Identity objects*, *Config objects*, *Status objects* and *Process objects*.

Command objects can be read and written. This makes it possible, for example, to transfer new network parameters to the device, to use Force Mode or to reset the entire device to its factory settings.

The following figures illustrate the OPC UA address space of the LioN-X devices. The objects and information displayed depend on the device variant used.

10.2.3 OPC UA configuration - Quick start guide

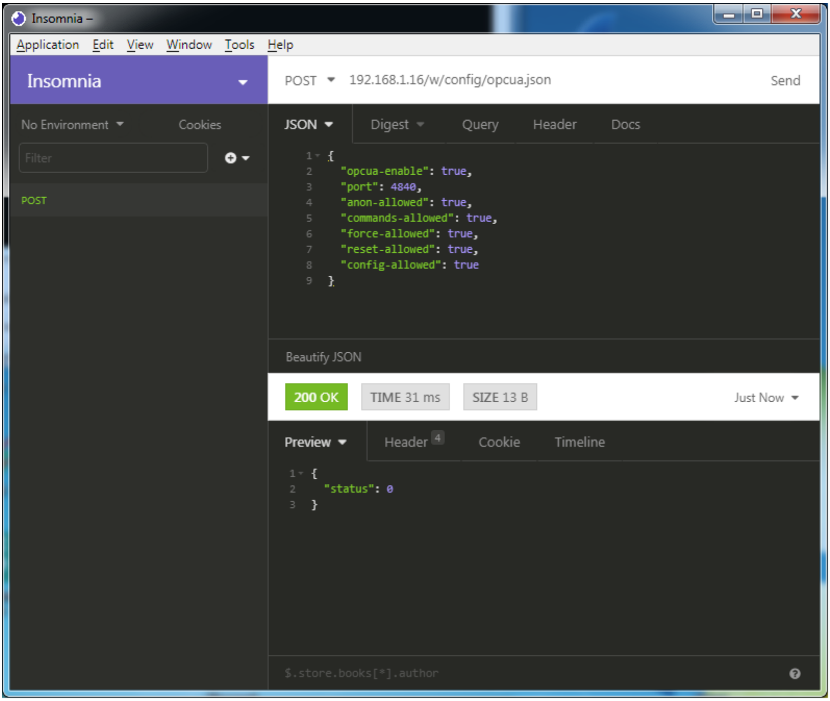
Attention: Lumberg Automation^{TM} is not responsible for any content of the referenced Web pages and provides no warranty for any functionality of the named third party software.

10.2.3.1 OPC UA configuration via JSON

1. Depending on your application case, download and install *Insomnia* or a comparable application: https://insomnia.rest/download/

2. Configure OPC UA:

POST: `[IP-address]/w/config/opcua.json`

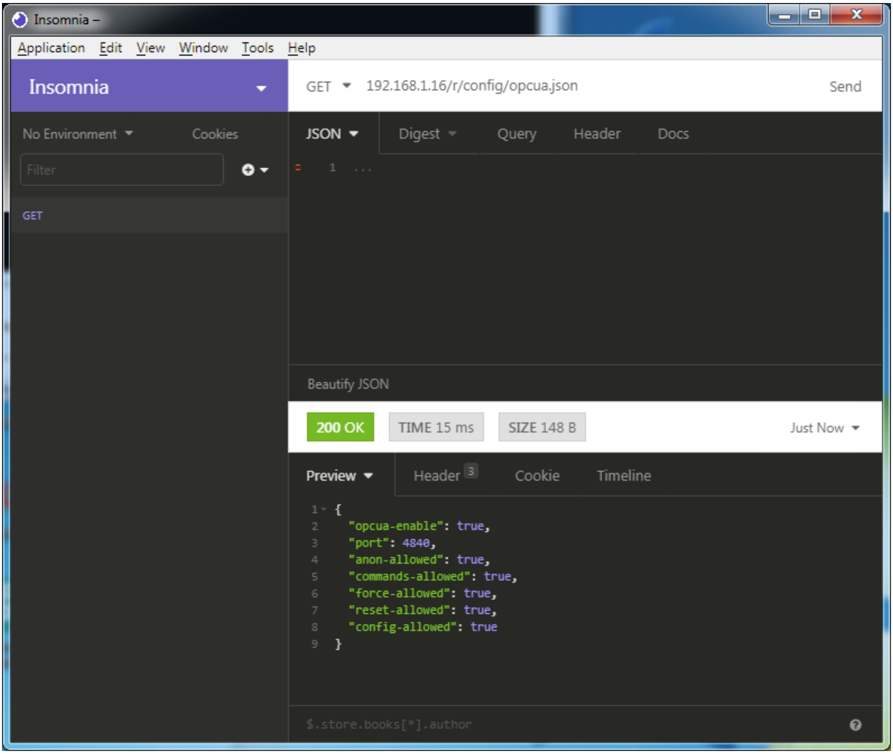


```
{
  "opcua-enable": true,
  "port": 4840,
  "anon-allowed": true,
  "commands-allowed": true,
  "force-allowed": true,
  "reset-allowed": true,
  "config-allowed": true
}
```

```
{
  "status": 0
}
```

3. Read OPC UA:

GET: `[IP-address]/r/config/opcua.json`



```
{
  "opcua-enable": true,
  "port": 4840,
  "anon-allowed": true,
  "commands-allowed": true,
  "force-allowed": true,
  "reset-allowed": true,
  "config-allowed": true
}
```

10.3 REST API

The Representational State Transfer – Application Programming Interface (REST API) is a programmable interface which uses HTTP requests to GET and POST data. This enables the access to detailed device information.

For all LioN-X variants, the REST API can be used to read the device status. For the LioN-X multiprotocol variants, the REST API can also be used to write configuration and forcing data.

The customized Belden REST API is described in the following chapters.

10.3.1 Standard device information

Request method:	http GET
Request URL:	`<ip>/info.json`
Parameters	n.a.
Response format	JSON

The goal of the "Standard device information" request is to get a complete snapshot of the current device status. The format is JSON.

10.3.2 Structure

Name	Data type	Description	Example
name	string	Device name	"0980 XSL 3912-121-007D-00F"
order-id	string	Ordering number	"935 700 001"
fw-version	string	Firmware version	"V.1.1.0.0 - 01.01.2021"
hw-version	string	Hardware version	"V.1.00"
mac	string	MAC address of the device	"3C B9 A6 F3 F6 05"
bus	number	0 = No connection 1 = Connection with PLC	1
failsafe	number	0 = Normal operation 1 = Outputs are in failsafe	0
ip	string	IP address of the device	
snMask	string	Subnet Mask	
gw	string	Default gateway	
rotarys	array of numbers (3)	Current position of the rotary switches: Array element 0 = x1 Array element 1 = x10 Array element 2 = x100	
ulPresent	boolean	True, if there is a UL voltage supply detected within valid range	
usVoltage_mv	number	US voltage supply in mV	
ulVoltage_mv	number	UL voltage supply in mV (only available for devices with UL supply)	
inputs	array of numbers (2)	Real state of digital inputs. **Element 0 = 1 Byte:** Port X1 Channel A to Port X4 Channel B **Element 0 = 1 Byte:** Port X5 Channel A to Port X8 Channel B	[128,3]
output	array of numbers (2)	Real State of digital outputs. **Element 0 =1 Byte:** Port X1 Channel A to port X4 Channel B **Element 0 = 1 Byte:** Port X5 Channel A to port X8 Channel B	[55,8]

Name	Data type	Description	Example
consuming	array of numbers (2)	Cyclic data from PLC to device	
producing	array of numbers (2)	Cyclic data from device to PLC	
diag	array of numbers (4)	Diagnostic information **Element 0 = 1 Byte:** Bit 7: Internal module error (IME) Bit 6: Forcemode active Bit 3: Actuator short Bit 2: Sensor short Bit 1: U_L fault Bit 0: U_S fault **Element 1 = 1 Byte:** Sensor short circuit ports X1 .. X8. **Element 2 =1 Byte:** Actuator short circuit ports X1 Channel A to X4 Channel B **Element 3 = 1 Byte:** Actuator short circuit ports X5 Channel A to X8 Channel B	
fieldbus	FIELDBUS Object		
FIELDBUS Object			
fieldbus_name	string	Currently used fieldbus	
state	number	Fieldbus state	
state_text	number	Textual representation of fieldbus state: 0 = Unknown 1 = Bus disconnected 2 = Preop 3 = Connected 4 = Error 5 = Stateless	
forcing	FORCING Object	Information about the forcing state of the device	
channels	Array of CHANNEL (16)	Basic information about all input/output channels	

Name	Data type	Description	Example
CHANNEL Object			
name	string	Name of channel	
type	number	Hardware channel type as number: 0 = DIO 1 = Input 2 = Output 3 = Input/Output 4 = Channel not available 5 = Channel not available 6 = Channel not available 7 = Channel not available 8 = Channel not available	
type_text	string	Textual representation of the channel type	
config	number	Current configuration of the channel: 0 = DIO 1 = Input 2 = Output 3 = Channel not available 4 = Deactivated 5 = Channel not available	
config_text	string	Textual representation of the current config	
inputState	boolean	Input data (producing data) bit to the PLC	
outputState	boolean	Output data bit to the physical output pin	
forced	boolean	True, if the output pin of this channel is forced	
simulated	boolean	True, if the input value to the PLC of this channel is simulated	
actuatorDiag	boolean	True, if the output is in short circuit / overload condition	
sensorDiag	boolean	True, if the sensor supply (Pin 1) is in short circuit / overload condition	

Name	Data type	Description	Example
maxOutputCurrent_mA	number	Maximum output current of the output in mA	
current_mA	number	Measured current of the output in mA (if current measurement is available)	
voltage_mV	number	Measured voltage of this output in mV (if voltage measurement is available)	
PORT Object			
port_type	string	Textual representation of the port type	
aux_mode	number	Indicates the configured mode for the Pin 2: 0 = No AUX 1 = AUX output (always on) 2 = Digital output (can be controlled by cyclic data) 3 = Digital input	
aux_text	string	Textual representation of the current aux mode	"AUX Output"
ds_fault	number	Data storage error number	
ds_fault_text	string	Textual data storage error.	
diag	array of DIAG (n)	Array of port related events	
DIAG Object			
error	number	Error code	
source	string	Source of the current error.	"device" "master"
message	string	Error message	"Supply Voltage fault"
FORCING Object		Forcing information of the device	
forcingActive	boolean	Force mode is currently active	
forcingPossible	boolean	True, if forcing is possible and force mode can be activated	
AuthPossible	boolean	True, if the JSON Interface can obtain forcing autorization	
ownForcing	boolean	True, if forcing is performed by REST API at the moment	
currentClient	string	Current forcing client identifier	

Name	Data type	Description	Example
digitalOutForced	array of numbers (2)	The force values of all 16 digital output channels.	
digitalOutMask	array of numbers (2)	The forcing mask of all 16 digital output channels.	
digitalInForced	array of numbers (2)	The force values of all 16 digital input channels.	
digitalInMask	array of numbers (2)	The forcing mask of all 16 digital input channels.	

10.3.3 Configuration and forcing

Method:	POST
URL:	`<ip>/w/force.json`
Parameters:	None
Post-Body:	JSON Object

Property	Data type	Example values	Description
forcemode	boolean	true / false	Forcing authority on/off
portmode	array (Port mode object)		
digital	array (Digital object)		

Table 30: Root object

Property	Data type	Example values	Remarks
port	integer	0..7	
channel	integer	"a","b"	optional default is "a"
direction	string	"dio","di","do", "off", "aux"	
inlogica	string	"no","nc"	
inlogicb	string	"no","nc"	

Table 31: Port mode object

Property	Data type	Example values	Remarks
port	integer	0..7	
channel	string	"a","b"	
force_dir	string	"phys_out","plc_in","clear"	optional default is "phys_out"
force_value	integer	0,1	

Table 32: Digital object

10.4 CoAP server

The **Co**nstrained **A**pplication **P**rotocol (CoAP) is a specialized Internet application protocol for constrained networks such as lossy or low power networks. CoAP is useful especially in M2M (Machine to Machine) communication and can be used to translate simplified HTTP requests of low speed networks.

CoAP is based on the Server-Client principle and a service layer protocol that lets nodes and machines communicate with each other. The LioN-X multiprotocol variants provide CoAP server functionalities via a REST API interface over UDP.

10.4.1 CoAP configuration

In delivery state, CoAP functions are *disabled*. The CoAP server can be configured either using the Web interface or directly via a JSON object sent in an HTTP request. For more information see chapter CoAP configuration - Quick start guide on page 101.

The configuration URL is:

```
http://[ip-address]/w/config/coapd.json
```

The configuration can also read back as a JSON file:

```
http://[ip-address]/r/config/coapd.json
```

The configuration is a JSON object. Each JSON member is a configuration element. The object must not contain all elements. Only the provided elements will be changed. The configuration changes apply only after a device restart.

The following configuration elements are available (default values in bold):

Element	Data type	Description	Example data
enable	boolean	Master switch for the CoAP server	true / **false**
port	integer (0 to 65535)	Port of the CoAP server	**5683**

Table 33: CoAP configuration

CoAP response:

The resulting response is a JSON object with a "status" field. Status should be "0" if no error occurred, and "-1" if there is an error.

In case of an error, the response contains an error array.

The error array contains an error object for each error occurred. The object consists of a field "Element" which names the config element that caused the error, and of a field "Message" for the error message.

Examples:

```
{"status": -1, "error": [{"Element": "upcua-enable", "Message": "Boolean
 expected"}]}

{"status": 0}

{"status": -1, "error": [{"Element": "root", "Message": "Not a JSON
 object"}]}
```

10.4.2 REST API access via CoAP

A connection to the CoAP server running on the LioN-X multiprotocol variants can be established via the following URL:

`coap://[ip-address]:[port]/[api]`

For LioN-X, the following REST API Requests (JSON format) can be accessed via a CoAP endpoint:

Type	API	Note
GET	/r/status.lr	
GET	/r/system.lr	
GET	/info.json"	
GET	/r/config/net.json	
GET	/r/config/mqtt.json	
GET	/r/config/opcua.json	
GET	/r/config/coapd.json	
GET	/r/config/syslog.json	
GET	/contact.json	
GET	/fwup_status	

Table 34: REST API access via CoAP

10.4.3 CoAP configuration - Quick start guide

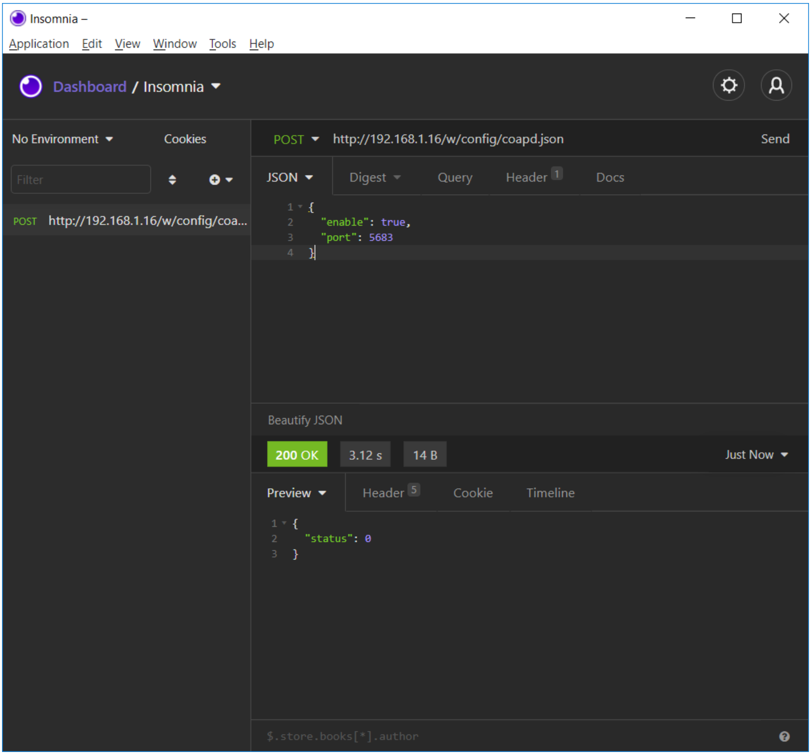
Attention: Lumberg Automation^{TM} is not responsible for any content of the referenced Web pages and provides no warranty for any functionality of the named third party software.

10.4.3.1 CoAP configuration via JSON

1. Depending on your application case, download and install *Insomnia* or a comparable application: https://insomnia.rest/download/

2. Configure CoAP:

POST: `[IP-address]/w/config/coapd.json`



POST http://192.168.1.16/w/config/coapd.json

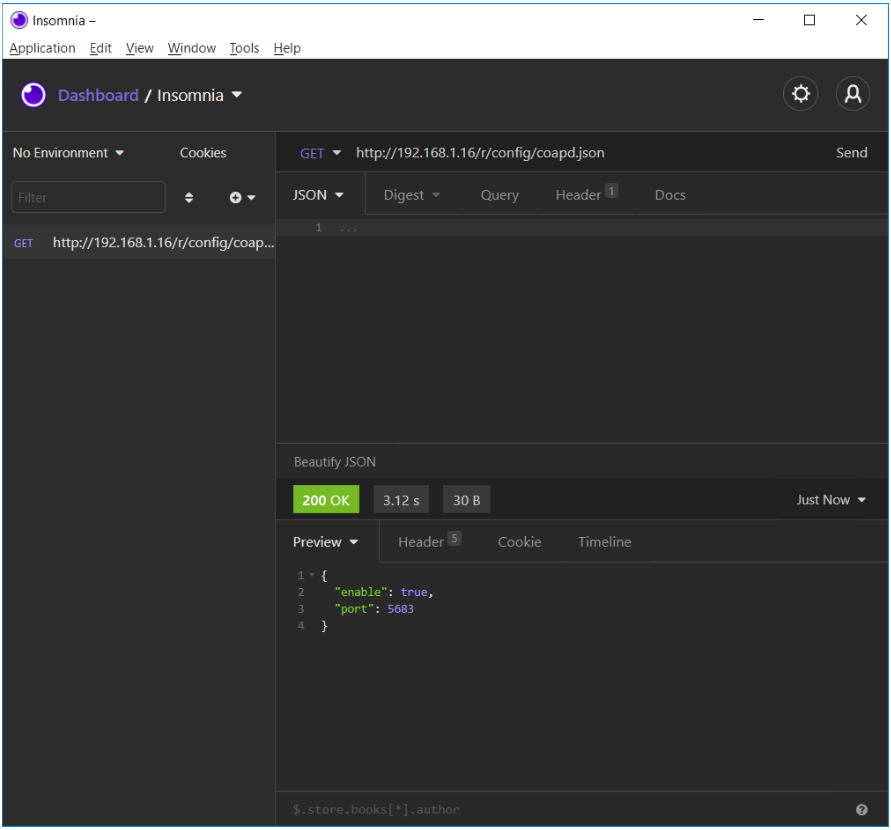
```
{
  "enable": true,
  "port": 5683
}
```

200 OK 3.12 s 14 B

```
{
  "status": 0
}
```

3. Read CoAP configuration:

GET: `[IP-address]/r/config/coapd.json`



GET http://192.168.1.16/r/config/coapd.json

```
{
  "enable": true,
  "port": 5683
}
```

10.5 Syslog

The LioN-X multiprotocol variants provide a Syslog client which can connect with a configured Syslog server and is able to log messages.

Syslog is a platform-independent standard for logging messages. Each message contains a timestamp as well as information about the severity level and the subsystem. The Syslog protocol RFC5424 is based on the Server-Client principle and lets machines and devices send messages in the network and collect them centrally. (For more details on the used syslog standard, please refer to https://datatracker.ietf.org/doc/html/rfc5424.)

LioN-X supports the storage of 256 messages in a ring buffer which are sent to the configured Syslog server. When the ring is full with 256 messages, the oldest message is always replaced by the newly arriving messages. All messages can be saved on the Syslog server. The Syslog client will not store any message permanently.

10.5.1 Syslog configuration

In **delivery state**, Syslog functions are **disabled**. The Syslog client can be configured either using the Web interface or directly via a JSON object sent in an HTTP request. For more information see chapter Syslog configuration - Quick start guide on page 106.

The configuration URL is:

```
http://[ip-address]/w/config/syslog.json
```

The configuration can also read back as a JSON file:

```
http://[ip-address]/r/config/syslog.json
```

The configuration is a JSON object. Each JSON member is a configuration element. The object must not contain all elements. Only the provided elements will be changed. The configuration changes apply only after a device restart.

The following configuration elements are available (default values in bold):

Element	Data type	Description	Example data
syslog-enable	boolean	Master switch for the Syslog client	true / **false**
global-severity	integer	Severity level of Syslog client 0 – Emergency 1 – Alert 2 – Critical **3 – Error** 4 – Warning 5 – Notice 6 – Info 7 – Debug The client will log all messages of severity according to the setting, including all below levels.	0/1/2/**3**/4/5/6/7
server-address	string (IP address)	IP address of the Syslog server	192.168.0.51 (Default: **null**)
server-port	integer (0 to 65535)	Server port of the Syslog server	**514**
server-severity	integer (0 to 7)	Severity level of Syslog server 0 – Emergency 1 – Alert 2 – Critical **3 – Error** 4 – Warning 5 – Notice 6 – Info 7 – Debug	0/1/2/**3**/4/5/6/7

Table 35: Syslog configuration

Syslog response:

The resulting response is a JSON object with a "status" field. Status should be "0" if no error occurred, and "-1" if there is an error.

In case of an error, the response contains an error array.

The error array contains an error object for each error occurred. The object consists of a field "Element" which names the config element that caused the error, and of a field "Message" for the error message.

Examples:

```
{"status": -1, "error": [{"Element": "upcua-enable", "Message": "Boolean
 expected"}]}

{"status": 0}

{"status": -1, "error": [{"Element": "root", "Message": "Not a JSON
 object"}]}
```

10.5.2 Syslog configuration - Quick start guide

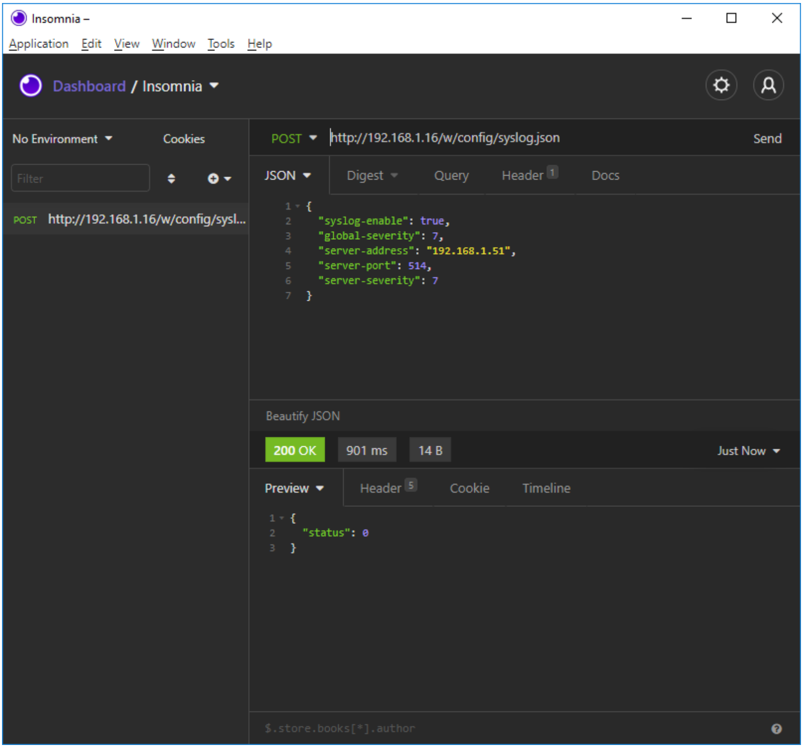
Attention: Lumberg Automation^{TM} is not responsible for any content of the referenced Web pages and provides no warranty for any functionality of the named third party software.

10.5.2.1 Syslog configuration via JSON

1. Depending on your application case, download and install *Insomnia* or a comparable application: https://insomnia.rest/download/

2. Configure Syslog:

POST: `[IP-address]/w/config/syslog.json`



POST http://192.168.1.16/w/config/syslog.json

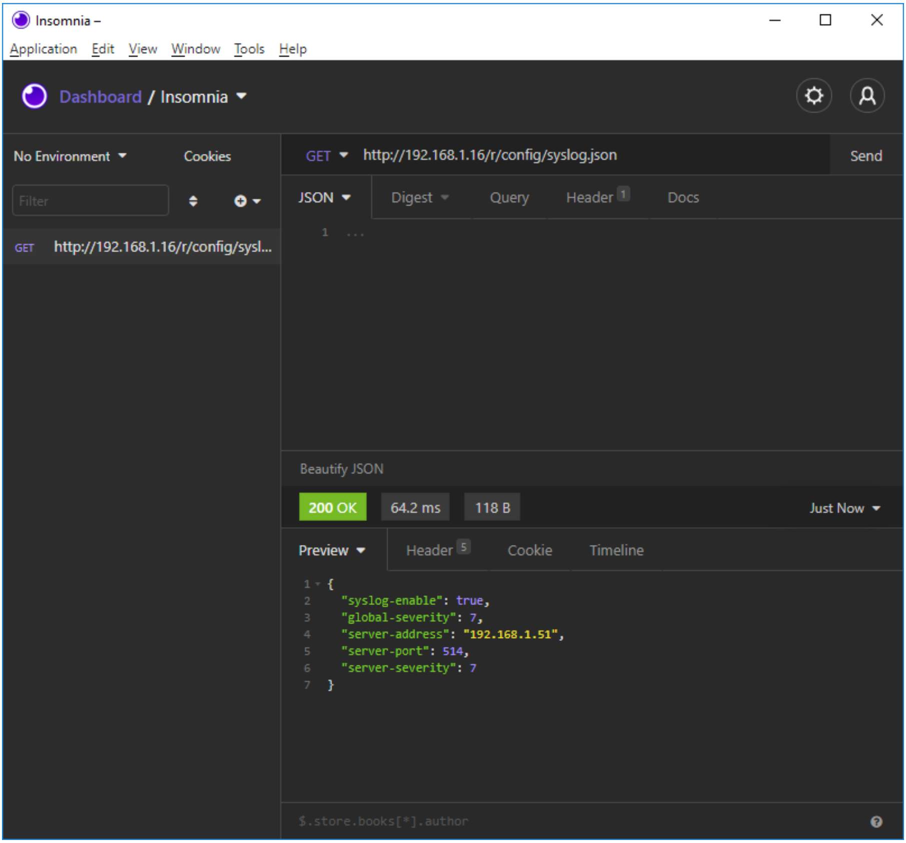
```
{
  "syslog-enable": true,
  "global-severity": 7,
  "server-address": "192.168.1.51",
  "server-port": 514,
  "server-severity": 7
}
```

200 OK 901 ms 14 B

```
{
  "status": 0
}
```

3. Read Syslog configuration:

GET: `[IP-address]/r/config/syslog.json`



GET http://192.168.1.16/r/config/syslog.json

200 OK 64.2 ms 118 B

```
{
  "syslog-enable": true,
  "global-severity": 7,
  "server-address": "192.168.1.51",
  "server-port": 514,
  "server-severity": 7
}
```

10.6 Network Time Protocol (NTP)

The LioN-X multiprotocol variants provide an NTP client (version 3) which can connect with a configured NTP server and is able to synchronize the network time at a configurable interval.

NTP is a network protocol which uses UDP datagrams to send and receive timestamps in order to synchronize with a local clock. The NTP protocol RFC1305 is based on the Server-Client principle and exclusively supplies the synchronization with Coordinated Universal Time (UTC). (For more details on the used NTP standard, please refer to https://datatracker.ietf.org/doc/html/rfc1305.)

10.6.1 NTP configuration

In **delivery state**, the NTP client is **disabled**. The NTP client can be configured either using the Web interface or directly via a JSON object sent in an HTTP request. For more information see chapter NTP configuration - Quick start guide on page 110.

The configuration URL is:

```
http://[ip-address]/w/config/ntpc.json
```

The configuration can also read back as a JSON file:

```
http://[ip-address]/r/config/ntpc.json
```

The configuration is a JSON object. Each JSON member is a configuration element. The object must not contain all elements. Only the provided elements will be changed. The configuration changes apply only after a device restart.

The following configuration elements are available (default values in bold):

Element	Data type	Description	Example data
NTP client state	boolean	Master switch for the NTP client	true / **false**
Server address	string	IP address of the NTP server	192.168.1.50
Server port	integer	Port of the NTP server	**123**
Update interval	integer	Interval at which the client will connect with the configured NTP server (see table row "Server address"). **Note: This value is in seconds.**	1/2/10/**60**

Table 36: NTP configuration

NTP response:

The resulting response is a JSON object with a "status" field. Status should be "0" if no error occurred, and "-1" if there is an error.

In case of an error, the response contains an error array.

The error array contains an error object for each error occurred. The object consists of a field "Element" which names the configuration element that caused the error, and of a field "Message" for the error message.

Examples:

```
{"status": -1, "error": [{"Element": "ntpc-enable", "Message": "Boolean
 expected"}]}

{"status": 0}

{"status": -1, "error": [{"Element": "root", "Message": "Not a JSON
 object"}]}
```

10.6.2 NTP configuration - Quick start guide

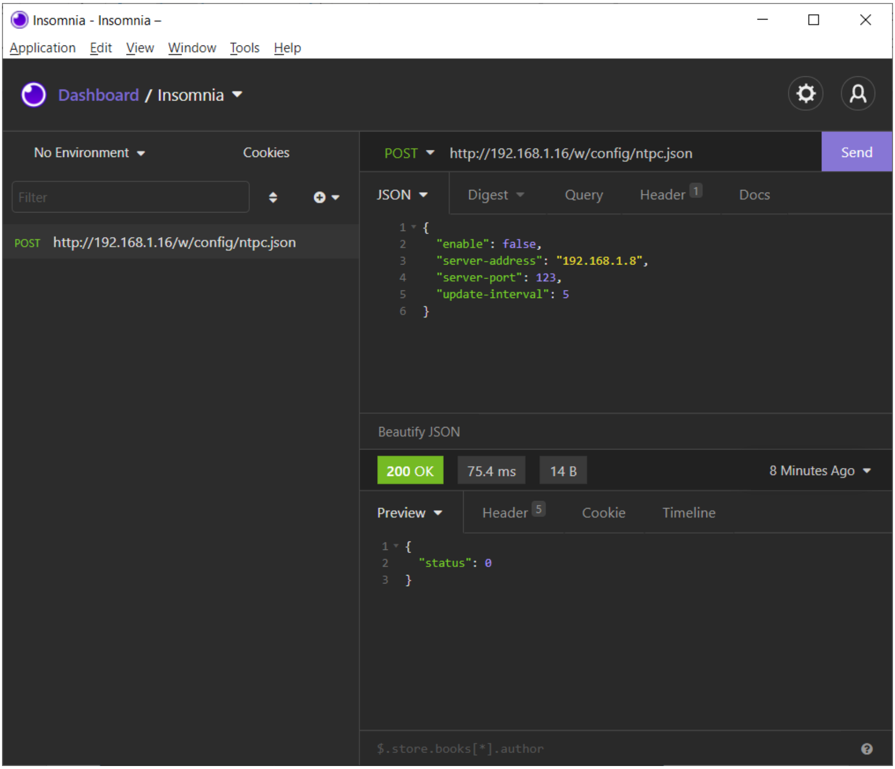
Attention: Lumberg Automation^{TM} is not responsible for any content of the referenced Web pages and provides no warranty for any functionality of the named third party software.

10.6.2.1 NTP configuration via JSON

1. Depending on your application case, download and install *Insomnia* or a comparable application: https://insomnia.rest/download/

2. Configure NTP:

POST: `[IP-address]/w/config/ntpc.json`



POST http://192.168.1.16/w/config/ntpc.json

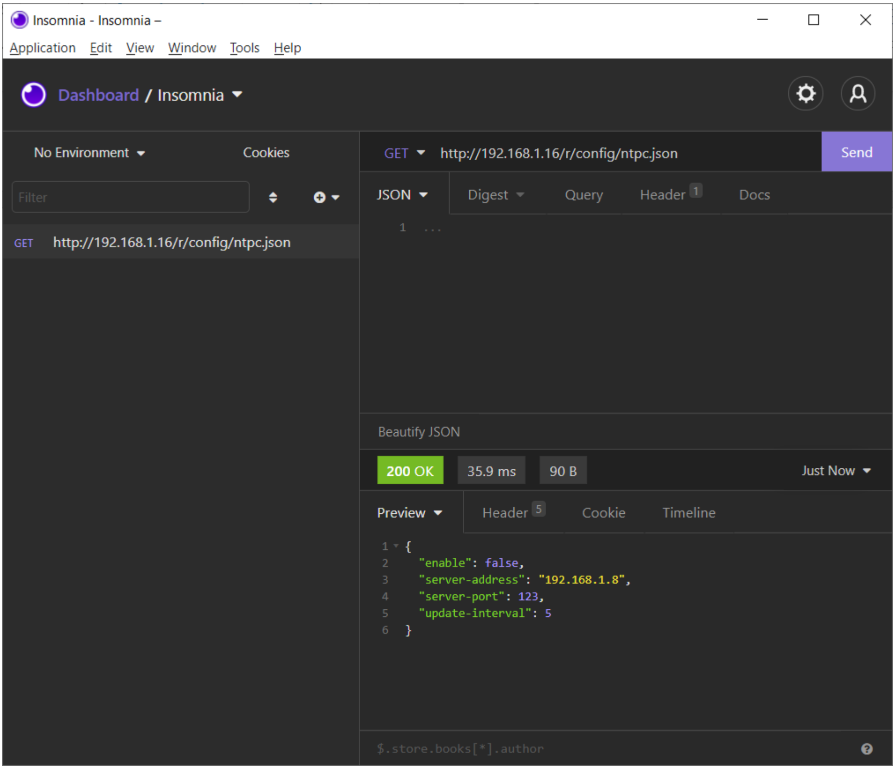
```
{
  "enable": false,
  "server-address": "192.168.1.8",
  "server-port": 123,
  "update-interval": 5
}
```

200 OK 75.4 ms 14 B 8 Minutes Ago

```
{
  "status": 0
}
```

3. Read NTP configuration:

GET: `[IP-address]/r/config/ntpc.json`



```
{
  "enable": false,
  "server-address": "192.168.1.8",
  "server-port": 123,
  "update-interval": 5
}
```

11 The integrated Web server

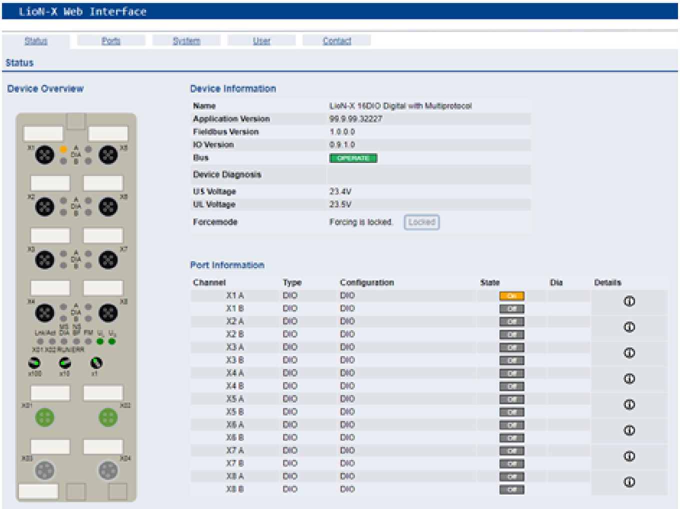
All device variants are equipped with an integrated Web server which makes functions for the device configuration and the display of status and diagnostic information available via a Web interface.

The Web interface provides an overview of the configuration and status of the device. It is also possible to use the Web interface to trigger a reboot, reset to the factory defaults, or perform a firmware update.

Enter "http://" followed by the IP address, such as "http://192.168.1.5", in your Web browser’s address bar. If the status page of the device is not displayed, check your browser and firewall settings.

11.1 LioN-X 0980 XSL... variants

11.1.1 The Status page



Device Information

Name	LioN-X 16DIO Digital with Multiprotocol
Application Version	99.9.99.32227
Fieldbus Version	1.0.0.0
IO Version	0.9.1.0
Bus	OPERATE
Device Diagnosis	
US Voltage	23.4V
UL Voltage	23.5V
Forcemode	Forcing is locked. Locked

Port Information

Channel	Type	Configuration	State	Dia	Details
X1 A	DIO	DIO	On		ⓘ
X1 B	DIO	DIO	Off		
X2 A	DIO	DIO	Off		ⓘ
X2 B	DIO	DIO	Off		
X3 A	DIO	DIO	Off		ⓘ
X3 B	DIO	DIO	Off		
X4 A	DIO	DIO	Off		ⓘ
X4 B	DIO	DIO	Off		
X5 A	DIO	DIO	Off		ⓘ
X5 B	DIO	DIO	Off		
X6 A	DIO	DIO	Off		ⓘ
X6 B	DIO	DIO	Off		
X7 A	DIO	DIO	Off		ⓘ
X7 B	DIO	DIO	Off		
X8 A	DIO	DIO	Off		ⓘ
X8 B	DIO	DIO	Off		

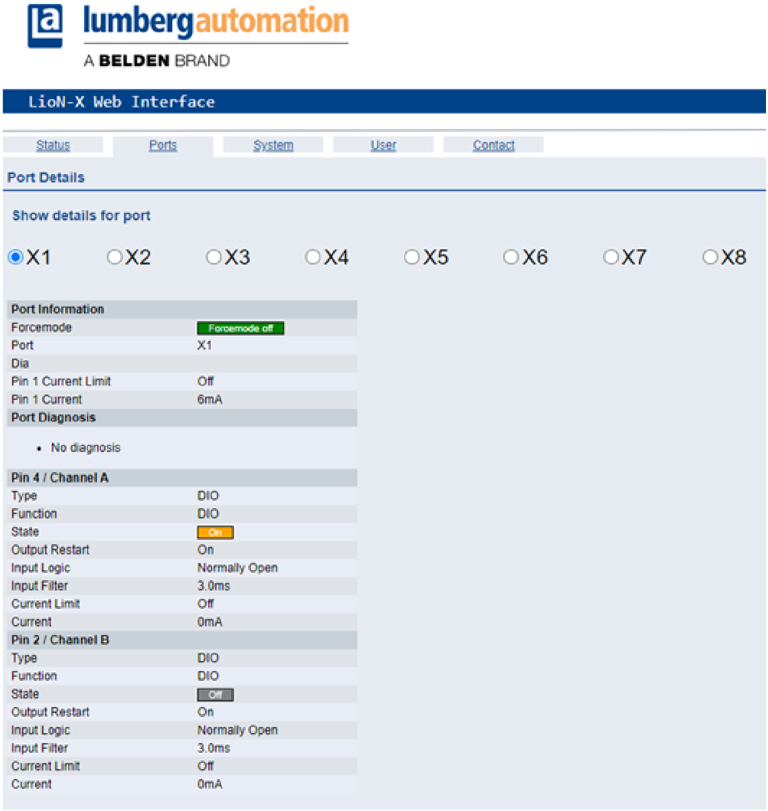
The status page provides a quick overview of the current state of the device.

The left side shows a graphical representation of the module with all its LEDs and the positions of the rotary encoding switches.

The right side shows the "Device Information" table with some basic data for the module; for example, the variant, the cyclic communication status and a diagnostic indicator. The indicator shows whether diagnostics for the module exist.

The "Port Information" table shows the configuration and state of the I/O ports.

11.1.2 The Ports page



Port Details

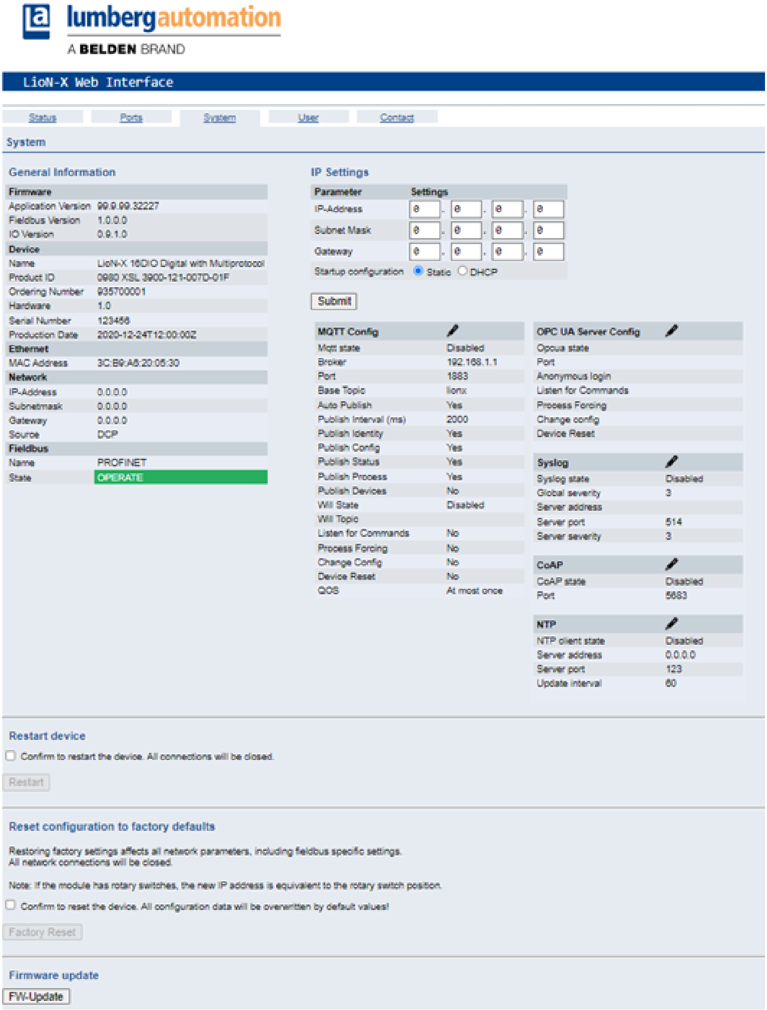
Show details for port

● X1 ○ X2 ○ X3 ○ X4 ○ X5 ○ X6 ○ X7 ○ X8

Port Information	
Forcemode	Forcemode off
Port	X1
Dia	
Pin 1 Current Limit	Off
Pin 1 Current	6mA
Port Diagnosis	
• No diagnosis	
Pin 4 / Channel A	
Type	DIO
Function	DIO
State	On
Output Restart	On
Input Logic	Normally Open
Input Filter	3.0ms
Current Limit	Off
Current	0mA
Pin 2 / Channel B	
Type	DIO
Function	DIO
State	Off
Output Restart	On
Input Logic	Normally Open
Input Filter	3.0ms
Current Limit	Off
Current	0mA

The page shows detailed port information. In the field **Port Diagnosis**, incoming and outgoing diagnostics are displayed as clear text. **Pin 2** and **Pin 4** contain information about the configuration and state of the port.

11.1.3 The System page



System

General Information

Firmware	
Application Version	99.9.99.32227
Fieldbus Version	1.0.0.0
IO Version	0.9.1.0
Device	
Name	LioN-X 16DIO Digital with Multiprotocol
Product ID	0980 XSL 3900-121-007D-01F
Ordering Number	935700001
Hardware	1.0
Serial Number	123456
Production Date	2020-12-24T12:00:00Z
Ethernet	
MAC Address	3C:B9:A6:20:05:30
Network	
IP-Address	0.0.0.0
Subnetmask	0.0.0.0
Gateway	0.0.0.0
Source	DCP
Fieldbus	
Name	PROFINET
State	OPERATE

IP Settings

Parameter	Settings
IP-Address	0 . 0 . 0 . 0
Subnet Mask	0 . 0 . 0 . 0
Gateway	0 . 0 . 0 . 0
Startup configuration	● Static ○ DHCP

Submit

MQTT Config	
Mqtt state	Disabled
Broker	192.168.1.1
Port	1883
Base Topic	lionx
Auto Publish	Yes
Publish Interval (ms)	2000
Publish Identity	Yes
Publish Config	Yes
Publish Status	Yes
Publish Process	Yes
Publish Devices	No
Will State	Disabled
Will Topic	
Listen for Commands	No
Process Forcing	No
Change Config	No
Device Reset	No
QOS	At most once

OPC UA Server Config	
Opcua state	
Port	
Anonymous login	
Listen for Commands	
Process Forcing	
Change config	
Device Reset	

Syslog	
Syslog state	Disabled
Global severity	3
Server address	
Server port	514
Server severity	3

CoAP	
CoAP state	Disabled
Port	5683

NTP	
NTP client state	Disabled
Server address	0.0.0.0
Server port	123
Update interval	60

Restart device

□ Confirm to restart the device. All connections will be closed.

Restart

Reset configuration to factory defaults

Restoring factory settings affects all network parameters, including fieldbus specific settings.
All network connections will be closed.

Note: If the module has rotary switches, the new IP address is equivalent to the rotary switch position.

□ Confirm to reset the device. All configuration data will be overwritten by default values!

Factory Reset

Firmware update

FW-Update

The System page shows the basic information for the module like Firmware version, Device information, Ethernet, Network and Fieldbus information.

Restart Device

The module initializes a software reset.

Reset to Factory Settings

The module restores to the default factory settings.

IP Settings

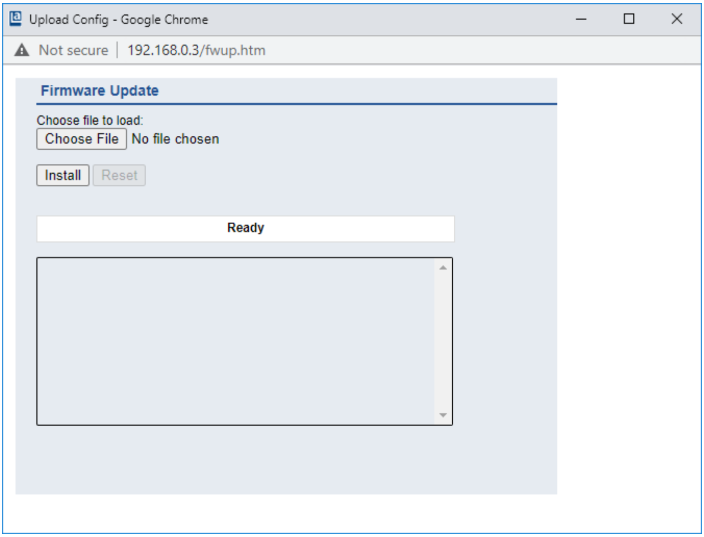
Use this parameter to change the current IP address of the module.

For PROFINET, this is only useful during commissioning. Normally, the PLC sets the IP address at start-up by detecting the PROFINET module via its device name.

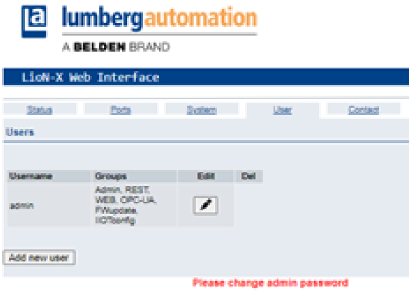
Firmware Update

The module initializes a Firmware update.

For a firmware update choose the **.ZIP* container available on our website or ask our support team. Afterwards follow the instructions shown on your screen.



11.1.4 The User page



Username	Groups	Edit	Del
admin	Admin, REST, WEB, OPC-UA, FWupdate, IIOTconfig	✎	

Please change admin password

The User page provides the user management of the Web interface. New users with access rights "Admin" or "Write" can be added here. For security reasons please change the default admin password immediately after configuring the device.

Default user login data:

- User: admin
- Password: private

12 Technical data

The following sections give an overview of the most important functional data needed to operate the device. For further information and detailed technical data, see the respective **Data Sheet** of your required product in the product specific download area on catalog.belden.com.

12.1 General

Protection class (Only applies if the connectors are screwed together or if protective caps are used.)[2]	IP65 IP67 IP69K	
Ambient temperature (during operation and storage)	0980 XSL 3x00-121... 0980 XSL 3x01-121... 0980 XSL 3x03-121...	-40 °C .. +70 °C (-40 °F .. +158 °F)
Weight	LioN-X 60 mm	approx. 500 gr. (17.6 oz)
Ambient moisture	Max. 98% RH (For UL applications: Max. 80% RH)	
Housing material	Die-cast zinc	
Surface finish	Frosted nickel	
Flammability class	UL 94 (IEC 61010)	
Vibration resistance (oscillation) DIN EN 60068-2-6 (2008-11)	15 g/5–500 Hz	
Shock resistance DIN EN 60068-2-27 (2010-02)	50 g/11 ms +/- X, Y, Z	
Fastening torques	M4 fixing screws	1 Nm
	M4 ground connection	1 Nm
	M12 connector	0.5 Nm
Permitted cables	Ethernet cables according to IEEE 802.3, min. CAT 5 (shielded) Max. length of 100 m, not routed out of facility (= local network)	

Table 37: General information

[2] Not under UL investigation.

12.2 Modbus TCP protocol

Protocol	Modbus TCP
Update cycle	1 ms
Transmission rate	100 Mbit/s, full duplex
Transmission procedure Autonegotiation	100BASE-TX supported
Product type	Modbus TCP server
Product code	41000 (0980 XSL 3900-121-007D-01F, 935705-001) 41001 (0980 XSL 3901-121-007D-01F, 935706-002) 41002 (0980 XSL 3903-121-007D-01F, 935707-001) 41xxx (0980 XSL 3923-121-007D-01F, 935708-001)
Supported Ethernet protocols	Ping ARP HTTP TCP/IP DHCP/BOOTP
Switch functionality	Integrated
Modbus TCP interface Connections Autocrossing	2 M12 sockets, 4-pin, D-coded (see pin assignments) 2 M12 Hybrid male/female, 8-pin supported
Electrically isolated Ethernet ports -> FE	2000 V DC

Table 38: Modbus TCP protocol

12.3 Power supply of the module electronics/ sensors

Port X03, X04	M12-L-coded Power, connector/socket, 5-pole Pin 1 / Pin 3		
Nominal voltage U_S	24 V DC (SELV/PELV)		
Current U_S	Max. 16 A		
Voltage range	21 .. 30 V DC		
Power consumption of module electronics	Typically 160 mA (+/-20 % at U_S nominal voltage)		
Power supply interruption	Max. 10 ms		
Voltage ripple U_S	Max. 5 %		
Current consumption sensor system (Pin 1)	0980 XSL 3x00-121... 0980 XSL 3x01-121...	Port X1 .. X8 (Pin 1)	max. 4 A per port (at $T_{ambient}$ = 30° C)
	0980 XSL 3x03-121...	Port X1 .. X4 (Pin 1)	max. 4 A per port (at $T_{ambient}$ = 30° C)
Voltage level of the sensor power supply	Min. (U_S – 1.5 V)		
Short circuit/overload protection of sensor supply	Yes, per port		
Reverse polarity protection	Yes		
Operational indicator (U_S)	LED green:	18 V (+/- 1 V) < U_S	
	LED red:	U_S < 18 V (+/- 1 V)	

Table 39: Information on the power supply of the module electronics/ sensors

Attention: Do not exceed the following maximum currents for the sensor supply:

▶ Max. 4.0 A per port

- Max. 5.0 A for each port pair X1/X2, X3/X4, X5/X6, X7/X8
- Max. 9.0 A in total for the whole port group X1 .. X8

Pay attention to the derating!

12.4 Power supply of the actuators

Port X03, X04	M12_L-coded Power, connector/socket, 5-pole Pin 2 / Pin 4
Nominal voltage U_L	24 V DC (SELV/PELV)
Voltage range	18 .. 30 V DC
Current U_L	Max. 16 A
Voltage ripple U_L	Max. 5 %
Reverse polarity protection	Yes
Operational indicator (U_L)	LED green: 18 V (+/- 1 V) < U_L LED red: U_L < 18 V (+/- 1 V) or U_L > 30 V (+/- 1 V) * if "Report U_L supply voltage fault" is enabled.

Table 40: Information on the power supply of the actuators

12.5 I/O ports

0980 XSL 3900-121...	Ports X1 .. X8	DI, DO	M12 socket, 5-pin
0980 XSL 3901-121...	Ports X1 .. X8	DI	
0980 XSL 39x3-121...	Ports X1 .. X4	DI	
	Ports X5 .. X8	DO	

Table 41: I/O ports: Overview of functions

12.5.1 Digital inputs

Input connection	0980 XSL 3900-121...		Type 3 as per IEC 61131-2
	0980 XSL 3901-121...		
	0980 XSL 39x3-121...		
Nominal input voltage	24 V DC		
Input current	Typically 3 mA		
Channel type	Normally open, p-switching		
Number of digital inputs	0980 XSL 3900-121...	X1 .. X8	16
	0980 XSL 3901-121...		
	0980 XSL 39x3-121...	X1 .. X4	8
Status indicator	yellow LED for Channel A (Pin 4) white LED for Channel B (Pin 2)		
Diagnostic indicator	red LED per port		

Table 42: I/O ports configured as digital input

12.5.2 Digital outputs

Attention: Do not exceed the following maximum currents for the sensor supply:

- Max. 2.0 A per port
- Max. 5.0 A for each port pair X1/X2, X3/X4, X5/X6, X7/X8
- Max. 9.0 A in total for the whole port group X1 .. X8 (X5 .. X8 at 8DI8DO devices)

Pay attention to the derating!

Output type	normally open, p-switching	
Nominal output voltage per channel		
Signal status “1”	min. (U_L -1 V)	
Signal status “0”	max. 2 V	
Max. output current per device	0980 XSL 3900-121...	9 A
	0980 XSL 39x3-121...	9 A
Max. output current per channel	0980 XSL 3900-121... (X1 .. X8)	2 A
	0980 XSL 39x3-121... (X5 .. X8)	2 A
Short-circuit/overload protected	yes/yes	
Behavior in case of short circuit or overload	deactivation with automatic power-on (parameterized)	
Number of digital outputs	0980 XSL 3900-121... (X1 .. X8)	16
	0980 XSL 39x3-121... (X5 .. X8)	8
Status indicator	yellow LED per output Channel A (Pin 4) white LED per output Channel B (Pin 2)	
Diagnostic indicator	red LED per channel	

Table 43: I/O ports configured as digital output

Warning: If devices with electric isolation and devices without electric isolation are used within the same system, the electric isolation of all connected devices is annulled.

12.6 LEDs

LED	Color	Description
U_L	Green	Auxiliary sensor/actuator voltage OK 18 V (+/- 1 V) < U_L < 30 V (+/- 1 V)
	Red*	Auxiliary sensor/actuator voltage LOW U_L < 18 V (+/- 1 V) or U_L > 30 V (+/- 1 V) * if "Report U_L supply voltage fault" is enabled.
	OFF	None of the above conditions.
U_S	Green	System/sensor voltage OK 18 V (+/- 1 V) < U_S < 30 V (+/- 1 V)
	Red	System/sensor voltage LOW U_S < 18 V (+/- 1 V) or U_S > 30 V (+/- 1 V)
	Red flashing	Device performs a factory reset (position of rotary encoding switches: 9-7-9)
	OFF	None of the above conditions.
X1 .. X8 A	Yellow	Status of digital input or digital output on pin 4 line "on".
	Red	Short circuit on pin 4 line. / Overload or short circuit on L+ (pin 1) line / communication error
	OFF	None of the above conditions.
X1 .. X8 B	White	Status of digital input or digital output on pin 2 line "on".
	Red	Short circuit on pin 2 line. / Overload or short circuit on L+ (pin 1) line / communication error
	OFF	None of the above conditions.
P1 Lnk/Act P2 Lnk/Act	Green	Ethernet connection to another subscriber exists. Link detected.
	Yellow flashing	Data exchange with another subscriber.
	OFF	No connection to another subscriber. No link, no data exchange.

LED	Color	Description
BF	Red	Bus fault. No configuration, no or slow physical connection.
	Red flashing at 2 Hz	Link exists but no communication link to the Modbus TCP controller.
	OFF	Modbus TCP controller has established an active connection to the device.
DIA	Red	Modbus TCP module diagnostic alarm active.
	Red flashing at 1 Hz	Watchdog time-out; fail safe mode is active.
	Red double flash	Firmware update
	OFF	None of the above conditions.

Table 44: Information on the LED colors

12.7 Data transfer times

The following tables give an overview of the internal data transfer times of LioN-X.

There are three measured data direction values for each use case:

- **PLC to DO:** Transfer of a changed PLC output data to the digital output channel.
- **DI to PLC:** Transfer of a changed digital input signal on digital input channel to PLC.
- **Round-trip time (RTT):** Transfer of a changed PLC output data to digital output. The digital output is connected to a digital input. Transfer of the changed digital input signal on the channel to PLC. RTT = [PLC to DO] + [DI to PLC].

The measured values are taken from the ethernet data transmission line. The values are therefore without PLC processing times and PLC cycle time.

For calculation of user specific data transfer and round-trip times of possible input filters, PLC processing and cycles times must be taken into calculation.

Use case 1:

LioN-X Digital-I/O configuration with enabled Web interface and *disabled* IIoT protocols

16DIO variant (0980 XSL 3900-121-007D-01F):

Data direction	Data transfer time in ms		
	Minimum	Average	Maximum
PLC to DO	2.2	3.6	5.0
DI to PLC	3.1	3.0	4.7
RTT	6.0	7.6	9.0

8DI/8DO variant without galvanic isolation (0980 XSL 3913-121-007D-01F):

Data direction	Data transfer time in ms		
	Minimum	Average	Maximum
PLC to DO	1.9	3.2	4.7
DI to PLC	2.1	2.6	3.1
RTT	4.0	5.8	7.0

8DI/8DO variant with galvanic isolation (0980 XSL 3903-121-007D-01F):

Data direction	Data transfer time in ms		
	Minimum	Average	Maximum
PLC to DO	2.2	3.6	5.3
DI to PLC	3.3	4.0	4.6
RTT	6.0	7.6	9.0

Use case 2:

LioN-X Digital-I/O configuration with enabled Web interface and *enabled* IIoT protocols

16DIO variant (0980 XSL 3900-121-007D-01F):

Data direction	Data transfer time in ms		
	Minimum	Average	Maximum
PLC to DO	3.4	5.1	7.6
DI to PLC	5.8	6.4	7.6
RTT	10.0	11.5	14.0

8DI/8DO variant without galvanic isolation (0980 XSL 3913-121-007D-01F):

Data direction	Data transfer time in ms		
	Minimum	Average	Maximum
PLC to DO	3.2	4.8	7.1
DI to PLC	3.3	3.8	4.3
RTT	7.0	8.6	11.0

8DI/8DO variant with galvanic isolation (0980 XSL 3903-121-007D-01F):

Data direction	Data transfer time in ms		
	Minimum	Average	Maximum
PLC to DO	3.5	5.2	7.6
DI to PLC	5.7	6.4	7.1
RTT	10.0	11.6	14.0

13 Accessories

In order to get access to various types of accessories, please visit our Web page:

http://www.beldensolutions.com